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1 Running head: Selection in UK Junior Rugby League

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5 Using Anthropometric and Performance Characteristics to Predict Selection in Junior UK

6 Rugby League Players

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9 Kevin Till^a, Steve Copley^a, John O’Hara^a, Amy Brightmore^a, Carlton Cooke^a and Chris

10 Chapman^b

11

Abstract

1
2 *Objectives.* Research examining the factors influencing selection within talented junior
3 Rugby League players is limited. The aims of this study were firstly to determine whether
4 differences existed for anthropometric and performance characteristics between regional and
5 national selection in high performance UK junior Rugby League players, and secondly to
6 identify variables that discriminated between these selection levels. *Method.* Regional
7 representative (n=1,172) selected junior players (aged 13-16 years) undertook an
8 anthropometric and fitness testing battery with players split according to selection level (i.e.,
9 national, regional). *Results.* MANCOVA analyses, with age and maturation controlled,
10 identified national players as having lower sum of 4 skinfolds scores compared to regional
11 players, and also performed significantly better on all physical tests. Stepwise discriminant
12 analysis identified that estimated maximum oxygen uptake ($\dot{V}O_{2max}$), chronological age, body
13 mass, 20m sprint, height, sum of 4 skinfolds and sitting height discriminated between
14 selection levels, accounting for 28.7% of the variance. This discriminant analysis
15 corresponded to an overall predictive accuracy of 63.3% for all players. *Conclusions.* These
16 results indicate that performance characteristics differed between selection levels in junior
17 Rugby League players. However, the small magnitude of difference between selection levels
18 suggests that physical qualities only partially explain higher representative selection. The
19 monitoring and evaluation of such variables, alongside game related performance
20 characteristics, provides greater knowledge and understanding about the processes and
21 consequences of selection, training and performance in youth sport.

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Key Words: Talent; Maturation; Identification; Homogenous

1 Introduction

2 Rugby League is a collision sport played at junior and senior levels around the world
3 with game popularity most established in Great Britain, France, Australia and New Zealand^{1,2}.
4 The game involves frequent periods of high-intensity activities (e.g. tackling, ball carrying)
5 separated by bouts of low intensity activity (e.g. jogging; ^{3,4}). Due to the physically
6 demanding nature of the game, players are required to have highly developed physiological
7 capacities of muscular strength, power, speed, agility and aerobic power ^{2,5,6}.

8 In the UK, the Rugby Football League (RFL) used a player performance pathway for
9 the selection of high performance junior players (See Till et al., ⁷ for a more detailed
10 description of the pathway). The major purpose of the pathway was to assist in the
11 development of the most talented junior players with regional and national representative
12 selection key components of this development model. Regional selection (i.e., County
13 standard – Yorkshire, North-West, Cumbria in the UK) resulted in 100 players being selected
14 at under 13, 14 and 15 annual-age categories each year in which players attended a week long
15 training camp to undertake specialised coaching and training. Following performances at
16 regional level, players were then selected for national level (n=40 at Under 13s; n=24 at under
17 14 and 15 each year) where they received further support and development from the RFL.
18 Therefore, the RFL identified 100 talented players at each annual-age group each year to
19 regional level with the best of this group of players selected to respective national squads.

20 Previous research in junior Rugby League players ^{3,8-11} has shown that anthropometric
21 and physiological characteristics increase and develop across annual-age groups and playing
22 level. For instance, Gabbett ⁸ showed improved capacities as age increased from under 13 to
23 senior aged players, while further studies ^{10,11} found body mass, vertical jump, speed, agility
24 and estimated aerobic power to differentiate between elite (Australian National Rugby League
25 club development program) and sub-elite (club standard) juniors. Recent research in other

1 youth sports contexts, such as field hockey¹² and volleyball¹³ has begun to assess whether
2 anthropometric, physiological and skill data also discriminate between junior players within a
3 similar age and stage of development. For example, in volleyball¹³, no differences in
4 anthropometric and physiological characteristics were found between selected (n=19) and
5 non-selected (n=9) players to a Queensland Academy of Sport Talent Search Program.
6 Instead results found that passing accuracy, passing technique and spiking technique were the
7 discriminating factors. However, in junior handball players¹⁴, findings identified that body
8 mass, arm length, standing long jump, vertical jump and shuttle speed were able to distinguish
9 between elite and non-elite players.

