Original Article

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A comparative evaluation of anthropometric characteristics and respiratory functions' parameters among rugby and soccer players

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Abstract

Introduction: Evaluation of anthropometric characteristics and respiratory functions is imperative for investigating the health status of individuals and sportspersons. The objective of this study was to evaluate the anthropometric characteristics and respiratory function parameters of rugby and soccer players. *Methods:* Forty-four players (rugby, n=22; soccer, n=22) were selected for the present study. They were free of musculoskeletal and respiratory disorders. Their age was 21.49±1.41 years, height 173.62±6.26 cm, weight 71.40±14.44 kg, BMI 22.70±4.26 kg/m^2, PBF 17.35±12.27%, Fat Mass 24.43±13.61 kg, and LBM 55.98±7.26 kg. Anthropometric characteristics and body composition were measured using a weighing scale cum stadiometer and a bioelectric impedance analyzer. Respiratory function was assessed using a handheld spirometer. Standard procedures were followed to measure the anthropometric characteristics, body composition, and respiratory function. *Results:* The results of the study demonstrated no significant differences in anthropometric characteristics and body composition between rugby and soccer players. The respiratory function parameters were insignificant for vital capacity (VC) (MWU=213, p=0.496), forced expiratory volume in the first second (FEV1) (MWU=216, p=-0.541), forced expiratory volume in the first second divided by vital capacity (FEV/VC) (MWU=205.5, p=0.390), and maximum voluntary ventilation (MVV) (MWU=224.5, p=0.681) among rugby and soccer players; only a significant difference was found in forced vital capacity (FVC) (MWU=142.5, p=0.019) in rugby and soccer players. *Conclusion:* Based on findings from the study, it can be concluded that rugby players have higher values for respiratory functions than soccer players. The findings of this study can inform future researchers, coaches, and team instructors regarding the preparation of rugby and soccer players for specific training and competitions.

Keywords: vital capacity, expiratory reserve volume, force expiratory volume, maximum voluntary ventilation, soccer, rugby

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INTRODUCTION

Rugby and soccer games are high-intensity random intermittent dynamic sports carried out with high levels of anaerobic and aerobic capacity. Similar abilities and characteristics are required for both sports to achieve high performance [1]. Both sports require certain anthropometric measurements (height, weight, and body composition) as well as physical performance measures (strength, endurance, flexibility, agility, and coordination) [2,3], respiratory (vital capacity, expiratory volume, residual volume, maximal voluntary breathing), and cardiovascular (blood pressure, cardiac output, stroke volume, heart rate) performance. All of these reflexes encourage players to exert further physical effort. [4,5]. Consequently, rugby and soccer are physically demanding tasks. Players routinely participate in competitive sports and training sessions of high frequency, intensity, and duration, which place additional stress on their biological systems. [6]. Earlier studies have shown that exercise significantly improves respiratory function in such sports [7]. Ozdal [5] also revealed that high values of respiratory function have a chronic and acute positive effect on player performance. Respiratory function parameters can be determined objectively for rugby and soccer players and normal values can be established.

Respiratory functions are generally determined by the elastic recoil of the lungs, airway resistance, compliance of the thoracic cavity, and diaphragm strength [8]. Respiratory function testing is an essential and widely implemented diagnostic procedure owing to its ease of application [9]. Spirometry tests are most commonly employed to examine respiratory status and have become a standard part of routine health checks in public health monitoring, sports medicine, and clinical practices [10]. Spirometry tests provide quantitative and qualitative data on respiratory function. Respiratory capacities and volumes were used to define respiratory functions. Although respiratory functions are genetically regulated and influenced by environmental and dietary constituents, earlier research has shown that they can be enhanced through participation in physical and sports activities [11,12]. Prior investigations have found that athletes have greater respiratory function values than their control counterparts who do not engage in physical activity [13]. Herms et al. [14] stated that respiratory function impacts endurance, strength, and game performance among players.

Respiratory function in different populations has been extensively studied around the world. Although rugby and soccer are prominent sports in Fiji, the respiratory function of rugby and soccer players has not been sufficiently investigated. Therefore, this study aimed to investigate differences in respiratory function between male rugby and soccer players. This study helps to determine the possible differences in respiratory function among rugby and soccer players, which may significantly help prepare players for a specific competition during a specific period. A comparative cross-sectional study was conducted to achieve the aim of this study.

