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## Evaluation of physical and physiological capacities of elite's Brazzaville football field and assistant referees (Republic of Congo)

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### Abstract

This study aimed to assess the physical and physiological capacities of elite's Brazzaville football federation referees according to their competitive status. Twenty-five referees were grouped on field referee (n = 12) and assistant referee (n = 13). The physical and physiological capacities were measured using repeated sprint ability (RSA) test, split test (75/ 25), the linear straight sprinting tests and the Yo-Yo intermittent recovery level 1 test (YYIR1). The result showed that, assistant referee significantly faster in the 75/25 split test ( $p<0.05$ ;  $p<0.01$ ;  $p<0.001$ ) than field referee. In addition, assistant referee covers significantly ( $p<0.01$ ) less distance on the YYIR1 test than field referee and shows significantly ( $p<0.01$ ) lower  $VO_2\text{max}$  in the assistant referee group. FIFA and National female's assistant referee covers significantly ( $p<0.01$ ) less distance on the YYIR1 test than required. Our results suggested the need for specific training programs focused on maintaining the ability to repeat sprints, resistance, change of direction, acceleration and aerobic capacity in Congolese top level referees.

**Keywords:** FIFA, football, field referee, assistant referee, physical capacity, physiological capacity

### Introduction

In football, field referees and assistant referees are responsible for the control and supervision of matches. From a physical and physiological point of view, this control and supervision is dynamic and takes place through several intermittent actions throughout the match, going from low intensity actions to high intensity ones <sup>[1]</sup>. These actions are external and internal loads that trigger a positive adaptation to the organism and allow both a correct positioning closer to the actions to be supervised and taking of the right decisions <sup>[1, 3]</sup>. External load is a measure of physical activity across distances traveled, while internal load is a measure of a combination of biochemical and biomechanical stresses on the human system <sup>[2, 4]</sup>. They are measured by three most common methods: <sup>[1]</sup> global positioning systems (GPS), <sup>[2]</sup> ratings of perceived exertion (RPE) session, and (3) heart rate monitors (3). During a game, field referees covers the entire playing field while assistant referees will supervise on the sideline <sup>[5, 6]</sup>. It has been observed external loads of field referees between 9 and 14 km per match and those of assistant referees between 5 and 9 km per game, or about 33 to 50% less <sup>[7, 8]</sup>. For example, he was observed the field referees had traveled  $798.32\pm 310.19$  m at high speed ( $>18$  km/h) against  $273.74\pm 132.11$  m for assistant referees, i.e. 66% less <sup>[9]</sup>. These external loads had a direct impact on the internal loads, averaging around 77% of HR max. In field referees, mean heart rate is around  $152.87\pm 11.44$  bpm versus  $132.73\pm 13.63$  bpm in assistant referees <sup>[10]</sup>.

Facing these high physical and physiological demands during matches, football referees are huge challenges to meet. These recent years, the development of technology unable to better understanding these referee and assistant referee demands during competition and training through the use of national and international committee's test batteries <sup>[11]</sup>. At the beginning, officials fitness battery included three specific tests, namely: <sup>[1]</sup> the 12-minute continuous running test at a minimum average speed of 13.5 km/h; <sup>[2]</sup> the 2x50 m sprint and <sup>[3]</sup> the 2x200

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m sprint in a standard time of 7.5 and 32 seconds respectively for field referees and assistant referees respectively [11]. However, a lack of relationship between fitness battery and physical performance during matches (domestic and international) led to more reflection [12]. Nowadays, the test battery named "the new test 2005" introduced by the International Federation of Football Association (FIFA) serves as a standard to evaluate field referees and assistant referees external and internal loads in the conditions very close to the football field reality. This is why the 6x40 m repeated sprints ability (RSA) and the fractionated tests (10 laps of football field) are respectively used among field referees, 5x30 m RSA and the change of direction race (CODA) among assistant referees and level 1 intermittent recovery Yo-Yo iR1 among both [13].

In the Republic of Congo, the FIFA 2005 test battery is only used during advanced training courses or course of members association of football referees called "MA Course ". They are held regularly each year for elites (MA Elites Referees Course) and young talents (MA young talents Referee Course). Despite this advantage, the Congolese field referees and assistant referees are regularly absent from the refereeing of major African and world competitions. This absence is a major concern that caught our attention and we thought that an assessment of physical and physiological capacities of elite's Brazzaville field and assistant referees would be a welcome addition to the existing scientific literature.

