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DAVIDS AND GOLIATHS: KINANTHROPOMETRY AND GROUPING STRATEGIES IN YOUTH RUGBY

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Introduction

Youth rugby players are often organised into (bi)annual-age groups using specific cut-off dates (e.g., 1st September in England, 1st January in Australia) in attempts to create equal competition and development opportunities for all players. However, chronological age-grouping can result in large differences in body size between players of the same age. Furthermore, an age grouping structure in rugby alongside the natural processes of growth, maturation and development within children and adolescents can have implications for player participation and development within the codes. To date, a range of research has examined kinanthropometry (i.e., the study of size, shape, proportion, composition and maturation) in youth rugby players and the relationships with rugby performance, talent identification and injury. This has opened debate around appropriate grouping strategies within youth rugby to ensure equal competition and development opportunities for all.

This chapter aims to highlight and provide an overview of the research on the kinanthropometry of youth rugby players and its relevance for player development, talent identification and injury risk. A range of practical implications for coaches, sport scientists and practitioners working within youth rugby to consider in relation to kinanthropometry and grouping strategies within youth rugby development programmes are then presented.

Research Overview

Kinanthropometry in Youth Rugby

The most reported measurements in young rugby players are stature and body mass. Herein, a review of the literature (Patton et al., 2016) highlights that male

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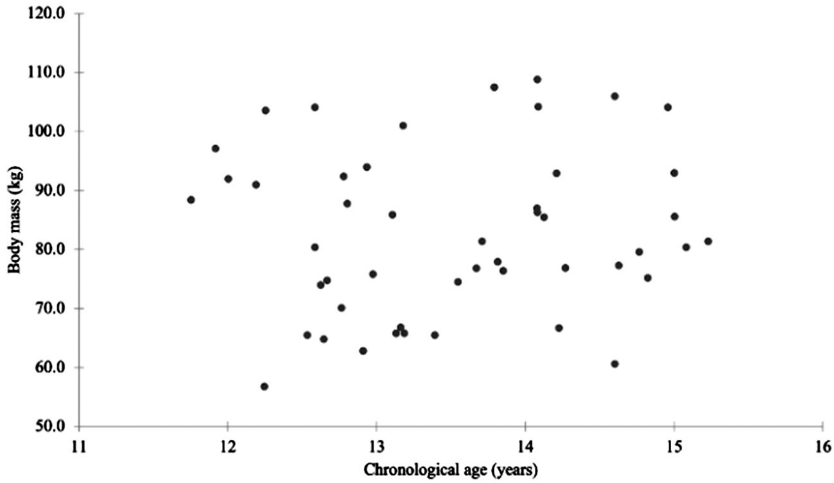

FIGURE 4.1 The Variability in Body Mass in Youth Rugby Players Aged 12–15 Years

rugby league and union players aged 12–18 years typically lie above the 50th percentile for stature, with body mass approaching the 95th percentile when compared to normative population data (http://www.cdc.gov/growthcharts). However, substantial variability in both stature and body mass is observed within young rugby players (Patton et al., 2016). For example, Krause et al. (2015) showed differences in stature of over 40 cm and body mass of almost 100 kg between players competing within both Under 12 (U12)–13 and U14–U15 rugby union age grades. Whilst these differences may seem substantial, the combination of age groups (i.e., biannual) in this study may exemplify the variability. Nonetheless, such data demonstrates the large variation in body size between players of a similar chronological age. Figure 4.1 shows exemplar data for the body mass distribution of a group of competitive rugby players aged 12–15 years playing in the same rugby competition.

Alongside stature and body mass, other kinanthropometric measures presented in male youth rugby research literature include body composition, somatotype, skeletal lengths, skeletal breadths and circumferences. Research has shown increases in absolute fat mass and fat-free mass (i.e., lean mass) with age (Gavarry et al., 2018). Yet, relative measures (e.g., sum of skinfolds, body fat percentage) remain relatively stable across adolescent rugby players (Darrall-Jones et al., 2015) and skeletal lengths, breadths, and circumferences of youth rugby players have been shown to increase with age aligned to growth and maturation (Cheng et al., 2014; Waldron et al., 2014). Body shape changes are observed, and somatotype develops from predominantly ectomorphic (i.e., tall and thin) to become more endomorphic (i.e., heavier and rounder) and mesomorphic (i.e., muscular development) during late adolescence (Cheng et al., 2014). However, like stature and body mass, large variability occurs within these kinanthropometric measures. For example, in consideration of ethnicity, Australian Polynesian players possess greater humeral and femoral breadths, bicep and calf circumferences and endomorphic and mesomorphic somatotypes than non-Polynesian players (Cheng et al., 2014). The observed variability can influence positional allocation with differences across a range of kinanthropometric measures between forwards and backs in youth rugby (e.g., Delahunt et al., 2013).

