A retrospective analysis of talent selection and progression within England's Rugby Football Union Elite Player Performance Pathway

Thesis submitted in accordance with the requirements of the University of Chester for the degree of Doctor of Philosophy

By Elisavet Velentza

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I certify that all work is in this thesis which is not my own work has been identified and that no material has previously been submitted and approved for the award of a degree by this or any other University.

………………………………………. (Signature)

Abstract

The England Rugby Football Union (RFU) Elite Player Performance Pathway (EPPP) is a player development system, structured into five playing squads (Under 18 [U18], Under 20 [U20], National academy [NA, age: 18-23 years], Saxons [Saxon, age: 18+ years] and Senior National Squad [SNS, age: 18+ years]), which attempts to develop players to play within the SNS. Despite its importance however, there is yet to be any scientific appraisal of its efficacy in successfully producing SNS players. Appraising the performances of 396 players enrolled on to the EPPP between 2008 and 2014, the purpose of this programme of research was therefore to investigate the nature of player transition and determine the key features associated with match performance between respective squads of the EPPP. To achieve this, the progression rates to subsequent squads, and the anthropometrical and position-specific technical performance data was quantified in conjunction with individual player progression within the EPPP system.

Of the 396 players assessed within the thesis, 121 reached the SNS. Involvement in the EPPP was defined by high rates of de-selection during progression to subsequent squads and this was most apparent within the U18, U20 and NA squads. Analyses revealed the proportion of selected players for higher squads was 48.70%, 37%, 57.10% and 61% for U18-U20, U20-NA, NA-Saxon and Saxon-SNS squads, respectively. Within the SNS (n = 121), only 5.80% experienced a linear development (U18-U20-NA-Saxons-SNS) whereas all other players displayed variability with respect to squad pathway trajectories (NA-SNS 0.82%, Saxon-SNS: 50.4%, U20-Saxon-SNS 4.95%, NA-Saxon-SNS 12.39%, U18-U20-NA SNS:2.57%, U18-U20-Saxon-SNS 3.30%, U20-NA-Saxon-SNS 2.47%, side entries [selection from outside the EPPP system] 17.35%) within the EPPP. Thus, progression within the talent development (TDE)

system was typified by variable patterns of sequential selection and de-selection processes throughout U18 to senior squads.

The prerequisite level of technical performance indicators (TPI), related to generic and position-specific performance characteristics, and anthropometrical features (body mass and stature) specific to six predefined positional groups (front row [FR], second row [SR], Back row [BR], scrumhalf [SH], inside backs [IB], outside backs [OB]), were examined. The SNS revealed similar TPIs to the Saxon squad in all positional groups, only SNS FR were heavier ($p \leq 0.01$; $r = 0.18$) and taller ($p \leq 0.001$; $r = 0.25$) than Saxons FR. Likewise, the results demonstrate that anthropometrical characteristics consistently differentiated respective squads though, on occasion, there were aspects of TPIs that discriminated youth (U18) adult (U20, NA) and senior (Saxons, SNS) age international squads for the six positional groups within the EPPP. Used in isolation therefore, TPIs might offer benchmarks across the respective squads, however the extent of the observed differences between younger (U18 and U20) and older (NA, Saxons & SNS) squads suggests they could be used in conjunction with coach intuition to improve the objectivity of player selection to future squads.

Where the performances of progressed and non-progressed players were considered results revealed that taller and heavier players, competing within a higher number of matches, for an increased period of time, were the most important variables influencing progression or deselection from the programme. Where the match TPIs were considered, there were stochastic differences between groups though it appeared as though selected players typically outperformed the non-selected group albeit by small margins and there were fewer differences between progressed and non-progressed in older age squads. Finally, in players selected to progress and those deselected, there was notable within-group variation in the technical demands. Such variation was typified by overlapping IQRs when groups were compared meaning selected players could perform more, or less, effectively than deselected players in any given match. Clearly, such an issue suggests that the technical performance during competition cannot be used to determine talent in such instances.

Collectively, the results provide insight to the key requirements of the EPPP, which could be used to develop future coaching, scouting methods, player TDE systems by providing normative levels of attainment for aspiring players, both enrolled or not, within the elite player developmental system.

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Abbreviations

AFL	Australian Football League
AIS	Australian Institute of Sport
BR	Back row
cgs	Centimetres, grams, seconds
cm	Centimetre
EAPs	England Academy Players
EPDGs	Elite Player Developmental Groups
EPPP	Elite Player Performance Pathway
FDR	False discovery rate
FGE	Full Game Equivalent
FH	Flyhalf
FR	Front row
H	Halfbacks or Halves
HRmax	Heart Rate maximum
IB	Inside backs
IQR	Interquartile range
IRB	International Rugby Board
kg	Kilogram
LF	Loose forwards
LTAD	Long Term Athlete Development
M	Mean
m	Meters
$m \cdot min^{-1}$	Metres per minute
MB	Midfield backs
n	Number
NA	National Academy
NRL	National Rugby league
OB	Outside Back
RAE	Relative age effect
RFU	Rugby Football Union
RWC	Rugby World Cup
SARU	South African Rugby Union

SD	Standard Deviation
SH	Scrumhalf
SNS	Senior national squad
SoR	School of Rugby Programme
SR	Second row
TD	Talent Detection
TDE	Talent Development
TF	Tight forwards
TID	Talent Identification
TPI	Technical Performance Indicators
TS	Talent Selection
U	Under
UK	United Kingdom
$VO^{2}max$	Maximal oxygen uptake

Chapter 1

Introduction

1.1 Current evidence and limitations of talent development and selection in rugby union

In recent years talent research has focused on talent detection (TD) and talent identification (TID), whereas contemporary talent research has acknowledged TDE, talent selection (Williams & Reilly, 2000; Vaeyens, Güllich, Warr, & Philippaerts, 2009) and talent transfer (Bullock et al., 2009) processes as paths to performance excellence. TD is the first stage where individuals who are not currently involved in sport are detected as potential athletes (Williams & Reilly, 2000; Vaeyens et al., 2009). The next stage within a sport governing supportive system is the TID where athletes within a sport are identified as talented and assumed to have the potential to achieve senior elite levels of performance (Vaeyens et al., 2009), and therefore enter a TDE system. The purpose of these organized and structured environments is to develop those athletes within optimized training conditions, in order to achieve senior elite levels of performance (Abbott & Collins, 2004). Guellich (2014a) indicated that the primary objective of talent selection procedures is a continuous selection process across the developmental ages, by selecting new athletes that have developed outside of the academies or the national U-teams, by deselection some other and/or reselecting them at later ages of development.

Talent selection and TDE are the main areas which have attracted scientific attention within Australian (Gulbin, Weissensteiner, Oldenziel, & Gagné, 2013a) and European sport support systems in youth elite sport (Guellich & Emrich, 2006a; Vaeyens et al., 2009; Schorer et al., 2012; Gulbin, Croser, Morley, & Weissensteiner, 2013b). Many studies have repeatedly stressed the failure of TDE processes to deliver long-term performance advancement, and thus continuity within sport governing supportive processes, which could potentially enable later success in senior elite sport. Research has reported that many senior elite athletes have not been identified during youth or adult ages (Helsen, Van Winckel, & Williams, 2005; Simonton, 2005; Cobley, Baker, Wattie & McKenna, 2009a) and are developed outside of any TDE system (Guellich, Papathanassiou, Pitsch & Emrich, 2001; Guellich & Emrich, 2006a; Gulbin, et al., 2013a; Guellich, 2014a, 2014b). Moreover, research has revealed the younger a player is recruited, the younger they typically exit the system, lowering the probability of attending senior elite level of performances (Guellich & Emrich, 2012; Barreiros, Cote, & Fonseca, 2014; Guellich 2014a; Guellich & Emrich, 2014). This was apparent for athletes from various sports within the German support system (Gullich & Emrich, 2006a; Guellich & Emrich, 2012, Guellich 2014a; Guellich & Emrich, 2014), the National Federation of Portuguese athletes (swimming, volleyball, judo and football) (Barreiros et al., 2014) and South Africa's rugby union developmental system (Durandt, Parker, Masimia & Lambert, 2011). To demonstrate the limited success of talent programmes, analysis within the Portuguese National Federation revealed that only one third of those athletes selected to compete at pre-junior national teams (≤ 16 years old) in footabll (male 34.1%), volleyball (male 58%; female 22.2%), swimming (male 30%; female 32.8%) and judo (male 9%; female 20%), were reselected to compete at senior national level (≥ 19 years old) (Barreiros et al., 2014).

Only 44% of the athletes that participated in the 2004 Olympic games in Athens had competed as juniors in international competitions, whilst the majority (56%) made their first international appearance in the senior age category (22.0 ± 3.1 years) (Guellich, 2007). Similarly, 22% of Australian and 32% of New Zealand World Junior Class medallists and finalists in track and field achieve finals and elite levels of performance as seniors (Hollings & Hume, 2011). Research signifies that exceptional success and performance advancement by youth athletes (Guellich & Emrich, 2006a; 2006b, Guellich & Emrich, 2012; Barreiros et al., 2014; Guellich & Emrich, 2014) is not a prerequisite for later success in team sports. However, it is premature to assume that findings supporting later selection (Guellich et al., 2014a; Guellich & Emrich, 2014) can be generalized and linked with direct senior success and thus simplified as a typical ‘pyramidal’ concept (Guellich, 2007; Gulbin et al., 2013a; Guellich & Emrich, 2014). Such an assumption also ignores individual variability (Gulbin et al., 2013a) with regards to senior elite development, since athletes could enter either at the base (i.e. recreational or local club school) or after adulthood within a TDE system and subsequently achieve senior elite levels of performance (Gulbin et al., 2013a).

Given the need to facilitate and clarify progression from youth and adult to senior elite levels of performance in sport (Lambert & Durandt, 2010; Till, Chapman, Cobley, O’Hara, & Cooke, 2012; Gulbin et al., 2013a; Barreiros et al., 2014), sport governing supportive systems attempt to substantiate the framework for future senior elite performance. That is, by altering their method of identifying and developing athletes, by integrating in talent selection programmes talent transfer initiatives (Bullock et al., 2009) and by identifying individuals who demonstrate requisite levels of performance at various stages of development (Wolstencroft, 2002). This circumvents the limitations of short-term performance assessments during junior years, derived from one-off selection processes within annual-age categories (Baker, Cote & Abernethy, 2003; Oldenziel, Gagne, & Gulbin, 2004; Tucker & Collins, 2012). The main theoretical premise behind this is to promote individual development and progression pathways while minimizing deselection (Till, Cobley, O'Hara, Chapman, & Cooke, 2013b).

The English RFU has created the Player Developmental Pathway to provide more opportunities for players to achieve on-going success either in elite or in community rugby union in England. If eligible, players could participate in an age structured long-term developmental system, called the "Elite Player Performance Pathway" (EPPP), which is divided into the international (Performance Pathway) and regional (Aspirational Pathway) levels. However, in an analysis of 27 different sports within the Australian Elite Sports Network, excepting 16.4% of cases, all other athletes evidenced a sinuous trajectory to senior membership (Gulbin et al., 2013a) suggesting that attainment of SNS membership might not be a linear process but rather an individualistic ascended route. Such information could resolve the discrepancy of the efficacy of RFU's EPPP regarding long-term development and continuity within the system, and might help the RFU change or adapt any training and selection processes within the EPPP. However, available evidence suggests that success before adulthood is not a prerequisite for senior success (Bullock et al., 2009; Gulbin et al., 2013a; Barreiros et al., 2014), subsequently this study aims to investigate if success after adulthood (e.g. U18, U20) is a prerequisite for senior elite membership within the EPPP.

Existing literature across senior rugby union players is lacking where TPIs are considered, with past research typically appraising the technical characteristics that distinguish the positional groups within teams (Vivian, Mullen, & Hughes, 2001; James, Mellalieu, & Jones, 2005; Quarrie, Hopkins, Anthonya, & Gilla, 2013). For example, James and colleagues (2005) assessed a professional rugby union team for a season and indicated that the two outside half players differed from each other by displaying an increased frequency in successful carries and tackles alongside a decreased frequency in successful passes and kicks, and vice versa. Additionally, Quarrie et al. (2013) indicated the general movement characteristics that the national New Zealand rugby union players performed during international matches. The researchers indicated for example that wings scored more kicks, fullbacks handled and kicked the ball more frequently, while OB participated less frequently in any tackle movements. Furthermore, Vivian et al. (2001) investigated specific positions (e.g. flanker, number8 and flyhalf (FH)) from the Welsh team during the Six Nations and the 1999 Rugby World Cup (RWC) revealing that for example, the flanker performed 38.85 actions during European games and 36.57 during international fixtures, while the SH performed 50 and 40 total actions during an international and during European games, respectively.

To date, research comparing the youth and adult level of the game has focussed merely on the physical (Read et al., 2016) and anthropometrical profiles of English Academy age representative squads across U16, U18 and U20 (Darrall-Jones, Jones, & Till, 2015b) and the movement demands of international U20 (Cunningham et al., 2016) rugby union players. For example, peak power, counter movement jump height, absolute and relative strength (Darrall-Jones et al., 2015b), increased across U16, U18 and U21 groups. Increases have also been noted in the height and body mass (Darrall-Jones, Jones, & Till, 2015a) of U16, U18 and U21, respectively, within England's Academy regional rugby union players. Where motion analysis is considered, Read et al. (2016) indicated that relative distance and high speed running decrease from U16 to U18 to U20 for forwards and backs. The aforementioned findings presented a detailed position-specific overview of many of the key demands of competition suggesting each position contributes to team performance in a novel way. Indeed, Hughes et al. (2012)

suggested that each playing position has specific responsibilities that contribute to the collective performance. As such, coaches and players could utilise the quantification of those performance profiles and structure their preparation and training loads for match demands. Moreover, further research could utilize such an approach to expand current knowledge, by comparing positional performance profiles across different ages and ability levels of rugby union players. However, studies appraising position-specific differences have failed to determine the specific strengths and weaknesses for an individual within a team (Hughes et al., 2012). Further research as such should utilise these TPIs to assess individual performance.

Research in rugby union comparing youth, adult and senior squads has appraised the anthropometrical characteristics (Argus, Gill, & Keogh, 2012), physical abilities and movement patterns during competition (Barr, Sheppard, Gabbett, & Newton, 2014). For example, Barr et al. (2014) assessed the physical and movement profiles of national U20 and senior national rugby union players and revealed differences between initial and maximum sprint velocity and momentum between senior and U20. Argus et al. (2012) assessed the strength, power and anthropometrical difference between 112 rugby union players, 43 professionals (24.4 ± 2.7 years), 19 semi-professionals (20.9 ± 2.9 years), 32 academic level (19.6 ± 1.8 years) and 18 high school level athletes (16.6 ± 0.8 years) from an international and provincial competition in Australia and New Zealand. Greater maximal strength and power for bench press, bench throw, box squat and jump squat were reported for the professionals compared with semi-professional, academy and high school level athletes. Similarly, professionals (103.4 ± 11.2 kg) were heavier compared to high school (86.5 ± 13.7_kg), academy players (95.6 ± 11.0 kg) and semi-professional

(100.7 ± 11.5 kg).

Though useful in determining the physical qualities underpinning elite performance, tests appraising isolated traits of performers in the laboratory or field appear unlikely to determine match performance in rugby union given it is typified by a complex interaction of physical, psychological, technical and tactical components (Drust, Atkinson, & Reilly, 2007). A method often utilized to overcome such limitations is to apply a performance analysis. Within rugby union however, use of performance analysis for assessing performance profiles in youth, adult and senior elite rugby union (Hughes & Bartlett, 2002) has documented little information regarding the TPI across youth, adult and senior elite players. Moreover, no research has compared the positional TPI at the international level of the game across age groups. Accordingly, based on the differences that past research has documented between players of higher and lower ability (Argus et al., 2012; Barr et al., 2014), differences between senior (Saxon, SNS) and youth (U18) or adult (U20, NA) squad players within the EPPP seem probable. Using similar approaches may provide information regarding the TPI that is required at the highest level of the game after adulthood.

Given the importance of specific qualities at the senior elite level of rugby union, a number of studies have considered the anthropometrical attributes and technical performance characteristics to characterize the superior ability of a player by comparing successful and unsuccessful teams, allowing coaches some insight into the positional requirements of a successful rugby union performance. Specifically, it has been demonstrated that successful teams are defined by frequent lineout success (Jones, Mellalieu & James, 2004; Hughes & White, 2001; Ortega, Villarejo, & Palao, 2009; Vaz, Van Rooyen & Sampaio, 2010), number of kicks out of hand and turnovers won (Ortega et al., 2009; Vaz, Mouchet, Carreras & Morente, 2011) while they lose less tackles and achieve a higher number of line breaks (Vaz et al., 2011; Ortega et al., 2009). Where anthropometry is considered, Sedeaud et al. (2012) demonstrated that forwards of winning teams during the 1987-2007 in the RWC were heavier (~107 kg) and had a greater (39.6 %) collective experience than forwards of all other teams (31.7%),who played together at previous RWC tournaments, while taller backs evidenced no difference in collective experience.

However, within team sports, research on higher squad selection or progression across ages supports that athletes at young or even at adult ages may not have yet developed the physical, psychological and technical performance attributes that are prerequisite for selection (Vaeyens et al., 2009). In rugby league for example, Waldron, Twist, Worsfold, and Lamb (2011) stressed that the characteristics (e.g. high intensity running) that are important at younger age groups may not account for selection at the adult or senior level, suggesting that other factors (e.g. perceptual responses) are more crucial at the senior level. Unfortunately, performance at younger ages stands predominantly as the criterion in the selection of team members during youth and/or adult international competitions and is assumed to be indicative of an individual's performance at a later age, or is associated with the prediction of senior elite performance (Iyer & Sharda, 2009). For instance, Australia and New Zealand nominate talented youth rugby union players before and after competitions to a central database (e.g. coaches nominate the top five from their school before the competition, and after the competition they nominate players from the opposition) and, at the end of the seasons the players that rank higher on the database are typically the ones who are selected for the national squads (Rugby Football Union [RFU] & Mackenzie, 2007). Such an approach from coaches and supporting staff could fail to consider the physical maturity advantages of the relatively older athletes in the early years of competition (Sherar, Baxter-Jones, Faulkner, & Russell, 2007; Cobley et al., 2009a; Till, Cobley, Wattie, O'Hara, Cooke, & Chapman, 2010).

To summarize, although comparative research in other sport associations exists (e.g. German football; Guellich 2014a), no research has investigated the efficacy of the English RFU EPPP in relation to the long-term development and continuity of individual players across U-teams, NA, Saxon and SNS teams. Accordingly, to understand the nature of TDE and the drop-out that might be occurring within the EPPP, it is important to note that coaches, scouts and supporting staff have limited objective data on which to base their selection of youth, adult and senior international athletes. Despite past research (Roberts, Trewartha, Higgitt, El-Abd, & Stokes, 2008; Hughes et al., 2012; Quarrie et al., 2013; Barr et al., 2014) appraising the position-specific anthropometrical, physical and technical characteristics of rugby union there is a dearth of objective data discriminating the prerequisite traits of elite youth, adult and senior rugby union players. To the author's knowledge, no study has documented reference norms related to specific positional TPI or anthropometrical characteristics across elite youth, adult and senior international rugby union players. Finally, it is not yet clear which variables discriminate and define rugby union players that experience higher squad selection and progression within a TDE system. Such information could facilitate the development and retention of talented players within the EPPP, by building a more comprehensive and long-term approach, potentially improving the SNS.

1.2 Thesis structure

The thesis adapted a retrospective research design since data were collected and recorded as part of the RFU player monitoring system ('Elite Hub') from 2008 to 2014. Specifically, this study provided a quantitative evaluation of the English international 'High Performance Pathway', which aims to produce England international rugby union players. Due to the unavailability of data for U13 to U17 international players, the present thesis took into consideration the effectiveness of the High Performance Pathway on the long-term development from U18, U20, NA, Saxon and SNS. All players selected for the international U-teams (U18, U20), Academy (NA) and senior (Saxon, SNS) teams were analysed with regard to their progression to the following representative squad.

Key to the membership within the EPPP was an empirical description of the continuity of individual careers, that is, the various pathways followed across age international squads within the EPPP. The approach of Guellich and Emrich (2012) provided the theoretical concept of the 'individualistic' and 'collectivistic' explanation regarding individual transition histories, selection and deselection rates across squads, as well as long-term development and continuity within the EPPP, which in turn exemplified the efficacy of RFU's EPPP. Furthermore the present thesis identified and assessed for six positional group (FR, SR, BR, SH, IB, OB), the characteristics that defined and distinguished the international players across the national youth (U18), adult (U20, NA) and senior squads (Saxon and SNS) in relation to the technical performance and anthropometrical characteristics. A further aim was to evaluate the technical and anthropometrical characteristics that are associated with higher squad selection across youth (U18), adult (U20, NA) and senior (Saxon, SNS) squads within the EPPP, which could provide normative data to inform talent selection programmes. Players were subcategorized into progressed vs non-progressed players and classified into one of six positional groups (FR, SR, BR, SH, IB, OB) for each age international squad (U18, U20, NA, Saxons, SNS).

1.3 Aims of the thesis

The specific aims of the thesis were to:

1. Establish the pathway variability and continuity (e.g. selection-deselection rates, individual player developmental pathways) within the EPPP, together with the SNS players' past membership and progression throughout youth (U18), adult (U20, NA) and senior squad (Saxons) within RFU's EPPP.
2. Establish the prerequisite level of performance specific to the positional TPI and anthropometrical characteristics across youth (U18), adult (U20, NA) and senior (Saxons, SNS) members of England's international RFU's EPPP.
3. Establish the differences in the position-specific TPI and anthropometrical characteristics of progressed vs non-progressed players across youth (U18 to U20), adult (U20 to NA, NA to Saxons) and senior (Saxons to SNS) squads within the EPPP.

Chapter 2

Review of Literature

2.1 Background

Rugby union is a high intensity-intermittent invasion sport, typically played on a grass pitch measuring approximately 100 m x 70 m with its laws and regulations enforced by the International Rugby Board (IRB) (Duthie, Pyne, & Hooper, 2005; Deutsch, Kearney, & Rehrer, 2007; Cunniffe, Proctor, Baker, & Davies, 2009). A competitive match is 80 minutes in duration and consists of two 40 minute halves (plus stoppage time). Each team is made up of 23 players, with the starting line-up comprising 15 players (Figure 2.1).

Figure 2.1. Overview of the starting positions of the 15 players in rugby union.

Playing positions are often sub-categorized into the 'forwards' (numbers 1 - 8) and 'backs' (numbers 9 - 15) and are further subdivided into the FR (1 - 3), SR (4 -5), BR (6 - 8), half backs or half's (H) (9 - 10), IB (10, 12 - 13), and OB (11, 14 -15) (Cahill, Lamb, Worsfold, Headey, & Murray, 2013). Forwards (loosehead props, tighthead props, locks, hooker, blindside flanker, openside flanker, number8) are often identified as the "ball winners" and are required to compete for possession in scrums, lineouts, rucks, and tackles (Quarrie et al., 2013), while backs (SH, FH, inside centre, outside centre, left wing, right wing, fullbacks) are the "ball users", who when in possession attempt to gain territory and/or score points, and when not in possession, defend (e.g. by tackling) their territory or prevent the opponent from scoring (Quarrie et al., 2013). Forwards are required to control the ball more frequently during possession (Holway & Caravaglia, 2009) and contact situations (Jones, West, Crewther, Cook, & Kilduff, 2015) than the backs. Typically, forwards are involved in tackling and physical contests such as rucks and mauls to gain possession of the ball thus requiring high levels of strength and power (Prim & Van Rooyen, 2011). Backs frequently receive and carry the ball (Green, Blake, & Caulfield, 2011), by avoiding opposition, being competent when handling the ball, protecting the ball at breakdown situations and supporting the forwards in securing possession (Scott et al., 2003). Halves (H, SH, FH) tend to control ball possession that is gained from the forwards. Moreover, MB (inside and outside centre) engage in contact situations more frequently, while OB (wings, fullbacks) are required to have speed and agility skills to outmanoeuvre their opponents, execute supporting runs, pursue kicks and support in defence (Duthie, Pyne, & Hooper, 2003).

With such different positional demands, players are required to have specific physical attributes and technical abilities to manage these positional requirements. The development and identification of such skills within individuals at the elite level of rugby union has, to date, received limited scientific attention.

2.2 Defining the concept of talent and the acquisition of expertise

For many years, sport organizations such as the RFU, identified and selected talented athletes based on a non-unified definition of talent with the potential to become elite. Until recently, no published evidence about the construction of rugby unions' TID, TDE and talent selection programmes existed. Nowadays however, coaching handbooks have been developed, with general coaching and selection guidelines for coaches and selectors accordingly, but still the procedure is reliant upon the perception of coaches of 'what talent is' and on their exclusive knowledge of 'how to develop it' (R. Headey, personal communication, May 20, 2013).

Talent "is not properly thought of as a genetic or innate endowment, but rather as a developed set of traits that are integral to the further development of expert/elite performance" (Ackerman, 2013, p. 11). However in several sports during youth and mid-adulthood, a failure to demonstrate superiority will be translated as lack of talent and subsequently as a lack of potential to achieve senior elite levels of performance (Ackerman, 2013). Subsequently, expert performance is often described as "a complex, dynamical system in which future behaviours emerge from an interaction of technical performance determinants such as psychological behaviours, motor abilities, and physical characteristics" (Abbott, Button, Pepping & Collins, 2005, p. 61), which are developed abilities (Ackermann, 2013). Interestingly, Pankhurst and Collins (2013) indicated that only when an individual has most of the required abilities/capacities, he/she should be considered to be talented.

Currently the RFU's official definition of talent is that from Elferink-Gemser, Visscher, Lemmink, and Mulder, (2004, p. 1053) stating that "A talented young athlete is considered to be someone who performs better than his or her peers during training and competition, and who has the potential to reach elite level". In a recent speech at RFU's Talent Symposium in London (May 19, 2013) Tim Radford concluded that it is acknowledged by the RFU that talent is a developmental process which can emerge from outside a TDE system. A challenge often faced by the RFU arises when 'talent' takes a different meaning for the professional club compared to the England coach. In the English Premiership, talent designates an individual that has the potential to maintain a professional playing career, while for the English RFU talent reflects the potential to be a starting player for at least a season within the SNS.

Regardless of its definition however, it is important to investigate the extent to which genetic and/or environmental factors contribute to the origins of individual differences (Plomin, Shakeshaft, McMillan, & Trzaskowski, 2013). The development of a talented individual into an elite athlete remains debated between extreme genetic endowment and the influence of environmental factors. The extreme nurture position supports that all differences in performance are accounted for by opportunity and practice, indicating that "distinctive characteristics of exceptional performers are the result of adaptations to extended and intense practice activities that selectively activate dormant genes that are contained within all healthy individuals DNA" (Ericsson, Nandagopal, & Roring, 2009, p. 199), and not due to any genetic cause.

In contrast, the hereditary view revolves around the notion that all differences between individual performers can be attributed to differences in their genetic endowment (Ackermann, 2013). However, innate factors fail to explain the development of exceptional performance. Yang and colleagues (2010) stated that almost 300,000

Single-Nucleotide Polymorphisms (i.e. SNPs) from 3,925 unrelated individuals are able to account for 40% to 84% of the variance in height, muscle mass, muscle fibre type, strength, metabolism, and muscle anaerobic power (Simoneau & Bouchard, 1995; Stewart & Rittweger, 2006). Tucker and Collins (2012) however suggest that athletic performance is undoubtedly more complex and that a single gene, or even a few thousand genes, cannot explain athletic performance. Thereafter articles in the area of sports genetics announcing "the discovery of the speed gene" such as a-actinin-3 (i.e. ACTN3) gene R577X polymorphism, the "power gene" such as a-actinin-3 gene R, or the "endurance gene" such as angiotensin I-converting enzyme insertion/deletion (i.e. ACE II) polymorphism are not helpful as they give the impression that genes are isolated entities that code for large complex human activities.

Although several studies have reported associations between genes and physical performance (Yang et al., 2003; Eynon et al., 2011; Eynon et al., 2013), and elite status or playing positions (Heffernan et al., 2015), for example, Heffernan, Kilduff, Day, Pitsiladis, and Williams (2015) evidenced an association between the ACTN3 R577X gene variant and the elite status (i.e. players who compete at the highest competition league) of 272 rugby union players, as well as the playing position. Despite its limitations (i.e. data are preliminary, and the study assessed a small number of players) it is important to remember that the simple presence of an allele (e.g. variant forms of a gene detected as different phenotypes) associated with physical performance is not able to predict whether any athlete can achieve elite performance in their chosen discipline (Wilber & Pitsiladis, 2012). Whilst, heredity studies tend not to indicate whether performance (speed, strength, endurance) (phenotypic) distribution is determined by a gene which acts together with others (polygenes) to produce the desired performance, or whether a large part of the performance is explained by the action of a single major gene (Brutsaert & Parra, 2006). Nonetheless, favourable genotypes or unidentified polymorphisms (genetic variation between population) that have beneficial effects for performance may exist, and certain populations may have favourable performance genotypes (Tucker & Collins, 2012), which may predispose them to elite sports performance (Wilber & Pitsiladis, 2012), and might influence human physical performance (Ma et al., 2013). To illustrate the difficulty in explaining exceptional performance, Ackerman (2013) outlined that even when it is provided, identical environments or equal practice opportunities for all participants would not yield zero differences in the final performance and would fail to verify that expert performance is achievable for any and every individual (Tucker & Collins, 2012).

Further research from Wilber and Pitsiladis (2012) appears to validate the above arguments, while they presented substantial evidence regarding Kenyan and Ethiopian success in middle and long-distance running in athletics. The researchers demonstrated that their successful performance was not a single prominent genetic, physiological, or psychological factor, but the inter-relationships between them that creates an optimal environment for distance running success. This East African running phenomenon success is due to a combination of advantageous somatotypical characteristics leading to unique biomechanical and metabolic economy/efficiency, chronic exposure to altitude in combination with moderate-volume, high-intensity training (live high and train high) and a strong psychological motivation to succeed athletically for the purpose of economic and social advancement (Wilber & Pitsiladis, 2012). The conclusion is that these elite athletes rely on the presence of a combination of advantageous genotypes and that the East African running phenomenon is not exclusively a genetically mediated phenomenon. A further opposing view to innate factors determining performance was given by Rabelo (2001), who highlighted the details of the success of Brazilian footballers. The research found that 16-18 year old Brazilian footballers, who were participating in the elite junior Brazilian players' squad, had little family support and formal coaching. That was compensated by their enjoyment of football and the substantial number of hours they practiced during their childhood in anticipation that they might grasp the financial rewards of becoming professional players in the future. These studies denote the similarity of socioeconomically motivations of underprivileged individuals that help them to strive for success and economic benefits, as Wilber and Pitsiladis (2012) highlighted with the enormous success of Kenyan and Ethiopian runners.

However, exceptional performance can also emerge when athletes with what may be perceived as less favourable genetic dispositions are provided an appropriate skill acquisition environment (Baker & Horton, 2004). For example, elite athletes tend to demonstrate a higher improvement from the same number of practice hours compared to their peers, and are able to achieve continuous performance advancement (Cleary & Zimmerman, 2001; Zimmermann, 2006; Jonker, Elferink-Gemser, & Visscher, 2010). Additionally, elite athletes may begin with high levels of the characteristics (phenotypes) needed for success in their particular sport and have superior adaptations in those characteristics after training (Skinner, 2001; Baquet, Van-Praagh, & Berthoin, 2003; Barnett et al., 2004; Baxter-Jones & Mundt, 2007; Ostrander, Huson, & Ostrander, 2009; Scott et al., 2009; Ahmetov et al., 2010).

Even if the association of genes with physical performance is proven, elite athletes de-emphasize the importance of physical attributes in attaining expertise and support that mainly psychological attributes underpin final performance (e.g. MacNamara, Button, & Collins, 2010a, 2010b). Researchers have repeatedly emphasized the importance of psychological characteristics for the acquisition and demonstration of exceptional performance (MacNamara et al., 2010a, 2010b; MacNamara & Collins, 2011; Baker, Cobley & Schorer 2012). For instance, psychological qualities will influence the training process, the willingness, continuity and extent of practice, the quality of preparation and the coping strategies during adverse times (Baker et al., 2012). It must be acknowledged however that genes also influence the inter-individual differences in psychological attributes (MacNamara et al., 2010a, 2010b; MacNamara & Collins, 2011; Baker et al., 2012).

It is important to consider that human behaviour is a result of various traits, whose basis comes from genetic variance (nature), but the expression of all these characteristics depend on complex environmental (nurture) influences (Ridley, 2003). Currently, in a recent speech at RFU's Talent Symposium in London (May 19, 2013) Tim Radford signified that the RFU recognizes that the evaluation of a developing athlete should not be based on present performance but on the potential of the athlete, and that it is therefore important for coaches to differentiate between present performance and future performance (Elferink-Gemser et al., 2004). As with other sports development organizations, the challenge for the RFU is whether it is able to select and develop an athlete who can perform at elite level of performance both as an individual athlete and also as part of a dynamic team (Iyer & Sharda, 2009), able to contribute to the probability of winning at international level (Dosil, 2006).

Brutsaert and Parra (2006) put forward the view of understanding human variation in performance by supporting that an individual should be considered not only as a gene plus the environment (main effects), but also through the interaction of both the gene and environment (gene × environment, where the influence of one element is based on the level of the other element). Indeed, the gene x environment procedure that is operating over a lifespan could be the fundamental factor to understand the variability within humans' complex attributes. Thus, it appears as though elite performance is a polygenic trait (Rankinen et al., 2010) affected by many known and yet unknown DNA variants (Lupski, Belmont, Boerwinkle, & Gibbs, 2011), which continuously interact with the training (Tucker & Collins, 2012), physical (Cahill et al., 2013), cognitive (Gray & Plucker, 2010), psychological (Ackermann, 2013), personality qualities (Ackermann, 2013), attitude (Claro, 2008) and mental skills (MacNamara et al., 2010a, 2010b). While other environmental factors, such as intrapersonal and chance factors (Gagne, 2004; Gagne & Schader, 2005), interest in the domain of sport, parental support (Woodcock, Holland, Duda, & Cumming, 2011), effort, persistence, impact of teaching/coaching (Cote, Salmela, & Russell, 1995a; Cote, Salmela, Trudel, Baria, & Russell, 1995b), personal qualities (Gee, Marshall, & King, 2010), opportunities to play with older children (Cote, Baker, & Abernethy, 2003; Soberlak & Cote, 2003), enjoyment (Cote et al., 2003), the place that you were born (birthplace effect) (Cote, MacDonald, Baker & Abernethy, 2006) and family (Cote, 1999) seem to contribute significantly to the premise of elite performance. By acknowledging and subsequently understanding the multifactorial influence on exceptional performance in sport, coaches, scouts and supporting staff may also acknowledge the multifaceted and individualistic nature of expertise. Such understanding will enable application of appropriate interventions (e.g. training, psychological, nutritional modification) when deficiencies in certain areas appear.

Predicting performance is a complex and problematic process and the initial identification of exceptional performance as “talented” ought to consider the multifactorial, dynamic and interactionist nature between genes, environment and training (Baker et al., 2003; Elferink-Gemser et al., 2004; Vaeyens, Renshaw, & Davids, 2008; Tucker & Collins, 2012). Therefore, talent should be expressed by potential, long-term development and continuity of performance advancement rather than by the present characteristics of athletes. Research should avoid defining talented individuals as simply out-performing the nearest competitive counterpart (Ericsson, 2007) or by “coaches that use their practical sense and their visual experience to recognize patterns of movement among the players” (Christensen, 2009, p. 365) or by observing authentic playing situations (Vrljic & Mallett, 2008). Thereafter, it is implied that each athlete should be assessed in the most holistic manner possible in order to maximize the predictive validity of the selection decision, since a combination of many factors will determine senior elite performance.

In summary, talent or exceptional performances are derived from the interaction of genetic, training and environmental factors. Similarly, the importance of an individual’s genetic make-up has been accentuated with biased interpretation of genomic studies and it is undeniable that the environment is important, and that gene and environment interact, not just over the short term, but also over the lifetime of an individual with permanent effects on the adult phenotype (Brutsaert & Parra, 2006). Subsequently, the development of expertise in sport is the result of successful interaction of biological, psychological, and sociological constraints (Davids & Baker, 2007), which interact to promote high levels of human achievement, and only then expertise may be defined as exceptional performance (Simonton, 2001).

2.3 Talent selection in team sports

Within team sports talent selection is defined as the repeated assessment of athletes' potential and their present performance during the developmental procedure. It includes the process of selecting the most appropriate athlete or group of athletes specific to the prerequisite roles and responsibilities within a team (Trninic, Papić, Trninić, & Vukičević, 2008). Selection depends on the ability of the coach to understand "the key elements" of an athlete (Vaeyens et al., 2006, p. 928) and to determine the most suitable position and role within a team sport (Guellich, 2014a). Team players are selected based on required technical and tactical elements during game situations (Reilly, Williams, Nevill, & Franks, 2000), while there are some expert coaches that base their selection criteria on teams tactics, "gut feeling", or instinct (Nash & Collins, 2006) and not on the personal and/or specific abilities of each athlete. However, a recent study by Waldron, Worsfold, Twist and Lamb (2014c) noted that talented youth players (U16) are sometimes missed during these selection processes because scouts and coaches can misinterpret up to 56% of players' skills, specifically when simulated sport-specific scenarios are used as a selection criterion. Subsequently, relying solely on game situations could fail to select the athlete with the prerequisite characteristics (Durand-Bush & Salmela, 2002). While, it is important for coaches to cultivate an independent thought, to use research for expanding their knowledge on what defines a talented athlete, and to learn to answer the question, why an athlete is talented and what differentiates him/her from the others (Pankhurst, Collins, & MacNamara, 2013).

Another issue confounding the identification of a talented player concerns the relative age effect (RAE) which represents the interaction between a players' 'birth date' and the dates used for chronological age grouping in relation to performance. For example, a study by Mujika et al. (2014) assessed 13,519 players from four groups of footballers who varied according to their age (senior professionals, youth academy, U11-U14 and U10-U11) and demonstrated that elite youth academy, U11-14 and U10-U11 players were born early in the selection year though this effect was not evident in senior professional football players. This suggests that footballers at academy age and below were selected or identified as talented because they are relative older (chronologically). Advanced physically (Sherar et al., 2007) and cognitive development of the relative older players are the main factors that those players are selected, whereas younger players may be neglected due to a lesser biological maturity and physical development (Baker, Janning, Wong, Cobley, & Schorer, 2014). However, when coaches are able to see talent (Helsen, Hodges, Van Winckel, & Starkes, 2000), or rely more on their "intuitive feelings" (Davids & Myer, 1990, p. 275); they tend to disregard the effect of the RAE (Wattie et al., 2014). Similarly, a review from Gray and Plucker (2010) illustrated that most youth football coaches identify talent based on present physical maturity and fail to consider the advantages of the relatively older athletes in the early years of competition (Sherar et al., 2007; Cobley et al., 2009a; Till et al., 2010), and as such mistakenly assess it as talent (Musch & Grondin, 2001). It should be acknowledged though that some positional groups in team sports require specific anthropometrical characteristics and as such coaches are likely to select older players. For example, props need to possess a large bone and muscle mass, so as to avoid injuries due to the increased number of collision (Sirotic, Coutts, Knowles, & Catterick, 2009; Twist, Waldron, Highton, Burt, & Daniels, 2011).

In rugby league, Till et al. (2010) assessed the junior representative rugby league players (n = 683, aged 13-16) and identified that the selected junior props were older and early matures compared to the non-selected peers. Likewise, in Australia the selected senior rugby league players for the professional (37%) and representative (40%) squad were comparatively older than their peer age squads (Abernethy & Farrow, 2005). In other sports such as football (Malina, Eisenmann, Cumming, Ribeiro, & Aroso, 2004) and ice hockey (Sherar et al., 2007), it was revealed that the higher the level of competition, the higher the physical demands for each position and the older the selected players. However, early in development parental influences seem to also be an important RAE contributing factor during sport enrolment (Hancock, Ste-Marie, & Young, 2013). Hancock and colleagues (2013) demonstrated in ice-hockey that RAE was evident in all age categories (i.e between 5-6, 7-8, 9-10, 11-12, 13-14 and 15-17 years old), while during junior (5-8 years old) years, RAE effect was apparent not only during coach selection of ice-hockey players for the competitive ice–hockey teams, but also for non-competitive ice-hockey teams, where there was no coaching selection procedure. This implies that RAE has a dramatic impact on the decisions taken by players, parents, coaches and sport federations, since stereotypes are created based on the required selection criteria that athletes are supposed to possess; even in early years of competition (Sherar et al., 2007; Cobley et al., 2009a; Till et al., 2010) and hence parents tend not to enrol their children in specific sports that lack the prerequisite anthropometrical characteristics (Hendricks, Karpul, & Lambert, 2014). Mistakenly though, junior or youth athlete assessment is guided implicitly by senior level requirements (Gould, Dieffenbach, & Moffett, 2002; Pankhurst et al., 2013), because sport clubs and teams are influenced by the need to develop winning youth and adult teams.

Despite the strong evidence of RAE during TID procedures (Cobley et al., 2009a), RAE is found to diminish in senior ages. For example, Vaeyens, Philippaerts, and Malina (2005) highlighted that at the senior level selected older players have no advantages over selected younger players, while older players tend to have an increased frequency in injuries compared to younger peers (Wattie et al., 2007). Research highlights that there is a “reversal of advantage” (McCarthy & Collins, 2014, p. 1605) with players being born later in the selection cycle representing, to a greater extent, the team compared to older peers (Ford & Williams, 2011). As such coaches, teachers and parents should be educated regarding talent selection on the qualities that define athletic talent without excluding late developers, who are delayed in their cognitive and physical skills development (Cote, 2006; Gray & Pluker, 2010).

2.4 Long-term performance development

Research into long-term performance development has elucidated the influence of early specialization (start training in a specific sport at an early age) or early diversification (youth individuals specialize in their primary sport at later ages of development) on senior performance. It is suggested that by participating in early years in specialized training programmes, athletes develop specific skills, create technical advancement and precision in action, as well as improved cognitive qualities such as anticipation, acknowledgment of the positional demands, ability to “read” the game and decision making, all of which favour long term development (Ford, Ward, Hodges, & Williams, 2009; Ford & Williams, 2011). Likewise, a study by Baker and Cote (2006) supported that during early phases of growing and maturing, diverse training may stimulate a broad-spectrum of physiological and cognitive adjustments, which may launch the foundation for specific physical and cognitive qualities crucial at later ages of development.

Indeed, it is suggested that athletes can attain a senior international level of performance in less than five years of practice in the main sport following diverse sport experience during early stages of development (Oldenziel et al., 2004; Cote, Baker, & Abernethy, 2007). For example, Bullock et al. (2009) indicated that after 14 months of structured training in ice-skeleton two athletes were able to participate in the Olympic Games of Beijing and in the World Junior championship, respectively. Vaeyens and colleagues (2009) reviewed several of the most successful (world class) senior athletes in summer Olympic sports, whose training (60.9% of world class athletes trained in other sports vs. national level athletes = 48.3%) and competition (47.2 % of world class athletes competed in other sports vs. national level athletes = 37.2%) in other sports was higher than the national-level athletes, and were also selected at a later age to participate in the TDE programmes, concluding that world class athletes started their training, competing and participating in international competitions later on in their lives.

Research by Guellich and Emrich (2006a) has provided support for the assertion that top-level international athletes that entered the elite promotion stage within the German sport governing system at later ages of development, and, competed in their main sport, and participated in their first international championships at a later age. Specifically, the developmental histories of 1,558 German national squad athletes from different Olympic sports were scrutinized, and it was revealed that 64% of the elite international athletes and 53% of the sub-elite successful athletes have been involved in other sports

($p < 0.01$). Additionally the internationally successful elite athletes have continued training in other sports for more years than the national level athletes (13.3 ± 5.6 vs. 11.8 ± 5.1 years; $p < 0.05$). A further example from Guellich (2014a) indicated that professional football players selected into a youth elite academy at the age of 13.6 ± 3.9 years became members in the second Bundesliga (n = 75), while those selected later at 14.3 ± 3.8 years ended up participating in the first Bundesliga (n = 275). Moreover, the same study revealed that the players attaining second Bundesliga level achieved their first membership within a national representative squad at the age of 18.0 ± 1.7 years whereas the players reaching the Bundesliga first represented their country aged 19.1 ± 2.3 years. Thus, senior elite performance is confounded by talented performance at an early age (Guellich, 2014a; Guellich & Emrich, 2014) since it is wrongly suggested that present-day performance could have a linear association with senior performance.

More recently, Guellich and Emrich (2014) re-evaluated the existing data set from 2006 in a combined retrospective and longitudinal approach, regarding the artistic composition of sports, game sports, martial art sports and sports that are measured in centimetres, grams or seconds (i.e. cgs). Specifically, for the 776 athletes within the German Sport Association the research denoted that 66% of senior world-class athletes were practiced more time in other sports, and 53% competed in other sports for over one year, compared to the 51% (trained in other sports) and 39% (competed in other sports) of the national class athletes, respectively. Moreover, world-class athletes were characterized by a deceleration of their involvement (i.e. a decreased participation in their domain sport during childhood and youth ages) in their domain sport (i.e. the sport that finally choose to compete, trained and participated at senior ages) during childhood and youth ages and by a later specialization compared to national class. Specifically, it was indicated that the beginning of training (11.4 ± 4.7 vs. 10.1 ± 4.3 years), competition (13.1 ± 4.3 vs. 12.0 ± 4.3 years) and complete specialization in the respective domain sport (14.4 ± 6.6 vs. 12.1 ± 5.5 years) occurred at significantly later ages among the world class compared to the national class senior athletes (all $p < 0.01$). Although there were no differences in the volume of the training before the age of 11 either in their main sport or in other sports, the amount of domain specific training till the age of 10 years old was considerably lesser in the world-class athletes.

Inconsistent developmental histories such as an early specialization, high-intensity and specific practice in the domain sport and little or no participation in other sport; as well as an early start age for training and competition favour early adolescent success and not senior world-class athletes. Likewise, Moesch, Elbe, Hauge, and Wikman (2011) evidenced that athletes in cgs sports, who accumulated more training hours until the age of 15 ($p < 0.001$) and years as members in the junior national team, have a reduced probability of achieving senior elite levels of performance, contrary to the accumulation of more training hours at the age of 18 ($p < 0.001$) that could lead to national team membership and participation at an international competition at an older age. This indicates that senior elite athletes ($n = 148$, top 10 at a World Championship, or medal in a European Championship up to the age of 21) specialize later in their career than near-elite athletes ($n = 95$), who have not won a medal in an international competition. Although Moesch et al. (2011) revealed no difference regarding the diverse participation in other sports between senior elite and non-elite athletes, it ought to be acknowledged that the study did not assess any information regarding the content of training (i.e. quality), which could have influenced the resultant data. Indeed, the adaptive changes on the organism in each athlete are dependent on the training load and on the type of training (i.e. strength training (Friedmann, 2007), endurance training (Jones & Carter, 2000), speed or plyometric training (Markovic, Jukic, Milanovic, & Metikos, 2005) that causes different physiological, neural and morphological adaptations. Evidently, diversification in other sports during the so-called "early specialization years" could have caused adaptations, which aid subsequently the specialization in the main sport at a later age could be associated with senior success. Therefore, specifically in team sports where peak professional performance emerges between 20-30 years of age (Claro, 2008), diverse sporting engagement in the earlier years is of crucial importance for long-term performance advancement rather than specific and early structured training (Baker et al., 2003; Cote et al., 2003; Capranica & Millard-Stafford, 2011).

