Section: Original Research

Title: Dietary intakes of elite 14 – 19 year old English academy rugby players during a pre-season training period.

Running Title: Dietary intakes of elite academy rugby players.

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Abstract

Good nutrition is essential for the physical development of adolescent athletes, however data on dietary intakes of adolescent rugby players are lacking. This study quantified and evaluated dietary intake in 87 elite male English academy rugby league (RL) and rugby union (RU) players by age (under-16 (U16) and under-19 (U19) years old) and code (RL and RU). Relationships of intakes with body mass and composition (sum of 8 skinfolds) were also investigated. Using 4-day diet and physical activity diaries, dietary intake was compared to adolescent sports nutrition recommendations and the UK national food guide. Dietary intake did not differ by code, whereas U19s consumed greater energy (3366 ± 658 *vs.* 2995 ± 774 kcal·day^{-1}), protein (207 ± 49 *vs.* 150 ± 53 g·day^{-1}) and fluid (4221 ± 1323 *vs.* 3137 ± 1015 ml·day^{-1}) than U16s. U19s consumed a better quality diet than U16s (greater intakes of fruit and vegetables; 4.4 ± 1.9 *vs.* 2.8 ± 1.5 servings·day^{-1}; non-dairy proteins; 3.9 ± 1.1 *vs.* 2.9 ± 1.1 servings·day^{-1}) and less fats and sugars (2.0 ± 1. *vs.* 93.6 ± 2.1 servings·day^{-1}). Protein intake *vs*. body mass was moderate ($r = 0.46$, $p < 0.001$), and other relationships were weak. The findings of this study suggest adolescent rugby players consume adequate dietary intakes in relation to current guidelines for energy, macronutrient and fluid intake. Players should improve the quality of their diet by replacing intakes from the fats and sugars food group with healthier choices, while maintaining current energy, and macronutrient intakes.

Key words: team sport, nutrition, adolescent

Introduction

Physical development of adolescent rugby players is of great importance, as the progression to professional senior level is dependent on the physical characteristics of a player (Duthie, 2006; Jones et al., 2015; Till, Jones, & Geeson-Brown, 2015). Due to rapid growth and changes in body composition during adolescence, where puberty marks the transition from childhood to adulthood (Malina, 1994), energy demands for 15-18 year olds are higher than at any other life-stage (COMA, 1991; Desbrow et al., 2014). During this time, lifelong relationships with food are also established (Desbrow, et al., 2014), therefore encouraging good dietary practices for healthy development is essential.

Adolescent rugby players engage in intense training programmes (Gabbett, Whyte, Hartwig, Wescombe, & Naughton, 2014), which differ between under-16 (U16) and under-19 year old (U19) players (Till, et al., 2015). However, energy required to meet these demands have not yet been quantified. Previous research in ice hockey (Fogelholm, Rankinen, Isokääntä, Kujala, & Uusitupa, 2000) or power team sports (Croll et al., 2006) reported male adolescent players consumed ~300 $kcal \cdot day^{-1}$ more than non-athletic populations. Insufficient energy (i.e. relative energy deficiency or low energy availability) over prolonged periods of time may impair a number of body functions including metabolic rate, bone health (high-risk stress fractures), immunity, protein synthesis, cardiovascular and psychological health, growth and development (Mountjoy et al., 2014), therefore a diet sufficient in energy is essential for performance and health.

Rugby league (RL) and rugby union (RU), are both high-intensity intermittent team sports, whereby players undertake repeated collisions during a match. RU is unique due to 'lineouts', 'rucks' and 'mauls' resulting in a greater number of static exertions (Cahill, Lamb, Worsfold, Headey, & Murray, 2013; Twist et al., 2014). Whereas RL involves a 'play the ball' rule and players typically cover a greater distance during match-play than RU players (Duthie, Pyne, & Hooper, 2003; Twist, et al., 2014). Given the collision aspect of rugby, momentum (velocity multiplied by body mass) is a key determinant of performance and differentiates between junior and senior players (Darrall-Jones, Jones, & Till, 2015; Till, et al., 2015). It is well known that dietary intake can influence body mass, as inadequate energy intake (EI) results in negative energy balance and weight loss (Loucks, Kiens, & Wright, 2011). Furthermore, suboptimal protein intake (i.e. negative nitrogen balance) may negatively impact lean mass which is key to rugby performance (Jones, Till, et al., 2015).