MATERIAL AND METHODS

Participants

A non-probability sampling technique was used to recruit the participants. Healthy male rugby (n=22) and soccer (n=22) players' average age of 21.49±1.41 years, height 173.62±6.26 cm, weight 71.40±14.44 Kg., BMI 22.70±4.26 kg/m^2, Percentage of body fat (PBF) 17.35±12.27%, Fat Mass 24.43 13.61 kg, and Lean Body Mass (LBM) 55.98±7.26 kg. were recruited from local sports clubs in the Lautoka and Ba regions of Fiji. All participants had at least five years of playing experience at the national level. Any participant with a musculoskeletal injury or a record of an active respiratory disorder or epileptic disorder was excluded from the study.

This study was conducted in a laboratory setting in the Department of Physical Education at the Lautoka Campus, Fiji National University, Fiji. Ethical approval (FNU-HREC-22-14) was obtained from the FNU Human Research Ethics Committee of Fiji National University, Fiji. The experiments reported in this manuscript were performed per the ethical standard of the Helsinki Declaration, and all the participants contributed to this study after signing a written informed consent.

Procedure

All experiments were conducted in the same session to avoid circadian interference in a climate-controlled room (15-20^0 C) with 45-65% relative air humidity. Upon arrival at the laboratory, the participants were informed of the procedure, methods, time duration, relative risks, and benefits of the study. It is clear that they could discontinue the test at any time. They signed a written consent form agreeing to participate in this study. The participants were demonstrated and familiarized with the experimental procedure to relieve their doubts. Anthropometric measurements were taken first then a respiratory function test was taken with the help of a portable dry spirometer. The participants sat on a chair with their nose plugged and performed forced inspiratory and expiratory maneuvers, as recommended by the American Thoracic Society. A minimum of three tests were recorded for every participant, and the best of the three tests was considered for further analysis. Participants were orally encouraged and motivated to attain maximum inspiratory and expiratory effort.

Measurement of Respiratory Functions

Respiratory function was measured using a spirometer following the standard procedure and predicted values recommended by the American Thoracic Society [10]. The respiratory functions were vital capacity (VC), which is the total volume of air that can be moved out from the lungs through a single maximal effort, and forced vital capacity (FVC), after which maximal air is discarded by a tough, rapid, and deep expiration, forced expiratory volume in the first second (FEV1), and after maximum inspiration, the volume of air expired by maximum expiration. It is commonly measured in the first second because the first half of the curve is based on the participants' efforts and cooperation. At the same time, the last section expresses capacity changes, FEV1/VC - it is the forced expiratory volume in the first second divided by the vital capacity, maximum voluntary ventilation (MVV) – the maximum breathing volume that occurs with voluntary effect in one minute [15].

Tools

Stadiometer: Height and body weight were determined using a self-calibrated stadiometer cum-weighing scale (Decteto, 0.65, USA). *Bioelectric impedance analyzer* Body composition was determined using a bioelectrical impedance analyzer with a tetra-polar impedance meter (BIA101, Florance, Italy). *Spirometer:* Respiratory function was determined using a handheld electronic spirometer (Contec SP70B; Contec Medical System Co. Ltd., China). This device is connected through Bluetooth transmission to the researcher's mobile device using a mobile app (Dr Lung). Respiratory function was determined after entering the participants' demographic information. The device has a ± 0.05 L volume of ± 0.2 L flow accuracy.

Preparation of Participants

A comparative cross-sectional study was conducted to achieve the aim of this study. The participants were instructed not to eat at least 2 h prior to the experiment, not engage in any vigorous physical activity, and empty their bladders before the experiment. Measurements were performed from 7:30 am to 9:30 am. The participants were allowed to rest for 30 min. A weighing machine cum stadiometer and bioelectrical impedance device recorded anthropometric measurements and body composition while the participants stood barefoot and wore sports-specific clothing [16].

Statistical Analysis

A normality test has been done to determine whether anthropometric characteristics, body composition, and respiratory function data are not normally distributed or normally distributed. The Kolmogorov-Smirnov test was performed to check the normality of the data using a significance level greater than 0.05, and the anthropometric characteristics and body composition data were normally distributed. In contrast, respiratory function data were not normally distributed. Thus, parametric tests (Student's t-test) for anthropometric characteristics and body composition and non-parametric tests (Mann-Whitney U test, two-sided) for respiratory functions were used to compare rugby and soccer players. A p-value less than or equal to 0.05 was considered statistically significant. Data are expressed as frequency, minimum, maximum, mean, and standard deviation for descriptive statistics, and mean rank and statistical error are expressed as inferential statistics for respiratory functions. Statistical analyses were performed using the Windows IBM Statistical Package for Social Sciences (IBM SPSS) version 21.

