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PHYSIOLOGICAL CHARACTERISTICS OF STRENGTH COMPONENT OF SPECIAL ENDURANCE IN RUGBY PLAYERS

N.Yu. Tarabrina[1]*, nata-tarabrina@mail.ru, https://orcid.org/0000-0003-1469-5010*
T. Wilczewski[2]*, akademiaeps@gmail.com, https://orcid.org/0000-0002-8575-3751*
[1]*Moscow Aviation Institute (National Research University), Moscow, Russia*
[2]*Academy of Physical Education in Katowice, Katowice, Poland*

Abstract. **Aim.** The purpose of the work was to identify the strength and special endurance of rugby players depending on their position. **Materials and methods.** In 2018–2019, the study involved 20 rugby players aged from 19 to 23 years. All athletes were divided into two functional groups of 10 people each (first group –forwards; second group – defenders). In both groups, special endurance and muscle strength were measured. **Results.** It was found that the strength measurements of the upper and lower extremities in the first group significantly exceeded the same parameter of the second group (14.7–31.03 %) ($p < 0.05$–0.01). However, the integral indicator of relative strength was 19.29 % ($p < 0.05$) lower. In the second group, physical performance measured by maximum oxygen consumption (VO2Max) was 18.89% ($p < 0,01$) lower than that of the first group. **Conclusion.** The results obtained provide the data about the anthropometric and strength parameters of college rugby players and can be used as reference values during athletic selection.

Keywords: rugby, strength, special endurance, forwards, defenders

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ФИЗИОЛОГИЧЕСКАЯ ХАРАКТЕРИСТИКА СИЛОВОГО КОМПОНЕНТА СПЕЦИАЛЬНОЙ ВЫНОСЛИВОСТИ РЕГБИСТОВ

Н.Ю. Тарабрина[1]*, nata-tarabrina@mail.ru, https://orcid.org/0000-0003-1469-5010*
Т. Вильчевски[2]*, akademiaeps@gmail.com, https://orcid.org/0000-0002-8575-3751*
[1]*Московский авиационный институт (национальный исследовательский университет), Москва, Россия*
[2]*Академия физического воспитания имени Ежи Кукучки в Катовице, Катовице, Польша*

Аннотация. **Цель:** изучение уровня развития силовых способностей и специальной выносливости регбистов различных игровых амплуа. **Материалы и методы.** В 2018–2019 гг. было обследовано 20 регбистов 19–23 лет, которые были разделены на две функциональные группы: первая группа состояла из 10 человек (игровое амплуа – «нападающие»), вторая группа состояла из 10 человек – «защитников». В обеих группах изучались специальная выносливость и интегральный показатель мышечной силы. **Результаты.** Показано, что показатели силы верхних и нижних конечностей игроков первой группы значительно превышают показатели игроков второй группы (14,7–31,03 %) ($p < 0,05$–$0,01$), однако интегральный показатель относительной силы на 19,29 % ($p < 0,05$) ниже. Физическая работоспособность по параметру максимального потребления кислорода (VO2max)

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у защитников на 18,89 % ($p < 0,01$) ниже, чем у нападающих. **Вывод.** Результаты этого исследования предоставляют описательную информацию об антропометрических и силовых показателях регбистов уровня колледжа, предлагая потенциальные стандарты, которые тренеры могут использовать при отборе спортивных игроков.

Ключевые слова: регби, сила, специальная выносливость, нападающие, защитники

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Introduction

The study of physiological mechanisms of control over the functional state of athletes in the conditions of training and competitive activity is an urgent interdisciplinary problem in the field of sports theory, sports pedagogy, physiology and medicine [17].

The requirements in modern rugby lead to an increase in the load on the body of athletes, which often leads to a shift in homeostatic constants to the upper biological boundaries and extreme performance of regulatory systems [17, 18].

