

Physiological and Motor Performance Characteristics in Rugby and Soccer Players: Data from a Developing Country

Baba Solomon Akumba¹, Monday Omoniyi Moses²

¹Final year student of Bachelors of Sports and Exercise Science, Department of Physiotherapy and Sports Science, Faculty of Allied Health Sciences, College of Health Sciences, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana, ²Associate Professor, Department of Physiotherapy and Sports Science, Faculty of Allied Health Sciences, College of Health Sciences, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana.

How to cite this article: Baba Solomon Akumba, Monday Omoniyi Moses. Physiological and Motor Performance Characteristics in Rugby and Soccer Players: Data from a Developing Country. International Journal of Physiology 2022;10(4).

Abstract

This study comparatively presents the physiological, anthropometric, and motor performance characteristics of rugby and football athletes in a developing country. 49 university soccer [(US: N=24, mean age = 22.54±2.24), university rugby (UR: N=25, mean age =21.84±1.81)] and 23 national rugby (NR) (mean age = 26.0±3.33) were recruited. Body weight, body mass index (BMI), waist-to-height ratio (WtHR), hip circumference (HC), waist circumference (WC), waist-to-hip ratio (WHR), blood pressure, heart rate, maximal oxygen consumption (VO₂max), 5-Jump Test (speed), agility, core muscle strength and stability (CMS), muscular endurance (ME), and sit and reach (SRT) were measured. NR significantly had higher age, weight, BMI, WtHR, HC, WC, WHR, SBP, VO₂max, 5JT/BM and ME ($P < 0.05$) compared to others. National and university rugby athletes had better anthropometric and physiological attributes with similar agility performance. To develop rugby in developing country, university soccer athletes could suggest good material, given needed tactical trainings and competitions, for national rugby team athletes.

Key words: Blood pressure, heart rate, maximal oxygen consumption, hip circumference, waist circumference, Speed, agility, core muscle strength and stability, muscular endurance.

Introduction

Rugby and soccer required much running and tackling.¹ Soccer does not involve full-contact as rugby but both engage in physical contact regarded as fair charging for the ball in a distance.²⁻⁴ To attain favorable performance outcomes, rugby and soccer players should possess adequate physical

fitness collectively and individual skills.^{5,6} Globally, emphasis is placed on the overall physical fitness parameters of rugby players such as muscular strength, muscular endurance, power, agility and flexibility either in a match or training session.^{6,7} Considering time and movement patterns, rugby players perform absolutely distinct activities in

Corresponding Author: Monday Omoniyi Moses, Department of Physiotherapy and Sports Science, Faculty of Allied Health Sciences, College of Health Sciences, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana.

E-mail: momoses@knust.edu.gh

Tel.: +233547336905

competition related to individual playing position than soccer.⁷

Rugby players are distinguished as backward and forward athletes whereas soccer players categorized as strikers, midfielders, and defenders.^{8,9} Based on lower body, rugby players received minimal attention due to collision at the lower extremities relative to soccer.^{10,11} Regarding contact sports, soccer players attract less publicity on upper extremity activities than rugby players.¹¹

Studies have advocate for well-developed physiological characteristics in elite rugby and soccer games.^{7,12-14} Given that physiological profile in rugby and soccer players depend on playing position, there is lower sameness within the playing position in rugby players compared to higher uniformity in soccer players. Also, development of adequate motor performance like muscular strength and endurance, agility, power, and flexibility cannot be overemphasized for success in rugby and soccer competitions.^{6,7} Studies have also addressed the combinations of sprinting tests of acceleration, maximal speed, and agility or tests of strength and power, whereas other studies have attempted a more holistic test battery.^{7,15-21}

Although rugby and soccer games are two very different sports, but whether the physique and body shape (anthropometric) and motor performance characteristics like power, muscular strength and endurance, agility, and flexibility of athletes in developing countries such as Ghana are different has not been investigated. This study comparatively presents the physiological, anthropometric, and motor performance characteristics of rugby and football athletes in a developing country.

Materials and Methods

Study design: The study adopted a descriptive cross-sectional research design. Participants were drawn from the national rugby (NR) Ghana's first team, a university rugby (UR) and a university soccer (US) team. 72 athletes (US=24, UR=25, and NR=23)

were recruited for the study. Participants diagnosed with injury and illness were excluded from the study.