RESULTS

A total of 44 players (22 rugby and 22 soccer) were investigated, and their anthropometric characteristics and body composition are presented in Table 1. The table shows no significant differences in anthropometric characteristics and body composition between the rugby and soccer players.

Tables 2 and 3 contains the descriptive statistics (frequency, minimum, maximum, mean, and standard deviation) of respiratory function (VC, FVC, FEV1, FEV/VC, and MVV) for rugby and soccer players, respectively. Comparative statistics for respiratory function between rugby and soccer players are presented in Table 4, which shows no significant differences in respiratory function (VC, FEV1, FEV/VC, and MVV) between rugby and soccer players, except for FVC.

Table 4 contains that there were no significant differences in respiratory function vital capacity (VC) (MWU=213, p=0.496), forced expiratory volume in the first second (FEV1) (MWU=216, p=-0.541), forced expiratory volume in the first second divided by the vital capacity (FEV/VC) (MWU=205.5, p=0.390), and maximum voluntary ventilation (MVV) (MWU=224.5, p=0.681) between rugby and soccer players, whereas a significant difference was found in the forced vital capacity (FVC) (MWU=142.5, p=0.019) between rugby and soccer players.

Table 1. Anthropometric characteristics and body composition parameters among rugby and soccer players.

Indicator	Rugby Players Mean±SD	Soccer Players Mean±SD	Both Mean±SD	p
Age (years)	22.42±2.55	21.73±1.21	21.49±1.41	0.124
Body Height (cm)	173.86±6.28	172.82±5.84	173.62±6.26	0.178
Body Weight (kg)	74.01±18.31	68.50±8.62	71.40±14.44	0.084
BMI (kg/m2)	22.72±3.22	22.48±2.78	22.61±2.86	0.243
PBF (%)	18.34±9.31	17.70±14.25	17.35±12.27	0.612
Fat Mass	25.19±14.24	24.71±12.02	24.43±13.61	0.178
LBM	56.78±7.25	54.70±6.71	55.98±7.26	0.521

BMI - body mass index; PBF - percentage of body fat; LBM - lean body mass; SD - standard deviation; p - statistical significance

Table 2. Descriptive statistics of respiratory functions among rugby players.

Indicator	Minimum	Maximum	Mean	SD
VC (L)	5.24	7.41	6.56	0.69
FVC (L)	5.18	7.38	6.39	0.65
FEV1 (L)	4.31	5.74	5.17	0.48
FEV / VC (L)	76.00	92.00	85.00	4.77
MVV (L/min)	175.00	242.00	207.36	20.52

VC - vital capacity; FVC - forced vital capacity; FEV1- forced expiratory volume in the first second- FEV1/VC - it is the forced expiratory volume in the first second divided by the vital capacity; MVV - maximum voluntary ventilation; SD - standard deviation

