Medical, morphological and functional aspects of Greek football referees

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Objective. The aim of the study was to investigate state of health, morphological and functional profile of football referees (Rs).
Experimental design. A prevalence study.
Participants. 188 Greek active male Rs of A, B, C and D football divisions have been evaluated.
Measures. Standard clinical-instrumental and anthropometric methods were used. Appropriate functional tests were used for evaluation of visual performance, physical condition and mental ability.
Results. Mean age, height, weight, and BMI were 36.3 ± 4.5 years, 177.4 ± 5.7 cm, 81.6 ± 7.8 kg, and 25.9 ± 2.1 $kg\cdot m^{-2}$ respectively. 64% and 6% were overweight and obese respectively. In 27.2% resting blood pressure exceeded upper normal limits. Active (41.5%) and former smokers (17.0%) were identified. Visual acuity and colour discrimination were defective in 2.4% and 0.7% respectively. Stereo depth perception deficiently in 7.1%. Compared to international standards, Rs' mean scores in the 6 physical condition field tests were found satisfactory. All Rs were found efficient in the agility test, two-thirds in the maximal and prolonged speed tests and half of them in the endurance test. Relatively more Rs of A and B divisions were found fit as compared to Rs of C and D divisions. Average IQ score was 112.5 ± 11.1, while about 90% and 34% of the Rs' IQ score was ≥100 and ≥120 respectively.
Conclusions. Average male Greek football R is an apparently healthy, young to middle aged, rather overweight, and functionally efficient. The great majority of Rs of A and B divisions appear better trained and somewhat better functional than Rs of C and D divisions.
KEY WORDS: Football referee - Health status - Sports medicine.

The referee (R), assisted by two linesmen (assistant referees), has the authority, granted to him, to offi-

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ciate each football game. This is accomplished by supervising and judging the action of the players and implementing the penalties to the violating athletes, according to the laws and regulations of the game, as they have been described by FIFA.[1] His ultimate goal is the "enhancement of the game for both players and spectators".[2]

Supervision of the game necessitates the R to be as close as possible where the ball is played, trying to reach the best observation point and angle of vision, and impartially assess any situation,[3] in spite of the fact that he is under physical and psychological pressures.

Scientific interest regarding football is vivid, particularly during the last decades. This is almost exclusively concerning the players, whose physiological and psychological status, as well as performance and sport-related injuries have been studied extensively.[4-20]

Despite the importance of R's role in a match-play, very little attention, as far as we know, has been paid to the study of the R's profile.

The aim of the study was to conduct a medical, morphological, and functional evaluation and assessment of active football Greek Rs. In addition to propose possible means and methods of improvement of their performance.

Materials and methods

The whole body of Greek football Rs living in Northern Greece, has been evaluated medically, morphologically and functionally in July 1992. This body consists of one hundred and eighty eight males and represents about 35% of the total number of active male Greek Rs. All Rs have served in the previous season in the nation-wide football divisions.

Medical examination and the morphological and functional evaluation of the Rs took place post-prandially in the hours between 8:30 to 13:00 and 15:00 to 21:00.

A) Medical examination was based on:

1) a carefully taken history and a thorough physical examination, particularly of the cardiovascular system;

2) measurement(s) of arterial blood pressure (BP) in the reclining position, using a mercury manometer with a standard cuff width 12.5 cm on the right arm. When first measurement exceeded 140/90 mmHg, two more measurements were taken with 1-min interval and the higher value was recorded. Each R had a 10-min rest before the blood pressure measurement. A measurement ≤140/90 mmHg was considered normal. Values of 140-159/90-94 mmHg and ≥160/95 mmHg indicated borderline hypertension, and hypertensive limits respectively;[21]

3) a 12 lead resting electrocardiogram (ECG) for diagnostic purposes. In case coronary heart disease was suspected, an exercise testing was conducted. For diagnosis of left ventricular hypertrophy (LVH) the "Este's criteria" [22] were used. Five points were necessary for diagnosis of LVH, while with 4 points LVH was probable;

4) a diagnostic echocardiography in those cases, where a murmur over chest was heard and,

5) evaluation of certain risk factors for developing coronary heart disease (CHD), such as: age above 30 years, BMI higher than 24.9 kg·m⁻² (see below), smoking habits, resting blood pressure above 140/90 mmHg and LVH.