## Materials and Methods

### Procedures

This study assesses the physical and physiological capacities of the [25] Congolese football referees selected for the MA Elites Referees Course development seminar. The data of relevant fitness tests were assessed by repeated sprints ability (RSA), the fractionated tests (10 laps of football field), the change of direction and the Yo-Yo iR1 among soccer referees during the 2021/2022 competitive season. Their Body weight and height were obtained with standard techniques to the nearest 0.1 kg and 0.1 cm, respectively. Body fat percentage was calculated from four skinfold measurements using a caliper (Hapenden Skinfold, Iceland) on the right side of the body [15].

### Participants

A convenience sample of 25 referees (12 fields and 13 lines) from the Congolese Football Federation (Republic of Congo) voluntarily participated in the study. Potential participants were informed of the risks and benefits of the study before signing the informed consent form. Only participants meeting the inclusion criteria were included in the study. The inclusion criteria for the study were as follows: (1) being selected for the MA Elites professional Referees Course, (2) being between 18 and 35 years old, (3) BMI status between 18.5 and 25.0 kg/m<sup>2</sup>, (4) having officiated first or second division matches, (5) training at least three sessions of 120 min plus one competitive match per week, (6) having competitive experience of at least 5 years old, and (7) not suffering from any injury or health problem that could hinder the development of the intervention. All participants received the same training. None of the study participants received any financial reward for their participation. This study was conducted taking into account the principles of the Declaration of Helsinki for research involving humans [14].

**Anthropometric characteristics:** Body weight and height were obtained with standard techniques to the nearest 0.1 kg

and 0.1 cm, respectively. Body fat percentage was calculated from four skinfold measurements using a caliper (Hapenden Skinfold, Iceland) on the right side of the body [15].

### The FIFA Physical fitness test

The assessment of the physical condition of the Congolese field and assistant referees was carried out as reported by Schmidt *et al.* [16]. They have passed the FIFA test at least once a year. This test battery was carried out by two qualified physical instructors assisted by three other auxiliaries. The field and assistant referees conducted the tests separately in groups of 12 or 13 respectively.

### The specific physical and physiological capacities tests for field referees consisted of two subtests

First, the repeated sprints ability (RSA): It measures the field referee's ability to perform six repeated sprints over 40 m (maximum time allowed: 6 s per trial); they received 60 s of recovery between each of the 6 × 40 m sprints. During their recovery, the referees walk to the start line. If the referee failed to achieve one of the six tries, they received a seventh try immediately after the sixth one. If he failed two out of seven attempts, the official match coach would inform that this participant failed the test.

Second, the fractionated test: It assesses the ability of the assistant referee to perform a series of high speed runs over 75 m (maximum time allowed = 15 s) interspersed with 25 m walking intervals (time recovery = 20 sec). The total number of executions was 40; the minimum speed for high speed runs was 18 km/h. The referees performed running intervals of 40 × 75 m + 25 m walk, making a total of 4000 m. At the end of each race, each referee must enter the walking area before the order given by the official event instructor (whistle). If the referee did not step inside the walk area in time, they received a warning from the test instructor. If he failed to place a foot inside the walking area in time for a second time, he was stopped by the test instructor and informed that he had failed the test.

### The specific physical and physiological capacities tests for assistant referee consisted of two subtests

First, the running test with change of direction (CODA): It assesses the ability of the assistant referee to change direction. They sprint 10 m forward, 8 m to the left side, 8 m to the right side and 10 m forward. If an assistant referee failed, he or she received an additional try. If he fails two attempts, the official test instructor informs him that the participant has failed the test. Reference time for male assistant referees: maximum 10 s per attempt. Reference time for female assistant referees: maximum 11 s per attempt. Second, the repeated sprint ability test (RSA): It measures the ability of the assistant referee to perform five 30m sprints (maximum time allowed per trial = 4.70 s for men and 5.10 s for women). The assistant referee had 30 s of recovery between each of the 5 × 30 m sprints. During their recovery, the assistant referee had to return to the starting point. If an AA failed, he or she received an additional try immediately after the failed sprint. If he failed two out of six attempts, the test instructor would inform him that he had failed the test.