To date, the nutrition profiles of players have been investigated in senior RU (Bradley, Cavanagh, Douglas, Donovan, Twist, et al., 2015; Bradley, Cavanagh, Douglas, Donovan, Morton, et al., 2015; MacKenzie, Slater, King, & Byrne, 2015), and RL players (Alaunyte, Perry, & Aubrey, 2015; Lundy, O'Connor, Pelly, & Caterson, 2006; Tooley et al., 2015). Energy, carbohydrate and fat intakes of RL players were higher and protein intakes lower than those observed in RU players. As such, there may be differences in dietary intakes between adolescent RL and RU players. Nutrition profiles of adolescents include dietary habits of RU players (Walsh, Cartwright, Corish, Sugrue, & Wood-Martin, 2011) and other studies which do not specify code (Imamura et al., 2013; Thivel et al., 2015). These studies report food preferences and energy intake in response to training sessions (Thivel, et al., 2015), and dietary intake specific to Japanese food composition tables (Imamura, et al., 2013). Therefore data on dietary intake of adolescent players, including comprehensive information on food groups, energy, macronutrient and fluid intakes are still lacking.

Adolescent sports nutrition guidelines (Desbrow, et al., 2014), suggest following adult sports nutrition recommendations for protein (1.3-1.8 $g \cdot kg^{-1} \cdot day^{-1}$) and carbohydrate intakes (3-5 $g \cdot kg^{-1} \cdot day^{-1}$ for skill-based activity). For other nutrients (fat [35% of energy intake], calcium, vitamin D and iron) guidelines suggest adolescent athletes should follow age specific nutrition guidelines for health (COMA, 1991). Understanding the dietary intake of adolescent players and their adequacy in relation to nutrition guidelines is key for health, performance and player development. Therefore this study aims to quantify the dietary intake of elite English academy rugby players, and evaluate in relation to adolescent sports nutrition recommendations. This study also aims to investigate the relationship of dietary intake with body mass and composition.

Methods

Study design

A cross-sectional design was used to investigate the dietary intake of 87 elite male English academy rugby players, during respective pre-seasons. Players were grouped by age (U16 and U19) and code (RL and RU).

Participants

Characteristics of participants are shown in Table 1. Players were of a representative standard, recruited into respective professional RL and RU academies. Although this was a pre-season training period, the professional rugby club's contact with players' ranged from 1 to 4 days per week. Given the age of participants, some players were also involved in other training and playing programmes. For example during this recording period some U16 players were involved in a rugby match for an amateur rugby club (Table 2).

Ethics approval for the study was granted by the Carnegie Faculty Research Ethics Committee (Leeds Beckett University, UK). Written informed consent, and where appropriate written informed player assent and parental consent was obtained.

Assessment of dietary intake

Based on previous studies in adolescent athletes (Gibson, Stuart-Hill, Martin, & Gaul, 2011) a 4-day (Friday-Monday) semi-quantitative diet diary was used in this study due to being perceived as less time-consuming or burdensome than longer reporting periods (e.g., 7-days), and thought to improve compliance (Livingstone & Robson, 2000). Players recorded a description and quantity of all food, fluid and supplements consumed, cooking methods, time of consumption, and physical activity undertaken. Prior to recording, the lead researcher (registered UK Sport and Exercise Nutritionist) delivered a workshop on best practice for completion and provided written instructions (Gibson, et al., 2011). Players served individual 'standard' portion sizes of common carbohydrate foods and recorded weights to inform their records. All other portion sizes were estimated using household measures, food packaging and providing photographs (Dhurandhar et al., 2014) and brand names where possible. Parents were encouraged to facilitate record keeping where required (Livingstone, Robson, & Wallace, 2004). Diaries were checked by the lead researcher with individual players to clarify any unclear recordings.