Biological Maturation

The large range of kinanthropometric measures between players of a similar age can occur due to maturation (the transition from childhood to adolescence). Maturation is defined as the timing and tempo of the progress towards the mature adult state (Malina et al., 2004). There are different types of maturation, including, but not limited to skeletal (i.e., development of the skeletal system usually presented as skeletal age), sexual (i.e., secondary sexual characteristics development or age at menarche in girls, or testicular volume in boys) or somatic (i.e., changes in height and mass, age at peak height velocity [APHV]) (see Lloyd et al., 2014; Sampson et al., 2022). While skeletal and sexual maturation can be estimated using a variety of techniques such as self-reported secondary sex characteristics or skeletal x-rays, somatic methods are most common in sport practice due to their relatively unobtrusive nature (i.e., using kinanthropometric measurements).

Somatic maturation can be evaluated by measuring stature longitudinally to obtain characteristics of the adolescent growth spurt. For example, for boys the growth spurt generally commences between 10.3 and 12.1 years (standard deviation [SD] = 0.9–1.0 years), lasts for between 2 and 5 years with peak height velocities (PHV) of ~8.2–10.3 cm/year (SD = 0.9–1.6 cm/year) observed around 13.4–14.3 years (SD = 0.8– 1.1 years). For girls, the adolescent growth spurt commences between 8.5 and 10.3 years (SD = 0.6–1.6 years) with PHVs of ~7. 5–9.1 cm/year (SD = 0.7–1.7) observed around 11.4–12.1 years (SD = 0.7–1.2 years) (Beunen & Malina, 1988). To the authors' knowledge, no studies have used longitudinal growth data spanning the adolescent growth spurt to obtain the timing of PHV or maturity status of youth rugby players. Instead, most researchers have used mathematical equations to estimate maturity offset (Box 4.1; Mirwald et al., 2002) or percentage of predicted adult height (PAH; Box 4.2; Khamis & Roche, 1994).

Box 4.1

The Mirwald maturity offset method (Mirwald et al., 2002) uses chronological age, stature, seated stature and body mass in sex-specific regression equations to calculate a maturity offset (i.e., years from PHV). Negative and positive maturity offset values generally classify individuals as pre-PHV and post-PHV, respectively. A maturity offset can then be used to estimate an individual's APHV by subtracting the maturity offset from chronological age. Estimated maturity offsets and APHVs have been used to classify players according to their *maturity status* by comparing an individual's estimated APHV with that of the sample mean from which the individual originates. For example, an individual with an estimated APHV <1 year compared to the mean APHV of the sample to which they belong can be considered relatively early maturing. On the other hand, an individual with an estimated APHV >1 year compared to the sample mean is considered relatively late maturing. Estimated APHVs within one year plus/minus the sample estimated APHV can be considered to be relatively on time (Malina & Kozieł, 2014). Other maturity status classification methods such as using the sample standard deviation as a cut-off value are also reported (Malina et al., 2004). It should be noted that significant estimating errors of ±1 year have been reported and that this method should only be used in youths who are near their APHV (see Fransen et al., 2021).

Box 4.2

The Khamis-Roche (1994) PAH method uses stature and parental stature (corrected for overestimation) in sex-specific regression equations to predict a child's adult height and calculate %PAH. Young players can then be grouped into respective maturity bands: <85% PAH, prepubertal; ≥85% to <90%, early pubertal; ≥90% to ≤95%, mid-pubertal, or ≥95%, late pubertal (Cumming et al., 2017). Of note, PHV will typically occur during 88–96% of PAH, often peaking, on average, at ~92% (Baxter-Jones, 2013). It should be noted that this method was developed using predominantly white youths and may be inappropriate in multi-ethnic populations such as youth rugby. The median error for the Khamis-Roche PAH method is ~2.0 cm within the 50th percentile but this error can increase to ~0.3 cm at the 90th percentile, and when considering age groups of interest in relation to maturation tempo (11–15 years), the median error is reported as 2.4–2.8 cm to 5.5–7.3 cm for the 50th and 90th percentiles, respectively (Towlson et al., 2021).

