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Original Article

Three-Compartment Body Composition Changes in Professional Rugby Union Players Over One Competitive Season: A Team and Individualized Approach

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Abstract

The purpose of this study was to investigate the longitudinal body composition of professional rugby union players over one competitive season. Given the potential for variability in changes, and as the first to do so, we conducted individual analysis in addition to analysis of group means. Thirty-five professional rugby union players from one English Premiership team (forwards: n = 20, age: 25.5 ± 4.7 yr; backs: n = 15, age: 26.1 ± 4.5 yr) received one total-body dual-energy X-ray absorptiometry scan at preseason (August), midseason (January), and endseason (May), enabling quantification of body mass, total and regional fat mass, lean mass, percentage tissue fat mass (%TFM), and bone mineral content (BMC). Individual analysis was conducted by applying least significant change (LSC), derived from our previously published precision data and in accordance with International Society for Clinical Densitometry guidelines. Mean body mass remained stable throughout the season ($p > 0.05$), but total fat mass and %TFM increased from pre- to endseason, and from mid- to endseason ($p < 0.05$). There were also statistically significant increases in total-body BMC across the season ($p < 0.05$). In both groups, there was a loss of lean mass between mid- and endseason ($p < 0.018$). Individual evaluation using LSC and Bland–Altman analysis revealed a meaningful loss of lean mass in 17 players and a gain of fat mass in 21 players from pre- to endseason. Twelve players had no change and there were no differences by playing position. There were individual gains or no net changes in BMC across the season for 10 and 24 players, respectively. This study highlights the advantages of an individualized approach to dual-energy X-ray absorptiometry body composition monitoring and this can be achieved through application of derived LSC.

Key Words: Bone mineral content; fat mass; imaging; lean mass; team sport.

Introduction

Rugby union is a field-based contact sport, contested by two teams of 15 players over 80 min of match play *(1)*. The Premiership constitutes the highest level of professional rugby union in England, comprising 12 teams that compete from September to May. In addition to 22 league fixtures, teams also compete in both domestic and international cup competitions. Successful performance in rugby union requires players to possess high levels of muscular power, strength, and speed, in addition to high aerobic and anaerobic capacity *(1–3)*. To meet the physical demands of the game, an optimal power-to-weight ratio is desired through lean mass and the avoidance of unfavorably high levels of fat mass. This assists players in maximizing their aerobic and anaerobic capacity *(4,5)*.

In rugby union, distinct physical differences exist between forwards and backs—forwards are taller, heavier, and possess greater fat, lean, and bone mass than backs *(6,7)*. These differences are indicative of the discrete demands

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placed upon each positional group, whereby forwards typically spend more time engaging in static tasks such as rucking, mauling, and scrummaging, and backs tend to cover greater total distances and perform more high-intensity running activity *(3,8,9)*. Hence, it is clear that divergent body composition profiles are required with regard to player position and these should be considered when assessing body composition.

Cross-sectional body composition data have been reported for academy and professional rugby players using skinfold assessment *(10,11)* and dual-energy X-ray absorptiometry (DXA) *(6,7,12,13)*. Although skinfold analysis is practical for field-based measurements, DXA provides more of an in-depth analysis, establishing individual levels of fat mass, lean mass, and bone mineral content (BMC), and is recognized as a criterion method for the measurement of total *(14,15)* and regional *(16,17)* body composition.

In rugby union, the professional season is preceded by a preseason period before weekly competition begins *(10)*. During this time, increased lean mass and decreased fat mass are primary objectives for most players *(2,10)*. The maintenance of this profile throughout the competitive season may be beneficial for performance and health, given the ergolytic effects of excess body fat on energy expenditure and movement economy *(1)*, and lean mass may attenuate the risk of contact injury *(18)*. However, seasonal changes in the three-compartment body composition of rugby league players, but not rugby union players, have been reported elsewhere *(19,20)*. Previous studies of athlete body composition change have not evaluated data at the individual level and hence rely solely on group differences that reach statistical significance. Interpretation of group means alone will not enable the capture of important information on potential heterogeneity in player response to exercise and recovery. Individual longitudinal change in body composition can be evaluated by applying least significant change (LSC) as determined from precision error for the specific group *(21,22)*. The purpose of the present study was to investigate both team and individual DXA-derived body composition changes across one competitive season in professional rugby union players.

Methods

Study Design

The present study followed players from an English Premiership rugby union team over a period of 10 mo using an observational, longitudinal research design.

Participants

Thirty-seven professional male rugby union players from an English Premiership rugby union club were recruited for participation in the study, constituting the entire senior playing staff. Two players (forwards) were excluded due to experiencing an injury that kept them from normal training and inclusion in games. The final sample consisted of 35 players (forwards: n = 20, age: 25.8 ± 4.7 yr, height: 186.0 ± 7.1 cm; backs: n = 15, age: 26.1 ± 4.5 yr, height: 183.3 ± 4.0 cm), with all players successfully completing the study. There were no instances of missing data or players lost to follow-up after beginning the study. Positional forwards consisted of 6 props, 5 hookers, 2 locks, and 7 backrow forwards, and positional backs consisted of 3 centers, 3 scrum-halves, 3 fly-halves, 3 wingers, and 3 fullbacks. By ethnic group, there were 17 Caucasian, 1 Black, and 2 Polynesian forwards, and 12 Caucasian, 1 Black, and 2 Polynesian backs. Before testing, all participants provided signed, informed consent and the study was approved by the University Faculty Research Ethics Committee.

Physical Measurements

For all tests, the players wore shorts without buckles or catches and removed all jewelry. Height was measured using a stadiometer (SECA Alpha; SECA Ltd, Birmingham, UK) to the nearest millimeter, and body mass was measured using calibrated electronic scales (SECA Alpha 770, SECA Ltd) to the nearest gram. Players received one total-body DXA scan (Lunar iDXA; GE Healthcare, Hatfield, UK) at the end of preseason (August), midseason (January), and end season (May) in a euhydrated state (urine osmolality < 700 mOsmol/kg) *(23)* to ensure that lean mass was not affected by hydration status *(17)*. The participants were positioned supine on the scanning table with arms situated to their side and ankles supported using the Lunar ankle strap. The standard mode scans took approximately 6.5 min, whereas heavier participants (those above 100 kg in body mass) necessitated the use of the thick mode scan, of which the duration was approximately 12.5 min. For consistency, the scan mode and position selected for the preseason measurement were used for the mid- and end-season measurements. From each scan, total and regional fat mass, lean mass, percentage tissue fat mass (%TFM), and BMC values were obtained. These values were determined from the ratio of soft tissue attenuation of 2 X-ray energy beams for each pixel containing a minimal amount of soft tissue but no significant bone *(24)*. All scanning and analysis procedures were completed by the same trained operator using the Lunar Encore software package (Version 15.0), with subsequent interpretation by a Certified Clinical Densitometrist. The machine was calibrated and checked on a daily basis in accordance with the manufacturer's recommendations.

The published in vivo short-term precision (root-mean-square standard deviation [RMS-SD] and percent coefficient of variation) and corresponding LSC in professional rugby players using the same Lunar iDXA *(21)* are provided in Table 1.

Data were collected on the type and number of training sessions completed during the competitive season (both gym- and field-based sessions) in addition to the number of fixtures completed each week (see supplementary material). The total number of games played by the team was