Measurements: Physiological characteristics of heart rate (pulse), systolic and diastolic blood pressure were measured using the Omron blood pressure monitor (HEM-7130 Blood Pressure Monitor). An externally paced running fitness beep test was deployed to used to determine the maximal oxygen consumption (VO_{2max}) of the participants. The height, body weight, waist circumference, and hip circumference of participants were measured. Body mass index (BMI) value obtained from the body composition analyzer was recorded and analysed in $(kg)/height^2 (m^2)$. The ratio of waist circumference over hip circumference resulted to waist-to-hip ratio were anthropometric characteristics measured. For motor performance, participants performed lower limb explosive power (*5-Jump Test, 5JT*), Illinois agility, eight stages core muscle strength and stability, isometric wall squat, and Acuflex I Modified Flexibility Sit and Reach Box (Model: 00011) tests.

Statistical analysis: Descriptive statistics of percentiles, mean and standard deviation and inferential statistics analysis of variance (ANOVA). Specific area of differences were analysed with post hoc test of Bonferroni. Significance was set at 0.05 alpha level.

Results

The groups had mean age of 26.0 ± 3.33 , 22.54 ± 2.24 , and 21.84 ± 1.81 years with 25th percentile of 23.00, 21.00 and 20.00, respectively. For body mass index value, differences were detected among the groups with 95th percentile of 37.720, 34.44 and 25.20. Associating the 95th percentile of BMI to the normative values of World Health Organization (WHO), NR athletes were at risk of obesity II, UR at obesity I, and US at overweight. Table 1 showed the differences in anthropometric, physiologic, and motor performance characteristics of the participants among the groups while table 2 presented post hoc test of Bonferroni results with specific significant difference ($p < 0.05$).

Table 1: Differences in Anthropometric, Physiologic and Motor Performance characteristics of the participants among the Groups (N=72).

| Variable | US | UR | NR | Percentile | | | | F | p |
|---------------------------------|-------------|--------------|--------------|---------------------|------------------|------------------|------------------|--------|-------|
| | Mean ± SD | Mean ± SD | Mean ± SD | | | | | | |
| | (N=24) | (N=23) | (N=25) | 25 th | 50 th | 75 th | 95 th | | |
| Age(yrs) | 22.54± 2.25 | 26.00±3.33 | 21.84±1.82 | 20.89 ^a | 22.92 | 24.82 | 30.11 | 18.376 | .000* |
| Height(m) | 1.73±6.32 | 1.77±9.47 | 1.74±8.59 | 1.71 ^a | 1.74 | 1.79 | 1.90 | 1.447 | .242 |
| Weight (kg) | 67.43±6.59 | 79.96±13.85 | 71.96±12.73 | 65.00 ^a | 71.25 | 77.27 | 101.57 | 7.139 | .002* |
| BMI (kg/cm ²) | 22.35±1.83 | 26.56±4.87 | 23.66±4.17 | 21.50 ^a | 23.20 | 25.37 | 34.20 | 7.358 | .001* |
| WtHR | 0.43±0.03 | 0.52±0.12 | 0.47±0.05 | 0.42 ^a | 0.45 | 0.53 | 0.61 | 7.968 | .001* |
| HC(cm) | 93.15±4.90 | 83.03±12.28 | 98.60±19.92 | 86.05 ^a | 92.63 | 98.64 | 113.80 | 7.652 | .001* |
| WC(cm) | 74.15±3.99 | 90.80±17.26 | 84.00±9.80 | 73.80 ^a | 78.42 | 92.50 | 108.70 | 12.360 | .000* |
| WHR | 0.79±0.03 | 1.10±0.21 | 0.82±0.06 | 0.78 ^a | 0.82 | 0.93 | 1.26 | 42.580 | .000* |
| SBP(mmHg) | 113.21±9.44 | 130.09±15.05 | 126.64±13.29 | 112.75 ^a | 121.20 | 132.17 | 150.73 | 11.581 | .000* |
| DBP(mmHg) | 69.50±7.89 | 80.00±11.02 | 86.44±13.89 | 70.00 ^a | 77.33 | 86.00 | 101.20 | 14.145 | .000* |
| HR(bpm) | 59.79±7.74 | 66.74±12.59 | 75.92±12.36 | 58.25 ^a | 65.86 | 75.20 | 92.90 | 12.983 | .000* |
| VO ₂ max (ml/kg/min) | 43.91±6.18 | 46.41±5.14 | 35.24±6.53 | 35.82 ^a | 41.91 | 47.72 | 52.45 | 23.218 | .000* |
| 5JT/BM (cm/kg) | 3.02±0.62 | 3.83±0.85 | 3.73±1.68 | 2.82 ^a | 3.37 | 3.91 | 4.99 | 3.410 | .039* |
| Agility (sec) | 12.37±0.81 | 12.52±1.02 | 12.78±2.25 | 12.03 ^a | 12.69 | 13.38 | 14.19 | .458 | .634 |
| CMS (sec) | 7.21±1.52 | 7.57±0.79 | 6.88±1.20 | 6.50 ^a | 7.52 | 0.00 | 0.00 | 1.898 | .158 |
| ME(sec) | 42.48±10.96 | 53.52±11.72 | 37.84±14.08 | 35.00 ^a | 41.57 | 52.17 | 68.93 | 10.071 | .000* |
| SRT(cm) | 34.75±7.21 | 32.57±9.12 | 33.56±7.35 | 28.43 ^a | 33.67 | 38.83 | 47.60 | .449 | .640 |

