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Original research

Player's success prediction in rugby union: From youth performance to senior level placing

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ABSTRACT

Objectives: The study questioned if and to what extent specific anthropometric and functional characteristics measured in youth draft camps, can accurately predict subsequent career progression in rugby union.
Design: Original research.
Methods: Anthropometric and functional characteristics of 531 male players (U16) were retrospectively analysed in relation to senior level team representation at age 21–24. Players were classified as International (Int: National team and international clubs) or National (Nat: 1st, 2nd and other divisions and dropout). Multivariate analysis of variance (one-way MANOVA) tested differences between Int and Nat, along a combination of anthropometric (body mass, height, body fat, fat-free mass) and functional variables (SJ, CMJ, t_{15m}, t_{30m}, VO_{2max}). A discriminant function (DF) was determined to predict group assignment based on the linear combination of variables that best discriminate groups. Correct level assignment was expressed as % hit rate.
Results: A combination of anthropometric and functional characteristics reflects future level assignment (Int *vs.* Nat). Players' success can be accurately predicted (hit rate = 81% and 77% for Int and Nat respectively) by a DF that combines anthropometric and functional variables as measured at ~15 years of age, percent body fat and speed being the most influential predictors of group stratification.
Conclusions: Within a group of 15 year-olds with exceptional physical characteristics, future players' success can be predicted using a linear combination of anthropometric and functional variables, among which a lower percent body fat and higher speed over a 15 m sprint provide the most important predictors of the highest career success.

1. Introduction

Rugby union (rugby) is a field-based team sport characterized by a combination of dynamic efforts and physical contacts.[1–3] Players are grouped in two distinct units, Forwards (FW) and Backs (BK) and in specific positional roles within each unit.[4,5] Within each role a specific combination of tasks such as pass, sprint, tackle, ruck, maul and scrum is required.[4]

Rugby players are characterized by a specific functional-profile as for aerobic power,[1,6] speed,[1] strength and agility,[7] and by a unique and level-dependent anthropometric-profile in terms of height, body mass, body fat and fat-free mass.[5] In addition, players are required to develop a wide range of general and role-specific technical and tactical skills.[8]

To meet the high and specific anthropometric, functional and technical-tactical requirements of the sport customised recruitment based on early and effective talent identification is a crucial element of a successful athlete's development process in this team sport.[8,9]

Identification models based on physical assessments of players at the junior stage have demonstrated some predictive capabilities in rugby league.[10–12] In addition, positive relationships between anthropometric and performance tests, conducted at junior draft camps, with subsequent player's career progression have been reported for different team sports (*i.e.* Football, Soccer, Basketball).[13–15] In rugby, players' morphology has been considered an important, or even the most relevant predictor of competitive success.[16] As a consequence, taller and heavier athletes have been progressively recruited, toward 'super-sized' young

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players.[8,17] Yet, in rugby, a specific and direct relationship between selection procedures at junior level and players' career progression has never been investigated and no published evidence strongly links test results with indexes of the athlete's success.

In Italy, the Italian Rugby Federation (FIR) regularly conducts national youth draft camps during which anthropometric and functional tests are performed for athletes in the U16 age category, with the aim of identifying players with the necessary morphological and functional attributes and potential for success in rugby. These events provide the primary pathway for talent identification and player recruitment. Yet, as described also in other contests, selection practices seem to be based on historical dogmas rather than on the use of identification models prevalent within the recent literature.[10,12] In addition, a verification of the effectiveness of the selection process is missing.

The availability of a specific database and of assignment prediction models would offer to the rugby community an objective, quantitative and continuously updated reference for the evaluation of prospective junior rugby players.

Base on the above considerations, the main purposes of this study were:

- to provide reference data on anthropometric and functional characteristics of youth Italian rugby players;
- to determine if and to what extent the results of anthropometric and functional tests, conducted during draft camps in youth players, are related to subsequent career progression;
- to develop and to test the performance of a mathematical model to predict future players assignment based on a combination of anthropometric variables and functional characteristics measured at junior level.

2. Methods

Anthropometrics and functional testing results collected during National draft camps for male players in the under sixteen (U16) age category, conducted by the Italian Rugby Federation (FIR) in collaboration with the University of Verona (Italy) between 2006 and 2009 inclusive, were retrospectively analysed in relation to senior level placing, as determined from FIR official records at age 22–24 (*i.e.* in the 2014–2015 competitive season).

