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Cardiorespiratory Fitness and Body Composition of Soccer Referees; Do These Correlate With Proper Performance?

Reza Mazaheri,[1,2] Farzin Halabchi,[1,2,*] Tohid Seif Barghi,[1,2] and Mohammad Ali Mansournia[3]

[1]Sports Medicine Research Center, Tehran University of Medical Sciences (TUMS), Tehran, IR Iran
[2]Department of Sports and Exercise Medicine, Tehran University of Medical Sciences (TUMS), Tehran, IR Iran
[3]Department of Epidemiology and Biostatistics, School of Public Health, Tehran University of Medical Sciences, Tehran, IR Iran

*Corresponding author: Farzin Halabchi, Department of Sports and Exercise Medicine, Tehran University of Medical Sciences (TUMS), P. O. Box: 14395578, Tehran, IR Iran. Tel: +98-9122041774, Fax: +98-2188003539, E-mail: fhalabchi@tums.ac.ir

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Abstract

Background: The elite-level referee is exposed to similar physical demands to those placed on a midfield soccer player. They have an important responsibility to implement the rules of the game. So, good health and performance of soccer referees have a great importance.
Objectives: The purpose of this study was to assess the cardiorespiratory fitness and body composition of all 78 soccer referees officiating at the Iranian Premier League and determine the correlation between these parameters and performance.
Patients and Methods: In a cross-sectional study, all referees selected for the competitions were enrolled. Participants underwent exercise stress test, pulmonary function test and body composition assessment. Then the weekly scores of each referee, assessed by qualified supervisors of national federation were obtained using the FIFA standard form throughout the season (34 weeks) and registered.
Results: Among 78 participants (including 32 center and 46 side referees), mean and standard deviation of age, body mass index, percent of body fat, VO_{2max} and performance scores were 37 ± 3.8, 23.6 ± 2.1, 20.7 ± 3.9, 59.9 ± 7.1 and 85.8 ± 0.25, respectively. No significant correlation between referees' mean score and selected parameters were found.
Conclusions: It seems that the acquired scores of top-class referees may be influenced by multiple factors other than the laboratory findings of cardiopulmonary fitness and body composition.

Keywords: Football, Physical Conditioning, Anthropometry, Athletic Performance, Body Mass Index

1. Background

Nowadays, soccer is considered as the most popular sport all around the world (1). According to the FIFA big count, about 270 million people are actively involved in this sport (2). It has been extrapolated that in each week of a competitive season more than one million referees take to the soccer pitch (3). Currently, more than 840000 registered referees are directly involved in soccer competition (2).

The referee has an important responsibility to implement the rules of the game. This indicates that the referee should keep up with play to be in a good place to notice rule violations (4). Despite the referee being considered as the 23rd player of a game, and his role in assuring that players obey the rules of the game, very little scientific literature is available on them, especially compared with that available on players (3).

Soccer refereeing is a very challenging profession. The elite-level referee is exposed to similar physical demands to those placed on a midfield soccer player (5). Research has shown that, during a match, international referees travel an average distance of between 9 and 13 kilometers (3, 6). Otherwise, referees exhibit several unique characteristics: they are older than the players (on average of 15 to 20-years-old), usually they aren't full-time professionals, and they normally cannot be substituted during the match (5). So, good health and performance of soccer referees have a great importance.

The physical performance of referees during a soccer match may be dependent on different factors such as physical fitness (7, 8), the development of fatigue (9, 10), and the standard of the competition (11, 12) or the amount of high-intensity activities performed by the players (10, 13).

Elite soccer referees officiate at the peak level at an average age of more than 40 years, when cardiovascular athletic performance starts to decline (14). Maximal oxygen uptake (VO_{2max}) and respiratory capacity have been reported to decrease after the age of 25-years-old in healthy sedentary men (15, 16). Of course, training status seems to have a significant effect on the age related decrease in aerobic fitness, by reducing the rate of decline in VO_{2max} (17). Since aerobic fitness is related to physical performance (18), this age-related decline in aerobic fitness may affect the referee's physical performance. As a consequence of the increased physical demands at the high level soccer competitions, there is a clear need for a proper fitness level of the match referees. Accordingly, the governing bodies of elite referees now implement regular fitness testing in order to control the physical fitness of referees (14).

2. Objectives

Based on the existing data, it seems that some selected parameters of fitness such as VO_{2max}, respiratory capacity and body composition may have a key role in the referees' performance. The aim of this study was to assess the cardiorespiratory fitness and body composition and the potential correlation between these parameters and performance scores of all referees of Iranian Premier Soccer League during season 2009 - 2010.

3. Patients and Methods

We measured variables of cardiorespiratory fitness and body composition in elite soccer referees officiating Iranian premier league and investigated whether these variables correlate with their performance throughout the season.

3.1. Subjects

In a cross sectional study, all referees who were selected for Iranian premier soccer league allocated in the project with assistance of refereeing committee and medical committee of Iranian national soccer federation. In total, 78 male referees (32 center and 46 side) were evaluated.

All the subjects accepted to participate in the study after being informed of the aim and protocol of the project, and each signed written informed consent. The study was approved by the ethics committee of Tehran University of Medical Sciences.