10 Unlike heterogeneous samples (i.e., different ages, stages of development and skill
11 levels) where anthropometric and physiological differences may be more striking, it is
12 difficult based on research to date, to consistently assume which variables are able to
13 discriminate between more homogenous (i.e., similar age and skill levels) samples in a given
14 sport context. Although studies have compared characteristics across age-categories and skill
15 levels in youth sport, no study has directly examined how anthropometric and performance
16 characteristics contribute to regional or national selection within a developmental and
17 representative group of junior Rugby League players. Thus using a large sample with data
18 collected over a number of years from the RFL player performance pathway, the initial
19 purpose of this study was to determine if differences existed for anthropometric and
20 performance characteristics between regional and nationally selected players, whilst
21 controlling for chronological age and maturation. The secondary purpose was to identify
22 potential variables which discriminated between the selection levels and were able predict the
23 likelihood of being a national compared to regional representative junior player.

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Methods

1 *Participants:* A total of 1,172 regional representative selected junior rugby league
2 players participated in the study. The data were separated by selection level (regional n=870;
3 national n= 302) and by annual-age category (Under 13 regional n=255, national n=130;
4 Under 14 regional n=309, national n=86; Under 15 regional n=306, national n=86). All
5 players undertook an anthropometric and fitness assessment, in which all protocols received
6 institutional ethics approval with parental and/or guardian consent provided.

7 *Procedures:* Fitness testing results from the 2005 to 2008 RFL's Regional
8 representative squads were collected in July each year. All assessments were carried out by
9 Leeds Metropolitan Sport Science Support Team, however all tests were decided by the RFL.
10 Standard anthropometry (height, sitting height, body mass, sum of 4 skinfolds), maturation
11 (age at peak height velocity; PHV) and performance characteristics (lower and upper body
12 power, speed, agility, estimated maximum oxygen uptake) were collected for each participant
13 during the regional camp.

14 *Anthropometry:* Height and sitting height were measured using a Seca Alpha stand, to
15 the nearest 0.1cm. Body mass, was measured using calibrated Seca alpha (model 770) scales,
16 to the nearest 0.1kg. The sum of four skinfold thickness was determined using calibrated
17 Harpenden skinfold callipers (British Indicators, UK) with procedures in accordance with
18 Hawes and Martin ^[15]. Intraclass correlation coefficients and typical error measurements for
19 reliability of skinfold measurements were $r=0.954$ ($p<0.001$) and 3.2% respectively,
20 indicating acceptable reliability based on established criteria (i.e., $> .80$; ¹⁶).

21 *Maturation (Age at PHV):* To measure maturity status, an age at PHV prediction
22 equation was used ¹⁷. The 95% confidence interval associated with this equation for boys is
23 ± 1.18 years ¹⁷. Years from PHV was calculated by subtracting age at PHV from chronological
24 age.

1 *Performance Characteristics:* To assess lower body power a vertical jump was
2 measured using a Takei vertical jump metre (Takei Scientific Instruments Co. Ltd, Japan). A
3 countermovement jump with hands positioned on hips was used, with jump height measured
4 to the nearest cm. The vertical jump score was the highest value recorded during three trials
5 ¹⁸. The intraclass correlation coefficient and typical error measurement for the vertical jump
6 was $r=0.903$ ($p<0.001$) and 2.9%, respectively.

7 The 2kg medicine ball (Max Grip, China) chest throw was used to measure upper
8 body power ¹⁹. Participants were seated with their backs against a wall and were instructed to
9 throw the ball horizontally as far as possible. Distance was measured to the nearest 0.1cm
10 from the wall to where the ball landed with the furthest of three trials used as the score. The
11 intraclass correlation coefficient and typical error measurement for the medicine ball chest
12 throw was $r=0.965$ ($p<0.001$) and 0.6%, respectively.

