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Comparative Study of Motor Fitness of Indian Soccer Referees at Different Levels

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Abstract – National and international soccer referees' associations routinely assess the fitness of elite-standard officials because high fitness is considered to be necessary to cope with the physical stress imposed on referees during matches (Castagna, Abt, & D'Ottavio, 2002).The aim of the present research was primarily to compare the motor fitness abilities of Indian Fe´de'ration Internationale de Football Association (FIFA) referees at different levels (category 1 and category 2) and, secondly, to investigate whether the fitness tests of FIFA provide reliable discrimination criteria between the different levels of referees. The main focuses of present research were speed and endurance, which were measured by the sprint test of FIFA —namely, Repeated Sprint Ability (RSA, 6*40m), and Interval Test (150m sprint+50m walk, 4000m (min)), respectively . In the study, the test results of 45 soccer referees were analyzed. Referees were classified into 3 different levels according to their results on motor fitness test. It included the results of the 30 CAT 1 referees (15 CAT 1R, 15 CAT 1AR) and the results from 15 CAT 2 referees (CAT 2R). The results show that in the interval run test, 86.7% CAT 1R (mode=4800m) covered the distance above required minimum distance (4000m), followed by 60% CAT 1AR (mode=4000m) and 26.7% CAT 2R (mode=4000m) (range: 4000m- 4800m). Differences between groups in the endurance event were significant (p<0.05) in all cases. In the sprint runs, there was no difference between CAT 1R and CAT 1AR while both CAT 1R and CAT 1AR significantly differed from CAT 2R. It can be concluded that the aerobic fitness level demonstrated in the interval runs provides the most adequate criteria for discrimination between category 1 and category 2 referees. Also, the major quality improvement phase in a referee's career can be located at the CAT 2 competition level.

Keywords: Football, Referee, Motor Fitness, Field Tests, RSA, CAT 1R, CAT 2R.

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INTRODUCTION

Association football or soccer is considered the most popular sport currently played in the world (Peiser B, Minten, 2003). In football, **Referee** assisted by two assistant referees is responsible for smooth conduction of match abided by the laws of football. Referees have to be in the right place at the right time, observe play closely, interpret the rules and make critical decisions. Referees are licensed and trained by the same national organisations that are members of FIFA.

Positioning

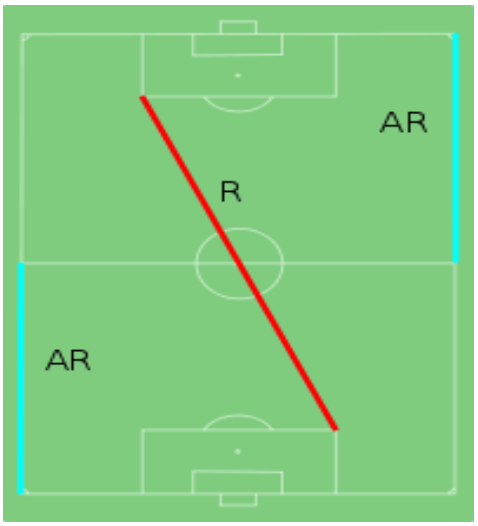


Figure 1: Diagonal system of control showing the paths of the Referee (R) and the Assistant Referees (AR)

A match of football exerts physical, physiological, cognitive demands on referees which is continuously increasing (D'Ottavio, 1993, Catterall et al., 1993; Johnston and McNaughton, 1994; Krustrup and Bangsbo, 2001). The referee's total distance covered during the match is similar to that described for soccer player, in particular to midfield players (Bangsbo et al., 1991; Mohr et al., 2003; Rienzi et al., 2000; Tumilty, 1993). Also, the distance covered at high intensity activities (running and sprinting) is correlated with referee's aerobic fitness (Castagna, 2002; Krustrup, 2001). More experienced referees probably demonstrate better positioning allowing them to follow the game more closely than the first division officials. The observation of an experienced referee over 8 years has shown that distances decrease although there is an increase in intensity of movement (Weston, 2004).

Relatively few studies have focused on the activity of assistant referees. Assistants have been shown to cover shorter distances than referees and perform brief intense bouts of forward running interspaced with long periods of inactivity. The ability of the linesman to keep level with the most forward striker is essential to avoid contentious fouls when players are judged to be "off side".