TID systems need to recognize the differences between the attributes that characterize someone with potential to be an expert adult or a senior and those who can perform better than others at a moment in time (Abbott & Collins, 2002). The evidence that correlates junior and senior success has repeatedly indicated that exceptional success and performance by juvenile athletes appeared to be neither a necessity nor a sufficient prerequisite for later success (Gullich & Emrich, 2006a, 2006b; Guellich, 2007). To illustrate, only a minority of youths that show signs of expert sporting potential will attain international sporting excellence (Tucker & Collins, 2012). Results of a study of elite sport schools showed that only 1.7% of athletes previously selected at an elite sport school in Germany achieved a medal in an international senior competition (Guellich, Thees & Bartz, 2005). Moreover Guellich and colleagues (2005) analysed 140 Olympians from elite sport schools in Germany from 2000 to 2006 demonstrating that the non-medallists were selected at age 13.3 ± 1.9 years, while the medallists were selected at 15.4 ± 2.0 years old. However, Olympians recruited earlier than 12 years old did not attain a medal, contrary to those (18%) selected between 13-15 years of age, and to those (56%) selected at later ages of development.

Furthermore, the research of Guellich and Emrich (2006a) on 1,558 German national squad athletes across all Olympic sports claimed also that juvenile success levels do not correlate with senior success. Of the world class athletes examined, four percent had attained top ten places at an international level when aged 14 years old, 31% at national, 23% at regional level and 42% below. However, when aged 18 years, 49% of the same world class athletes had attained international top ten achievements, 32% at national, 8% at regional level and 12% below. Similar evidence is seen from another study from Guellich and Emrich (2012), which utilised a seven year longitudinal analysis (n = 4,686) and a questionnaire panel study over three years (n = 244), corroborating the notion that the younger an athlete is selected, the younger they exited the system (r = 0.92; n = 1,963). This observation highlights the deficiency of long-term development and continuity within a sport governing system, as well as the difficulty in predicting future success based on early identification and selection.

A recent study by Guellich (2014a) scrutinised the selection, de-selection and developmental path of German football players. The study assessed if early TID and long-term nurture in talent promotion are the underlying factors of successful professional football players. Examining those players that have performed for the national U15 team to U19 (i.e. for the national U15 team from 2006-2013 (n = 189), and for the U16 (n = 870) and U19 (n = 1059) teams from 2011-2013), it was determined that 67%, 45.8%, 37.4%, and 25.2% of players from U18, U17, U16 and U15, respectively, attended the U19 team. Ultimately, under half of those (48.2% from n = 81) senior national German players that had competed in any U-team until U19 reappeared at the senior national team. These results corroborated the notion that exceptional performance and/or membership at youth and/or adult squads within a TDE system does not necessarily result in membership or exceptional performance at senior ages compared to other non-selected players that are developed outside national development systems.

In rugby union, there is scarce research scrutinizing the long-term development and continuity of players within a sport governing system, addressing the de-selections or progression of adult rugby union players to the senior squad, and analysing retrospectively the involvement of senior squad players to the developmental path. Ross Tucker (May 18, 2013) presented at the RFU Talent Symposium in London revealing that only 31.5% of South Africa rugby union players that have played at the age of 13 have played again at the age of 16, while from the age of 16 to 18 the transition was increased to 76%. In 2011, Durandt and colleagues retrospectively assessed the number of athletes that participated as U13, U16 and U18 in South African Rugby Union (SARU) national competitions. Precisely 69% and 76% from the U13 tournament were not selected for the U16 and for the U18 Craven Week (which includes national standard competition in South Africa) tournament. This again indicates that predicting a long-term successful career is challenging and the athletes that evidence successful performance at early ages are not necessarily successful senior athletes (Elferink-Gemser, Jordet, Coehlo-E-Silva & Vissher, 2011).

Consequently, talent selection procedures should take place at later ages of development (Vaeyens et al., 2009; Bottoni, Gianfelici, Tamburri, & Faina, 2011; Pinder, Renshaw, & Davids, 2012), following maturation, in order that athletes possessing elite potential are not excluded (Vaeyens et al., 2009). Moreover, to maximize the likelihood that recruited players progress to senior teams, programmes to support and promote athlete development appears logical. Thus, if TDE systems develop as many athletes as possible for as long as possible, and talent selection systems select athletes at later ages, then senior elite membership would be increased. Such an approach would appear to support a more holistic long-term performance development approach, creating a sports system that enhances as many variables (e.g. physical, psychological, technical, perceptual-cognitive, decision making) as possible better accounting for the sinuous developmental procedure of an athlete (Vaeyens et al., 2009; MacNamara, 2010a, 2010b; Gulbin et al., 2013a). Such a postulation is the basic premise of contemporary mature-age talent selection programmes (Gulbin, 2008; Vaeyens et al., 2008; Bullock et al., 2009; Vaeyens et al., 2009) that attempt to amplify the development and reduce the dropout or underachievement from strategic planning and by managing any situation (Bullock et al., 2009). Although talent selection at later ages seems to increase the possibilities for senior elite performance (Guellich, 2014a; Guellich & Emrich, 2014), the aforementioned examples infer that success at youth or even at adult stages is not a prerequisite factor for senior success. However, whilst less than 30% of players playing at U18 level typically progressed to senior squads in the literature (Gulbin et al., 2013a; Guellich 2014a), progression into senior elite membership was achieved through different pathways within the sport supporting systems; it remains however to be determined in the EPPP. Such information would provide a more specific approach to scrutinising athletes' development within the EPPP and would indicate the efficiency of the EPPP.

2.5 Patterns of development in elite athletes

Baker et al. (2012, p. 78) proposed that the key to developing talent is "encouragement of intelligent, motivated, highly adaptive individuals who are able to cope with predictable and unpredictable changes in sport that come about as a result of changes in interacting environmental, task and individual constraints". Past and recent research has reported that early detection and identification of talented athletes does not correlate with elite progression as performers mature, since each athlete has a unique physiological and environmental development. When reviewing the developmental paths that athletes follow to achieve elite performance in adulthood the literature on expertise is abound with examples, such as those of the Groningen talent studies (Elferink-Gemser et al., 2004; Elferink-Gemser, Visscher, Van Duijn, & Lemmink 2006; Elferink-Gemser, Visscher, Lemmink, & Mulder, 2007; Elferink-Gemser, Huijgen, Coelho-E-Silva, Lemmink, & Visscher, 2012). Physical, tactical, technical, match performance and anthropometrical data were examined, signifying that athletes have their own unique development patterns, which fluctuate across different age groups and ability levels. To illustrate, Elferink-Gemser et al. (2006) assessed 217 talented youth (12-19 years old) field hockey players to establish the relationship between various performance characteristics and performance level. Although the researchers established that body fat, motivation and additional training hours influence the development of the athletes, interval endurance capacity was found to improve more after the age of 15 years old for elite rather than sub-elite players, and after the age of 14 years old for the girls. Similar improvements over time were observed in football from an analysis of 492 players at professional clubs across different age groups (U13 through to U19) (Elferink-Gemser et al., 2012). However, Elferink-Gemser and colleagues in 2006 and in 2012 denoted that even when players evidenced a high endurance capacity, other performance characteristics were also important in becoming members of the elite team at the Dutch Field Hockey Association in professional clubs, since the interval endurance capacity could be compensated by other qualities.

Further research by Elferink-Gemser et al. (2004) compared elite (n = 38, mean age 13.2 years) with sub-elite (n = 88, mean age 14.2 years) youth field hockey players to determine the differences in the ability levels, and in 2007 examined retrospectively the same group of athletes from 2004, to predict the development and differences of the young elite field hockey players aged 14.2 years, by evaluating among others elite (n = 30) and sub-elite (n = 35) youth players. Interestingly, from 2004 until the 2007 study it was observed that some players experienced a downwards progression from elite to sub-elite (n = 5) and from sub-elite to club standard (n = 30), demonstrating that more than 25% of the players failed to achieve the prerequisite characteristics for adulthood selection over a period of two years. Likewise in 2004, as in the 2007 studies, it was demonstrated that the elite youth players achieved higher values in technical (e.g. peak shuttle dribble performance and dribble performance in a repeated shuttle run), tactical (‘game intelligence’, possession of ball: positioning-overview, anticipation) and psychological characteristics, but no differences were observed in anthropometrical or in physiological qualities. The Elferink-Gemser studies (2004, 2006, 2007, 2012) established that at the elite youth level of field hockey and football, technical, tactical and psychological qualities are essential rather than concentrating only on physical or physiological qualities. While, the development into elite athlete or the differentiation from sub-elite peers was not a result of a single performance characteristic, while the presence of one performance characteristic should not be associated with adult or even senior elite membership. Whilst studies in rugby union have shown that anthropometrical (i.e. body mass) (Sedeaud et al., 2012), physical (Venter, Opperman & Opperman, 2011; Barr et al., 2014; Darrall-Jones et al., 2015a, 2015b; Jones et al., 2015) and technical qualities (James et al., 2005; Jones, James, & Mellalieu, 2008; Quarrie et al., 2013) are essential for success, hence it would be worth exploring some of the aforementioned qualities as they are potentially more influential in a sport such as rugby union compared to hockey or football.

Guellich and Emrich (2012) and Guellich (2014a) based their studies on the theoretical framework regarding the individualistic and collectivistic approach to explain long-term development within a sport system. The individualistic approach refers to a group of athletes, members of a TDE programme that are supported by structured facilitative interventions. This support is provided on an individual level to provide long-term individual performance advancement (i.e. collectivistic approach, Guellich and Emrich, 2012), leading to the improvement of team/programme success (i.e. collective success). On the other hand, the collectivistic approach refers to the selection of successful senior athletes and enrolment into the TDE programmes across all age ranges while deselecting current athletes who are replaced by other athletes that are believed to have a greater future potential at that time. Based on this theoretical framework, Guellich and Emrich (2012) described the development of athletes within the German sport system finding that it was based on continuous selection, deselections and replacement of the athletes across various ages.

To illustrate, Guellich and Emrich (2012) recorded 12,369 transitions (without Olympians) from one year to the next within a German sport supporting system (squad system A (highest squad), B, C, DC, D (i.e. squad classification, with D being the lowest squad), including Olympians [n = 597] transitions). The results highlighted that 31% (Olympians 49%) remained in the same squad, 32% (Olympians 13%) experienced downwards, 37% (Olympians 38%) upwards transitions, and 8% (Olympians 90%) were side entries (outside of the system) above the initial stage D for the first time. Most notably, there was a 44% turnover of players per year, signifying that ~17% of all squad members remain within the squad system after 3 years, while only ~3% remain after 6 years.

Likewise, Guellich (2014a) indicated that within the youth elite academies of football there was a mean annual turnover of 24.5% from U10 to U19 squads and it was further noted that from U15 to U19, 44.3% competed in an age representative squad for only one season, 23.4% for two, 15% for three, 11.4% for four, and only 5.9% played continuously across all representative squads (U15 to U19). Thus, it appears in football that players did not follow a long-term developmental. It was further discussed that youth players selected at an early age within the academy, were replaced by other athletes later on developed outside of the system and most young players did not reach adult squads within the system or achieve senior membership. What is indicated by both studies (Guellich & Emrich, 2012; Guellich, 2014a) is that successful senior players emerged from the collectivistic approach within the system. Whereas frequent selection and de-selection procedures were apparent across all age periods rather than a result of early TID and selection into the system, and a long-term development and continuity of individuals through application of facilitative procedures. Such a failure is partly due to one-off assessments of current performance and anthropometrical qualities that fail to describe the developmental nature of talent (Abbott & Collins, 2002, 2004).

In an analysis of 27 different sports within the Australian elite sports network, the majority (> 80%) of athletes evidenced a sinuous progression to senior membership (Gulbin et al., 2013a), which was also apparent in German Olympic athletes across all sports (Guellich & Emrich, 2006a; Guellich & Emrich, 2014). For example, Gulbin et al. (2013a) investigated the development of 256 (107 males and 149 females) high performance athletes having an average age of 23.2 years and representing 27 different sports within the Australian Institute of Sport (AIS). Based on a psychometric questionnaire (National Athlete Development Survey (i.e. NADS) (Gulbin, Oldenziel, Weissensteiner, & Gagne, 2010) it was revealed that the majority of athletes (83.6%) experienced non-linear trajectories, with pure junior to senior developmental linearity evident in less than 7% of cases. Some 42.6% of athletes attended the senior level of competition without descending to any lower level of competition. Athletes in cgs sports were less likely (43%) to experience a descending trajectory in comparison with non-cgs athletes (70%; $p < 0.001$). Hence, the long-term development to a successful non-cgs athletes may be difficult to be achieved over a given time frame (i.e. age categories) within a sport supporting systems, and maybe within the EPPP.

Moreover, Gulbin et al. (2013a) further illustrated that senior national representation was not a linear ascent (i.e. upwards development; except for only 16.4% out of n = 256 athletes; with 26.2% mixed ascent and 57.4% with mixed descent), but rather athletes demonstrated sport-type pathway variability, by specifically experiencing crossover patterns between higher junior competitions at a lower senior competition level, or between junior and senior competitions levels in order to eventually progress to senior elite competition. Specifically, Guellich and Emrich (2012) reported that out of 12,369 athletes from various sports (e.g. cycling, table tennis, athletics, rowing, field hockey, wrestling and weight lifting), 31% remained within the same squad, 37% progressed, 32% moved downwards, while the status 'no squad' (i.e. no membership within the EPPP) was common among Olympians. Similarly, Guellich (2014a) determined that professional football players followed diverse developmental pathways.

The reason for such an ascending development within a sport supporting system in cgs sports appears to be linked to the fact that physiological abilities are more important (Moesch et al., 2011), while in non-cgs sports (e.g. rugby) (Guellich & Emrich, 2014) perceptual-cognitive skills (Gabbett, Georgieff, & Domrow, 2007), tactical awareness (Williams, 2000), and technical qualities (Duthie et al., 2005) are also equally important in regard to the physiological qualities (Cunningham et al., 2016; Read et al., 2016). Additionally it appears that senior elite performance is underpinned by inconsistent progression, which implies that there are numerous pathway possibilities for senior success (Barreiros et al., 2014; Gulbin et al., 2013a) and where progression is somewhat delayed, athletes might benefit from additional time to address weaknesses in training.

Ultimately, the research does not provide evidence that there is a common optimal performance development and instead emphasizes that the athlete and their individual experiences, over a prolonged period of time, defines the pathway to expertise (Brutsaert & Parra, 2006). Consequently, the development of elite athletic performance is highly idiosyncratic and multidimensional (Johnson, Tenenbaum, Edmonds, & Castillo, 2008). Therefore, coaches and scouts should acknowledge that numerous interactions between various systems (i.e. physiological, psychological, biomechanical, societal) underpinning elite success might lead to 'suppressive or enhancing effects' depending upon the individual (Hohmann & Seidel, 2003, p. 18). Accordingly, coaches and scouts should not expect a steady performance improvement; since improvement typically occurs in 'sudden spurts in a non-linear fashion' (Hohmann & Seidel, 2003, p. 18).

Although research in other sport associations exists (i.e. German Football Association, Guellich, 2014a), no research to date has investigated the efficacy of England's EPPP in rugby union or any other rugby union talent system, analysing the elite promotion stage with regard to the long-term continuity of elite squad members within system. Since there is limited information describing the transition histories of elite adult and senior squad rugby union players across their long-term involvement within an elite player development system, a longitudinal investigation will add to the existing knowledge on the efficacy of talent programmes.

Based upon the theoretical framework advocated by Guellich and Emrich (2012) and Guellich (2014a), the present thesis aimed to evaluate the efficacy of the RFU's EPPP related to the long-term development and continuity of rugby union players. Indeed, it is possible to quantify retrospectively SNS development within the EPPP, by identifying whether SNS membership is based on talent promotion procedures, be it long-term development and promotion strategies within the EPPP programme (individualistic) or whether it based on repeated selection and de-selection procedures within the programme during and after adulthood (collectivistic). The theoretical concept of the 'individualistic' and 'collectivistic' approach (Guellich & Emrich, 2012) has been adjusted accordingly for this thesis:

1. The "individualistic approach": Squad and academy players receive continuous individual interventions underpinned by talent promotion procedures within the EPPP. Such efforts accelerate the long-term development of players and hence senior participation within the EPPP. Therefore, players from each squad have an increased probability of reinforcing SNS and enhancing team success within the EPPP.
2. The "collectivistic approach": SNS emerge from frequent procedures of de-selection and re-selection in the 'High Performance Pathway' programme across all age categories, thus indicating that the rates of youth and adult player progression is less than desirable. This implies replacements of current international senior players by players who were developed outside of the EPPP's talent promotion procedures.

2.6 The analysis of England's Rugby Football Union Elite Player Performance Pathway

Rugby union was invented in England (Sheard & Dunning, 2005), which is the country with the greatest number of rugby players, and home to the first 117 clubs in International Rugby. However, England's RFU do not typically rank highest in world standings. England is home to around 1,800 rugby union clubs with more than 1.4 million players; the current Premiership League contains 12 professional clubs and nearly 500 senior professional players, within the English professional system there are 14 rugby academies developing the talents of around 2,000 young players in 29 centres

(R. Headey, personal communication, May 20, 2013). The developmental pathway for players within the RFU begins aged 13 at the 'School of Rugby Programme' (see Figure 2.2) which identifies individuals based on a multifaceted approach by examining physical, technical, game sense and psychological attributes. Players in this system have been evaluated as potential elite athletes and as such, can enter the talent system of the RFU. If identified as talented, players enter the 'Elite Player Developmental Groups' (EPDGs) (from U14), then the developmental camp (U15) and subsequently, the U17 Developmental Squad before progressing on to the EPPP. The EPDGs are led by the regional academies and involve 1089 players nationally between U14 and U18. Players are generally divided into two cohorts with Junior EPDG (U14 to U16) undertaking weekly sessions with the academies, while Senior EPDG (U16 to U18) programmes involve twice weekly contact. Regional academies engage with younger players (typically at 14 to 16 years old) to assist with their development offering high-level coaching, sports science services, medical care, personal development, and information about the upcoming competitions. As such, players are competing in divisional, regional or county championships.

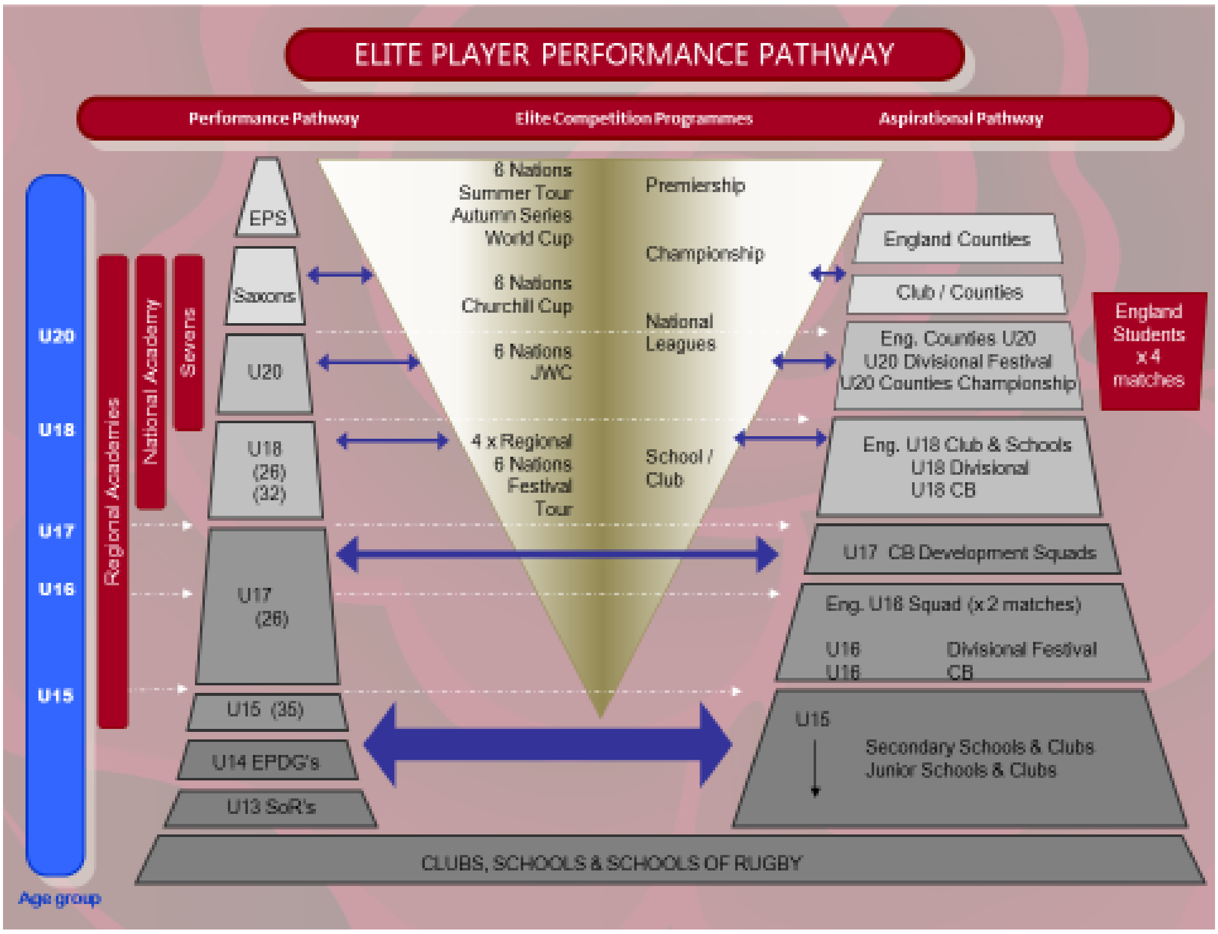

Figure 2.2. Overview of England's Rugby Football Union Elite Player Performance and Aspirational Pathway.

At the age of 16, players are also eligible to enter the EPPP, which is divided into a high performance pathway, which includes the best players, and an 'Aspirational' pathway for the late developers (see Figure 2.2). The Aspirational pathway is the primary vehicle for identifying players for the high performance pathway within the EPPP though both pathways promote the long-term development from youth and adult levels. Furthermore, the squads are selected annually within each age category with some players progressing, others deselected and new players entering the system, who are trained and developed outside of the TDE processes. The present thesis is concentrated on the high performance pathway within the EPPP, which supports and develops international youth, adult, and senior teams. Headey (personal communication, May 20, 2013) outlined that the best academy players are referred to as England Academy Players (EAPs) who are selected from regional academy programmes and regarded as players likely to receive contracts at 18 years old. EAPs receives additional individual support beyond that of the EPDG programmes.

At the age of 18 to 23 years old, players can be selected for the NA which includes SNS players training full-time with one of the fourteen regional academies or those who received a nomination to the NA. Talent selection begins between 18 and 23 years old in rugby union. Specifically, at these ages selected players experience a talent confirmation period, which is characterized by 12 to 36 months of continuous assessments of their development while playing for a senior club, or progressing to the Saxons or to the SNS. NA players follow a personal development plan towards senior selection, either to Saxons or to SNS, while the Saxon squad precedes the SNS team and is thus considered a reserve senior team. Another pathway to the SNS may be that a member of England U20s would play for the England Saxons, alongside playing for a Premiership or Championship club. R. Headey (personal communication, May 20, 2013) signified that the RFU recruits players at a senior age and those who perform successfully in ten matches, are defined as talented and continue to play at the senior team level, while the others are dismissed and replaced by new players.

In 2012, the RFU launched a National and Divisional Selection/Assessment Handbook (http://files.pitchero.com/clubs/11228/RFUAssessmentHandbook.pdf) for coaches; outlining the physical, mental, technical/skill, game awareness and personal attributes. Yet, information received from R. Headey (personal communication, June 17, 2013) indicated that players are still selected according to the perception of coaches and consequently, talented players or those possessing potential, might fail to progress to the SNS. The RFU's sport policy is a partial reproduction of other nations polices, such as Australia and New Zealand, which attempts to aid the long-term performance development and to increase the talent pool of potential elite athletes. In Australia and New Zealand, talented rugby union players are identified by specified schools during championships. For example, in New Zealand the TID procedure starts with schools and regional clubs, from where they are invited to play in age representative teams. During a season, eight schools participate, while scouts and coaches observe the games and subsequently, three squads are created from this tournament who play in the state championship. During this event, coaches with years of experience select players to represent New South Wales in the national championship, while the All Blacks U18s are selected from such an event (i.e. national championship). This procedure illustrates that the TID and TDE of future All Black players in New Zealand starts from the schools. Specifically, at the beginning of each season each school propose five players to a central database, which is controlled from each school at Auckland's RFU in New Zealand. After a number of weeks, and while coaches observe the Championships, they are asked to nominate players from the opposition school; thereafter these names are added to the database. Selected players are then ranked within the database and coaches select players and/or create a representative team for the Auckland provincial championship. Based upon their match performances during this championship, players can be selected for the national championship and potentially for the U18 All Blacks (RFU & Mackenzie, 2007). However, no information regarding any specific talent selection criteria was presented in this paper, as such the talent system in New Zealand needs further investigation on the exact criteria that coaches use to evaluate the players during these tournaments. Since selecting players based only on match performance criteria does not seem appropriate to evaluate high performing players (Till, Cobley, O'Hara, Brightmore, Cooke, & Chapman, 2011) in contrary to a more holistic approach (i.e. psychological, physical, technical and tactical variables, Till et al., 2011).

Like New Zealand, the RFU involves schools and academies, and supports premiership clubs, principally aims to increase the pool of athletes by adapting the policy “Sport for all” when organizing rugby festivals. Despite the negative effects of TID at early ages (Guellich, 2014a, 2014b), the RFU enables nine year old children to be identified as ‘gifted and talented’ through the schools ‘Gifted and Talented’ scheme and to give them the opportunity to be supported and become member of a TDE process. Additionally, the RFU has linked with other general sport community programmes in order to lower the age at which talented athletes are targeted and to increase the talent pool of athletes. The system provides structured participation for children (Gulbin et al., 2013b) and the potential to increase a pool of talent that could reach the adult national U-teams and Academies (Burgess & Naughton, 2010). However, Guellich et al. (2013b) criticizes such TID approaches at early ages because they endanger general sport involvement and limit the amount of structured training and participation to a limited number of sports.

The development of rugby based festivals at English state schools in conjunction with the RFU is an attempt to draw talent into EPDG academies. It has recently been proposed that sport colleges should host and run TID inset courses to educate PE teachers who are not rugby specialists (R. Headey, personal communication, July 20, 2013). Research however has documented the failure of physical education (PE) teachers to differentiate current performance from future potential in any given sport, due to their lack of specific knowledge (Bailey et al., 2010). However it is important for PE teachers to be educated regarding TID and talent selection procedures so as to be able to contribute to such programmes. Nevertheless, it remains unknown whether such education of PE teachers would enhance their ability to identify talent, particularly given that experienced coaches fail to do in some instances (Waldron et al., 2014c).

Despite the difficulty in identifying and selecting talented athletes either within school environments or sport clubs, like other governing bodies, the RFU have adopted the Long Term Athlete Development model (i.e. LTAD) (Balyi & Hamilton, 2004) as a method to identify and develop players based on their physical maturity. LTAD (Balyi & Hamilton, 2004) focuses also on the training development of 'Late specialization sports' such as rugby union. To illustrate, Tim Radford suggested at the RFU's Talent Symposium in London (May 19, 2013) that the latest data gathered from the RFU over the last 20 years indicated that among the winners of the previous 4 Rugby World Cups, the mean age of the starting players was approximately 28 years of age, whereas the mean age for first caps in the English SNS over the last 20 years was 23.9 years old. Such evidence indicates that athletes do not reach their peak performance before adulthood (Balyi & Hamilton, 2004), which exemplifies rugby as a late specialisation sport.

Despite the fact that some factors (i.e. biological maturity, hormones, neurological and musculoskeletal changes) are not addressed within LTAD, it chronologically describes the stages based upon physiologically components (Ford et al., 2011). Indeed, the LTAD proposes five stages of training development that address speed, strength, aerobic capacity, flexibility training. It is suggested that there are 'windows of opportunity' during which coaches ought to adjust the training stimulus and hence strengthen the physical developmental (Ford et al., 2011). For example, "the fundamental stage" (males 6-9 years old) is the first window of opportunity for higher adaptability in speed and training, and is based on playing experience and fun. The second stage is 'the learning to train stage' (males 9-12 years old, competition-training ratio 70:30), which is defined from a higher adaptation of motor coordination skills. Later on, athletes progressed to "the training to train stage" (males 12-16 years old, competition-training ratio 60:40) defined as the stage at which maximal adaptation in aerobic and strength attributes is achieved. However, whilst Balyi and Hamilton (2004) signify that if athletes miss the 'training to train' stage (i.e. 12-16 years old) they will not attain their full potential, it is unlikely to be that important given much research from Bullock and colleagues (2009), Barrerios et al. (2014), Gulbin et al. (2013a) and Guellich (2014a) that suggest side-sentries, late developers and talent transfer across sports are prominent after adulthood. Furthermore at "the training to compete stage" (males 16-18 years old, competition-training ratio 50:50), athletes should develop their fitness, recovery, psychological and technical skills, while they learn to participate and perform under competitive situations. Ultimately, at 'the training to win stage' (males > 18 years old, competition-training ratio 25:75) athletes are maximizing their physical, technical, tactical and psychological skills (Balyi & Hamilton, 2004). However coaches should be conscious about the term 'windows of opportunity', since it suggests that this is the only time where some physical skills can be developed, which is not the case for most physiological processes (Ford et al., 2011)

Based upon LTAD that accounts for individual maturation through specific physiological evaluation tools (i.e. peak height and peak weight velocity referring to the period where the maximum change of growth takes place) the RFU structured the EPPP (i.e. U17 building the foundations, U18 playing with ambition and defending with passion, U19 measuring development, U20 learning to win, Saxons training to win, SNS winning) (R. Headey, personal communication, July 15, 2013) and as such, coaches are advised to adjust the training process accordingly. However, the LTAD model has yet to be evaluated in the employment of the proposed training methods, which are supposed to be underpinned by scientific evidence in children, adolescents and seniors (Balyi & Hamilton, 2004; Waldron et al., 2011), yet attempts to balance competition and training loads during childhood, youth, adolescence and senior levels of performance by emphasising the development process over results (Bompa, 1995). Despite the debate around the readiness of each youth, adult and senior athlete for the specific training stimulus (Balyi & Hamilton, 2004) and the chronological age classification (Ford et al., 2011), which may diminish the developmental process, LTAD is a prominent model to optimise long term performance development (Balyi & Hamilton, 2004; Ford et al., 2011).

2.7 The qualities of elite youth, adult and senior rugby union players

Despite the dynamic environment, optimised rugby union performance necessitates a particular set of position-specific anthropometrical attributes (Fuller, Taylor, Brooks, & Kemp, 2013). Several researchers have indicated specific anthropometry that define rugby union players aged 16 to 20 years old (Van Gent & Spamer 2005; Darrall- Jones et al., 2015a, 2015b; Read et al., 2016), however the ability to find and select players that possess the specific characteristics across different age spans is challenging (Barreiros et al., 2014). Indeed, several studies have shown that morphologies in rugby union, such as player height and mass, are found to be above those observed in the general population (Norton & Olds 2001; Olds, 2001; Sedeaud et al., 2012; Fuller et al., 2013). To illustrate whether anthropometry is a predictor of success in sport, Olds (2001) conducted a study looking at the evolution of athletes over a period of time. The research showed that the average body mass, body stature and BMI of rugby union players steadily increased from 1905 to 1975 and then again between 1975 and 1999, albeit at 3-4 times the earlier rate of increase. Such increases indicates that the specific anthropometrical criteria that currently define a talented/selected player during TID or talent selection procedures, are subject to considerable changes after a period of time. Hence, the changes in anthropometrical characteristics should be used to guide TID and talent selection assessments of rugby union coaches.

Moreover, Olds (2001) determined position-specific differences in player anthropometry noting for example that from 1905 till 1974, the average body mass of forwards and backs were 92.7 and 80.0 kg respectively, while between 1975 - 1999 the average body mass increased and forwards weighed 103.7 kg on average and had a mean height of 1.83 cm, whilst backs had a mean height of 1.79 cm and weighed 84.7 kg. Sedeaud et al. (2012) confirmed earlier assertions that forwards and backs are becoming heavier between 1987 and 2007 RWC, for example, in 1987 forwards weighted 102.42 kg (e.g. backs 82.96 kg) and in 2007 evidenced a weight of 109.05 kg (e.g. backs 89.64 kg), while their height increased from 187.6 cm (e.g. backs 180.31 cm) to 188.21 cm (e.g. 181.84 cm), respectively. Similarly, Fuller et al. (2013) demonstrated that from 2002 to 2011, forwards and backs increased significantly in body height (1.3 - 1.4 $cm \cdot decade^{-1}$), however only the fly-half (4.6 $cm \cdot decade^{-1}$) and prop (3.1 $cm \cdot decade^{-1}$) positions evidenced significant increases.

Such studies thus reveal an evolution of player physique and morphology likely resulting from the changes in the playing environment (e.g. rule changes, shifts in tactics, and the development of global rugby union) (Duthie et al., 2003). This is unsurprising since players undergo frequent collisions (tackler and tackled) ranging from 0.3 (~24 per match) to 0.7 (~57 per match) per minute with an increased frequency in forwards (0.63-0.71 collision per minute) compared to backs (0.31-0.5 collisions per minute) (King, Jenkins & Gabbett, 2009; Sirotic et al., 2009; McLellan, Lovell, & Gass, 2011; Twist et al., 2011). Subsequently body mass likely reflects a key facet of the game in which players strategically take the ball into contact situations with opposition players attempting to prevent ball-carriers progressing to the try line (Hendricks et al., 2014). Research has also established that higher ability rugby union matches involve a higher incidence of tackles (McIntosh, Savage, McCrory, Frechede, & Wolfe, 2010) and thus the selection of heavier and taller athletes to the senior squad therefore appears logical in rugby union. For example, players involved in a high number of tackles and collisions would likely benefit from additional mass given the relationship between force, mass and acceleration in which a defending player would have to generate higher forces to achieve the same resultant acceleration of the attacking player (Barr et al., 2014).

Past research has established the anthropometrical characteristics defining rugby union players in national teams participating in different international competitions, either by grouping them as forwards and backs (Duthie, Pyne, Hopkins, Livingstone, & Hooper, 2006; Crewther, Lowe, Weatherby, Gill, & Keogh, 2009) or in subcategorizing forwards into specific positional groups (Quarrie & Wilson, 2000; Bramley, 2006) or by comparing different ability levels (Cruiz-Ferreira & Fonte Ribeiro, 2013). For example, Crewther et al. (2009) assessed senior elite professional forwards and backs from Australia, New Zealand and South Africa during the Super 12 competitions. Results showed that senior professional forwards body mass was 110.6 ± 6.3 kg and backs 93.3 ± 6.9 kg, while their body height was 187.9 ± 6.4 cm and 180.9 ± 5.5 cm, respectively. While Bramley (2006) investigated the positional group of forwards from the Brisbane premier rugby union competition in Australia, and found that props from the first division club rugby teams revealed a height of 180.6 ± 0.8 cm and a body mass of 109.1 ± 5.4 kg. Thus, it is clear that rugby union is typified by athletes with body masses that exceed that of other team sports such as football (Gil, Gil, Ruiz, Irazusta, & Irazusta, 2010) supporting the view that body mass in rugby union is beneficial to performance.

However, further research addressing the anthropometrical characteristics of U16, U18, and U20 or U21 forwards and backs rugby union players, indicating that older forwards and backs players tended to possess a greater body mass and height than the younger age groups (Darrall-Jones et al., 2015a, 2015b; Read et al., 2016). For example, Read et al. (2016) assessed the anthropometrical characteristics of English U16, U18 and U20 players revealing that U16 (182.3 ± 5.5 cm) and U20 forwards (182.8 ± 5.2 cm) were shorter than U18 forwards (185.1 ± 4.6 cm), while U20 forwards (99.6 ± 9.3 kg) were heavier than U18 (96.4 ± 7.1 kg), who were heavier than U16 forwards (85.9 ± 10 kg). U20 backs (179.9 ± 0.5 cm) were taller than U16 (176.2 ± 3.9 cm), and U18 backs (176.7 ± 5.5 cm), while U20 backs (84.4 ± 8.9 kg) were heavier than U18 backs (79.7±5.5 kg), who were also heavier than U16 backs (73.2 ± 11 kg). Although age group differences are informative, the data fails to evaluate position-specific anthropometry. Interestingly however, Van Gent and Spamer (2005) attempted to appraise the anthropometrical characteristics within specific positional groups of the elite U16, U18, U19 South African rugby union players. For example, the analysis displayed that U18 elite South African tight forwards (TF) were heavier (96.57 kg) than loose forwards (LF) (83.50 kg) and U18 back line players (77.50 kg) were heavier than U18 H (68.67 kg). On the other hand, LF were taller (188 cm) than TF (187.86 cm), H (172 cm) and BL (182.75 cm) players. Although useful, there remains a dearth of research describing anthropometrical data across young, adult and senior ages. Such analysis could improve understanding of the anthropometrical prerequisites across a number of age groups potentially supporting the TID approach of coaches and scouts.

Successful performance in rugby union is highly dependent on various factors. Research has shown that the behaviour of an athlete, and the entire team, changes from match-to-match and from one competition to the next (McGarry, 2009). Indeed, game behaviour is the result of the accumulated behaviours of its players and is influenced by the opponents (McGarry, 2009), the strength of the opposition and match status (Gabbett, 2013), interchanged players (Black & Gabbett, 2014) and season phase (Kempton, Sullivan, Bilsborough, Cordy, & Coutts, 2015) and such independent variables also influence the variability in physical loads (McLaren, Westona, Smith, Crambd, & Portas, 2016). Additionally, an invasion game such as rugby can be dependent upon environmental conditions (Mohr et al., 2010), pacing elements, competition strategy, match location and score status (Aughey, 2011; Gabbett, 2013; Kempton et al., 2015; Goodale, Gabbett, Tsai, Stellingwerff, & Sheppard, 2016; Kempton & Coutts, 2016).

Importantly, match performance fails to provide stability in certain behaviours, which in turn affects the application into training programmes and selection processes regarding individual performance (Glazier, 2010). For example, McLaren et al. (2016) demonstrated that professional rugby union players evidenced high variability in very high-speed running distance (forwards CV = 68 ± 19%; backs: CV = 34.1 ± 7.5%), in total impacts (forwards CV = 24.0 ± 5.9%; backs CV = 36.4 ± 7.9%) and repeated high-intensity efforts (forwards CV = 18.7 ± 4.4%; backs: CV = 39.5 ± 8.8%) from match-to-match. Moreover, Aughey (2011) indicated that elite Australian football players increased their physical activity profile during finals in home matches in contrast to away games. Such fluctuations in performance, indicates that the way that athletes perform is a sequence specific to particular opposition (O'Donoghue, 2009). Additionally, individual performance profiles are also influenced by situational variables such as each team possessing different styles of play (James et al., 2005), which indicates that performance is a result of various strategies and factors during a game, which may not explain individual or team performance (Bracewell, 2003). Thus, a tactical pattern or performance indicator that is successful in a specific tournament might not be successful in another and it is likely that teams will adopt different styles of play depending on the contextual factors of a match. Thus, it appears that match performance profiles may never "stabilize" due to the variability and unpredictability of individual and team performance (McGarry, 2009), hence selection criteria based on specific match performance profiles may never provide accuracy in differentiating players of higher and lower ability. Such evidence indicate the limitations of match performance assessments to contribute to TID or talent selection processes.

Where technical performance is considered, James et al. (2005) developed performance profiles identifying position-specific performance indicators through the examination of 22 video recorded matches from the domestic season of a European professional rugby union team. The study developed performance profiles for ten different rugby positions and considered between-player differences (i.e. inter-individual differences). They demonstrated that outside halves ($p < 0.01$) were typified and discriminated from other positions by more successful carries and tackles at the expense of successful passes and kicks compared to other positions. Moreover, in comparing two props it was revealed for example that some players performed successful carries more frequently (e.g. player 24: median = 4 ± confidence limits (CLs) of 6 and 2, player 2: median = 2 ± CLs of 4 and 1) and that within-player analyses revealed a noteworthy spread of values within which the population estimate was deemed to reside (via confidence limits) (e.g. player 1 successful carries: median = 6.22, ± CLs of 15.52 and 2.07). As the findings of the study are derived from the inspection of one club-level rugby team it may not be appropriate to generalize the findings (Hobart, Cano, Warner, & Thompson, 2012). Nonetheless, such an approach would be an interesting future direction in order to understand the TPI that differentiate international rugby union players across different age squads.

In a more recent study of the New Zealand national team by Quarrie et al. (2013), 763 players performing between 2004 and 2010 were assessed within international matches, regarding the physical qualities, actions and movements completed. It was determined that forwards were involved more frequently in rucks, scrums, tackles and lineouts whereas backs aimed to gain territory or score points when in possession or prevent their opponents from scoring or gaining territory when not in possession. For example, scrumhalves handled and passed the ball more frequently than fly-halves, while MB performed more tackles than OB. Such findings are in general agreement with previous research that position-specific technical differences exist (Parson & Hughes, 2001; Vivian et al., 2001).

The aforementioned findings present a detailed position-specific overview of many of the key technical demands of competition suggesting each position contributes to team performance in a novel way. As such, coaches and players could utilise the quantification of those performance profiles and structure their preparation and training loads for match demands. Indeed, further research could utilize such an approach to expand current knowledge, by comparing positional performance profiles across different ages and ability levels of rugby union players. However, previous studies have tended to assess team-based indicators which cannot determine specific strengths and weaknesses for an individual within a team (Hughes et al., 2012). Indeed, Hughes et al. (2012) suggested that each playing position has specific responsibilities that contribute to the collective performance. Further research should therefore utilise TPI to assess individual performance more extensively.

Though few studies have determined the TPI (James et al., 2005; Quarrie et al., 2013) of senior players and anthropometrical characteristics of youth, adult (Darrall-Jones et al., 2015a, 2015b; Read et al., 2016) and senior players (Bramley, 2006; Crewther et al., 2013; Cruiz-Ferreira & Fonte Ribeiro, 2013), many studies have appraised the physical demands during competition in youth, adult and senior athletes. For example, Cahill and colleagues (2013) demonstrated that senior SH covered the furthest distance and at the highest average speed (5.8 km·hr-1), while OB achieved the highest peak speeds (31.7 $km \cdot hr^{-1}$). Further research investigating the physical demands of senior rugby union players has revealed that the positional group of prop, locks and BR forwards tend to perform more frequently at high intensities than IB and OB (Deutsch, Maw, Jenkins & Reaburn, 1998), while FR and BR experienced the highest number of impacts and collision (Venter et al., 2011; Cunningham et al., 2016). Specifically, Venter et al. (2011) indicated that the U19 BR players experienced the highest total amount yet least severe impacts compared to U19 IB, who experienced the most severe impacts. Research for example has repeatedly evidenced that there is an increased frequency of collisions in senior forwards (0.63-0.71 collision per minute) compared to senior backs (0.31-0.5 collisions per minute) (King et al., 2009; Sirotic et al., 2009; Twist et al., 2011; McLellan et al., 2011). It also appears there exists a relationship between the anthropometry of players and the associated running demands during a match. Indeed, Fuller et al. (2013) demonstrated that the body mass index for the forwards was 30.9 compared to 27.6 for the backs reinforcing the necessity of specific body types according to the positional requirements.

In addition to the appraisals of the physical demands of competition, further research has assessed the physical characteristics of player in laboratory settings (Darrall-Jones et al., 2015a, 2015b). Indeed, laboratory testing provides controlled and detailed measurements of specific characteristics known to be related to successful rugby performance (Vaeyens et al., 2009). However, laboratory (closed environment) testing can reduce the external validity of athlete assessment, particularly where the movement demands do not mimic that of the competitive environment (Vaeyens et al., 2009). Indeed, Darrall-Jones et al. (2015b) investigated the physical qualities (e.g. sprint tests, YO-YO test, squat, and agility 505 test) of junior rugby union players (U16 [n = 29], U18 [n = 23], U21 [n = 15]) from a professional regional academy. Results evidenced that anthropometrical qualities (e.g. body mass and height), anaerobic speed reserve, as well as sprint momentum and acceleration could distinguish U16, U18 and U21 players. For example, absolute and relative strength discriminated U16 from U18 and U21, and mean and peak force discriminated the age categories U16 vs U18, U16 vs U21 and U18 from U21 (i.e. ES = > 0.8). Such evidence may assist coaches in designing specific training practices and may guide the talent selection processes where current performance must be considered.

The relationship between the physical demands during competition and the technical demands has also received greater attention in recent years, since technical proficiency during match play may differentiate higher from lower ability athletes (Waldron, Worsfold, Twist & Lamb, 2014a; Smart, Hopkins, Quarrie & Gill, 2014). For example, Waldron et al. (2014a) displayed that 10m force had a strong correlation in the U15 ($r = 0.61$, $p < 0.001$), in the U16 ($r = 0.69$; $p < 0.001$) and in the U17 group ($r = 0.64$; $p < 0.001$) with successful carries. Whilst, between vertical power and successful carries, there was a strong and moderate correlation in the U15 ($r = 0.63$, $p = 0.011$) and U17 ($r = 0.40$, $p = 0.030$) group, but a poor correlation in the U16 group ($r = 0.09$, $p < 0.37$). Hence, coaches should account the physical influence on TPI different for each age group, when evaluating a player during TID or talent selection procedure. In contrast Quarrie and Wilson (2000) identified that senior elite props (effect size = 0.53) and locks (effect size = 0.63) produced higher scrummaging forces than LF (1420, 1450 and 1270 N for props, locks and LF, respectively). Smart and colleagues (2014) illustrated that sprinting ability over 10 meters displayed a low correlation with successful line breaks ($r \approx -0.26$) and tackles breaks ($r \approx -0.16$), and that all running evasion phases with the ball were moderate associated with forwards 10m and 20 m sprint (r = -0.33, r = -0.439, respectively). Furthermore, Waldron et al. (2014a) indicated that sprinting force (mass x acceleration) associated with successful carries. Evidenced as such that there is a better relationship with match contacts (frequency) than sprinting or acceleration alone. The relationship between performance and physical qualities, evidenced the multidimensional nature of performance in team sports (Brink, Nederhof, Visscher, Schmikli, & Lemmink, 2010) and provide coaches and scouts with evidence of the mechanisms responsible for superior performance during TID and talent selection procedures.

The relationship between physical qualities and match performance have provided important information for the components that contribute to superior performance, however there is an increasing need to investigate the actions of rugby union players during match performance to better understand the requirements of successful performance. The present use of performance analysis for assessing positional performance profiles at senior (James et al., 2005; Van Rooyen, Lambert, & Noakes, 2005), youth and adult levels of performance (Van Gent & Spamer, 2005) has documented little information at the international level of the game. Ultimately, in rugby union, the construction of individual performance profiles, by utilization of common and positional technical performance characteristics is an important area of investigation (Hughes & Bartlett, 2002) since rugby union is described as a sport that includes both positional and general skills (Greenwood, 1997; James et al., 2005). Despite the aforementioned approaches, there is still a scarce research regarding the anthropometrical and technical qualities that could lead to a more holistic approach to talented performance across youth, adult and senior players during competition, and thus, it remains difficult to apply a talent selection model (Bullock et al., 2009). Due to the physically demanding nature of the game, physical ability is one of the most common attributes that coaches assess to discriminate higher from lower ability players (Till et al., 2011; Cahill et al., 2013). However, research has shown that there is a noteworthy relationship between physical and technical ability (Waldron et al., 2014a; Smart et al., 2014) during performance. Unfortunately past research has failed to provide sufficient information on TPIs that describe different ages at the international level of the game and discriminate higher from lower ability players. In response to the paucity of knowledge, it is apparent that technical performance characteristics and anthropometrical qualities that characterize and differentiate youth, adult and senior elite players across specific positional groupings requires further appraisal. Such objective analyses could assist coaches, scouts and supporting staff to recognize the level of players based on specific TPI within sport clubs, academies or national sport supporting systems and as such to develop them towards elite youth, adult and senior level of performance. Finally, when players fail to meet the required criteria coaches could apply specific training loads to support continuous development (Cunningham et al., 2016) or support a decision to de-select a player using objective markers of performance rather than rely upon subjective approaches.