B) Morphological evaluation was based on height and body weight measurements. Height and weight were measured with an approximation of 0.5 cm and 0.5 kg respectively. Body mass index (BMI) was then calculated. Subjects wore a light dress and no shoes. Body fatness was estimated in 122 of the above subjects two years later (summer 1994). A Harpenden skinfold caliper was used for measurement of subscapular and thigh skinfolds. Body fatness was estimated using Sloan's equation.[23] Estimation of body fatness was made for indicative purposes only.

C) Functional evaluation was based on the assessment of their visual, intelligence and physical conditioning performance scores.

For visual performance assessment an electronic Titmus Vision Tester was used, according to manufacturer's instructions.[24] Far point (~6 m) acuity for both eyes, stereo depth perception (stereopsis) and colour discrimination were tested. We assume inability of colour discrimination if the subject under control failed to read correctly five out of six numbers.

Mental ability was evaluated using the intelligent quotient (IQ). Standard progressive matrices, prepared by Raven [25] were used for IQ evaluation.

Physical conditioning assessment was based on a series of field tests suggested in 1989 by FIFA.[26] According to these suggestions Rs have to be tested in: a shuttle race 4×10 m* - agility, a 200 m race-prolonged speed, a 50 m race-speed, another 200 m race and 50 m race and finally a Cooper 12-min run for distance-endurance. All subjects tested had to complete those tests in a two hours period, in a morning or afternoon session, and in the order mentioned above. An outdoors tartan-surfaced 400 m track for all run tests was used. Sufficient recovery time between tests was provided by five experienced physical education teachers, who were also working as time keepers. Criteria of fitness used were those suggested recently by FIFA.[27]

Statistical analysis was carried out using a SPSS software package. Analysis of variance (ANOVA) and correlation of all variables among the subgroups of Rs were carried out.

Results

Mean age, height, body weight, and BMI of the Rs examined are given in Table I.

Mean age of all Rs was 36.3±4.5 years (range 24-46 years). 93.6%, 71.3% and 23.4% of them exceeded the 30, 35 and 40 years of age respectively.

Average R of division A was about 3 to 4 years older than average R of all other divisions.

Mean height, weight and BMI of all Rs were 177.4±5.7 cm, 81.6±7.8 kg and 25.9±2.1 kg·m⁻² respectively. Mean body fatness of the 122 subjects examined in 1994 was found 16.7±4.5% of their body weight,

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*Since 1995 the 4×10 m shuttle race was omitted.

TABLE I.—*Age and morphological characteristics of the Rs evaluated, classified by division ($\overline{X}\pm SD$).*

Division	N	Age (years)	Height (cm)	Weight (kg)	BMI ($kg \cdot m^{-2}$)
A	15	39.3±3.7	177.5±4.8	83.5±4.8	26.5±1.1
B	37	36.4±3.9[1]	179.2±5.4	81.2±7.8	25.3±1.8[1]
C	76	35.4±4.2[2]	177.3±5.4	81.9±7.8	26.1±2.1[2]
D	60	36.6±4.8[3]	176.5±6.1[1]	80.9±8.3	25.9±2.4
Total	188	36.3±4.4	177.4±5.7	81.6±7.8	25.9±2.1

Age: 1. A-B p<0.05, 2. A-C p<0.001, 3. A-D p<0.05. Height: 1. B-D p<0.05. BMI: 1. A-B p<0.05, 2. B-C p<0.05.