The motor activity of a rugby player is characterized by frequent high-intensity sprint movements, accelerations, scramming, linear exits and contractions realized during strenuous work of variable power: alternating aerobic activity with a lower intensity (for example, walking and/or jogging). All this requires a high level of development of the basic qualities of a rugby player: strength and endurance, the upbringing and improvement of which must be carried out, taking into account the functions performed by rugby players in the game, since the nature of the competitive activity of the offensive line players is significantly different from the playing activity of the defensive line players [8].

A number of researchers have shown that forwards spend more time in snatches, fights and high-intensity static loads, compared to defenders and they are taller and heavier athletes [4, 10]. In particular, it was shown that forwards spend 46,2 % of their time on "jogging" [2] and in comparison with defenders, forwards spend more time at a lower speed (6–12 km/h) and make more contact forwards (+60 % more than defenders) [5]. Meanwhile, defenders, receiving the ball from forwards, move away from rucks, mauls and scrums, dodge the opponent and move the ball down the field to create scoring chances [4]. Defenders, as a rule, have lower height and weight parameters with high speed capabilities [6, 10]. In the works of Cunniffe B., et al. it was shown that regardless of the playing position, the majority of moderate and intense accelerations in rugby were observed in 4–6 second intervals, while the overall ratio of work and rest is 1:5,7 [5]. In particular, defenders are faster at short distances [1], cover long distances per game, and the share of the sprint is 35,4% higher than the share of forwards [15]. Da Cruz-Ferreira and Fontes Ribeiro showed that defenders have greater aerobic endurance [4] and they also go at high speeds (> 20 km/h) almost twice as often as forwards [5]. Despite significant speed differences among players of different playing positions [15], additional parameters such as anthropometry and strength indicators can help to explain these discrepancies. Current evidence suggests that rugby players generally perform from 80 to 95 % of HRmax, with the largest relative share being spent within 80–90 % of HRmax for defenders (42,2 % of playing time) and within 90–95 % of HRmax for forwards (35,7 % of playing time) [10].

The **purpose** of the paper is to study the level of development of power capabilities and special endurance among rugby players of various playing roles.

Materials and Methods

Participants

The research part was carried out on the basis of Crimean Engineering and Pedagogical University in Simferopol in 2018–2019. 20 young rugby players of 19–23 years old were examined. All subjects were divided into two functional groups: the first group consisted of 10 people (playing role – "forwards") and the second group of 10 people ("defenders"). All youths play in one team and have the first category sports qualification with at least 5–6 years of sports training experience. All athletes voluntarily agreed to participate in the study. The examinations were carried out in the first half of the day, from 9.00 to 11.00. For all athletes, one day before the survey and on the day of it, training sessions were not conducted.

Study design

The athletes of both groups registered indicators of anthropometry, strength and special endurance.

The strength of the flexor muscles of the hand and fingers was determined with DRP-120 wrist dynamometer (Russia). The athlete, standing on the floor, takes his hand with the device to the side parallel to the floor, on command squeezed the dynamometer plate as much as possible. The measurement was made alternately with both hands twice, and the best result was taken into account [16].

The strength of the extensor muscles of the spine was measured with a DS-200 bench dynamometer (Russia). From the starting position, standing on the footrest, feet are parallel, the handle is at the level of the patella, the athlete pulled the handle of the device towards himself and up with maximum effort, the legs are straightened in the process of traction at the knees. The highest indicator of the three measurements was taken into account [3].

The strength of the leg extensor muscles was measured using squats with a barbell on the shoulders weighing 45 kg. From the starting position, the stand "feet shoulder-width apart", the bar with a barbell on the shoulders is held by an average grip. The subject squatted as deep as possible until the upper thigh was parallel to the floor [13].

To determine the strength of the muscles of the shoulder girdle, a bench press was used. The subject lay down on the bench and lowered the bar until it touched the chest. Then he raised it to full extension in the elbow joint [11].