Maturity Status in Youth Rugby

Studies in rugby league (Till et al., 2010; Waldron et al., 2014) and union (Howard et al., 2016) have assessed somatic maturity status using prediction equations. Howard et al. (2016) assessed the maturity status using the percentage of PAH (%PAH) method of 51, 14–17-year-old academy rugby union players with

44 players classified as on-time, seven as early maturing and no players as late maturers. Similarly in rugby league players, Till et al. (2010) estimated APHV (using the Mirwald maturity offset method) as 13.6±0.6 in U13–U15. These studies subsequently demonstrate that early to on-time maturing players are favoured within player identification and selection in youth rugby.

Relationships with Injury Risk, Physical Performance and Talent Identification

The variability and observed differences in body size and maturity status of young rugby players have raised public debate. Media reports (Gould, 2011; Lewis, 2014) and parental concerns (Boufous et al., 2004) have raised fears that size and maturity mismatches within age-grade rugby competitions may effect development and influence injury risk. However, the only research study to date has shown no association between injury risk and body size in youth rugby (Krause et al., 2015). Yet, injury risk (in general) may be heightened during maturation as large increases in the length of bones, increased tendon stiffness and muscle growth can place additional strain on the growing body resulting in overuse injuries (e.g., Osgood Schlatter's) and increased risk of other injuries (e.g., anterior cruciate ligament injuries in girls) (Gerrard, 1993; Radnor et al., 2018).

When considering rugby performance in adult rugby, a larger body size has been positively associated with scrummage performance (Quarrie & Wilson, 2000), competition success (Gabbett, 2009) and running momentum (body mass x running velocity) (Hendricks et al., 2014). Whilst limited research exists exploring maturity and youth rugby performance, positive associations between 10 m momentum and successful ball carries have been observed in elite U15–U17 rugby league players (Waldron et al., 2014), but in U12–U15 recreational rugby union players body size had no effect on rugby performance (Krause et al., 2015). Increased body mass may favour the expression of maximal strength, power and initial sprint momentum in youth rugby (Baker & Newton, 2008) and one would expect advanced body size to facilitate physical components of the game at the youth level considering the positive relationships between maturation and physical performance (e.g., strength, power, speed; Till & Jones, 2015). This is evidenced in youth players who are identified and selected to talent development programmes being usually advanced in body size and maturation (Cheng et al., 2014; Howard et al., 2016; Till et al., 2010). However, research has actually shown that later maturing players between 13 and 15 years gained more height and improved their 60 m sprint performance and upper body power more than earlier maturing players (Till et al., 2014) and that body size and maturity status at 13–15 years were not associated with future career outcomes in rugby league (Till et al., 2016).

These research findings infer that the physical advantages afforded to bigger and earlier maturing youth players may lead to increased opportunities within youth rugby (Figure 4.2). However, such advantages may be transient in nature, potentially masking weaknesses in technical, decision-making and/or

Chronological Annual Age Grouping

+

Individual Variability in Kinanthropometry & Biological Maturation

+

Relationship Between Kinanthropometry, Maturation & Performance

=

Children & Adolescents may be (Dis)Advantaged within Performance and Talent ID in Youth Rugby

FIGURE 4.2 Summary of Kinanthropometry, Maturation and Outcomes within Youth Rugby

psycho-social attributes. A challenge for player development stakeholders in rugby is thus to create opportunities for, and avoid the early deselection of relatively younger, smaller and/or later maturing players.

Grouping Strategies

Based on the above research and knowledge, classifying youth rugby players by age has become a matter of debate. Whilst age grouping is the most common grouping strategy, several federations have adopted the intuitive method of grouping youth players according to body mass (see Lentin et al., 2021; Patton et al., 2016). Players with advanced anthropometric characteristics may be 'accelerated' (i.e., play up) to participate against older players. Conversely, the term 'dispensation' is used for smaller players who are eligible to compete in younger age categories (i.e., play down) and is considered a strategy that may increase participation (Cassidy, 2018). Lentin et al. (2021) showed a weight grading model helped to reduce the variability in body size of young players whilst maintaining the identity of age category in French rugby. However, such a grouping strategy resulted in mainly obese players being 'accelerated' which subsequently resulted in large variability and body composition mismatches. Furthermore, anthropometric-based grading does not consider important performance features such as body composition (Fontana et al., 2017), mental maturity (Patton et al., 2016) and skill competency (Pienaar et al., 1998). Whilst bio-banding (i.e., the grouping of individuals according to maturation instead of chronological age) has been used in other sports (e.g., soccer; Cumming et al., 2017), to date no research on this topic is available in rugby. Thus, whilst alternative 'grouping' strategies may offer advantages for player development and participation, there is a lack of research in youth rugby to substantiate this claim and as such future research is needed.