The classification of referees into different competitive levels has been a complex and difficult phenomenon. Because game performance cannot really be measured using objective criteria, no one can really make a reliable classification of game officials; therefore, a need for an objective discrimination between referees has been raised. One part of the measurable inclusion criteria is the fitness level of the referees. Referees' conditional abilities are measured with the help of specific fitness tests defined by the Fe´de´ration Internationale de Football Association (FIFA). According to these criteria, referees at the national and international levels must participate every 6 months in compulsory, predetermined measurements; so far, the measurements used are the fitness tests of FIFA. The fitness tests include 6*40-m sprint runs and an interval run test. The suggested limits set by FIFA for the international level are:

a. interval run ≥ 4000 m(10 lap of standard 400-mtr track),

b. 6*40-mtr runs in 6.20s (each sprint) for CAT 1R, and CAT 2R and 6.40s for CAT 2R.

The question raised here is whether these fitness tests can be used to classify referees and separate them into different qualification levels. It has been demonstrated (Castagna, C. et al.) that, among the above field tests, the one that shows the strongest correlation with game performance is the endurance run, which emphasizes, once more, the importance of the aerobic fitness of referees; the credibility of the sprint runs concerning referees' game performance is still an open question. The purpose of the present study was to compare the motor fitness of football referees at different levels (CAT 1 and CAT 2) and also investigate whether the fitness tests significantly contribute in categorizing referees into different levels.

METHOD AND MATERIALS

Participants

For the purpose of the present study, as per the availability of subjects, 45 soccer referees (15 CAT 1R, 15 CAT 1AR and 15 CAT 2R) were selected from different states of India with officiating experience of minimum 8-9 years at different level of championships and tournaments organized by the State Football Associations and All India Football Federation (AIFF). The mean age and body mass of the referees was 38.0 years (s.d.=5.1yr) and 80.8 kg (s.d.=10.0kg), respectively. Written informed consent was received from all referees after verbal and written explanations of the experimental design.

Experimental design

Two fitness tests, which are the official FIFA referee fitness tests, were performed: 6*40-m sprint test and an interval test. The referees arrived at the test session having rested for a minimum of 48 h and having followed nutritional guidelines to ensure they were fully hydrated and energized. All referees had performed the tests on at least one occasion before the test session and had not reported any injuries throughout the period of pre-season training that preceded the fitness tests.

(1) 6*40-m sprint test: The FIFA test procedures state a maximum of 90s recovery between each of the 6*40-m linear sprints. However, the recovery time for the sprints in the present study was standardized at exactly 90 s. After a brisk warm-up, the referees performed the test. The referees' starting position was 1.5 m behind the starting line, in line with FIFA procedures, and the sprint times were recorded using photoelectric beams at 0 m and 40 m (Microgate, Italy). The referees were instructed to perform each sprint maximally and each sprint had to be completed in a maximum time of 6.2s for CAT 1 while 6.40s for CAT 2. The sprints were performed on a regular athletics track and the use of spikes was not allowed. If a referee failed one of the sprints, he was allowed an extra sprint. However, if a referee failed to run below deadline on two occasions, he failed the test (FIFA, 2008). The referees' fastest 40-m sprint time, and mean 6*40-m sprint time (Weston et al. 2014) were used for analysis. After a recovery period of 8 min, the referees performed the interval test.

Figure 2. Schematic illustration of FIFA referees' 6*40m repeated sprint ability test.

(2) **Interval test**: The referees' interval test alternated 150 m of running, which had to be completed in a maximum of 30 s, with 50 m of walking, which had to be completed in 35 s, around a 400-m athletics track (see Figure 3). During the interval runs as well as the recovery periods, an audio signal was played over a loudspeaker system warning the referees when 10 s (single bleep), 5 s (double bleep), and 0 s (whistle) were remaining (FIFA MP3 package). The referees were required to complete a minimum of 10 laps to pass the test, which represented 20 high-intensity runs (4000 m in total, of which 3000 m consisted of high-intensity running). If a referee failed to complete a 150-m interval in 30 s on one occasion, they received a verbal caution. If they then failed to complete another 150-m interval in 30 s, they failed the test.