13 Running speed was assessed over 10m, 20m, 30m and 60m using timing gates
14 (Brower Timing Systems, IR Emit, USA). Times were recorded to the nearest 0.01s, with the
15 shortest time recorded during 3 trials used for the sprint measurement. Intraclass correlation
16 coefficients and typical error measurements of the 10m, 20m, 30m and 60m sprints were
17 $r=0.788$ ($p<0.001$), $r=0.852$ ($p<0.001$), $r=0.899$ ($p<0.001$) and $r=0.924$ ($p<0.001$), and 8.4%,
18 4.5%, 3.3% and 2.3% respectively.

19 Change of direction speed was assessed using the agility 505 test ²⁰. Participants were
20 positioned 15m from a turning point with timing gates positioned 10m from the start point.
21 Players accelerated from the starting point, through the timing gates, turned on the 15m line
22 and ran as quickly as possible back through the gates ¹⁰. Three attempts were performed on
23 each foot with times recorded to the nearest 0.01s. Intraclass correlation coefficients and
24 typical error measurements for the agility 505 left and right were $r=0.823$ and $r=0.844$
25 ($p<0.001$), and 3.5% and 3.1% respectively.

1 Maximal oxygen uptake ($\dot{V}O_{2\max}$) was estimated using the multistage fitness test²¹.
2 Keeping in time with a series of beeps, on a pre-recorded multistage fitness test compact disc,
3 players were required to shuttle run 20m. Player's running speed (i.e. frequency of the beeps)
4 increased progressively until they reached volitional exhaustion. Regression equations were
5 used to estimate maximal oxygen uptake from the level reached during the multistage fitness
6 test²¹. Intraclass correlation coefficients and typical error measurements for the multistage
7 fitness test were 0.90 and 3.1%¹¹.

8 *Data Analysis:* Mean and standard deviation (SD) scores were calculated for all
9 dependant variables with selection level acting as the independent variable. A multivariate
10 analysis of covariance (MANCOVA) test was applied with selection level (regional vs
11 national) as the fixed factor. Chronological age and maturity (Years from PHV) were entered
12 as covariates to adjust for variations in age and maturation status. Partial eta squared effect
13 sizes (η^2) were also calculated. For identifying discriminating variables between regional and
14 national players, a stepwise discriminant analysis was applied with selection level used as the
15 discrete outcome variable. SPSS version 15.0 was used for all analysis with significance set as
16 $p < 0.05$.

17

18 Results

19 *Regional & National Characteristics:* Table 1 presents the mean and SD of the
20 anthropometric and performance measures across selection levels (i.e. regional and national).
21 Results identified that chronological age had a confounding effect on all measures whilst
22 maturation had a significant effect on all variables except vertical jump and 60m sprint.
23 MANCOVA analyses between selection levels for all players revealed that national players
24 significantly outperformed regional players for sum of skinfolds, vertical jump, medicine ball
25 chest throw, 10m, 20m, 30m, 60m sprint, agility 505 left and right and estimated $\dot{V}O_{2\max}$.

1 *Insert Table 1 near here*

2 *Annual-age categories:* Table 2 presents the means and standard deviations of
3 characteristics across selection level by annual-age category (i.e. under 13s, 14s, 15s).
4 MANCOVA analyses identified national player's outperformed Regional players at under 13
5 for sum of four skinfolds and all performance characteristics except agility 505 right. At the
6 under 14 age category national players outperformed regional players on all performance
7 characteristics, however at the under 15s age category a significant difference was only
8 identified for the vertical jump performance. Therefore regional and national under 15 players
9 were similar for anthropometric and all but one physical characteristic.