To control the level of development of the players' general strength potential, integral indicator of the relative strength of rugby players (IIRSR) was calculated (formula 1), which characterizes the general model characteristic of a rugby player and his general strength preparedness [18]:

$$IIRSR = \frac{F1}{P} + \frac{F2}{P} + \frac{F3}{P} + \frac{F4}{P} + \frac{F5}{P} \qquad (1)$$

IIRSR is the integral indicator of the relative strength of rugby players (conventional units). F1 is the leg muscle strength, F2 is the arm muscle strength, F3 is the back strength, F4 is the left hand strength, F5 is the right hand strength, P is the body weight.

The special endurance of rugby players was assessed using the multi-stage fitness test Bleep Test VO2Max [12, 13]. The athlete ran between the pieces located in the 20 m segment according to the sound commands, the time of giving which was reduced every minute. The starting speed of the race was 8,5 km/h and increased every minute by 0,5 km/h. The level of a sportsman's readiness (L) was assessed by the number of covered distance segments (SN). The assessment was made according to the formula developed by R. Ramsbottom, et al. [12, 13].

Statistical Analysis

Statistical data processing was performed using Microsoft Excel and STATISTICA-10.0. Shapiro-Wilk test was used to check the normal distribution [9]. For paired comparison of groups, Student's t-test was used. The arithmetic mean (M) was used as a measure of the central tendency, and the standard error of the mean (m) was used as the scattering measure.

Results

During the experiment, it was revealed that the tallest players are forwards: their height was 186,1 ± 6,22 cm, their weight was 92,89 ± 8,92 kg and body mass index (BMI) was 499 g/cm. The lightest and lowest are midfield players. Great mobility, combined with agility and speed, impose quite definite requirements for their height and weight. These indicators for midfielders were 176,1 ± 5,1 cm and 77,0 ± 5,67 kg, respectively, and BMI was 437 g/cm. The middle value is occupied by defenders. According to their game functions, they are all-round athletes. Great strength combined with good mobility, speed and endurance also place significant demands on the basic total body size of rugby players. The height of the defenders was 179,0 ± 4,78 cm, the weight was 79,55 ± 6,3 kg and BMI was 444 g/cm.

To control the level of development of the general power potential of the players, we used IIRSR, which characterizes the general model characteristics of the player and his general strength readiness.

As it is shown in the Table 1, forwards have all the studied power parameters significantly higher than defenders. So, F1 is 175,0 ± 1,98 kg, F2 is 145,0 ± 0,94 kg, F3 is 225,35 ± 0,85 kg, wrist dynamometry (F4 and F5) is 68,0 ± 0,86 kg and 63,5 ± 0,78 kg, respectively. For defenders, these indicators are the following: F1 is 123,75 ± ± 2,05 kg, F2 is 100,0 ± 1,04 kg, F3 is 156,25 ± ± 2,09 kg, wrist dynamometry (F4 and F5) is 58,0 ± 0,85 kg and 57,37 ± 0,65 kg, respectively. The intergroup difference in all strength indicators is shown in the Figure 1.

In terms of F1, F2 and F3, forwards outperform the defenders by 29,28 % ($p < 0,05$), 31,03 % ($p < 0,01$) and 30,66 % ($p < 0,01$), respectively (Figure 1). The strength of the muscles of the right

Table 1

Integral indicator of the relative strength of rugby players of various playing roles (M ± m)

Playing role	IIRSR (c.u.)	F1 (kg)	F2 (kg)	F3 (kg)	Wrist dynamometry	
					F4 (kg)	F5 (kg)
Forwards	3,6 ± 0,1	175,0 ± 1,9	145,0 ± 0,9	225,3 ± 0,8	68,0 ± 0,8	63,5 ± 0,7
Defenders	6,1 ± 0,3	123,7 ± 2,0	100,0 ± 1,0	156,2 ± 2,0	58,0 ± 0,8	51,2 ± 0,7
Team	4,8 ± 0,1	149,3 ± 1,9	122,5 ± 0,9	149,3 ± 1,0	63,0 ± 0,6	57,3 ± 0,6

Notes. IIRSR is the integral indicator of the relative strength of rugby players (conventional units), F1 is the leg muscle strength, F2 is the arm muscle strength, F3 is the back strength, F4 is the right hand strength, F5 is the left hand strength.