2.8 Successful performance of rugby union players

Given the importance of anthropometrical qualities for senior elite rugby union players, it appears logical that similar traits could influence the performances, and thus rates of retention on talent programmes in lower age players. Indeed, Lambert and Durandt (2010) highlighted that in South Africa, such player characteristics could act as a limiting factor preventing athletes who are not of the requisite size from progressing to senior squads. Likewise, following an analysis of the senior national New Zealand players, Smart and colleagues (2014) concluded that mesomorph, stronger and faster players were more likely to be selected for elite rugby union teams.

Anthropometric and physical variables are important factors in rugby union, however since rugby union has a multidimensional nature (Brink et al., 2010), TPIs during match play (Smart, Hopkins, Quarrie, & Gill, 2011) may further explain the prerequisites characteristics for a successful performance in rugby union. The construction of the TPIs in senior rugby union is attributed to the differences between winning and losing teams (Hughes & White, 1997; Hunter & O'Donoghue, 2001; Jones et al., 2004; Prim, Van Rooyen, & Lambert, 2006; Ortega et al., 2009; Vaz et al., 2011; Bishop & Barnes, 2013) or successful and unsuccessful teams (Hughes & White, 1997, 2001; Prim & Van Rooyen, 2011). For instance, Jones et al. (2004) analysed 20 matches of a professional male rugby union team during a domestic season and found that winning teams achieved higher success rates during lineouts, opposition throws and tries scored. However, such findings, which are typical of performance analyses of rugby (Jones et al., 2008; Hughes et al., 2012), has established performance profiles regarding successful performance at the professional era of the game with less known about the international level since only 44% of professional players (n = 231) (Jones et al., 2004) have participated in an international competition. Nevertheless, the TPIs mentioned above could provide objective indications of performance to support coaches during talent selection procedures.

Research evaluating successful performance of international teams has mainly concentrated on tries scored, the percentage of ball possession and some defensive qualities (i.e. tackles, turnover, mauls) (Van Rooyen, et al., 2005; Ortega et al., 2009;

Bishop & Barnes, 2013; Prim et al., 2006). For example, Ortega et al. (2009) evaluated 58 games in Six Nations and displayed that winning teams were defined by more mauls won, conversions, possessions kicked, successful drops, tackles completed, line breaks, and turnovers won. Likewise, Bishop and Barnes (2013) appraising the knockout matches of the 2011 World Cup (8 winning teams vs. 8 losing teams) established that winning teams evidenced a higher percentage (35.50% vs. 19.50%) of total penalties between 50 m and the opposition 22 m, and kicked the ball out of the hand more, whilst losing teams were typified by poor performance during scrums and lineouts. Although the above studies appraised senior elite performance, it appears plausible that some TPIs that determine a successful team performance may also account for the selection and retention of elite players within RFUs EPPP hence ought to be appraised.

Scoring the highest number of points is related to success pre and post professionalism of rugby union (Hughes et al., 2012), lineout success on a team's own and opposition ball has always been an important factor in rugby union (Vaz et al., 2011). While an increased frequency in rucking, mauling and tackling seems to define the superiority of international teams (Hughes & White, 1997; Vaz et al., 2011). Whilst such findings provide useful information regarding the specific TPIs that determine winning and successful performance in rugby union, they might also be used as objective indications of talented players within talent selection procedures. Indeed, there is no data in rugby union relating the aforementioned TPIs to progression within a sport supporting system (e.g. EPPP). In addition, position specific TPIs could further highlight the importance of a player position since the actions of rugby union players construct general and unique roles during a game (Deutsch et al., 2007; Roberts et al., 2008). Indeed, the positional classification from Deutsch et al. (2007) and Roberts et al. (2008) could be adopted to assess positional TPI at the elite level of the game, which might further support the coaches during talent selection procedures. Therefore, given the dearth of position-specific TPIs across age groups, further insight would appear useful in order that higher squad selection within a sport supporting system is better understood.

2.9 Influence of playing experience on selection processes in team sports

Owing to the importance of the physical and technical demands during competition, they have received noteworthy scientific attention in recent years (Smart et al., 2014; Waldron et al., 2014a). Nevertheless, it is acknowledged that higher squad selection is unlikely to be based upon one or two factors, but other predictors such as skills, individual performance during competition, technical, tactical and psychological attributes given their importance in rugby match-play (Till et al., 2011). For example, Till et al. (2011) assessed (n = 1172) junior rugby league players (13-16 years old) and predicted that the interaction of age, body mass, height, sitting height, lower total skinfold and VO^2max, contribute towards national selection of UK junior rugby league players. In Australian Football League (AFL), Burgess, Naughton, and Norton (2012) signified that player speed, the percentage of time spent sprinting, time on field and overall game speed, were superior for the U18 players that were selected to participate in the senior AFL squad during their first year AFL competitions.

The requirements for competitive match play lead many researchers to investigate further those criteria that explain selection in a team together with the superiority in physical and physiological qualities (Gabbett, 2002a; Gabbett, Kelly, Ralph, & Driscollc, 2009; Till et al., 2011; Burgess et al., 2012). For example, Gabbett et al. (2009) indicated that selected junior rugby league players were taller, possessed greater playing experience (years), were faster in changing direction and evidenced increased speed and maximal aerobic power, while heavier and more experienced semi-professional rugby league players were selected to play in a first grade team (Gabbett, 2002a). Gabbett et al. (2009) indicated in rugby league that elite junior (aged 16 ± 0.2) starters were taller, heavier and evidenced a higher estimated $\dot{V}O^2$max than non-starters, while junior (aged 15.9 ± 0.6) sub-elite starters were taller, had greater playing experience, change of direction speed and estimated VO^2max than junior sub-elite non-starters. Eventually, evidence seems to suggest that higher ability players are defined by a greater playing experience throughout the years.

Owing to the aforementioned evidence, an essential factor that tended to contribute to each athlete's performance was the years of experience that was accumulated throughout his/her career (Gabbett, 2002a; Gabbett et al., 2007; Gabbett, Jenkins, & Abernethy, 2011a; Argus et al., 2012; Sedeaud et al., 2012). Examining rugby league, Gabbett et al. (2011a) revealed that professional starters, non-starters and non-selected rugby league players in the first National Rugby league (NRL) game were leaner, older and had greater playing experience. For example, 'starters' were aged 24.6 ± 3.9 years old and had participated in 96.2 ± 75.5 NRL games, whereas non-starters were 23.3 ± 3.9 years old and had competed in 64.2 ± 71.3 NRL games. Further, results highlighted that there was a relationship between age and playing experience and tackling performance with older and more experienced players more effective tacklers (i.e. tackles completed).

Gabbett and colleagues (2007) analysed the years of experience across rugby league players within various senior competitions in Australia. It was revealed that first grade players had 16.3 ± 6.7, second grade 14.3 ± 7.3, and third grade 9.4 ± 4.3 years of experience. Further analysis between positional groups, from Gabbett (2002a), verified that professional first grade rugby league forwards aged ~25.1 years old had ~19.1 years of experience ($p < 0.05$) than the second grade players who were aged ~23.8 years old and had ~15.2 years of experience, whereas no difference was established between first (age: ~23.4 years old, experience: ~16.2 years) and second grade backs (age: ~21.9, experience: ~13.0 years).

Ultimately, given the complexity of the competitive environment (Glazier, 2010; Lames & McGarry, 2007), which is a product of the task, organismic and environmental constraints (Glazier & Robins, 2013), previous experience could influence the technical-tactical decision making dynamics of a match (Glazier, 2010), which in turn might be an implicit requirement for superior performance within a team (Sedeaud et al., 2012). Sedeaud et al. (2012) investigated age, mass, height and collective experience for all players that participated from 1987-2007 in the Rugby World Cups. Research classified the players into forwards and backs to investigate the collective experience based on players' positions, and on the level that each team reached within World Cups (e.g. winners, finalists, semi-finalists and quarter-finalists). It was established that winning teams possess forwards aged ~26.0 years old with a collective experience (i.e. experience gained from previous World Cups and a season of four competitions between them) of 39.6% compared to forwards of all other teams (31.7%), while there were no differences between the winning and other teams where the backs were examined. An explanation of such evidence may came from the specific positional role of forward players, which is to gain possession of the ball (e.g. from lineout) (Duthie et al., 2003). Gaining possession is defined not only from anthropometrical (i.e.

body mass, body height, Hendricks et al., 2014) and physical characteristics (i.e. strength, speed, acceleration) (Waldron et al., 2014a), but also from specific strategic and tactical approaches (Reilly et al., 2000; Nash & Collins, 2006) that rugby players follow during a match. Suggesting as such that by accumulating playing and competitive experience (Gabbett & Ryan, 2009; i.e. by participating/experiencing a number of previous RWC, Sedeaud et al., 2012; or competing approximately in ~100 matches Gabbett & Ryan, 2009; Gabbett, et al., 2011a), there is a potential benefit on cognitive development of players (Waldron et al., 2011) and, therefore, they tend to influence winning or losing performance within match games. Subsequently, collective experience appears to be linked with improved cognitive factors, such as a better decision-making, (Berry & Abernethy, 2009), game intelligence (Singer & Janelle, 1999), creative thinking (Memmert & Perl, 2005), accuracy and quickness in recognizing and recalling patterns of play (Berry & Abernethy, 2009; Gabbett, Jenkins, & Abernethy, 2011b) and finally to a higher anticipation of the actions that the opponent may follow (Williams & Davids, 1995). Teams that reached the finals, semi-finals and quarterfinals revealed a higher collective experience (33.4%, $p < 0.05$) than the teams that did not qualify for the knockout stages of the tournament suggesting it is an important component of successful performance. To illustrate, 38.1% of forwards in a finalist team have already experienced a World Cup compared to forwards of other teams (i.e. 31.1%), which supports the idea that forwards with collective experience have an advantage during different phases of the game (Sedeaud, et al., 2012). Future analyses of TID programmes might therefore benefit by documenting the exposure players attain as part of their membership to particular squads.

2.10 Conclusion

Although long-term development and continuity within a sport governing system is defined by a sinuous trajectory across youth and adult ages (Gulbin et al., 2013a), it should be acknowledged that players selected at later ages of development tend to reach more frequent senior elite levels of performance (Guellich & Emrich 2012; Guellich, 2014a). Evidence signifies a complex fluctuation in the junior to senior competition transition, which indicates highly varied transitions, because a single linear path to expertise is rare (Gulbin et al., 2013a). Based on that, some nations have created specific TID or talent selection programs, by identifying or by transferring athletes at later ages of development from other sports to amplify the available pool of athletes for selection. Ultimately, coaches, scouts and supporting staff should be cognizant that talent should be approached in a more holistic approach.

The RFU has created the EPPP which aims to assist the development of talented rugby union players in order that they might represent the SNS in future years. However, the success of the programme remains unknown (i.e. how likely is a player to progress to the SNS), as are the pathways athletes typically follow within the EPPP during their involvement. It is not clear how many players are selected from outside of the system (i.e. from professional clubs). Such information could ultimately help the RFUs' talent selection and TDE systems in maximizing the retention of talented players.

To further enhance the RFU's understanding of the EPPP, determination of the position-specific technical performance indicators and anthropometrical qualities that define youth, adult and senior international rugby union players would appear a worthwhile endeavour. Such evidence may develop position-specific performance profiles at the international level of the game and by identifying the requisite qualities at the elite level of the game, across different age groups, TDE within the EPPP could be enhanced by assisting coaches with decision-making regarding talented players and in structuring specific training programmes.

Furthermore, the current thesis aims to develop our understanding of the technical performance indicators and anthropometrical characteristics that underpin higher squad selection, which will allow coaches to identify any improvements necessary for progression. It seems plausible that a coach would benefit by knowing the key technical and anthropometrical characteristics of various squads in order that they can make informed decisions regarding player retention and to adapt any training processes to enhance the number of players progressing to subsequent squads. Since no rugby union research has focused on the technical performance indicators and anthropometrical qualities that underpin higher squad selection in rugby union, it would be of interest to understand whether any such variables describe player progression across different age international squads. Thus, the analysis could enhance the understanding of coaches, scouts and support staff where the future success of players is concerned. That there remains little understanding of the criteria utilized by coaches to retain talented players suggests they could utilize the findings of the subsequent analyses to objectify their decision-making (Robertson, Woods, & Gastin, 2014), ensuring that talented players are retained on the EPPP.

Chapter 3

Selection, de-selection and progression of players within England's Rugby Football Union's (RFU) Elite Player Performance Pathway (EPPP)

3.1 Abstract

The present study explored the efficacy of the English Rugby Football Union's Elite player Performance Pathway (EPPP) in relation to long-term progression from youth (U18) and adult (U20, NA) teams to senior (Saxon, SNS) age international squads. Retrospective data (2008-2014) from 396 elite male rugby union players was analysed. Progression rates across squads were identified alongside the patterns (number of squads attended, which squads attended and specific developmental trajectories) of progression within the EPPP. Analyses revealed the proportion of deselected players and selected players for higher age squad selection (U18-U20 48.70%; U20-NA 37%; NA-Saxons 57.10%, U18-U20 51.30%; U20-NA 37%; NA-Saxons 57.10%) with the Saxon squad producing the highest transition rates to the SNS (61.10 %). In most players (98.24%, when n = 396), membership of the EPPP was typified by non-linear progression (i.e. entering the EPPP at a higher age squad level; e.g. at U20 and not at the U18 squad level), players 'skipping' squads and subsequently reappearing at higher levels, with the remaining players experiencing a linear from youth to senior squads development (from the lowest squad level (U18) to the highest (SNS) within the EPPP, i.e. U18-U20-NA-Saxon-SNS). Within the SNS (n = 121) of 2014, only 5.80% experienced a linear development, the rest displayed variability with respect to squad pathway trajectories (NA-SNS 0.82%; Saxon-SNS 50.4%; U20-Saxon-SNS 4.95%; NA-Saxon-SNS 12.39%; U18-U20-NA-SNS 2.47%; U18-U20-Saxon-SNS 3.30%; U20-NA-Saxon-SNS 2.47%; side entries 17.35%) within the EPPP. Findings suggest that senior elite membership emerged through a variable pattern of sequential selection and de-selection processes throughout U18 to senior squads. The data presented here emphasize that athletes follow various pathways within the EPPP and that membership at the U18 or even at the U20 squads is not a prerequisite for senior success.

3.2 Introduction

Given the need to facilitate progression from junior to adult and finally to senior elite levels of performance in sport, research has sought to identify the rates of progression through age groups and the specific progression pattern of development within a sport supporting system from youth (U18) to adult (U20, NA) and into senior squad teams (Saxon, SNS) (Lambert & Durandt, 2010; Gulbin et al., 2013a; Barreiros et al., 2014; Guellich, 2014a).

Unfortunately, appraising senior elite performance has identified a failure of TID and TDE processes to deliver a pyramidal-like long-term performance advancement within a developmental system (Gulbin et al., 2013a). Such failure is due in part to one-off assessments of current performance and anthropometrical qualities that fail to describe the developmental nature of talent (Abbott & Collins, 2002, 2004). In an analysis of 27 different sports within the Australian elite sports network, the majority (> 80%) of athletes evidenced a sinuous progression to senior membership (Gulbin et al., 2013a), this was also apparent in German Olympic athletes across all sports (Guellich & Emrich, 2006; Gulbin et al., 2013a; Guellich & Emrich, 2014). Specifically, Guellich and Emrich (2012) reported that out of 4,686 athletes, 31% remain within the same squad, 37% progressed, 32% regressed (i.e. moved down the system to lower levels), while it was common among Olympians to have been members in ‘no squad’ in the past years before entering the German sport supporting system. To illustrate from the subsample of Olympians (n = 107), of those who entered the highest squads within the German sport supporting system, 54% were not members in any squad during the previous year whereas fewer athletes transitioned from lower ability squads. Similarly, Guellich (2014a) determined that professional football players followed diverse developmental pathways. It therefore appears that senior elite performance is underpinned by inconsistent progression, which implies that there are numerous pathway possibilities for senior success (Gulbin et al., 2013a; Barreiros et al., 2014) and that athletes potentially benefit by delaying or descending their long-term developmental process in order that they amend weaknesses in aspects of their performance.

Moreover, analyses of governing body programmes intending to support athletes from youth to senior levels have revealed that the younger a player is recruited, the lower the probability they attain senior elite level (Durandt et al., 2011; Guellich & Emrich, 2012; Gulbin et al., 2013a ; Barreiros et al., 2014; Guellich, 2014a; Guellich & Emrich, 2014). One explanation for this observation is that as players reach senior elite levels of performance there is a 'relative age effect reversal' where the physical and anthropometrical differences evident during youth ages (≤ 18) are diminished through the developmental process and hence more players are eligible for selection at senior ages (Gibbs, Jarvis, & Dufer, 2011). Comparing junior (≤ 16 years) and senior (≥ 19 years) success indicated that less than 70% of those selected at junior levels in soccer, swimming and judo were reselected at senior levels (Barreiros et al., 2014). In German professional football players however, only 30.6% of senior national players have competed at least one match in a national U-team (Guellich, 2014a) and senior elite athletes from various sports within support programmes in Germany (Guelich & Emrich, 2012) entered the developmental system at later ages (19.2 ± 2.7). This signifies that exceptional success and performance advancement by youth or adult athletes is not a prerequisite for later success in team sports (Guellich & Emrich, 2012). However, it may be premature to assume later selection (Guellich, 2014a; Guellich &

Emrich, 2014) can be generalized to all late specialization sports (Moesch et al., 2011) and individual athletes and linked to senior success (Guellich, 2007; Gulbin et al., 2013a; Guellich & Emrich, 2014). Such an assumption ignores individual variability, specific to the trainability and adaptability of each athlete (Gulbin et al., 2013a).

Whilst there are several studies appraising talent ID in soccer and in rugby league (Till et al., 2010; Wladron et al., 2014a; Waldron, Worsfold, Twist, & Lamb, 2014b), there is a scarcity of research illustrating the developmental pattern (i.e. progression within a TDE system) from youth to senior development in rugby union. In the quest for enhanced international status the English RFU has created the EPPP, which incorporates TID, talent selection and TDE processes, by aiming to assist in the development of rugby union players. The EPPP provides continuous support during development aimed at enhancing a multitude of performer traits at all playing levels. However, the efficacy of the RFU's EPPP system has not been appraised in relation to the developmental journey (i.e. selection, deselection and reselection) of athletes achieving or failing to achieve SNS selection. Therefore the aim of the present study was to assess the effectiveness of the EPPP in identifying, developing and retaining talented English rugby union players from youth to senior squads.

The research questions addressed in the Chapter are as follows:

- How many, and what proportion of current SNS players have competed at the national U-teams, academies and squads at adult ages?
- Do players entering the elite player development system at a later age progress to the senior squad more often than players that enter the system at an earlier stage?

- What typical pathway transitions do players follow and how many squads do players attend before achieving SNS selection within the EPPP?
- The proportion (%) of players' progression across national U-teams, academies and squads.

3.3 Method

3.3.1 Participants

Retrospective data retrieved from the RFU player monitoring system ('Elite Hub') was used to assess the performances of England's male rugby union players within the national U-teams (U18, U20), academy (NA, age: 18-23 years) and senior squads (Saxons, SNS, both age: 18+\ years) (n = 396) (see Table 3.1). The analysis consisted of 1,941 performances in total, which were derived from various tournaments (Churchill Cup, Six Nations, England Autumn Internationals, England Summer Tour, RWC Warmup, RWC 2011, and Junior World Championships).

Table 3.1. The sample sizes across age groups and the TPI availability across 2008 - 2014.

Squad	Sample size	Available TPI for the Years
U18	199	2008-14
U20	138	2009-14
NA	70	2011-14
Saxon	157	2008-14
SNS	121	2008-14

3.3.2 Study design

The developmental pathways, selection and de-selection rates of the 396 rugby union players were assessed within the EPPP. Side-entries were deemed only those instances where a player entered the SNS with no previous involvement in any other squad team within the EPPP. Likewise, all players who played in the SNS (n = 121) during the last six seasons 2008-2014 were analysed retrospectively with regard to their earlier involvement in the EPPP.

Following approval from the Rugby Football Union to access the EPPP, Ethical approval was obtained from the Faculty of Applied Sciences Ethical Committee at the University of Chester.

3.3.3 Data analysis

Similar to previous research in the area (Guellich & Emrich, 2006, 2012; Gulbin et al., 2013a), descriptive statistics (i.e. frequencies and proportions) were calculated to identify the developmental pathways (i.e. linear or non-linear progression) within the EPPP and the progression rates (i.e. number of and rate (%) of selection and deselection) across all age representative squads (adult squads: U18-U20, U20-NA; senior squads: NA-Saxon, Saxon-SNS). All analyses were performed using Microsoft Excel (Version 2013, Redmond, WA).

3.4 Results

3.4.1 The transition of SNS players from 2008-2014 within the EPPP

In total, 396 rugby union players were involved in the RFU squads (U18 to SNS) during 2008 - 2014. Some 275 players (69.4%) of all squad members failed to enter the SNS compared to 121 (30.6%) who achieved involvement. It is noteworthy that of the 396 players, 21 (5.3%) players had not participated in any developmental squad within the EPPP before entering the SNS.

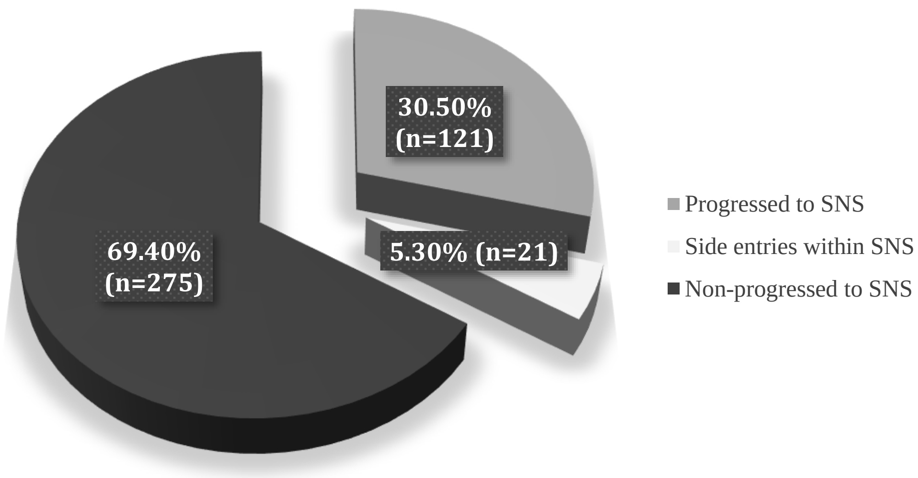

Figure 3.1. Proportion (%) of the progressed, non-progressed and side-entries into the SNS during 2008 - 2014.

3.4.2 Retrospective membership of SNS players across all age squads within the EPPP

Figure 3.2 presents the squad memberships of senior players prior to playing for the SNS. It was determined that 79.33% (n = 96) of players competed in the Saxon squad, compared to 36.36% (n = 29) who had been members in NA, 19% in U20 (n = 23) and 17.35% (n = 21) deemed side-entries. Only 11.57% (n = 14) of SNS players competed within the U18 squad.

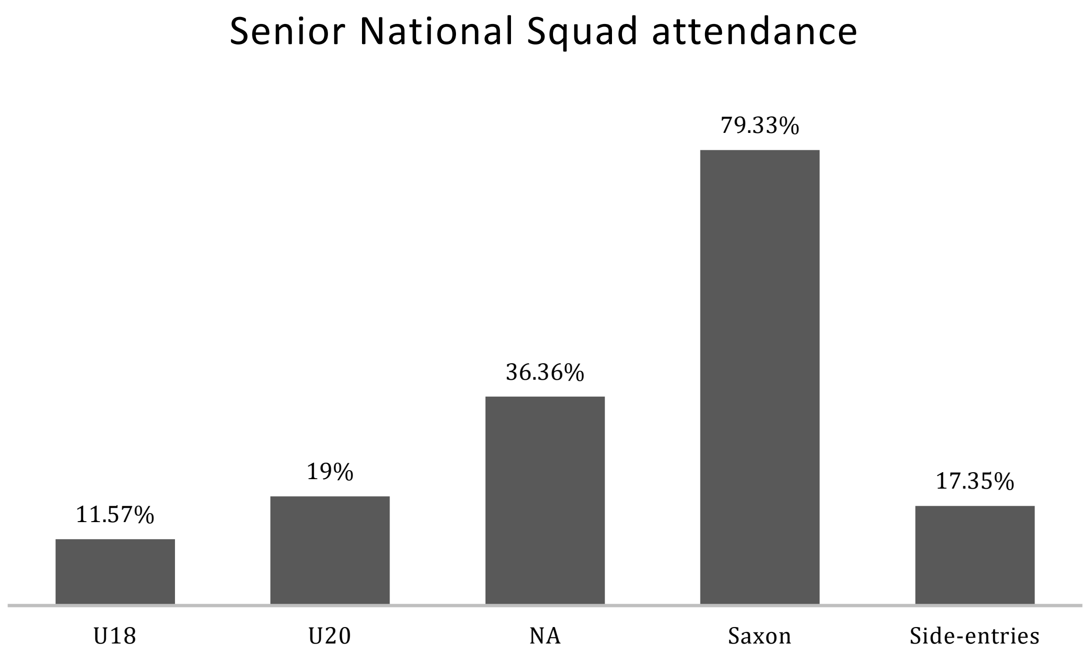

Figure 3.2. Proportion (%) of SNS players (n = 121), who have been members in any other age international squads (2008 - 2014) prior to becoming members of the SNS.

3.4.3 Pathway progression and variability of SNS players within the EPPP

Retrospective analyses of SNS (n = 121) players' long-term development within the programme revealed that players followed different developmental paths prior to playing for SNS (see Table 3.2). Data revealed that the majority (51.23%) of senior players were members of only one squad before competing within the SNS. More specifically, approximately half of the players competed for the Saxon squad (Saxon-SNS pathway n = 61; 50.4%, in contrast to NA-SNS n = 1; 0.82%) before progressing to SNS. Moreover, 17.35% (n = 21) of players entered directly into the SNS, which was the next most prevalent pathway leading to senior squad selection. Approximately 4.95% (n = 6) and 12.39% (n = 15) participated in two squads, and developed solely through the U20-Saxon or NA-Saxon path until SNS selection. Results also indicated that there were fewer players who entered three squads before SNS selection. Some 2.47% (n = 3) entered the developmental process from U18 and progressed to U20-NA-SNS, 3.30% (n = 4) from U18-U20-Saxon-SNS and 2.47% (n = 3) from U20-NA-Saxon-SNS. In total, only 5.80% (n = 7) experienced a pyramidal concept of development within the EPPP by attending all four squads prior to SNS membership.

Table 3.2. Overview (%) of SNS selection (n = 121) with regard to the number of squads and pathway variability across all age representative squads prior to SNS membership.

Squad participation of SNS (n = 121) 2008-2014									
	Side entries	**One squad**		**Two squads**		**Three squads**			**Four squads**
Successful SNS transition (%)	17.35%	51.23%		17.35%		8.26%			5.8%
Squads attended	SNS	NA	Saxon	U20 Saxon	NA Saxon	U18 U20 NA	U18 U20 Saxon	U20 NA Saxon	U18 U20 NA Saxon
SNS Pathway transition (%)	17.35%	0.82%	50.4%	4.95%	12.39%	2.47%	3.30%	2.47%	5.80%

3.4.4 Evaluation of the developmental pathway and the percentages of higher squad selection of England's Rugby Union players within the EPPP (2008-2014)

Figure 3.3 displays the percentage of higher age squad selection within the EPPP. Analyses revealed that 51.30% (n = 102) of the U18 squad progressed to the next age representative squad, compared to 48.70% (n = 97) who did not. In the U20 (n = 138) squad, 63% (n = 87) did not progress compared to 37% (n = 51) who progressed. More than half of the NA players (57.10%; n = 40) experienced a higher squad selection, as opposed to 42.90% (n = 30) who failed to progress. However, there was a substantially higher rate of progression from the Saxon squad to the SNS (61.10 %; n = 96), with the remainder of the group (38.90%; n = 61) deselected.

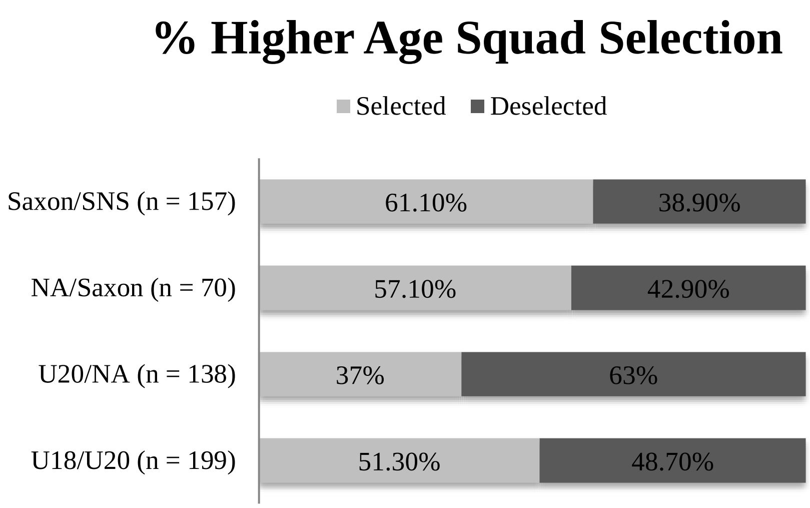

Figure 3.3. The percentage of players that experienced a higher squad selection within the EPPP at each level (U18-U20, U20-NA, NA-Saxon, Saxon-SNS). Note: represents all players that have passed through a squad within the EPPP.

The findings in Table 3.3 illustrate a wide range of individual variability with respect to starting level and pathway development within the EPPP. Out of 396 players, 24.49% (n = 97) played solely for the U18 squad, 13.38% (n = 53) developed to U20, 4.79% (n = 19) progressed from U20 to NA, whilst only 2.52% (n = 10) competed for the NA following U18 involvement.

Forty seven players entered the EPPP at the U20 squad level, of those, 8.58% (n = 34) played only for U20 squad, while the twenty players that entered the EPPP at the NA level 3.78% (n = 15) progressed to Saxon and finally to the SNS. Moreover, 110 players entered the EPPP at the Saxon squad level, of those 12.12% (n = 48) didn’t progress, in contrast to 15.40% (n = 61) that progressed to the SNS. Interestingly though 5.30% (n = 21) were side entries into the SNS. It is important to note that only 1.76% (n = 7) players experienced the typical ascending developmental pathway into the SNS (U18-U20-NA-Saxon-SNS) within the EPPP. A further 1.76% (n = 7) of U18 players who progressed to the SNS skipped one or two squads, for example, 0.75% skipped the Saxon squad (n = 3; U18-U20-NA-SNS) and 1.01% the NA squad (n = 4; U18-U20-Saxon-SNS).

Table 3.3. The pathway variability of all players (n = 396) spanning from 2008-2014.

	Pathway Variability within the EPPP (n = 396)					
	U18	U20	NA	Saxon	SNS	% Based on 396 players
U18 (n = 199)**	✓					24.49%
	✓	✓				13.38%
	✓	✓	✓			4.79%
	✓	✓	✓	✓		1.26%
	✓	✓	✓	✓	✓	1.76%
	✓	✓	✓		✓	0.75%
	✓	✓		✓	✓	1.01%
	✓		✓	✓		0.25%
	✓		✓			2.52%
U20 (n = 47)**		✓				8.58%
		✓		✓		0.50%
		✓	✓	✓		1.51%
		✓	✓	✓	✓	0.75%
		✓		✓	✓	1.51%
NA (n = 20)**			✓			0.25%
			✓	✓		0.75%
			✓		✓	0.25%
			✓	✓	✓	3.78%
Saxon (n = 110)**				✓		12.12%
				✓	✓	15.40%
SNS (n = 21)**					✓	5.30%

**Represent the number of players that enter the EPPP for their first time and their subsequent development.

3.5 Discussion

The EPPP was designed to facilitate the identification and development of talented athletes based on a typical chronological pyramidal scale (McCarthy & Collins, 2014). Contrary to the popular 'pyramidal concept' of athlete development, progression was complex with athletes entering at a range of levels (from U18 to SNS) within the EPPP, whilst others failed to progress or reappeared within the system again at a higher squad level. In total, there were nine developmental trajectories identified revealing the variable and individual routes of progression experienced by the senior international rugby union players. Based on the theoretical approach of Guellich and Emrich (2012), the current study identified sizeable de-selections of its members in all representative squads within RFU's EPPP system. That is, each age squad provided limited transition rates to the senior squad (collectivistic approach) rather than from their participation in the U-teams or at the NA, which is achieved by a long-term continuous supporting process within the EPPP programme (individualistic approach).

Consistent with previous finding from Guellich (2014a) in national German football players, who evidenced that 59.60% of the U18 players progressed to U19, present outcomes signified that 51.30% of the U18 players progressed to U20. Likewise, further results evidenced increased selection rates across U18, NA and Saxon, which could be attributed to the observation that players reaching senior elite levels of performance potentially experience a 'RAE reversal' where the physical and anthropometrical differences are diminished through the developmental process (Coutts, Kempton, & Vaeyens, 2014), and hence more players are eligible for selection (Gibbs et al., 2011). While it is unclear why the smallest percentage of players progress from U20 to NA (37%), the RFU suggests that the NA develop the future senior elite players within the EPPP, and as such the players within the NA follow a personal development plan towards senior elite development, which may be considered as an explanation for the increase in the selection rates towards the Saxon squad (R. Headey, personal communication, May 20, 2013). As such, since the NA is expected to prepare players for the SNS, the lower progression rate from U20 to NA may be due to the fact that players are selected based on senior level performance qualities (Vaeyens et al., 2006; Till et al., 2010).

Furthermore, in the context of team sports, it appears plausible that the determinants underpinning selection for a particular squad (e.g. U20), might be dissimilar to those of the subsequent squad (e.g. NA) (Durandt et al., 2011), and hence many players may fail to meet the criteria for a higher squad selection. This has been shown in rugby league where high intensity running was prerequisite for adult level rugby but not for youth players (Waldron et al., 2014a). Another factor that coaches and scouts should consider is that athletes are developed based on their own unique developmental rhythms and as such may need more time to develop the prerequisite characteristics (physical, physiological, technical and tactical) for higher squad selection (Elferink-Gemser et al., 2006, 2012).

Information received from the RFU (R. Headey, personal communication, May 20, 2013) determined that players who did not attend a higher representative squad are believed (from coaches and scouts) not to acquire the specific attributes for senior success, which was also evident in a rugby union study by Durand et al. (2011) and within German professional football (Guellich, 2014a). However, the criterion of selection regarding the ability of a team player is mainly the subjective opinion of a coach or a scouts, by recording technical and tactical observations of players in a game situation (Durandt et al., 2011; Waldron et al., 2014a), or by assessing various qualities (Reilly et al., 2000; Williams & Reilly, 2000; Vaeyens et al., 2006). Yet, Waldron et al. (2014a) established that coaches and selectors, who base their selection solely on performance during game situations might fail to differentiate between current performance and future potential. For example, in rugby league players aged U15 and U17, coaches could not differentiate them based on match-related performance characteristics, and this can lead to selection failure of the athlete with the prerequisite characteristics (Waldron et al., 2014a).

The pyramidal sport development system (Bailey et al., 2010) based on chronological cut-off (Cobley et al., 2009a), which defines the EPPP, is concentrated on current performance across ages, which leads to fewer athletes participating at higher age international squads within the EPPP. Although research supports that such approach fails to account the chronological-biological disparity in relation to the RAE (Wattie et al., 2007) that affects growth and maturation and thus creates physiological and anthropometrical gaps at youth ages (Till, Cobley, O'Hara, Cooke, & Chapman, 2013a; Till et al., 2013b). However, it seems like non-selected youth players are developed outside of the sport supporting system, and enter the EPPP at later ages, such as at the U20, NA, Saxon, and even at the SNS level.

Within the EPPP, the typical routes into the SNS are changeable after the age of 18 based on the assumptions that probably there is a 'RAE reversal' where the physical and anthropometrical differences evident during youth ages (≤ 18) are diminished through the developmental process and hence more players are eligible for selection at senior ages (Gibbs et al., 2011) (see Table 3.3). Indeed, even when players progressed to the U20 squad level within the EPPP, on occasion, they reappeared (e.g. U20-Saxon-SNS; see Table 3.3) or were deselected and probably replaced by other players (e.g. U18-U20-NA; see Table 3.3). To illustrate only ~30% (e.g. 11.57% at U18 and 19% at U20, see Figure 3.2) of the SNS players participated in any of the U-teams, which was in accordance with the findings from a study by Guellich (2014a) in national German football, who indicated that only 48.2% of the players competed at the U19 level or earlier. It is important to acknowledge that some younger deselected athletes are found to develop better coping mechanisms as a result previous setbacks during the developmental journey, such disappointment can lead to the establishment of a personality better equipped to deal with high-performance sports (Collins & MacNamara, 2012), which can help future progression back into the system at senior ages. It has been recognized that this trait can enable younger players to become more competitive than their early-matured peers (Gibbs et al., 2011), since the physical (Cobley et al., 2009a), anthropometrical (Carling Le Gall, Reilly, & Williams, 2009) and cognitive (Robert & Stott, 2015) advantage is diminished at the senior age. That said, examples from Bullock et al. (2009) study in ice-skeleton, highlight the possibility that high performance athletes at later ages (> 18 years old) can transfer to sports with similar physical attributes (i.e. 30m sprint, countermovement jumps) and become elite performers within 14 months (athletes achieved World and Olympic level performance). Likewise, Gulbin et al. (2013a) identified 256 athletes from 27 different sports entered the Australian supportive system at later ages (20.7 ± 5.5 years old) when compared to other sports.

Similar to previous studies (Vaeyens et al., 2009; Guellich, 2014a; Barreiros et al., 2014), the present data imply that success and progression within the EPPP does not contribute to predicting long-term success and subsequently senior national squad selection, though competing within the Saxon squad, seems to be comparatively important. Considering the decreased progression rates at U18 and U20 level, and the increased participation rates in Saxon squad of the SNS within the EPPP (see Figure 3.2) suggests that the Saxon squad seems to be the stage where players outside of the developmental system attain the prerequisite ability that allows them to enter the EPPP. Whilst, the players entering the EPPP at this age possess many of the prerequisites or similar characteristics (i.e. mass, technical, tactical abilities) of the SNS and thus are most likely to progress. Indeed, the majority of SNS players were members at the Saxon squad before entering the SNS. Ultimately, the present findings provide evidence that the older a player attended an elite promotion programme, the higher the probability of attending senior elite performance and are similar to data published on elite football, swimming, judo and hockey athletes of similar age groups (Guellich & Emrich, 2006; Vaeyens et al., 2009; Guellich & Emrich, 2012; Barreiros et al., 2014; Guellich, 2014a; Guellich & Emrich, 2014).

The findings also reveal the progression of players within the system was not a predictable ascent. To illustrate, the Saxon squad was the main path into the SNS, and there was substantial individual variability with respect to squad pathway trajectories. SNS selection within the EPPP was not a predictable linear progress (excepting 5.8% [n = 7]/or 1.8% related to the 396 analysed rugby union players), but instead was characterized by irregular transitions (nine developmental pathways, see Table 3.2), which was in accordance with Guellich (2014a), who indicated that only 5.8% participated consecutively from U15 to U19 in German football. Such findings question the pyramidal concept based on chronological cut-off within the EPPP as an effective developmental environment for senior elite success, and challenges the notion that youth and adult (U18, U20 until NA, NA could include also senior player ≥ 20) membership within the EPPP is an essential prerequisite for senior attendance. Present findings are consistent with previous observations regarding the patterns of performance development within a range of supportive governing systems, where players within AIS (Gulbin et al., 2013a) followed diverse developmental pathways and experienced crossover patterns between higher junior competitions at a lower senior competition level, or between junior and senior competitions levels in order to eventually progress to senior elite competition. Whilst Olympians (Guellich & Emrich, 2012) within the German sport supporting system experienced discontinuity, interruption and downgrade during their progression to the senior squads (Guellich & Emrich, 2012; Gulbin et al., 2013a). Ultimately, previous research (Guellich & Emrich, 2012; Gulbin et al., 2013a) and the current findings indicate that players would probably demonstrate a 'sinuous and irregular progression' in their pathway to high-level performance, which in turn does not necessarily affect the probability of future involvement in the SNS.

Deselection and reselection within the EPPP may indicate the subjectivity of coaches in identifying higher ability players at each annual age group (Vaeyens et al., 2008). Despite the dynamic environment, optimised rugby union performance necessitates a particular set of position-specific anthropometrical attributes (Fuller et al., 2013). For example, props need to possess a large bone and muscle mass, so as to avoid injuries due to the increased number of collision (Sirotic et al., 2009; Twist et al., 2011). Furthermore, due to the physically demanding nature of the game (Smart et al., 2014; Waldron et al., 2014a), physical ability is one of the most common attributes that coaches assess to discriminate higher from lower ability players (Till et al., 2011; Cahill et al., 2013) rather than psychological abilities. Despite the fact that research has indicated the predominant influence of psychological effects on successful performance over time such as coping with highly competitive environments (MacNamara et al., 2010a, 2010b), mental toughness (Jones, Hanton, & Connaughton, 2002, 2007), self-confidence, concentration and commitment (Hodge, Lonsdale, & Ng, 2008). Nevertheless, it seems plausible that coaches disregard such factors that could affect the long-term continuous progression of a player within a talent development programme (MacNamara et al., 2010a, 2010b).

The sinuous progression until SNS selection could be a result of environmental and socio cultural settings (Champagne, 2010; Slavich & Cole, 2013), each individual's adaptability and trainability to training (Tucker & Collins, 2012), early diversification (participate in early ages in other sports) or late specialization (Guellich & Emrich, 2012) as well as psychological skills and attributes (Ackermann, 2013) that shape and structure the development of each individual over time (Champagne, 2010; Slavich & Cole, 2013). It was revealed that athletes in cgs sports (46% of the 256 athletes) (those measured in centimetres, grams or seconds) were less likely (43%) to experience a descending trajectory in comparison with non-cgs athletes (54% of the 256 athletes) (70%; $p < 0.001$). The reason for such a trend in cgs-sports appears to be linked to the fact that physiological abilities are more important in cgs sport (Moesch et al., 2011), in contrary to the equal necessity of physiological (Cunningham et al., 2016; Read et al., 2016), perceptual-cognitive (Gabbett et al., 2007), tactical awareness (Williams, 2000) and technical qualities (Duthie et al., 2005) that are important for non-cgs sports (i.e. rugby) (Guellich & Emrich, 2014). Subsequently, coaches, scouts and supporting staff within the EPPP should also acknowledge each athlete's psychological, physical, physiological, technical and tactical qualities throughout the developmental years accordingly.

Such observations, in conjunction with the current findings, question the effectiveness of the EPPP in generating confidence that selection and participation within the EPPP would manifest into SNS selection. Among the 396 players 15.4% of those players progressed from Saxon squad to SNS, with the next best retention within the EPPP being 3.78% of those players that progressed from NA to Saxon and finally to the SNS. Gulbin et al. (2013a) assessed within the Australian elite sports network 256 high performance athletes and showed that few athletes (21-30%) progressed from junior to senior national teams, compared to the most common path (81-90%) from senior state to senior national team, which was consistent with present outcomes, that most England's' national players have passed from the Saxon squad (79.33%, see Figure 3.2) on their way to SNS membership. Although research has indicated that development within a sport supporting system has positive effects on athletes' development in, for example, game-based decision-making skills (Woods, Raynor, Bruce, & McDonald, 2015), deselected players or those yet to enter the EPPP still compete professionally and thus will develop such skills outside of the EPPP regardless of involvement in the programme.

The current outcomes do not necessarily imply that the EPPP or youth U-teams are ineffective, or that talent promotion programmes do not cultivate senior elite levels of performance (Guellich & Emrich 2012). Rather, the findings imply that a shift of approach from a single clear pathway towards senior elite status, to a perspective that is underpinned mainly by different levels of performances and stages of development. Consequently, players that enter and exit the system according to their own unique development up to senior elite level of performance should be primarily expected as a possible route to success. The preceding squads might not therefore act as a prerequisite factor for senior performance but they may support future potential.

If the system was to be changed, a new approach, such as the 'structured recycling of talent' (Vaeyens et al., 2009, p. 1374) that is happening in other developmental programmes (AIS, ASPIRE in Qatar and the UK High Performance Talent Programme) or talent transfer initiatives (Bullock et al., 2009) could possibly change the percentages of athletes attaining SNS selection from within the EPPP. An example that the RFU could benefit from is the UK Sport's 'Sporting Giants campaign', which was looking for notable 'tall' talented athletes (i.e. 1.90cm for men and 1.80cm for women, between 16 and 25 years old), and evidenced a 4%

entry of new athletes into the overall Olympic talent pool (UK Sport, 2008). Deriving from the fact that it is a necessity also for rugby union athletes to have a specific size and shape to compete at the highest level of rugby union (Olds, 2001; Fuller et al., 2013); for example, forwards need to have a body mass over ~100kg and backs a body height over ~180cm (Sedeaud et al., 2012); the RFU could utilize such talent search initiatives to increase the talent pool of athletes within the EPPP. However, MacNamara & Collins (2011) highlighted that these systems also possess inherent limitations. Indeed, as there is a cross-sectional assessment of the physiological, performance (e.g. technical, tactical qualities) and anthropometrical qualities those possessing talent might not be identified as currently possessing the prerequisite qualities, and psychological abilities are neglected during talent selection procedures even after adulthood (Collins & MacNamara, 2012). Moreover, coaches should acknowledge that assessments of sport-specific skills in simulated playing environments could result in misinterpreting the athletes' playing ability (Waldron et al., 2014a, 2014b). Thus, the RFU ought to avoid one-dimensional selection procedures or techniques adapted for talent selection purposes as they may fail to reveal talented players, while psychological qualities are also essential during selection procedures (MacNamara et al., 2010a, 2010b; MacNamara & Collins, 2011). Ultimately, it is particularly important for RFU to invest more money in the EPPP (Hogan & Norton, 2000) for structured scientific support in order that player ability, and future potential, are better monitored.

3.6 Conclusion

The current findings assert that the later a player joined the EPPP, the more likely were they to play in the SNS. Further, findings established frequent de-selection within U18, U20, NA and Saxon players, compared to the few athletes that progressed within long-term development and promotion within EPPP representative squads, prior to becoming SNS players. Thus, senior elite level of performance derives from a diverse developmental pathway. Future work should sought to determine the exact technical performance indicators and anthropometrical qualities that define each age international squad within the EPPP (Van Gent & Spamer, 2005; Ortega et al., 2009; Vaz et al., 2011; Jones et al., 2015). By illustrating the technical performance indicators and anthropometrical characteristics related to the U18, U20, NA, Saxon and SNS; coaches would be able to quantify the necessary level of performance and utilize them as norms for squad selection (Robertson et al., 2014). Additionally such approaches would influence training processes and will allow coaches to evaluate the development of players and identify for any improvements needed at each age international squad.

