Analyses Of The Energy Sources Used By Turkish Referees During Ninety Minutes Soccer Match

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Abstract: The purpose of this study was to predict the percentages of various energy sources used by volunteer 5 official soccer Turkish Referees (mean age: 38.40 ± 1.1 years, height: 178 ± 0.5 cm, body mass: 85.20 ± 2.5 kg) and to analyze the locomotor motions during 90min amateur soccer a match expressed in anaerobic threshold level (ATL). Each subject's heart rate was monitored during a match using a short-range radio telemetry (Sport Tester™ PE_{3000}), and was sampled at 5-s intervals.Percentage of heart rate (x= 181.8 beats/min) and estimated anaerobic threshold level (x= 171.2 beats/min). The locomotor movements (walking, jogging, fast running, backward running and sideway running) of each subjects were recorded on the field by using hand-notational system for whole match period. The frequency and duration of each activity were recorded and these data were utilized to calculate the distance covered by the referee. The result indicated that the mean work ratio below A.T.L. was 77.04% , there was no significant differences between heart rates recorded in the first and second halves and the mean value of total distance covered was 6166 meter; significant fall in the work rate was noted in the second half ($p<.05$). According the results of this study referees doesn't need vigorous training for officiating a match. But they should participate in aerobic conditioning programs on regular basis and also should be abrupt acceleration and deceleration, charges of direction and angles runs. Additionally, muscle glycogen levels should not be lowered by strenuous activities the day before or the morning of soccer match to be officiated.

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Introduction

Soccer is a dynamic game. It is a ninety minutes paced activity, and it is played with a ball by two sides, each trying to kick it over the others goal line. These and other definitions describe soccer as an object or basic mechanism of playing the game. Demands on fitness and mobility have increased with changing tempo of modern soccer. Refereeing is an athletic activity. It is a common sense that any athlete who wishes to perform his activity well should begin by assessing his basic health and then take positive action to improve deficiencies and develop whatever physical and mental requirements are necessary for his task. The referee is not required, as player is, to develop the ability to head a ball powerfully or kick to it. But he is required to accelerate quickly from a standing start, to have speed of movements and ability to maneuver over heavy grounds to turn and change direction while in motion and possess sufficient reserves of stamina to last more than two hours. To determine what improvements to his health may be required, the referee should know, by analyzing each game, how efficient he has been in keeping up with the play, in moving to the position selected after reading situations and what degree of fatigue he has experienced during the later stages of a hard game. Very few people refer to a soccer referee as an athlete. Although many people take it for granted that referees must undergo adequate physical fitness training in order to be able to keep up with modern soccer requirements of the 90's. Like a top class player that must gain his physical fitness though hard work, the same applies to a top class referee (Stanley, 1988). Physiological fitness levels required for match-play depend on the work-rate demands of the game which vary with the level of competition. Specific positional roles of referee may demand unique physiological attributes. These are reflected in the anthropometric and physiological fitness profiles of referee. Heart rate measurements of the referee is one way of the prediction various energy sources used by a referee. Heart rate is one index of physiological strain incurred by the referee during match-play. It is relatively unobtrusive as it can be monitored continuously by radio telemeter. The international literature has unfortunately often neglected the performance aspects of the so-called 23rd player—the referee. In fact, referees' activities during actual match play have been addressed in the international literature only rarely (Asami et al., 1988; Catterall et al., 1993) despite the many referees officiating all over the world at whatever the level. This led to a lack of specific

knowledge that could be otherwise useful for the specific conditioning, both technical and physical, of the officials. Furthermore, in those research reports (Asami et al., 1988; Catterall et al., 1993) match analysis was performed with technology that gave only a gross idea of the activity performed by the referees during the match (Ohashi et al., 1988). Today's fast action of the game with every changing direction and speed requires the referee to be closed to the ball which means referee must be all over the field and be able to keep up with the pace of the game. Therefore, referee has to have significantly high physical fitness because the performance of the referee effect decisions and fluidity of the game. Measuring of referee's energy expenditures and analysis of the movements can give results and helpful to decide what type of training program needs to be selected.

This study was concerned with outlining the work-rate demands of refereeing top-level soccer matches and monitoring physiological responses of referees during matches.