3.2. Procedures

All of the participants underwent a researcher designed station based pre-participation evaluation (PPE) including assessment of body composition using bioelectrical impedance (model Avis 333-South Korea), cardiovascular exercise stress test using Bruce ramp protocol (BMS software-USA and Track master treadmill) and pulmonary function test with spirometer (model Pony Fx-Cosmed, Italy). Exercise stress test was maximal and the subjects were motivated to do their best performance on treadmill. The end-point criteria of exercise test were volitional fatigue and exhaustion.

Then the weekly scores of each referee, assessed by qualified supervisors of the national soccer federation using FIFA standard referee assessor form (0-100 points), were obtained throughout the season (34 weeks) of 2009-2010 and registered in the personal profile of each referee (19).

3.3. Statistical Analysis

The characteristics of referees were described using mean, standard deviation and 95% confidence interval. The weighted Pearson correlation coefficient, with number of judgments as weights, was used to quantify the linear relationship between referees' mean score and selected characteristics. All analyses were performed using STATA version 10 (Stata Corporation, College Station, TX). Significance was set at $P \leq 0.05$ for all tests.

This project has been approved by ethical committee of Tehran University of Medical Sciences.

4. Results

Seventy-eight male referees (32 center and 46 side) were evaluated (36.96 ± 3.84). The mean number of judgments for each referee (center and side) during season was 13.16 (0.674) [Center referees: 10.97 (1.27), Side referees: 14.66 (0.65)]. Measured parameters in 3 fields of body composition, cardiovascular exercise test and pulmonary function test are shown in Table 1.

Table 1. Descriptive Characteristics of Referees

Parameter	Mean ± SD	Confidence Interval 95%
Body composition		
Weight, Kg	74.94 ± 8.08	73.11 - 76.77
Height, Cm	177.98 ± 5.83	176.66 - 179.30
Body Mass Index, kg/m^2	23.64 ± 2.06	23.17 - 24.11
Percent of body fat, %	20.67 ± 3.92	19.78 - 21.56
Lean Body Mass, kg	59.38 ± 6.05	58.01 - 60.75
Cardiopulmonary endurance		
Resting heart rate, beat/min	67.72 ± 9.44	65.56 - 69.88
Maximal heart rate , beat/min	159.45 ± 20.19	155.01 - 164.13
VO_2 max estimate, ml/kg/min	59.94 ± 7.09	58.31 - 61.57
Pulmonary function		
FEV_1, L	4.17 ± 0.51	4.05 - 4.28
FEV_1, %	101.59 ± 11.67	98.95 - 104.23
FVC, L	4.79 ± 0.68	4.64 - 4.94
FVC, %	97.13 ± 14.09	93.94 - 100.32
FEV_1/FVC	0.87 ± 0.07	0.86 - 0.89

Overall Mean ± SD of acquired performance score for all referees during the season was 85.8 (2.12) [95% CI: 85.3-86.29]. The scores of center and side referees were 84.56 (2.2) [95% CI: 83.76-85.36] and 86.43 (1.79) [95% CI: 85.89-86.97], respectively.

Then, according to the number of judgments and considering the weight of this important factor, correlation between referees' mean score and parameters such as age, weight, body mass index, body fat percent, lean body mass, resting heart rate, maximal heart rate, aerobic capacity (VO_{2max}), Forced expiratory volume in 1 second (FEV_1) and Forced vital capacity (FVC) were analyzed using Pearson's equation. No statistical correlations ($P < 0.05$) were found (Table 2).

The only significant correlation was shown between the mean score and the number of judgments for each referee (correlation coefficient: 0.6184, $P < 0.001$). This correlation was more prominent in side referees (correlation coefficient: 0.7270, $P < 0.001$ for side referees vs. 0.4494, $P = 0.012$ for center referees).

Table 2. Correlation Between Selected Parameters and Referees' Mean Score

Parameter	Correlation Coefficient	P Value
Age, y	0.06	0.62
Center	-0.04	0.84
Side	0.20	0.19
Weight, kg	-0.11	0.37
Center	0.18	0.36
Side	0.02	0.90
BMI, kg/m^2	-0.09	0.42
Center	0.12	0.53
Side	-0.07	0.64
Fat percent	-0.05	0.68
Center	0.13	0.51
Side	-0.09	0.57
Lean body mass	-0.09	0.46
Center	0.13	0.48
Side	0.08	0.62
Resting heart rate	-0.34	0.004
Center	-0.20	0.32
Side	-0.19	0.23
Maximal heart rate	-0.19	0.11
Center	-0.23	0.23
Side	0.09	0.55
VO_{2max}	-0.20	0.09
Center	-0.13	0.50
Side	-0.02	0.88
FEV_1	0.06	0.61
Center	0.29	0.12
Side	0.09	0.55
FVC	0.13	0.27
Center	0.42	0.02
Side	0.17	0.26

5. Discussion

At first glance, it may be suitable to compare our findings with similar studies. In our study, the average of BMI among Iranian soccer referees (23.6 ± 2.1) was relatively lower than values reported in similar studies conducted by Helsen et al. who reported BMI values of 24.2 ± 2.6 kg/m^2 in high-class referees of Euro 2000 Championship finals (20) and also by Rontoyannis et al. in 188 Greek referees whose average value was 25.9 ± 2.1 kg/m^2 (21). In contrast to the research done by Rontoyannis et al. (21) who found overweightness and obesity in 70% and 6% of the studied referees, respectively; and also by Helsen et al. (20) who reported a BMI value of 31.4 kg/m^2 in top-class referees, our study revealed that only 29.5% of the referees were overweight and none of them were obese.