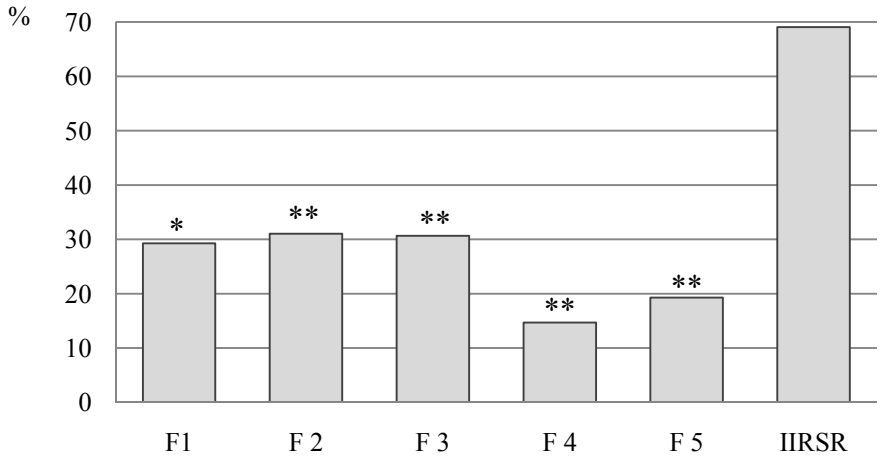

Fig. 1. Difference in the basic power indicators of rugby players of different playing roles (M ± m)*:* IIRSR is the integral indicator of the relative strength of rugby players (conventional units), F1 is the leg muscle strength, F2 is the arm muscle strength, F3 is the back strength, F4 is the right hand strength, F5 is the left hand strength; * – $p < 0,05$; ** – $p < 0,01$ reliability of differences according to Student's t-criterion

and left hand in the first group exceeds the indicators of the second group by 14,7 % ($p < 0,01$) and 19,29 % ($p < 0,01$) (Figure 1). IIRSR in the defense line exceeds the indicator of the same name for forwards, but the difference between them is not significant (Figure 1). In the second group, IIRSR is equal to 6,12 ± 0.3 conventional units, and in the first it is 3,62 ± 0,1 conventional units. The overall team indicator was 4,87 ± 0,1 conventional units. It is known that the higher the IPOSR coefficient, the higher the athlete's power potential.

Discussion

The level of development of aerobic capabilities of all team players as a whole corresponded to the level of "well" and "above average". However, there are significant differences in these indicators among players performing various game tasks.

The athletes of the first group found a lower result on Bleep Test. VO2max value was 48,5 ± ± 0,6 ml/kg/min, which is the lower limit of "above average" level. In the second group, VO2max is 59,8 ± 0,8 ml/kg/min, which is the upper limit of "well" level.

There are a few studies of the level of development of power capabilities and special endurance among young men-rugby players of various playing roles. Thus, the purpose of this study was to characterize the anthropometric indicators and indicators of strength and special endurance in the forwards and defenders of the male student rugby team. As it was expected, our results are consistent with previous studies showing that defenders have more body mass, body fat and greater absolute strength, compared to leaner defenders who have better aerobic endurance [2, 4, 6, 10]. This work complements the current rugby literature by providing data on sports anthropometry, as well as the assessment of strength and endurance to further differentiate between forwards and defenders.