### The physical and physiological capacities tests common to field and assistant referees consisted of one sub-test

Aerobic capacity was assessed using a progressive incremental protocol to exhaustion using the Yo-Yo Intermittent Recovery Level 1 (Yo-Yo iR1) test according to the procedures used by Hammami *et al.* [17] in young North

African elite female footballers. This test was used as a predictor of high intensity aerobic capacity and  $VO_2\max$ . Prior to data collection, all participants familiarized themselves with the test. The field and assistant referees ran between two parallel lines 20 meters apart, at progressively increasing speeds controlled by the "beeps" of a CD. They have had a 10-second active rest period (deceleration and return to the starting line) between each run. Yo-Yo IR1 was also used to estimate  $VO_2\max$  (ml/min\*kg). Once the referee did not reach the line in time, the distance covered was recorded and was used to determine his aerobic capacity [8].

## Results

**Table 1:** Characteristics of Congolese football referees

Variables	Total	Statut compétitif		Age	
		Field referee	Assistant referee	< 30 ans	≥ 30 ans
N	25	12	13	14	11
Age (an)	29,60±4,26	30,33±4,81	28,92±3,75	26,50±2,34	33,55±2,42***
Size (m)	1,69±0,06	1,68±0,05	1,69±0,06	1,69±0,05*	1,67±0,06
Weight (Kg)	62,36±6,43	62,25±4,65	62,46±7,93	60,71±5,06	64,45±7,58
BMI (kg/m <sup>2</sup> )	21,02±4,81	20,21±6,44	21,77±2,66	19,60±5,88	22,83±2,05
% MG	11,80±4,57	11,43±3,97	12,15±5,20	9,43±3,58*	14,83±3,95

**Legend:** AT = indicates field referees; AA = indicates assistant referees;  $\bar{y}$  30 years old = indicates referees aged 30 and over < 30 years old = indicates referees aged 30 or younger.

This table shows the anthropometric parameters (age, height, weight, BMI) and body composition (% body fat) of field and assistant referees. Statistical analysis reported mean ages, average heights, average weights, average BMIs and % MG.

## Statistical analysis

Data were coded and processed with Excel 2016 and analyzed using SPSS software version 25 (SPSS Inc., Chicago, IL, USA). All of our analyzes were based on the exploitation of anthropometric variables, external load (distance traveled) and internal load ( $VO_2\max$ ). These data were analyzed using the one-sample t- test and the ANOVA test for repeated measures. A difference was considered significant at the 5% level.

Finally, it shows the anthropometric parameters and body composition of referees aged under 30 and over 30. Statistical analysis reported mean heights, mean weights, mean BMIs and % GM

**Table 2:** the split test for field and assistant referees

		Split 1	Split 2	Split 3	Split 4	Split 5	Split 6	Split 7	Split 8	Split 9	Split 10
FR	$\bar{x}$	15,46	15,42	15,49	15,82	15,96	15,97	16,24	15,99	16,43	16,30
	$\epsilon$	0,72	1,04	1,24	1,72	1,99	2,21	2,05	2,73	3,24	2,55
AR	$\bar{x}$	15,31	14,82	15,56	15,45	15,59	15,79	15,56	15,47	15,79	15,50
	$\sigma$	0,36	0,70*	0,50#	0,38	0,61**	0,70	0,59***	0,93	0,70	0,62

**Legend:** FR: indicates field referee; AR: indicates assistant referee;  $\bar{x}$  = indicates the arithmetic mean;  $\epsilon$  = indicates the standard error; \*: indicates a difference significant between Split 1 and Split 2; #: Indicates a significant difference between Split 2 and Split 3; significant difference between Split 2 and Split 3; \*\*: Indicates a significant difference between Split 2 and Split 3; \*\*\*: Indicates a significant difference between Split 2 and Split 7.

This table showed that assistant referee significantly faster in the 75/25 split test 2, 5 and 7 ( $p < 0.05$ ;  $p < 0.01$ ;  $p < 0.001$ ).