Diet recommendations

Diet quality was assessed using food group recommendations from an adapted model of the UK national food guide (Food Standards Agency, 2009). Basal metabolic rate (BMR) was estimated using the Schofield equation (Schofield, 1984). Accounting for sex, age and body mass this is a recommended equation for prediction of BMR in the UK population (COMA, 1991). A physical activity level was determined for each player based on reported physical activity and was multiplied by BMR for daily energy expenditure (Black, 2001;

COMA, 1991). Sports nutrition recommendations for adolescents (Desbrow, et al., 2014), which include nutrition guidelines for health (COMA, 1991), were used to assess adequacy of reported macronutrient intakes. Fluid recommendations were calculated as 1 $ml \cdot kcal \cdot day^{-1}$ (Kleiner, 1999). Due to greater variability in micronutrient intake, particularly in adolescents, records >20 days are required to capture habitual intakes (Livingstone, et al., 2004). Due to the 4-day recording period in the present study analysis of micronutrient intakes were omitted. The contribution of alcohol to overall energy intake was negligible, thus also omitted from the results.

Anthropometrics and body composition

Height was measured pre, and body mass pre and post the 4-day recording period (Stewart, Marfell-Jones, Olds, & Ridder, 2011), using a stadiometer (Seca Alpha, Birmingham, UK) and calibrated scales (Seca Alpha 220, Birmingham, UK) to the nearest 0.1 cm and 0.1 kg respectively. The sum of 8 skinfolds (∑Sf) was measured across 8 sites (biceps, triceps, subscapular, suprailliac, supraspinale, abdominal, front thigh and medial calf) using calibrated skinfold callipers (Harpenden, British Indicators, UK) by the lead researcher (International Society for the Advancement of Kinanthropometry accredited practitioner; technical error of measurement = 2.9%).

Analysis of Data

Diet diaries were coded and portion sized by the lead researcher prior to data entry using NetWISP nutritional-analysis software (Tinuviel Software, 2004). Substitutes were found for foods not included on the programme database, and manufacturer's declaration of content was entered manually for supplements. Data entries were checked on two occasions by separate investigators.

Statistical analyses were computed using SPSS version 21 (IBM, 2012), with statistical significance set at $p < 0.05$. Data are presented as means ± standard deviation (*SD*) for each age group within each code. Before analysis, normality and equality of variance were assessed using a Kolmogorov-Smirnov test. Mahalanobis distances were computed to check for multivariate normality.

A two-way multivariate analysis of variance (ANOVA) was conducted to analyse differences between age groups and codes for food group, macronutrient and fluid intakes, body mass and composition. Energy intake correlated too high with macronutrients and was therefore analysed using two-way ANOVA. *Post-hoc* analysis was undertaken with a Bonferroni adjustment. Recommended *vs.* reported dietary intakes were analysed using a paired samples t-test. Where data showed no violation of normality, linearity or homoscedasticity (body mass) a Pearson product-moment correlation coefficient, and where data violated these assumptions (body composition and age) Spearman rho was used to explore relationships with energy, macronutrients and fluid intakes.

Effect sizes (*ES*) were calculated between groups (i.e. age, code and actual *vs.* recommended intakes) using Cohen's *d,* and interpreted as 0–0.19 being a ‘trivial’, 0.20–0.49 ‘small’, 0.50–0.79 ‘medium’, or >0.80 ‘large’ effect (Cohen, 2013). 95% confidence intervals (*CI*) were also calculated. Where the CI crossed 0, the effect was interpreted as ‘unclear’ (Batterham & Hopkins, 2006).

Results

Dietary intake by code and age

There were no differences for dietary intake between code (p = 0.466). U19s consumed higher intakes than U16s for absolute energy (3366 ± 658 *vs.* 2995 ± 774 $kcal \cdot day^{-1}$; p = 0.013, d = -0.6 [-0.93 to -0.08]), protein (207 ± 49 *vs.* 150 ± 53 $g \cdot day^{-1}$; $p < 0.001$, d = -1.1 [-1.53 to -0.64]) and fluid intake (4221 ± 1323 *vs.* 3137 ± 1015 $ml \cdot day^{-1}$; $p < 0.001$, d = -0.9 [-1.31 to -0.44]), and protein relative to body mass (2.3 ± 0.5 *vs.* 1.9 ± 0.6 $g \cdot kg^{-1} \cdot day^{-1}$; p = 0.002, d = -0.7 [-1.14 to -0.28]). No significant interaction effect was observed between code and age group for energy (p = 0.703) or macronutrients and fluid intake (p = 0.876). Tables 3 and 4 show dietary intakes for each age group within each code. Overall, 74% of players consumed dietary supplements. Supplement intake in RL players (mean 77%; U16 68% and U19 92%) was greater than RU players (mean 71%; U16 65% and U19 81%). Overall 41% of players consumed a protein supplement during the study, which was greater for RL players (mean 43%; U16 23% and U19 77%) than RU players (mean 40%; U16 26% and U19 62%).