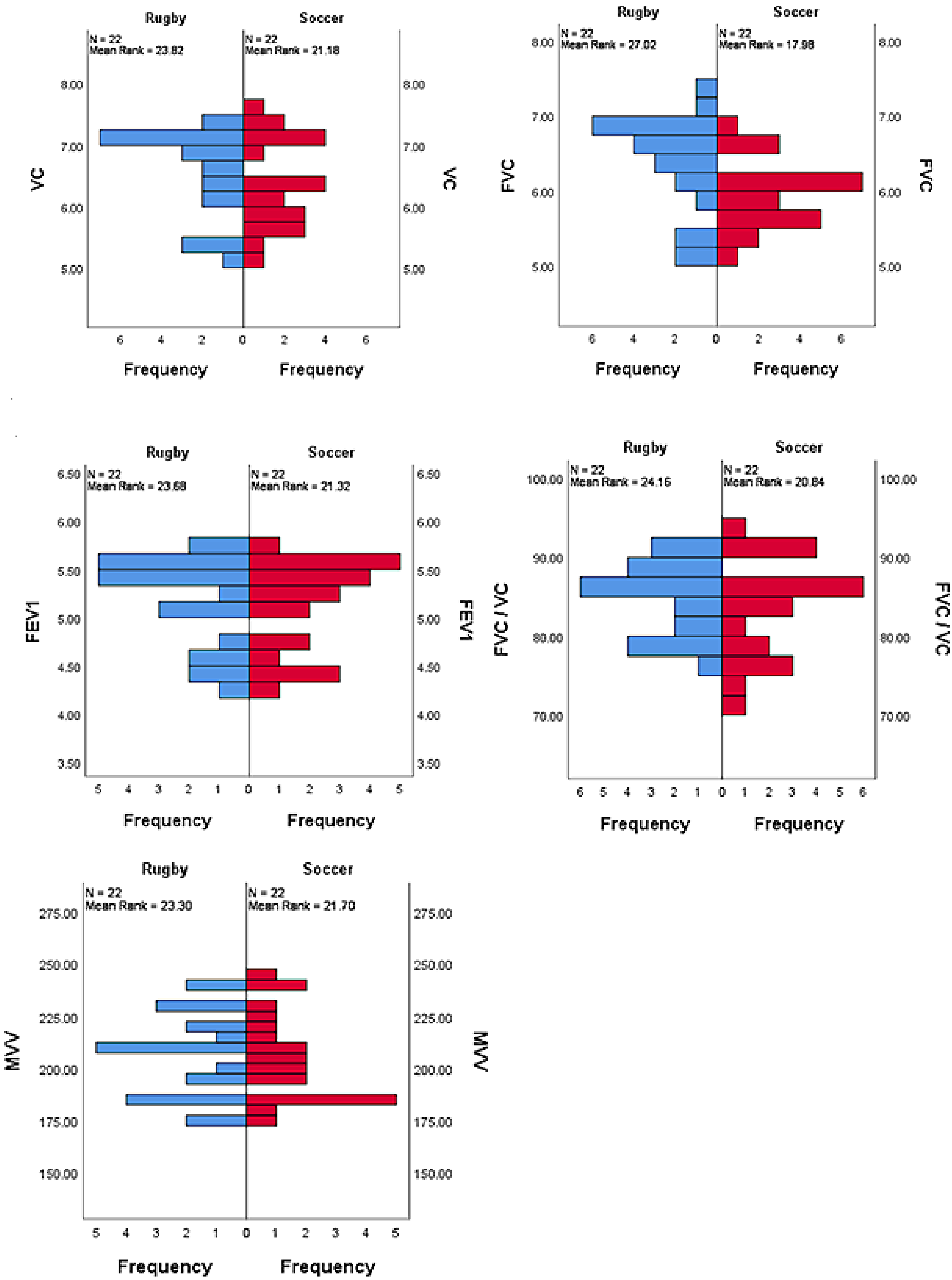

Figure 1. Independent - samples Mann-Whitney U test between rugby and soccer players.

Table 3. Descriptive statistics of respiratory functions among soccer players.

Indicator	Minimum	Maximum	Mean	SD
VC (L)	5.00	7.64	6.39	0.73
FVC (L)	5.00	6.98	5.98	0.49
FEV1 (L)	4.31	5.71	5.11	0.47
FEV / VC (L)	72.00	94.00	83.36	6.38
MVV (L/min)	176.00	243.00	205.09	20.98

VC - vital capacity; FVC - forced vital capacity; FEV1- forced expiratory volume in the first second- FEV1/VC - it is the forced expiratory volume in the first second divided by the vital capacity; MVV - maximum voluntary ventilation; SD - standard deviation

Table 4. Comparative statistics of respiratory function between rugby and soccer players.

Indicator	Players	Mean Rank	SE	Mann-Whitney U	Asymptotic Sig. (2-sided test)
VC (L)	Rugby	23.82	42.57	213.00	0.496
	Soccer	21.18			
FVC (L)	Rugby	27.02	42.58	142.50	0.019*
	Soccer	17.98			
FEV1 (L)	Rugby	23.68	42.52	216.00	-0.541
	Soccer	21.32			
FEV / VC (L)	Rugby	24.16	42.44	205.50	0.390
	Soccer	20.84			
MVV (L/min)	Rugby	23.30	42.50	224.50	0.681
	Soccer	21.70			

VC - vital capacity; FVC - forced vital capacity; FEV1- forced expiratory volume in the first second- FEV1/VC - it is the forced expiratory volume in the first second divided by the vital capacity; MVV - maximum voluntary ventilation; SD - standard deviation

DISCUSSION

This study compared the respiratory function of rugby and soccer players. Vital capacity was found as 6.56±.69 (L) in rugby players and soccer players as 6.39±0.79 (L); there was no significant difference (p=0.496). The average forced vital capacity was found as 6.39±0.65 (L) in rugby players, while in soccer players, as 5.98±0.49 (L), there was a significant difference (p=0.019). The average forced expiratory volume in the first second was 5.17±0.48 (L) in rugby players and soccer players was 5.11±0.47 (L); there was no significant difference (p=-0.541). The average FEV/VC was 85±4.77 (L) in rugby and soccer players as 83.36±.38 (L); no significant difference (p=0.390) was found. The average maximum voluntary ventilation was 207.36±20.52 (L/min) in rugby players, while 205.09±20.98 in soccer players. This result indicated an insignificant difference (p=0.681) between rugby and soccer players for maximum voluntary ventilation.

