International Journal of Physical Education, Sports and Health 2020; 7(4): 218-222

P-ISSN: 2394-1685
E-ISSN: 2394-1693
Impact Factor (ISRA): 5.38
IJPESH 2020; 7(4): 218-222

www.kheljournal.com
Received: 14-05-2020
Accepted: 18-06-2020

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Player positions: Anthropometric and physical fitness in elite rugby

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Abstract
The aim of this study was to measure the anthropometric and physical fitness (speed, agility, power, and aerobic fitness) of elite rugby players by play positions. Data were collected during an in-season period and comprised of body weight and height, 30-m sprint test, 505 agility test, Sergeant jump test, and 20-m multistage shuttle run test. The independent sample t-test demonstrated significant differences between backs and forwards for weight, speed, agility, power, and aerobic fitness. Back players were faster, more agile, and aerobically fitter than the forward players. Forwards, who are responsible in contact and collision situations were heavier. The relationships between the weight and physical fitness were moderate and strong. Overall, the rugby players were fast and agile, but fair in power and aerobic fitness. These findings provide normative profiles for specific positions and can be a guideline for player selection or junior development programs.

Keywords: Elite players, fitness components, physical fitness, play position, rugby

1. Introduction
Rugby union has existed in Malaysia since the British colonial rule of Malaya. Until now, more than 300 clubs are affiliated to the Malaysian Rugby Union. This sport covers about eighty minutes of duration and ten minutes for the second-half break. Due to the long and intense duration, a great aerobic fitness is required (Johnston, Gabbett, & Jenkins, 2014) [1]. Rugby is a high-intensity intermittent contact sport which requires high-intensity efforts of incomplete recovery periods (Duthie *et al*., 2003; Smart, 2011) [2, 3]. The movements reflecting the high-intensity nature of the sport involve acceleration, sprinting, ball carrying and tackling, alternating between jogging and walking to further play the ball (Duthie *et al*., 2003; Duthie *et al*., 2006) [2, 4] Skill-related fitness is also demanded, i.e., speed (Gabbett, 2002) [5], agility (Delaney *et al*., 2015) [6], and muscular power (Johnston, Gabbett, & Jenkins, 2014; Johnston, Gabbett, & Seibold, 2014) [1].

Moving in high speed based on position is very crucial in rugby games. To cover some distance while playing the game by the position played, a player does highly need a sprint high ability. Agility, on the other hand, is the ability of the body to move another direction while sprinting. This has been specifically identified as change-of-direction speed in rugby (Delaney *et al*., 2015) [6]. To perform this skill, a lower body muscular power plays an important role to produce an explosive force. Huge body mass, which is a prominent size among rugby players, could contribute to poor speed, agility, and muscular power (Gabbett *et al*., 2007) [8]. It is difficult to move faster with a massive body size in a game. Therefore, play positions in rugby have their own roles in taking advantage of anthropometry. Understanding the physical performance and the anthropometric characteristics of rugby players would provide an insight into the physical qualities that influence the effectiveness of game performances (Gabbett *et al*., 2007) [8].

Two main types of play positions in rugby are forwards and backs, with each likely to require different fitness levels and anthropometry due to different game demands. For example, the main responsibilities of the forward players are to gain and retain possession of the ball, usually in contact situations involving multiple players acting in unison. Hence, players in this position are usually the biggest and strongest and take part in the set piece restarts scrum and line-out (James *et al*., 2005) [9].

On the other hand, backs can vary a lot in terms of body height, but tend to have low body fat, lighter, faster, and more agile than the forwards. Their role involves running quickly over greater distances where they try to create and convert point-scoring opportunities. Both types of players have to stop the opposition from running with the ball by tackling them, yet kicking is usually left for the backs.

For elite rugby players, the four skill-related fitness is highly demanded. It is agreed that a specific training which involves all skill-related fitness in the sport should be provided by coaches (Young & Willey, 2010). For example, among sub-elite rugby players, trainings provided may be basic, while among the elite rugby players, the trainings should be more comprehensive. Fitness gained by the elites is superior than the juniors or sub-elites due to the significant training level (Gabbett *et al*., 2007) [8].