Method

Participants

5 official soccer Turkish Referees (mean age: 38.40 ± 1.1 years, height: 178 ± 0.5 cm, body mass: 85.20 ± 2.5 kg) were involved in the study. All referees had official medical clearance according to the national law. Written informed consent was received from all referees after verbal and written explanation of the experimental design and potential risks of the study. All the assessments were performed for the each match. All of the testing procedures were completed in season.

Procedures

Work-rate evaluation: In order to estimate the distance that a referee covered during the 90 min of play, each game was recorded on the field by using hand-notational system. In determining the distance covered four levels of locomotor movements were categorized. These were; walking, jogging, fast running, backward running and sideway running. Each individual referee's stride lengths were calculated by monitoring his movement directly across the centre circle. Once the stride length for each type of action (walking, jogging, fast running, backward running and sideway running) had been calculated, it was then possible to estimate the distance covered during the game for each particular action. This was performed by counting the total number of walking, jogging, fast running, backward running and sideway running strides that the referee took during the game and multiplying these by the appropriate stride lengths. The frequencies of each action were recorded in 45-min periods in order to compare the two halves.

Heart rate monitoring: The heart rate was used as an indication of the cardiovascular strain imposed on referees during matches. Thus any relations between the work rate and the heart rate could be determined. Exercise heart rate was determined by Karvonen formula (Target Heart Rate = ((max HR − resting HR) × %Intensity) + resting HR). Heart rate was recorded for the full duration of each game by means of short-range radio telemetry (Sport Tester^{TM} PE_{3000}). A chest monitor transmits the heart-rate signal to a receiver worn on the wrist. The heart rate was recorded every 5 s. The data stored in the watch were down-loaded on to a personal computer for analysis following the game. The heart-rate monitor was placed on the referee approximately 10min before kick-off. This allowed the subject to become familiar with the equipment.

Statistical analyses

Mean values for work rates in each half were compared using t tests. The alpha level of significance was determined as 5% ($P < 0.05$). Maximal heart rates were estimated using the formula 220 – age (Astrand and Rodahl, 1986). Work rates were calculated as a percentage of these maxima. Relations between work rate (distance covered) and cardiovascular strain (mean heart-rate) were examined with Pearson's correlation coefficient.

Results

The distances covered over the period of a 90min soccer match ranged from 4226m to 7883m (Table 1). Mean values for each half were compared statistically using a t test on 5 subjects. Significantly less distance was covered by the referees in the second half compared to the first half ($P < 0.05$).

Table 1. Total Distance (m) covered by each referee

Subject		*First half*	*Second half*	*Total*
1		3769	3249	7018
2		4283	3600	7883
3		2736	2184	4922
4		2123	2103	4226
5		3577	3206	6783
Mean(s.d.)		3298(861)	2868(679)	6166(1530)