Chapter 4

Technical performance indicators and anthropometrical characteristics of playing positions within England's Rugby Football Union Elite Player Performance Pathway.

4.1 Abstract

The aim of this study was to determine the prerequisite level of TPIs and to establish the generic and position-specific TPIs and anthropometrical features (body mass, body stature), specific to six predefined positional groups (Front Row (FR), Second Row (SR), Back Row (BR), Scrumhalf (SH), Inside Backs (IB) and Outside Backs (OB)) across youth (U18, U20), adult (NA) and senior (Saxons, SNS) international squad members within the RFU's EPPP. Retrospective performance data (2008 - 2014) from elite male rugby union players of different age representative squads within England's EPPP (U18, U20, NA, Saxons and SNS) was appraised twenty-two TPIs per positional group. The results of the study demonstrate that anthropometrical characteristics together with sporadic TPI differences discriminate youth, adult and senior age international squads for the six pre-defined positional group within the EPPP. Ultimately, the larger the age difference between international squads, the more frequent the differences in anthropometrical qualities and TPIs though the technical performance in the SNS was similar to the Saxon squad for all positional groups. The resultant characteristics provide reference norms regarding the prerequisite level of performance for the specific age squads according to six positional groups. Ultimately, technical TPIs might not distinguish one squad from the subsequent team, though the extent of the observed differences between younger (U18 & U20) and older (NA, Saxons & SNS) squads, could be used in conjunction with coach intuition to improve the objectivity of player selection to future squads.

4.2 Introduction

Rugby union is an invasion sport, characterized by intermittent low- and high-intensity running, periods of static exertion and multiple physical contacts (Roberts et al., 2008; Cahill, et al., 2013; Jones et al., 2015). Ultimately, in rugby union, the construction of individual performance profiles, by utilization of common and positional technical performance characteristics is an important area of investigation (Hughes & Bartlett, 2002) since the sport includes both positional and general skills (Greenwood, 1997; James et al., 2005). However, research has shown that there is an unquestionable relation between physical and technical ability (Smart et al., 2014; Waldron et al., 2014a) during performance and unfortunately past research failed to provide sufficient information regarding the TPIs that describe different ages at the international level of the game.

James et al. (2005) developed performance profiles identifying position-specific indicators through the examination of twenty-two video recorded matches from the domestic season of a European professional rugby union team. The study developed performance profiles for ten different rugby positions and also determined the between-player differences within the positional groups. They established typical performance and the associated confidence in their estimates (via CLs) and demonstrated that the outside halves ($p < 0.01$), for example, were discriminated by more successful carries and tackles at the expense of successful passes and kicks compared to other positions. Moreover, within a given position, the analyses revealed that for some TPIs, similarity existed, whereas for others (e.g. successful carries in props) there were notable differences. Together, the analyses therefore suggests rugby union performance differs according to player position and can also be influenced by the particular strengths of a given player. However, the findings of this study are derived from the inspection of one club-level rugby team meaning the conclusions might not generalize to senior rugby performance per se (Hobart et al., 2012). On the other when Cunningham and colleagues (2016b) compared U20 international with senior international rugby union players during 2014 and 2015 seasons regarding their movements' patterns, indicated that U20s FR players outperformed senior FR in high speed running (i.e. relative to > 18.1km·h-1) and in high metabolic load distance (i.e. acceleration and deceleration over 2 m·s-2 and/or distance > 5 m·s-2). While senior centres evidenced an increased number of high speed running and covered greater relative distance (i.e. m•min-1) compared to U20 centres. Such results expand our knowledge regarding the movement demands of elite senior and adult international rugby union players within talent development pathways and signified whether U20 could act as 'stepping stone' for senior elite membership. Despite the knowledge of movement demands at the international level of the game, there is lack of similar research at the TPIs of adult and senior elite international players.

In a more recent study of the New Zealand national team by Quarrie et al. (2013), the physical qualities, actions and movements of 763 players performing between 2004 and 2010 were assessed within international matches. It was determined that forwards were involved more frequently in rucks, scrums, tackles and lineouts whereas backs aimed to gain territory or score points when in possession or prevent their opponents from scoring or gaining territory when not in possession. For example, scrumhalves handled and passed the ball more frequently than FH, while MB performed more tackles than OB. Such findings are in general agreement with previous research that position-specific technical differences exist (Parson & Hughes, 2001; Vivian et al., 2001).

Another approach that research has adopted to define senior elite levels of performance was by evaluating winning and losing (Hughes & White, 1997; Hunter & O'Donoghue, 2001;

Jones et al., 2004; Prim et al., 2006; Ortega et al., 2009; Vaz et al., 2011; Bishop & Barnes, 2013) or successful and unsuccessful teams (Hughes & White, 1997; 2001; Prim & Van Rooyen, 2011). Specifically, it has been demonstrated that successful teams are defined by lineout success (Jones et al., 2004; Hughes & White, 2001; Ortega et al., 2009; Vaz et al., 2010), the number of kicks out of hand (Ortega et al., 2009; Vaz et al., 2011), turnovers conceded (Ortega et al., 2009; Vaz et al., 2011), lose less tackles and achieve a higher number of line breaks (Ortega et al., 2009; Vaz et al., 2011; Bishop & Barnes, 2013). Van Rooyen et al. (2005) indicated that successful performance during the 2003 Rugby World Cup was correlated with possession, points scored in the second half and the likelihood of losing possession in dangerous areas. Jones et al. (2004) indicated that lineout success on opposition ball and tries scored were associated with winning performance during the domestic season of a professional male rugby union team. Although informative, such analyses fails to consider the position-specific contribution of players to team performance (James et al., 2005; Hughes et al., 2012) and there is yet to be an analyses of successful and unsuccessful teams across a range of national squads varying by age; existing data therefore might fail to generalise to various age groups.

In youth and adult rugby union, research has concentrated on the development of specific rugby skills (e.g. catching, throwing, passing for distance, passing for accuracy) across U16 and U18 players (Spamer & De la Port, 2006) or evidenced that the older the rugby union players (U13, U16, U18, U19), the fewer the differences within each age group in the physical abilities and rugby-specific skills (e.g. ground skills ability, side step ability, aerial and ground kick ability, passing for distance, passing for accuracy over 4 m and over 7m, kicking ability, kicking off, catching ability while moving) (Van Gent & Spamer, 2005). Consequently, existing research has not appraised the TPI at youth and adult rugby union players which could inform talent selection and retention within the EPPP. Such evidence might help coaches and scouts to realize the technical factors that define youth and adult elite international players within the TDE system and as such to adapt the training process. While the TPIs could be used as benchmarks in the selection process for assessing youth, adult and senior elite international players.

In addition to considerations regarding the TPIs, rugby union demands a particular set of anthropometrical attributes for each position (Fuller et al., 2013). Several researchers have revealed specific anthropometry that define rugby union players aged 16 to 20 years old (Van Gent & Spamer, 2005; Darrall- Jones et al., 2015a, 2015b; Read et al., 2016). For example, analyses of the anthropometry at youth and adult ages of development revealed that U21 (186.7 ± 6.61 cm) and U18 (183.5 ± 7.2 cm) were moderately taller than U16 (178.8 ± 7.1 cm), while U21 (98.3 ± 10.4 kg) and U18 (88.3 ± 11.9 kg) were significant heavier than U16 (79.4± 12.8 kg) (Darrall-Jones et al., 2015a) reinforcing the importance of specific body types in rugby union.

Research has also evidenced that heavier and taller players are selected to senior squads as it is believed such players are better able to cope with the higher incidence of tackles at this level (McIntosh et al., 2010). Owing to the specific anthropometrical qualities that define senior elite players, Sedeaud et al. (2012) demonstrated that forwards of the winning teams during the 1987-2007 season in the rugby World Cups were heavier (~107kg) while taller backs (~182cm) participated in winning teams during the World Cups. Likewise, Holway and Garavaglia (2009) compared 133 players from the Buenos Aires Rugby Union championship to those of the RWC 2003 and established world cup players were heavier and taller than the national players of Buenos Aires across all positional groups. Collectively, the existing research therefore outlines the importance of anthropometry and so, any analyses of a talent programme might benefit by determining the anthropometrical characteristics of respective squads. Such evidence may act as strong predictors for future success and may differentiate players of different ability levels.

Selecting youth and adult athletes with the potential to perform at senior elite level, remains challenging in team sports (Barreiros et al., 2014), since the existing research addressing youth and adult levels of performance (Van Gent & Spamer, 2005) has documented little information about the traits underpinning success at the international level of the game. Ultimately, in rugby union, the construction of individual performance profiles, by utilization of common and positional technical performance characteristics appears a worthwhile area of investigation (Hughes & Bartlett, 2002) since rugby union is described as a sport that includes both positional and general skills (Greenwood, 1997; James et al., 2005). Indeed, research has failed to provide normative values across a range of youth, adult and senior squads at the international level of the game where TPIs and anthropometry are considered. Greater knowledge of such variables in youth, adult and senior age international players could help coaches, scouters and support staff in evaluating the specific qualities needed at each age supporting the identification, progression and de-selection processes of the EPPP. A fundamental endeavour of the EPPP is to ensure progression from one team to the subsequent squad, such normative values therefore support the appropriate developmental plan for the players to maximise the likelihood of continued selection. Therefore, the aim of the study was to establish the position-specific TPIs and anthropometrical qualities of youth, adult and senior age players within the EPPP.

4.3 Methods

4.3.1 Participants

Elite male rugby union players (n = 396) of different age representative squads (U18, U20, NA [age: 18-23 years], Saxons [18+ years] & SNS [18+years]) within England's EPPP were assessed within their specific playing positions (FR, SR, BR, SH, IB, OB). The analysis consisted of 1,941 performances in total, derived from various tournaments such as Churchill Cup, Six Nations, England Autumn Internationals, England Summer tour, RWC Warmup, RWC 2011 and Junior World Championships. Ethical approval for the study was granted by the Faculty of Applied Sciences Ethical Committee at the University of Chester.

4.3.2 Player Grouping

To enable data analysis, all players in the representative squads were assigned to one of six positional groups (adapted from Duthie et al., 2005; Deutsch et al., 2007; Roberts et al., 2008) though the SH were assigned a category of their own due to their unique role within the game (Duthie et al., 2005, Deutsch et al., 2007, Roberts et al., 2008). Thus, the groups were as follows: FR (loose-head prop, hooker, and tight-head prop), SR (left lock, right lock), BR (blindside flanker, open side flanker, and number8), SH, IBs (FH, inside centre, and outside centre) and OB (left wing, right wing and fullback) (Table 4.1).

Table 4.1. Sample size (n) within the six positional groups, across all squads.

	Front row (n)	Second row (n)	Back row (n)	Scrumhalf (n)	Inside Backs (n)	Outside Backs (n)
U18	81	54	101	24	77	94
U20	63	41	88	16	87	102
NA	38	19	53	4	40	35
Saxon	72	59	124	19	107	98
SNS	66	53	92	27	105	94

4.3.3 Procedure

All data were collected from the RFU ‘Elite Hub’ and TPIs were previously identified and agreed by the England Rugby senior coaching team, and the senior performance analysts from PGIR Ltd. A coding template was created after reviewing previous rugby union literature (Gabbett et al., 2008; Gabbett et al., 2009; Ortega et al., 2009; Vaz et al., 2010; 2011; Hughes & Bartlet, 2012, Hughes et al., 2012; Bishop & Barnes, 2013; Higham et al., 2014; Bennett et al., 2016; Sasaki, 2016) to classify the performance indicators into playing experience, offensive and defensive skills, handling, set piece and possession. Table 4.2 details the common (applicable to all positions) and Table 4.3 displays the position-specific TPIs that were assessed within the current research. Operational definitions for each of the TPIs are presented in Appendix 3.

Table 4.2. The common Technical Performance Indicators.

Anthropometrical	Playing experience	Defensive	Offensive	Possession	Handling
Body stature (cm)	Total Matches (number)	Total Tackles (number)	Total Carries (number)	Total Possessions (number)	Passes (number)
Body mass (kg)	Total Minutes	Missed Tackles (number) Tackle Completion (%) Total Breakdown (number) Total Clear-outs (number) Clear-out efficiency (%) Rebounds (%)	Total Carries (%) Pick & Go (number)		Total Passes (number) Pass – (number) Pass + (number) Pass Completion (%)

Note: 'number' number of occurrences; '%' the percentage of each performance.

Table 4.3. The position-specific Technical Performance Indicators.

Front row		Second row		Back row		Scrumhalf Inside backs Outside backs
Set Piece	Possession	Set Piece	Possession	Set Piece	Possession	Offensive
Total Scrums (number)	Lineout won (number) Lineout lost (number) Lineout success (%)	Total Scrums (number)	Lineout won (number) Lineout lost (number) Lineout success (%) Lineout steal (number)	Total Scrums (number)	Lineout won (number) Lineout lost (number) Lineout success (%) Turnover steal (number)	Total Kicks (number) Kick neutral(number) Kick + (%) Kick – (%)

Note: 'number' number of occurrences; '%' the percentage of each performance.

4.3.4 Data transformation

A rugby match lasts 80 minutes though the duration that an individual contributes to the game may vary owing to match-related factors such as substitution or injury. Consequently, the data was adjusted to account for the varying match durations a player completed using 'full game equivalents' (FGE) which were calculated as follows (James et al., 2005):

FGE= ${}^{n}/_{80\ minutes}$

Where 'n' is the number of minutes played.

Subsequently, the normalization of the data was completed using:

Data normalization = ${}^{nr}/_{FGE}$

Where 'number' is the number of instances of a TPI.

4.3.5 Data analysis

Initially, diagnostic tests (Shapiro-Wilk & Levene's test for equality of variance) were performed on the distributions of all the dependent variables to check the assumptions of normality and homogeneity of variance. As most (FR: 70%, SR: 96%, BR: 80%, SH: 30%, IB: 38%, OB: 73%) variables did not satisfy these conditions, descriptive data is presented as medians and inter-quartile ranges (IQR). Comparisons between the five squads were achieved using Kruskal-Wallis and post-hoc Mann-Whitney U tests (Jones et al., 2004; James et al., 2005).

Owing to the high number of one-way comparisons, control over the increased risk of type I errors associated with multiplicity testing was established using the step-up False Discovery Rate (FDR) (Benjamini & Hochberg, 1995). The approach controls the rate of rejecting false null hypotheses, and is a more powerful approach than controlling the family wise error rate (FWER), which is widely acknowledged as excessively conservative (Benjamini & Hochberg, 1995; Benjamini & Yekutieli, 2001; Garcia, 2003; Moran, 2003; Verhoeven, Simonsen, & McIntyre, 2005). Initially, P-values were ranked in ascending order, with 'j' being the resulting rank. Proceeding from j = n to j = 1, the first P-value (defined as 'k') satisfying $P \leq j * \alpha/n$ was identified. Once this was established, null hypotheses equalling j ≤ k were rejected whilst all other hypotheses accepted. Hence, for a group of related Mann-Whitney U tests (i.e. age representative squads), the P-value was adjusted to a more stringent criterion compared to the typical alpha of 0.05.

Furthermore, to report the observed magnitude of the difference, effect sizes were calculated using the following equation (Field, 2013):

$$r = \frac{z}{\sqrt{n}}$$

where 'z' was the z-score produced during the Mann-Whitney U test and 'n' the sample size of each positional group. Effect sizes were deemed as: small ≥ 0.1, medium ≥ 0.3, and large ≥ 0.5. All statistical analyses were performed using SPSS (Version 20, Armonk, NY) and Microsoft Excel (Version 2013, Redmond, WA).

4.3.6 Inter and Intra-rater Reliability

Intra and inter-observer reliability was appraised for each of the 26 TPIs (see Appendix 4) using the percentage error calculation (Hughes et al., 2002) and the overall strength of agreement established using the kappa statistic (Bloomfield, Polman, & O'Donoghue, 2007). The acceptable limits of error (i.e. % difference) used across all TPIs was 90% (O'Donoghue, 2007) given its use in several other studies including those appraising rugby union performance (James et al., 2005). Moreover, with rugby union a stochastic and complex environment (Glazier & Robins, 2013), which increases the difficulty in objectively defining the actions involved. Therefore, some bias is inevitable in research of this nature. Ultimately, application of 90% limits of error as indicative of sufficient consistency infers that a single error in 10 instances of an action is permissible which seemingly suffice in differentiating successful and unsuccessful performances given the notable differences between winning and losing teams (Hughes et al., 2012). Based on Altman (1991, p 404, in O'Donoghue, 2012) values of 0.8 or above signified a very good strength of agreement, values between 0.6 and 0.8 represent a good strength of agreement, between 0.4 and 0.6 a moderate, between 0.2-0.4 a fair and if less than 0.2 a poor strength of agreement. Given that the analysis concerned position-specific TPIs, it was deemed necessary to analyse one match for each of the six positional groups. For intra-observer reliability, the performance analyst trained by PGiR re-analysed the same six performances under test-retest conditions separated by one-week to reduce the influence of recall (Portney & Watkins, 2000; Cooper, Hughes, O'Donoghue, & Nevill, 2007). For inter-observer reliability, the data generated by the PGiR performance analysts was contrasted to an impartial analyst trained by PGiR.

The overall results indicated near-perfect agreement with regard to intra (Table 4.4) ($k > 0.9$) and inter-observer ($k > 0.8$) reliability (Table 4.5) and the percentage error calculation, in the main, suggested the analyses was sufficiently consistent to enable detection of important changes in TPIs across respective squads. However, there was a moderate strength of agreement ($k > 0.4$) related to the IB positional group and there remained some instances (e.g. IB total clear-outs 14.3%, total breakdowns 26.6%) where error was beyond the tolerance of 10%. However, this was typically a facet of infrequent occurrences (Cooper at al., 2007) augmenting the percentage error.

Table 4.4. Summarised intra-observer agreement (i.e. % difference) for the six positional clusters.

	Front row	Back row	Second row	Scrumhalf	Inside backs	Outside backs
Defensive						
Total Tackles	0	0	0	0	0	0
Missed Tackles	0	0	0	0	0	0
Total Clear-outs	5.13	**16**	0	0	0	10.5
Total Breakdowns	4.4	0	0	0	0	10.5
Offensive						
Total Carries	0	3	0	0	0	10.5
Pick and Go	0	0	0	0	0	0
Handling						
Passes	0	**66.7**	0	0	0	0
Passes +	0	2	0	0	0	**66.7**
Passes -	0	0	0	0	0	0
Set piece						
Total Scrums	0	100	0	0	N/A	N/A
Positional Possession						
Total Possession	0	5	0	0	0	0
Lineout won	N/A	23	0	N/A	N/A	N/A
Lineout lost	N/A	17	0	40	N/A	N/A
Lineout steal	N/A	N/A	0	0	N/A	N/A
Turnover steal	N/A	0	N/A	N/A	N/A	N/A
Offensive						
Total Kicks	NA	NA	N/A	0	N/A	0
Kick neutral	N/A	N/A	N/A	**66.7**	0	0
Kappa	**0.97**	**1.00**	**1.00**	**0.97**	**1.00**	**0.93**

Note: N/A = not applicable for the given position.

Table 4.5. Summarised inter-observer agreement (% difference) for the six positional clusters.

	Front row	**Back row**	**Second row**	**Scrumhalf**	**Inside backs**	**Outside backs**
Defensive						
Total Tackles	0	0	**13.3**	**40**	**40**	**40**
Missed Tackles	**200**	**200**	0	0	0	0
Total Clear-outs	5.4	0	**15.4**	**18.2**	**14.3**	0
Total Breakdowns	**20**	**42.1**	**28.6**	**18.2**	**26.6**	0
Offensive						
Total Carries	0	**28.6**	0	**100**	**200**	0
Pick and Go	0	**200**	0	0	0	0
Handling						
Passes	40	0	**66.7**	1.9	**200**	**46.2**
Passes +	0	0	0	**200**	0	**200**
Passes -	**200**	0	**200**	**100**	0	**200**
Positional						
Set piece						
Total Scrums	**12.5**	0	0	N/A	N/A	N/A
Offensive						
Total Kicks	N/A	N/A	N/A	0	0	0
Kick neutral	N/A	N/A	N/A	100	0	0
Possession						
Total Possession	0	0	0	0	**200**	**28.6**
Lineout won	N/A	0	0	N/A	N/A	N/A
Lineout lost	N/A	0	0	N/A	N/A	N/A
Lineout steal	N/A	N/A	0	N/A	N/A	N/A
Turnover steal	N/A	0	N/A	N/A	N/A	N/A
Kappa	**0.84**	**0.83**	**0.84**	**0.87**	**0.42**	**0.81**

Note: N/A = not applicable for given position. All results over the 10% range are in bolded font.

4.4 Results

Front row

A Kruskal-Wallis test revealed significant differences across squads where body mass and stature was concerned (H (4) = 23.852; H (4) = 33.725; both $p = 0.001$). Post-hoc analyses identified that SNS players were taller than U18 ($p \leq 0.001$; $r = 0.43$), U20 ($p \leq 0.001$; $r = 0.35$) and Saxons ($p \leq 0.001$; $r = 0.25$) and heavier than U18 ($p \leq 0.01$; $r = 0.38$), U20 ($p \leq 0.001$; $r = 0.31$), NA (106 kg; $p \leq 0.01$; $r = 0.24$) and Saxons ($p \leq 0.01$; $r = 0.18$). However, Saxons players were shorter than U18 ($p \leq 0.05$; $r = 0.18$), whilst NA players were taller than U18 FR ($p \leq 0.001$; $r = 0.29$).

When comparing only the SNS with U20 and NA squads, typically there were differences across defensive, offensive, handling, possession and set piece TPIs (see Table 4.6 for specific differences). Particularly, in terms of possession actions, SNS won the lineout more times than U18 ($p \leq 0.001$; $r = 0.36$), U20 ($p \leq 0.001$; $r = 0.55$) and NA ($p \leq 0.01$; $r = 0.49$) players. In defensive actions, the SNS performed a higher number of total clear-outs ($p \leq 0.01$; $r = 0.19$) and breakdowns ($p \leq 0.01$; $r = 0.28$), though they evidenced a lower rebound rate ($p \leq 0.01$; $r = 0.49$) when compared to the U20s.

Further results indicated that the Saxon team differed in the positional TPIs relevant to possession and set piece compared to the other groups, for example, Saxons FR evidenced a higher number of lineouts won than U18 ($p \leq 0.01$; $r = 0.18$) and U20 ($p \leq 0.05$; $r = 0.21$). Interestingly in five of the seven defensive actions Saxons differed with U18, U20 and NA, for example, a lower rebound rate than U18 ($p \leq 0.01$; $r = 0.18$), U20 ($p \leq 0.001$; $r = 0.28$) and NA players ($p \leq 0.01$; $r = 0.28$) was indicated. More specific differences in offensive and possession actions are displayed in Table 4.6. Moreover, NA differed in one set piece and in one defensive action when compared to the U18 team, NA performed fewer scrums ($p \leq 0.01$; $r = 0.13$) and had a higher clear-out efficiency ($p \leq 0.01$; $r = 0.27$) compared to U18 players. No other significant differences were established between Saxons and SNS players, NA and U20 players or U20 and U18 players. Further results are presented in Table 4.6 (see Appendix 5 for effect sizes).

Table 4.6. Typical performances across U18, U20, NA, Saxon and SNS for FR players.

	U18^{+} (n = 81)	IQR	U20* (n = 63)	IQR	NA$^{\wedge}$ (n = 38)	IQR	Saxons$^{\sim}$ (n = 72)	IQR	SNS (n = 66)	IQR
Anthropometrical										
Body stature (cm)	1.83	(1.78-1.86)	1.82	(1.80-1.84)	1.84^{+S*S}	(1.83-1.86)	1.83^{+S}	(1.78-1.85)	$1.85^{+L*M\sim S}$	(1.77-1.88)
Body mass (kg)	105	(97-110)	106	(101-110)	106	(101.5-111)	102	(100-108)	$111^{+M*M\wedge M\sim S}$	(101-111)
Playing experience										
Total Matches	4	(2-5)	6^{+S}	(2-9)	7^{+L*M}	(3.5-17)	17^{+L*L}	(13-25)	$26^{+L*L\wedge L\sim S}$	(17.5-28.3)
Total Minutes	109	(35-193)	193	(41.5-414.5)	386^{+L*M}	(200.5-630.5)	$903^{+L*L\wedge M}$	(394-1340)	$1259.5^{+L*L\wedge L\sim S}$	(886.8-1664.5)
Defensive										
Total Tackles	10.9	(8.7-16)	10.8	(7.8-13.83)	13.6	(10.5-18.7)	12.5	(8.9-14.7)	12.5	(10.3-14.3)
Missed Tackles	0.3	(0-1.3)	0.6	(0-3.1)	0.4	(0.1-4.0)	0.7	(0.1-3.2)	0.7	(0.2-2.5)
Tackle Completion (%)	97.7	(87.5-100)	91.3	(77.7-100)	94.1	(82.4-99.5)	94.6	(87.5-99)	94.1	(82.7-98.6)
Rebound (%)	70	(60-83)	75	(56-82)	65	(61-75.5)	$55^{+S*S\wedge S}$	(49-67)	64^{*S}	(52.5-71.3)
Total Clear-outs	15.7	(10-24)	13.4	(8.1-16.5)	18.5	(14.9-20.7)	20.6^{*S}	(13.5-25.1)	16.7^{*S}	(13.9-20.6)
Total Breakdowns	15.7	(10-24)	12.6	(8.1-15.9)	18.1	(14.5-20.7)	19^{*S}	(12.8-24.4)	16.3^{*S}	(13.4-19.9)
Clear-out efficiency (%)	91	(83-96)	95	(80-100)	96^{+S}	(93.5-97)	$92^{\wedge S}$	(91-95)	93.5^{+S}	(91.8-95)
Offensive										
Total Carries	6.4	(3.2-9.6)	6.3	(4.4-9.5)	6.5	(5.4-10.1)	$6.5^{*S\wedge M}$	(4.5-8)	$7.1^{*S\wedge S}$	(4.6-8.2)
Total Carries (%)	70	(50-90.6)	59.1	(42.7-83.1)	81.8	(64.8-90.1)	65	(52.1-75)	68.6	(61.3-74.8)
Pick and Go	0.9	(0-1.5)	0.4	(0-1.2)	0.63	(0.2-1.7)	0.9	(0.6-1.8)	0.8	(0.5-1.6)

	$U18^{+}$	IQR	$U20^{*}$	IQR	$NA^{\wedge}$	IQR	$Saxons^{\sim}$	IQR	SNS	IQR
Handling										
Passes	1.8	(0.6-3.3)	1.9	(0.1-3.6)	1.1	(0.4-2.8)	1.6	(1.0-1.9)	1.7	(1.1-2.5)
Passes +	0	(0-0)	0	(0-0)	0^{+S}	(0-0.2)	0^{+S}	(0-0.1)	0.1^{+S}	(0-0.2)
Passes -	0	(0-0)	0	(0-0)	0^{+S}	(0-0.1)	0^{+S}	(0-0.2)	0.1^{+M}	(0-0.2)
Total Passes	1.8	(0.6-3.5)	2.2	(0.1-3.6)	1.3	(0.4-3.2)	1.7	(1.2-2.1)	1.8	(1.3-2.9)
Pass Completion (%)	100	(75-100)	100	(37.5-100)	100	(87.2-100)	94.7	(88.2-100)	95.5	(89.9-100)
Possession										
Total Possessions	7.6	(5-13.0)	10.31	(4.7-13.1)	9.77	(6.2-12.5)	9.5	(7.4-10.7)	10	(7.5-11.6)
Positional										
Set Piece										
Total Scrums	22.5	(19.1-29.6)	19.2	(0-25.1)	18.3^{+M}	(0-22.4)	17.4^{+M}	(0-20.2)	19^{+S}	(15.2-20.2)
Possession										
Lineout won	5.8	(1.6-8.3)	7	(0-9.3)	8.8	(5-10.3)	10.2^{+S*S}	(8.2-10.9)	$10.8^{+M*L\wedge L}$	(9.5-11.7)
Lineout lost	0.8	(0-2.0)	0.8	(0-2.6)	1.8	(0.8-2.8)	1.7	(0.9-1.9)	1.7	(1.5-2)
Lineout success (%)	75	(50-90.9)	74.6	(0-90.1)	80	(72.5-84.9)	85.2	(80.5-87.4)	86.4	(82.9-88.1)

Significant differences at $P \leq 0.05$ were subjected to the FDR. Total matches and minutes were not transformed. All defensive, offensive, possession and set piece actions were transformed into 80 minutes match play. Significant difference vs. $^{+}$ U18; * U20; $^{\wedge}$ NA; $^{\sim}$ Saxons. Effect sizes: Small (^{S}) ≥ 0.1-0.29, Medium (^{M}) ≥ 0.3-0.49, Large (^{L}) ≥ 0.5 (O'Donoghue, 2012).

Second row

In terms of anthropometrical characteristics, the SNS ($p \leq 0.01$; $r = 0.26$), Saxons ($p \leq 0.05$; $r = 0.24$) and NA players ($p \leq 0.01$; $r = 0.32$) were heavier than those of the U18 team. Furthermore a Kruskal-Wallis test revealed significant differences across squads in positional set piece and possession TPIs where total scrums ($H (4) = 14.382$; $p = 0.006$) and lineout lost ($H (4) = 10.726$; $p = 0.03$) was concerned. Post-hoc analyses identified that SNS players' demonstrated lower performance in scrums (both $p \leq 0.01$; both $r = 0.28$) and lost more lineouts ($p \leq 0.02$; $r = 0.22$) than U18. When SNS players were assessed for offensive actions, they performed fewer pick and go actions than NA ($p \leq 0.001$; $r = 0.39$) players.

Saxons evidenced no difference in offensive, defensive and possession actions with any of the other teams. However, they had a lower set piece and possession success than the U18 team, by performing fewer scrums ($p \leq 0.01$; $r = 0.28$) and losing more lineouts ($p \leq 0.05$; $r = 0.18$) than U18. When comparing only the NA to U18 and U20 squads, typically there were differences across offensive and possession TPIs (see Table 4.7 for specific differences). For example, the NA players performed the pick and go more frequently than members of the U20 ($p \leq 0.01$; $r = 0.38$) and U18 ($p \leq 0.01$; $r = 0.32$) squads whilst NA players lost the lineouts more frequently ($p \leq 0.05$; $r = 0.29$) than U18 players. No differences were established when comparing the Saxons and U20 SR to the SNS SR. No significant differences were revealed between Saxons and NA SR, or between U20 and U18 SR. Further results are presented in Table 4.7 (see Appendix 5 for effect sizes).

Table 4.7. Typical performances across U18, U20, NA, Saxon and SNS for SR players.

	U18⁺ (n = 54)	IQR	U20* (n = 41)	IQR	NA^ (n = 19)	IQR	Saxons~ (n = 59)	IQR	SNS (n = 53)	IQR
Anthropometrical										
Body stature (cm)	1.97	(1.93-1.99)	1.98	(1.95-2), n = 40	1.98	(1.95-2)	1.98	(1.95-1.98)	1.97	(1.95-2)
Body mass (kg)	109	(105.8-115)	110.50	(104.5-115), n = 40	112^{+M}	(110-120)	112^{+S}	(109-116)	114^{+S}	(109.5-117)
Playing experience										
Total Matches	2.5	(1-5.3)	4.5	(2-8.8)	9^{+L}	(3-20)	13^{+L*M}	(3-23)	16^{+L*M}	(2-25.5)
Total Minutes	92.5	(35-282)	225	(32-625.3)	542^{+L}	(107-1155)	832^{+L*M}	(148-1413)	988^{+L*M}	(110-1532.5)
Defensive										
Total Tackles	11.72	(6.5-16)	10.76	(7-16)	12.7	(8.7-17.5)	11.3	(8.2-15.4)	14.2	(10.7-17.3)
Missed Tackles	0.3	(0-2.1)	0.5	(0-2.7)	0.5	(01.-4.6)	0.5	(0-2.4)	0.8	(0-6.9)
Tackle Completion (%)	97.6	(81.7-100)	95.7	(66.9-100)	96.5	(85.7-99.3)	96.2	(77.8-100)	94.1	(74.2-100)
Rebound (%)	44.5	(19.8-60)	54.5	(41.3-74)	53	(42-60)	52	(42-71)	6	(46-70.5)
Total Clear-outs	21.6	(16-24.9)	19	(13.9-22.6)	20.9	(15.5-25.6)	21.1	(16.6-23.4)	18.8	(15.6-23.3)
Clear-out efficiency (%)	93	(87.8-100)	92	(88-96)	95	(92-96)	95	(92-97)	94	(92-96)
Total Breakdowns	19.68	(14.9-24.9)	18.51	(13.2-22.5)	19.9	(14.3-24.6)	20.5	(16-22.9)	18.5	(15.3-22.5)
Offensive										
Total Carries	4.8	(2.7-5.8)	4.5	(2.9-7)	6.1	(4.9-7)	4.6	(3.2-6.9)	4.7	(3.7-6)
Total Carries (%)	50	(29.7-70.4)	46.2	(29.1-66.2)	57.1	(51.5-64.7)	49.5	(37.3-59.2)	49	(41.4-58.2)
Pick and Go	0.1	(0-1.1)	0.2	(0-0.6)	0.9^{+M*M}	(0.6-1.4)	0.4	(0-0.8)	$0.4^{\wedge M}$	(0.2-0.7)

	U18^{+}	**IQR**	**U20***	**IQR**	**NA$^{\wedge}$**	**IQR**	**Saxons$^{\sim}$**	**IQR**	**SNS**	**IQR**
Possession										
Total Possessions	8	(5.8-10.7)	9.2	(6.3-12.8)	10.4	(9.4-13.3)	9.7	(7.7-13.3)	9.9	(8-12.7)
Handling										
Passes	1	(0-2.2)	1.1	(0.1-2.4)	1.7	(0.9-2.3)	1.6	(0.7-2.5)	1.7	(1.2-2.4)
Passes +	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0)	0	(0-0.1)
Passes -	0	(0-0)	0	(0-0)	0^{+M*M}	(0-0.3)	0^{+S*S}	(0-0.2)	0^{+M*S}	(0-0.2)
Total Passes	1.2	(0-2.4)	1.4	(0.1-2.4)	1.9	(0.9-2.8)	1.7	(0.9-2.5)	1.9	(1.3-2.5)
Pass Completion (%)	91.8	(0-100)	100	(16.7-100)	90	(80-97.3)	94.9	(85.2-100)	94.9	(88.2-100)
Positional										
Set piece										
Total Scrums	22.5	(15.8-26.3)	19.8	(1.5-23.4)	20.4	(0-22.2)	17.8^{+S}	(0-21.5)	18.4^{+S}	(5.1-21.1)
Possession										
Lineout won	2	(0-3.4)	2	(0-3.6)	2.4	(0.2-3.7)	2.9	(0-3.6)	2.2	(0.2-3.5)
Lineout lost	0	(0-0.3)	0	(0-0.4)	0.2^{+S}	(0-0.3)	0.2^{+S}	(0-0.5)	0.2^{+S}	(0-0.5)
Lineout success (%)	85.4	(0-100)	82	(0-100)	83.8	(50-93)	87.7	(0-93.8)	87.4	(73.9-93.7)
Lineout steal	0	(0-0.5)	0	(0-0.4)	0.1	(0-0.6)	0.3	(0-0.5)	0.2	(0-0.5)

Significant differences at P≤0.05 were subjected to the FDR. Total matches and minutes were not transformed. All defensive, offensive, possession and set piece actions were transformed into 80 minutes match play. Significant difference vs. $^{+}$ U18; * U20; $^{\wedge}$ NA; $^{\sim}$ Saxons. Effect sizes: Small (^{S}) ≥ 0.1-0.29, Medium (^{M}) ≥ 0.3-0.49, Large (^{L}) ≥ 0.5 (O'Donoghue, 2012).

Back row

A comparison of BR performances across the EPPP squads is presented below (Table 4.8). A Kruskal-Wallis test revealed significant differences across squads where body mass and stature was concerned (H (4) = 59.419; H (4) = 18.775; both $p \leq 0.001$). Post-hoc analyses identified that SNS ($p \leq 0.001$; r = 0.31) and Saxon ($p \leq 0.05$; r = 0.17) players were taller than U18, and SNS were heavier than U18 ($p \leq 0.001$; r = 0.50), U20 ($p \leq 0.001$; r = -0.30) and Saxons ($p \leq 0.01$; r = -0.20). Likewise, the Saxons ($p \leq 0.001$; r = 0.37) and U20 ($p \leq 0.001$; r = 0.25) possessed a higher body mass than U18 players while analyses established that NA had a higher body mass ($p \leq 0.001$; r = 0.29) and stature ($p \leq 0.05$; r = 0.20) than U18.

When evaluating TPIs, SNS players performed more defensive actions than the U18 players, and more offensive actions than U20 yet less than the NA team (for further details see Table 4.7). Where positional possession TPIs were appraised, the SNS players won more lineouts than U18 ($p \leq 0.001$; r = 0.41), U20 ($p \leq 0.001$; r = 0.29) and NA ($p \leq 0.001$; r = 0.27) players and evidenced a higher lineout success rate than U18 ($p \leq 0.001$; r = 0.33) and U20 ($p \leq 0.001$; r = 0.25) players. No differences were observed between SNS and Saxon BR players.

When analysing the positional set piece and possession TPIs for the Saxon team, Saxons performed fewer scrums ($p \leq 0.001$; r = 0.25) and executed fewer turnover steal ($p \leq 0.01$; r = 0.22), while they won more lineouts ($p \leq 0.001$; r = 0.22) and had a higher lineout success rate ($p \leq 0.05$; r = 0.18) compared to the U18s. Further analyses in offensive and defensive actions revealed that the Saxons performed an increased number of pick and go movements compared to the U20 ($p \leq 0.001$; r = 0.24), though they evidenced a lower rebound rate ($p \leq 0.001$; r = 0.26) than NA players. Furthermore, in the positional possession actions Saxons revealed a higher turnover steal ($p \leq 0.05$; r = 0.22) than NA. Moreover, the NA were distinguished in two of the seven defensive actions from

U18, and displayed an increased rebound ($p \leq 0.01$; $r = 0.23$) and clear-out rate (%) ($p \leq 0.01$; $r = 0.25$) in contrast to the U18 players. However, NA seemed to be better in possession and offensive skills than U18 and U20, by revealing an increased frequency in turnover steal ($p \leq 0.01$; $r = 0.19$, $p \leq 0.01$; $r = 0.25$, for U18 and U20, accordingly), and by carrying the ball more times ($p \leq 0.01$; $r = 0.24$) than U20. Further results are presented in Table 4.8 (see Appendix 5 for effect sizes).

Table 4.8. Typical performances across U18, U20, NA, Saxon and SNS for BR players.

	U18^{+} (n = 101)	**IQR**	**U20* (n = 88)**	**IQR**	**NA$^{\wedge}$ (n = 53)**	**IQR**	**Saxons$^{\sim}$ (n = 124)**	**IQR**	**SNS (n = 92)**	**IQR**
Anthropometrical										
Body stature (cm)	1.88	(1.86-1.93)	1.91^{+S}	(1.88-1.96)	1.90^{+S}	(1.88-1.95)	1.91^{+S}	(1.86-1.96)	1.93^{+M}	(1.88-1.95)
Body mass (kg)	101	(95-107.8)	104	(100-110.8)	107^{+S}	(100-112)	107^{+M}	(103-112)	110^{+L*M}	(106-114)
Playing experience										
Total Matches	2	(1-5)	3	(1-9)	4^{+S}	(2-10.50)	$14^{+L*M\wedge M}$	(4-23.8)	$11.5^{+M*M\wedge S}$	(2.3-22)
Total Minutes	105	(50-217.5)	160	(40.5-497.8)	263^{+S}	(37-638)	$899.5^{+L*M\wedge M}$	(182-1430)	$704.5^{+M*M\wedge S}$	(80.5-1571.8)
Defensive										
Total Breakdowns	18.6	(12.8-24.7)	16.1	(12.4-21.9)	19.1	(13.6-25)	17.4	(13.5-21.8)	17.1	(14.4-20)
Total Tackles	13.7	(9.3-17.8)	14.8	(11-18.8)	13.4	(10.9-19.1)	14.5	(11.4-20)	15.4	(12.7-19.4)
Missed Tackles	0.4	(0-2.1)	0.1	(0-3.5)	0.7	(0-5.1)	1.1^{+S}	(0-2.7)	0.6^{+S}	(0-3.2)
Tackle Completion (%)	96.8	(888.6-100)	98.9	(70.6-100)	94.4	(72.5-100)	93.8	(85.3-100)	96.1	(81.9-100)
Rebound (%)	53.5	(33-70.5)	57.5	(40.5-78.8)	66^{+S}	(51-75.5)	$54.5^{\wedge S}$	(0-69.3)	59^{+S}	(50-71.8)
Total Clear-outs	19.4	(13.4-24.8)	16.2	(12.8-22.1)	19.8	(13.6-25.1)	18	(13.7-22.5)	17.5	(14.7-21)
Clear-out efficiency (%)	93	(88-96.8)	93	(90-97)	96^{+S}	(92.5-100)	94	(91-97)	95^{+S}	(93-97.8)
Offensive										
Total Carries	6.5	(4.5-9.7)	5.6	(3.3-8.5)	8^{*S}	(5.1-11.6)	6.6	(4.6-10.6)	5.7^{*S}	(3.8-8)
Total Carries (%)	60	(41.5-79.6)	60	(35.4-74)	66.1	(56.7-80.9)	61	(49.9-73.1)	58.2	(50-66.7)
Pick and Go	0.6	(0-2.2)	0.5	(0-1.4)	0.8	(0-2.2)	0.9^{*S}	(0.3-1.9)	1.2^{*S}	(0.3-2)

	U18^{+}	IQR	U20*	IQR	NA$^{\wedge}$	IQR	Saxons$^{\sim}$	IQR	SNS	IQR
Possession										
Total Possessions	9.9	(6.7-15.5)	9.6	(6.6-13.2)	11.5	(8-16.1)	11.1	(7.6-16.1)	12^{*S}	(9.2-16.8)
Handling										
Passes +	0	(0-0)	0	(0-0)	0^{+S}	(0-0.1)	0^{+S}	(0-0.1)	0^{+S*S}	(0-0.1)
Passes -	0	(0-0)	0	(0-0)	0^{+S*S}	(0-0.3)	0	(0-0.2)	0.1^{+S*M}	(0-0.3)
Total Passes	2.5	(1.1-4.6)	2.1	(0.6-3.3)	2.4	(1-3.4)	2.3	(1.2-4)	2.7	(1.4-4.5)
Pass Completion (%)	100	(75-100)	100	(76.3-100)	94.4	(83.9-100)	96.4	(88.2-100)	93.7	(87.7-100)
Positional										
Set piece										
Total Scrums	21.2	(0-25.8)	18.9	(0-21.8)	16.7	(0-21.5)	15.6^{+S}	(0-20)	17.7^{+S}	(12.4-20.1)
Possession										
Lineout won	0	(0-0.8)	0.3	(0-1.2)	0.3	(0-1)	0.4^{+S}	(0-1.8)	$1^{+M*S\wedge S}$	(0.2-2.7)
Lineout lost	0	(0-0)	0	(0-0.2)	0	(0-0.2)	0^{+S}	(0-0.1)	0^{+M}	(0-0.3)
Lineout success (%)	0	(0-100)	60	(0-100)	66.7	(0-100)	81.9^{+S}	(0-100)	90.5^{+M*S}	(0-100)
Turnover steal	0	(0-0.4)	0	(0-0.2)	0.2^{+S*S}	(0-0.5)	$0^{\wedge S}$	(0-0.2)	0.1	(0-0.3)

Significant differences at P≤0.05 were subjected to the FDR. Total matches and minutes were not transformed. All defensive, offensive, possession and set piece actions were transformed into 80 minutes match play. Significant difference vs. $^{+}$ U18; * U20; $^{\wedge}$ NA; $^{\sim}$ Saxons. Effect sizes: Small (^{S}) ≥ 0.1-0.29, Medium (^{M}) ≥ 0.3-0.49, Large (^{L}) ≥ 0.5 (O'Donoghue, 2012).

Scrumhalf

In terms of anthropometrical characteristics SNS players were heavier than U18 ($p \leq 0.01$; $r = 0.43$) and Saxons ($p \leq 0.01$; $r = 0.36$). A Kruskal-Wallis test revealed significant differences in positional offensive TPIs across squads where total kicks (H (4) = 12.121; $p = 0.016$) and kick positive rate (H (4) = 12.121; $p = 0.016$) were concerned. Post-hoc analyses identified that SNS players evidenced a higher frequency in total kicks ($p \leq 0.001$; $r = 0.46$) than U18, when compared to the NA team they demonstrated a lower frequency in positive kick rate ($p \leq 0.001$; $r = 0.54$). Although SNS offensive player actions related to kicking performance was higher than U18, SNS evidenced a decreased frequency in defensive actions, by carrying the ball fewer times ($p \leq 0.001$; $r = 0.45$) and by demonstrating a decreased frequency in pick and go movements ($p \leq 0.01$; $r = 0.44$) than the U18 team. Further specific differences in possession actions are displayed in Table 4.9.

Despite the lack of differences that Saxons established in defensive, handling and possession TPIs with the other teams, further analyses revealed specific differences in offensive TPIs only with the U18 players. Specifically, Saxons executed more kicks ($p \leq 0.016$; $r = 0.37$) than U18, though they evidenced a lower frequency of total carries ($p \leq 0.01$; $r = 0.41$), total carry rate ($p \leq 0.05$; $r = 0.38$), and in pick and go actions ($p \leq 0.01$; $r = 0.41$) in contrast to the U18 players. No significant differences were established when comparing the Saxons and U20 to the SNS, or the NA and U20 to the Saxon. Finally, NA displayed no significant difference when compared to the U20 or the U18 players, as well as when comparing the U20 to the U18 players. Further results are presented in table 4.9 (see Appendix 5 for effect sizes).

Table 4.9. Typical performances across U18, U20, NA, Saxon and SNS for SH players.