It is important to profile the fitness components of elite rugby players. More detailed data in comparing the physical fitness via play positions and relationships between the fitness components with anthropometry are provided by this study. Elite rugby players were recruited from the Kuching Rugby Football Club which consists elites who are active in national rugby games. A past study was conducted among national rugby players based in Klang Valley (Chong *et al*., 2011) [11], however, it only measured and reported three basic fitness testing: sit-and-reach (flexibility), bleep test (aerobic fitness), and standing broad jump (muscular power). These fitness testing were insufficient to outline the physical fitness characteristics of rugby players.

Thus, this study aimed to provide extensive norms for the elite rugby players in Malaysia. The current status can be improved, and sports development programs can be setup by establishing the updated norms. This was achieved by examining and measuring the anthropometry and skill-related fitness: speed, agility, power, and aerobic fitness using a standardised fitness testing protocol.

2. Materials and methods

2.1 Participants

This study utilised a quasi-experimental design which is an ex-post facto design, a category of research design in which the investigation starts after the fact has occurred without interference from the researcher (Salkind, 2010) [12]. There is no treatment given to the participants. By employing convenience sampling, N = 14 participants who were well-trained rugby players from Kuching Rugby Football Club had undergone a specific training program at the time of the data collection were recruited. All of them had sport experience of at least five years.

2.2 Procedure

A written consent form and a general health screening using Physical Activity Readiness Questionnaire (PAR-Q) were obtained from the participants prior to taking the measurements. Even though sportspersons were assumed to be healthy, the basic screening was compulsory for ethical purposes. All of them passed the screening and the coaches' permission was obtained. The participants were not only notified that they could withdraw from the study, but also informed on the objective of the study and the benefits of participating. The testing procedures were explained and demonstrated on the day of the testing. The participants might be familiar to the tests conducted; however, the demonstration of each test was performed to ensure internal validity of the data collected. All testing was completed across two sessions during the in-season training period. The first session involved gathering of the anthropometric measures (height and body mass) and the multistage shuttle run. Forty-eight hours later, the second session was conducted involving a 30-m sprint test, a 5-0-5 agility test, and a sergeant jump test. A standardised warm-up of dynamic movements and stretching were completed before all tests

2.3 Anthropometry

Standardised anthropometric measurements (height and body weight) were obtained. For body height, participants were instructed to remove their shoes and socks before undergoing the height measurement. They must stand properly with assistance from a ruler before their height value was taken. The height of the participants was recorded nearest to 0.1 cm. A weighing scale, OMRON HBF-375 was used to measure the participants' weight with a capacity of not more than 210kg. To undergo the weight measurement, again, participants were instructed to remove their shoes and socks. They too had to remove anything from their pockets that could influence their weight reading. They were instructed to stand properly on the weighing scale without making any movement. The reading was recorded to the nearest 0.1 kg.

2.4 Sprint

A 30-m sprint test was performed to assess the participants' speed. The test required the participants to run a sprint over 30 metres within three trials. Participants were then instructed to start the test with a stationary position with one foot behind the starting line. The time was measured with a stopwatch when they crossed the finishing line. Maximal sprints must be performed and a 3-minute rest between trials was given. The best of the three trials was taken as the score to the nearest 0.01 seconds. This test has been reported as having high reliability and validity (Green *et al*., 2009) [13].

2.5 5-0-5 Agility

The participants were instructed to start the test in a stationary position with one foot behind the starting line. They were required to sprint for over 15 meters within three trials. There were three stations in this test, i.e., A, B, and C. The participants accelerated from the start (Station A) to Station C at 15-m mark, through Station B (time taken was started when the participants went through Station B), made a turning 180° at Station C, and sprinted back through to Station B as the finishing line. The time was stopped when the participants passed through Station B. All attempts were recorded to the nearest 0.01 second. The best of the three trials was taken as the score. This test has been reported as having high reliability and validity. The protocol followed was from (Draper & Lancaster, 1985) [14].