The study shows that the strength indicators and the level of special endurance of defenders and forwards differ in many respects. As it was in our previous studies, forwards had more body

weight than the leaner defenders [18]. This feature of forwards can provide a reliable defensive advantage, since they, as a rule, have a greater number of power contacts per training and are more often involved in racquets, mauls and fights [6]. Roberts, et al. [14] showed that forwards perform more fights (89 versus 24) and spend more average time (5,2 versus 3,6 seconds) on sprints, forwards, line-outs, tackles and grappling than defenders. However, defenders are lighter and slimmer, they have higher speed and more ability to move the ball forward [7]. In the present study, the difference in height between the athletes in both groups was not significant, but the forwards were taller than the defenders. Although the literature on growth is ambiguous, as a rule, the higher the level of the players, the more significant the difference between forwards and defenders [7, 18].

Strength and power are very important for forwards [7]. The results of this study showed that forwards, in all the studied strength parameters, were significantly stronger than defenders. The most pronounced difference was in terms of strength of the muscles of legs, arms and back. The strength indicators of rugby players (so-called three-quarter lines) (defenders and midfielders), are significantly inferior to the forwards. Despite the fact that BMI of athletes in this group is 12,42 % lower, these differences were not significant when recalculated to body weight (IIRSR). Comparing the obtained data with Australian rugby athletes, according to the result of relative strength, it was shown that the level of strength of the forwards corresponds to the international and “high” level of competitions in bench press and squat, respectively, while the indicators of forwards correspond to the “high” and “medium” levels [10]. In particular, the relative strength observed in the bench press and squat among professional Australian rugby players is consistent with our findings [4]. However, in comparison with other studies, it was shown that this sample of rugby students was weaker than professional American ones [10], but similar in strength to semi-professionals [5]. Such differences can be associated with different historical and methodological approaches and differences in the structure of training programs.

The strength indicators of rugby players (so-called three-quarter lines) (defenders and midfielders), are significantly inferior to forwards. Despite the fact that BMI of athletes in this group is 12,42 % lower, the generalized indicator of strength characteristics is higher. The specificity of the activity of athletes in this group is mainly characterized by high-speed loads with a near-limit and/or maximum speed. Consequently, their work is mainly carried out in alactate and glycolytic modes. Therefore, the indicator of special endurance for defenders surpasses the players in the offensive line. It is recommended to develop special endurance using an interval training method with a component of jerks and running exercises, due to the efficiency and power of anaerobic processes in alactate mode in order to improve the creatine phosphate mechanism, which is an energy supplier.

The results of this study provide a descriptive analysis of university level rugby players, thus providing data for comparison among athletes from other countries at different skill levels. Given the growing popularity of rugby among students, determining the physical qualities of players will help coaches in team selection and development of appropriate training programs to develop the leading physiological parameters of rugby players, specific to each position.

Conclusions

The study emphasizes the importance of using a differentiated approach in training athletes in playing sports. The analysis of the studied indicators allows asserting that the target selection of players for various playing positions must necessarily be carried out taking into account the main anthropometric indicators: weight, height, body center of gravity and arm span. It is shown that the players-forwards have the indicators of strength of the upper and lower extremities significantly higher than of the players-defenders (14,7–31,03 %) ($p < 0,05–0,01$), however, IIRSR is lower. At the same time, the line of defense is 18,89 % ($p < 0,01$) more resistant to aerobic loads. The results of this study provide descriptive information about the anthropometric and special endurance strength of college-level male rugby players, suggesting potential standards for coaches that can be used in athletic player selection.

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Information about the authors

Natalia Yu. Tarabrina, Candidate of Biological Sciences, Associate Professor, Associate Professor of the Department of Physical Education, Moscow Aviation Institute (National Research University), Moscow, Russia.

Tomasz Wilczewski, Postgraduate student, Faculty of Physical Education, Academy of Physical Education in Katowice, Katowice, Poland.

Информация об авторах

Тарабрина Наталья Юрьевна, кандидат биологических наук, доцент, доцент кафедры физического воспитания, Московский авиационный институт (национальный исследовательский университет). Россия, 125993, Москва, А-80, ГСП-3, Волоколамское шоссе, д. 4.

Вильчевски Томаш, аспирант факультета физического воспитания, Академия физического воспитания имени Ежи Кукучки в Катовице, Катовице, Польша.

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