Practical Applications

Based on the research overview, this practical applications section aims to provide practitioners (e.g., coaches, sport scientists) and administrators/organisations (e.g., clubs, national governing bodies) with a series of recommendations of how and where they can apply this knowledge into practice.

Understand Growth and Maturation

Practitioners and administrators must acknowledge, be aware of, and consider the substantial variability in body size within young rugby players when applying appropriate development opportunities for all players. The key concept is that players may be of a similar chronological age but may demonstrate large differences in size, especially during adolescence (i.e., 11–13 years in girls and 12–16 years in boys) when differences in maturity status are apparent. The knowledge described above can help practitioners and administrators across the micro- (e.g., coaching sessions), meso- (e.g., clubs, management) and macro- (e.g., national governing bodies, policy) levels of the youth sport system (Eisenmann et al., 2020). For example, at the micro-level coaches working with young rugby players may adapt their training focus to provide a greater challenge for earlier maturing players and more support for later maturing players to aid their development. At the meso- and macro-levels, organisations may implement multiple grouping strategies (e.g., age, size, maturity, skill) within training and competition and implement policies around competition and talent identification (Eisenmann et al., 2020). Specifically, rugby unions have delayed the age when talent identification into academy programmes occurs to post-maturation, in an attempt to reduce maturity selection biases (Till et al., 2020). However, to understand and apply this within practice requires gaining an accurate understanding of an individual's maturation status. In a non-clinical context, the recommended method is to estimate the occurrence of PHV either by %PAH or an estimation of the attainment of PHV. These estimations are sufficiently sensitive to assign players into categories (i.e., pre, circum or post puberty), which can, alongside players' chronological age, offer valuable insights into youth players' growth and development (Fransen et al., 2021). Researchers and practitioners should yet carefully contemplate the large variability in timing and tempo of maturational events and shortcomings of non-invasive estimations of somatic maturity (Fransen et al., 2021).

Measurement Guidelines and Protocols

The implementation of consistent kinanthropometric measurement and assessment protocols is recommended in youth rugby players. Detailed instructions for kinanthropometric assessments are detailed elsewhere (e.g., Malina et al., 2004), however, too often practitioners and researchers use these methods without considering if they present the right fit for the sport, the athletes and the logistical means of the organisation. Therefore, some guidelines and recommendations for rugby scientists and practitioners tasked with assessing rugby players' anthropometry, growth and maturation are presented. A number of pragmatic methods are available to measure kinanthropometry (specifically stature and body mass) and estimate an individual's maturity status in youth rugby (e.g., longitudinal monitoring of stature or mass; maturity offset [Mirwald et al., 2002]; %PAH [Khamis & Roche, 1994]). Whilst these methods have strengths and limitations, important considerations are described below.

a Appropriate measurement tools and standardised procedures

Random and systematic error both require consideration in the context of measuring kinanthropometry and estimating maturity in the context of rugby. Random error can be the result of variations in the subjects being measured, or the assessors performing the measurements (Malina et al., 2004). It is considered random because it is randomly greater or smaller than the actual phenomenon and may therefore not cause an issue (i.e., sometimes there is an over-measurement, and sometimes under-measurement, and both cancel each other out). Systematic measurement error is usually skewed in one direction and can include a data entry mistake in a spreadsheet aimed at estimating a player's APHV. To overcome measurement error issues, scientists or practitioners can take two important steps. First, as a single assessor is unlikely to be consistently available to record all measures for the same player(s), the development of standardised protocols to dictate how anthropometric measurements should be developed. Second, the measurement instruments (e.g., skinfold calipers, stadiometer) should be consistently and properly calibrated to optimise their validity and reliability. For example, plastic stadiometers for measuring stature can bend easily during assessment threatening measurement consistency.