TABLE II.—*Average IQ score (±SD) of soccer referees (Rs) and percentages of Rs with IQ score ≥110, by division.*

Division	Rs	IQ score ≥110 Rs %
A	116.0±9.9	93.3
B	114.0±9.9	75.0
C	111.8±10.8	73.7
D	112.5±11.1	76.3
Total	112.5±11.07	

which was unchanged in the 1992 and 1994 examination (80.8±8 kg *vs* 80.7±7.4 kg respectively - N.S.). No differences were found among Rs of the various divisions for weight, BMI and body fatness. Normal BMI was found in almost 30% of all Rs. Overweighted (25-29.9 kg·m⁻²) were found 64% and obese (30-39.9 kg·m⁻²) 6% of all Rs.

Although the majority of all Rs were found clinically healthy, the following findings are interesting and worth to be mentioned:

1) in 27.2% of all Rs resting blood pressure exceeded the upper normal limits. In 9.5% of all Rs blood pressure exceeded the 160/95 mmHg;

2) 41.5% and 17.0% of all Rs were not cigarette smokers and former smokers, respectively. From the active smokers 25.5%, 10.6% and 5.3% of all Rs smoke 1 to 19, 20 and more than 20 cig./day respectively;

3) an innocent systolic ejection murmur, of intensity 1-3/6, over chest was audible in 16 cases (8.5%). Echocardiographic examination disclosed normal heart structure in all cases;

4) in 3 subjects, suspected for coronary heart disease, stress testing was normal, while 5 subjects exhibited venous varicoses, in the lower limbs, of no clinical importance.

From the ECG study it was found that:

1) basic cardiac rhythm was sinus in all Rs and mean resting heart rate was 70±12 b·min⁻¹;

2) in two cases P-R segment exceeded 0.20 s ($\overline{x}=0.16\pm0.03$ s) and from 31 cases with RBBB pattern (16.5%), in only one case RBBB was complete. Mean Q-T segment was 0.37±0.02 s. Repolarization abnormalities were found in 2 cases, and mean ÂQRS and ÂP were 40.8±31.2° and 46.9±13.1° respectively. LVH was detected in one case and probable hypertrophy in four others.

Only 2.6% of those aged less than 30 years were not exposed to risk factors for developing CHD. To 1, 2, 3 or 4 risk factors were exposed 17.7%, 38.5%, 34.4% and 7.8% of all Rs respectively.

Functional profile of the Rs examined is presented in Tables II and III. Mean average IQ values are shown in Table II. Almost 90% of all Rs have had IQ value ≥100, while one third had 120-130 scores. Relatively higher percentage (93.3%) of IQ scores ≥110 was

TABLE III.—*Mean average scores (±SD) in each of the six consecutive fitness tests, in which soccer referees (Rs), divided by division, were tested. Percentages shows Rs with equal or better scores than the limiting of fitness scores suggested by FIFA.*

Division	4×10 m Shuttle race (sec)		50 m race (sec)		200 m race (sec)		50 m race (sec)		200 m race (sec)		12 minute run (m)	
	11.5 sec*	%	32 sec	%	7.5 sec	%	32 sec*	%	7.5 sec*	%	2700m**	%
A	10.1±0.4	100	30.2±1.1	93.3	7.3±0.3	86.7	30.8±1.2	86.7	7.4±0.2	80	2778.7±128.9	86.7
B	10.2±0.3	100	30.6±1.8	75.7	7.4±0.3	78.4	31.2±1.5	72.9	7.5±1.0	70.2	2792.5±176.0	70.2
C	10.3±0.3	100	31.5±1.6[1 3]	71.1	7.5[1]±0.3	73.7	32.0±1.4[1 4 5]	56.6	7.5±0.3[2]	65.8	2709.6±165.0	35.0
D	10.3±0.3	100	31.6±1.8	70.0	7.5±0.4	65.0	32.6±1.7	45.0	7.6±0.4	55.0	2670.7±167.7	41.7
Total	10.25±0.3		31.2±1.7		7.45±0.3		31.9±1.6		7.5±0.3		3719.2±171.6	

*FIFA's 1994 suggested upper limits of fitness; **FIFA 's 1994 suggested lower limit of fitness. 1. p<0.01 between A and C, 2. p<0.05 between A and C, 3. p<0.05 between B and C, 4. p<0.01 between B and C and 5. p<0.05 between B and D.

found in the Rs of A division. However, no statistically significant differences were observed amongst the four groups of Rs studied.