	U18+ (n = 24)	IQR	U20* (n = 16)	IQR	NA^ (n = 4)	IQR	Saxons~ (n = 19)	IQR	SNS (n = 27)	IQR
Anthropometrical										
Body stature (cm)	1.75	(1.73-1.78), n = 22	1.77	(1.74-1.82)	1.75	(1.71-1.77)	1.75	(1.73-1.80)	1.77	(1.74-1.78)
Body mass (kg)	82	(76.8-85.8), n = 22	85.5	(81-88)	86.5	(78.8-89)	83	(81.5-84.3)	85+M	(83-92)
Playing experience										
Total Matches	5.5	(1.8-6.3)	10.5+L	(5.3-12.8)	9.5	(6.3-19.5)	22+L*M	(6.8-26.5)	24.5+L*M	(16.8-30)
Total Minutes	153	(51-263)	420.5+M	(181.3-579.5)	400	(221-837.8)	1240+M*M	(225.8-1618.5)	1542+L*L	(963-1825.3)
Defensive										
Total Breakdowns	1.5	(0.5-3.8)	1.5	(1-2)	1.2	(0.4-3.1)	1.7	(1.4-3.3)	2.1	(1.5-3.2)
Total Tackles	7	(5.1-9.9)	5.9	(5.3-7.6)	7	(5.6-10.1)	6.9	(5.5-9.3)	7.5	(5.9-9.3)
Missed Tackles	0.7	(0-2.3)	0.8	(0.1-2.8)	0.4	(0-3)	0.6	(0-1.5)	1.2	(0-2.5)
Tackle Completion (%)	87.8	(77.7-100)	88.2	(65.9-99)	93.9	(77.5-100)	90.5	(83.5-100)	86.7	(76.5-99.5)
Rebound (%)	75	(50-90.3)	76	(53.8-81.3)	79.5	(70.3-84.3)	69.5	(58.5-86.5)	68.5	(59.3-78.8)
Total Clear-outs	1.5	(0.5-3.8)	1.5	(1-2)	1.2	(0.4-3.1)	1.7	(1.4-3.3)	2.1	(1.5-3.2)
Clear-out efficiency (%)	64	(24.8-90.3)	76	(62.5-100)	94.5	(67.3-100)	77.5	(67.8-89.3)	77.5	(70.3-82.5)
Offensive										
Total Carries	5.4	(2.7-8.3)	3.5(M), U18	(2.2-4.6)	4.7	(4.1-18.6)	3.2+M	(2.2-4.2)	2.8+M	(2.1-4.3)
Total Carries (%)	8.8	(3.9-10.6)	4.9	(3.1-7.7)	8.2	(0.7-4.3)	4.8+M	(3.6-6)	4.7	(4-5.6)
Pick and Go	2.4	(1.3-4.6)	1.4	(1-2.8)	2.1	(77.5-100)	1.2+M	(0.6-1.7)	1.1+M	(0.8-1.7)

	U18+	IQR	U20*	IQR	NA^	IQR	Saxons~	IQR	SNS	IQR
Possession										
Total Possessions	60.5	(48-79.3)	67.4	(48.4-72.3)	56.5	(43.1-69.1)	65.8	(47.2-74.1)	64.5	(46.8-75)
Handling										
Passes	55.1	(48.3-67.1)	62	(51.8-64.9)	59.8	(54.3-65.4)	54.6	(35.8-61.1)	$54^{+M, (M), U20}$	(37.6-61.5)
Passes +	0	(0-1.1)	0.2	(0-0.9)	1.1	(0.2-1.8)	0.6	(0-0.7)	0.7	(0-1)
Passes -	1.5	(0-2.7)	1.5	(0-2.5)	1.4	(1-1.9)	1.5	(0-2.5)	1.8	(0-2.3)
Total Passes	60.1	(49.9-69.8)	65	(53.3-67.9)	63.2	(55.9-67.7)	56.8	(35.8-64.7)	56.9	(37.6-65.7)
Pass Completion (%)	97.7	(95.1-100)	97.8	(96.2-100)	97.7	(97-98.5)	96.9	(94.9-99)	96.8	(95.2-99.6)
Positional										
Offensive										
Total Kicks	2.9	(2.1-4.7)	4.6	(2.6-5.9)	4.7	(2.2-7.1)	5.9+M	(2.4-7.7)	5.9^{+M}	(4.4-7.4)
Kick neutral	2.3	(0.5-4.6)	3.5	(1.6-5.7)	3.1	(0.8-5.1)	5.1	(2.3-6.9)	4.8	(3.4-6)
Kick + (%)	0	(0-6.3)	1	(0-11.3)	$18.5^{(L), U18}$	(14.9-31.3)	$6^{(M), NA}$	(0-8.5)	$6.5^{\wedge L}$	(0-10.8)
Kick - (%)	12.5	(0-34)	6	(0-15.5)	11.5	(6.5-45.8)	3.5	(0-12)	7	(0-10)

Significant differences at P≤0.05 were subjected to the FDR. Total matches and minutes were not transformed. All defensive, offensive, possession and set piece actions were transformed into 80 minutes match play. Significant difference vs. $^{+}$ U18; * U20; $^{\wedge}$ NA; $^{\sim}$ Saxons. Effect sizes: Small (^{S}) ≥ 0.1-0.29, Medium (^{M}) ≥ 0.3-0.49, Large (^{L}) ≥ 0.5 (O'Donoghue, 2012).

Inside backs

In terms of anthropometrical characteristics, SNS players were taller than U18 ($p \leq 0.001$; $r = 0.29$) and Saxons ($p \leq 0.05$; $r = 0.17$), and heavier than U18 ($p \leq 0.001$; $r = 0.32$) and U20 ($p \leq 0.05$; $r = 0.16$). While, Saxons were heavier ($p \leq 0.001$; $r = 0.29$) compare to the U18 players. A Kruskal-Wallis test revealed significant differences in offensive TPIs across squads where total carries (H (4) = 18.07; $p = 0.001$), and kick positive rate (H (4) = 14.903; $p = 0.005$) were concerned. Post-hoc analyses identified that SNS carried the ball fewer times ($p \leq 0.001$; $r = 0.24$), though evidenced a higher positive kick rate ($p \leq 0.001$; $r = 0.26$) than U18. However, SNS handling actions evidenced a lower number of total passes ($p \leq 0.05$; $r = 0.18$) than U18. When SNS players were compared to the U20 team, the defensive actions of SNS evidenced a higher frequency in total tackles ($p \leq 0.01$; $r = 0.20$) than U20.

Further analyses in the offensive TPIs for the Saxon revealed a lower frequency in total carries ($p \leq 0.001$; $r = 0.25$) than U18. However, Saxons evidenced an increased positive kick rate ($p \leq 0.01$; $r = 0.22$) compared to U18. In contrast to the positional offensive actions, the handling actions of the Saxon team revealed that Saxons executed fewer total passes ($p \leq 0.05$; $r = 0.17$) when compared to the U18 players. No further differences in defensive actions were apparent when the Saxon players were compared with the U18 players. Further results displayed that NA IB differ from the U18 team only in positional offensive actions, for example, NA displayed an increased positive kick rate ($p \leq 0.01$; $r = 0.27$) in contrast to the U18 players. No significant differences were established when comparing the Saxons and NA to the SNS, the NA and U20 to the Saxon squad, the NA to the U20 IB, or the U20 to the U18. Further results are presented in Table 4.10 (see Appendix 5 for effect sizes).

Table 4.10. Typical performances across U18, U20, NA, Saxon and SNS for IB players.

	U18^{+} (n = 77)	**IQR**	**U20* (n = 87)**	**IQR**	**NA$^{\wedge}$ (n = 40)**	**IQR**	**Saxons$^{\sim}$ (n = 107)**	**IQR**	**SNS (n = 105)**	**IQR**
Anthropometrical										
Body stature (cm)	1.83	(1.80-1.85)	1.84	(1.81-1.88)	1.84	(1.80-1.87)	1.83	(1.80-1.86)	1.85^{+S}	(1.83-1.88)
Body mass (kg)	87.5	(84-95)	92	(86-96)	91	(87-94)	92^{+S}	(88-96)	93^{+M}	(89-97)
Playing experience										
Total Matches	2	(1-6)	5	(1-11)	4.5^{+S}	(1-16)	5^{+S}	(2-19)	12^{+M*S}	(1-21)
Total Minutes	105	(57.3-296.5)	257	(40-640)	256^{+S}	(72.5-963.5)	378^{+S}	(68-1291)	827^{+M*S}	(80-1453)
Defensive										
Total Tackles	9	(6.1-11.5)	7.7	(4.4-10.9)	9.8	(7.7-12)	9.4	(6.7-12.3)	10.6^{*S}	(7.1-13.3)
Missed Tackles	0.7	(0-3.6)	0.6	(0-3.3)	0.8	(0.1-4.5)	0.9	(0-4.2)	0.8	(0-5.3)
Tackle Completion (%)	91.5	(66.7-100)	86.7	(52.4-100)	92.6	(57.3-99.3)	91.1	(72.7-100)	92.5	(50-100)
Rebound (%)	74	(60-87.3)	77	(60-88)	76.5	(66.8-86.8)	75	(63-85)	73	(61-82)
Total Clear-outs	6.8	(3.9-9.7)	5.7	(3.6-9.6)	6.5	(3.8-9.4)	6.5	(3-9.5)	6.7	(3.9-10.2)
Clear-out efficiency (%)	87.5	(75-100)	91	(80-100)	94.5	(88-100)	92	(86-100)	93	(88-100)
Total Breakdowns	6.7	(3.9-9.6)	5.7	(3.5-9.3)	6.5	(3.7-9.1)	6.5	(3-9.4)	6.5	(3.8-9.7)
Offensive										
Total Carries	6.9	(4.5-8.2)	5.48	(3.6-7.3)	6.2	(3.8-7.8)	4.9^{+S}	(3.2-6.9)	5^{+S}	(3.1-6.9)
Total Carries (%)	39.7	(14-60)	40	(10.6-63.2)	40.4	(19.6-62.3)	40	(10.2-57.1)	40	(11.6-57.1)
Pick and Go	0	(0-0.2)	0	(0-0.1)	0	(0-0.2)	0	(0-0.1)	0	(0-0.1)

	U18+	IQR	U20*	IQR	NA^	IQR	Saxons~	IQR	SNS	IQR
Possession										
Total Possessions	16.5	(11.2-31.1)	13.4	(9.5-24)	15.2	(11.2-29.9)	13.7	(10-30)	13.4	(10.3-26.2)
Handling										
Passes	8	(3.5-20.9)	4.6	(2.3-16)	6.1	(3-17.1)	4.7	(3-16.1)	4.9	(3-14.3)
Passes +	0.1	(0-1.5)	0.1	(0-0.8)	0.4	(0-1)	0.2	(0-0.5)	0.2	(0-0.6)
Passes -	0.2	(0-1.3)	0	(0-0.5)	0.3	(0-0.8)	0.2	(0-0.8)	0.2	(0-0.5)
Total Passes	9.1	(3.9-22.8)	5.7	(2.7-18)	7.5	(3.6-19.2)	5.5+S	(3.5-17.8)	5.3+S	(3.4-15.8)
Pass Completion (%)	94.8	(89.9-100)	96.4	(90.6-100)	94.8	(88.1-99.4)	93.9	(89.1-100)	94.2	(91.1-100)
Positional										
Offensive										
Total Kicks	0.9	(0-4.4)	1	(0-4.4)	1.5	(0.3-4.7)	1.1	(0.2-7)	1	(0.3-6.2)
Kick neutral	0.6	(0-3.1)	0.4	(0-3.5)	1.3	(0.2-3.9)	1	(0.1-5)	1	(0.2-4.3)
Kick + (%)	0	(0-0)	0	(0-9)	0+S	(0-14.5)	0+S	(0-16)	0+S	(0-14)
Kick - (%)	0	(0-12)	0	(0-12)	3	(0-15)	0	(0-15)	0	(0-16)

Significant differences at P≤0.05 were subjected to the FDR. Total matches and minutes were not transformed. All defensive, offensive, possession and set piece actions were transformed into 80 minutes match play. Significant difference vs. + U18; * U20; ^ NA; ~ Saxons. Effect sizes: Small (S) ≥ 0.1-0.29, Medium (M) ≥ 0.3-0.49, Large (L) ≥ 0.5 (O'Donoghue, 2012).

Outside backs (OB)

A comparison of OB performances across the EPPP squads is presented below (Table 4.11). A Kruskal-Wallis test revealed significant differences across squads where boy mass and stature was concerned (H (4) = 21.736; p = 0.001, H (4) = 17.327; p = 0.002). Post-hoc analyses identified that SNS were taller than U18 ($p \leq 0.001$; r = 0.26) and U20 ($p \leq 0.001$; r = 0.18), and heavier than U18 ($p \leq 0.001$; r = 0.27) and U20 ($p \leq 0.05$; r = 0.17). Saxons were taller and heavier (both $p \leq 0.001$; both r = 0.28) than U18, whilst taller ($p \leq 0.01$; r = 0.19) when compare to the U20 team. Further analyses revealed that NA players were taller ($p \leq 0.05$; r = 0.22) and heavier ($p \leq 0.05$; r = 0.20) than U18.

A Kruskal-Wallis test revealed significant differences in handling and offensive TPIs across squads where positive passes (H (4) = 15.044; p = 0.005), negative passes (H (4) = 35.171; p = 0.001) and pick and go actions (H (4) = 18.374; p = 0.001) was concerned. Post-hoc analyses identified that SNS revealed a higher number of positive passes ($p \leq 0.01$; r = 0.20), negative passes ($p \leq 0.001$; r = 0.31) and pick and go movement ($p \leq 0.01$; r = 0.25) in contrast to the U18 players. Further positional analysis evidenced in positional offensive TPIs significant differences between squads where total kicks (H (4) = 17.633; p = 0.001), kick neutral (H (4) = 15.325; p = 0.004), kick positive rate (H (4) = 20.624; p = 0.001) and kick negative rate (H (4) = 26.164; p = 0.001) were concerned. Post-hoc analyses identified that SNS performed an increased number of total kicks ($p \leq 0.001$; r = 0.30), neutral kicks ($p \leq 0.001$; r = 0.28), and a higher positive ($p \leq 0.001$; r = 0.30) and negative ($p \leq 0.001$; r = 0.34) kick rate compared to the U18 players.

By comparing SNS players with the U20 team, the handling TPIs evidenced that SNS players performed more positive passes ($p \leq 0.01$; r = 0.19) and negative passes ($p \leq 0.001$; r = 0.27) than U20. Further analyses in offensive TPIs revealed that SNS players executed more frequently a pick and go movement compared to the U20 ($p \leq 0.001$; $r = 0.24$), though they evidenced a higher frequency in negative kick rate ($p \leq 0.05$; $r = 0.18$) than the U20 players. For specific differences see Table 4.11. Analyses in offensive actions between the Saxon and the U18 team revealed that Saxons evidenced a lower frequency of total carries rate ($p \leq 0.001$; $r= 0.25$) than U18. Saxons performed an increased number of total kicks ($p \leq 0.01$; $r = 0.19$), neutral kicks ($p \leq 0.05$; $r = 0.18$), and evidenced a higher frequency in positive kick rate ($p \leq 0.001$; $r = 0.27$) and negative kick rate ($p \leq 0.001$; $r = 0.29$) than U18. Additional analyses in possession and defensive actions displayed that Saxons possessed more frequently their own lineout (i.e. total possession, $p \leq 0.01$; $r = 0.19$), while they achieved a higher rate of clear-out efficiency ($p \leq 0.01$; $r = 0.19$) in contrast to the U18 players. For specific differences see Table 4.11.

The handling actions of the NA players evidenced a higher frequency in negative ($p \leq 0.001$; $r = 0.36$) and positive passes ($p \leq 0.01$; $r = 0.24$), though they evidenced a lower completion rate of passes ($p \leq 0.01$; $r = 0.24$) than U18 players. On the other hand the positional offensive actions revealed that NA performed an increased total number of kicks ($p \leq 0.01$; $r = 0.23$), neutral kicks ($p \leq 0.05$; $r = 0.21$), and a higher positive ($p \leq 0.001$; $r = 0.35$) and negative ($p \leq 0.001$; $r = 0.32$) kick rate than U18. No statistically significant differences were established when comparing the Saxons and NA to the senior squad, or between Saxons and NA OB. Further results are presented in Table 4.11 (see Appendix 5 for effect sizes)

Table 4.11. Typical performances across U18, U20, NA, Saxon and SNS for OB players.

	U18^{+} (n = 94)	IQR (Q3-Q1)	U20* (n = 102)	IQR	NA$^{\wedge}$ (n = 35)	IQR	Saxons$^{\sim}$ (n = 98)	IQR	SNS (n = 94)	IQR
Anthropometrical										
Body stature (cm)	1.83	(1.79-1.85), n = 89	1.83	(1.80-1.85)	1.84^{+S}	(1.83-1.85)	1.85^{+S}	(1.81-1.86)	1.85^{+S*S}	(1.83-1.86)
Body mass (kg)	88	(83.5-93), n = 89	89	(84-94)	92^{+S}	(87-93)	92^{+S*S}	(88-94)	92^{+S*S}	(88-93)
Playing experience										
Total Matches	2	(1-5)	3	(1-8)	5^{+M}	(2-13)	8^{+M*S}	(1-21)	12.50^{+M*S}	(2-25)
Total Minutes	134	(48.5-261.5)	194	(49.3-502.8)	305^{+M}	(80-954)	562^{+M*S}	(42-1484.8)	805^{+M*M}	(80.8-1837)
Defensive										
Total Tackles	4.4	(2.4-6.3)	3.8	(2-5)	4.8	(3.4-5.7)	5^{*S}	(3.3-7)	5.5^{+S*M}	(4-7.4)
Missed Tackles	0	(0-1.4)	0.1	(0-2)	0.4^{+S}	(0.1-2.1)	0.3^{+S}	(0-1.8)	0.5^{+S}	(0-2.4)
Tackle Completion (%)	100	(76.4-100)	91.8	(48.6-100)	90	(66.7-98.4)	92.9	(75.1-100)	88.1	(63.8-100)
Rebound (%)	66	(36.5-90.5)	67	(24.8-83.5)	70	(62-80)	66	(46.5-80)	70	(51.5-80)
Total Clear-outs	5.4	(3.5-7.9)	5.2	(3.9-7.9)	5.6	(4.6-7.7)	5.7	(3.9-8.1)	5.3	(4.1-6.6)
Clear-out efficiency (%)	86	(73.5-95.5)	90	(80.8-100)	93^{+S}	(88-97)	93^{+S}	(84.8-97.8)	92^{+S}	(84.8-96.3)
Total Breakdowns	5.3	(3.5-7.9)	4.9	(3.9-7.7)	5.3	(4.3-7.7)	5.5	(3.9-8.4)	4.9	(4.1-6.5)
Offensive										
Total Carries	6.6	(5.2-8.6)	6	(4.4-8.3)	6.4	(4.3-8.6)	5.7	(3.8-7.4)	6	(4.1-8.1)
Total Carries (%)	58.1	(36.6-75)	53.8	(32.9-64.7)	58.7	(34.9-67.2)	48.2^{+S}	(30.8-58.9)	47^{+S}	(33.8-55.8)
Pick and Go	0	(0-0)	0	(0-0)	0^{+S}	(0-0.3)	0	(0-0.1)	0.04^{+S*S}	(0-0.2)

	U18^{+}	IQR	U20*	IQR	NA$^{\wedge}$	IQR	Saxons$^{\sim}$	IQR	SNS	IQR
Possession										
Total Possessions	9.9	(5.9-14.3)	11.9	(9-16.7)	12	(9.7-16.8)	12.1^{+S}	(9.1-17.9)	12.3^{+S}	(9.6-17.1)
Handling										
Passes	2.4	(1.2-4.6)	2.3	(1.3-3.8)	2.1	(1.1-3)	3	(1.3-5.6)	3	(1.6-5.2)
Passes +	0	(0-0.1)	0	(0-0.1)	0.1^{+S}	(0-0.3)	0	(0-0.3)	0.04^{+S*S}	(0-0.4)
Passes -	0	(0-0)	0	(0-0.1)	0.1^{+M*S}	(0-0.3)	0^{+S*S}	(0-0.3)	0.1^{+M*S}	(0-0.3)
Total Passes	2.9	(1.3-5)	2.7	(1.4-4.4)	2.5	(1.6-4)	3.2	(1.4-6.3)	3.3	(1.8-5.9)
Pass Completion (%)	100	(85.7-100)	100	(89.6-100)	92.3^{+S}	(87.1-100)	95.1^{+S}	(88.2-100)	95.3^{+S}	(89.4-100)
Positional										
Offensive										
Total Kicks	0.6	(0-1.3)	1.1	(0-2.8)	1.2^{+S}	(3.3-0.4)	1.1^{+S}	(3-0.4)	1.5^{+M}	(3-0.7)
Kick neutral	0.5	(0-1.2)	0.9	(0-2)	1^{+S}	(0.3-2.9)	0.9^{+S}	(0.2-2.6)	1.1^{+S}	(0.6-2.8)
Kick + (%)	0	(0-0)	0^{+S}	(0-7.8)	0^{+M}	(0-11)	0^{+S}	(0-11)	0^{+M}	(0-8.3)
Kick – (%)	0	(0-0)	0	(0-5.3)	0^{+M}	(0-13)	0^{+S}	(0-10.3)	0^{+M*S}	(0-11.3)

Significant differences at P≤0.05 were subjected to the FDR. Total matches and minutes were not transformed. All defensive, offensive, possession and set piece actions were transformed into 80 minutes match play. Significant difference vs. $^{+}$ U18; * U20; $^{\wedge}$ NA; $^{\sim}$ Saxons. Effect sizes: Small (^{S}) ≥ 0.1-0.29, Medium (^{M}) ≥ 0.3-0.49, Large (^{L}) ≥ 0.5 (O'Donoghue, 2012).

4.5 Discussion

Collectively, the analyses described above provide a unique critique of elite player development within a national development system, more specifically an understanding of the position-specific anthropometrical characteristics and TPIs underpinning each squad within the EPPP. Position-specific differences were typified by increased body mass and stature though there appeared no clear trend distinguishing the TPI of the players across age squads. However, in all positions, the emergence of many significant differences in the TPI of the U18 and U20 squads compared to those of the NA, Saxons and SNS suggests that the former squads could be considered 'developmental' where the latter squads serve as 'preparatory' teams for elite performance. Since there is no study appraising an entire development programme in this manner, the current findings could be of virtue to coaches, scouts and players, not only in rugby union, but also in other sports in which players are expected to improve match performance as part of involvement in a developmental programme.

A persistent discrepancy between respective squads (i.e. U18 to U20, U20 to NA etc.) concerned the increased body mass and stature when comparing higher and lower levels of the EPPP. A plausible explanation for such differences may come from the fact that youth (U18) and adult (U20) players of the EPPP are still developing physically; while those youth and adult players participating for longer period within the EPPP are engaged in specific strength training (Friedmann, 2007), to match senior elite demands (Cunningham et al., 2016b) and subsequently attain greater muscle mass and body mass at later ages of development. Similar to sports more generally (Norton & Olds, 2001), the body mass and stature of rugby union players has increased at a rapid rate in recent (> 1975) years (Olds, 2001) likely owing to greater financial and social incentives, as well as the use of more specialized methods of training (Norton & Olds, 2001). Furthermore, such a trend for increased body mass and stature has continued to persist in contemporary (> 2002) rugby leagues (Fuller et al., 2013) as teams seek to maximise potential advantages. Indeed, alongside a general increase in the mass and stature of players (Olds, 2001), research suggests that higher standard players tend to be heavier and taller (Norton & Olds, 2001; Argus et al., 2012) and teams possessing such players progress further in World Cup events (Olds, 2001; Sedeaud et al., 2012). Whilst an increase in body mass would increase the energy cost of locomotive activities (e.g. walking, jogging, high-intensity running, sprinting), since rugby is a sport necessitating a multitude of physical and physiological abilities (Roberts et al., 2008). More specifically, players undergo frequent collisions (as tackler and tackled player) ranging from 0.3 (~24 total) to 0.71 (~57 total) per minute of playing time, which has an increased frequency in forwards (0.63-0.71 collision per minute) than backs (0.31-0.5 collisions per minute) (King et al., 2009; Sirotic et al., 2009; Twist et al., 2011; McLellan et al., 2011). Consequently, body mass likely reflects a key facet of the game in which players strategically take the ball into contact situations with opposition players attempting to prevent ball-carriers progressing to the try line (Hendricks et al., 2014). Research has also established that higher ability rugby union matches involve a higher incidence of tackles (McIntosh et al., 2010) and thus the selection of heavier and taller athletes to the senior squad therefore appears logical given increased mass could increase forces players deliver (with acceleration held constant) or reduce the impact of external forces (Barr et al., 2014).

Whilst the mass of players has increased generally, there has also been position-specific alterations that are likely a facet of the individualised performance-focused training and associated with the tactical roles of players. Indeed, it is acknowledged that the Saxon squad represents a 'second' national team and, thus heavier FR players are potentially selected to the SNS given the association between mass and success in the sport (Olds, 2001; Fuller et al., 2013). For example, Sedeaud et al. (2012) demonstrated that the forwards of the winning teams during the 1987-2007 season, in the Rugby World Cups were heavier (~107 kg) and had a greater (39.6%) collective experience than forwards though this relationship was not evident in backs. Such differences might be reflected in the increased number of collisions (Johnston, Gabbett, & Jenkins, 2015), tackling actions (Roberts et al., 2008) and static exertions (Preatoni, Stokes, England, & Trewartha, 2013) that forwards required to perform more frequently compared to backs.

Furthermore, U18 and U20 seem to be used as developmental squads while NA and Saxons serve as preparatory squads for SNS membership. The U18 and U20 squads were defined as developmental squads since there were many significant differences in TPIs when compared to adult (NA) and senior squads (Saxons, SNS). For example, the results evidenced that SNS OB performed a greater number of offensive movements (i.e. number of total kicks, neutral kicks, higher positive and negative kick rate) compared to the U18 players, while SNS performance was characterised by a higher frequency of handling (i.e. positive passes) and offensive (i.e. pick and go) actions compared to the U20 team. Interestingly, only body mass and stature (i.e. heavier and taller SNS FR players) differentiated between SNS and Saxons players, while NA evidenced a limited number of differences with small effect sizes (e.g. SNS players won more lineouts than NA [$p \leq 0.001$; $r = 0.27$]) when compared with the senior squads (Saxons, SNS). Such evidence indicate the need to concentrate on players' physical development (i.e. U18) so as to improve the performance on technical and tactical skills (Read et al., 2016). Whilst coaches should acknowledge the relationship between the biological maturity of U18 players and their physical maturity status (Carvalho, Coehlo-E-Silva, Eisenmann, & Malina, 2013), and bear in mind that U18 players may require to gain body mass for developing match movements' demands to attain senior elite level of performance (Cunningham et al., 2016b). For fully matured players (i.e. 21 years old) coaches could concentrate more in maximizing physical, technical and tactical performance without worrying about biological and physical maturity status (Carvalho et al., 2013), when preparing players for senior membership.

Besides, present results evidenced a decreased technical performance in offensive and defensive actions across higher ability squads where (i.e. SNS, Saxon) SH, IB and OB carry the ball less frequently and evidenced a lower rebound rate compared to their U18 equivalents. Inferior values for older age groups were also found by Read et al. (2016) who evidenced that relative distance, low and high speed running per minute were lower in U20 than that of U16 and U18 performers. Hence, higher physical abilities of the U18 and U20 players may counterbalance their technical deficiencies (Cunningham et al., 2016b), while the increased number of collisions and static exertions that senior experience (Roberts et al., 2008; Johnston et al., 2015) could be considered as an additional explanation for such results. Whilst, past research has repeatedly showed that those physical characteristics (high intensity running) that are important at younger age (16) groups may not account for selection at the adult or senior level, assuming that other factors such as perceptual responses are more crucial at the senior level (Waldron et al., 2011). Moreover, assuming physical and physiological differences across squads influence the technical-tactical dynamics of a match (Glazier, 2010), those TPIs underpinning lower age squads may not be essential characteristics of senior squads within the EPPP (Waldron et al., 2011). Despite the fact that in some occasions U18 and/or U20 outperformed senior squads and/or that the frequency of some technical aspects may be lower in senior ages compared to youth and adult age squads; rugby union practitioners should opting for a holistic approach considering a multitude of qualities (e.g. physical, physiological, cognitive abilities, game sense, skill acquisition and 'coachability', alongside features of match play, Burgess & Naughton, 2010), when they include TPIs derived from match performance to identify and select players. Additionally, present findings (e.g. inferior values of SNS compare to U18 or U20) indicate the inability of coaches to select and retain players with the highest success rates across all squads within the TDE system. Therefore, the results of the present study may have implications of the developmental programme that coaches should design and implement in order to prepare the players for senior membership. Present results represent the level of performance that U-teams, NA and senior squads should aim to reach in the future. Used in isolation therefore, TPIs might offer benchmarks across the respective squads, however the extent of the observed differences between younger (U18 and U20) and older (NA, Saxons & SNS) squads suggests they could be used in conjunction with coach intuition to improve the objectivity of player selection to future squads.

Moreover, the discrepancy in technical performance likely reflects the demands of competition and the different standards of opposition (Andersson, Randers, Heiner-Moller, Krustrup, & Mohr, 2010). Indeed, the variation in performance could be derived from the strength of the opposition (Gabbett, 2013; Murray, Gabbett, & Chamari, 2014), match location and time of day (Hiscock, Dawson, Heasman, & Peeling, 2012), playing experience (Sedeaud et al., 2012), level of competition (Brewer, Dawson, Heasman, Stewart, & Cormack, 2010), biological maturity level (Gastin, Bennett, & Cook, 2013) and match-related fatigue (Coutts, Quinn, Hocking, Castagna, & Rampinini, 2010). For example, Gabbett (2013) demonstrated that when athletes participated in winning teams, they performed an increased frequency of absolute and relative accelerations and a greater number of repeated high intensity bouts efforts than in losing teams. Likewise, in football (Rampinini, Impellizzeri, Castagna, Coutts, & Wisløff, 2009), rugby league (Gabbett, Stein, Kemp, & Lorenzen, 2013) and in rugby union (Quarrie et al., 2013; McLaren et al., 2016) players when competing against better teams tend to improve their performance. Moreover, the relation (Impellizzeri & Marcora, 2009) between the importance of the match (Hale, 2004) and the amount of time that the ball is out of play (Kempton & Coutts, 2016) affect players' physical, tactical (Kempton, Sirotic, & Coutts, 2014), and technical (Kempton et al., 2015) performance and approach, as well as player match load (McLaren et al., 2016). Collectively such evidence increase our understanding on the technical demands of competition experienced by players across the respective age squads within the TDE system.

The consensus view seems to be that team sport performance is influenced by a multitude of variables, and is defined by an unstable and stochastic nature (Atkinson, 2002), which might account for the unexpected observations within this study. More specifically, alongside a general fluctuation of performance indicators, the interaction between performance of opposing team and individuals (e.g. Interaction Performance Theory, O'Donoghue, 2009) indicates that the way athletes perform is a sequence between particular opponents (O'Donoghue, 2009). On the basis of the evidence currently available, it seems fair to suggest that whenever there was no clear discrepancy of technical performance between the developmental (U18, U20) and the preparatory squads (NA, Saxons, SNS) within the EPPP, TPIs may lack the sensitivity to capture the qualities that could distinguish ability levels and talented performance across age squads. Then, present information indicated that in conjunction with the aforementioned situational factors could improve the objectivity of player selection to future squads given the established importance of such variables in a multitude of other team sports (Kempton et al., 2015; Kempton & Coutts, 2016).

An explanation of present findings (e.g. non-significant differences) may come from the fact that since the analysis has been made at the highest level of the game, it may corroborate the notion that at this level of performance the differences are small, because the margin for development is small, and performance from this level on typically has minor improvements (Tucker & Collins, 2012). For example, for the positional group of IB there were very few differences in most of the defensive (total tackles), offensive (total carries), handling (total passes number) and positional offensive TPIs (kick + (%), see Table 4.9, 4.10) across age squads. Likewise, Jones et al. (2004) investigated a number of performance characteristics but indicated that winning teams were discriminated from losing teams only in higher success rates during opposition lineouts (i.e. in possession) and in the number of tries scored (i.e. in offensive actions). Moreover, another study appraised all knockout matches of the 2011 World Cup (8 winning teams vs. 8 losing teams) and revealed that only two performance indicators differentiated winning and losing teams (winning teams had a higher percentage of penalties between 50 m and the opposition 22 m and kick the ball out of the hand more) (Bishop & Barnes, 2013). Thus, the technical appraisal of a rugby player's performance ought to consider a range of characteristics which would tend to minimize dropouts (Bullock et al., 2009; Lambert & Durandt, 2010; Barreiros et al., 2014). By addressing all these data, the foregoing discussion implies that occasionally, these TPIs and anthropometrical selection norms will have sufficient accuracy in discriminating talent as well as the 'integrative' eye of the coach or scouter; though when there is an insufficient power of discrimination per se, this should not be regarded as a flaw, rather than an accurate selection of elite players for a representative squad may simply sometimes be extremely challenging in rugby union (Guellich, 2014a).

The available evidence supports that player's general and positional performance can be influenced by various factors which interact with each other and finally emerge within a chaotic and complex environment, such as rugby union. Since the present study is non-experimental and the analyses was based solely on match data, the present results cannot demonstrate a cause and effect relationship (O'Donoghue, 2012); subsequently, the specific TPIs presented here have limitations and should be considered accordingly. It should be acknowledged that despite careful consideration of operational definitions through content validity procedures by PGiR and panels of expert coaches and performance analysts, some errors are inevitable in the retrospective data analysed in the current study (James et al., 2005). Researchers using similar approaches should be mindful of the issues with regard to the intra and inter-observer reliability of some TPIs, which was deemed poor across positional groups (i.e. total breakdowns across FR, BR, SR, SH, IB, OB, see Table 4.4 and 4.5). Whilst the consequence of low reliability is restricted ability to find significant differences, since it introduces variability into the data, which might have contributed to the limited notable trends between groups. Future research might however improve the consistency of observation compared to the study herein.

Moreover, given the complexity of the competitive environment (Lames & McGarry, 2007; Glazier, 2010), which is a product of the task, organismic and environmental constraints (Glazier & Robins, 2013) it could be argued that the generalizability of the data is limited. Indeed, every action is performed in a unique environment (i.e. the location of team-mates, opposition players, weather, and physical qualities of team-mates/opposition players), as such the resulted frequency of TPIs, might not be a valid indication of what experts, coaches and scouts should expect in another rugby game (Glazier & Robins, 2013). The study has also not presented the number of home or away matches, and the percentage of winning or losing matches across squads. Such information could have better addressed why in some TPIs U18 or U20 achieved a higher frequency of match data compared to adult (NA) and senior (Saxons, SNS) squads (McLaren et al., 2016). Additionally, present research has not analysed any perceptual-cognitive factors (Williams & Ford, 2008), such as decision-making skills, pattern recognition or the ability to process information, that may have provided more information relating to the explicit discrimination between the developmental and the preparatory squads. Indeed, such qualities have been shown to distinguish talented players (Berry & Abernethy, 2003; Williams, Hodges, North, & Barton 2006; Gabbett et al., 2007; Vaeyens, Lenoir, Williams, & Philippaerts, 2007) in other sports hence are worthy of consideration in appraising talented players in rugby union also. However, no study has included such a vast sample across an entire developmental programme and it can take several years for physical changes to occur (Cormery, Marcil, & Bouvard, 2008), hence the data likely remains applicable to talented rugby union players between U18 and SNS squads.

From an applied perspective, the present results provide an overview of the TPIs that define elite Rugby Union players for each age international squad within the EPPP. Ultimately, these results represent the level of performance that youth (U18), adult (U20, NA) and senior squads (Saxons, SNS) should aim to reach in the future. Accordingly, the reliability of the data is an important consideration and assuming adequate consistency was achieved during the analysis, the data could be representative of current selection processes despite the changing nature of rugby union players (Norton & Olds, 2001; Olds, 2001; Fuller et al., 2013). Furthermore, the findings of this study might help guide coaching interventions for the types of players required and the level of performance that players need to achieve for potential selection in England's national teams. Whilst, those players identified in Chapter 3 as developing outside of the EPPP ('side-entries'), can orientate their progress towards the importance of playing experience alongside defensive, offensive, positional and handling TPI norms to maximise the chance of being selected for England's international squad. Moreover, the inconsistent differences across squads in the present analysis together with the high dropouts and the various developmental path that player followed in Chapter 3, signified the variability in each players' development for the prerequisite level of technical performance for senior elite membership. Whilst situational factors, match-to-match variability and the observational design could reflect a limitation of this study, future research ought to analyse further the anthropometrical and technical TPIs to confirm current findings. Since it is the overall intention of the present thesis to demonstrate whether match data could discriminate higher from lower ability athletes and hence define talent across ages, players may become discernible based on match data factors as a function of progression or non-progression within EPPP. For that reason, further research should compare progressed vs non-progressed players within age squads and illustrate if match data could establish any discriminator factors.

4.6 Conclusion

The present study elucidated the anthropometric and TPI attributes underpinning performance in youth (U18, U20), adult (NA) and senior (Saxons, SNS) international squads within RFU's EPPP system. The resultant characteristics can provide reference norms regarding TID and talent selection processes (Burgess & Naughton, 2010). Present findings indicated that an increase in body mass across ages is an essential characteristic, and subsequently anthropometrical characteristics could distinguish youth, adult and senior squads within the EPPP. Furthermore, based on Chapter 3 and the present findings, it was established that U18/U20 act as developmental squads, and the NA/Saxons as preparatory squads for senior elite performance. It was uncertain why few or no differences in technical TPIs occur across ages, but may relate to some of the situational and/or perceptual-cognitive factors and thus future analyses of rugby union ought to consider such variables in order that our understanding of match performance is further enhanced.

Chapter 5

Technical performance indicators and anthropometrical characteristics of progressed and non-progressed players within England's Rugby Football Union Elite Player Performance Pathway

5.1 Abstract

TDE programmes attempt to retain players likely to achieve success in future competition. However, there is currently a dearth of research distinguishing the key features of players who progress to higher ability squads compared to those who fail to progress despite much information regarding the anthropometrical features and TPIs of players more generally. Therefore, the aim of this study was to determine the technical and anthropometrical characteristics associated with higher squad selection within the EPPP. Retrospective anthropometrical and TPIs (2008-2014) of 396 (1941 performances) elite male rugby union players were separated into progressed vs non-progressed players and classified into one of six positional groups (FR, SR, BR, SH, IB, OB) for each age international squad (U18, U20, NA, Saxons, SNS). Results established positive associations between playing time and anthropometry (i.e. stature & body mass) and the likelihood of progression to subsequent squads. However, there were inconsistent differences between groups where the TPI of players were considered. The findings add to our understanding of the variables supporting progression within a development pathway though it appears that the technical match performances of players should not be used in isolation to distinguish between retained and released players.

5.2 Introduction

To facilitate the development of talent, several sporting governing bodies have established programmes which aim to maximize the likelihood of progressing players into elite competition. However, it is largely unknown whether the TID or talent selection programmes in rugby union base their selection on the technical, tactical, psychological or physiological attributes that are important for progression into senior squads for team sports (Reilly et al., 2000; Elferink-Gemser et al., 2004; Huijgen, Elferink-Gemser, Lemmink, & Visscher, 2014) or if their decision is the result of a combination of variables.

The identification of traits underpinning successful performance is an important endeavour in sport science (Bishop, 2008). Whilst these qualities are typically multifaceted (Glazier, 2010), it is necessary to initially describe the competitive environment to identify variables that might underpin performance (Bishop, 2008). In rugby union, Smart et al. (2014) determined the importance of high physical ability at the elite level and suggested players lacking the physical prerequisites by the time they reach selection for the provincial level in New Zealand, will ultimately be deselected. Moreover, it was revealed that players possessing mesomorph physiques, who were quicker or stronger were more likely to be selected for elite teams. Research in rugby union has also appraised the progression of physical ability across a range of youth and adult squads finding significant improvements in counter movement jump height, peak power and absolute and relative strength (Darrall-Jones et al., 2015a, 2015b) reinforcing the importance of physical ability in the sport. Furthermore, a motion analysis of an invasion game such as rugby could reveal the importance of repeated sprint ability suggesting players ought to engage in high-intensity exercise in preparation for match performance (Duthie et al., 2003). Indeed, Cahill et al. (2013) analysed elite rugby union players (n=98) from eight Premiership Clubs during 44 matches and demonstrated rugby union is played mainly in low speeds. More specifically, the SH covered the greatest distance (7098 ± 778 m) and the FR players the least (5158 ± 200 m) and further analysis revealed that the BR players performed the greatest distances at 'sprinting' speeds (i.e. 81-95% Vmax sprinting). Such details suggest key facets underpin elite performance which players can then address during preparatory phases. Given the importance of physical and physiological fitness to performance in many sports, there exists a wealth of research detailing the physical prerequisites for successful participation. However, in rugby union players must perform intermittent high and low-intensity periods of exercise which are typically interspersed by technical actions and sport-specific 'collisions' (Duthie et al., 2005; Deutsch et al., 2007; Cunniffe et al., 2009; Cahill et al., 2013), which also require consideration in determining successful performance.

Whilst the motion and physical requirements for successful participation are important endeavours, further evidence indicate the association between tactical awareness (Williams, 2000) and perceptual-cognitive qualities (better anticipation, Gabbett et al., 2007; decision-making, Vaeyens et al., 2007; higher recall pattern, Williams et al., 2006) are equal essential for successful performance. While, the ability to win a match does not depend only on tactical proficiency but also on technical proficiency (i.e. defensive actions and point of contacts correlated to successful outcomes) (Smart et al., 2011). Indeed, it has been previously shown that tackle and breakdown technique might influence the outcome of a game (Smart et al., 2011; Hendricks, Roode, Matthews, &

Lambert, 2013). Therefore, technique dependent characteristics may provide further value as a discriminator between higher and lower ability players.

Typically, research assessing technical actions in rugby union has sought to compare elite winning and losing teams (Hughes & Bartlett, 2002; Lames & McGarry, 2007) and winning performances for example, are typified by improved passing, kicking, tackling and lineout performance (Jones et al., 2004; Ortega et al., 2009; Vaz et al., 2010). Likewise, it is well established that catching, rucking, mauling and set piece skills are also crucial to successful performance in rugby (Jones et al., 2004; Hughes & White, 2009; Ortega et al., 2009; Vaz et al., 2010; Prim & Van Rooyen, 2011). Although informative for coaches and players at the elite level, the likelihood a high ability player will be selected to compete at the elite international level is typically the result of a very complex path in which players might progress from recreational involvement through to elite participation (Gulbin et al., 2013a) and so further information about this process would appear useful.

Though the anthropometrical and physical qualities of a player are undoubtedly crucial in a sport such as rugby union (Lambert & Durandt, 2010; Fuller et al., 2013), it appears plausible that there exists a relationship between match performance and the progression of a player from lower to higher ability squads. Further research has also showed that team players could be selected based on each teams' tactical approach (Nash & Collins, 2006) and different styles of play depending on the level and format of the competition. Indeed, Read et al. (2016) revealed that relative distance ($m.min^{-1}$) covered and high speed running (HSR; > 3.33 $m.s^{-1}$) decreased across U16, U18 and U20 forward and back players, which may be due to the fact that players at older ages experienced more collision and static exertions than at younger ages (Roberts et al., 2008; Johnston et al., 2015). Although ostensibly counterintuitive, such a finding suggests that the behavioural, perceptual-cognitive aspects of performance (i.e. the technical actions) might be of greater importance at the higher levels of rugby union. However, it remains unknown which, if any, behavioural actions during match performance differentiate players progressing to higher ability squads compared to those deselected.

Within England, the RFU established the EPPP in an attempt to facilitate the progression and retention of talented players to higher ability squads, though it appears as though 69.40% (i.e. n = 275 out of total n = 396) of players do not progress to compete within the SNS (Chapter 3). The present study was therefore an attempt to determine the variables indicative of progression to subsequent squads with a focus not only upon the anthropometry of the players given its importance in rugby union (Sedeaud et al., 2012), but also on actual match performance. To our knowledge, no study has assessed the technical and anthropometrical characteristics that explain higher squad selection across youth, adult and senior international age groups within rugby union.

5.3 Method

5.3.1 Participants

The same data set described within Chapter 4 was utilized for the study herein. Briefly, retrospective anthropometrical and performance-based data (2008 - 2014) recorded as part of England's RFU player monitoring system ('Elite Hub') was consulted which included 396 players and 1,491 performances. To enable data analysis, all players in the representative squads were assigned to one of six positional groups (adapted from Duthie et al., 2005; Deutsch et al., 2007; Roberts et al., 2008) similar to Chapter 4 (see Chapter 4.3.2). Furthermore, the athletes were sub-categorized into progressed and non-progressed groups (for details see Table 5.1). However, some variation data were missing, for example, the analysis for the U18 SR non-progressed players was made for n = 18 instead of n = 21, specifically for the anthropometrical qualities (i.e. body mass, body height). Hence, the sample might vary though where this is the case it will be stated. Institutional ethical approval for the experimental procedures was granted by the Faculty of Applied Sciences Ethics Committee.

Table 5.1. Players' performances in each squad according to progression and position within the EPPP.

	U18		U20		NA		Saxon	
	Progressed	**Non-progressed**	**Progressed**	**Non-progressed**	**Progressed**	**Non-progressed**	**Progressed**	**Non-progressed**
Front row	51	28	33	30	21	17	39	32
Second row	33	21	18	23	13	6	37	22
Back row	70	32	44	44	30	23	66	58
Scrumhalf	11	13	6	10	1	3	15	4
Inside backs	54	21	42	45	26	14	86	21
Outside backs	62	36	49	54	26	9	77	21

5.3.2 Procedure

For a given player competing in a squad, progression or non-progression was determined by their involvement in subsequent squads (‘progressed’) or not (‘non-progressed’) (i.e. regardless of whether they reappeared at an older age squad within the EPPP). Players were again classified into one of six positional groups with the scrumhalves assigned a category of their own due to their unique role within the game (adapted from Duthie et al., 2005; Deutsch et al., 2007; Roberts et al., 2008). Analysis was again based upon two anthropometrical variables and twenty-two TPIs albeit on this occasion, the comparison was based upon progressed and non-progressed players.

5.3.3 Data analysis

Similar to Chapter 4, performance data were transformed to standardize values where a player did not complete the entire match (i.e. full game equivalents; see section 4.3) and the tests of normality and equality of variance suggested a non-parametric approach was warranted. Consequently, data were reported as medians and inter-quartile ranges (IQR) (Jones et al., 2004; James et al., 2005) and non-parametric Mann-Whitney U hypothesis tests were used to compare the dependent variables across progressed and non-progressed players according to the squad and position of the players.

For all comparisons, the level of significance (0.05) was subjected to the FDR approach (i.e. control over type I error, Benjamini & Hochberg, 1995) (for details see Chapter 4.3.5). To report the magnitude of the difference, effect size estimates were derived using the following equation (Field, 2013).

$r = z/\sqrt{n}$

Where ‘z’ represented the z-score produced during the Mann-Whitney U test and ‘n’ the sample size of each positional group. Specifically, effect sizes were defined as small when ≥ 0.1, as medium when ≥ 0.3, and large when ≥ 0.5. All statistical analyses were performed using SPSS for Windows (Version 20, Armonk, NY) and Microsoft Excel (Version 2013, Redmond, WA).

5.4 Results

Front row

Comparisons between U18 and U20 progressed and non-progressed FR players are presented in Table 5.2. Progressed U18 FR participated in significantly more matches ($p \leq 0.001$; $r = 0.35$) and played more minutes ($p \leq 0.001$; $r = 0.33$) than non-progressed U18 FR. Likewise, progressed U20 FR played more minutes ($p \leq 0.01$; $r = 0.39$) though were also significantly taller ($p \leq 0.001$; $r = 0.50$) and heavier ($p \leq 0.00$; $r = 0.46$) than non-progressed U20 FR. While there were no statistical differences between progressed and non-progressed U18 or U20 FR players where the TPIs were appraised, players selected to progress typically outperformed their counterparts, in defensive, offensive, possession and set piece actions even if only by small margins.

Table 5.2. Anthropometry and TPIs of progressed and non-progressed FR players in U18 and U20 squads (median [IQR]).