The results discussed above suggest that rugby players have higher respiratory function values than soccer players. Our findings were consistent with those of Laszlo et al.. He revealed that respiratory function volumes mostly depend on the individual height; therefore, higher respiratory values were expected from rugby players as their height was higher than that of soccer players [17]. Mazic et al. [18] reported that lung volume could be predicted reasonably well based on anthropometric characteristics, such as age, weight, and height. However, higher lung volumes could be predicted in players who do not engage in regular physical activity than in their control counterparts. Rowe et al. [19] conducted a study to determine the association between pulmonary function and anthropometric measurements. They revealed that height is an essential component that positively correlates with different pulmonary function parameters. The reference values of FVC and FEV1 are generally known as functions of age and standing height, whereas body weight has been shown to have little impact on lung function parameter estimations [20]. The effect of obesity surgery on weight loss improves pulmonary function [21].

Regarding body composition, rugby players showed higher values for all the measured parameters than soccer players, which could be limiting factors for respiratory functions as they did not show any significant differences between both team players. The study also revealed that the respiratory function parameters of both team players had nearly identical values, indicating no statistically significant differences, except for FVC. An earlier study reported that lung function and volume were negatively associated with body mass index. The FEV1 and FVC were significantly reduced with increasing body mass index [22]. Few studies have shown that body fat has an inverse association with forced expiratory volume in 1 s and forced vital capacity. As body fat increases, the respiratory function parameters decrease [23]. A recent study revealed that fat mass (visceral and total adipose tissue) is correlated with poor respiratory functions [24].

Regarding the types of sports, rugby players showed higher mean values of respiratory function than did soccer players. Players from sports such as rugby and soccer have higher respiratory functions than those from endurance sports such as running and cycling. The literature contains few studies on performance, as Ates et al. [25] conducted a study evaluating the physical and physiological parameters of elite rugby players. They compared rugby players with other sports players and suggested that the lung volumes and capacities of rugby players were higher than those of other players. Rugby players are usually selected based on their anthropometric characteristics such as being heavier and taller. They naturally performed higher volumes of strength-based training, such as rucking, scrummaging, and mauling, than soccer players [26]. An earlier study revealed that professional or elite players with intense sports training led to 10-20 per cent higher FEV1 values than moderate sports training players [27]. An early study completed by McLean [28] stated that the intensity of physical work and vital preparation for conditioning programs significantly affect the respiratory functions of rugby players. Mazic et al. [18] determined respiratory parameters in different elite athletes. They concluded that force vital capacity was higher in soccer players than in the volleyball, handball, taekwondo, boxing, tennis, and control groups. In elite players, aerobic and endurance training significantly improves respiratory function compared with other sports training types [29]. Rugby and soccer players must have high speed and relative strength because they make repeated sprints and cut maneuvers throughout the game. The current study indicated that soccer players have statistically the same values as rugby players, and it is evident from this study that there were no significant differences in respiratory function between soccer and rugby players. A study completed by Adegoke and Arogundade [30] revealed that soccer players have higher respiratory function than control players. Furthermore, similar findings have demonstrated that Hagberg showed no statistically significant difference between soccer and control players [31].

The cross-sectional aspect of this study limits it; for example, alterations in these respiratory functions could not be observed over time across numerous training sessions or even within a single competition session. It is challenging to determine if the players' differences were due to their training regimens or inherent abilities. Extended follow-up or linear studies with a large sample size could expand our understanding of many more respiratory parameters among different sports players.

CONCLUSION

Our findings are consistent with earlier research showing that rugby and soccer players have significantly higher values for major respiratory variables (VC, FVC, FEV1, and MVV). To our knowledge, no study has examined such differences, which makes our research even more influential. One plausible reason is that each sports activity contrasts in the types and intensity required, which fluctuates with climatic conditions and sport-specific body composition adaptations. More research is needed to investigate the influence of different exercise patterns as well as the effects of exercise length, severity, intensity, and genetic factors on respiratory function among different sports players.

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