Data reported in Mean value and Standard deviation (Mean± SD); ^a Percentiles are calculated from grouped data. Body weight, body mass index (BMI), waist-to-height ratio (WtHR), hip circumference (HC), waist circumference (WC), waist-to-hip ratio (WHR), blood pressure, heart rate, maximal oxygen consumption (VO₂max), 5-Jump Test (5JT/BM), agility, core muscle strength and stability (CMS), muscular endurance (ME), and sit and reach (SRT) were measured. *p<0.05, Mean value and Standard deviation: Mean± SD, SS: Sum of Square, MS: Mean Square, CI: Confidence Interval, MD= mean Difference

Table 2: Post hoc tests of Bonferroni

| Variable | (I) | (J) | Mean Diff.(I-J) | P | 95% CI |
|---------------------------|-----|-----|-----------------|-------|-------------|
| Age (yrs) | NR | US | 3.458* | 0.000 | 1.65, 5.26 |
| | | UR | 4.160* | 0.000 | 2.37, 5.95 |
| Weight(kg) | NR | US | 12.527* | 0.001 | 4.30, 20.75 |
| | | UR | 2.901* | 0.033 | 0.18, 5.62 |
| BMI (kg/cm ²) | NR | US | 4.202* | 0.001 | 1.46, 6.95 |
| | | UR | 2.901* | 0.033 | 0.18, 5.62 |
| WtHR | NR | US | 0.093* | 0.000 | 0.04, 0.15 |
| | | UR | 0.286* | 0.000 | 0.20, 0.38 |
| HC (cm) | US | NR | 10.124* | 0.046 | 0.15, 20.10 |
| | UR | NR | 15.574* | 0.001 | 5.70, 25.45 |
| WC (cm) | NR | US | 16.659* | 0.000 | 8.38, 24.94 |
| | UR | US | 9.854* | 0.012 | 1.74, 17.96 |
| WHR | NR | US | 0.307* | 0.000 | 0.22, 0.40 |
| | | UR | 0.286* | 0.000 | 0.20, 0.38 |
| SBP (mmHg) | NR | US | 16.879* | 0.000 | 7.73, 26.03 |
| | UR | US | 13.432* | 0.001 | 4.47, 22.39 |
| DBP(mmHg) | NR | US | 10.500* | 0.006 | 2.46, 18.54 |
| | UR | US | 16.940* | 0.000 | 9.07, 24.81 |

| Variable | (I) | (J) | Mean Diff.(I-J) | P | 95% CI |
|--------------------------------|-----|-----|-----------------|-------|-------------|
| HR (bpm) | UR | US | 16.128* | 0.000 | 8.33, 23.93 |
| | | NR | 9.181* | 0.017 | 1.30, 17.06 |
| VO ₂ max(ml/kg/min) | US | UR | 8.671* | 0.000 | 4.46, 12.88 |
| | UR | UR | 11.173* | 0.000 | 6.92, 15.43 |
| ME (sec) | NR | US | 11.043* | 0.009 | 2.19, 19.89 |
| | | UR | 15.682* | 0.000 | 6.92, 24.45 |

* $p < 0.05$, CI: Confidence Interval

Discussion

This study investigated the physiological, anthropometric, and motor performance characteristics of rugby and football athletes in a developing country. Results showed significant difference in weight, body mass index, waist to height ratio, waist to hip ratio, blood pressure, heart rate and VO₂max, and muscular endurance among the categories differences which support earlier submissions that variations in anatomical body shapes may influence physical performance.²²⁻²⁴

Although there were significant differences in physiological and motor performance among the groups, similarities showed in some characteristics. For example, players' height and weight in the NR team were more than that of UR and US teams. Differences in professional recruitment strategy where specific standard criteria should be met to qualify for selection could be implicated.¹⁶ Roscoe established that NR players had higher, broader, and stability body shape than UR and US teams.²⁴ This suggests that university athletes have no strict recruitment process comparatively since players are drawn from the pool of students admitted. Hence, university sports coaches, irrespective of sports discipline, would expectedly work vigorous with the materials within reach to attain optimal success.