	U18→U20, NA, Saxons, SNS		U20→NA, Saxons, SNS	
	Progress (n = 51)	**Non-Progress (n = 28)**	**Progress (n = 33)**	**Non-progress (n = 30)**
Anthropometrical				
Body stature (cm)	1.82 (1.80-1.85)	1.81 (1.76-1.83)^{S}	1.84 (1.83-1.85)	1.80 (1.78-1.83)^{*L}
Body mass (kg)	102 (100-108)	98 (96-110)	109.5 (105.8-112)	102 (99-110)^{*M}
Playing experience				
Total Matches	4 (2-5)	3.50 (2-6.8)^{*M}	5 (2-8.8)	6 (2.50-9)^{*M}
Total Minutes	135 (23-208)	92.50 (68-218)^{*M}	240 (20.5-493.5)	191 (66-410.5)^{*M}
Defensive				
Total Tackles	12.17 (8.7-16)	10.73 (5.7-17.3)^{S}	13.79 (10.29-21.01)	8.92 (7.2-12.8)^{S}
Missed Tackles	0 (0-0.8)	0.29 (0-1.2)^{S}	0.27 (0-2.82)	0.79 (0.1-3.4)^{S}
Tackle Completion (%)	100 (84-100)	97.86 (94-100)^{S}	97.45 (100-81.5)	90.91 (75.4-97.9)^{S}
Rebound (%)	70 (62-81)	68.50 (44-86)^{S}	76.50 (60.5-96.5)	75 (0-80.5)^{S}
Total Clear-outs	13.85 (8-23.3)	15.08 (11-26.9)^{S}	12.97 (6.8-23.3)	14.68 (8.1-16)^{S}
Clear-out efficiency (%)	92 (83-100)	86 (77-93)^{S}	91.50 (70.8-96)	97 (81.5-100)^{S}
Total Breakdowns	13.9 (8-23.3)	15.1 (10.9-26.9)^{S}	12.13 (6.8-22.6)	13.7 (8.1-15.2)^{S}
Possession				
Total Possessions	7.55 (5.2-13.2)	7.03 (5.2-10.7)^{S}	11.12 (5.6-13.2)	10.18 (4.7-14)^{S}

*Significant difference between progressed and non-progressed players. Effect sizes: Small (^{S}) ≥ 0.1 – 0.29, Medium (^{M}) ≥ 0.3 – 0.49, Large (^{L}) ≥ 0.5.

	U18→U20, NA, Saxons, SNS		U20→NA, Saxons, SNS	
	Progress (n = 51)	**Non-Progress (n = 28)**	**Progress (n = 33)**	**Non-progress (n = 30)**
Offensive				
Total Carries	6.40 (4.2-10.1)	5.44 (2.4-6.5)^S	7.10 (4.4-10.3)	6.1 (4.4-9.5)^S
Total Carries (%)	80.5 (55.6-90.6)	54.6 (41.4-83.1)^S	74.4 (43.2-90.4)	57.1 (22.2-79.1)^S
Pick and Go	1.2 (0-1.9)	0.5 (0-1.2)^S	0.53 (0-2.1)	0.4 (0-1.2)^S
Handling				
Passes	1.8 (0-3.3)	2.4 (1.1-3.7)^S	0.7 (0-2.9)	2.2 (0.3-3.9)^S
Passes +	0 (0-0)	0 (0-0)^S	0 (0-0)	0 (0-0)^S
Passes -	0 (0-0)	0 (0-0)^S	0 (0-0)	0 (0-0)^S
Total Passes	1.8 (0-3.5)	2.4 (1.1-3.9)^S	0.72 (0.1-3.1)	2.5 (0.3-4)^S
Pass Completion (%)	100 (0-100)	100 (100-100)^S	100 (22.4-100)	100 (37.5-100)
Positional				
Set piece				
Total Scrums	22.4 (10-25.2)	23.2 (5.1-30.3)	20.5 (0-31.2)	19.2 (0-23.7)
Possession				
Lineout won	7 (1.6-8.3)	6.1 (3.8-7.6)	7.6 (1.7-9.4)	7 (0-9.2)^S
Lineout lost	0.8 (0-2)	1.6 (0.2-2.6)^S	1 (0-2.9)	0.8 (0-2.3)
Lineout success (%)	80 (50-91.7)	75.2 (54.2-88.8)^S	78 (17.6-89.7)	71.4 (0-90.1)^S

*Significant difference between progressed and non-progressed players. Effect sizes: Small (^{S}) ≥ 0.1 – 0.29, Medium (^{M}) ≥ 0.3 – 0.49, Large (^{L}) ≥ 0.5.

Both the progressed NA FR and Saxons FR players competed in more matches ($p \leq 0.001$; r = 0.51 and r = 0.40 for NA and Saxons, respectively) than their non-progressed equivalents, though the Saxon players also played more minutes ($p \leq 0.001$; r = 0.48) and were taller ($p \leq 0.01$; r = 0.32) than non-progressed Saxon players.

Interestingly, where TPIs were appraised, medium and large effect sizes, though deemed insignificant, were associated with the progressed NA FR in defensive (total NA FR in defensive (total tackles, r = 0.33; clear-out efficiency (%), r = 0.32) and in possession-related (lineout won, r = 0.59) actions. However, they evidenced a lower frequency in some TPI, for example, in defensive (rebound (%), r = 0.32) and offensive (total carries (number), r = 0.33) activities than non-progressed NA FR. In contrast, where TPIs were assessed for Saxon FR players, they evidenced improved carrying (i.e. total carries (%), $p \leq 0.001$; r = 0.39) though performed fewer defensive movements (total clear-outs, $p \leq 0.01$; r = 0.31; total breakdowns, $p \leq 0.01$; r = 0.32) and lost the lineout possession more frequently ($p \leq 0.01$; r = 0.62) than non-progressed Saxons FR.

Table 5.3. Anthropometry and TPIs of progressed and non-progressed FR players in NA and Saxon squads (median [IQR]).

	NA→Saxons, SNS		Saxons→SNS	
	Progress (n = 21)	**Non-Progress (n = 17)**	**Progress (n = 39)**	**Non-progress (n = 32)**
Anthropometrical				
Body stature (cm)	1.83 (1.83-1.85)	1.85 (1.84-1.87)^{S}	1.85 (1.85-1.86)	1.80 (1.78-1.83)^{*M}
Body mass (kg)	105 (102-109)	109 (96-112)^{S}	102 (102-111)	105 (98-108)^{S}
Playing experience				
Total Matches	14 (5-25)	5.5 (2.8-8.5)^{*L}	24 (14-25)	14 (1.5-22.5)^{*M}
Total Minutes	386 (223-1004)	300.5 (150-512.8)^{S}	1086 (860.5-1485)	394 (55-885)^{*M}
Defensive				
Total Tackles	18.3 (11.2-24.0)	11.6 (8.3-14.4)^{M}	11.8 (8.5-15.8)	12.6 (9.8-15.4)
Missed Tackles	0.7 (0.2-4.3)	0.3 (0-3.9)^{S}	0.7 (0.1-2.6)	0.7 (0.1-17.6)
Tackle Completion (%)	93.6 (84.8-99)	96.3 (77.4-100)^{S}	95.2 (88.7-99.3)	94.6 (64.4-99.5)
Rebound (%)	63 (53-75)	66.5 (61.5-89.5)^{M}	58 (51-67.5)	55 (23-70)^{S}
Total Clear-outs	18.7 (17-22.4)	16.2 (10-20.2)^{S}	14 (11.9-19.8)	25.35 (22-45.2)^{*M}
Clear-out efficiency (%)	96 (95-98)	93.5 (69-96)^{M}	92 (90.5-94.50)	94 (90-97.5)^{S}
Total Breakdowns	18.7 (16.8-22.4)	16 (8.8-19.7)^{S}	13.3 (11.8-19.5)	25.4 (19.3-45.2)^{*M}

*Significant difference between progressed and non-progressed players. Effect sizes: Small (^{S}) ≥ 0.1-0.29, Medium (^{M}) ≥ 0.3-0.49, Large (^{L}) ≥ 0.5.

	NA→Saxons, SNS		Saxons→SNS	
	Progress (n = 21)	**Non-Progress (n = 17)**	**Progress (n = 39)**	**Non-progress (n = 32)**
Offensive				
Total Carries	6.4 (5.1-9.4)	9.3 (6-11.1)^{M}	6.5 (5.6-7.9)	6.5 (1.3-8.4)^{S}
Total Carries (%)	74.4 (51.7-81.9)	90.1 (70.2-110.4)^{S}	73.9 (66.2-79.8)	56.3 (13.3-62.6)^{*M}
Pick and Go	0.6 (0.1-0.7)	1.7 (0.5-2.3)^{S}	0.9 (0.6-1.8)	1 (0.1-1.9)^{S}
Possession				
Total Possessions	9.4 (7.7-11.5)	11.5 (4.5-15)^{S}	9.5 (7.9-10.3)	10.7 (2.3-20.4)^{S}
Handling				
Passes	1.1 (0.4-1.9)	1.6 (0.3-4)^{S}	1.7 (1.2-1.9)	1.2 (0-2.2)^{S}
Passes +	0 (0-0.2)	0 (0-0.5)	0 (0-0.1)	0 (0-0.1)^{S}
Passes -	0 (0-0.1)	0 (0-0.4)	0.09 (0-0.2)	0 (0-0.1)^{S}
Total Passes	1.3 (0.4-2)	2 (0.3-4.3)^{S}	1.8 (1.3-2)	1.2 (0-2.4)^{S}
Pass Completion (%)	100 (85-100)	95.8 (67.1-100)^{S}	94.7 (88.2-10)	92.3 (0-100)^{S}
Positional				
Set piece				
Total Scrums	20 (18-23.4)	0 (0-22.8)^{S}	18.2 (15-20.6)	16.7 (0-22.9)^{S}
Possession				
Lineout won	10.2 (8.8-11.2), n = 6	7.6 (2.3-8.9)^{L}, n = 7	10.2 (9.3-11.2)	10.4 (0-11.1)^{S}
Lineout lost	1.8 (1.7-2.7), n = 6	0.8 (0.6-2.9)^{S}, n = 7	1.9 (1.7-2.1)	0.9 (0-1.6)^{*L}
Lineout success (%)	82.8 (75.7-84.4), n = 6	77.3 (52.7-91.1)^{S}, n = 7	84.3 (83.2-86.5)	87 (0-90)^{S}

*Significant difference between progressed and non-progressed players. Effect sizes: Small (^{S}) ≥ 0.1-0.29, Medium (^{M}) ≥ 0.3-0.49, Large (^{L}) ≥ 0.5.

Second row

Progressed U18 SR (Table 5.4) players evidenced a greater playing experience competing in more matches ($p > 0.05$; $r = 0.21$) and for longer ($p > 0.05$; $r = 0.26$). Where TPIs were considered, the progressed U18 players also outperformed their non-progressed counterparts with the differences deemed small-to-medium though, in the main, insignificant; this was the case for defensive (total tackles, $r = 0.26$; rebounds (%), $r = 0.26$; total clear-outs, $r = 0.10$; total breakdowns, $r = 0.14$), for possession (total possessions; $r = 0.32$) and for handling actions (passes, $r = 0.31$; total passes, $r = 0.35$, pass completion (%), $r = 0.27$). In terms of positional TPIs, progressed U18 SR also evidenced better match performance in set piece (total scrums, $r = 0.19$) and possession actions (lineout won, $r = 0.20$), however in lineout steals they evidenced a significant higher frequency ($p \leq 0.01$; $r = 0.43$) when compared to non-progressed.

Though none of the differences were deemed significant, there were several notable discrepancies between progressed and non-progressed U20 SR. For example, medium effect sizes were determined where anthropometrical (weight, $r = 0.32$), playing experience (total number of matches, $r = 0.31$; total minutes played, $r = 0.33$), and offensive TPIs (pick and go, $r = 0.31$) were compared. There were also small effects determined for several variables with progressed players evidencing improved technical performance in defensive (e.g. total tackles, $r = 0.15$; missed tackles, tackle completion (%), both $r = 0.16$), possession (possessions; $r = 0.27$) and offensive (total carries, $r = 0.26$; (%) $r = 0.15$) activities (Table 5.4).

Table 5.4. Anthropometry and TPIs of progressed and non-progressed SR players in U18 and U20 squads (median [IQR]).

	U18→ U20, NA, Saxons, SNS		**U20→NA, Saxons, SNS**	
	Progress (n = 33)	**Non-Progress (n = 21)**	**Progress (n = 18)**	**Non-progress (n = 23)**
Anthropometrical				
Body stature (cm)	1.98 (1.93-1.99)	1.96 (1.96-1.99), n = 18	1.98 (1.96-2.01)	1.98 (1.92-1.99)^{S}, n = 22
Body mass (kg)	109 (106-115)	109 (103-115.3), n = 18	114 (107.8-120)	109.50 (100.8-115)^{M}, n = 22
Playing experience				
Total Matches	4 (1-7)	2 (1-3)^{S}	8 (2-13)	3.5 (1-5.3)^{M}
Total Minutes	220 (32.5-362.5)	65 (38.8-111.7)^{S}	487 (49.3-822.5)	98.5 (25-315.5)^{M}
Defensive				
Total Tackles	12.4 (7.7-16)	9.75 (5.8-16)^{S}	12.8 (7.7-18)	9.7 (4.4-14.3)^{S}
Missed Tackles	0.3 (0-1.7)	0.5 (0-4.4)^{S}	0.05 (0-1.59)	0.6 (0-13.4)^{S}
Tackle Completion (%)	97.9 (86.6-100)	92.7 (65.7-100)	97.6 (85.4-100)	95.2 (14.7-100)^{S}
Rebound (%)	54 (40.50-60)	34 (0-67.3)^{S}	52.5 (43.5-65)	55.5 (0-80.8)^{S}
Total Clear-outs	21.7 (16-30.7)	21.6 (15.7-23)^{S}	17.3 (15.1-21.1)	21 (11.6-27.4)^{S}
Clear-out efficiency (%)	92 (89-98)	96 (86-100)	92.5 (88.8-96.3)	90 (84-95.5)^{S}
Total Breakdowns	19.9 (15.4-29.4)	19.7 (14.7-22.7)^{S}	17.3 (14.2-20.9)	19.1 (11.6-23.8)^{S}

*Significant difference between progressed and non-progressed players. Effect sizes: Small (^{S}) ≥ 0.1 – 0.29, Medium (^{M}) ≥ 0.3 – 0.49, Large (^{L}) ≥ 0.5.

	U18→ U20, NA, Saxons, SNS		U20→NA, Saxons, SNS	
	Progress (n = 33)	**Non-Progress (n = 21)**	**Progress (n = 18)**	**Non-Progress (n = 23)**
Offensive				
Total Carries	4.8 (2.6-5.9)	5.2 (3-6.1)	5.3 (3.8-8.3)	3.8 (2.1-5.8)^{S}
Pick and Go	0.3 (0-1.1)	0 (0-1)^{S}	0.5 (0-1.3)	0 (0-0.4)^{M}
Total Carries (%)	48.7 (31.9-67.2)	51.5 (31.8-76.3)	50.7 (41.1-66)	36.2 (18.4-67.4)^{S}
Possession				
Total Possessions	8.9 (7-12.4)	6.9 (4.2-9.7)^{M}	10.7 (9.1-13.3)	7.5 (5.5-11.6)^{S}
Handling				
Passes	1.5 (0.3-2.4)	0 (0-2)^{M}	1.2 (0.2-2.4)	1.1 (0-2.3)^{S}
Passes +	0 (0-0)	0 (0-0)^{M}	0 (0-0)	0 (0- 0)
Passes -	0 (0-0)	0 (0-0)^{M}	0 (0-0.2)	0 (0-0)^{M}
Total Passes	1.5 (0.3-2.7)	0 (0-2)^{M}	1.6 (0.2-2.5)	1.2 (0-2.4)^{S}
Pass Completion (%)	100 (25-100)	0 (0-100)^{S}	95 (50-100)	100 (0-100)^{S}
Positional				
Set piece				
Total Scrums	23.8 (20.4-26.7)	20.9 (0-26.1)^{S}	21.3 (12.8-23.3)	19.3 (0-23.7)^{S}
Possession				
Lineout won	2.4 (0-3.5)	1 (0-3.5)^{S}	2.2 (0.8-3.9)	0.7 (0-3.2)^{S}
Lineout lost	0 (0-0.4)	0 (0-0)^{S}	0.2 (0-0.4)	0 (0-0.1)^{S}
Lineout success (%)	88.9 (0-100)	90 (0-100)^{S}	86.3 (55.7-96.8)	58.1 (0-100)^{S}
Lineout steal	0.2 (0-0.7)	0 (0-0)^{*M}	0.1 (0-0.6)	0 (0-0.4)^{S}

*Significant difference between progressed and non-progressed players. Effect sizes: Small (^{S}) ≥ 0.1 – 0.29, Medium (^{M}) ≥ 0.3 – 0.49, Large (^{L}) ≥ 0.5.

Comparisons between NA and Saxon progressed and non-progressed SR are presented in Table 5.5. Large effect sizes were established between progressed and non-progressed NA SR in anthropometrical qualities (body mass, $p \leq 0.01$; $r = 0.66$) and retaining their own lineout more frequently (total possessions, $p \leq 0.01$; $r = 0.64$). Though no other differences were deemed significant, there were several notable discrepancies between progressed and non-progressed NA SR. Progressed NA evidenced a greater playing experience (total matches; $r = 0.30$), and a higher frequency in defensive (e.g. total tackles, $r = 0.44$; rebound (%), $r = 0.49$; total breakdowns, $r = 0.48$) and offensive activities (total carries, $r = 0.50$) via medium and large effects than non-progressed.

Compared to non-progressed Saxon SR players, progressed players performed more total scrums ($p \leq 0.001$; $r = 0.44$). All other differences were deemed non-significant with small effect sizes, To illustrate, when in defence, they executed more tackles (total tackles, $r = 0.19$) and clear-outs ($r = 0.07$), and a higher clear-out efficiency ($r = 0.18$), while when in offense they tend to carry more (total caries, $r = 0.21$) than non-progressed Saxons SR.

Table 5.5. Anthropometry and TPIs of progressed and non-progressed SR players in NA and Saxon squads (median [IQR]).

	NA→ Saxons, SNS		**Saxons→SNS**	
	Progress (n = 13)	**Non-progress (n = 6)**	**Progress (n = 37)**	**Non-progress (n = 22)**
Anthropometrical				
Body stature (cm)	1.98 (1.96-2.01)	1.97 (1.93-1.99)^{S}	1.97 (1.96-1.98)	1.98 (1.93-2.01)^{S}
Body mass (kg)	118 (112-120)	109.50 (108-110)^{*L}	112 (112-115.5)	114 (107-116.3)
Playing experience				
Total Matches	13 (2.5-22)	7 (2.5-10)^{M}	14 (1.5-24)	12 (5.5-20.5)
Total Minutes	832 (104.5-1351)	405.5 (166.3-635)^{S}	951 (52-1450)	764 (317.3-1313.3)^{S}
Defensive				
Total Tackles	14.4 (10.51-18)	9.5 (5.1-13.5)^{M}	12.6 (8.7-17.31)	10.7 (8.1-13.4)^{S}
Missed Tackles	0.3 (0-2.9)	1.8 (0.1-50.6)^{S}	0.6 (0.1-4.8)	0.4 (0-1.5)^{S}
Tackle Completion (%)	97.5 (86.8-99.7)	88.7 (37.5-98.9)^{S}	95.4 (75-99.4)	96.7 (84.4-100)^{S}
Rebound (%)	56 (52-62.5)	41.5 (28.5-54)^{M}	50 (42-70.5)	54.5 (0-75.5)
Total Clear-outs	21.8 (15.6-26.2)	16.2 (12.8-19.5)^{M}	21.5 (17.2-23.7)	20.4 (16.5-22.3)^{S}
Clear-out efficiency (%)	95 (94-96.5)	91.5 (89.3-97)^{S}	95 (92-98)	94 (88-96.3)^{S}
Total Breakdowns	21.8 (14.9-25.5)	15.2 (11.4-19)^{M}	20.9 (16.7-23)	19.8 (15.6-22.4)^{S}
Possession				
Total Possessions	12 (9.8-14)	6.9 (4-9.9)^{*L}	9.5 (8.1-12.4)	10.7 (6.5-13.5)

*Significant difference between progressed and non-progressed players. Effect sizes: Small (^{S}) ≥ 0.1 – 0.29, Medium (^{M}) ≥ 0.3 – 0.49, Large (^{L}) ≥ 0.5.

	NA→ Saxons, SNS		Saxons→SNS	
	Progress (n = 13)	**Non-progress (n = 6)**	**Progress (n = 37)**	**Non-progress (n = 22)**
Offensive				
Total Carries	6.6 (5.3-9.6)	5 (3.1-5.9)^{L}	4.6 (3.7-6.7)	5.5 (1.4-7)^{S}
Total Carries (%)	54.8 (51.6-62.9)	62.5 (29.6-92.8)^{S}	50 (41.6-64.5)	48.9 (24.6-55)^{S}
Pick and Go	0.9 (0.7-1.3)	0.9 (0.4-1.5)	0.4 (0-0.7)	0.4 (0-0.9)
Handling				
Passes	1.7 (0.7-2.2)	1.6 (0.8-2.5)	1.4 (0.8-2.2)	1.9 (0-2.5)^{S}
Passes +	0 (0-0)	0 (0-0.4)^{M}	0 (0-0.1)	0 (0-0)^{S}
Passes –	0.1 (0-0.3)	0.2 (0-0.3)^{S}	0 (0-0.1)	0 (0-0.2)^{S}
Total Passes	1.9 (0.7-2.6)	1.8 (0.9-3)	1.4 (0.9-2.4)	1.9 (0-2.7)^{S}
Pass Completion (%)	90 (75.9-98.7)	87.5 (60-96.1)^{S}	97.3 (87.1-100)	90.5 (0-100)^{S}
Positional				
Set piece				
Total scrums	20.4 (2.5-21.9)	10.6 (0-27)^{S}	19.8 (14-22.7)	0 (0-17)^{*M}
Possession				
Lineout won	2.7 (0.9-4.2), n = 6	1.8 (0.1-2.6)^{S}, n = 7	2.9 (1.5-3.5)	2.9 (0-4.1)
Lineout lost	0.3 (0.1-0.9), n = 6	0.1 (0-0.2)^{M}, n = 7	0.3 (0-0.5)	0.1 (0-0.3)^{S}
Lineout success (%)	83.3 (37.1-92.4), n = 6	88.8 (37.5-98)^{S}, n = 7	85.9 (66.7-92.3)	89.6 (0-95.2)^{S}
Lineout steal	0.1 (0-0.5)	0.4^{S} (0-0.6)	0.2 (0-0.4)	0.3 (0.1-0.5)^{S}

*Significant difference between progressed and non-progressed players. Effect sizes: Small (^{S}) ≥ 0.1, Medium (^{M}) ≥ 0.3, Large (^{L}) ≥ 0.5.

Back row

Progressed U18 BR (Table 5.6) were significantly heavier ($p \leq 0.01$; $r = 0.30$) and evidenced a higher clear-out efficiency ($p \leq 0.01$; $r = 0.31$) than non-progressed players. Though accompanied by only small and medium effect sizes, progressed U18 BR players evidenced a greater playing experience (total minutes, $r = 0.25$), and better defensive (rebound (%), $r = 0.25$; clear-out efficiency (%), $r = 0.31$) and set-piece skills (total scrums, $r = 0.15$) compared to non-progressed.

Progressed U20 BR demonstrated a greater playing experience, by participating in more matches ($p \leq 0.01$; $r = 0.28$), and playing for a greater duration ($p \leq 0.01$; $r = 0.28$). Where possession actions were appraised, results evidence that although they possessed their own lineout more frequently (total possession: $p \leq 0.001$; $r = 0.36$), they also lost the lineout more frequently ($p \leq 0.01$; $r = 0.31$). There were also significant differences in offensive movements, by carrying the ball more times ($p \leq 0.01$; $r = 0.31$) and performing an increased number of pick and go actions ($p \leq 0.05$; $r = 0.25$) than non-progressed. Moreover, U20 progressed players evidenced a higher frequency in handling actions, they passed more ($p \leq 0.01$; $r = 0.26$), demonstrated more positives passes ($p \leq 0.01$; $r = 0.26$), and had a higher number of total passes ($p \leq 0.01$; $r = 0.30$), yet they also displayed more negative passes ($p \leq 0.001$; $r = 0.39$) than non-progressed U20 BR.

Table 5.6. Anthropometry and TPIs of progressed and non-progressed BR players in U18 and U20 squads (median [IQR]).

	U18→ U20, NA, Saxons, SNS		**U20→NA, Saxons, SNS**	
	Progress (n = 70)	**Non-progress (n = 32)**	**Progress (n = 44)**	**Non-progress (n = 44)**
Anthropometrical				
Body stature (cm)	1.88 (1.86-1.93)	1.88 (1.84-1.89)^{S}, n = 29	1.93 (1.88-1.96)	1.88 (1.86-1.96)^{S}
Body mass (kg)	101 (97-109)	95 (94-105.5)^{*M}, n = 29	106.5 (100.8-113.5)	104 (100-110)^{S}
Playing Experience				
Total Matches	2 (1-6)	2 (1-4)^{S}	7 (2-10)	2 (1-5.8)^{*S}
Total Minutes	140 (55.8-292)	59 (35-135.5)^{S}	380 (63.3-697.8)	85 (27-263.3)^{*S}
Defensive				
Total Tackles	13.8 (9.2-17.9)	13.7 (9.2-19.4)	14.8 (10.9-19.8)	14.9 (11.1-17.4)^{S}
Missed Tackles	0.4 (0-2.3)	0 (0-1.7)^{S}	0.2 (0-2.4)	0 (0-7.4)
Tackle Completion (%)	96.2 (85.6-100)	100 (88.8-100)^{S}	98.9 (86-100)	97.5 (60.2-100)^{S}
Rebound (%)	57 (40.8-74.3)	40 (0-66)^{S}	59.5 (49.3-75.8)	55.5 (6.3-80)
Total Clear-outs	19.5 (14.2-25)	18.1 (9.1-26.4)^{S}	16.1 (13.2-21.1)	16.9 (11.1-22.8)
Clear-out efficiency (%)	94 (90.8-97.8)	85 (70-94)^{*M}	93.5 (90.3-96)	93 (88-100)
Total Breakdowns	19 (13.3-24.8)	17.1 (9.1-28.9)^{S}	16 (13-21)	16.1 (11.1-22.8)
Possession				
Total Possessions	9.8 (7-14.8)	11.4 (2.3-19.1)	12.1 (7.8-15.1)	7.3 (3-10.6)^{*M}

*Significant difference between progressed and non-progressed players. Effect sizes: Small (^{S}) ≥ 0.1-0.29, Medium (^{M}) ≥ 0.3-0.49, Large (^{L}) ≥ 0.5.

	U18→ U20, NA, Saxons, SNS		U20→NA, Saxons, SNS	
	Progress (n = 70)	**Non-progress (n = 32)**	**Progress (n = 44)**	**Non-progress (n = 44)**
Offensive				
Total Carries	5.9 (4-8.8)	8.3 (6-12.6)^{S}	6.5 (4.5-11.2)	4.7 (2.8-6.5)^{*M}
Total Carries (%)	60 (44-78.4)	57.1 (21.4-87.1)	65.1 (44.3-75)	50.1 (7.1-69.2)^{S}
Pick and Go	0.5 (0-1.8)	1.6 (0-2.4)^{S}	0.6 (0-1.7)	0 (0-0.9)^{*S}
Handling				
Passes	2.2 (1.1-3.7)	2.5 (1.1-4.9)^{S}	2.3 (1.4-3.3)	1.6 (0-2.5)^{*S}
Passes +	0 (0-0)	0 (0-0)^{S}	0 (0-0.1)	0 (0-0)^{*S}
Passes -	0 (0-0.1)	0 (0-0)	0 (0-0.2)	0 (0-0)^{*M}
Total Passes	2.5 (1.1-4.1)	3 (1.1-5.5)^{S}	2.5 (1.5-3.7)	1.7 (0-2.5)^{*M}
Pass Completion (%)	100 (78.8-100)	100 (66.7-100)	98.9 (87.7-100)	100 (0-100)^{S}
Positional				
Set piece				
Total Scrums	21.4 (7.2-26.1)	4.1 (0-27.2)^{S}	19.4 (6.8-21.7)	17.9 (0-22.8)^{S}
Possession				
Lineout won	0 (0-1)	0 (0.21-0)^{S}	0.53 (0-1.63)	0 (0-1.2)^{S}
Lineout lost	0 (0-0)	0 (0-0)^{*S}	0 (0-0.3)	0 (0-0)^{*M}
Lineout success (%)	0 (0-100)	0 (0-50)^{S}	75 (0-92.2)	0 (0-100)^{S}
Turnover steal	0 (0-0.4)	0 (0-0.3)	0 (0-0.4)	0 (0-0)^{S}

*Significant difference between progressed and non-progressed players. Effect sizes: Small (^{S}) ≥ 0.1-0.29, Medium (^{M}) ≥ 0.3-0.49, Large (^{L}) ≥ 0.5.

Where defensive skills were appraised, progressed NA BR (Table 5.7) tackled more frequently ($p \leq 0.01$; $r = 0.42$), however, though non-significant they also evidenced a lower rebound (%) ($r = 0.32$). There were also medium effect sizes in anthropometrical qualities, with progressed players heavier (body mass, $r = 0.30$) and possessing greater playing experience (total matches, $r = 0.19$; total minutes, $r = 0.14$), and better offensive (total carries, pick and go, both $r = 0.15$) and set piece actions (total scrums, $r = 0.22$) compared to non-progressed NA BR.

Surprisingly, where the Saxons BR performances were considered, progressed players played in fewer matches ($p \leq 0.001$; $r = 0.24$). In terms of defensive actions progressed Saxons BR were involved in fewer breakdowns (total clear-outs: $p \leq 0.001$; $r = 0.22$), while they achieved a higher rebound rate ($p \leq 0.001$; $r = 0.27$), a higher clear-out efficiency ($p \leq 0.001$; $r = 0.28$). Where handling skills were appraised, they produced a higher number of negative passes ($p \leq 0.001$; $r = 0.21$) than non-progressed players. Moreover, they evidenced an increased number in offensive activities, hence they carried the ball more times ($p \leq 0.001$; $r = 0.21$), performed an increased number of pick and go movements ($p \leq 0.001$; $r = 0.25$) and participated in scrums more frequently ($p \leq 0.001$; $r = 0.33$) than non-progressed. Furthermore, progressed Saxons BR demonstrated overall better positional TPIs related to possession actions. For example, they retained their own lineout throw more frequently (total possession; $p \leq 0.001$; $r = 0.25$), they evidenced a higher number in lineouts won ($p \leq 0.001$; $r = 0.29$), and although they demonstrated a higher number in lineout lost ($p \leq 0.001$; $r = 0.29$) they displayed a higher lineout success rate ($p \leq 0.001$; $r = 0.20$). Progressed Saxons BR also stole possession more frequently from the opposition (turnover steals: $p \leq 0.001$; $r = 0.28$).

Table 5.7. Anthropometry and TPIs of progressed and non-progressed BR players in NA and Saxon squads (median [IQR]).

	NA→Saxons, SNS		Saxons→ SNS	
	Progress (n = 30)	**Non-progress (n = 23)**	**Progress (n = 66)**	**Non-progress (n = 58)**
Anthropometrical				
Body stature (cm)	1.88 (1.86-1.96)	1.91 (1.88-1.95)^{S}	1.91 (1.88-1.95)	1.91 (1.84-1.96)
Body mass (kg)	109.5 (101.3-120)	106 (100-109)^{M}	108 (106-112)	106 (102-113)^{S}
Playing experience				
Total Matches	4.5 (1-13.5)	3 (1-7)^{S}	8.5 (2-20)	19 (6.8-25)^{*S}
Total Minutes	283.5 (29.5-1003)	160 (40-419)^{S}	603.5 (81.5-1376.8)	1264 (351.3-1478)^{S}
Defensive				
Total Tackles	16.31 (12.1-20.9)	11.8 (8.8-13.7)^{*M}	16.8 (11.9-20.2)	12.5 (10.5-18.9)^{S}
Missed Tackles	0.6 (0-8.3)	1 (0-2.2)	0.7 (0-3.4)	1.3 (0-2.2)
Tackle Completion (%)	96.8 (57.5-100)	93.3 (80.7-100)	96 (85.1-100)	91.4 (85.3-99.8)^{S}
Rebound (%)	62.5 (47.5-67.8)	71 (56-82)^{M}	58 (44-71)	40 (0.7-2.0)^{*S}
Total Clear-outs	20.5 (15.2-26.3)	19.2 (13.5-23)^{S}	15.3 (13.4-20.5)	19.3 (14.6-23.6)^{*S}
Clear-out efficiency (%)	96.5 (93.5-100)	95 (91-100)^{S}	95 (93-98)	92 (87.8-97)^{*S}
Total Breakdowns	19.9 (15-26.2)	18.7 (13.5-22.5)^{S}	15 (12.9-19.9)	19.2 (14.4-23.7)^{S}
Possession				
Total Possessions	12.2 (9.7-17.4)	9.9 (5.1-15.4)^{S}	12.3 (9.4-16.8)	8.8 (6.5-15.2)^{*S}

*Significant difference between progressed and non-progressed players. Effect sizes: Small (^{S}) ≥ 0.1-0.29, Medium (^{M}) ≥ 0.3-0.49, Large (^{L}) ≥ 0.5

	NA→Saxons, SNS		Saxons→ SNS	
	Progress (n = 30)	**Non-progress (n = 23)**	**Progress (n = 66)**	**Non-progress (n = 58)**
Offensive				
Total Carries	8.6 (5.8-12.7)	6.2 (4.6-11.1)^{S}	7.4 (5.6-11.1)	5.5 (4.4-9.5)^{*S}
Total Carries (%)	65.9 (58.8-76.5)	67.8 (50-88.9)^{S}	61 (50-69.8)	61.2 (48.6-83.8)^{S}
Pick and Go	1.2 (0.2-2.2)	0.4 (0-2.3)^{S}	1.4 (0.6-2)	0.6 (0.3-1.3)^{*S}
Handling				
Passes	2.1 (1-2.7)	2.1 (0.7-3.4)	2.4 (1.2-4.1)	1.9 (1-3.2)^{S}
Passes +	0 (0-0.1)	0 (0-0.1)^{S}	0 (0-0.1)	0 (0-0)^{S}
Passes -	0 (0-0.2)	0 (0-0.4)^{S}	0.1 (0-0.3)	0 (0-0.1)^{*S}
Total Passes	2.3 (1-3.2)	2.6 (0.7-3.7)^{S}	2.8 (1.3-4.7)	2.2 (1-3.4)^{S}
Pass Completion (%)	94 (85.1-100)	95 (80-100)^{S}	94 (88.1-100)	100 (88.2-100)^{S}
Positional				
Set piece				
Total Scrums	18.4 (10.7-22)	0 (0-20.9)^{S}	17.9 (14.1-20.4)	0 (0-18.8)^{*M}
Possession				
Lineout won	0.3 (0-1.9)	0.3 (0-0.9)^{S}	1 (0-2.2)	0 (0-0.7)^{*S}
Lineout lost	0 (0-0.3)	0 (0-0.2)	0 (0-0.2)	0 (0-0)^{*S}
Lineout success (%)	76.8 (0-100)	60 (0-100)^{S}	88.7 (0-100)	0 (0-100)^{*S}
Turnover steal	0.2 (0-0.5)	0.2 (0-0.5)	0 (0-0.4)	0 (0-0)^{*S}

*Significant difference between progressed and non-progressed players. Effect sizes: Small (^{S}) ≥ 0.1-0.29, Medium (^{M}) ≥ 0.3-0.49, Large (^{L}) ≥ 0.5.

Scrumhalf

Although none of the differences were deemed significant, there were several notable discrepancies between progressed and non-progressed U18 SH. Progressed U18 SH players were notably heavier than their non-progressed counterparts (r = 0.59), and evidenced a greater playing experience (total matches, r = 0.48; total minutes, r = 0.48) and a greater number of positional offensive actions (kick positive (%), r = 0.38) than non-progressed players. A large effect size in defensive actions (rebound rate, r = 0.65) and medium effect sizes in anthropometrical (height, r = 0.35), handling (passes positive, r = 0.42), and positional offensive activities (kick positive (%), r = 0.47) were evident when progressed U20 SH players compared with their non-progressed peers.

Table 5.8. Anthropometry and TPIs of progressed and non-progressed SH players in U18 and U20 squads (median [IQR]).

	U18→U20, NA, Saxons, SNS		U20→NA, Saxons, SNS	
	Progress (n = 11)	**Non-progress (n = 13)**	**Progress (n = 6)**	**Non-progress (n = 10)**
Anthropometrical				
Body stature (cm)	1.75 (1.73-1.77)	1.73 (1.73-1.79), n = 11	1.76 (1.70-1.77)	1.80 (1.75-1.82)^{M}
Body mass (kg)	85 (80-89)	77 (74-82)^{L}, n = 11	84 (77-89.8)	86.5 (81-88)^{S}
Playing experience				
Total Matches	6 (4-8)	2 (1-6)^{M}	11.50 (9-13)	8 (4-13)^{S}
Total Minutes	259 (82-300)	81 (35-182)^{M}	480 (355.3-713.8)	274.5 (81.8-594.3)^{S}
Defensive				
Total Tackles	8.3 (6-10.2)	5.3 (3.1-9.1)^{S}	5.7 (5.4-7.8)	6 (4.1-8.1)
Missed Tackles	0.6 (0-2.4)	0.8 (0-2.3)^{S}	1.11 (0-1.6)	0.8 (0.2-5.2)^{S}
Tackle Completion (%)	92.9 (78.6-100)	83.3 (66.7-100)^{S}	86.7 (81.3-100)	88.2 (37.9-96.9)^{S}
Rebound (%)	77 (47-87)	75 (50-100)^{S}	80.5 (77.8-89.5)	65.6 (45.8-75.5)^{L}
Total Clear-outs	1.2 (0.5-3)	1.6 (0-4.6)^{S}	1.1 (0.8-2.2)	1.7 (1.2-2.2)^{S}
Clear-out efficiency (%)	75 (33-100)	62 (0-80)^{S}	85 (53.3-100)	76 (53.3-88.8)^{S}
Total Breakdowns	1.2 (0.5-3)	1.6 (0-4.6)^{S}	1.1 (0.8-2.2)	1.7 (1.2-2.2)^{S}
Possession				
Total Possessions	60.5 (46-78.2)	60.6 (48-828)	57.4 (45.9-70.4)	66.7 (48.6-73.3)^{S}

*Significant difference between progressed and non-progressed players. Effect sizes: Small (^{S}) ≥ 0.1-0.29, Medium (^{M}) ≥ 0.3-0.49, Large (^{L}) ≥ 0.5

	U18→U20, NA, Saxons, SNS		U20→NA, Saxons, SNS	
	Progress (n = 11)	**Non-progress (n = 13)**	**Progress (n = 6)**	**Non-progress (n = 10)**
Offensive				
Total Carries	5.1 (2.4-9.3)	6.9 (4-8.3)^{S}	3.8 (2.1-5.1)	3.2 (2.2-5-2)^{S}
Total Carries (%)	6.5 (3.5-11.6)	9.6 (7.7-10.3)^{S}	6.9 (4.3-8)	3.9 (1.8-8.5)^{S}
Pick and Go	2.4 (1.4-3.1)	2.5 (1.3-6.9)^{S}	2 (1-2.9)	1.2 (0.7-2.5)^{S}
Handling				
Passes	53.3 (48.4-69.9)	55.3 (48-66.2)^{S}	62 (47.7-63.6)	62.4 (50.5-66.4)^{S}
Passes +	0 (0-0.8)	0 (0-1.2)^{S}	0.7 (0.3-1.2)	0 (0-0.6)^{M}
Passes –	1.6 (0-2.3)	1.4 (0-3.1)^{S}	2 ^{S} (0.7-3)	1.1 (0-2.4)^{S}
Total Passes	56.6 ^{S} (50.5-72.2)	61.2 (48-69)^{S}	65.3 (51.4-66.4)	63.4 (51.5-69.3)^{S}
Pass Completion (%)	97.6 (96-8-100)	98 (94.7-100)^{S}	96.9 (95.2-99)	98.3 (96.7-100)^{S}
Positional				
Offensive				
Total kicks	2.8 (2-5.6)	3 (2.1-4.7)^{S}	4.8 (3.7-5.8)	4.6 (0.8-6)^{S}
Kick neutral	2.3 (0.6-5.1)	2.2 (0-4.6)^{S}	3.93 (5.2-2.6)	3.31 (0.78-6.13)
Kick + (%)	0 (0-14)	0 (0-0)^{M}	8.5 (1.5-21.5)	0 (0-3.8)^{M}
Kick – (%)	12 (0-27)	16 (0-37)	9 (3.8-16.5)	2 (0-16)^{S}

*Significant difference between progressed and non-progressed players. Effect sizes: Small (^{S}) ≥ 0.1-0.29, Medium (^{M}) ≥ 0.3-0.49, Large (^{L}) ≥ 0.5.

There were insufficient data for statistical analyses due to the small sample size between progressed and non-progressed NA and SH players; nevertheless, results are displayed in Table 5.9.

Though none of the differences were deemed significant, there were several notable discrepancies between progressed and non-progressed Saxon SH. For example, large and medium effect sizes determined anthropometrical (height, r = 0.61; weight, r = 0.55) and playing experience (total minutes, r = 0.36). Progressed Saxon SH were also better in some technical performance actions, with small, medium and large effect sizes identified. Specifically, in defensive (total tackles, r = 0.29; missed tackles, r = 0.46; tackle completion rate, r = 0.51; clear-out efficiency, r = 0.21) and in offensive actions (total carries, r = 0.32; pick and go, r = 0.32; positional offensive actions: total kicks, r = 0.25; kick neutral, r = 0.24).

Table 5.9. Anthropometry and TPIs of progressed and non-progressed SH players in NA and Saxon squads (median [IQR]).

	NA→ Saxons, SNS		Saxons→ SNS	
	Progress (n = 1)	**Non-progress (n = 3)**	**Progress (n = 15)**	**Non-progress (n = 4)**
Anthropometrical				
Body stature (cm)	1.70 (N/A)	1.75 (1.75-N/A)^{L}	1.75 (1.75-1.80), n = 14	1.72 (1.70-1.73)^{L}
Body mass (kg)	77 (N/A)	89 (84-N/A)^{L}	84 (83-85), n = 14	81 (77.8-82)^{L}
Playing experience				
Total Matches	22 (N/A)	7 (6-N/A)^{L}	23.5 (13.8-29)	14 (2.3-22)^{S}
Total Minutes	942 (N/A)	275 (203-N/A)^{L}	1463.5 (873.5-1648.5)	541.5 (39.8-1323)^{M}
Defensive				
Total Tackles	5.8 (N/A)	8.3 (5.5)^{S}	7.6 (5.7-9.3)	5.2 (1.1-9.4)^{S}
Missed Tackles	0 (N/A)	0.8 (0-N/A)^{M}	0 (0-1.1)	1.6 (0.7-2.8)^{M}
Tackle Completion (%)	100 (N/A)	87.8 (74-N/A)^{M}	99.4 (87.7-100)	83.5 (20.8-87.7)^{L}
Rebound (%)	85 (N/A)	77 (68-N/A)^{L}	65 (58.5-80.5)	78 (17.8-91)^{S}
Total Clear-outs	1.61 (N/A)	0.8 (0.3-N/A)^{S}	1.57 (1.34-2.35)	2.4 (1.6-3.3)^{S}
Clear-out efficiency (%)	89 (N/A)	100 (60-N/A)^{S}	78.5 (69.5-90.8)	70 (54-85.3)^{S}
Total Breakdowns	1.6 (N/A)	0.8 (0.3-N/A)^{S}	1.5 (1.3-2.4)	1.9 (1.6-3.1)^{S}
Possession				
Total Possessions	68.2 (N/A)	44.8 (42.5- N/A)^{S}	62.4 (46.2-72.5)	69.1 (52.7-97.9)^{S}

*Significant difference between progressed and non-progressed players. Effect sizes: Small (^{S}) ≥ 0.1-0.29, Medium (^{M}) ≥ 0.3-0.49, Large (^{L}) ≥ 0.5. Note**:** N/A = not applicable for the given position.

	N/A→ Saxons, SNS		Saxons→ SNS	
	Progress (n = 1)	**Non-progress (n = 3)**	**Progress (n = 15)**	**Non-progress (n = 4)**
Offensive				
Total Carries	2 (N/A)	5.91 (3.5-N/A)^{L}	2.9 (2.2-3.8)	4.4 (2.4-5.5)^{M}
Total Carries (%)	2.9 (N/A)	8.5 (7.8-N/A)^{L}	4.6 (3.6-6.1)	5.6 (3.5-7.4)^{S}
Pick and Go	0.5 (N/A)	3.2 (1.1-N/A)^{L}	1.1 (0.6-1.4)	1.8 (0.8-3.1)^{M}
Handling				
Passes	57.3 (N/A)	62.3 (53.2-N/A)^{S}	50.1 (35.7-60)	46.3 (35.1-88.4)^{S}
Passes +	1.3 (N/A)	0.9 (0-N/A)^{S}	0.5 (0-0.7)	0.8 (0.1-1.2)^{S}
Passes -	2 (N/A)	1.2 (0.9-N/A)^{L}	1.2 (0-2.45)	1.8 (0.4-2.7)^{S}
Total Passes	60.6 (N/A)	65.8 (54.4-N/A)^{S}	53 (35.7-63)	47.9 (35.1-90.9)^{S}
Pass Completion (%)	96.8 (N/A)	97.9 (97.6-N/A)^{L}	96.7 (94.6-99)	97.5 (95-99.6)^{S}
Positional				
Offensive				
Total kicks	7.2 (N/A)	2.6 (2-N/A)^{L}	6.5 (3.8-7.9)	3.4 (0.3-6.8)^{S}
Kick neutral	4.8 (N/A)	1.4 (0.6-N/A)^{S}	5.7 (3.1-7.1)	2.7 (0.1-5.5)^{S}
Kick + (%)	20 (N/A)	17 (14-N/A)^{S}	6 (0-8)	10 (0-42.5)^{S}
Kick – (%)	12 (N/A)	11(5-N/A)^{S}	7.5 (0-12), n = 14	0 (0-9)^{S}

*Significant difference between progressed and non-progressed players. Effect sizes: Small (^{S}) ≥ 0.1-0.29, Medium (^{M}) ≥ 0.3-0.49, Large (^{L}) ≥ 0.5. Note**:** N/A = not applicable for the given position.

Inside backs

Though accompanied by only small effect sizes, progressed U18 IB (Table 5.10) players evidenced a greater playing experience, by competing in more matches ($r = 0.16$) and with more playing time ($r = 0.15$). Where TPIs were appraised, the progressed U18 IB evidenced a significantly higher frequency of handling actions (pass completion, $p \leq 0.001$; $r = 0.45$) than non-progressed players. Further differences between progressed and non-progressed U18 IB displayed were identified in the number of defensive (rebound (%), $r = 0.17$) and possession-related movements (total possession, $r = 0.17$).

Progressed U20 IB evidenced significant differences when compared with non-progressed peers. For example, they displayed a higher playing experience by participating in more matches ($p \leq 0.001$; $r = 0.38$) and playing for a longer duration ($p \leq 0.001$; $r = 0.35$). Where TPIs were appraised, progressed U20 IB demonstrated an improved technical performance in defence, by executing an increased number of tackles ($p \leq 0.01$; $r = 0.30$), establishing a higher tackle completion rate ($p \leq 0.01$; $r = 0.26$); likewise in actions related to possession, they retained their own lineout more frequently (total possession, $p \leq 0.01$; $r = 0.31$), and similarly in handling activities, evidenced a greater number of successful passes (number) ($p \leq 0.05$; $r = 0.25$) and total passes ($p \leq 0.05$; $r = 0.26$). Though progressed U20 IB were associated with improved positional offensive movements, for example, a higher rate in positive kicks ($p \leq 0.01$; $r = 0.28$), they also executed a higher rate in negative kicks ($p \leq 0.05$, $r = 0.25$) when compared to non-progressed.