10 *Insert Table 2 near here*

11 *Predictors of National Selection:* The stepwise discriminant analysis predicted that a
12 combination of seven variables would successfully discriminate between regional and
13 national players. The variables (in order) were estimated $\dot{V}O_{2\max}$ (0.980), chronological age
14 (0.966), body mass (0.953), 20m sprint (0.939), height (0.934), sum of 4 skinfolds (0.923) and
15 sitting height (0.917). The average squared canonical correlation was 0.287, showing that
16 these seven variables, accounted for 28.7% of the overall variance in the data set. Cross-
17 validation results were calculated to identify correct classification of Regional and National
18 players based on the discriminant analysis. The discriminant analysis corresponded to an
19 overall predictive accuracy of 63.3% for all players with an accuracy of 62.6% and 65.1% for
20 Regional and National players respectively.

21

22 Discussion

23 The aims of the present study were to firstly determine if anthropometric and physical
24 performance differences existed (whilst controlling for chronological age and maturational
25 status) between regional and national selected UK junior Rugby League players. The second

1 purpose was to identify potential variables which discriminated between the selection levels,
2 and were able to predict the likelihood of being a national compared to regional representative
3 junior player. To meet these purposes, a large relatively homogenous sample of high
4 performance junior players was utilised. The study differs from previous research in Rugby
5 League^{8,10,11} and other sports contexts¹⁴ where skill level comparisons have only been made
6 between more heterogeneous groups of elite and non-elite players. Likewise, the study adds to
7 present understanding by examining data obtained over four years of implementing a national
8 governing body's talent identification and development pathway (i.e. RFL player performance
9 pathway). Present findings demonstrated a significant main effect for chronological age,
10 maturational status and selection level with both anthropometric and physical performance
11 differences found between selection levels.

12 Findings suggest that biological growth and physical performance qualities contribute
13 toward national selection level in UK junior Rugby League, even though the testing battery
14 was not used as a basis for selection. Chronological age and maturational status (years from
15 PHV), entered in the analyses as covariates to adjust for age and maturational variation, were
16 consistent and strong influences upon dependent variables. Effect sizes identified strong
17 relationships between chronological age and maturation with anthropometric characteristics
18 (e.g. sitting height, body mass). These outcomes were expected as they are used in the
19 prediction of age at PHV¹⁷. Effect sizes between covariates and physical performance
20 measures were relatively smaller, with results consistent with the view that maturation is more
21 strongly related to anthropometric than performance measures^{14, 22} during periods of growth
22 and development (i.e., puberty).

23 For anthropometric variables, the sum of four skinfolds produced a significant
24 difference between selection levels, which differs from comparisons of body fat, when
25 comparing elite and sub-elite Australian junior players¹¹ where no differences were found.

1 No differences were found for body mass in the current sample, which is consistent with
2 Gabbett et al.¹¹, however, contrasts with Gabbett and Herzig's¹⁰ whom identified significant
3 differences in body mass. Research in field hockey¹² and volleyball¹³ found no significant
4 differences in anthropometric characteristics, with both studies examining a homogenous
5 (junior elite v sub-elite) sample. In contrast, Mohamed and colleagues¹⁴ did find significant
6 differences in body mass, arm length, arm span and arm circumference in their elite and non-
7 elite under 16 handball players, potentially highlighting the impact of sport demand, position
8 and contextual variables upon the dependent variables in such studies.

9 For physical performance variables, national players outperformed regional players on
10 all measures when controlling for chronological and maturational age. One possible
11 explanation for the greater physical qualities amongst national players could be the significant
12 difference in sum of four skinfolds. Previous research^[23] has identified a negative
13 relationship between body fat and performance (e.g. vertical jump) with possible reasons due
14 to a reduction in power to body mass ratio⁴ and an increase in thermoregulation demands².
15 Assuming all other things are equal, the increased body fat of regional players could have led
16 to a decrease in vertical jump, speed, change of direction speed and estimated $\dot{V}O_{2\max}$; thereby
17 impacting the level of discrimination between regional and national levels.