Figure 1 shows positive significant relationships between age and energy, protein, carbohydrate and fluid intakes, but fat intakes were not significant.

A comparison of the daily number of servings per food group according to an adapted UK national food guide are shown in Figure 2, where no difference was observed between code (p = 0.328). U19s reported higher intakes for fruit and vegetables (4.4 ± 1.9 *vs.* 2.8 ± 1.5 servings·day^{-1}; p = 0.001, d = -0.9 [-1.3 to -0.4]) and non-dairy protein (3.9 ± 1.1 *vs.* 2.9 ± 1.1 servings·day^{-1}, p <0.001, d = -0.9 [-1.3 to -0.4]) food groups, and consumed lower fat and sugar intake (2.0 ± 1. *vs.* 93.6 ± 2.1 servings·day^{-1}; p = 0.001, d = -0.8 [0.3 to 1.2]) than U16s. No significant interaction effect was observed between code and age group (p = 0.463).

Reported dietary intake *vs.* recommendations

Reported EI did not statistically differ (unclear *ES*) from recommendations for RL and RU players (Tables 3 and 4). There was no significant difference between carbohydrate intakes and recommended range for all groups (unclear *ES* for higher end of intake range). U19s consumed significantly more than the higher end of the recommended range for protein intakes (large *ES*), however U16 intakes did not statistically differ from recommended (unclear *ES*). Fat intakes were significantly lower than recommended values for RU U16s (medium *ES*). Lower fat intakes were also observed for RU U19s absolute intakes (medium ES), and RL U16s and U19s intake relative to body mass (medium and large ES). There was no significant difference between recommended and reported fluid intakes for U16s (unclear *ES*), whereas U19s consumed significantly more fluid than recommended (large *ES*).

Figure 2 demonstrates that only RU U19s achieved guidelines of at least 5 servings of fruit and vegetables per day, with other groups consuming less. RL U19s consumed a greater amount of starchy foods than recommended, and RL U16s under-consumed milk and dairy foods. All other players achieved guidelines for these food groups. U19s were within guidelines for servings of non-dairy proteins, however U16s under-consumed. Players of all age groups consumed more foods than recommended from the fats and sugars food group.

Dietary intake in relation to body composition

Table 1 summaries body mass and composition. Body mass was significantly higher for RU *vs.* RL (p = 0.006, d = 0.6 [0.19 to 1.07]), and U19s *vs.* U16s (p < 0.001, d = -0.7 [-1.18 to -0.27]). Over the recording period this did not significantly change (p = 0.179, d = 0.0 [-0.31 to 0.30]). There were no significant difference for ∑Sf for RU vs. RL (p = 0.230, d = 0.3 [-0.12 to 0.75]) or U19 vs. U16 (p = 0.496, d = -0.1 [-0.57 to 0.31]) (Table 1). No significant interaction effect was observed between code and age group for body mass and composition (p = 0.852).

Figure 1 shows there were positive significant relationships between body mass with protein and fluid intakes, although no significant relationship with energy, carbohydrate or fat intakes were observed. There was a significant negative relationship observed between ∑Sf and fat intake, and negative relationships with energy and carbohydrate intakes. A positive relationship was observed between ∑Sf and protein intake, and no relationship was observed between ∑Sf and fluid.

Discussion

The findings of this study show no difference in dietary intakes of RL and RU players, whereas U19 players consumed greater energy, protein and fluid intakes than U16s. The strong significant relationship whereby protein intake increased with age may be due to older players reporting to consume more protein supplements than U16s. Since age showed weak to moderate relationships with other nutrients, at least 50% or more of the variation could be accounted for by other factors such as growth and maturation (Malina, 1994), training exposure (Gabbett, et al., 2014) or body mass (Darrall-Jones, et al., 2015). U19s consumed a better quality diet, with greater servings of fruit and vegetables, non-dairy proteins and lower intakes of fats and sugars. As such practitioners should focus on improving the quality of dietary intake, particularly in younger players.