**Table 3:** repeated sprint ability, CODA and Yo-Yo IR1 tests

Variables	Groups	
	Field referee (n = 12) $\bar{x} \pm \epsilon$	Assistant referee (n = 13) $\bar{x} \pm \epsilon$
RSA1	5,76±0,47	4,35±0,21
RSA2	5,66±0,48	4,38±0,29
RSA3	5,72±0,45	4,35±0,22
RSA4	5,70±0,42	4,37±0,25
RSA5	5,73±0,42	4,37±0,27
RSA 6	5,80±0,42	/
CODA test	/	9,37±0,52
Bad performance	5,83±0,39	4,47±0,27
Best performance	5,59±0,39	4,28±0,23
Average performance	5,70±0,39	5,19±0,27
Fatigue index	0,24±0,10	0,19±0,11
Distance YoYo-IR1 (m)	1510,0±442,8**	1107,6±225,9
$VO_2\max$ (ml/min*kg)	49,07±3,70**	45,72±1,90

This table shows the performances of the RSA test respectively in field referee (6 x 40 m with 3 min of recovery) and assistant referee (5 x 30 m with 3 min of recovery). Statistical analysis reported average RSA (5.70±0.39 s and 5.19±0.27 s), best performance (5.59±0.39 s and 4.28±0.23 s) and bad performance (5.83±0.39 s and 4.47±0.27 s). Next, it shows the performance of the CODA test for assistant referee. Statistical analysis reported an average CODA (9.37±0.52). Finally, the field referee travelled an average of 1510.0±442.8 m for a  $VO_2\max$  of 49.07±3.70 ml/min\*kg while the assistant referee travelled an average of 1107.6±225.9 m for a  $VO_2\max$  of 45.72±1.90 ml/min\*kg in Yo-Yo IR1 test

**Table 4:** comparison of internal and external loads of AT and AA

Variables		Measured values	Required values	p
Field referee FIFA & Nationals	<b>Men</b>			
	<i>Distance covered</i>	1800	1800	Ns
	<i>VO<sub>2</sub>max</i>	51,5	51,5	Ns
	<b>Ladies</b>			
	<i>Distance covered</i>	930	1240	0,06
	<i>VO<sub>2</sub>max</i>	44,22±1,78	46,8	0,06
Assistant referee FIFA & Nationaux	<b>Men</b>			
	<i>Distance covered</i>	1200	1470	Ns
	<i>VO<sub>2</sub>max</i>	46,5	46,5	Ns
	<b>Ladies</b>			
	<i>Distance covered</i>	600	1080*	0,05
	<i>VO<sub>2</sub>max</i>	41,45±0,79	46,5	0,50

This table showed the distances and VO<sub>2</sub>max of the field and assistant referees in Yo-Yo IR1 test. Statistical analysis reported means distances covered of 1800 m with VO<sub>2</sub>max of 51, 5 ml/min\*kg and 930 m with VO<sub>2</sub>max of 44, 22±1, 78 ml/min\*kg in male and female field referee respectively. Furthermore, this table also reported means distances covered of 1200 m with VO<sub>2</sub>max of 46, 5 ml/min\*kg and 600 m with VO<sub>2</sub>max of 41, 45±0,79 ml/min\*kg in male and female assistant referee respectively

## Discussion

This study aimed to assess the physical and physiological capacities of Congolese football federation referees according to their competitive status. To this end, the levels of physical and physiological capacity were evaluated using the FIFA 2005 test battery. Intermittently, the field and assistant referee capacity were in accordance with the FIFA's requirement (Table 2). We observed that the time achieved on the 75/25 m split test was lowered compared to the times required by FIFA. This result reveals that the Congolese elite field referee all achieved the performance within the time limits required by FIFA for each repetition. It means that Congolese elite referees are physically ready to meet the requirements of FIFA, which requires them to complete a minimum of ten (10) laps, the equivalent to four thousand (4000 m). Synonymously, this can be explained by their great capacity for resistance. It seems that the training volume performed during the resistance training sessions played a very important role in chronic muscle adaptations, muscle strength and the achievement of the 75/25 test.<sup>[18]</sup>