b Measuring *vs.* estimating maturity

Using non-invasive anthropometric measurements to estimate maturity in youth athletes is practical, but it must be recognised that they are estimations with inherent systematic error (Fransen et al., 2021). For example, Mirwald et al. (2002) recognised the systemic error stating that: 'maturity offset can be estimated within an error of ± one year, 95% of the time'. Furthermore, it should be considered that estimations of APHV derived from a participant's chronological age and maturity offset (Mirwald et al., 2002; Moore et al., 2015) or maturity ratio (Fransen et al., 2018) are most accurate when measured at a chronological age close to APHV, but become increasingly biased as chronological age is further removed from their APHV. The inaccuracies of non-invasive estimations of maturity are also magnified in exactly those athletes where the estimations are of most value (e.g., those who are late or early maturing [Cumming et al., 2017]), with anthropometric measurements tending to overestimate APHV in early maturing, and underestimate in late maturing individuals (Malina et al., 2015). Maturity status classified by the percent of predicted adult stature is a relatively simple and feasible to administer somatic measure. Errors (linked to the reliance on self-reporting of parental stature) should yet be recognised with estimates ranging from poor-moderate (Malina et al., 2007, 2012, 2015); that said, equations are available to adjust for their systematic over-estimation (Epstein et al., 1995). The technique is yet redundant in circumstances where accurate reporting of both biological parents stature is unavailable. Maturity estimations should as such, only be used as they were intended (i.e., to qualitatively classify players according to their maturity status rather than as a quantification of the timing of the adolescent growth spurt).

c The 4C's of Implementation

Regular implementation of growth and maturity monitoring is challenging based on the contact time available and the number of athletes to assess. It has been recommended that a robust measurement and assessment programme requires the following four key principles to be applied to data collection and result in actionable implementation into the coaching practice (Eisenmann et al., 2020);

1 Commitment of an individual(s) to direct the process, select appropriate measures and educate stakeholders.
2 Consistent collection of the relevant data on a quarterly basis.
3 Communication of data along with training recommendations for athletes. Spreadsheets from Towlson et al. (2021) are useful for predicting maturity status.
4 Collaboration between multiple practitioners (if available) to develop appropriate training strategies.

Player Assessment and Talent Identification

Applying growth and maturation information to player assessment and talent identification processes (see more in Chapter 5) is an important consideration for practitioners. Such practices would allow practitioners to demonstrate greater awareness and understanding of the effect of growth and maturity on player performance and potential (Till & Baker, 2020). This is demonstrated by two examples below (Boxes 4.3 and 4.4).

Box 4.3

Player A is a relatively small, later maturing U14 fullback with less developed physical attributes compared to his/her age grouped peers. This often results in Player A not carrying the ball into contact at high speeds and failing to make tackles when opponents break the line. However, Player A demonstrates high technical skills (e.g., passing), tactical awareness (e.g., decision making) and psycho-social skills and characteristics (e.g., resilience, communication) that may suggest future potential capabilities for rugby within this position.

Box 4.4

Player B is an earlier maturing U14 player who also plays fullback. He is referred to as the most 'talented' player on his school team. Player B is very fast and athletic, often making numerous line breaks and scoring tries every game based on his athleticism. Whilst Player B has these transient physical advantages (owing to advanced maturity), he often fails to make the right decision in a two v one situation (preferring to use his pace) and fails to communicate with his teammates defensively.

Whilst these examples only provide a short snapshot of two players, they help coaches and practitioners consider how advanced size and maturity for players within the same position may influence performance and whether these performance attributes are related to long-term potential and hence talent identification.

Training Programme Design

Linked to practical application 1, coaches and practitioners can design and adapt training sessions and programmes that consider the body size and maturity status of the players related to (1) temporary plateaus or decrements in motor performance (referred to as adolescent awkwardness), (2) increased overuse injury risk (e.g., Osgood Schlatter's disease) and (3) large variability in size and maturity. First, related to adolescent awkwardness, practitioners should realise this is a temporary stage of decline and focus upon long-term not short-term selection decisions. Second, to improve co-ordination, implementing physical development, especially gross motor coordination and strength-based work within training sessions and programmes in relation to maturity status would be beneficial. Third, practitioners can implement constraints or challenges within games or training according to player maturity status. This could be to harvest the gains (i.e., increased physical attributes) that occur during maturation or to adjust the level of challenge for early/later maturing individuals. For example, to encourage an early maturing, physically dominant rugby player (like Player B example, Box 4.4) to use and develop evasive running and passing skills instead of using their physical prowess to run through their smaller and later maturing opponents, a constraint could be applied to them that states if they run straight into contact it is an automatic turnover. Including these in the participants' goal setting and development plan (whether informal or formal) also adds greater focus and perceived value from the participant. Chapter 15 provides further information on the implementation of an injury prevention programme. Lastly, the growth spurt can be a period of high training volumes for adolescent rugby players (Hendricks et al., 2019). Therefore, practitioners should consider the volume and intensity of training sessions, especially when players undertake multiple modes of training (see Chapter 12) alongside other periods of stress (e.g., school exams).