Physical fitness scores are shown in Table III. All Rs tested showed better scores than the minimum scores suggested by FIFA in the 4×10 m race. Mean scores of all other races (tests) of division C Rs were found statistically significantly lower (Table III) than those of division A while no differences were found for the 12-min run scores among the Rs of the various divisions. There is a clear tendency of progressive decline percentages of scores in all but the 4×10 m race tests for Rs from A to D divisions. On the average, Rs from divisions A and B showed a tendency of better scores in all tests than the Rs of divisions C and D.

Visual acuity was found defective with both eyes in only 0.4%, while visual acuity with each eye separately was defective in 3% of all cases. Stereo depth perception deficiency was noted in 7.1% and failure for colour discrimination was found in 0.7% of all cases.

Finally, the "coefficient of correlation" showed that all scores of fitness tests in Rs correlated positively not only with the subscapular and thigh skinfolds but with other morphologic variables as well, such as body fatness and BMI. While Cooper test scores were negatively correlated, all other test scores were correlated positively with these morphological variables. In a similar way each Rs fitness test score was significantly correlated with all other fitness test scores. This correlation was positive in all three tests: 4×10 m race, 50 m race and 200 m race and negative in the Cooper test run.

Discussion

Based on the principles of the diagonal system adopted by FIFA, in modern football match-play,[28] in an effort to improve maximal control of the game the R, most of the time, moves on the field across an imaginary large area, that is extended from one to the cross-opposite corner, while each assistant R moves along half the length of the touch-line. Moving in that way the R and his assistants, are expected to supervise adequately the play, particularly in the "difficult" penalty areas.

In a 90 minutes match-play, an elite football player is expected to cover, running or walking, about 10 km (range 8-13 km),[8 9 29] have an average energy expenditure of about 70 kj·min-1,[10] and conduct about 900

discrete bouts of action, with or without the ball (a change in action every 6 s), mainly submaximal, but not regular in rate. At the same time "volume", "intensity" and "frequency" of the R's effort is estimated to be fairly small, moderate and low, respectively.[3] His commitment has to be concentrated not only on the first half of the game, when the effort of the players is usually relatively more vigorous,[11 13] but on the second half as well, when almost two thirds of the violations are encountered.[28] The R's total estimated running time, on the average, has been estimated to be about 22 minutes. Approximately 86% of his total running time, the R is acting in a slow-steady speed, about 6.5% at high speed and about 8% in increasing speed (acceleration).[3]

Skilful movements are not included in the referee's regular action.

Although, a relatively large number of the Rs examined were borderline hypertensives, and almost half of them heavy smokers, no case of clinically active coronary heart disease or any other heart disease contraindicated for the refereeing was observed. Prevalence of current and former smokers among the Rs is very high, when they are compared to athletes,[30] implying a serious handicap for the Rs' aerobic capacity. On the other hand, the prevalence of hypertension in the Rs examined, is quite similar with the prevalence in 889 young and middle-aged Greek army population, studied in 1977.[31]

Ninety eight percent of the Rs examined, were predisposed from one to four major risk factors for developing CHD. The findings of this study, justify FIFA's suggestions and measures, taken by the Hellenic Football Referees Association, for medical examination, besides regular functional evaluation, once a year of all Greek Rs. As no blood lipid profile was determined in this population, we would suggest determination of blood lipid levels to any R, older than 30 years of age and exposed to at least two risk factors. This, regardless of the fact that no case of coronary sudden death occurred in Greek Rs the last decades. At the same time, in the same period, few sporadic sudden deaths of football players, in Greece, have been officially reported.