Distinctions were also discovered in body mass index (BMI) which correlates with the body mass of US players.²⁴ US and UR players had better waist to hip ratio and low health risk compared to UR and NR players with high health risk.²⁵⁻²⁸ Study reiterates that in contact situation extra body fat function as a supportive cushion especially among the forwards, though directly affect players' power-to-weight ratio, reduces boost ability and increase energy consumption.²⁹

Among the groups, US players had normal

blood pressure and lowest heart rate while UR and NR players were prehypertensive and hypertensive respectively. This might be related to changes in the product of demand in respiratory functioning.³⁰ Low heart rate at rest implies better breathing capacity when blood is elevated, reduced stress level, drug impact and inadequate blood flow to the athletes' subconscious within the game.³¹ The ability to understand playing patterns and perform efficient actions amid pressure and stress was an element of successful athletes. This study showed that NR players had dominant VO₂max over US and UR players accordingly. The rational, considering NR, US, and UR at large, will give credence to the levels of participation. It can also be seen that UR was emerging game compared to US games in Ghana. Elite athletes need agility levels to withstand the physiological constraints and execute the variety of offensive and defensive capabilities that competition needed.³²⁻³³

Conclusion

There are differences and similarities in the physiological, anthropometric, and motor performance characteristics of rugby and football athletes in a developing country. University soccer athletes could be good material, given needed tactical trainings and competitions, for national rugby team athletes. Considering the physiological characteristics, electrocardiogram assessment will certainly add strength our findings.

Sources of Funding: Authors declare that declare this study, both in part or as a whole, did not receive financial support from any individual or organization

Conflict of Interest: Authors have no conflict of interest to be declared.

Ethical Considerations: The participants consented to participate in the study. The study was also submitted to the Committee on Human Research Publication and Ethics of the Kwame Nkrumah University of Science and Technology & Komfo Anokye Teaching Hospital for approval.

References

1. Tierney P, Blake C, Delahunt E. Physical characteristics of different professional rugby union competition levels. *J Sci Med Sport*. 2021;24(12):1267-71. <https://doi.org/10.1016/j.jsams.2021.05.009>
2. Le Flao E, Siegmund GP, Borotkanics R. Head Impact Research Using Inertial Sensors in Sport: A Systematic Review of Methods, Demographics, and Factors Contributing to Exposure. *Sports Med*. 2021;1-24. <https://doi.org/10.1007/s40279-021-01574-y>
3. Salmon DM, Badenhorst M, Walters S, et al. The rugby tug-of-war: Exploring concussion-related behavioural intentions and behaviours in youth community rugby union in New Zealand. *Int J Sports Sci Coach*. 2022;17(4):804-16. <https://doi.org/10.1177/174795412111047661>
4. Vedung F, Hänni S, Tegner Y, Johansson J, Marklund N. Concussion incidence and recovery in Swedish elite soccer—Prolonged recovery in female players. *Scand J Med Sci Sports*. 2020;30(5):947-57. <https://doi.org/10.1111/sms.13644>
5. Parker DA, Angadi DS. Rugby. In: Rocha Piedade S, Neyret P, Espregueira-Mendes J, Cohen M, Hutchinson MR. (eds). *Specific Sports-Related Injuries*. Springer, Cham. 2021; 117-145. https://doi.org/10.1007/978-3-030-66321-6_8.
6. Van Zanten JJ, Fenton SA, Rouse PC, et al. Autonomous motivation, cardiorespiratory fitness, and exercise in rheumatoid arthritis: Randomised controlled trial. *Psychol Sport Exerc*. 2021;55:101904. <https://doi.org/10.1016/j.psychsport.2021.101904>
7. Meir R, Newton R, Curtis E, Fardell M, Butler B. Physical fitness qualities of professional rugby league football players: determination of positional differences. *J. Strength Cond. Res*. 2001;15(4):450-8.
8. Pojskic H, Åslin E, Krolo A, et al. Importance of reactive agility and change of direction speed in differentiating performance levels in junior soccer players: Reliability and validity of newly developed soccer-specific tests. *Front Physiol*. 2018;9:506. <https://doi.org/10.3389/fphys.2018.00506>.
9. Harper DJ, Carling C, & Kiely J. High-Intensity Acceleration and Deceleration Demands in Elite Team Sports Competitive Match Play: A Systematic Review and Meta-Analysis of Observational Studies. *Sports Med*. 2019; 49(12):1923-47. <https://doi.org/10.1007/s40279-019-01170-1>.
10. Strauss SB, Fleysher R, Ifrah C, et al. Framing potential for adverse effects of repetitive subconcussive impacts in soccer in the context of athlete and non-athlete controls. *Brain Imaging Behav*. 2021;15(2):882-95. <https://doi.org/10.1007/s11682-020-00297-4>.
11. Wass J, Mernagh D, Pollard B, et al. A comparison of match demands using ball-in-play vs. whole match data in elite male youth soccer players. *Sci. Med. Footb*. 2020;4(2):142-7. <https://doi.org/10.1080/24733938.2019.1682183>.
12. Gabbett TJ. Physiological characteristics of junior and senior rugby league players. *Br. J. Sports Med*. 2002;36(5):334-9.
13. Gabbett TJ. Changes in physiological and anthropometric characteristics of rugby league players during a competitive season. *J. Strength Cond. Res*, 2001; 19(2), 400-8.
14. Gallo TF, Cormack SJ, Gabbett TJ, Lorenzen CH. Pre-training perceived wellness impacts training output in Australian football players. *J. Sports Sci*. 2016;34(15):1445-51.
15. Baker DA. A comparison of running speed and quickness between elite professional and young rugby league player. *Strength Cond Coach*. 1999;7(3):3-7.
16. Clarke N, Farthing JP, Norris SR, Arnold BE, Lanovaz JL. Quantification of training load in Canadian football: application of session-RPE in collision-based team sports. *J. Strength Cond. Res*. 2013;27(8):2198-205.
17. Baker D. Differences in strength and power among junior-high, senior-high, college-aged, and elite professional rugby league players. *J. Strength Cond. Res*. 2002;16(4):581-5.
18. Baker D. Comparison of lower body strength and power between national, state and city level rugby league football players. *Strength Cond Coach*. 2000;8(4):3-7.
19. Brewer J, Davis J, Kear J. A comparison of the physiological characteristics of rugby league forwards and backs. *J Sports Sci*. 1994;12(2):158.
20. Little T, Williams A. Specificity of acceleration, maximum speed and agility in professional soccer players. Routledge: London, UK; 2003.