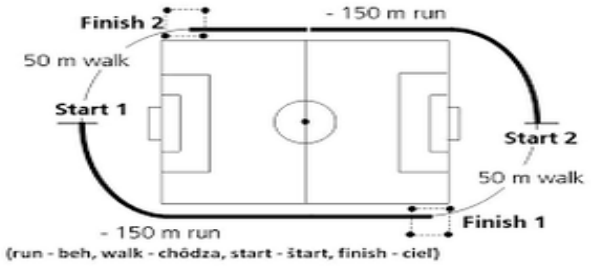


Figure 3. Schematic illustration of the FIFA referees' interval test.

STATISTICAL ANALYSES

The data are presented as means, modes and standard deviations (s). The assumption of normality was tested with the Shapiro-Wilk W-test. Shapiro-Wilk W-test showed insignificance for data on sprint test while it became significant for variable interval run. Relationships between the referees' repeated sprint ability test (6*40m) performances and interval test performances were examined using Pearson's product–moment correlation coefficient, with 95% confidence intervals also presented. Levene's test confirmed equality of variances for 6*40m sprint test data while it failed for endurance data (table 5). Thus, One-way Analysis of variance (ANOVA) (for 6*40m sprint test) and Kruskal-Wallis H-test (for endurance test) were performed between CAT 1, CAT1 AR and CAT 2 referees. Post-hoc analyses (LSD-least significant difference and Kruskal-Wallis one-way ANOVA for k samples) were employed. Statistical significance was set at $P<0.05$. All calculations were performed using the SPSS statistical analysis software package (Version 20, IBM Inc., USA).

RESULTS

All referees completed minimum 20 interval runs (10 laps) on the interval test (total test time of 21 min and 40 s). The fastest 40-m sprint time was 5.30sec (s=0.220), mean 6*40m sprint time was 5.79s (s=0.031) and mean interval run distance was 4386.66m (s.d.=55.56). Each referee successfully achieved the FIFA standard on all 6*40-m sprints.

Table 1: Descriptive statistics for the dependent Variable: Sprint data

	N	Mean	Std. Deviation
CAT1 R	15	5.6353	.09694
CAT1 AR	15	5.6953	.06081
CAT2 R	15	6.0533	.13345
Total	45	5.7947	.21133

Table 2: Descriptive Statistics on dependent variable: Interval data

	Mean	Std. Dev.	PERCENTAGE 4000m 4600m	4200m 4800m			4400m
CAT 1R	4693.33	281.49	13.3				86.7
CAT 1AR	4346.66	350.23	40	13	6.7	13.3	26.7
CAT 2R	4120	236.64	73.3	6.7	13.3		6.7

Table 3: Mean ranks for intervaldata on different categories

	CATEGORY	N	Mean Rank
INTERVALDATA	CAT 1R	15	32.97
	CAT 1AR	15	21.67
	CAT 2R	15	14.37
	Total	45	

There was a nearly perfect correlation between fastest 40-m sprint time and mean 6*40m sprint time ($r=0.941$, $p<0.05$). Significant correlations were also

observed between interval test performance and mean 6*40m sprint time (r= -0.631, p<0.05).

Table 4: correlation coefficients for relationships between sprint test data with interval test data and with best sprint test time.

	Interval Data	Fastest
SPRINTDATA Pearson Correlation	-.631*	0.941**
Sig. (1-tailed)	.000	0.000
N	45	45

*.Correlation is significant at the 0.05 level (1-tailed).

**. Correlation is significant at the 0.05 level (1-tailed).

There was a statistically significant difference between CAT 1R, CAT 1AR and CAT 2R groups on 6*40-m sprint test as determined by one-way ANOVA (F (2, 42) = 74.377, p < .05). A LSD post hoc test revealed that the mean 6*40-m sprint time of CAT 1R (5.63sec±0.096) and CAT 1AR (5.69sec±0.061) were statistically significantly better than CAT 2R (6.05sec±0.13) but were insignificant with each other (table 5-7).