To eliminate existing and modifiable risk factors, for developing CHD disease, such as smoking habits, arterial hypertension and obesity, certain measures and/or dietary recommendations combined with aerobic exercise have to be suggested.

No smoking is highly recommended, particularly for heavy smokers, because smoking has negative short-term effects on exercise capacity. It has been reported in the literature increases of cost of breathing, due to increase of airways resistance.[32-34] Decrease in oxygen transport capacity and therefore of the $\dot{V}O_2$max, as a result of the carbon monoxide combined with hemoglobin, has been documented in normal active and passive smokers during exercise.[35-38]

Restriction of salt consumption to less than 5 g/day, decreases in caloric intake and improvement of aerobic power,[39-44] should be recommended to the hypertensive and/or obese or overweight referees.

Compared to the average elite football player,[4 45 46] the average Greek R shows the following differences, that are expected to have a negative impact on his refereeing performance, and therefore, on the control of the game:

1) He is a decade older. In another study,[47] in which 78 Rs have been compared to 120 basketball and ice hockey players, it was discovered that the average R was six years older than the average player. We assume that Rs in ball games are consistently, but not considerably, older than the average player. Although it can be argued that in healthy man physical vigour can be expected to be retained, there is a slight decline during the fourth decade of life.[48]

2) He is about 5 kg heavier.

3) He has about 3 $kg \cdot m^{-2}$ higher BMI.

4) He has an average 6% higher body fatness.

5) He has slower maximum running speed. Indeed, his maximum running speed, in the 50 m run and his prolonged speed in the 200 m, are 6.7 $m \cdot s^{-1}$ and 6.35 $m \cdot s^{-1}$ respectively. Compared to the maximum and prolonged running speed of an average elite football player in the 60 m and 300 m run, the average speed of the Greek R is 20% and 18% slower respectively.[46]

This difference must be considered particularly important, due to the dominant role of speed in modern football.

6) He has lower aerobic power. Based on the 12-min running score, R's average aerobic power is considered almost "superior" compared to non-athlete males, aged 30-39 years.[49] However it is by 6% lower compared to Hong Kong elite football players,[12] 23% lower compared to elite Brazilian football players,[4] and 12% lower compared to German[47] and Italian[50] elite football players. High aerobic power of Rs seems to be important since aerobic power in football players is directly related to the player's ability to move on the field without the ball. This stands particularly for the midfielders.[11]

Ideally, R's and players physical conditioning should be comparable, but practically this requisite can only rarely be encountered in Rs.

Therefore, the question is whether the existing differences can be compensated and how. To reply to this question, the basic abilities possessed by a R, and the determining factors for a satisfactory refereeing have to be known. The known requirements and factors should be considered also criteria for Rs selection, while various other factors, possibly related to the refereeing performance, have to be further investigated.

Among the basic requirements, besides adequate knowledge of the playing rules, a R should be healthy, have excellent visual performance for short and distance vision, stereopsis and colour discrimination, superior level of intelligence, high aerobic power and speed of reaction to visual stimuli and low body fatness.

A good state of health of all active and candidate Rs should be established, during the annual medical evaluation, by: a) exclusion above all of those Rs with CHD; b) counselling and recommending diet and exercise to those exposed to modifiable risk factor(s) for developing CHD, and c) treating any trivial medical ailment found. The annual evaluation, on the other hand, of the Rs has, according to our experience, only positive impact on their health and fitness and therefore on their performance.

A reduction, with diet and training of Rs' body fatness to ≤10% of body mass, that is, the elite football players' fatness, will have a favourable impact on their speed and mainly on endurance. However, this task is rather difficult to be achieved and even more difficult to be maintained. Training, aiming to improve aerobic and anaerobic power, as well as speed of running, apparently important for refereeing performance, can be pursued following suggestions reported earlier.[51]

Superior intelligence (IQ≥110) is obviously important, particularly for the international Rs. This is because of the continuous mental demands made upon them during matches, due to the numerous different and ever-changing situations and the necessity for correct and instant evaluation, prompt decision and intervention to control the game. It was estimated,[52] indeed, that a R has to make about 120 decisions per football match.