As aerobic metabolism is heavily taxed during competitive soccer refereeing, some studies focused on the measurement of VO_{2max} in referees. For example, Castagna et al. (18) reported relative VO_{2max} values of 49.30 ± 8.0 mL/kg/min in elite Italian referees. Krustrup and Bangsbo (7) reported similar values for ten Danish top-class referees with their average VO_{2max} being 46.3 mL/kg/min. In another study, Bangsbo et al. found VO_{2max} levels of 47.7 ± 1.5, 45.9 ± 1.1 and 44.7 ± 0.8 mL/kg/min in younger (age 29 to 34-years-old), intermediate (age 35 to 39-years-old) and older (age 40 to 46-years-old) referees, respectively (22). In English Premier League referees, Weston and Brewer found values slightly higher than those reported for Italian and Danish elite referees, VO_{2max} averaging 50.9 ± 5.7 mL/kg/min (23).

In our study, VO_{2max} has been estimated using an indirect method of exercise stress testing, which may overestimate the real capacity of referees and the average values were 59.9 ± 7.1. VO_{2max} levels of 51.1 ± 8.4, 60.7 ± 6.4 and 57 ± 7 mL/kg/min were estimated in younger (age 29 to 34-years-old), intermediate (age 35 to 39-years-old) and older (age 40 to 45-years-old) referees, respectively. These findings are relatively better than above mentioned studies on elite-level referees.

Despite previous research demonstrating reduced match physical performances in older referees, our study did not show a significant influence of the age on the referees' mean score. This finding is compatible with the studies of Weston et al. (24), and Castagna et al. (25) who reported no significant effect of age on the referees' fitness and performance. In other words, the fitness status of top level referees is high enough to meet the varying physical demands of their matches (24). In this study there was an inverse correlation between resting heart rate and the referees' mean score. However, as the other more important measures of the cardiorespiratory fitness such as VO_{2max} were not correlated with performance score and also the correlation was not significant in each subgroup of referees (center and side), this correlation doesn't seem to have any practical implication.

The lack of correlation between body composition, VO_{2max} and pulmonary function variables with acquired performance scores of referees may be viewed from two perspectives. First, as the elite soccer referees have been qualified by standard fitness tests administered by the national federation, all of them have a good basic fitness level and proper training schedule in their routine life and due to the importance of mental awareness and experience in decision making, the minor differences between the fitness level may have no significant effect on performance scores. In other words, if a referee does not have a good fitness level, he will not be qualified for judgment in this high level of competition and above a defined level of fitness, the better performance may be related to other mental and cognitive skills and in these cases extra fitness may not bear any advantages for the referee. In these occasions, the years of officiating, hours of practice per week, and number of matches officiated may be positively correlated with skill (26).

Another point is that these laboratory tests may not be precise tools to estimate the functional fitness level of referees. Using more functional field tests by FIFA is based on this rationale that simulating the dominant activity pattern of a soccer referee in field fitness tests may demonstrate his success more accurately.

Another matter may be related to the FIFA referee assessor's form (19). In this form, a selected referee assessor should consider points in each section. These sections include correctness and consistency in decision making (40 points), control of the game (30 points), physical fitness, movement and positioning (20 points) and cooperation with the assistant referees (10 points). The section of physical fitness, movement and positioning is further divided to stamina, speed, acceleration whenever necessary (10 points) and positioning (10 points). As the positioning may be the function of many factors other than pure fitness, such as experience and intelligence, it seems that only 10 points is directly related to fitness of referees. As the assessors may not have an objective tool to estimate the fitness of referees in the pitch, they frequently allocate full points in this section and focus more on other critical parts such as decision making and control of the game that may directly influence the result of the game.

Finally, the significant correlation between the mean score and the number of judgments for each referee indicates that the referees with higher performance have been naturally selected by the referee committee to judge in more competitions.

In conclusion, it seems that the laboratory findings of cardiopulmonary fitness and body composition may not correlate well with the acquired scores of each top-class referee. This can be partially explained by the fact that performance of a soccer referee may be influenced more by cognitive, psychological and experiential factors.

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Footnotes

Authors' Contribution: Farzin Halabchi, Reza Mazaheri and Tohid Seif Barghi were responsible for the conception and design of the study; Farzin Halabchi and Reza Mazaheri have been involved in the data collection over the study period; Mohammad Ali Mansournia and Farzin Halabchi conducted the analyses which were planned and checked with the coauthors; Farzin Halabchi wrote the first draft of the paper, which was critically revised by Reza Mazaheri and Tohid Seif Barghi.

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