Table 5.10. Anthropometry and TPIs of progressed and non-progressed IB players in U18 and U20 squads (median [IQR])

	U18→ U20, NA, Saxons, SNS		**U20→NA, Saxons, SNS**	
	Progress (n = 54)	**Non-progress (n = 21)**	**Progress (n = 42)**	**Non-progress (n = 45)**
Anthropometrical				
Body stature (cm)	1.83 (1.80-1.85)	1.82 (1.78-1.83)^{S}	1.84 (1.83-1.85)	1.83 (1.80-1.88) ^{S}
Body mass (kg)	89.5 (84-95)	86 (85-94.8)^{S}	91 (87-94.5)	92 (83-97)
Playing experience				
Total Matches	4 (1-7)	2 (1-3.8)^{S}	10 (2.5-16.5)	2 (1-7)^{*M}
Total Minutes	174.5 (67-349.5)	87.5 (58.8-203.8)^{S}	578.5 (85-1025.3)	80 (39-462)^{*M}
Defensive				
Total Tackles	8.8 (6.1-11.4)	8.6 (5.5-12.5)^{S}	9.5 (6.6-11.9)	5.9 (3.9-10.2)^{*M}
Missed Tackles	0.4 (0-6)	1.2 (0-2.3)	0.1 (0-2.1)	1.6 (0-5.6)^{S}
Tackle Completion (%)	93.8 (62.4-100)	89.3 (77.7-100)	98.5 (80.3-100)	77.8 (22.5-100)^{*S}
Rebound (%)	76 (60-90.5)	65.5 (54.8-80.8)^{S}	77 (66-88.8)	75 (52-89)^{S}
Total Clear-outs	6.6 (3.9-9.2)	7.2 (3.1-10.8)^{S}	5.3 (2.9-8.6)	6 (4.1-10.7)^{S}
Clear-out efficiency (%)	87 (75-97.8)	88.5 (67-100)	91.5 (83.3-97.3)	91 (80-100)
Total Breakdowns	6.5 (3.9-9.2)	7.2 (3.1-10.8)	5.1 (2.9-8.5)	6 (4.1-10.4)^{S}
Possession				
Total Possessions	19 (11.4-32)	13.3 (8.5-17.6)^{S}	16.4 (11.6-33.2)	11.5 (8.3-19.5)^{*M}

*Significant difference between progressed and non-progressed players. Effect sizes: Small (^{S}) ≥ 0.1-0.29, Medium (^{M}) ≥ 0.3-0.49, Large (^{L}) ≥ 0.5.

	U18→ U20, NA, Saxons, SNS		U20→NA, Saxons, SNS	
	Progress (n = 54)	**Non-progress (n = 21)**	**Progress (n = 42)**	**Non-progress (n = 45)**
Offensive				
Total Carries	6.8 (4.2-8.2)	5.9 (3.7-7.5)^{S}	4.6 (3.2-7.3)	6 (4.3-7.3)^{S}
Total Carries (%)	36.9 (10.4-60)	42.2 (13.7-62.5)	30.8 (9.9-56.7)	52 (12.4-74.2)^{S}
Pick and Go	0 (0-0.2)	0 (0-0)^{S}	0 (0-0.1)	0 (0-0)^{S}
Handling				
Passes	8.4 (3.9-24.2)	6.9 (0-15.8)^{S}	8.3 (2.9-18.6)	4 (1.6-10.2)^{*S}
Passes +	0.1 (0-1.6)	0 (0-1.1)^{S}	0.4 (0-0.9)	0 (0-0.7)^{S}
Passes -	0.2 (0-1)	0.6 (0-1.7)^{S}	0.2 (0-0.6)	0 (0-0.4)^{S}
Total Passes	9.3 (4.1-24.3)	7.8 (0-19.8)^{S}	9.8 (3.4-20)	4 (1.8-11.3)^{*S}
Pass Completion (%)	96.8 (92.7-100)	85.4 (0-92.8)^{*M}	96.3 (93.2-100)	96.6 (81.3-100)^{S}
Positional				
Offensive				
Total kicks	1.1 (0-4.4)	0.3 (0-2.9)^{S}	1.5 (0-7.5)	0.4 (0-2.6)^{S}
Kick neutral	0.8 (0-3.1)	0 (0-2.8)^{S}	1 (0-5.4)	0.3 (0-2)^{S}
Kick + (%)	0 (0-0)	0 (0-0)^{S}	0.5 (0-13.3)	0 (0-0)^{*S}
Kick – (%)	0 (0-9)	0 (0-12)^{S}	3.5 (0-16.3)	0 (0-2)^{*S}

*Significant difference between progressed and non-progressed players. Effect sizes: Small (^{S}) ≥ 0.1-0.29, Medium (^{M}) ≥ 0.3-0.49, Large (^{L}) ≥ 0.5.

For the progressed NA IB, none of the differences were deemed significant, though medium effect sizes determined the greater anthropometrical qualities (height, r = 0.32; weight, r = 0.31). Further results demonstrated that progressed NA IB evidenced insignificant differences accompanied by small effect sizes in defensive, offensive, handling and possession movements (Table 5.11) when compared with non-progressed.

Comparisons between progressed and non-progressed Saxon IB are presented in Table 5.11. Analyses revealed no significant differences and small effect sizes in defensive, offensive, handling and possession actions (Table 5.11) between the groups.

Table 5.11. Anthropometry and TPIs of progressed and non-progressed IB players in NA and Saxon squads (median [IQR]).

	NA → Saxons, SNS		Saxons→ SNS	
	Progress (n = 26)	**Non-progress (n = 14)**	**Progress (n = 86)**	**Non-progress (n = 21)**
Anthropometrical				
Body stature (cm)	1.85 (1.83-1.88)	1.81 (1.77-1.86)^{M}	1.85 (1.81-1.86)	1.83 (1.79-1.85)^{S}
Body mass (kg)	93 (88.5-94.5)	89.5 (92.3-75)^{M}	93 (88-96)	92 (90-96)
Playing experience				
Total Matches	12.5 (1-18)	3 (1.8-7.5)^{S}	8 (2-21)	4.5 (1.5-15.8)^{S}
Total Minutes	855 (54.3-1205.3)	150 (85-457.5)^{S}	579 (67-1381)	271.5 (88.3-784.5)^{S}
Defensive				
Total Tackles	9.8 (7.4-12.1)	9.8 (8.4-12.3)^{S}	9.72 (6.7-13)	8.5 (7.2-10.4)^{S}
Missed Tackles	0.6 (0.1-8.4)	1.5 (0-4)	1.1 (0-6.4)	0.6 (0.1-2.5)^{S}
Tackle Completion (%)	93.5 (26.3-99.3)	89 (58.3-100)^{S}	90.2 (57.9-100)	93.7 (84.9-99.5)^{S}
Rebound (%)	75.5 (63-86.3)	76.5 (69-88.5)^{S}	72 (62-82)	80.5 (69.8-87.8)^{S}
Total Clear-outs	6 (4.3-10.2)	6.7 (3.1-8.7)^{S}	6.5 (2.9-10.2)	6.6 (3.1-9.2)
Clear-out efficiency (%)	95 (91-97.8)	90.5 (85.3-100)^{S}	92 (87-100)	91 (84-98.8)
Total Breakdowns	6 (4.2-10.2)	6.5 (3.1-8.7)^{S}	6.5 (2.9-9.5)	6.6 (3.1-9.1)
Possession				
Total Possessions	15.2 (12.3-35.2)	15.3 (10.3-27.4)^{S}	14.5 (10.7-30)	11.3 (8.2-29.3)^{S}

*Significant difference between progressed and non-progressed players. Effect sizes: Small (^{S}) ≥ 0.1-0.29, Medium (^{M}) ≥ 0.3-0.49, Large (^{L}) ≥ 0.5.

	NA → Saxons, SNS		Saxons→SNS	
	Progress (n = 26)	**Non-progress (n = 14)**	**Progress (n = 86)**	**Non-progress (n = 21)**
Offensive				
Total Carries	5.4 (3.8-9.6)	6.8 (4.1-7.5)^{S}	4.9 (3.8-7)	4.2 (2.3-6.7)^{S}
Total Carries (%)	34.8 (12.8-58.2)	48.9 (22.1-68.8)^{S}	42 (10.5-57.1)	26 (9-57.2)^{S}
Pick and Go	0 (0-0)	0.3 (0-0.7)^{M}	0 (0-0.1)	0 (0-0.2)
Handling				
Passes	6.4 (3.8-18.2)	5.4 (1.2-12.9)^{S}	4.9 (3.3-16.1)	3.5 (2.4-17)^{S}
Passes +	0.4 (0-0.8)	0.3 (0-1.5)	0.2 (0-0.7)	0 (0-0.5)^{S}
Passes -	0.5 (0-0.9)	0.2 (0-1)^{S}	0.3 (0-0.8)	0 (0-0.9)^{S}
Total Passes	7.5 (3.9-20.2)	7.8 (1.7-14.5)^{S}	5.6 (3.6-17.8)	4.4 (2.4-18.5)^{S}
Pass Completion (%)	94.4 (88.8-97.2)	94.8 (76.4-100)	93.9 (88.9-100)	94.7 (90.7-100)^{S}
Positional				
Offensive				
Total kicks	1.6 (0.2-7.6)	1.2 (0.5-2.8)^{S}	1.1 (0.3-7.3)	0.6 (0-4.5)^{S}
Kick neutral	1.5 (0.1-5.2)	1.1 (0.4-2.4)^{S}	1 (0.2-5.2)	0.4 (0-3.9)^{S}
Kick + (%)	8 (0-15.3)	0 (0-13)^{S}	0 (0-17), n = 79	0 (0-6.5)^{S}, n = 20
Kick – (%)	9 (0-16.5)	0 (0-10.5)^{S}	0 (0-15), n = 79	0 (0-15), n = 20

*Significant difference between progressed and non-progressed players. Effect sizes: Small (^{S}) ≥ 0.1-0.29, Medium (^{M}) ≥ 0.3-0.49, Large (^{L}) ≥ 0.5.

Outside backs

Significant differences and medium effect sizes were established between progressed and non-progressed U18 OB. Progressed U18 OB evidenced a greater playing experience, by participating in more matches ($p \leq 0.01$; $r = 0.31$) for a longer duration (total minutes, $p \leq 0.001$; $r = 0.35$) than non-progressed. Though no other differences were deemed significant, small effect sizes determined. For example, progressed U18 OB evidenced a higher frequency of defensive (tackle completion (%), $r = 0.17$) and offensive actions (total carries, $r = 0.10$).

Where TPIs were considered the progressed U20 OB outperformed their non-progressed counterparts, with the differences deemed small-to-medium effect sizes, though, in the main insignificant. For example, they displayed a higher playing experience (total matches, $r = 0.15$; total minutes, $r = 0.07$), and an improved performance in defensive (tackle completion (%), $r = 0.22$), offensive (total carries (%), $r = 0.19$), and handling movements (pass completion rate, $p \leq 0.01$; $r = 0.30$) compared to non-progressed U20 OB.

Table 5.12. Anthropometry and TPIs of progressed and non-progressed OB players in U18 and U20 squads (median [IQR]).

	U18→ U20, NA, Saxons, SNS		U20→ NA, Saxons, SNS	
	Progress (n = 62)	**Non-progress (n = 36)**	**Progress (n = 49)**	**Non-progress (n = 54)**
Anthropometrical				
Body stature (cm)	1.83 (1.80-1.85)	1.83 (1.78-1.87), n = 29	1.84 (1.81-1.85)	1.82 (1.80-1.88)
Body mass (kg)	88 (84.5-93)	86 (82-93.5)^{S}, n = 29	89 (87-93)	87 (82.8-96.3)^{S}
Playing experience				
Total Matches	3 (1-5)	1 (1-3)^{*M}	4 (2-9)	2.5 (1-8)^{S}
Total Minutes	160 (58.8-318.3)	70 (22.5-157.5)^{*M}	214 (43.5-576)	162.5 (49-454.5)^{S}
Defensive				
Total Tackles	4.1 (2.7-5.8)	4.6 (1.7-7.5)	4.8 (2.1-5.9)	3 (1-4.6)^{S}
Missed Tackles	0 (0-0.8)	1 (0-2.9)^{S}	0 (0-0.8)	0.6 (0-4.5)^{S}
Tackle Completion (%)	100 (81.9-100)	82.4 (33.3-100)^{S}	100 (64.6-100)	73.9 (28.6-100)^{S}
Rebound (%)	66 (40-85.8)	75 (0-100)	70 (50-82)	61 (0-85.3)^{S}
Total Clear-outs	5.5 (3.6-7.4)	5 (2.3-8.2)	5.6 (4.2-7.9)	4.9 (3.1-8)^{S}
Clear-out efficiency (%)	85 (76.5-92.5)	87 (25-100)	90 (83-100)	89.5 (72.8-100)^{S}
Total Breakdowns	5.5 (3.6-7.4)	5 (2.3-8.2)	5.3 (4.1-7.8)	4.7 (3.1-7.6)^{S}
Possession				
Total Possessions	10 (6.5-14.3)	8 (3.7-14.3)	12 (9.4-16)	11 (8.2-16.9)

*Significant difference between progressed and non-progressed players. Effect sizes: Small (^{S}) ≥ 0.1-0.29, Medium (^{M}) ≥ 0.3-0.49, Large (^{L}) ≥ 0.5.

	U18→ U20, NA, Saxons, SNS		U20→ NA, Saxons, SNS	
	Progress (n = 62)	**Non-progress (n = 36)**	**Progress (n = 49)**	**Non-progress (n = 54)**
Offensive				
Total Carries	6.8 (5.6-8.5)	5.8 (3.6-9.3)^S	6.8 (4.4-8.4)	5.8 (4-7.8)^S
Total Carries (%)	57.1 (50-68.8)	59.3 (20-80)	58.1 (38.2-67.4)	50 (27.4-60)^S
Pick and Go	0 (1.4-0.2)	0 (0-0)^S	0 (0-0.1)	0 (0-0)^S
Handling				
Passes	2.4 (1.2-4.1)	2.6 (1.2-6.6)	2 (1.1-3)	2.7 (1.3-5.6)^S
Passes +	0 (0-0.3)	0 (0-0)^S	0 (0-0.2)	0 (0-0)^S
Passes -	0 (0-0.3)	0 (0-0)^S	0 (0-0.2)	0 (0-0)^S
Total Passes	2.9 (1.3-4.7)	2.6 (1.2-6.8)	2.5 (1.3-3.4)	2.9 (1.7-6.2)^S
Pass Completion (%)	100 (84.5-100)	100 (90-100)^S	94.9 (78.9-100)	100 (97.7-100)^M
Positional				
Offensive				
Total kicks	0.7 (0-1.4)	0.2 (0-1.2)^S	1.2 (0.2-2.1)	1.1 (0-3)
Kick neutral	0.5 (0-1.3)	0.2 (0-1)^S	0.9 (0-1.8)	0.9 (0-2.1)
Kick + (%)	0 (0-0)	0 (0-0)^S	0 (0-10)	0 (0-0)^S
Kick – (%)	0 (0-0)	0 (0-0)^S	0 (0-7.5)	0 (0-0)^S

*Significant difference between progressed and non-progressed players. Effect sizes: Small (^{S}) ≥ 0.1-0.29, Medium (^{M}) ≥ 0.3-0.49, Large (^{L}) ≥ 0.5.

Though none of the differences were deemed significant, there were several notable discrepancies between progressed and non-progressed NA OB. For example, differences were revealed in player anthropometry (weight, r = 0.34), and in playing experience (total matches, r = 0.05; total minutes, r = 0.03). Where TPIs were appraised progressed NA OB displayed better technical performances in defence (tackle completion, r = 0.22; rebound (%), r = 0.11; clear-out efficiency (%), r = 0.48), possession (total possession, r = 0.45), in offensive (total carries (%), r = 0.31), and in handling actions (passes, r = 0.38; total passes, r = 0.31) when compared with non-progressed.

Lastly, progressed Saxon OB revealed no significant differences and small effect sizes (Table 5.13) in defensive, offensive, handling and possession-related movements when compared with non-progressed. However, progressed Saxon OB evidenced a greater playing experience (total matches, r = 0.20; total minutes, r = 0.04) and possessed more frequent their own lineout (total possession, r = 0.12). There were also some variables with small effect sizes, where progressed Saxon OB displayed a lower technical performance, for example, in offensive (total carries (%), r = 0.16) and in handling actions (pass completion (%), r = 0.11; total breakdowns, r = 0.04) (see Table 5.13).

Table 5.13. Anthropometry and TPIs of progressed and non-progressed OB players in NA and Saxon squads (median [IQR]).

	NA → Saxons, SNS		Saxons→ SNS	
	Progress (n = 26)	**Non-progress (n = 9)**	**Progress (n = 77)**	**Non-progress (n = 21)**
Anthropometrical				
Body stature (cm)	1.85 (1.83-1.85)	1.84 (1.77-1.89)^{S}	1.85 (1.83-1.86)	1.83 (1.83-1.86)^{S}
Body mass (kg)	93 (88-94)	89 (86-92)^{M}	91 (88-93)	92 (90-102)^{S}
Playing experience				
Total Matches	6 (1.8-14)	4 (2.5-11)^{S}	8 (1-20)	6 (2-21.5)^{S}
Total Minutes	438.5 (73.3-1074.3)	258 (143-709)	572 (41.5-1447.5)	413 (61-1633)
Defensive				
Total Tackles	4.9 (3.4-5.8)	4.7 (3.2-6)^{S}	5.1 (3.5-7.7)	4.9 (2.9-6)^{S}
Missed Tackles	0.2 (0-2.2)	0.8 (0.6-2.3)^{S}	0.3 (0-1.6)	0.1 (0-1.8)
Tackle Completion (%)	96.2 (72.1-99.5)	77.2 (64.8-89)^{S}	92.6 (75.7-100)	97.4 (70-100)^{S}
Rebound (%)	74 (62-81.8)	66 (51.5-80.5)^{S}	66 (49.5-79)	68 (35-83.5)
Total Clear-outs	5.6 (4.8-7.9)	5.1 (3.7-7.6)^{S}	5.6 (4.2-8)	7.2 (3.2-10)^{S}
Clear-out efficiency (%)	95 (90.5-100)	88 (80.5-91)^{M}	93 (84.5-100)	93 (85-96)
Possession				
Total Possessions	13.43 (10.7-17.3)	9.7 (6.2-11.2)^{M}	12.31 (9.1-17.9)	10.8 (8.4-18)^{S}

*Significant difference between progressed and non-progressed players. Effect sizes: Small (^{S}) ≥ 0.1-0.29, Medium (^{M}) ≥ 0.3-0.49, Large (^{L}) ≥ 0.5.

	NA→Saxons, SNS		Saxons→SNS	
	Progress (n = 26)	**Non-progress (n = 9)**	**Progress (n = 77)**	**Non-progress (n = 21)**
Offensive				
Total Carries	6.4 (4.2-8.8)	6.3 (5.8-7.3)^{S}	5.8 (3.7-7.5)	5.7 (4-7)
Total Carries (%)	53.1 (32.7-66.1)	64.9 (57.1-79.1)^{M}	42.9 (29.8-57.1)	53 (36.5-59.8)^{S}
Pick and Go	0 (0-0.3)	0.1 (0-0.3)^{S}	0 (0-0.1)	0 (0-0.1)^{S}
Handling				
Passes	2.3 (1.5-4.2)	1.1 (1-2.1)^{M}	3.3 (1.5-5.6)	2.4 (0.8-5.5)^{S}
Passes +	0.1 (0-0.4)	0 (0-0.4)^{S}	0 (0-0.3)	0 (0-0.2)^{S}
Passes -	0.1 (0-0.4)	0.2 (0-0.3)	0 (0-0.3)	0 (0-0.2)^{S}
Total Passes	2.7 (1.7-4.7)	1.6 (1.2-2.7)^{M}	3.8 (1.6-6.2)	2.6 (0.8-6.4)^{S}
Pass Completion (%)	91.6 (86.2-98.2)	93 (85.9-100)^{S}	94.3 (86.9-100)	100 (90.6-100)^{S}
Total Breakdowns	5.3 (4.4-7.9)	5 (3.1-7.3)^{S}	5.3 (4.1-8)	7.2 (3.2-10)^{S}
Positional				
Offensive				
Total kicks	1.6 (0.5-5.1)	1.1 (0.1-1.4)^{S}	1.1 (0.5-2.9)	0.6 (0-3.2)^{S}
Kick neutral	1.1 (0.4-3.4)	0.9 (0.1-1.2)^{S}	1 (0.4-2.5)	0.4 (0-3)^{S}
Kick + (%)	0 (0-11.5)	0 (0-8.5)^{S}	0 (0-11)	0 (0-5)
Kick – (%)	0 (0-12.3)	0 (0-23)^{S}	0 (0-11), n = 79	0 (0-6)^{S}, n = 20

*Significant difference between progressed and non-progressed players. Effect sizes: Small (^{S}) ≥ 0.1-0.29, Medium (^{M}) ≥ 0.3-0.49, Large (^{L}) ≥ 0.5.

5.5 Discussion

The findings of the current study demonstrated that taller and heavier players, competing within a higher number of matches, for an increased duration, were the most important variables influencing progression or deselection from the programme. Where the match TPIs were considered, there were stochastic differences between groups though it appeared selected players typically outperformed the non-selected group albeit by small margins and there were fewer differences between progressed and non-progressed in older age squads. Finally, in players selected to progress and those deselected, there was notable variation in the technical performances.

Whilst it is known that more successful teams often possess heavier forwards players and taller backs (Argus et al., 2012; Sedeaud et al., 2012), it has not been established that being a heavier or taller player influences the likelihood of progressing from a given squad in many positions. Interestingly, Fuller et al. (2013) demonstrated that the body height of forwards (1.3 cm · decade^{-1}), FH (4.6 cm · decade^{-1}) and props (3.1 cm · decade^{-1}) increased in height suggesting 'large' players are deemed important members of union teams. Although the body mass for forwards is associated with success in World Cups (Sedeaud et al., 2012), Fuller and colleagues (2013) indicated that props (1.9 kg · decade^{-1}) and backs (2.4 kg · decade^{-1}) body mass increased across the years but evidenced no significant trends, only the positional groups of FH (2.9 kg · decade^{-1}) and BR (2.7 kg · decade^{-1}) evidenced significant changes across the years. Though additional mass would increase the energy expenditure of running at a given velocity (assuming constant economy), for many players, the key features of their tactical role could benefit from additional mass (Hendricks et al., 2014). For example, players involved in a high number of tackles and collisions would likely benefit from additional mass given the relationship between force, mass and acceleration in which a defending player would have to generate higher forces to achieve the same resultant acceleration of the attacking player. With the general increase in the mass of rugby players noted in previous research (e.g. Norton & Olds, 2001; Argus et al., 2012), the relationship between collective team weight and success (Sedeaud et al., 2012), and the relationship between body mass and sprinting speed (i.e. sprint momentum) as key traits for rugby union players (Barr et al., 2014), it appears as though coaches are tending to select players likely to better fulfil the requirements of their positional role.

However, it was apparent that the weight of the players was not as important across all playing positions. For example, in U18, U20, and Saxons, there was no difference in weight between progressed and non-progressed IB, OB players whereas in the BR, there were important differences in the mass of players progressing in each team. Such a finding is likely a reflection of the prerequisites of the position in which front and back players are required to perform. For example, BR players experience the highest frequency of impacts (Venter et al., 2011) and tackles (Prim & Van Rooyen, 2011), while OB require considerable speed and agility skills to outmanoeuvre their opponents, to perform support running, chase down kicks and cover in defence (Duthie et al., 2003) and as such, additional mass is unlikely to facilitate the key objectives of the OB position but likely contributes to the roles of forwards (Eaton & George, 2006; Hendricks et al., 2014). Though, there were occasions where the weight of the players distinguished selected and deselected players in positions typified more frequently by high-intensity running (i.e. the backs) (Roberts et al., 2008; Cahill et al., 2013). Such a finding reflects the fact that on occasion they are required to tackle and that increased mass could increase the momentum of the player (Barr et al., 2014) thus benefitting the player during collisions. An increase in player momentum carrying the ball would likely make it increasingly difficult to tackle the player and turnover the ball.

Another prominent finding was that progressing players participated in more matches and accumulated greater playing time. Though in rugby league, this was consistent with findings from Gabbett (2002b) who established that players with more playing experience were selected to play for the first grade team compared to second grade players in semi-professional rugby league teams. Similarly, Waldron et al. (2011) indicated that selected U16 youth elite rugby league scholarship/academy players performed for longer match periods compared to deselected players. This match exposure has a clear advantage due to the fact that players accumulate competitive experience, which results in higher ability athletes owing to the additional opportunity for learning in those players alongside the physiological stimulus experienced during competition enhancing conditioning (Gabbett, 2002a; Baker & Horton, 2004; Gabbett et al., 2007; Gabbett et al., 2009; Gabbett & Ryan, 2009; Gabbett et al., 2011a). Indeed, research has established that the ‘collective experience’ of the players contributes to success in international rugby union performance (Sedeaud et al., 2012) which is believed to produce tactically astute players. The research of Gabbett and Ryan (2009) further demonstrated that national rugby league players with 150 matches evidenced improved tackling technique than players with less than 150 matches, suggesting that expertise in sport can develop due to accumulated playing experience and the players of the current study likely benefitted from additional competitive experience. Hence, coaches might consider distributing match time participation more equally across squad members (Waldron et al., 2011) to ensure parity in the developmental opportunities experienced. Such a finding would appear pertinent given the premise that players appear to individually develop at random stages throughout talent programmes (Gabbett et al., 2009; Gabbett et al., 2011a).

The data are in agreement with previous research in that the behavioural actions of the players, independent of the squad or whether they progressed or not, were engaged in a higher frequency of activities associated with their playing position. For example, players within the generic ‘forward’ classification were involved more frequently in defensive actions (i.e. tackle situations) whereas ‘backs’ were involved more frequently in handling action (passing movements) (Deutsch et al., 2007; Roberts et al., 2008; Cunniffe et al., 2009; Quarrie et al., 2013). On occasion, it was evident that progressed players had outperformed their non-progressed equivalents in facets of match-play related to their position. For example, the BR players are required to engage in a high number of contact situations (Vivian et al., 2001; Eaton & George, 2006; Quarrie et al., 2013) and clearly a player that is able to more frequently perform tackles (perhaps owing to superior spatiotemporal awareness; Vilar, Araujo, Davids & Button, 2012) could enhance team performance. Thus, the finding that the progressed BR players of the NA and Saxon squads were engaged in more tackles appears logical. That this difference was not established at the U18 and U20 level in BR players suggests other features of performance not accounted for using the TPIs might better discriminate players.

Despite the presence of apparently ‘logical’ differences between players, overall, when comparing the TPIs of progressed and non-progressed players, there appeared only one consistent difference across the various squads. That is, progressed U18 and NA players possessed better defensive skills than their counterparts in all positional groups.

Likewise, the International Rugby Board Game Analysis (2011a, 2011b, 2011c) has reported that 50% of the game is spent in defensive strategies, therefore successful performance in rugby union is partially dependent on the defending ability of a team (Hendricks et al., 2013). Since past research has indicated that specific defensive actions (i.e. tackle breaks: attackers avoid the attempted tackle and moves forward, Wheeler, Askew, & Sayers, 2010; the line-speed of defence, the area of contact phase in relation to the previous phase, Hendricks et al., 2013) are associated with successful outcome in rugby union. It might be that the defensive actions of rugby union players during competition might be used as part of a talent ID process to determine which players should progress to higher ability squads. However, a recent review of talent ID research in adolescent performance suggested that effective talent programmes ought to obtain objective measurements of 'game sense' and determine other qualities such as 'coachability', leadership, and cognitive competencies that were not accounted for herein (Burgess & Naughton, 2010). As such, it appears a more holistic approach to talent ID and development is warranted (Vaeyens et al., 2009; Gee et al., 2010; MacNamara et al., 2010a, 2010b; Gulbin et al., 2013a).

The absence of consistent differences between groups could also be a facet of the large within-group variability in the performance indicators. Such variance is likely a product of situational factors that could influence technical playing performance. For example, it has been demonstrated that the format of the competition may influence a team's tactical approach and which performance indicators are most important for success (Bishop & Barnes, 2013) and the patterns of play, game plan and various strategies could determine a player's movement during a play (Bracewell, 2003; Roberts et al., 2008). Likewise, the strength of the opposition, the rank of the opponent, match outcome (Rampinini, Coutts, Castagna, Sassi, & Impellizzeri, 2007; Gabbett, 2013), environmental conditions (Mohr et al., 2010), pacing elements, competition strategy, time of the season, match location and score status, can influence performance (Aughey, 2011; Gabbett, 2013; Sullivan et al., 2014; Kempton et al., 2015; Goodale et al., 2016; Kempton & Coutts, 2016); all of which were not available for consideration within the sampled dataset. Moreover, that the sample of the present study within each group was not balanced according to the situational factors means the differences, or lack thereof, could be a product of such conditions. For example, enhanced performance in some positions or age groups could merely be a product of the success of that particular team rather than genuine differences in technical playing ability. Future research might consider appraisals of technical match performance with equally balanced groups where the more important situational variables (i.e. opposition, match location & match status) are considered (Mohr et al., 2010; Gabbett, 2013; Sullivan et al., 2014).

That said, despite the absence of consistent significant differences across TPIs when comparing progressed to non-progressed players, it seemed apparent that the selected players did more frequently (using the median as an indication of 'typical' performance) outperform their deselected counterparts, even if only by small margins. Such a finding would suggest that subtle discrepancies in performance could influence the selection process of the coach. For example, Van Gent and Spamer (2005) determined that the older the players (i.e. U18, U19) the fewer the differences in rugby specific skills (i.e. passing, kicking, catching ability, etc.), physical and motor components (i.e. flexibility, power, agility, strength components) within age groups, irrelevant of positional group. That said sports performance at the highest level of the game is defined by a small margin of differences, challenging as such the discriminatory value of technical match performance, especially when coaches select higher ability athletes among a homogenous group of talented players.

Currently, the extensive use of physical ability tests means such data is often used as part of the selection process (Burgess & Naughton, 2010) which neglects the importance of the various factors influencing player development. Indeed, Smart et al. (2014) revealed that senior professional rugby union players are not selected for provincial level competition if they lack the prerequisite physical characteristics. Furthermore, Gabbett et al. (2011a) demonstrated that selected players into national rugby league teams are leaner, able to generate greater acceleration, lower body muscular power and estimated VO^2max. The limited trends observed in the technical match performance between progressed and non-progressed players might therefore reflect the physical ability of players progressing. Indeed, the most consistent variable distinguishing the groups was one based upon anthropometry (i.e. player weight) and so, coaches selecting players to progress potentially utilize such data to inform their decisions.

Within team sports talent selection relies primarily upon the ability of the coach to understand “the key elements” (Vaeyens et al., 2006, p. 928) of a player “with the potential to excel” (Abbott & Collins, 2004). Indeed, coaches might base their selection criteria on slightly different success indicators (i.e. physiological, game skill, cognitive indicator) and hence might not adhere to a consensus perspective about what makes an effective player (Cupples & O’Connor, 2011). For example, some coaches will select heavier players (Sedeaud et al., 2012), others might prefer players with greater physical ability (Smart et al., 2014), where others might choose to select players based on their match performance (Hughes et al., 2012). That said, when Waldron et al. (2014c) scrutinized the agreement between expert observers in rugby league, the findings indicated that coaches tend to misinterpret a player's ability when using specific criteria (i.e. catching, passing) for skill assessment within a simulated sport-specific scenario. Indeed, coaches selecting players to progress who potentially utilize such data may fail to identify the factors underlying superior performance, and so higher ability players could be deselected or not experience a higher squad selection within a TDE system. Additionally, when coaches selecting players based solely on TPIs may increase the objectivity during selection procedures, since the various situational factors (i.e. strength of opponent, match day, venue, seen in Aughey, 2011; Gabbett, 2013) that have found to add more complexity to the execution of a skill (i.e. tackling technique) are potentially disregarded.

Additionally, in the current study there were some positions with inadequate sample sizes, and in the presence of substantial variability, researchers ought to maximize the sample size suggesting further analyses is warranted in those positions (i.e. SR, SH) (Batterham & Atkinson, 2005). Still, the present study has utilized one of the largest elite cohorts' to-date improving understanding of the selection process across an entire development programme. Similar to the limitations highlighted in Chapter 4, the reliability of the data is an important consideration and assuming adequate consistency was achieved during the analysis, the data could be representative of current selection processes despite the changing nature of rugby union players (Norton & Olds, 2001; Olds, 2001; Fuller et al., 2013).

From an applied perspective, identifying talented youth, adult and senior rugby union players may require the ability to recognize factors both within and beyond match performance characteristics (i.e. TPIs). Coaches should remain cognisant whilst using TPIs to discriminate talent, which may preclude the use of TPIs in isolation during selection processes. It would appear logical therefore to conclude other qualities within respective squads where notable levels of TPIs failed to explain progression, which may account to the fact that skilled rugby union athletes may have progressed to a higher squad selection, based on superior (Williams & Ford, 2008) and faster decision making skill, on higher response precision (Vaeyens et al., 2007) and on greater ability to recognize, recall (analogous to the game) (Williams et al., 2006) and predict patterns of play (Berry & Abernethy, 2003). All these qualities allow players to adapt rapidly to changes in situational demands (Vaeyens et al., 2007). Ultimately, the anthropometrical (weight) and playing experience (i.e. total minutes, total minutes) data presented here as important factors, could be used in conjunction with other qualities to contribute to the selection and progression within EPPP or within any TDE system. For example, physical (Smart et al., 2014; Darrall-Jones et al., 2015a, 2015b; Read et al., 2016) and psychological attributes (MacNamara et al., 2010a, 2010b), together with tactical awareness (Williams, 2000) and perceptual-cognitive qualities (i.e. better anticipation, Gabbett et al., 2007; decision-making, Vaeyens et al., 2007; higher recall pattern, Williams et al., 2006).

5.6 Conclusion

In conclusion, the findings have identified that playing time and anthropometrical characteristics are prerequisites for higher squad selection within EPPP. Where TPIs were considered, in the main, spurious differences were identified between progressed and non-progressed players of the EPPP. Therefore, a potential method coaches ought to consider game-specific skills alongside perceptual-cognitive and psychological and physiological qualities, so as to provide a holistic overview of the characteristics that describe higher squad selection (Burgess & Naughton, 2010).

Chapter 6

General Conclusion

6.1 Overview

This thesis has provided a comprehensive analysis of the effectiveness of the EPPP in retaining rugby union players, describing the position-specific anthropometrical and technical characteristics of players across squads and across selection procedures. The first study highlighted the various paths that athletes follow during their long-term development within England's RFU talent developmental sport system. Study two provided original data with respect to the position-specific anthropometrical characteristics and TPIs underpinning youth (U18), adult (U20, NA) and senior (Saxon, SNS) squads within the EPPP. Finally, study three determined whether TPIs and anthropometrical characteristics determine higher squad selection within the EPPP. The following sections present an overview of the key outcomes from all three studies, an acknowledgment of the relevant limitations, as well as the practical implications of the findings and recommendations for further research.

6.2 Main findings

Profiling elite player progression in team sports remains an important endeavour (Guellich, 2014b) hence Chapter 3 examined the progression of 396 male rugby union players within the EPPP. The study identified that player development was not a predictable linear progress (excepting 1.8% of players), but was instead characterized by irregular transitions and de-selections. Moreover, analysis revealed that 17.35% attained SNS selection having not been developed within the EPPP, 51.23% participated in one squad (NA or Saxons), 17.35% in two squads (U20-Saxons or NA-Saxons), 8.26% in three squads (U18-U20-NA or U18-U20-Saxons or U20-NA-Saxons) and 5.8% in four squads (U18-U20-NA-Saxons) before becoming a member in the SNS (n=121). Chapter 3 therefore revealed that the SNS is typified by athletes who have in the main, been deselected and reselected and each age squad providing limited transition rates to the senior squad (collectivistic approach) (Guellich, 2014a). Such varied development has been reported within high performance athletes within other team sports suggesting those involved in the development of athletes should not expect linear progression across respective squads (Guellich & Emrich, 2006a, 2012; Gulbin et al., 2013a; Guellich, 2014a; Guellich & Emrich, 2014).

Additionally, in Chapter 3 the Saxon squad was revealed as the squad where most players (36.36%) entered the RFU's EPPP, followed by the NA (19%). Appraising the interplay between youth, adult and senior level selection, Chapter 3 highlighted that the trajectory to SNS selection was not a predictable ascent after initial selection onto the EPPP, since only 11.20% and 19% from the current SNS passed through U18 and U20 squads compared to 36.36% and 79.33% that passed through NA and Saxon squad. Again, findings were in agreement with an appraisal of Australian athletes from 27 different sports who tended to enter the Australian supportive system at higher levels of development rather than at the earliest opportunity (Gulbin et al., 2013a). Research has signified that the older a player attended an elite promotion programme, the higher the probability of achieving senior elite performance, and that successful senior athletes tend to have a relatively later success in their sport (Guellich & Emrich, 2006b; Vaeyens et al., 2009; Guellich & Emrich, 2012; Barreiros et al., 2014; Guellich, 2014a; Guellich & Emrich, 2014). Indeed, the majority of SNS players (79.33%) were members at the Saxon squad before entering the SNS (see Figure 3.2).

Across all groups, position-specific differences were typified by increased body mass and stature though there appeared no clear trend distinguishing the technical performance of the players. SNS FR were heavier and taller than the Saxon FR, illustrating as such the greater anthropometrical demands on this position at international level. Acknowledging that the Saxon squad represents a 'second' national team, heavier FR players are potentially selected to the SNS given the association between mass and success in the sport (Olds, 2001; Sedeaud et al., 2012; Fuller et al., 2013). Such findings in Chapter 4 are largely consistent with previous observations of mass in union players given its influence during frequent collisions (McLellan et al., 2011; Twist et al., 2011). No other significant differences were evident between Saxon and SNS across all positional groups in Chapter 4 reinforcing the similarity between teams.

Furthermore, Chapter 4 revealed that there was no clear trend distinguishing the technical performance of the players across age squads. For example, U18 and U20 OB players evidenced a higher frequency in offensive (e.g. total carries (%)) and defensive actions (e.g. rebound [%]) than Saxons and SNS OB players. Assuming physical and physiological differences across squads influence the technical-tactical dynamics of a match (Glazier, 2010), those TPIs underpinning lower age squads may not be essential characteristics of senior squads within the EPPP. To illustrate, the SNS FR players performed a lower frequency of set-piece TPIs (e.g. total scrums), some offensive (e.g. total carries [%]) and possession-related actions (e.g. more lineouts lost) compared to the U18 team. However, they evidenced a greater playing experience and better defensive actions than U18 FR. Given the current findings, the specific TPIs (e.g. higher frequency of tackles in senior squads [Saxons and SNS]) that define older from younger squads requires further exploration and potentially relates to the fact players at senior ages experienced more collision and static exertions than at younger ages (Roberts et al., 2008; Johnston et al., 2015). Whilst their association with muscle damage (McLellan et al., 2011) and neuromuscular fatigue after each game (McLellan & Lovell, 2012) ultimately affecting the technical performance. Moreover, the findings could be the result of situational (Hale, 2004; Hiscock et al., 2012; Gabbett, 2013; Murray et al., 2014) and/or perceptual-cognitive factors (Williams & Ericsson, 2005; Baker & Cote, 2006; Williams et al., 2006; Ford et al., 2009; Ford & Williams, 2011) not considered in the current analysis. Thus, the technical performance during match-play match data related to set piece, defensive, offensive, possession and handling TPIs were typically ineffective in discriminating ability levels across squads. However, such evidence might help coaches and scouts to realize the technical factors that define youth, adult and senior elite international players within the EPPP system and as such to adapt the training process. While the TPIs could be used as benchmarks in the selection process for assessing youth, adult and senior elite international players.

When contrasting selected from deselected players, anthropometrical qualities were important in discriminating higher from lower ability players, and in defining progression within EPPP (Chapter 5). Indeed, research suggests that higher standard players tend to be heavier and taller (Norton & Olds, 2001; Argus et al., 2012) and teams possessing such players progress further in World Cup events (Olds, 2001; Sedeaud et al., 2012). Whilst it is known that more successful teams possess heavier players (Durandt et al., 2011; Argus et al., 2012; Sedeaud et al., 2012), it has not been established that being a heavier player influences the likelihood of progressing from a given squad in many positions. It appears as though coaches are tending to therefore select players more physically able to fulfil the requirements of their role (e.g. Norton & Olds, 2001; Argus et al., 2012).

Where TPIs were appraised, stochastic differences were again established between groups (Chapter 5). It appears as though selected players typically outperformed the non-selected group albeit by small margins and there were fewer differences between progressed and non-progressed players in older age squads. More specifically, analyses revealed that progressed Saxons differed in a range of sporadic characteristics including anthropometrical and technical performance variables, even if only by small margins. Such findings corroborate the notion that at the elite level of performance, differences are few and with small margins. Similarly, Van Gent and Spamer (2005) determined that the older the players (i.e. U18, U19) the fewer the differences in rugby specific skills (i.e. passing, kicking, catching ability, etc.), physical abilities (i.e. flexibility, power, agility, strength) within age groups, irrespective of player position. Moreover, a study by Till and colleagues (2011) highlighted that physical attributes together with psychological, technical and tactical awareness are necessary to distinguish higher from lower ability players amongst talented youth, adult and senior rugby union players hence it seems unsurprising an appraisal of the TPIs alone did not clearly distinguish selected and deselected groups. It would appear logical, therefore, to conclude that in the age representative squads where TPI, anthropometrical attributes or playing experience failed to explain progression, other characteristics, which have not been addressed in Chapter 5, may contribute to positional selection and progression within EPPP. For example, physical abilities (Smart et al., 2014; Darrall-Jones et al., 2015a, 2015b; Read et al., 2016), psychological attributes (MacNamara et al., 2010a, 2010b), tactical awareness (Williams, 2000) and perceptual-cognitive (Williams & Ericsson, 2005; Williams et al., 2006) might provide a better indication of the potential an ability possesses.

Finally, a variable that constantly distinguished respective squads and selected from non-selected players was that of match exposure (i.e. number of matches and total minutes played). Such a finding is in agreement with several studies in rugby (union and league) in which playing experience was key to player ability and progression across squads and team success (Gabbett, 2002a; Waldron et al., 2011; Sedeaud et al., 2012). Coaches and scouts should acknowledge that when selecting players to compete or progress to subsequent squads, those players with increased exposure to the competitive environment have potentially enhanced their physical and cognitive abilities. As such, coaches might consider distributing match time participation more equally across squad members (Waldron et al., 2011) to ensure parity in the developmental opportunities experienced. Such a finding would appear pertinent given the premise that players appear to individually develop at random stages throughout talent programmes (Gabbett et al., 2009; Gabbett et al., 2011a). Collectively, these findings suggest that coaches select heavier and/or taller players to participate in U-teams. Subsequently these players likely gain more match exposure, and are those who then progress to subsequent squads and finally to the SNS. Fundamentally, knowing that mass for example is related to match outcome, the coaches appear to be picking the players most likely to meet the demands and they are then being retained within the system.

Used in isolation therefore, TPIs might not therefore distinguish respective squads or higher from lower ability athletes, though the extent of the observed differences between younger (U18 and U20) and older (NA, Saxons & SNS) squads and between progressed and non-progressed players, suggests they could be used in conjunction with coach intuition to improve the objectivity of player selection to future squads. Moreover TPIs could provide normative data for each age squad and for those seeking to progress within the EPPP.

6.3 Limitations

Whilst the sub-discipline of performance analysis has been criticised for affording only a rudimentary examination of the competitive environment, generating outcome-oriented data (Glazier, 2010) and inadequately considering the context within which performance takes place (Mackenzie & Cushion, 2013), it is now acknowledged that match performance is influenced by various factors including those termed ‘task’, ‘organismic’ and ‘environmental’ constraints (Glazier & Robins, 2013) and these interact with one another to influence competitive performance. The actions that players execute are therefore undertaken within a chaotic and complex environment (McGarry & Perl, 2004) meaning the current data, particularly where the TPIs are considered, could be a product of the competitive contexts within which the performances occurred (O'Donoghue, 2012). Attempts to circumvent this issue are typically based upon the quantification of the impact of various situational factors (Mohr et al., 2010; Gabbett, 2013; Kempton et al., 2015) though this was not possible in the current thesis. Therefore, it is not known for example, how the impact of match status (i.e. score line) (Rampinini et al., 2007) or location (Kempton et al., 2015) influenced performance. Given the extensive research that has determined the positive influence of winning (Gabbett, 2013) and playing at home venues (Aughey, 2011; Kempton & Coutts, 2016) in a range of sports, including rugby union, such an omission diminishes the generalizability of the findings (Mackenzie & Cushion, 2013).

Where the TPIs were appraised, the somewhat spurious significant differences that emerged between groups (i.e. respective squads and selected vs. non-selected players) could also be a facet of the large variability evidenced. Such variance is likely a product of situational factors that could influence technical playing performance (Kempton et al., 2015). Moreover, the absence of significant differences could be due to the relatively small position-specific sample sizes in some cases resulting in under-powered analyses (Beck, 2013). Likewise, analyses using non-parametric statistical approaches has also been criticized for lacking statistical power (Asthana & Bhushan, 2007; Hopkins, Marshall, Batterham, & Hanin, 2009). Therefore, to circumvent the above problems the present thesis reported the magnitude of differences, by calculating the effect sizes (Field, 2013). The use of the effect size was a measure to provide an indication of effect independent of sample size (Sullivan & Feinn, 2012) and the small-sample sizes are essentially the result of providing position-specific data per squad – the kind of which has not been explored before in a development squad and, given it is known that back vs. forward comparisons fail to provide specific data (Greenwood, 1997; James et al., 2005), such an approach appeared justified.

It should also be acknowledged that despite careful consideration of the operational definitions through content validity procedures (Williams, 2012), some errors were inevitable in the retrospective data (James et al., 2005). Essentially, measurement error increases the variability of the observed TPIs of the players and subsequently reduces the likelihood of detecting genuine differences between groups (i.e. Type II error) (O'Donoghue, 2007). In this respect, conclusions drawn using TPIs that did not achieve adequate intra and inter-observer reliability potentially require reappraisal.

Finally, Olds (2001) indicated that significant increases in body mass occurred over a 25 year period (e.g. study assessed 1975-1999) while Fuller et al. (2013) indicated that significant changes occurred over a 9 year period (e.g. study assessed 2002-2011). Although previous research has revealed the anthropometry of rugby union players continually evolves (Olds, 2001; Fuller et al., 2013), present data could be generalized to current rugby union players, since this thesis assessed players between 2008 and 2014. Additionally, no study has included such a vast sample across an entire developmental programme and it can take several years for physical changes to occur (Cormery et al., 2008) hence the data likely remains useful.

6.4 Practical Applications

A key finding of the current programme of research was that the path to SNS selection was typified by various transition routes and participation within the EPPP was also not a prerequisite. Consequently, there is a need for the EPPP to acknowledge that SNS selection may come from various developmental trajectories (i.e. RFUs' Aspirational Path, which includes the development of regional and county players). Therefore, the RFU could aid talent transfer initiatives (Bullock et al., 2009) which typically aim to enhance mature age talent selection programmes and address later stages of development, though the efficacy of such programmes would require confirmation. Nevertheless, the transition rates were somewhat typical of development systems of other nations across a number of different sports (Gulbin et al., 2013a; Guellich, 2014a, 2014b) and it is therefore plausible that the transition rates might not be increased further with drop-out rates reflecting a 'natural' structure (i.e. survival of the fittest).