For all National camps a standardised testing battery was applied to groups of 20–40 athletes tested simultaneously by a single team of trained researches, using the same equipment. The testing day started at 9.00 a.m. with the anthropometric tests followed by the functional tests; the whole battery was completed within three hours.

A total of 531 junior male players (15.2 ± 0.6 years) participated in this study. Parental or guardian approval was obtained for all players and the Ethics committee of the Department approved the study in accordance with the Declaration of Helsinki.

In preparation for draft camps, the players were requested to refrain from strenuous exercise in the previous 48 hours and to consume a light breakfast on the testing day. The player's age and playing experience (*i.e.* number of years since the first enrolment) were recorded based on official FIR records.

Body mass (digital scale, Seca 877, Seca, Leicester, UK) and height (vertical stadiometer, Seca, Leicester, UK) were determined to the nearest 0.1 kg and 0.5 cm. Skin folds thickness was measured, in triplicate, by a single skilled investigator at pectoral, scapular, triceps, iliac, abdominal and thigh site (Holtain T/W skinfold caliper, Holtain limited, UK). An average value was calculated for each skin fold and percent body fat was estimated[5,18]:

$$\text{percent body fat} = (0.22 \times (\text{SS})) - 0.00029 \times (\text{SS}^2 + (0.133 \times \text{age})) - 5.73$$

where SS is the sum of the skin folds in mm.

Fat-free mass (FFM) was calculated as:

$$\text{FFM} = \text{body mass} - (\text{body mass} \times \text{percent body fat})$$

A standardized 10-min warm-up consisting of light running and dynamic mobility preceded the beginning of the testing session,[19] while 10-min recovery periods separated jump and sprint tests (performed in random order).

Lower leg muscular power was assessed by Squat Jump (SJ) and Counter Movement Jump (CMJ), using an optical measurement system (Opto-jump, Microgate, IT).[20] The players performed three trials for every test (each separated by 2-min recovery) and the best result was considered for analysis.

Three repetitions of 30-m sprints were performed (each separated by 2-min recovery) and the best result was considered for all the subsequent analysis. Speed was evaluated by 15 (t_{15m}) and 30 (t_{30m}) meter sprint times,[21] using electronic timing gates (Racetime2, Microgate, IT). On command the players sprinted as fast as possible from a standing start along the 30 m distance. Sprint time was measured to the nearest 0.01 s.

Maximal aerobic power (VO_{2max}) was estimated using a multi stage fitness test[22] and the Ramsbottom equation.[23]

Success was defined based on the highest playing level reached by individual athletes in the early years of their career as senior players (*i.e.* age between 22 and 24 inclusive), as determined from FIR official records in the 2014–2015 competitive season.

Players were classified in categories as follows:

- International (Int), players who were drafted by International-level teams (*i.e.* IT: National team and Pro 12 teams, FR: Top 14 clubs; UK: premiership teams);
- First Division (1st D), Elite "Excellence" Italian Rugby teams;
- Second Division (2nd D), "Serie-A" Italian rugby teams;
- Other (O), lower level Italian clubs (*i.e.* "Serie-B" and lower Italian rugby teams);
- Drop-out (DO), no longer enrolled by FIR at the investigated time window;

A further categorization was introduced in order to differentiate the International level players (*i.e.* "Int" group) from the National level players (*i.e.* "Nat" group including 1st D, 2nd D, O, DO categories merged together).

Frequency data (n, %) and descriptive statistics ($M \pm SD$ and 95% confidence interval (CI)) were calculated for categories (*i.e.* Int, 1st D, 2nd D, O, DO) and for groups (*i.e.* Int, Nat).

Normality plots and Bivariate Overlap Zone analysis (BOZ),[5,24] were used to describe the differences between the mean body mass and height of a reference population of 15-year-old Italian young men,[25] and those of the junior rugby players recruited for FIR draft camps and included in the current study.

After assumptions verification, two multivariate analysis of variance (One-way MANOVAs) were performed in order to test whether groups (*i.e.* Int, Nat) and categories (*i.e.* Int, 1st D, 2nd D, O, DO) differed along a simultaneous combination of anthropometric variables (body mass, height, body fat and FFM) and functional variables (SJ, CMJ, t_{15m}, t_{30m} and VO_{2max}).[26] MANOVAs were subsequently followed-up by: (i) independent-samples *t*-tests (Int *vs.* Nat); (ii) analysis of variance (ANOVA) and planned contrasts (inter-category difference).[27]

Thereafter, a discriminant analysis (DA) was performed to determine the linear combination of the measured variables (DVs) and the corresponding discriminant coefficients (as in a

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