Table 5 : Levene's test for Homogeneity of Variance

Levene Statistic	df1	df2	Sig.
1.609	2	42	**.212**

Table 6: ANOVA table for dependent variable: sprint data

	Sum of square	df	Mean Square	F	Sig.
Between groups (combined)	1.532	2	.766	74.377	0.000
Within groups	.433	42	.010		
Total	1.965	44			

Table 7: Multiple Comparisons for dependent variable: Sprint data using LSD test

(I) CATEGORY	(J) CATEGORY	Mean Difference (I-J)	Std. Error	Sig.
CAT1 R	CAT1 AR	-.06000	.03706	.113
	CAT2 R	-.41800*	.03706	.000
CAT1 AR	CAT1 R	.06000	.03706	.113
	CAT2 R	-.35800*	.03706	.000
CAT2 R	CAT1 R	.41800*	.03706	.000
	CAT1 AR	.35800*	.03706	.000

*. The mean difference is significant at the 0.05 level.

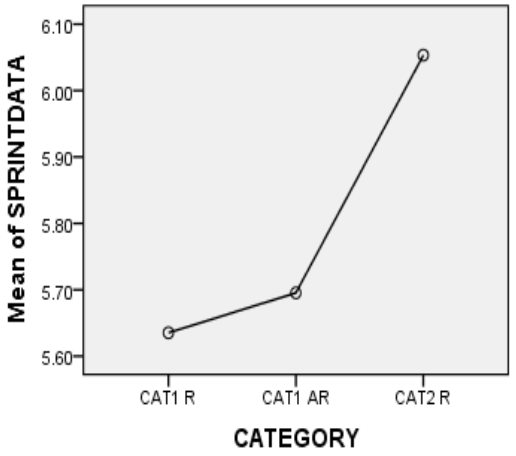


Figure 6: mean plot for sprint data

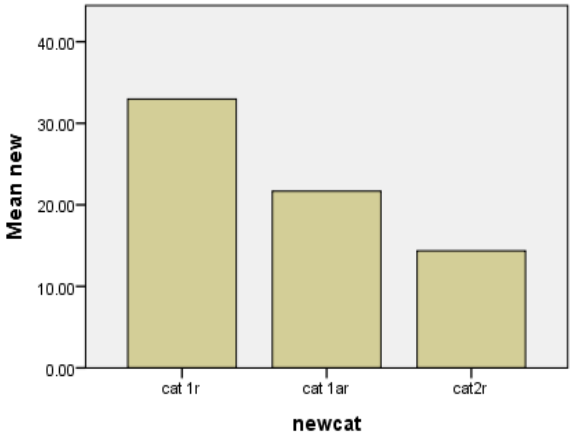


Figure 7: mean rank plot for interval data

A Kruskal-Wallis H test showed that there was a statistically significant difference in endurance test performance of different categories ($\chi 2$ (2) = 17.750, p<0.05), with a mean rank score of 32.97 for CAT 1R, 21.67 for CAT 1AR and 14.37 for CAT 2R. Post-hoc analyses showed that CAT 1R differed significantly with CAT 1AR and CAT 2R but CAT 1AR and CAT 2R failed to show any significant difference although mean ranks showed that difference existed there.

Table 8: Kruskal-Wallis H-Test table

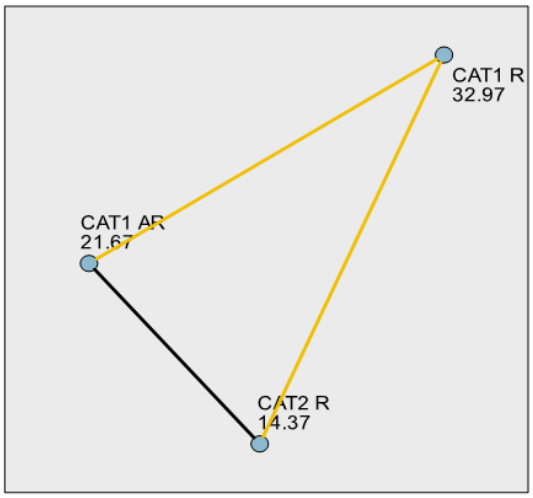
Test Statistics	
	INTERVALDATA
Chi-Square	17.750
Df	2
Asymp. Sig.	.000

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of INTERVALDATA is the same across categories of CATEGORY.	Independent-Samples Kruskal-Wallis Test	.000	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Pairwise Comparisons of CATEGORY



Each node shows the sample average rank of CATEGORY.