Players achieved guidelines for energy intake, and were similar to 19.5 ± 1 year old Japanese collegiate rugby players (forwards; 3579 ± 848, backs; 2963 ± 111 $kcal \cdot day^{-1}$) (Imamura, et al., 2013), and relative to body mass intakes were greater than 20.5 ± 2.3 year old RU players (33.5 $kcal \cdot kg^{-1} \cdot day^{-1}$) (MacKenzie, et al., 2015). Energy intake was greater than age group recommendations for health (2755 $kcal \cdot day^{-1}$), however this recommendation is based on an average 15-18 year old male body mass of 64.5 kg (COMA, 1991), which is less than the average rugby player (84.2 kg) in this study. When calculating this recommendation relative to body mass (42.7 $kcal \cdot kg^{-1} \cdot day^{-1}$), the lowest consumption for an age group (RU U19s) suggests some players under-achieved energy requirements for growth, maturation and daily activity (40.6 $kcal \cdot kg^{-1} \cdot day^{-1}$). The highest energy consumption relative to body mass was RL U16s (44.0 $kcal \cdot kg^{-1} \cdot day^{-1}$) suggesting they were not at risk of impairing physiological functions.

Within this study, additional controls were used to minimise any potential error in self-reported dietary intakes. While it is acknowledged that under-reporting may still occur within this age group (Caccialanza, Cameletti, & Cavallaro, 2007), to date no alternative method exists in applied practice.

Body mass appeared stable (Table 1) during the data collection period, suggesting players were in energy balance. Given the data collection period was only 4 days, any changes in body mass may be more representative of a daily fluid flux (Jones, O'Hara, Till, & King, 2015; Lundy, et al., 2006) as opposed to weight loss or gain from energy balance, which would be more evident over longer observation periods.

If the objective of these players was to increase lean mass during the pre-season training period, taking into account under-reporting, energy intake may need to be increased within these players. Therefore practitioners may need to ensure that players consume regular meals and snacks to provide adequate energy for growth, maturation and training adaptations.

It has previously been shown that body mass and ∑Sf are higher in rugby players than other athletic populations (Santos et al., 2014). For all groups in this study, the ∑Sf values were lower than previously reported (body mass; 92.2 kg, ∑7Sf; 110.5 mm) in 20.4 ± 4.0 year old rugby players (Santos, et al., 2014). It should also be noted that the number of sites used by Santos et al., (2014) was less (n=7) than the number of sites used in this study (n=8). Santos et al. (2014) omitted the iliac crest measure, thus it is clear that players in this study have less relative fat mass, than previously reported in older players.

Although there are no distinct dietary guidelines specific to adolescent rugby players, carbohydrate intakes recommended for skill-based activity (Desbrow, et al., 2014) were achieved by all groups in this study. These intakes were lower than those previously reported (forwards; 567 ± 160, backs; 457 ± 267 $g \cdot day^{-1}$) in collegiate rugby players (Imamura, et al., 2013), yet similar to reported carbohydrate intakes of 2.5-5 $g \cdot kg^{-1} \cdot day^{-1}$, where such intakes have been suggested to be more appropriate for senior RU players during pre-season due to improvements in body composition (Bradley, Cavanagh, Douglas, Donovan, Morton, et al., 2015; MacKenzie, et al., 2015), and performance measures (Bradley, Cavanagh, Douglas, Donovan, Morton, et al., 2015). Although carbohydrate intakes relative to body mass were at the higher end of the recommended intake range, findings suggest that recommendations for skill-based activity may be appropriate for pre-season training in elite adolescent rugby players. Players should focus on the quality of carbohydrate intake given RU and RL U19s only achieved the minimum recommendation for fruit and vegetable intakes and starchy foods respectively, and all groups exceeded guidelines for fats and sugars intake.

U16s consumed adequate protein, whereas U19s significantly exceeded the higher end of the recommended intake. All players consumed more protein than previously reported (forwards; 93 ± 22, backs; 80 ± 32 $\mathrm{g \cdot day^{-1}}$) (Imamura, et al., 2013), and U19s protein intakes were similar to older RU players (211 $\mathrm{g \cdot day^{-1}}$ or 2.2 $\mathrm{g \cdot kg^{-1} \cdot day^{-1}}$) (MacKenzie, et al., 2015). While adolescent sports nutrition guidelines suggest protein intakes of 1.3-1.8 $\mathrm{g \cdot kg^{-1} \cdot day^{-1}}$, higher intakes >2 $\mathrm{g \cdot kg^{-1} \cdot day^{-1}}$ (as reported in this study by U19 players) have been shown to provide a positive nitrogen balance and prevent lean mass loss during periods of energy deficit to promote fat loss (Tipton, 2011). No negative health impact has been shown in healthy adults, although further research is warranted to investigate the appropriateness for adolescent population groups.