P<.05

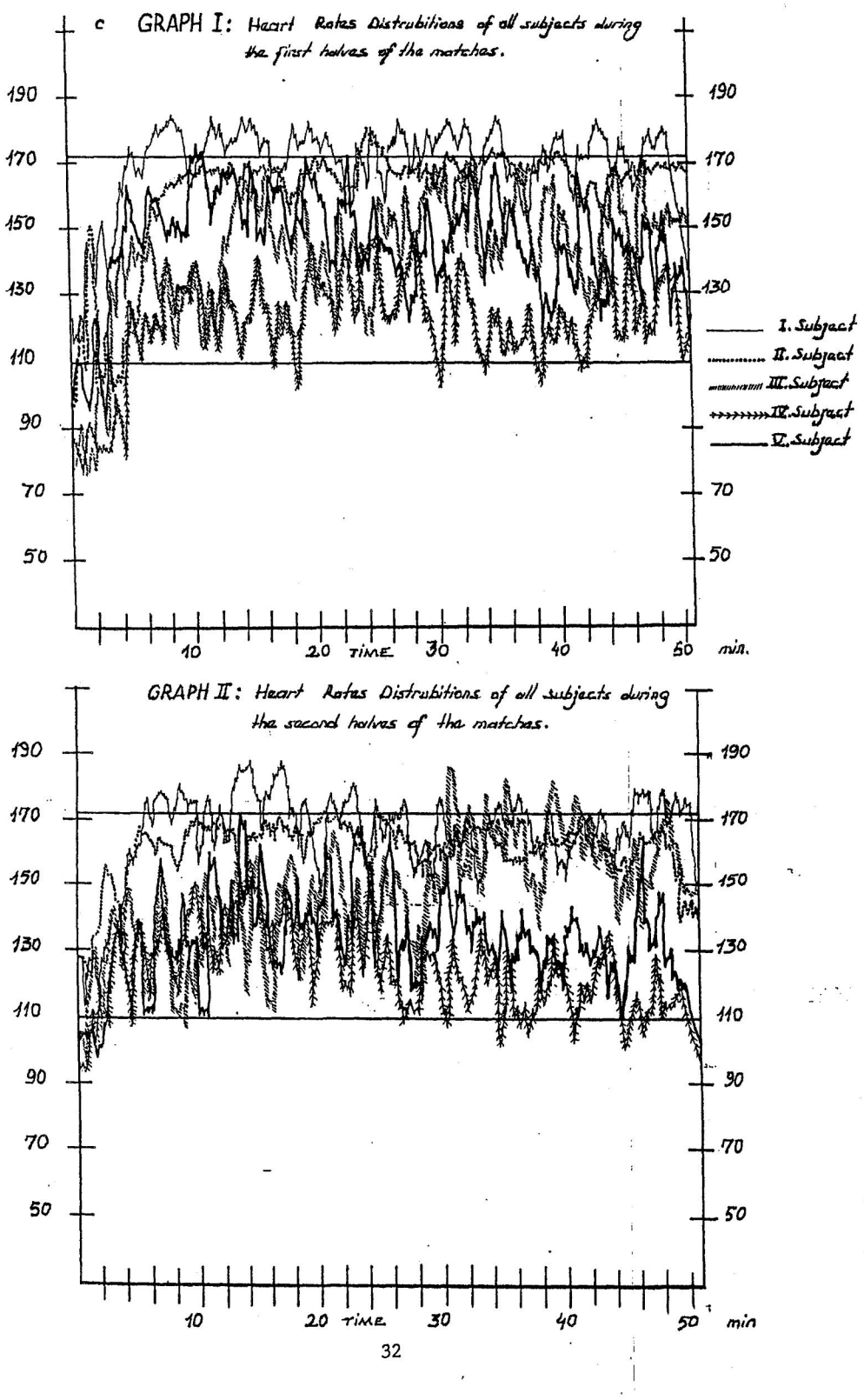

Fig. 1. The mean heart-rate recording of all subjects

A breakdown of the distances covered in each of the activity categories is provided in Table 2. These results indicate that the majority of the game was spent jogging with walking being the next main activity. A distance (43m) was covered running backwards, with fast running and backward running being the least common activity among the referees.

Table 2. Total Distance (m) covered for each locomotor movement

Subject	*Walking*	*Jogging*	*Fast running*	*Backward running*	*Sideway running*
1	1570 (22.3)	4447(63.4)	596(8.5)	367(5.3)	38(.5)
2	2268(28.8)	4308(55.2)	789(10)	419(5.4)	49(.6)
3	1600(32.4)	3013(61.2)	265(5.3)	10(.2)	34(.8)
4	1849(43.6)	2086(49.3)	199(4.7)	36(.8)	56(1.6)
5	2004(29.5)	3814(56.2)	220(3.2)	709(10.4)	36(.7)
Mean(%)	1858(30)	3534(57)	414(6.7)	323(5.2)	43(1.1)

The distance covered in each locomotor movements expressed as a percentage of the total distance is given in parentheses(P<.05).

Resting heart rates before kick-off were high, approaching 100 beats/min. The heart-rate recordings for all subject is shown in Figure 1. The mean heart rate for all the referees over the duration of a full game was 147 beats/min. This corresponds to approximately 77.4% of the referees' estimated maximal heart rate. The highest peak heart rates were incurred in the top division matches and reached 188 beats/min in some instances. The mean heart rate was unaffected by the category of competition. No significant correlation ($r = 0.15$; $P > 0.05$) was found between the mean heart rate and the distance covered during a game, indicating the individual variations in the responses. There was no significant difference ($P < 0.05$) between the heart rates recorded in the first and second halves (Table 3). This was despite the reduced work rate (as measured by distance covered) in the second half.