2.6 Sergeant jump test

This test was conducted to measure the power or the elastic strength of the legs (Harman *et al*., 1991) [15]. The participants were instructed to stand on their side against the wall while keeping both feet remained on the ground, reach up as high as possible with one hand, and mark the wall with the tips of their fingers. From a static position, participants were instructed to complete the jump by moving to a self-selected depth, jump as high as possible, and mark the wall with a chalk on their fingertips. Three maximal jumps were completed with a 3-minute rest in between trials. The best of three trials was recorded nearest to 1 cm.

2.7 20-m multistage shuttle run test

Aerobic fitness was measured by using a 20-m multistage shuttle run test. This test required continuous running between two lines of 20 metres apart in accordance to a pre-recorded audio. In a standing position of one foot behind the starting line facing the second line, the participants started the test after they heard the audio beeped. The participants continued running between two lines and turned when signaled by the recorded beeps. The tempo of the beeps gradually increased as the level increased. If the participants did not reach the line before the beeps, the test was stopped when the participants failed to reach the line after two consecutive ends.

2.8 Statistical analysis

The data collected were analysed using the Statistical Package of Social Science (SPSS) version 24.0. Data were presented in mean and standard deviation (*M±SD*) values. Pearson correlation was employed to measure the relationship between anthropometry, speed, agility, power, and aerobic fitness obtained. The participants' anthropometry, speed, agility, power, and aerobic fitness between play positions (back and forward) were compared among the elite rugby players using an Independent Sample t-test. Statistical was set as $p < 0.05$. Cohen's effect size (ES) was calculated with < 0.2 (very weak), 0.2 – 0.6 (weak), 0.6 – 1.2 (moderate), 1.2 – 2.0 (large), and > 2.0 (very large) (Cohen, 1998) [16]. The effect size of negative or positive implies this categorisation (Hopkin *et al*., 2009) [17].

3. Results

This study involved 14 elite rugby players that consisted of 9 back and 5 forward play positions who had playing experience of at least five years and above. Table 1 shows the anthropometric and age of the participants by play positions (backs and forwards). Play positions had a significant effect on body weight (p = .010), with forwards being significantly heavier than the backs. Age and body height were not significantly different between the play positions (p > .05). However, a significant large difference was found for body weight between the back and forward play positions (ES = -4.69). The ES of their body heights suggested that the backs and forwards had a weak difference (0.53). Age was not a variable of effect in this analysis.

Table 2 shows the speed, agility, power, and aerobic fitness of participants by play positions. The findings identified that play positions had a significant effect on all measures; speed (p = .001), agility (p = .001), power (p = .001), and aerobic fitness (p = .001). Differences between back and forward positions could be found in speed (-0.90), agility (-0.49), power (10.25), and aerobic fitness (1.44) which were weak (agility) to very large (power). Speed (very large, ES = -7.07) and agility (very large, ES = -2.92) were faster and agile among the backs than the forwards. Muscular power and aerobic fitness were greater in the back position (very large, ES = 3.50, 2.08) than the forward. Again, the backs had significantly greater muscular power and were more aerobically fitter than the forwards.

Table 3 represents the correlations between anthropometry and physical fitness measured. The result shows that there were significant correlations between body weight and speed, agility, muscular power, and aerobic fitness (p< .05). Nonetheless, body height was not significant in any of the physical fitness (p > .05).

Table 1: Description of the participants; Kuching Rugby Club's players (N=14) by position play

	Overall *N*=14	Backs *n* = 9	Forwards *n* = 5	*t*	*p*	*ES*
	Mean ± *SD*					
Age (years)	22.64 ± 1.865	22.33 ± 1.50	23.30 ± 2.49	-.823	.427	-0.65
Body height (cm)	167.14 ± 3.085	167.78 ± 3.35	166.00 ± 2.45	1.036	.321	0.53
Body weight (kg)	73.68 ± 15.463	66.34 ± 4.38	86.89 ± 19.99	-3.047	.010*	-4.69

*significant at .05 (p< .05)

Table 2: Speed, agility, muscular power and aerobic fitness of Kuching Rugby Club players by position play