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
CAT2 R-CAT1 AR	7.300	4.449	1.641	.101	.302
CAT2 R-CAT1 R	18.600	4.449	4.181	.000	.000
CAT1 AR-CAT1 R	11.300	4.449	2.540	.011	.033

Each row tests the null hypothesis that the Sample 1 and Sample 2 distributions are the same.
Asymptotic significances (2-sided tests) are displayed. The significance level is .05.

Figure 5: Post-hoc comparison for interval data in different categories.

DISCUSSION

It was hypothesized that the sprint test scores would be correlated to best 6*40-m time trial and distance covered in interval run test. The groups showed a reasonably large correlation between sprint data and interval data (r= -0.631) and nearly perfect correlation between sprint data and fastest 40-m sprint (r= 0.941). These findings demonstrate a clear relationship between performances on the two tests, because those referees who performed better on the interval test tended to produce the fastest 6*40-m sprint times. Following scale of magnitudes proposed by Hopkins (2008) was used to interpret the correlation coefficients:

r<0.1=trivial;

0.10–0.29=small;

0.30–0.49=moderate;

0.50–0.69=large;

0.70–0.90=very large;

>0.90=nearly perfect.

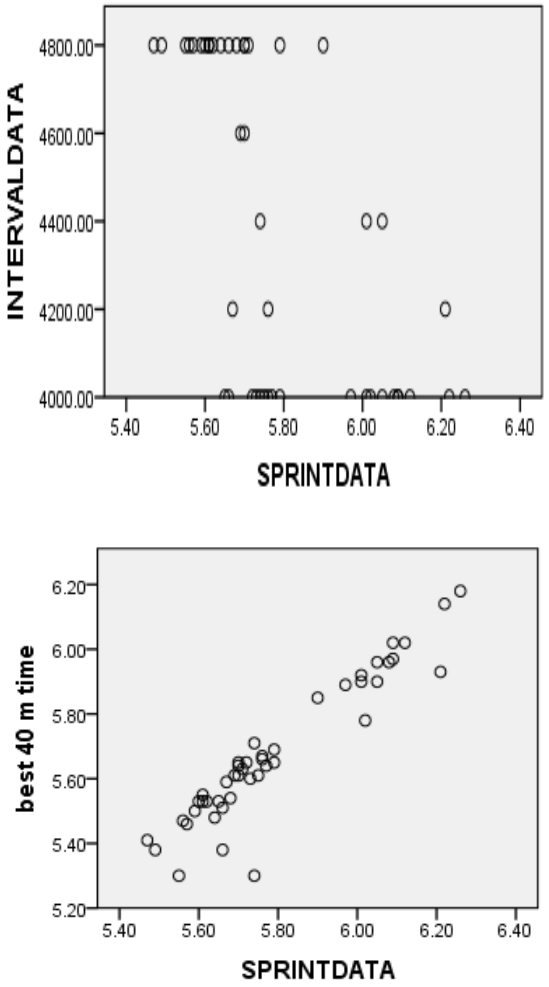


Figure 4. Scatterplots of Correlations

The findings of the study suggest that the fitness test can provide discrimination criteria between CAT 1R