The repeated sprints ability capacity achieved by Congolese field and assistant referees was in accordance with the FIFA's requirement (table 4). This result is explained by the application of repeated acceleration sequences instead of the repeated sprint capacity<sup>[1]</sup>. For repeated sprint ability, the times achieved in the 6 x 40 m and 5 x 30 m tests are respectively 5"8 and 4"7 and the recovery time should be 1' for the first and 30" for the second<sup>[19]</sup>. The 3 min seems to be so large and excluded any solicitation of the lactic anaerobic system and the ability to maintain a velocity as the onset of fatigue progresses. The Congolese referees undoubtedly mobilized aerobic metabolism instead of lactic anaerobic metabolism. In technical terms, the field referee mean time and the best time in the 6 x 40 m RSA test, was slightly bad than that reported by Banda *et al.*<sup>[21]</sup> and Weston *et al.*<sup>[22]</sup> among Zimbabwean and English referees respectively. This could be explained by the low level of competition and the lack of opportunity to officiate in encounters with the significant demands of the anaerobic lactic sector. Furthermore, the assistant referee mean time and best time in the 5 x 30 m RSA test was slightly bad than that is reported by Riiser *et al.*<sup>[23]</sup> in Norwegian assistant referee and the 4.70 s required by the FIFA. Consequently, this can be explained

by having a low level of aptitude necessary to meet the demands of refereeing.

The ability to change direction (CODA) was in accordance with the FIFA's requirement. We observed that the elite Congolese field referee best time of 9.37±0.52 s was slightly better compared to 9.60±0.42 s reported by Banda *et al.*<sup>[21]</sup> and 9.61±0.45 s reported by Castagna *et al.*<sup>[24]</sup> respectively among the Zimbabwean and Italian referees. This can be explained by the specificity of the match activities of assistant referee. The Congolese assistant referee had undoubtedly become familiar with the test as they regularly attend MA seminars organized by FIFA. It also seems that Congolese soccer assistant referee trained regularly at CODA to keep in mind the ability to change direction during the game due to the nature of the game.

The distance covered capacity was in accordance with the FIFA's requirement. We observed that the Congolese field referee significantly covered a greater distance ( $p < 0.01$ ) than that covered by the assistant referee (Table 3). This is similar to the result reported by Lategan *et al.*<sup>[25]</sup> where the field referee covered a greater distance than their assistant referee counterparts. Moreover, this distance of 1510.0±442.8 m achieved by the Congolese field referee is slightly lower than 1720±276 m much lower than and the 2480±454.90 m reported by Weston *et al.*<sup>[22]</sup> among Belgian international field referees and Lategan *et al.*<sup>[25]</sup> among South African field referees respectively. Furthermore, the distance of 1107.6±225.9 m achieved by the Congolese assistant referee is much lower than the 2595.39±733.13 m reported by Lategan *et al.*<sup>[25]</sup> among South African assistant referees. The Congolese field and assistant referee's bad results could plausibly be attributed to the number of women in the group. When presented separately, we observed that the male field referee covered the distance of 1800 m required. Whereas, female field referee as well as male and female assistant referee significantly ( $p < 0.05$ ) unable to reach the required distances of 1240 m, 1470 m and 1080 m respectively (Table 4). This weakness is probably due to the fact that referees had reached their maximum effort zones faster compared to other similar samples.

The physiological capacity was also in accordance with the FIFA's requirement (Table 3). We observed that the VO<sub>2</sub>max of 49.07±3.70 ml/kg/min in elite Congolese field referee was significantly higher ( $p < 0.01$ ) compared to the VO<sub>2</sub>max of



their assistant referee counterparts and is slightly higher than the  $48.9 \pm 3.8$  ml/kg/min reported by Almeida *et al.* [26]. However, it is lower than the  $50 \pm 1.3$  ml/kg/min reported by Silva *et al.* [27] may be due to their low levels of aerobic fitness and/or an inability to maintain the high intensity levels of the Yo-Yo IR1 test. Moreover, it had been argued that the  $VO_2\max$  of 50 ml/kg/min is sufficient for arbitration [21]. Current result of elite Congolese field referee is well below the 50ml/kg/min value, suggesting that Congolese field referee have low levels of aerobic fitness. This can be explained undoubtedly by the type of training. By separating women in the group, we have observed that male field and assistant referees reached the FIFA required values of 51.5 and 46.5 ml/kg/min respectively. This proves that the preparation before the MA courses based on the pre-training guide has enabled Congolese referees at FIFA and national levels to develop their aerobic and anaerobic capacities necessary for good performance.

### Conclusion

In general, the physical and physiological capacities of Congolese elite referees meet the requirement of the FIFA. But technically, the Congolese field and assistant referees are slightly or much lower physical and physiological capacities than the published results in international level. Furthermore, the elite Congolese field referee performances are significantly better than that obtained by assistant referee and that of women are significantly lower than that obtained by men.

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