Fat intakes were ~10-15 $\mathrm{g \cdot day^{-1}}$ below recommendations, based on a 35% contribution of recommended energy intake (COMA, 1991), although not lower than the minimum recommended intake (20% contribution of total energy intake (Potgieter, 2013)), suggesting fat intake appears adequate. Furthermore, intakes were higher than previously reported in collegiate (forwards; 92 ± 25 , backs; 77 ± 31 $g \cdot day^{-1}$) (Imamura, et al., 2013) and older RU players (101 ± 34 $g \cdot day^{-1}$ or 1.1 ± 0.5 $g \cdot kg^{-1} \cdot day^{-1}$) (MacKenzie, et al., 2015).

To date there are no comparative fluid intakes for adolescent rugby players. However, intakes were within recommendations and *ad libitum* intake for adolescent players were likely adequate to maintain fluid balance given losses previously reported in senior RU (Jones, O'Hara, et al., 2015) and RL players (O'Hara et al., 2010).

Novelty

This is the first study to report dietary intake of elite English adolescent rugby players from different age groups and codes. Although there was no difference between codes, U19 players consumed greater energy, protein and fluid intakes and had a better quality diet than U16s.

Practical Application

Adolescent rugby players appear to consume an adequate diet in relation to current recommendations for energy, carbohydrate, protein, fat and fluid. Despite this, players appear to over-consume from the fats and sugars food group. Therefore, practitioners working with adolescent rugby players should provide alternative healthy food options from other food groups to increase the quality of dietary intake, while maintaining current energy, carbohydrate, protein, fat and fluid intakes. Given that players maintained body weight, it could be suggested that adolescent players with a goal to increase lean body mass during pre-season training may need to consume more energy.

Acknowledgements

The study was designed by DRS, BJ and LCD; data were collected and analysed by DS; data interpretation and manuscript preparation were undertaken by DRS, BJ, LCD, LS and RFGJK. All authors approved the final version of the paper. The author would like to thank all of the players and coaching staff involved in this project. This research was part funded by Leeds Rugby as part of the Carnegie Adolescent Rugby Research (CARR) project.

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Figure 1. Dietary intake of elite English academy rugby players in relation to age, body mass and sum of 8 skinfolds.

Figure 2. Reported food group intakes and recommendations of elite English academy rugby players.

Table 1. Participant characteristics of elite English academy rugby players

	Rugby Union		Rugby League	
	U16 (n = 31)	**U19 (n=21)**	**U16 (n=22)**	**U19 (n=13)**
Age (years)	15.8 ± 0.5	18.1 ± 0.8	15.6 ± 0.8	18.0 ± 0.6
Height (m)	1.81 ± 7.3	1.84 ± 7.6	1.75 ± 7.1	1.78 ± 3.2
Pre body mass (kg)	83.7 ± 12.3	91.4 ± 13.4	76.1 ± 9.8	85.2 ± 8.3
Post body mass (kg)	82.8 ± 12.1	90.9 ± 13.3	76.6 ± 9.8	85.1 ± 8.1
Sum of 8 skinfolds (mm)	91.3 ± 29.4	93.6 ± 31.2	76.9 ± 21.3	88.8 ± 27.1

Table 2. Typical training exposure during the 4-day recording period.

	Rugby Union		Rugby League	
	U16 (n = 31)	**U19 (n=21)**	**U16 (n = 31)**	**U19 (n=21)**
Light training days [1]	0-3	1-3	0-2	2
Heavy training days [2]	1	0-2	1	1
Rugby match [3]	0-1	0	0-1	0
Rest day [4]	0-3	1-2	0-2	1

[1] Light day consisted of either one resistance or one rugby training session/other sporting activity, [2] Heavy day consisted of both resistance and rugby training sessions, [3] Rugby match with amateur rugby club, [4] Rest days players did not report any physical activity.

Table 3. Reported and recommended dietary intake of under 16 rugby league and rugby union players.