and CAT 2R referees; however, it seems that between the category 1 referees and assistant referees, the criteria (6*40-m test) and between the category 1 assistant referees and category 2 referees, the criteria (interval run test) are inadequate. The fact that the significant differences between the groups were more marked in the interval run than in the 6*40-m sprint runs seems to confirm the findings of previous studies (7,8), in which the importance of aerobic endurance ability in soccer refereeing has been emphasized. This also supports earlier finding that the distance covered by a referee during a soccer game decreases significantly from the first half to the second half of the game (9, 10). However, this has not been confirmed by some other authors (13). Both tests discriminate significantly between category 1 and category 2 referees, reflecting the qualification standards of the referees' classification, but fail to do so with assistant referees. According to previous studies (11,12,13,14), high-intensity(>70%) exercise may result in decreased cognitive and psychomotor function. The importance of the physical condition must be emphasized here because we can clearly understand that a better fitness level—and, thus, a better tolerance of high-intensity exercise— will result in a higher game performance. Therefore, fitness level differences may reflect the quality differences in soccer refereeing. It is also noteworthy that, in all tests, the results among the different levels of referees differed significantly but pairwise comparisons were not significant between some groups. This can be attributed to a degree, to less number of subjects who participated in the testing, resulting in a statistical insignificance of the differences. On the other hand, it shows a quality difference between the referees even on the lowest qualification levels. Conditional preparation has a close relationship with training hours. Most likely, one of the reasons for the great differences between the category 1 and category 2 referees is the amount of time engaged in training in order to be physically and mentally well prepared. Elite referees must participate on a weekly basis in compulsory training sessions organized by the soccer federation and instructed by qualified trainers. Regardless, elite referees probably follow training sessions individually on a regular basis 2–3 times weekly. On the other hand, the relevant authorities have less supervision over the training habits of lower-level referees, and thus it may happen that these referees spend less time developing their conditional abilities. However, there is no evidence regarding the referees' training background or exercise schedule, and therefore we cannot establish any possible association between the results of this study and training background. Furthermore, at the elite level, it is quite common to attend the fitness tests frequently, and thus the referees maintain good physical fitness level continuously. Of course, similar to the athletes' selection, another reason could be referee selection. Through the selection process, talented referees will be more likely to progress to higher qualification levels. Moreover, mentality disparities between elite and lower-level referees result in the elite referees being more conscious and goal-oriented than their lower-level colleagues, and they also are better motivated to achieve good results during the testing procedures. It is observed that category 1 and category 2 referees had difference in their fitness test results, which once more reflects the high qualification standards concerning conditional abilities.

The movement of assistant referees is characterized by short, intense exercise interrupted by long, low-intensity periods (5,12,15). Sprint performance among the assistant referees is important in the game. It was as hypothesized, therefore, that top-class assistant referees (category 1) had the faster times in the sprint tests and they also covered longer distances in the interval run.

It can be concluded that the aerobic fitness level demonstrated in the interval run is the most significant conditional ability in refereeing. In this fitness test, category 1 referees showed a higher performance than category 2 referees. But, further validation and possible modifications on the selection criteria for the interval test are required if it is to be considered a truly valid measure of selection in elite-standard soccer referees. The Yo-Yo intermittent recovery test is considered a specific soccer refereeing test, since it has been reported to possess construct validity (Castagna, Abt, & D'Ottavio, 2005) and training sensitivity (Krustrup & Bangsbo, 2001; Weston, Helsen, MacMahon, & Kirkendall, 2004) in elite-standard soccer referees. In the interest of worldwide uniformity, FIFA require all fitness tests to be performed on a standard athletics track with limited specialized testing equipment. However, the Yo-Yo test is also performed on a consistent surface and requires the same specialist equipment (i.e. a pacing signal and audio speakers). Therefore, the use of the Yo-Yo test should be taken into consideration, although the setting of a FIFA minimum standard would still require empirical validation.

RECOMMENDATIONS

1. The use of the Yo-Yo test, although the setting of a FIFA minimum standard would still require empirical validation,

2. Use of some criterion score for sprint test as some referees can achieve the selection criterion with sub-maximal efforts, thus defeating the purpose. Rampinini et al. (2007) used a single sprint immediately before the repeated-sprint test and this trial provided the criterion score for the subsequent test. This procedure is not included in the FIFA referees' sprint test. This protocol might provide an accurate reflection of referees' repeated-sprint ability.

3. To accurately measure repeated-sprint ability in soccer referees, the recovery time on the FIFA

sprint test should be decreased and the test protocol harmonized with previously validated tests (Balsom et al., 1992; Rampinini et al., 2007; Spencer et al., 2006). A recovery time of 90s equates to an exercise-to-rest ratio of 1:14, which is higher than the critical 1:10 previously reported for soccer referees (Abt, Castagna, Belardinelli, & McCarthy, 2004).

PRACTICAL APPLICATIONS

The conditional abilities measured by the FIFA fitness tests differ in category 1 and category 2 referees but some additional protocol should be added to test assistant referees. The results of the fitness tests can help in the evaluation of the referees' physical condition in relation to the qualification criteria. Each referee can know the distance he or she needs to cover to be included in the various competitive levels. However, inclusion criteria for the different levels do not seem to offer accurate discrimination in every case, and therefore the results of the fitness tests should be supported by additional criteria. Finally, it seems that the major quality step in a referee's career can be located at the lower division competition level.

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