The data of Chapter 4 and 5 provided an overview of the position-specific anthropometrical features of players and technical TPIs exhibited during performance. As is typical of performance analysis research (James et al., 2005; Hughes et al., 2012), the competition data provides a comprehensive description of the match demands which could inform the preparatory training and competitive strategy of rugby union players (Hendricks et al., 2013). Moreover, such descriptions of the players and their performances reflects the position-specific prerequisites that ought to be attained when performing at youth, adult and senior levels but reveals that there are few variables of those examined that can be used to distinguish players who ought to retain their membership within the EPPP and thus progress to subsequent squads. It therefore appears as though coaches ought to consider more than the technical performance of the players during matches when deciding to retain a player within the EPPP. Such factors might include physical abilities (Smart et al., 2014; Darrall-Jones et al., 2015a, 2015b; Read et al., 2016), psychological attributes (MacNamara et al., 2010a, 2010b), tactical awareness (Williams, 2000) and perceptual-cognitive (Williams & Ericsson, 2005; Williams et al., 2006), which might provide a better indication of talent in youth, adult and senior rugby union players (Till et al., 2011).

That coaches have typically retained players who are no different to those dropped from the EPPP where competitive performance is considered and therefore could suggest that the coaches did not necessarily retain the most effective players. Indeed, research (Jones et al., 2004; James et al., 2005; Ortega et al., 2009; Vaz et al., 2010) has established that successful teams display improved technical performance (e.g. passing, kicking, tackling, possession of the ball) and so players that evidence these traits could be those most likely to succeed in future squads. Indeed, coaches have been shown to possess inadequate consistency when appraising technical performance during skills testing (Waldron et al., 2014c) and they cannot accurately recall the performances of players during matches (Laird & Waters, 2008) suggesting they could have failed to select the most talented players. Nevertheless, players may have progressed to a higher squads based other qualities such as perceptual-cognitive qualities (Williams & Ericsson, 2005; William et al., 2006; Gabbett et al., 2007; Vaeyens et al., 2007) or greater physical (Smart et al., 2014, Darrall- Jones et al., 2015a, 2015b; Jones et al., 2016; Read et al., 2016), psychological (MacNamara et al., 2010a, 2010b) and tactical awareness (Williams, 2000).

6.5 Future Directions

Further appraisal of the coaches' subjective selection criteria for each age category remains a worthwhile task given that the technical match performance was unable to clearly differentiate players retained or dropped from the EPPP. There is however a dearth of understanding of the performance indicators and anthropometrical characteristics that coaches consider during the selection process. Such information may contribute to the development of a more robust and comprehensive talent selection profile. Whilst previous studies have performed semi-structured and in-depth interviews in soccer (Vrljic & Mallett, 2008; Christensen, 2009), there has been no study in rugby union which directly compares coaches' selection criteria with actual performance characteristics. Indeed, recent research suggests that coaches tend to choose athletes displaying 'good behaviour' and a 'favourable personality' over athletes with better sports skills (Johansson, 2010) and so a holistic appraisal of players, and their coaches, appears worthy of further appraisal (Martindale, Collins, & Abraham, 2007) to better understand the selection processes involved in talent systems.

There were some positions (i.e. SH) possessing inadequate sample sizes (i.e. Chapter 5) and in the presence of substantial variability, as was the case with the technical performance data, researchers ought to maximize the sample size (Batterham & Atkinson, 2005). As such, future studies sampling larger groups of players appears warranted. Nevertheless, the sample size (n = 396) and the longitudinal approach to data collection denotes the data still provides the most precise estimates of the anthropometry and technical performance of rugby union players enrolled on a national talent programme.

Despite the position-specific appraisal of Chapters 4 and 5, given the specific roles that players of different positions undertake, it would appear pertinent that future analyses determine the position-specific anthropometrical and technical profiles across ten positional clusters defined by James et al. (2005) to further enhance the specificity and accuracy of the scientific appraisal. Moreover, the technical performance data could be criticised as being somewhat rudimentary failing to encapsulate the dynamic nature of the competitive environment (Mackenzie & Cushion, 2013). Similar to other analyses in rugby (McGarry, 2009; Gabbett, 2013; Kempton et al., 2014; Goodale et al., 2016; Kempton & Coutts, 2016) future studies ought to therefore consider the impact of situational variables upon match performance given their influence within other team sports typified by open environments (Hughes & Franks, 2004). With this in mind, research should utilise balanced groups (Biau, Kerneis & Porcher, 2008) where the more important situational variables (e.g. opposition quality, match location & match status/outcome) are concerned (Mohr et al., 2010; Gabbett, 2013; Sullivan et al., 2014), in order to control the external influence of situational factors on the TPIs of international level rugby union players. Moreover, further examination of the competitive demands could increase the depth of insight of the technical performance considering, for example, the location of the actions, the temporal structure of performance (Borrie, Jonsson, & Magnusson, 2002) or the dyadic nature of performance (Lames & McGarry, 2007).

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Appendices

APPENDIX 1: ETHICAL APPROVAL

Faculty of Life Sciences
Research Ethics Committee

frec@chester.ac.uk

07/05/2015

Mrs Elisavet Velentza
Department of Sports and Exercise Sciences.
University of Chester.
Parkgate Road
Chester CH1 4BJ

Dear Elisavet

Study title:	The process of talent selection within RFU's Elite Player Performance Pathway
FREC reference:	**1009/15/EV/SES**
Version number:	**1**

Thank you for sending your application to the Faculty of Life Sciences Research Ethics Committee for review.

I am pleased to confirm ethical approval for the above research, provided that you comply with the conditions set out in the attached document, and adhere to the processes described in your application form and supporting documentation.

The final list of documents reviewed and approved by the Committee is as follows:

Document	Version	Date
Application Form	1	February 2015
Appendix 2 – List of References	1	February 2015
Appendix 3 – Summary CV for Lead Researcher	1	February 2015
Appendix 4 – Written permissions form the relevant organisations to undertake the research	1	February 2015
Appendix 4 – Participant Information Sheet [PIS]	1	February 2015
Appendix 5 – CV from external supervisor	1	February 2015
Response to FREC request for further information or clarification		April 2015

Please note that this approval is given in accordance with the requirements of English law only. For research taking place wholly or partly within other jurisdictions (including Wales, Scotland and Northern Ireland), you should seek further advice from the Committee Chair / Secretary or the Research and Knowledge Transfer Office and may need additional approval from the appropriate agencies in the country (or countries) in which the research will take place.

With the Committee’s best wishes for the success of this project.

Yours sincerely,

Dr. Stephen Fallows
Chair, Faculty Research Ethics Committee

Enclosures: Standard conditions of approval.

Cc. Supervisor/FREC Representative

APPENDIX 2: RUGBY FOOTBALL UNION'S CONSENT FORM

RUGBY FOOTBALL UNION

Elisavet Velentza
28 Wendover Avenue
Aigburth
Liverpool
L17 4LG

22 July 2013

Dear Elisavet

As requested, I am pleased to confirm that you can use the data from Elite Hub for the purposes of the Talent PhD project.

Yours sincerely

Roy Headey
Head of Sports Medicine

Rugby House, Twickenham Stadium, 200 Whitton Road, Twickenham, TW2 7BA
Tel: 0871 222 2120 Fax: 020 8892 9816 Web: rfu.com

APPENDIX 3: OPERATINAL DEFINITIONS

Playing experience

Total Matches (number): the number of matches that a player has played from 2008 to 2014.

Total Minutes (playing time): the total minutes that a player has played from 2008 to 2014.

Defensive actions

Total Tackles (number): (Primary Tackles + Assist Tackles) preventing an attacking player reaching the defending team's try line with the ball.

Missed Tackles (number): Any tackle that is missed in the defensive line. Any tackle that is missed when a player 'scrambles' back to make a tackle to cover a break by the opposition.

Tackle Completion (%): (Total Tackles / (Total Tackles + Missed Tackles)

Rebound (%): (Rebound [+] / (No Rebound + Rebound N/A + Rebound [+]) Percentage of times the player gets straight back to their feet and back into the defensive line.

Total Clear-outs (number): (Effective + Ineffective + Redundant) A player enters a breakdown with the aim of dealing with the opposition threat.

Clear-outs efficiency (%): (Effective / Total) A player enters the breakdown and deals with the opposition threat and the ball is recycled.

Total Breakdowns (number): The total number of own and opposition breakdowns entered, regardless of action or contribution.

<u>Offensive actions</u>

Total Carries (number): The number of any carry made by a player that is not a pick and go. A carry is where a player has the ball and runs with the intention of beating/committing an opponent.

Total Carries (%): (Carries / Possession Gained) the percentage of times a player carries after gaining possession, as opposed to passing kicking or any other action.

Pick & Go (number): The number of times that a player performs a 'pick and go' from the base of the contact area and carries the ball into contact.

Total Kicks (number): (open play kicks, Kick neutral + kick [+] + Kick [-]) the action of a player striking the ball with their foot, regardless of outcome.

Kick neutral (number): The number of complete kicks that does not give the opposition a good counter attacking opportunity. The number of kicks that do not create half-break, clean-break, or try.

Kick + (%): (Kick [+] / Total Kicks) the percentage of kicks that lead to a half-break, a clean-break or a try. The percentage of kicks that forces the opposition into a turnover. The percentage of kicks that provides a large territory gain.

Kick – (%): The percentage of kicks that does give the opposition a good counter attacking opportunity. The percentage of kicks that leads to an opposition try. The percentage of kicks that goes out on the full. (Kick - / Total Kicks)

Possession

Total Possession (number): The percentage of own Lineout possession retained by the team with the throw in, (before the referee has deemed the lineout over).

Lineout success (%): (Lineout Throw Won / Lineout Throw won + Lineout Throw Lost) the percentage of own lineout possession retained by the team with the throw in, (before the referee has deemed the lineout over).

Set piece/Lineout win (number): A scrum or lineout successfully retained by the team with the restart input (scrum or lineout).

Set piece/Lineout lost (number): A team or player unsuccessful at retaining the ball from the input (scrum or lineout)

Turnover steal (number): A player successfully steals possession from an opposition player on the floor, usually after a tackle).

Lineouts steal (number): When a player jumps at an opposition's lineout throw and steals the ball

Handling

Passes (number): When a player passes the ball to a teammate and the pass is successfully completed.

Total Passes (number): (Passes + Passes [-] + Passes [+]) the total number of times a player passes the ball, regardless of whether it is successful or not.

Pass + (number): A pass that leads to a half-break, clean-break or try. A pass that cuts out defenders and puts a player into space. A flat, fast pass allowing a player to run on to it.

Pass - (number): A pass that is unsuccessful or cause a loss in momentum

Pass Completion (%): (Pass + Pass [+] / Total Pass) the percentage, when a player passes the ball to a teammate and the pass is successfully completed.

Set piece

Total Scrums (number): Total involvement/participation in own and opposition Scrums, regardless of success or contribution.

APPENDIX 4: TABLES OF INTER AND INTRA-RATER RELIABILITY

Front row

Intra-rater reliability

Appendix 4.1. Technical performance indicators recorded for one positional cluster (Front row) by one independent observer (Six Nation 2014: England vs Italy).

	Observer 1 R2								
Observer 1 R1	Total Tackles	Total Clear-outs	Total Carries	Total Possession	Passes	Passes -	Total Breakdowns	Total Scrums	Total
Nothing	0	1	0	0	0	0	1	0	2
Total Tackles	5	0	0	0	0	0	0	0	5
Total Clear-outs	0	20	0	0	0	0	0	0	20
Total Carries	0	0	5	0	0	0	0	0	5
Total Possession	0	0	0	7	0	0	0	0	7
Passes	0	0	0	0	3	0	0	0	3
Passes -	0	0	0	0	0	2	0	0	2
Total Breakdowns	0	0	0	0	0	0	22	0	22
Total Scrums	0	0	0	0	0	0	0	15	15
Total	5	21	5	7	3	2	23	15	81

R1: First time rating Observer 1
R2: Second time rating Observer 1. Note: All analysed TPI are referred to the total number of actions.

The intra-rater reliability was found to be almost perfect (Kappa = 0.97; $p \leq 0.001$). This measure of agreement reveals a statistically significant and almost perfect agreement between the two observations of rater A (Viera & Garrett, 2005).

Inter-rater reliability

Appendix 4.2. Technical performance indicators recorded for one positional cluster (Front row) by the 2 independent observers (Six Nation 2014: England vs Italy).

	Observer RFU									
Observer 1	Nothing	Total Tackles	Missed Tackles	Total Clear-outs	Total Carries	Total Possession	Passes	Total Breakdowns	Total Scrums	Total
Nothing	0	0	1	0	0	0	0	0	2	3
Total Tackles	0	5	0	0	0	0	0	0	0	5
Total Clear-outs	1	0	0	18	0	0	0	0	0	19
Total Carries	0	0	0	0	5	0	0	0	0	5
Total Possession	0	0	0	0	0	7	0	0	0	7
Passes	1	0	0	0	0	0	2	0	0	3
Passes -	2	0	0	0	0	0	0	0	0	2
Total Breakdowns	4	0	0	0	0	0	0	18	0	22
Total Scrums	0	0	0	0	0	0	0	0	15	15
Total	8	5	1	18	5	7	2	18	17	81

Note**:** All analysed TPI are referred to the total number of actions.

The inter-rater reliability for the raters was found to be Kappa = 0.836 with $p \leq 0.001$. This measure of agreement reveals a statistically significant and roughly perfect agreement among raters (Viera & Garrett, 2005).

Second row

Intra-rater Reliability

Appendix 4.3. Technical performance Indicators recorded for one positional cluster (Second row) by one independent observer (England Summer Tour 2013: England vs Barbarian).

	Observer1 R2									
Observer 1 R1	Total Tackles	Missed tackles	Total Clear-outs	Total Carries	Total Possession	Passes	Passes -	Total Breakdowns	Total Scrums	Total
Tackles	8	0	0	0	0	0	0	0	0	8
Missed Tackles	0	1	0	0	0	0	0	0	0	1
Total Clear-outs	0	0	7	0	0	0	0	0	0	7
Total Carries	0	0	0	4	0	0	0	0	0	4
Total Possession	0	0	0	0	5	0	0	0	0	5
Passes	0	0	0	0	0	2	0	0	0	2
Passes -	0	0	0	0	0	0	1	0	0	1
Total Breakdowns	0	0	0	0	0	0	0	8	0	8
Total Scrums	0	0	0	0	0	0	0	0	6	6
Total	8	1	7	4	5	2	1	8	6	42

R1: First time rating Observer 1
R2: Second time rating Observer 1. Note**:** All analysed TPI are referred to the total number of actions.

The intra-rater reliability was found to be Kappa = 1.00 with $p \leq 0.001$. This measure of agreement reveals a statistically significant and perfect agreement between the two observations of rater A (Viera & Garrett, 2005).

Inter-rater Reliability

Appendix 4.4. Technical performance Indicators recorded for one positional cluster (Second row) by the 2 independent observers (England Summer Tour 2013: England vs Barbarian).

	Observer RFU									
Observer 1	.00	Total Tackles	Missed tackles	Total Clear-outs	Total Carries	Total Possession	Passes	Total Breakdowns	Total Scrums	Total
Total Tackles	1	7	0	0	0	0	0	0	0	8
Missed Tackles	0	0	1	0	0	0	0	0	0	1
Total Clear-outs	1	0	0	6	0	0	0	0	0	7
Total Carries	0	0	0	0	4	0	0	0	0	4
Total Possession	0	0	0	0	0	5	0	0	0	5
Passes	1	0	0	0	0	0	1	0	0	2
Passes -	1	0	0	0	0	0	0	0	0	1
Total Breakdowns	2	0	0	0	0	0	0	6	0	8
Total Scrums	0	0	0	0	0	0	0	0	6	6
Total	6	7	1	6	4	5	1	6	6	42

Note**:** All analysed TPI are referred to the total number of actions.

The inter-rater reliability for the raters was found to be Kappa = 0.836 with $p \leq 0.001$. This measure of agreement revealed a statistically significant and roughly perfect agreement among raters (Viera & Garrett, 2005).

Back row

Intra-rater Reliability

Appendix 4.5. Technical performance Indicators recorded for one positional cluster (Back row) by one independent observer (Six Nations 2013: England vs Ireland).

	Observer 1 R2							
Observer 1 R1	Total Tackles	Total Clear-outs	Total Carries	Total Possession	Passes	Total Breakdown	Total Scrums	Total
Total Tackles	12	0	0	0	0	0	0	12
Total Clear-outs	0	16	0	0	0	0	0	16
Total Carries	0	0	3	0	0	0	0	3
Total Possession	0	0	0	5	0	0	0	5
Passes	0	0	0	0	2	0	0	2
Total Breakdowns	0	0	0	0	0	23	0	23
Total Scrums	0	0	0	0	0	0	17	17
Total	12	16	3	5	2	23	17	78

R1: First time rating Observer 1
R2: Second time rating Observer 1. Note**:** All analysed TPI are referred to the total number of actions.

The intra-rater reliability was found to be Kappa = 1.00 with $p \leq 0.001$. This measure of agreement reveals a statistically significant and perfect agreement between the two observations of rater A (Viera & Garrett, 2005).

Inter-rater Reliability

Appendix 4.6. Technical performance Indicators recorded for one positional cluster (Back row) by the 2 independent observers (Six Nations 2013: England vs Ireland).

	Observer RFU										
Observer 1	.00	1.00	2.00	3.00	4.00	5.00	6.00	7.00	10.00	11.00	Total
.00	0	0	1	0	1	0	2	0	0	0	4
Total Tackles	0	12	0	0	0	0	0	0	0	0	12
Total Clear-outs	0	0	0	16	0	0	0	0	0	0	16
Total Carries	0	0	0	0	3	0	0	0	0	0	3
Total Possession	0	0	0	0	0	5	0	0	0	0	5
Passes	0	0	0	0	0	0	0	2	0	0	2
Total Breakdowns	8	0	0	0	0	0	0	0	15	0	23
Total Scrums	0	0	0	0	0	0	0	0	0	17	17
Total	8	12	1	16	4	5	2	2	15	17	82

Note**:** All analysed TPI are referred to the total number of actions.

The inter-rater reliability for the raters was found to be Kappa = 0.825 with $p \leq 0.001$. This measure of agreement revealed a statistically significant and roughly perfect agreement among raters (Viera & Garrett, 2005).

Scrumhalf

Intra-rater Reliability

Appendix 4.7. Technical performance indicators recorded for one positional cluster (scrumhalf) by one independent observer (Six Nations 2012: England vs Wales).

	Observer 1 R2												
Observer 1 R1	.00	Total Tackles	Missed Tackles	Total Clear-outs	Total Carries	Total Possession	Passes	Passes +	Passes -	Total Breakdowns	Total Kicks	Kick neutral	Total
.00	0	0	0	0	0	0	0	0	0	0	0	1	1
Total Tackles	0	6	0	0	0	0	0	0	0	0	0	0	6
Missed tackles	0	0	1	0	0	0	0	0	0	0	0	0	1
Total Clear-outs	0	0	0	5	0	0	0	0	0	0	0	0	5
Total Carries	0	0	0	0	3	0	0	0	0	0	0	0	3
Total Possession	0	0	0	0	0	59	0	0	0	0	0	0	59
Passes	0	0	0	0	0	0	51	0	0	0	0	0	51
Passes +	0	0	0	0	0	0	0	1	0	0	0	0	1
Passes -	0	0	0	0	0	0	0	0	1	0	0	0	1
Total Breakdowns	0	0	0	0	0	0	0	0	0	5	0	0	5
Total Kicks	0	0	0	0	0	0	0	0	0	0	4	0	4
Kick neutral	0	0	0	0	0	0	0	0	0	0	0	1	1

R1: First time rating Observer 1
R2: Second time rating Observer 1. Note**:** All analysed TPI are referred to the total number of actions.

The intra-rater reliability was found to be Kappa = 0.97 with $p \leq 0.001$. This measure of agreement reveals a statistically significant and almost perfect agreement between the two observations of rater A (Viera & Garrett, 2005).

Inter-rater Reliability

Appendix 4.8. Technical performance indicators recorded for one positional cluster (scrumhalf) by the 2 independent observers (Six Nations 2012: England vs Wales).

	Observer RFU											
Observer 1	.00	Tackles	Missed Tackles	Clear-outs	Carries	Possession	Passes	Passes -	Total Breakdowns	Kick	Kick neutral	Total
.00	0	0	0	0	0	0	0	2	1	0	2	5
Tackles	2	4	0	0	0	0	0	0	0	0	0	6
Missed Tackles	0	0	1	0	0	0	0	0	0	0	0	1
Clear-outs	0	0	0	5	0	0	0	0	0	0	0	5
Carries	2	0	0	0	1	0	0	0	0	0	0	3
Possession	0	0	0	0	0	59	0	0	0	0	0	59
Passes	1	0	0	0	0	0	50	0	0	0	0	51
Passes +	1	0	0	0	0	0	0	0	0	0	0	1
Passes -	0	0	0	0	0	0	0	1	0	0	0	1
Total Breakdowns	0	0	0	0	0	0	0	0	5	0	0	5
Kick	0	0	0	0	0	0	0	0	0	4	0	4
Kick Neutral	0	0	0	0	0	0	0	0	0	0	1	1
Total	8	4	1	5	1	59	50	3	6	4	3	145

Note**:** All analysed TPI are referred to the total number of actions.

The inter-rater reliability for the raters was found to be Kappa = 0.873 with $p \leq 0.001$. This measure of agreement revealed a statistically significant and near to perfect agreement among raters (Viera & Garrett, 2005).

Inside backs

Intra-rater Reliability

Appendix 4.9. Technical performance indicators recorded for one positional cluster (Inside backs) by one independent observer (Six Nations 2010: England vs Ireland).

	Observer 1 R2						
Observer 1 R1	Total Tackles	Total Clear-outs	Total Carries	Total Possession	Passes	Total Breakdowns	Total
Total Tackles	2	0	0	0	0	0	2
Total Clear-outs	0	16	0	0	0	0	16
Total Carries	0	0	6	0	0	0	6
Total Possession	0	0	0	10	0	0	10
Passes	0	0	0	0	4	0	4
Total Breakdowns	0	0	0	0	0	16	16
Total	2	16	6	10	4	16	54

R1: First time rating Observer 1
R2: Second time rating Observer 1. Note**:** All analysed TPI are referred to the total number of actions.

The intra-rater reliability was found to be Kappa = 1.00 with $p \leq 0.001$. This measure of agreement reveals a statistically significant and perfect agreement between the two observations of rater A (Viera & Garrett, 2005).

Inter-rater Reliability

Appendix 4.10. Technical performance indicators recorded for one positional cluster (Inside backs) by the 2 independent observers (Six Nations 2010: England vs. Ireland).

	Observer RFU				
Observer 1	.00	Total Tackles	Total Clear-outs	Total Breakdowns	Total
.00	0	1	0	0	1
Total Tackles	0	2	0	0	2
Total Clear-outs	2	0	13	0	15
Total Carries	6	0	0	0	6
Total Possession	10	0	0	0	10
Passes	4	0	0	0	4
Total Breakdowns	4	0	0	13	17
Total	26	3	13	13	55

Note**:** All analysed TPI are referred to the total number of actions.

The inter-rater reliability for the raters was found to be Kappa = 0.424 with $p \leq 0.001$. This measure of agreement, while statistically significant, displayed a moderate agreement among raters (Viera & Garrett, 2005).

Outside backs

Intra-rater Reliability

Appendix 4.11. Technical performance indicators recorded for one positional cluster (Outside backs) by one independent observer (Six Nations 2011: England vs Ireland).

	Observer 1 R2											
Observer 1 R1	.00	Total Tackles	Missed Tackles	Total Clear-outs	Total Carries	Total Possession	Passes	Passes +	Total Breakdowns	Total Kicks	Kick neutral	Total
.00	0	0	0	0	1	0	0	0	0	0	0	1
Total Tackles	0	3	0	0	0	0	0	0	0	0	0	3
Missed Tackles	0	0	1	0	0	0	0	0	0	0	0	1
Total Clear-outs	1	0	0	9	0	0	0	0	0	0	0	10
Total Carries	0	0	0	0	9	0	0	0	0	0	0	9
Total Possession	0	0	0	0	0	15	0	0	0	0	0	15
Passes	0	0	0	0	0	0	8	0	0	0	0	8
Passes +	1	0	0	0	0	0	0	1	0	0	0	2
Total Breakdowns	1	0	0	0	0	0	0	0	9	0	0	10
Total Kicks	0	0	0	0	0	0	0	0	0	4	0	4
Kick neutral	0	0	0	0	0	0	0	0	0	0	3	3
Total	3	3	1	9	10	15	8	1	9	4	3	67

R1: First time rating Observer 1
R2: Second time rating Observer 1. Note**:** All analysed TPI are referred to the total number of actions.

The intra-rater reliability was found to be Kappa = 0.931 ($p \leq 0.001$). This measure of agreement reveals a statistically significant and almost perfect agreement between the two observations of rater A (Viera & Garrett, 2005).

Inter-rater Reliability

Appendix 4.12. Technical performance indicators recorded for one positional cluster (Outside backs) by the 2 independent observers (Six Nations 2011: England vs Ireland).

	Observer RFU										
Observer 1	.00	Total Tackles	Missed Tackles	Total Clear-outs	Total Carries	Total Possession	Passes	Total Breakdowns	Total Kicks	Kick neutral	Total
.00	0	0	0	0	0	5	0	0	0	0	5
Total Tackles	1	2	0	0	0	0	0	0	0	0	3
Missed Tackles	0	0	1	0	0	0	0	0	0	0	1
Total Clear-outs	0	0	0	10	0	0	0	0	0	0	10
Total Carries	0	0	0	0	9	0	0	0	0	0	9
Total Possession	0	0	0	0	0	15	0	0	0	0	15
Passes	3	0	0	0	0	0	5	0	0	0	8
Passes +	2	0	0	0	0	0	0	0	0	0	2
Total Breakdowns	0	0	0	0	0	0	0	10	0	0	10
Total Kicks	0	0	0	0	0	0	0	0	4	0	4
Kick neutral	0	0	0	0	0	0	0	0	0	3	3
Total	7	2	1	10	9	20	5	10	4	3	71

Note**:** All analysed TPI are referred to the total number of actions.

The inter-rater reliability for the raters was found to be Kappa = 0.804 with $p \leq 0.001$. This measure of agreement revealed a statistically significant and substantial agreement among raters (Viera & Garrett, 2005).

Appendices 5: Tables of effect sizes for the six positional groups across squads

Appendix 5.1. Table of effect sizes across all age representative squads within the EPPP, regarding TPI and anthropometrical characteristics, for the positional group of FR.

	Effect size ($r = z/\sqrt{n}$)									
	U18/U20	U18/NA	U18/Saxon	U18/SNS	U20/NA	U20/Saxon	U20/SNS	NA/Saxon	NA/SNS	Saxon/SNS
Anthropometrical										
Body stature (cm)	0.08	0.29	0.21	0.43	0.22	0.12	0.35	0.06	0.22	0.25
Body mass (kg)	0.09	0.08	0.14	0.38	0.01	0.04	0.31	0.05	0.30	0.24
Playing experience										
Total Matches	0.28	0.50	0.63	0.76	0.31	0.51	0.66	0.24	0.45	0.23
Total Minutes	0.21	0.50	0.64	0.76	0.32	0.51	0.68	0.27	0.51	0.25
Defensive										
Total Tackles	0.07	0.13	0.13	0.16	0.07	0.05	0.09	0.02	0.02	0.05
Missed Tackles	0.12	0.18	0.18	0.17	0.06	0.05	0.03	0.01	0.03	0.03
Tackle Completion (%)	0.13	0.12	0.12	0.11	0.02	0.03	0.06	0.01	0.05	0.03
Rebound (%)	0.08	0.03	0.22	0.11	0.07	0.28	0.19	0.28	0.17	0.16
Total Clear-outs	0.10	0.07	0.15	0.15	0.21	0.26	0.29	0.11	0.11	0.01
Clear-out efficiency (%)	0.13	0.27	0.12	0.18	0.10	0.10	0.03	0.28	0.20	0.13
Total Breakdowns	0.12	0.02	0.13	0.13	0.18	0.26	0.28	0.13	0.13	0.02

	Effect size (r = z/√n)									
	U18/U20	U18/NA	U18/Saxon	U18/SNS	U20/NA	U20/Saxon	U20/SNS	NA/Saxon	NA/SNS	Saxon/SNS
Possession										
Total Possessions	0.14	0.10	0.01	0.06	0.05	0.16	0.22	0.13	0.19	0.03
Offensive										
Total Carries	0.08	0.12	0.17	0.14	0.04	0.25	0.22	0.31	0.27	0.04
Total Carries (%)	0.10	0.01	0.16	0.06	0.12	0.09	0.03	0.24	0.11	0.17
Pick and Go	0.07	0.03	0.07	0.04	0.07	0.02	0.14	0.06	0.07	0.15
Handling										
Passes	0.03	0.08	0.04	0.04	0.06	0.07	0.07	0.15	0.17	0.01
Passes +	0.17	0.34	0.21	0.28	0.15	0.01	0.08	0.18	0.11	0.08
Passes -	0.18	0.34	0.23	0.35	0.14	0.02	0.13	0.14	0.07	0.11
Total Passes	0.04	0.10	0.03	0.03	0.07	0.09	0.08	0.17	0.18	0.00
Pass Completion (%)	0.07	0.04	0.02	0.02	0.05	0.11	0.08	0.08	0.04	0.04
Positional										
Set piece										
Total Scrums	0.13	0.28	0.33	0.29	0.15	0.18	0.12	0.02	0.07	0.13
Possession										
Lineout won	0.04	0.17	0.24	0.36	0.12	0.21	0.55	0.25	0.49	0.26
Lineout lost	0.00	0.11	0.09	0.18	0.10	0.04	0.22	0.12	0.04	0.11
Lineout success (%)	0.02	0.03	0.08	0.14	0.04	0.09	0.23	0.22	0.36	0.14

Appendix 5.2. Table of effect sizes across all age representative squads within the EPPP, regarding TPI and anthropometrical characteristics, for the positional group of SR.

	Effect size ($r = z/\sqrt{n}$)									
	U18/U20	U18/NA	U18/Saxon	U18/SNS	U20/NA	U20/Saxon	U20/SNS	NA/Saxon	NA/SNS	Saxon/SNS
Anthropometrical										
Body stature (cm)	0.08	0.09	0.04	0.05	0.02	0.05	0.04	0.06	0.06	0.00
Body mass (kg)	0.08	0.32	0.24	0.26	0.22	0.13	0.16	0.08	0.06	0.04
Playing experience										
Total Matches	0.21	0.41	0.44	0.45	0.28	0.32	0.36	0.07	0.14	0.09
Total Minutes	0.15	0.41	0.45	0.48	0.29	0.35	0.41	0.08	0.17	0.09
Defensive										
Total Tackles	0.00	0.10	0.02	0.21	0.09	0.02	0.19	0.09	0.08	0.20
Missed Tackles	0.05	0.13	0.11	0.15	0.09	0.06	0.10	0.03	0.00	0.05
Tackle Completion (%)	0.07	0.08	0.10	0.10	0.01	0.02	0.02	0.02	0.00	0.00
Rebound (%)	0.13	0.12	0.13	0.24	0.04	0.02	0.11	0.02	0.18	0.13
Total Clear-outs	0.15	0.08	0.01	0.08	0.06	0.16	0.07	0.07	0.02	0.11
Clear-out efficiency (%)	0.09	0.12	0.11	0.10	0.23	0.22	0.21	0.00	0.07	0.06
Total Breakdowns	0.14	0.08	0.00	0.07	0.05	0.17	0.08	0.08	0.01	0.09

	Effect size (r = z/√n)									
	U18/U20	U18/NA	U18/Saxon	U18/SNS	U20/NA	U20/Saxon	U20/SNS	NA/Saxon	NA/SNS	Saxon/SNS
Possession										
Total Possessions	0.11	0.25	0.21	0.23	0.16	0.09	0.10	0.07	0.09	0.01
Offensive										
Total Carries	0.02	0.31	0.08	0.08	0.26	0.05	0.06	0.21	0.27	0.01
Total Carries (%)	0.06	0.16	0.01	0.01	0.23	0.04	0.06	0.24	0.27	0.00
Pick and Go	0.00	0.32	0.09	0.10	0.38	0.10	0.10	0.34	0.39	0.01
Handling										
Passes	0.08	0.14	0.16	0.22	0.09	0.09	0.18	0.01	0.05	0.08
Passes +	0.12	0.04	0.08	0.22	0.07	0.05	0.08	0.03	0.15	0.17
Passes -	0.05	0.46	0.28	0.31	0.44	0.23	0.27	0.20	0.18	0.04
Total Passes	0.07	0.16	0.15	0.22	0.12	0.08	0.17	0.05	0.02	0.08
Pass Completion (%)	0.14	0.01	0.08	0.13	0.21	0.09	0.04	0.13	0.21	0.06
Positional										
Set piece										
Total Scrums	0.21	0.24	0.32	0.28	0.06	0.13	0.09	0.06	0.01	0.06
Possession										
Lineout won	0.02	0.09	0.14	0.08	0.11	0.15	0.09	0.05	0.03	0.08
Lineout lost	0.07	0.29	0.24	0.22	0.21	0.18	0.16	0.02	0.03	0.02
Lineout success (%)	0.07	0.07	0.06	0.01	0.01	0.04	0.08	0.04	0.07	0.03
Lineout steal	0.04	0.14	0.18	0.16	0.13	0.13	0.12	0.02	0.03	0.02

Appendix 5.3. Table of effect sizes across all age representative squads within the EPPP, regarding TPI and anthropometrical characteristics, for the positional group of BR.

	Effect size ($r = z/\sqrt{n}$)									
	U18/U20	U18/NA	U18/Saxon	U18/SNS	U20/NA	U20/Saxon	U20/SNS	NA/Saxon	NA/ SNS	Saxon/ SNS
Anthropometrical										
Body stature (cm)	0.22	0.20	0.17	0.31	0.02	0.04	0.06	0.01	0.11	0.10
Body mass (kg)	0.25	0.29	0.37	0.50	0.05	0.15	0.30	0.05	0.21	0.20
Playing experience										
Total Matches	0.19	0.23	0.52	0.44	0.05	0.40	0.32	0.32	0.25	0.05
Total Minutes	0.15	0.20	0.51	0.43	0.07	0.40	0.33	0.31	0.27	0.03
Defensive										
Total Tackles	0.04	0.04	0.09	0.15	0.00	0.05	0.10	0.05	0.11	0.06
Missed Tackles	0.04	0.15	0.18	0.16	0.12	0.13	0.13	0.01	0.01	0.02
Tackle Completion (%)	0.02	0.10	0.13	0.09	0.09	0.10	0.08	0.01	0.02	0.05
Rebound (%)	0.12	0.23	0.04	0.15	0.09	0.15	0.01	0.26	0.11	0.18
Total Clear-outs	0.11	0.05	0.07	0.10	0.16	0.06	0.05	0.12	0.15	0.01
Clear-out efficiency (%)	0.04	0.25	0.11	0.23	0.21	0.06	0.19	0.16	0.07	0.13
Total Breakdowns	0.11	0.04	0.08	0.11	0.16	0.04	0.04	0.12	0.16	0.01

	Effect size (r = z/√n)									
	U18/U20	U18/NA	U18/Saxon	U18/SNS	U20/NA	U20/Saxon	U20/SNS	NA/Saxon	NA/ SNS	Saxon/ SNS
Possession										
Total Possession	0.08	0.09	0.08	0.14	0.19	0.17	0.25	0.02	0.05	0.08
Offensive										
Total Carries	0.14	0.11	0.02	0.05	0.24	0.17	0.19	0.10	0.08	0.03
Total Carries (%)	0.05	0.13	0.04	0.05	0.18	0.10	0.00	0.12	0.25	0.11
Pick and Go	0.12	0.01	0.09	0.10	0.14	0.24	0.25	0.06	0.07	0.04
Handling										
Passes	0.13	0.07	0.03	0.02	0.05	0.10	0.16	0.05	0.10	0.06
Passes +	0.06	0.20	0.20	0.27	0.14	0.15	0.21	0.00	0.07	0.07
Passes -	0.03	0.18	0.14	0.25	0.24	0.18	0.30	0.04	0.06	0.11
Total Passes	0.14	0.07	0.04	0.02	0.07	0.10	0.16	0.03	0.09	0.06
Pass Completion (%)	0.03	0.11	0.04	0.13	0.09	0.01	0.10	0.10	0.02	0.09
Positional										
Set piece										
Total Scrums	0.13	0.17	0.25	0.16	0.08	0.16	0.05	0.06	0.06	0.17
Possession										
Lineout won	0.14	0.16	0.22	0.41	0.02	0.09	0.29	0.06	0.27	0.20
Lineout lost	0.17	0.15	0.16	0.31	0.02	0.02	0.13	0.00	0.14	0.16
Lineout success (%)	0.11	0.15	0.18	0.33	0.04	0.10	0.25	0.05	0.20	0.14
Turnover steal	0.04	0.19	0.01	0.12	0.25	0.04	0.17	0.22	0.12	0.15

Appendix 5.4. Table of effect sizes across all age representative squads within the EPPP, regarding TPI and anthropometrical characteristics, for the positional group of SH.

	Effect size ($r = z/\sqrt{n}$)									
	U18/U20	U18/NA	U18/Saxon	U18/SNS	U20/NA	U20/Saxon	U20/SNS	NA/Saxon	NA/ SNS	Saxon/ SNS
Anthropometrical										
Body stature (cm)	0.15	0.11	0.00	0.18	0.25	0.16	0.00	0.07	0.25	0.16
Body mass (kg)	0.29	0.24	0.18	0.43	0.04	0.21	0.08	0.15	0.05	0.36
Playing experience										
Total Matches	0.52	0.45	0.53	0.64	0.08	0.34	0.47	0.21	0.28	0.11
Total Minutes	0.47	0.43	0.49	0.66	0.06	0.36	0.50	0.25	0.32	0.15
Defensive										
Total Tackles	0.17	0.01	0.04	0.05	0.19	0.20	0.33	0.01	0.08	0.11
Missed Tackles	0.01	0.13	0.12	0.02	0.15	0.13	0.02	0.09	0.15	0.11
Tackle Completion (%)	0.05	0.14	0.12	0.01	0.17	0.14	0.05	0.05	0.12	0.12
Rebound (%)	0.10	0.04	0.12	0.24	0.18	0.04	0.18	0.18	0.30	0.10
Total Clear-outs	0.01	0.05	0.12	0.17	0.13	0.18	0.31	0.19	0.24	0.14
Clear-out efficiency (%)	0.21	0.31	0.20	0.20	0.21	0.05	0.05	0.26	0.25	0.02
Total Breakdowns	0.01	0.05	0.09	0.08	0.13	0.16	0.19	0.14	0.14	0.05
Possession										
Total Possessions	0.01	0.12	0.04	0.12	0.23	0.03	0.03	0.14	0.06	0.03

	Effect size (r = z/√n)									
	U18/U20	U18/NA	U18/Saxon	U18/SNS	U20/NA	U20/Saxon	U20/SNS	NA/Saxon	NA/ SNS	Saxon/ SNS
Offensive										
Total Carries	0.33	0.09	0.41	0.45	0.17	0.08	0.13	0.21	0.23	0.04
Total Carries (%)	0.30	0.02	0.38	0.26	0.25	0.00	0.08	0.26	0.17	0.07
Pick and Go	0.27	0.06	0.41	0.44	0.15	0.18	0.21	0.16	0.18	0.02
Handling										
Passes	0.00	0.05	0.26	0.33	0.02	0.29	0.38	0.25	0.28	0.03
Passes +	0.00	0.27	0.06	0.08	0.31	0.06	0.09	0.28	0.22	0.06
Passes -	0.02	0.01	0.04	0.04	0.02	0.04	0.03	0.03	0.04	0.03
Total Passes	0.00	0.06	0.24	0.30	0.02	0.29	0.33	0.25	0.25	0.04
Pass Completion (%)	0.02	0.03	0.16	0.20	0.02	0.19	0.22	0.14	0.21	0.04
Positional										
Offensive										
Total Kicks	0.26	0.20	0.37	0.46	0.06	0.20	0.23	0.11	0.07	0.01
Kick neutral	0.26	0.07	0.31	0.33	0.15	0.11	0.08	0.14	0.11	0.04
Kick + (%)	0.20	0.55	0.22	0.25	0.52	0.05	0.08	0.55	0.54	0.04
Kick - (%)	0.07	0.12	0.21	0.14	0.24	0.16	0.08	0.34	0.28	0.05

Appendix 5.5. Table of effect sizes across all age representative squads within the EPPP, regarding TPI and anthropometrical characteristics, for the positional group of IB.

	Effect size ($r = z/\sqrt{n}$)									
	U18/U20	U18/NA	U18/Saxon	U18/SNS	U20/NA	U20/Saxon	U20/SNS	NA/Saxon	NA/ SNS	Saxon/ SNS
Anthropometrical										
Body stature (cm)	0.21	0.16	0.15	0.29	0.04	0.05	0.12	0.02	0.14	0.17
Body mass (kg)	0.15	0.16	0.29	0.32	0.00	0.12	0.16	0.10	0.14	0.05
Playing experience										
Total Matches	0.20	0.25	0.29	0.35	0.09	0.15	0.23	0.08	0.14	0.06
Total Minutes	0.15	0.26	0.26	0.32	0.12	0.15	0.23	0.04	0.13	0.07
Defensive										
Total Tackles	0.11	0.11	0.00	0.12	0.18	0.10	0.20	0.08	0.05	0.12
Missed Tackles	0.02	0.00	0.10	0.08	0.09	0.08	0.05	0.01	0.04	0.02
Tackle Completion (%)	0.06	0.25	0.07	0.06	0.02	0.02	0.01	0.00	0.01	0.01
Rebound (%)	0.08	0.01	0.03	0.06	0.02	0.11	0.15	0.13	0.17	0.03
Total Clear-outs	0.08	0.04	0.06	0.01	0.06	0.00	0.06	0.06	0.01	0.05
Clear-out efficiency (%)	0.08	0.07	0.13	0.16	0.16	0.03	0.07	0.14	0.10	0.05
Total Breakdowns	0.08	0.01	0.10	0.06	0.06	0.03	0.02	0.09	0.05	0.04
Possession										
Total Possessions	0.12	0.01	0.12	0.14	0.11	0.00	0.01	0.11	0.13	0.01

	Effect size (r = z/√n)									
	U18/U20	U18/NA	U18/Saxon	U18/SNS	U20/NA	U20/Saxon	U20/SNS	NA/Saxons	NA/ SNS	Saxon/ SNS
Offensive										
Total Carries	0.16	0.04	0.25	0.24	0.10	0.12	0.11	0.20	0.19	0.02
Total Carries (%)	0.03	0.07	0.08	0.05	0.04	0.11	0.07	0.15	0.11	0.03
Pick and Go	0.08	0.05	0.01	0.01	0.13	0.07	0.10	0.06	0.04	0.03
Handling										
Passes	0.16	0.12	0.18	0.21	0.06	0.01	0.04	0.08	0.10	0.02
Passes +	0.05	0.02	0.13	0.08	0.09	0.08	0.03	0.19	0.14	0.06
Passes -	0.16	0.02	0.06	0.13	0.19	0.10	0.04	0.09	0.16	0.06
Total Passes	0.16	0.11	0.17	0.21	0.07	0.01	0.04	0.08	0.11	0.03
Pass Completion (%)	0.06	0.04	0.07	0.04	0.11	0.14	0.11	0.04	0.01	0.04
Positional										
Offensive										
Total Kicks	0.04	0.17	0.15	0.14	0.12	0.11	0.10	0.03	0.04	0.01
Kick neutral	0.05	0.18	0.15	0.14	0.13	0.10	0.09	0.04	0.06	0.02
Kick + (%)	0.15	0.27	0.22	0.26	0.13	0.08	0.12	0.05	0.02	0.04
Kick - (%)	0.05	0.14	0.07	0.12	0.10	0.03	0.08	0.06	0.02	0.06

Appendix 5.6. Table of effect sizes across all age representative squads within the EPPP, regarding TPI and anthropometrical characteristics, for the positional group of OB.

	Effect size ($r = z/\sqrt{n}$)									
	U18/U20	U18/NA	U18/Saxon	U18/SNS	U20/NA	U20/Saxon	U20/SNS	NA/Saxon	NA/ SNS	Saxon/SNS
Anthropometrical										
Body stature (cm)	0.07	0.22	0.20	0.26	0.14	0.13	0.19	0.02	0.04	0.07
Body mass (kg)	0.07	0.20	0.28	0.27	0.11	0.19	0.17	0.06	0.05	0.00
Playing experience										
Total Matches	0.16	0.32	0.35	0.43	0.18	0.25	0.34	0.06	0.15	0.10
Total Minutes	0.16	0.32	0.32	0.43	0.19	0.23	0.36	0.04	0.15	0.12
Defensive										
Total Tackles (n	0.13	0.09	0.15	0.21	0.21	0.28	0.34	0.08	0.14	0.05
Missed Tackles	0.10	0.24	0.16	0.21	0.14	0.06	0.11	0.10	0.03	0.06
Tackle Completion (%)	0.14	0.17	0.10	0.17	0.01	0.06	0.01	0.09	0.01	0.08
Rebound (%)	0.03	0.05	0.05	0.00	0.08	0.03	0.02	0.12	0.07	0.06
Total Clear-outs	0.01	0.06	0.05	0.03	0.07	0.06	0.01	0.02	0.11	0.08
Clear-out efficiency (%)	0.13	0.24	0.19	0.19	0.10	0.04	0.03	0.05	0.08	0.03
Total Breakdowns	0.01	0.04	0.05	0.03	0.06	0.06	0.01	0.00	0.08	0.07
Possession										
Total Possessions	0.14	0.15	0.19	0.20	0.02	0.06	0.06	0.04	0.04	0.00

	Effect size (r = z/√n)									
	U18/U20	U18/NA	U18/Saxon	U18/SNS	U20/NA	U20/Saxon	U20/SNS	NA/Saxon	NA/ SNS	Saxon/ SNS
Offensive										
Total Carries	0.09	0.05	0.19	0.13	0.03	0.10	0.04	0.13	0.07	0.06
Total Carries (%)	0.13	0.02	0.25	0.25	0.10	0.14	0.14	0.23	0.22	0.02
Pick and Go	0.01	0.21	0.12	0.25	0.20	0.11	0.24	0.11	0.00	0.14
Handling										
Passes	0.02	0.09	0.08	0.10	0.07	0.09	0.12	0.16	0.20	0.01
Passes +	0.03	0.24	0.14	0.20	0.22	0.12	0.19	0.10	0.04	0.07
Passes -	0.08	0.36	0.27	0.31	0.32	0.22	0.27	0.09	0.04	0.04
Total Passes	0.03	0.07	0.08	0.10	0.05	0.10	0.13	0.13	0.17	0.01
Pass Completion (%)	0.06	0.24	0.18	0.16	0.20	0.13	0.12	0.10	0.13	0.02
Positional										
Offensive										
Total Kicks	0.17	0.23	0.19	0.30	0.07	0.02	0.12	0.06	0.03	0.10
Kick neutral	0.14	0.21	0.18	0.28	0.07	0.03	0.13	0.05	0.04	0.10
Kick + (%)	0.19	0.35	0.27	0.30	0.14	0.07	0.08	0.08	0.07	0.02
Kick - (%)	0.15	0.32	0.29	0.34	0.16	0.13	0.18	0.05	0.01	0.06

Appendix 6: RAW DATA DISK

As arranged on a disc supplied