Dietary intake		Rugby Union Reported (n = 31)	Rugby Union Recommended* (n = 31)	Rugby Union Cohen's *d* (95% CI)	Rugby Union *p* =	Rugby League Reported (n = 22)	Rugby League Recommended* (n = 22)	Rugby League Cohen's *d* (95% CI)	Rugby League *p* =
Energy	($kcal \cdot day^{-1}$)	3269 ± 766	3115 ± 367[3]	-0.3 (-0.8 to 0.2)	0.308	3009 ± 804	2997 ± 269[3]	0.0 (-0.6 to 0.6)	0.947
	($kcal \cdot kg^{-1} \cdot day^{-1}$)	37.9 ± 10.4	39.2 ± 2.2[3]	0.2 (-0.3 to 0.7)	0.449	40.5 ± 11.3	40 ± 1.9[3]	-0.1 (-0.7 to 0.5)	0.834
Protein	($g \cdot day^{-1}$)	155.4 ± 56.4	Low; 109.0 ± 15.6[1]	-1.1 (-1.6 to -0.6)	0.000	144.9 ± 46.1	Low; 98.0 ±12.7[1]	-1.4 (-2.0 to -0.7)	0.000
			High; 151.0 ± 21.6[1]	-0.1 (-0.6 to 0.4)	0.651		High; 135.8 ±17.5[1]	-0.3 (-0.8 to 0.3)	0.348
	($g \cdot kg^{-1} \cdot day^{-1}$)	1.9 ± 0.6	Low; 1.3 ± 0[1]	-1.4 (-2.0 to -0.8)	0.000	1.9 ± 0.6	Low; 1.3 ± 0[1]	-1.4 (-2.0 to -0.7)	0.000
			High; 1.8 ± 0[1]	-0.2 (-0.7 to 0.3)	0.567		High; 1.8 ± 0[1]	-0.2 (-0.8 to 0.4)	0.281
Carbohydrate	($g \cdot day^{-1}$)	392.2 ± 108.2	Low; 251.6 ± 36[1]	-1.7 (-2.3 to -1.1)	0.000	395 ± 107.2	Low; 226.3 ±29.2[1]	-2.1 (-2.8 to -1.4)	0.000
			High; 419.3 ± 60[1]	0.3 (-0.2 to 0.8)	0.229		High; 377.1 ±48.7[1]	-0.2 (-0.8 to 0.4)	0.481
	($g \cdot kg^{-1} \cdot day^{-1}$)	4.8 ± 1.1	Low; 3 ± 0[1]	-2.3 (-2.9 to -1.6)	0.000	5.3 ± 1.6	Low; 3 ± 0[1]	-2.0 (-2.7 to -1.3)	0.000
			High; 5 ± 0[1]	0.2 (-0.3 to 0.7)	0.370		High; 5 ± 0[1]	-0.3 (-0.9 to 0.3)	0.352
Fat	($g \cdot day^{-1}$)	112.3 ± 34.2	127.1 ± 14.2[2]	0.6 (0.1 to 1.1)	0.038	105 ± 31.5	116.6 ±10.4[2]	0.5 (-0.1 to 1.1)	0.104
	($g \cdot kg^{-1} \cdot day^{-1}$)	1.4 ± 0.5	1.5 ± 0.1[2]	0.3 (-0.2 to 0.8)	0.077	1.4 ± 0.4	1.6 ± 0.08[2]	0.7 (0.1 to 1.3)	0.124
Fluid	($ml \cdot day^{-1}$)	3171 ± 918	3269 ± 367[4]	0.1 (-0.4 to 0.6)	0.524	3159 ± 1132	2997 ± 269[4]	-0.2 (-0.8 to 0.4)	0.509
	($ml \cdot kg^{-1} \cdot day^{-1}$)	38 ± 10.3	39.2 ± 2.2[4]	0.2 (-0.3 to 0.7)	0.520	42.3 ± 15.1	40 ± 1.9[4]	-0.2 (-0.8 to 0.4)	0.468

* Recommendations calculated individually and presented as a group mean ± *SD,* [1]Desbrow, et al. (2014), [2] COMA (1991), [3] Schofield (1984), [4] Kleiner (1999), 'low' and 'high' refer to the lower and higher end of the recommended intake range, respectively.

Table 4. Reported and recommended dietary intake of under 19 rugby league and rugby union players.