	Overall *N*=14	Backs (*n* = 9)	Forwards (*n* = 5)	*t*	*p*	*ES*
Mean ± *SD*						
Speed (*s*)	4.113 ± 0.469	3.792 ± 0.127	4.690 ± 0.186	-10.763	.001*	-7.07
Agility (*s*)	2.520 ± 0.234	2.382 ± 0.133	2.77 ±0.155	6.467	.001*	-2.92
Power (*cm*)	37.071 ± 5.783	40.733 ± 2.932	30.480 ± 2.653	-4.896	.001*	3.50
Aerobic fitness (L)	7.690 ± 1.049	8.200 ± 0.691	6.760 ± 0.976	3.237	.001*	2.08

*significant at .05 (p < .05); L = level performed

Table 3: Correlation between anthropometry and physical fitness of Kuching Rugby Club players (*N*=14)

	Speed	Agility	Power	Aerobic fitness
Body height	-.177	-.117	.121	-.239
Body weight	.604*	.723*	-.746*	-.774*
Speed	1	.857*	-.858*¥	-.747*¥
Agility		1	-.712*¥	-.785*¥
Power			1	.670*
Aerobic fitness				1

*correlation is significant at .05 (p< .05). *¥ correlation is interpreted as direct relationship even though the relationship is inversed between the variables, due to the scores obtained indicate that the lower the score, the faster or the quicker the performance.

4. Discussion

As most literatures were published on the anthropometric and physical characteristics of rugby players in European countries and the United States, available research that presents these measures among elite Malaysian rugby players were limited. Therefore, this study aimed to evaluate the anthropometric and physical fitness characteristics of Kuching Rugby Club elite players by play positions: backs and forwards using a physical testing battery. As hypothesised, there were significant differences in body weight, speed, agility, power, and aerobic fitness between the two play positions. Body height was similar in distribution among those play positions.

Forwards were heavier among the elite players. This is consistent with the previous findings as in the elite Portuguese rugby union players (Vaz *et al*., 2014) [18], the elite academy rugby league players in the United States (Dobbin *et al*.,

2019) [19], the English academy rugby league players (Till *et al*., 2016) [20] and the national Malaysian rugby players (Chong *et al*., 2011) [11]. Differences were evidently noted between the play positions with the forwards being heavier than the backs. Heavier forwards enabled them to involve in more physical collisions and tackling (Gabbett *et al*., 2009) [21]. Therefore, most coaches are more likely to consider body weight as a criterion for choosing forwards as it could contribute to the success in the performance.

For physical fitness characteristics, the overall mean score indicated that the rugby players were in an excellent level of speed. This indicates a great finding. Rugby players need a high sprint ability to perform during the game. On the other hand, they are also highly agile, which is a crucial component to be a good rugby player. In contrast, power and aerobic fitness were average among these players. The results were extended further by comparing the physical fitness of play positions.

The findings revealed that all measures were different by play positions. The back players were faster, agile, powerful in elastic strength, and aerobically fitter than the forwards. This explains the lighter body weight of the back players. The lighter and leaner the back players, the faster and agile they are. Agility was measured by 505 agility test, which was designed to assess agility, i.e., in changing directions and speed (Young *et al*., 2002) [10, 22], which explained the faster and agile back players. Young *et al*. (2002) [10, 22] identified that agility consisted of two subcomponents, which are speed in changing of direction and cognitive factor. Furthermore, it was previously reported that body mass of players influences running performance (Gabbett *et al*., 2012) [23]. The ability to move and change direction and position of the body quickly and effectively while under control (Quinn, 2018) [24] does benefit the players in tackling and changing direction while running with the ball and kicking. Backs are at advantage of a fast game as they contribute more due to fast movement. Meanwhile, forwards are responsible in defence and spend a large proportion of match-plays that involve tackling and physical collisions (Gabbett *et al*., 2007) [8]. Forwards typically perform in shorter distance (10 – 20 m) sprints during a game (Duthie *et al*., 2006) [4], while backs would be in longer distance. Such similar outcomes might contribute to the result of the difference in the speed test performance of using a 30m sprint test in this study. The ES was very large, -7.07. Thus, for forwards, the ability to attain maximum speed quickly following an interval was an important performance in this group.