Fortunately, the average Greek R's IQ score is by 3.7% higher than that of the mean IQ score of 20 elite Greek football players studied earlier.[53] His average reaction time (0.20 s) to visual stimuli, as it was measured in a previous study,[54] was found somewhat longer than that of elite football players (0.21 s vs 0.20 s) respectively.[55]

Furthermore, certain determining factors and/or major requisites such as independence and fairness of judgement, ability to command respect, aim at being accepted and ability to anticipate the development of the players' action, or the motor schemes to be observed and a number of a few other psychological and cognitive characteristics, have been previously identified.[56]

Cognitive abilities, such as attention, thinking promptness, field perception, visual orientation, observational ability and a personality background, based on emotional and stress stability, persistence, dominance and self-confidence, were found to be important for the football players' performance.[57] It is logical, therefore, to consider these abilities equally important, for the referees as well and worth to be further investigated. In addition, a well-developed sense of justice, ability to analyse the information and exclude irrelevant data, and knowledge of what and when to observe, were considered [56] important for the refereeing performance.

From the above mentioned cognitive abilities only the attention to free and preset rhythm was studied.[53] [55] It was found to be 12.3% and 9.3% better in football players than in Rs, respectively. Concentrated (spontaneous and provoked) attention, on the other hand, was found to be better in 20 umpires (8 Rs were included) than in 20 athletes (8 football players were included too) of the same age.[58] As attention studied till now in Rs is limited to the short lasting attention, further investigation of the long lasting attention will be interesting. Furthermore, attention under the time pressure in Rs was studied recently (1996) by one of the authors (A.S.) using the Test d2 (Aufmerksamkeits - Belastungs - Test.[59] He noticed (unpublished data) that the average percentiles of attention in 54, 50 and 89 football Rs of Division A, B, and C were 71.2, 69.4 and 72.6 respectively. No differences were found among the groups. The average percentiles were considered sufficient.

Mental training, aiming to develop psychological and cognitive abilities for better refereeing performance, has already been proposed elsewhere.[58] This must be considered complementary to physical conditioning.

Fitness criteria, over the years,[26] [27] used for fitness evaluation and selection, according to our data and the previous discussion, are a relatively easy task for a young well trained adult. For this reason we suggest the following minimum fitness criteria for selection of Rs during annual evaluation. For the 200 m and the 50 m races, to be 30.5 s and 7.3 s respectively and for the 12-min race to be higher than the 2950 m in case of international and even national level (A, B and C division) Rs.

A retired elite football player, around the age of thirty, is expected to be gifted with higher than average speed and endurance. His physical qualities, at this stage of his life, as well as the thorough knowledge of the play, qualifies him as the best candidate to become a successful football referee. However, due to the regulations, the time it takes for someone to become a leading referee, and for various socio-economic reasons, professional players seldom become professional Rs.

In conclusion, the average male Greek R is a healthy, young to middle aged adult, rather tall and overweight. His visual performance and IQ are satisfactory. Physical condition of the great majority of Rs, in divisions A and B seems adequate, when compared to international standards. Referees of division A, are relatively older than the other subgroups, and better trained. Compared to the players, a R is at a disadvantage in modern football, mainly in terms of physical fitness. This factor inevitably limits his refereeing performance. A good state of health, a well-maintained physical condition through training, will create a solid base for his performance. Using more strict criteria, during annual evaluation, it is expected that better trained Rs will be selected. A retired young professional football player, would be ideal, among other healthy young adults, to join the Rs class, if a more promising generation of referees is desired. More information is needed, mainly about determining factors (psychological and cognitive) for football refereeing.

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