Dietary intake		Rugby Union: Reported (n = 21)	Rugby Union: Recommended* (n = 21)	Rugby Union: Cohen's *d* (95% CI)	Rugby Union: *p* =	Rugby League: Reported (n = 13)	Rugby League: Recommended* (n = 13)	Rugby League: Cohen's *d* (95% CI)	Rugby League: *p* =
Energy	($kcal \cdot day^{-1}$)	3412 ± 670	3287 ± 342[3]	-0.2 (-0.8 to 0.4)	0.482	3432 ± 714	3239 ± 234[3]	-0.4 (-1.1 to 0.4)	0.348
	($kcal \cdot kg^{-1} \cdot day^{-1}$)	38.2 ± 9.8	36.3 ± 3.3[3]	-0.3 (-0.9 to 0.4)	0.344	40.8 ± 8.6	38.4 ± 2.2[3]	-0.4 (-1.1 to 0.4)	0.336
Protein	($g \cdot day^{-1}$)	210.7 ± 46.7	Low; 118.9 ± 17.2[1]	-2.6 (-3.4 to -1.7)	0.000	189.4 ± 50.1	Low; 110.1 ± 11.1[1]	-2.2 (-3.1 to -1.2)	0.000
			High; 164.6 ± 23.9[1]	-1.2 (-1.9 to -0.6)	0.000		High; 152.4 ± 15.4[1]	-1.0 (-1.8 to -0.2)	0.011
	($g \cdot kg^{-1} \cdot day^{-1}$)	2.3 ± 0.5	Low; 1.3 ± 0[1]	-2.8 (-3.6 to -1.9)	0.000	2.2 ± 0.5	Low; 1.3 ± 0[1]	-2.5 (-3.5 to -1.4)	0.000
			High; 1.8 ± 0[1]	-1.4 (-2.1 to -0.7)	0.000		High; 1.8 ± 0[1]	-1.1 (-1.9 to -0.3)	0.013
Carbohydrate	($g \cdot day^{-1}$	416.2 ± 107.2	Low; 274.3 ± 39.8[1]	-1.8 (-2.4 to -1.0)	0.000	444.1 ± 102.2	Low; 254 ± 25.7[1]	-2.6 (-3.5 to -1.4)	0.000
			High; 457.1 ± 66.3[1]	0.5 (-0.2 to 1.1)	0.159		High; 423.3 ± 42.9[1]	-0.3 (-1.0 to 0.5)	0.518
	($g \cdot kg^{-1} \cdot day^{-1}$)	4.7 ± 1.4	Low; 3 ± 0[1]	-1.7 (-2.4 to -1.0)	0.000	5.3 ± 1.3	Low; 3 ± 0[1]	-2.5 (-3.4 to -1.4)	0.000
			High; 5 ± 0[1]	0.3 (-0.3 to 0.9)	0.256		High; 5 ± 0[1]	-0.3 (-1.1 to 0.5)	0.420
Fat	($g \cdot day^{-1}$)	111.8 ± 34.8	127.9 ± 13.2[2]	0.6 (0.0 to 1.2)	0.074	111.3 ± 25.7	126 ± 9.2[2]	0.8 (-0.1 to 1.5)	0.062
	($g \cdot kg^{-1} \cdot day^{-1}$)	1.3 ± 0.5	1.4 ± 0.1[2]	0.3 (-0.3 to 0.9)	0.156	1.3 ± 0.3	1.5 ± 0.1[2]	0.9 (0.1 to 1.7)	0.069
Fluid	($ml \cdot day^{-1}$)	4105 ± 1482	3287 ± 342[4]	-0.8 (-1.4 to -0.1)	0.026	4079 ± 928	3239 ± 234[4]	-1.2 (-2.0 to -0.4)	0.007
	($ml \cdot kg^{-1} \cdot day^{-1}$)	45.5 ± 16.7	36.3 ± 3.3[4]	-0.8 (-1.4 to -0.1)	0.024	48.4 ± 11.2	38.4 ± 2.2[4]	-1.2 (-2.0 to -0.4)	0.007

* Recommendations calculated individually and presented as a group mean ± *SD,* [1]Desbrow, et al. (2014), [2] COMA (1991), [3] Schofield (1984), [4] Kleiner (1999) , 'low' and 'high' refer to the lower and higher end of the recommended intake range, respectively.