Power is defined as an ability to generate high levels of muscular power (Sapega & Drillings, 1983) [25]. Hence, this study measured the vertical jump for muscular power, which assists in the line-out situation which can lead to a successful game. This finding suggests that back players can be very helpful in line-out situations due to their greater force production while jumping upwards, if compared to forwards. The power of jump also may contribute to the leg drive in the tackles and greater ball-play speed (Gabbett *et al*., 2009) [21]. In addition, aerobic fitness sometimes refers to high intensity running that assists the success of a rugby game with a typical match of up to 90 minutes. In contrast with the findings from studies by Gabbett *et al*. (2007) [8] and Chong *et al*. (2011) [11], the backs were significantly higher in aerobic fitness than the forwards. However, the aerobic fitness of the overall players in the studies was in fair category. Even though the backs were greater in aerobic fitness and muscular power, this fitness component should be taken into consideration for improvement. Sad but true, these findings are similar to Chong *et al*.'s (2011) [11] which assessed the national Malaysian rugby players. They also reported fair aerobic fitness. The study was conducted on national players in different regions of Malaysia, which revealed a moderate ES of -0.8, whilst in the present study, the ES was very large, i.e., 2.08. Based on these current findings, improving aerobic fitness and power should be expected by emphasising on high-intensity aerobic and lower body explosive power improvement with appropriate periodization.

Regarding body weight correlation with physical fitness, the results displayed strong relationships with speed, agility, power, and aerobic fitness among the elite rugby players. The correlations obtained were comparable to studies who conducted a study on amateur Rugby Union players in United Kingdom (Muller *et al*., 2018) [26], and Brazil (Nakamura *et al*., 2016) [27]. The lighter and leaner the players, the faster and agile they are. On the other hand, muscular power and aerobic fitness decreased with higher body weight. The greater the weight, the lower their power and aerobic fitness. As observed from the relationship analysis, speed and power were found interrelated, but not exclusive. Therefore, greater speed produces an optimal force (Gabbett *et al*., 2007) [8]. Power was measured by using a sergeant jump test which focused more on vertical jumping, which is more likely to be performed during line-outs in catching the ball. Speed, on the other hand, was measured in a linear and horizontal plan. Thus, the nonparallel result of the speed and muscular power of the players could be explained by the average performance of power. For aerobic performance, the heavier the players, the lower the aerobic fitness. This again was related to the body weight of the forwards who were heavier and the backs who were aerobically fitter than the forwards.

5. Conclusions

In conclusion, this study presented the anthropometric and the physical fitness of elite rugby players of Kuching Football Rugby Club. The findings observed that body weight, speed, muscular power, and aerobic fitness are different according to playing positions, in this case the backs and the forwards. Height is similar across the groups. Body weight as well as speed, muscular power, and aerobic fitness revealed similar important physical and fitness characteristics for rugby performance, which improvement in speed and aerobic fitness is warranted. These findings suggested that body weight and physical fitness are significant in the roles of the backs and the forwards. Backs are lighter, faster, more agile, and aerobically fitter than the forwards. While significant relationships were observed between body weight and speed, agility, power, and aerobic fitness, they were unrelated to body height. The relationships were moderate to strong. Body weight was found to have a moderate to strong positive significant relationship with speed and agility. The differences and relationships revealed in body size indicated by the body weight in the play positions might influence the physical performance of the players.

The present data can advise in detail on the need to improve attributes that will enhance the role performance of the backs and the forwards in competitions. Regular fitness tests as these will inform coaches to better understand the players' current fitness level and what to be achieved by them in training before the in- seasons. These data also provide normative profiles of specific positions and the basis for junior development programs. Future research is required to identify female rugby players based on play positions with similar age range to describe the difference in anthropometric and physical fitness characteristics. As hormonal differences are significant between genders, the future studies will provide greater insight into elements that matter in rugby performance.

6. Acknowledgments

The authors acknowledge the support from Faculty of Sports Science and Recreation, Universiti Teknologi MARA Kampus Samarahan, Sarawak, Malaysia for the research and ethical approval. Special thanks to Kuching Rugby Football Club's coaches for the permission and to all players for the participation in this study.

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