18 Current findings for performance measures are consistent with previous findings^{10,11}
19 with advanced physical performance characteristics contributing toward the likelihood of
20 national selection. However, although differences were evident, the magnitude of differences
21 between regional and national level in the current sample were small, when assessed against
22 differences between the Australian junior players (e.g., effect sizes for $\dot{V}O_{2\max}$ was $\eta^2=0.04$ in
23 the present analysis). A more descriptive example of this is the 0.02s difference in 10m sprint
24 time between regional and national players in the current sample compared to 0.13s¹¹ and
25 0.34s¹⁰ between playing levels in other studies. These data support the assertion that

1 comparisons between groups that are substantially different in performance and/or skill level
2 can be problematic, as they overstate the importance of physical qualities toward playing
3 success²⁴. The current sample of junior Rugby League players, who were all selected based
4 on a broader basis of overall Rugby League performance, provides a more refined evaluation
5 and discrimination between high performance playing levels than has been presented
6 previously. The findings from this study identify that although physical qualities underpin
7 playing success in Rugby League, the small differences in performance characteristics
8 between regional and national players reported here, suggest that physical attributes combined
9 with technical skills and tactical knowledge are all important for player selection at national
10 junior level.

11 In similar research studies^{12,13}, where talented youngsters have been examined,
12 technical characteristics (e.g. passing technique and accuracy in volleyball;¹³) have been
13 shown to discriminate between selection levels. The lack of such assessments on technical
14 and tactical skills amongst the current sample is a limitation of the present study. Although
15 the current study only provides anthropometric and physical performance characteristics,
16 coaches in the RFL pathway did provide an overall player evaluation, including attributes
17 related to technical, tactical and attitude, which were measured subjectively. These may be
18 useful indices in future studies.

19 The stepwise discriminant analysis determined that seven variables distinguished
20 between regional and national players. These included (in order): estimated $\dot{V}O_{2\max}$,
21 chronological age, body mass, 20m sprint, height, sum of 4 skinfolds and sitting height,
22 accounting for 28.7% of the overall variance. This means that seven anthropometric and
23 physical performance measures accounted for 28.7% of those selected, with the remaining
24 71.3% likely to be made up from other variables associated with Rugby League performance
25 (e.g. technical, tactical, psychological, etc.). Five of the seven variables were associated with

1 age and anthropometric characteristics, demonstrating that in high performance junior groups,
2 selection is affected and biased by particular factors and processes previously identified (e.g.,
3 relative age effects, ^{7,23}).

4 Conclusion

5 In summary, the present study examined differences in anthropometric and
6 performance measures within a relatively homogenous high performing group of junior
7 Rugby League players. Findings identified that national players outperformed their regionally
8 selected counterparts on performance measures. However, due to the small magnitude in these
9 differences, physical attributes may only partially contribute toward national selection in
10 junior Rugby League. Instead, it seems more appropriate to consider a combination of
11 physical, technical, tactical and psychological variables as more able to identify high
12 performing players for a given context and stage of development. Thus, in talent identification
13 research, it is important that future studies consider carefully, the sport context, age and skill
14 level of participants, as well as the nature of referent groups used for comparison.

16 Practical Implications

- 17 • Junior Rugby League coaches should consider chronological age and maturational
18 status in player assessments.
- 19 • Junior coaches should highlight the importance of low body fat to physical
20 performance.
- 21 • Player selection should consider physical, technical, tactical and psychological
22 variables.
- 23 • The sport context, participant characteristics (e.g. age, skill level) and levels of
24 comparison should be considered when examining selection within junior sport.

25

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4

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Table 1. Selection Level (regional v national) characteristics of UK junior Rugby League players.

