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Original research

Understanding mismatches in body size, speed and power among adolescent rugby union players

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ABSTRACT

Objectives: With adolescent sport increasingly challenged by mismatches in size, new strategies are important to maximize participation. The objectives were to (1) improve the understanding of mismatches in physical size, speed and power in adolescent rugby union players, (2) explore associations between size and performance with demographic, playing-history, and injury profiles, and (3) explore the applicability of existing criteria for age/body mass-based dispensation (playing-down) strategies.
Design: Cross-sectional study.
Methods: Four hundred and eighty-five male community rugby union players were recruited from three Australian states selected to represent community-based U12, U13, U14 and U15 players. Body mass, stature, speed (10, 30, and 40 m sprints) and lower-leg power (relative peak power and relative peak force) were measured. Independent student *t*-tests, linear regressions and Chi square analyses were undertaken.
Results: Mean values in age groups for size, speed and power masked considerable overlap in the ranges within specific age groups of adolescent rugby players. Only a small proportion of players (approximately 5%) shared the highest and lowest tertiles for speed, relative peak power and body mass. Physical size was not related to injury. The mean body mass of current community rugby union players was above the 75th percentile on normative growth-charts.
Conclusion: The notion that bigger, faster, and more powerful characteristics occur simultaneously in adolescent rugby players was not supported in the present study. Current practices in body mass-based criteria for playing down an age group lack a sufficient evidence for decision-making. Dispensation solely based on body mass may not address mismatch in junior rugby union.

1. Introduction

Globally, sports participation peaks during early adolescence followed by a steady decline occurring towards early adulthood.[1,2] Mismatches in maturation (often reported as age differences) and development of physical, cognitive, and sport-specific skills may contribute to drop out and injury concerns in adolescent sport,[3] with reports of younger boys more likely to leave or avoid an activity.[4]

Considerable differences in the timing, tempo and duration of biological maturation are synonymous with adolescence as a stage of development showing the greatest variability in players' physical size and performance.[5] Part of the complexity of maturational mismatch is that biological age can vary as much as three years in individuals sharing the same chronological age.[6] In contact team sports, early maturing adolescents are likely to have an advantage over their late maturing peers,[7] due to significant increases in muscle mass that occur at and following peak growth in height.[8]

Specifically, in the high contact sport of rugby union, evidence describing the size and performance variability of Australia's adolescent rugby players (U12–U16 years) is almost non-existent, with the most recent data describing the 2002/2003 playing seasons.[9] However, this research was undertaken in schoolboy rather than community rugby and only reported anthropometric data without performance measures. Nevertheless, body mass data along with normative data from growth charts have been used sporadically[10]

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in determining criteria for players to play "down" an age group (dispensation) in Australia. Uncertainty and inconsistency around playing down criteria remains controversial in junior sport.

Although not all aspects of mismatch can be prevented, research specifically addressing the diversity of physical size and performance among adolescent players requires urgent attention. Size in relation to differences in Caucasian and Polynesian/Maori players has also been the source of injury concerns for parents of rugby players,[11] however these concerns lack an evidence base.

Size and performance data describing adolescents participating in the collision sport of rugby union may provide more information on mismatch. Currently, the evidence-base informing policies addressing mismatch for adolescent rugby union players is limited and lacks national consensus. Furthermore, existing profiles of adolescent rugby players are largely restricted to anthropometric variables, even though physical size may not predict performance.[9] Based on this evidence, the objectives of this study were (1) to improve the understanding of mismatches in physical size, speed and power in adolescent rugby union players, (2) explore associations between size and performance with demographic, playing-history, and injury profiles and (3) explore the applicability of existing criteria for age/body mass-based dispensation (playing-down) strategies.

2. Methods

In collaboration with the Australian Rugby Union, 485 male adolescent (U12 $n = 147$, U 13, $n = 129$, U14, $n = 119$, U15 $n = 90$) players from community rugby union were recruited from New South Wales ($n = 137$), Queensland ($n = 279$) and Victoria ($n = 69$). Selected clubs were representative of the current Australian rugby union population. Players were tested once, during the first half of the 2013-playing season. The Australian Catholic University Ethics Committee approved all procedures and parent/guardians provided informed consent.

Participants completed a 'playing experience and demographic survey' and were tested at club venues in relatively dry conditions for standard anthropometry (body mass, stature), lower-leg power (countermovement jump) and speed (10 m, 30 m, and 40 m sprint). Only players free from injury participated. Testing consistently occurred mid-week between 5 and 7 pm to minimize any potential game-fatigue. Testing also occurred in randomized order with standard warm-ups at each station (where appropriate).