21. Clark MD, Varangis EM, Champagne AA, Giovanello KS, Shi F, Kerr ZY, Smith JK, Guskiewicz KM. Effects of career duration, concussion history, and playing position on white matter microstructure and functional neural recruitment in former college and professional football athletes. *Rad.* 2018;286(3):967.
22. Gajdosik RL, Giuliani CA, Bohannon RW. Passive compliance and length of the hamstring muscles of healthy men and women. *Clin Biomech.* 1990;5(1):23-9.
23. Duncan MJ, Woodfield L, Al-Nakeeb Y. Anthropometric and physiological characteristics of junior elite volleyball players. *Br. J. Sports Med.* 2006;40(7):649-51.
24. Roscoe LJ. Wellness: A review of theory and measurement for counselors. *J Couns Dev.* 2009;87(2):216-26.
25. Kim MK, Han K, Park YM, et al. Associations of variability in blood pressure, glucose and cholesterol concentrations, and body mass index with mortality and cardiovascular outcomes in the general population. *Circul.* 2018;138(23):2627-37.
26. De Koning L, Merchant AT, Pogue J, Anand SS. Waist circumference and waist-to-hip ratio as predictors of cardiovascular events: meta-regression analysis of prospective studies. *Eur. Heart J.* 2007;28(7):850-6.
27. Huxley R, Mendis S, Zheleznyakov E, Reddy S, Chan J. Body mass index, waist circumference and waist: hip ratio as predictors of cardiovascular risk – a review of the literature. *Eur. J. Clin. Nutr.* 2010;64(1):16-22.
28. Duthie GM. A framework for the physical development of elite rugby union players. *Int J Sports Physiol Perform.* 2006;1(1): 2-13.
29. Hofmann P, Pokan R. Value of the application of the heart rate performance curve in sports. *Int J Sports Physiol Perform.* 2010;5(4):437-47.
30. Bouzat P, Sala N, Payen JF, Oddo M. Beyond intracranial pressure: optimization of cerebral blood flow, oxygen, and substrate delivery after traumatic brain injury. *Ann. Intensive Care.* 2013;3(1):1-9.
31. Gabbett TJ, Domrow N. Relationships between training load, injury, and fitness in sub-elite collision sport athletes. *J. Sports Sci.* 2007;25(13):1507-19.
32. Chaouachi M, Granacher U, Makhlof I, et al. Within session sequence of balance and plyometric exercises does not affect training adaptations with youth soccer athletes. *J. Sports Sci. Med.* 2017;16(1):125.