			Covariates			η^2
	Regional	National	Age	Years PHV	MANCOVA	
Age (years)	14.62 ± 0.84	14.47 ± 0.84				
Age at PHV (years)	13.64 ± 0.58	13.54 ± 0.54				
Years from PHV	0.98 ± 0.95	0.93 ± 0.90				
Height (cm)	174.4 ± 7.8	174.4 ± 7.4	***	**		
Body Mass (kg)	69.7 ± 12.3	69.8 ± 10.9	***	**		
Sum of skinfolds (mm)	40.0 ± 16.3	36.6 ± 13.1	***	**	***	0.01
Vertical Jump (cm)	40.4 ± 5.5	41.3 ± 5.3	***		***	0.01
MB Chest Throw (m)	5.8 ± 0.8	5.9 ± 0.8	*	*	*	0.01
10m (seconds)	1.90 ± 0.12	1.88 ± 0.12	***	**	***	0.02
20m (seconds)	3.27 ± 0.19	3.23 ± 0.16	***	**	***	0.03
30m (seconds)	4.57 ± 0.26	4.52 ± 0.24	***	*	***	0.03
60m (seconds)	8.49 ± 0.55	8.37 ± 0.49	***		***	0.03
Agility 505 L (s)	2.51 ± 0.15	2.49 ± 0.14	***	***	***	0.01
Agility 505 R (s)	2.53 ± 0.15	2.51 ± 0.14	***	**	**	0.01
$\dot{V}O_{2max}$ (ml.kg ⁻¹ .min ⁻¹)	48.7 ± 5.2	50.3 ± 3.8	***	***	***	0.04

* $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$.

Table 2. Selection level and age category characteristics of UK junior Rugby League players.

	Under 13s			Under 14s			Under 15s		
	Regional	National	η^2	Regional	National	η^2	Regional	National	η^2
Age (years)	13.57±0.27	13.65±0.22		14.58±0.26	14.61±0.25		15.56±0.29	15.57±0.27	
Age at PHV (years)	13.58±0.68	13.44±0.51		13.59±0.55	13.53±0.52		13.75±0.53	13.68±0.57	
Years from PHV	-0.01±0.69	0.21±0.55		0.99±0.57	1.07±0.59		1.81±0.58	1.88±0.58	
Height (cm)	169.6±8.4	171.0±7.1		175.0±6.5	175.3±6.5		177.8±6.3	178.3±6.4	
Body Mass (kg)	62.4±11.4	63.7±9.0		70.2±10.8	71.1±9.3		75.8±10.9	77.6±9.7	
Sum of skinfolds (mm)	38.6±16.4	34.9±12.3**	0.03	40.1±17.1	35.8±12.2		41.1±15.8	39.9±14.5	
Vertical Jump (cm)	38.2±5.1	39.6±5.0*	0.02	40.3±5.3	41.9±5.1*	0.01	42.5±5.4	43.5±5.0*	0.02
MB Chest Throw (m)	5.1±0.7	5.4±0.6*	0.01	5.8±0.7	6.0±0.5*	0.02	6.4±0.7	6.5±0.6	
10m (seconds)	1.95±0.12	1.91±0.12**	0.03	1.91±0.09	1.87±0.10***	0.03	1.86±0.14	1.85±0.14	
20m (seconds)	3.38±0.20	3.29±0.14***	0.04	3.29±0.25	3.21±0.15***	0.04	3.19±0.17	3.17±0.17	
30m (seconds)	4.75±0.26	4.61±0.22***	0.05	4.58±0.22	4.50±0.21**	0.02	4.43±0.22	4.40±0.23	
60m (seconds)	8.89±0.56	8.59±0.47***	0.05	8.49±0.46	8.32±0.44**	0.02	8.17±0.41	8.10±0.43	
Agility 505 L (s)	2.59±0.14	2.55±0.13*	0.01	2.49±0.14	2.44±0.12***	0.04	2.46±0.14	2.45±0.16	
Agility 505 R (s)	2.61±0.14	2.57±0.14		2.51±0.15	2.46±0.11**	0.02	2.48±0.13	2.47±0.14	
$\dot{V}O_{2\max}$ (ml.kg ⁻¹ .min ⁻¹)	46.35±4.66	49.46±3.74***	0.11	48.7±5.3	50.9±3.9**	0.03	50.6±4.8	51.1±3.6	

* $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$.