Demographic and playing history were obtained from a short survey; with questions on postcode, cultural heritage, playing position, previous playing experience, injury in the previous season and intentions of playing next season.

Standing stature was measured with a stadiometer (Mentone Educational, Melbourne, ±1.0 cm) and body mass with calibrated medical-grade, digital scales (SECA 813, Hamburg, Germany, ±0.1 kg).[12] The mean of two measurements for body mass and stature was recorded. The intraclass correlation coefficients (ICC) for test–retest reliability on two consecutive measurements were strong for both stature and body mass (ICC (2,1) = 0.99). The coefficient of variation (CV%) was 0.1% for stature, and 0.3% for body mass.

Players performed two 40 m sprints (with a minimum of 3 min rest between sprints) on grassed outdoor surfaces using electronic timing gates (Swift Performance Equipment, Australia, ±0.03 s) placed cross-wind at exact distances of 0, 10, 30 and 40 m. Split times were recorded to the nearest 0.01 s and 30–40 m flying time was calculated. The fastest time from two trials was recorded. The ICCs for 10, 30 and 40 m sprint times were 0.89, 0.93, and 0.96, and the CV% values were 2.3%, 1.7%, and 1.6%, respectively.

Repeated bouts of high intensity muscle power aid performances in tackles, scrums, sprinting and changes in direction.[14] Lower-leg power was measured from two countermovement jumps using a Quattro force platform (Quattro Jump, Type 9290BD, Kistler, Switzerland), with one minute rest between jumps. For both trials, players stood with feet flat, shoulder-width apart with 'hands on hips' to isolate lower leg movement.

The highest value from each jump trial was used for subsequent analysis. The ICCs for jump height, relative peak force, relative peak power and flight time were 0.96, 0.99, 0.99, and 1.00, respectively. The CV% values for jump height, relative peak force, relative peak power and flight time were 3.8%, 4.4%, 2.6% and 2.6% respectively.

To maintain statistical power in descriptive and performance variables (minimum of 175 per group for at least 0.35 standard deviation differences, power = 90% and significance = 0.05), the U12 and U13 age groups ($n = 276$) and U14 and U15 age groups ($n = 209$) were combined, and named 'younger' and 'older' groups, respectively. Data were checked for normal distribution and non-conforming data were log-transformed. Differences between group means were evaluated using independent *t*-tests ($p < 0.05$) and the magnitude of difference assessed using effect sizes (<0.2 trivial, 0.2–0.6 small, 0.6–1.2 moderate, 1.2–2.7 large).[15] Chi-square analyses were used to explore associations between upper and lower tertiles of anthropometric and performance data (derived from single age groups before combining) and other dichotomous population descriptors ($p < 0.02$). Linear regressions were used to explain the variability in relative peak power ($p < 0.05$); stability of modelling was assessed using R square change. To more effectively demonstrate mismatch within and between age groups, some age-specific data are presented.

3. Results

Despite consistent differences from independent *t*-tests (larger size, faster speeds and more powerful performances) for all variables in older than younger players ($p < 0.001$), range values reveal considerable overlap (Table 1). Supplementary Table S1 showed forward and back position players were evenly represented, 8% of players were playing out of their correct age group, 21% were from an Islander heritage (Maori or Pacific Islanders), 19% lived in areas rated in the lowest 5 of 10 categories for socioeconomic status (SES), and although 11% were first season players, 61% had played four or more seasons. One quarter of players perceived their physical size as either an advantage (13%) or disadvantage (13%). Reports of rugby-related injuries in the previous season were minimal with 24% of players missing 1–4 games and 6% missing more than four games. Most players (92%) stated their intention to return to play next season.

Body mass-based growth charts (CDC growth charts) currently used for clinical purposes in Australia,[16] were compared against means from individual age groups. The rugby population fell between the 75th and 90th percentiles for the U12, U13 and U14 groups and above the 90th percentile for the U15 age group using the CDC data (Supplementary Fig. S1). However, when the more recent values from the Australian Child Nutrition and Physical Activity Health Survey[22] were included on the graph, the age-specific body mass of rugby players remained between the 50th and 75th percentiles for U12 and U13 players, but again above the 75th percentile for the older players.

Supplementary Tables S2–S4 demonstrated several results consistent to both age groups. Specifically, body mass, stature, BMI were greater in forwards than backs. However, with the exception of relative peak power in older players, backs were faster and more powerful than forwards. Players perceiving a physical size advantage were generally taller than those perceiving a size disadvantage.

Within the younger age group, low SES and being relatively inexperienced (first season of rugby union) were associated with players from tertiles for the heaviest body mass (57% low SES,