Grouping Strategies and Practices within Training and Competition

Annual-age grouping remains the most prevalent grouping strategy within youth rugby. However, to create different developmental experiences that support or challenge individual and groups of players, practitioners may consider implementing alternative grouping strategies within their training and competition programmes. These alternative grouping strategies may include:

a The organisation of small-sided games within training that groups individuals by age, maturity, body size and positions. Herein, the appropriateness of including both age-, size-, maturity- and skill-matched and mis-matched training opportunities should also be considered to encourage the development and preparedness of the varied demands of game-play.
b Provide participants with opportunities to progress and be challenged through a change of training environment. For example, joining sessions with relatively older participants (move up to train with the next age group). This could be within a planned transition period, for a specific session, on a regular basis, or more informally. Such practices could also be replicated in competition allowing player dispensation rules to allow players to play up or down.
c Include rules to allow equal playing time. The Rugby Football Union in England now has a Half Game rule that means all players must play for a minimum of half a game.
d Create competitions and adapt rules of the games to increase or decrease the challenge and technical and psychological aspects of rugby (and general athletic) performance and development (Côté & Vierimaa, 2014). For example, games could be implemented that reward technical skill, effort and psychosocial skills and characteristics (e.g., communication) rather than traditional scoring systems. Such competitions may encourage wider participation within the sport and the development of skills required for all players and reduce the physical emphasis associated with size and maturity variability.

Create 'Wider' Pathways

Based on research demonstrating the increased opportunities for large and earlier maturing players, rugby organisations should consider how they create development opportunities for all players. For example, the Leeds Rhinos RLFC designed and implemented a parallel later maturing developing programme as part of their talent pathway (see Till & Bell, 2019). As there is a restriction on the number of opportunities within the talent pathway within the United Kingdom rugby league from U15 (i.e., 20 player opportunities), the club implemented a parallel pathway for those players classified as later maturing individuals who were not recruited by any other professional rugby league club to increase the talent pool consistent with recommendations in other sports (e.g., soccer; Bennett et al., 2019). This created an additional talent development opportunity for players, who do not normally receive such support and included rugby player development and high-quality coaching, strength and conditioning coaching and home programme, player and parent education sessions (e.g., nutrition, psychology), fitness testing, individual player feedback and regular monitoring and feedback with parents and community club. Such a strategy could be considered by other sports and professional clubs within their talent identification and development processes, hopefully providing more developmental opportunities to more players in the future.

Communication and Collaboration

Whilst the above practical implications are recommended for consideration by practitioners and organisations, one vital aspect to successful implementation is the communication of the above information in relation to growth and maturation with a range of stakeholders (e.g., players, parents/guardians, other coaches). Being able to explain the changes and why you are organising training or policies in such a way may increase player buy-in and motivation to take part. This will help in the messaging and collaboration between others (e.g., parents and coaches) in providing explanations for these decisions. Furthermore, helping parents/guardians to understand the stages of development and nonlinear nature of growth and maturation is crucial. Being aware of how this impacts upon rugby performance enables parents/guardians to embrace the journey their child is on, rather than unhealthy expectations and unrealistic pressure to 'perform'.

Key Take Home Messages

- Youth rugby players are taller and heavier than normal populations but large variations in body size exists that mean players of all shapes and sizes compete within the codes of rugby.
- Maturation is defined as the timing and tempo of the progress towards the mature adult state. Large variability can exist in the timing and tempo of maturation. Studies in rugby show early to on-time maturing players are usually favoured within player identification and selection in youth rugby.
- The physical advantages afforded to bigger and earlier maturing youth players alongside the chronological annual age grouping system used may result

in advantages for earlier maturing and disadvantages for later maturing players. As such, practitioners need to understand maturation and where possible, measure maturation to inform their decision-making.

- When assessing maturation, the use of appropriate measurement tools and standardised procedures are needed to ensure as accurate information as possible.
- Practitioners can use growth and maturity information to inform their talent identification decisions, training and competition practices.
- It is recommended to create different developmental experiences and grouping strategies to support and challenge individual and groups of players. This could include organisation of small-sided games within training by age, maturity or body size; implementation of rules to allow equal competition time; provide opportunities for playing up or down; and adapt competition rules to focus on technical skill rather than traditional scoring systems.
- National governing bodies and professional organisations could consider developing wider talent pathways for the inclusion of later maturing individuals.
- Communication with stakeholders (e.g., parents, coaches, players) is key to successful implementation.

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