Table 3. Mean heart rates (beats/min) in the first and second halves of the match for each referee

Subject	*First half*	*Second half*	*Total*
1	169	165	167
2	160	160	160
3	147	147	147
4	121	121	121
5	145	135	140
Mean	148.4	145.6	147

P<.05

Discussion

Physiological fitness levels required for match play depend on the work rate demands of the game which vary with the level of competition. Use of the heart rate in such field has been defended on the grounds that it was at once indicator of the total circulatory load imposed on the body. During the game many exercises or activities require a blend of both anaerobic and aerobic metabolism. The results of this study suggest that referees cover a distance of almost 6.2 km over the duration of an amateur football match. Although, Catterall et al. (1993) found that referees cover a distance of almost 9.5 km over the duration of an elite-level football match. In addition, Asami et al. (1988) showed that the mean values of 10.5 km for seven foreign referees at international matches in Japan and 11.18km for ten Japanese referees of the Japan National Soccer League matches. This difference may occur because of level of the matches. In our study work-ratio decreased in the second halves of the matches. The drop in the referee's work rate in the second half of a game has also been shown for football players (Reilly and Thomas, 1976). This is thought to result from fatigue linked to diminished energy stores within the active muscles (Saltin, 1973). In the present study, however, it was unclear whether the reduced work rate of the referees in the second half was a consequence of fatigue or merely an artefact of the reduced work rate of the players. If the former is true, the second half decrement may be reduced by increasing fitness and adopting a carbohydrate loading diet, in the 3 days preceding the match. Previously, Brodie (1981) reported no difference in work rates of soccer referees between first and second halves..

In the our study, mean value of walking 30%, jogging 57%, fast running 6.7%, backward running 5.2% and sideway running 1.1% in whole matches.In such a study was observed with referees spending 52% of the total match time walking, 19% jogging and 15%

standing. These prevalence of a pattern of movements at low speed (walking and jogging) have been observed in others studies (Asami et al., 1988; Catterall et al., 1993; Da Silva and Rodriguez-Añez, 1999; D'Ottavio and Castagna, 2001; Johnston and Mcnaughton, 1994; Krustrup and Bangsbo, 2001), which a range between 41.8% and 73.8% of match coverage (Castagna et al., 2007). The results of this study were found to be in the upper limit of this range (71%). It has previously been described that low-intensity activities are negatively correlated with aerobic fitness (Castagna and D`Ottavio, 2001). Differences in game style and match intensity among countries are other factors that should also be taken into account when results are compared (Rebelo et al., 2002; Helsen and Bultynck, 2004). Recently, it has been reported that work-rates of referees during match-play were partly related to the physical activities of the players (Weston et al., 2007). The high percentage (71%) of movements at low speed (walking and jogging) found in the present study could be the result of a lower match intensity of the regional championship where referees officiated, and/or differences in game style between south American and Europeans players.

One way to facilitate exercises prescription was to estimate exercise intensity in relation to subject's heart rate. Activities were based on the heart rate response during the work interval. Intensity of exercises at or slightly above the anaerobic threshold of subject represented anaerobic work. Heart rate below anaerobic threshold level of subject represented aerobic work. First and second subject's maximum heart rates reached were above the estimated maximum heart rates at times during the matches. Therefore, it can be said that these subject's estimated max. Heart-rates were underestimated. When this was true, the lowest percents that were obtained by these two, subjects (54.6% and 35.8% respectively) showed as the percent of period worked below ATL would have been increased. Fourth subject worked 100% of the time at below ATL. This subjects worked not too intense during the match and this could be seen at his average heart rate obtained (121 beats/rnin). The high heart rates of first and second subject-could have been also due to emotional factor and some degree of nervousness during the game. Shephard (1992) concluded that the stress on the heart from anxiety reactions may be more intense that that from maximum exercises and Porter and Allsen's (1978) study of basketball coaches support the role of psychological stress increasing heart- rate. Subjects' heart- rates during the match varied considerably and in some cases their heart rate was maintained close the maximal level. Holland and Cherry (1971) reported the highest heart rate after the officials sprinted 20 to 25 yards to cover a play (182 beats/rnin 91% maximum). Except of the third subjects the average heart rates of all subjects decreased in second half this was due to the fact that the tempo of the games dropped down when losing teams appeared to have lost interest in the game. In general the heart-rate of subjects during the matches was, 20 to 30 beats/rnin below maximal level (GRAPH I and II).

During the exercises below anaerobic threshold level, subjects, required energy may be produced almost exclusively by aerobic processes. During less intermitted work subjects used aerobic system predominantly by ATP production from breakdown mainly of carbohydrates and fats and sometimes of protein, to carbondioxide and water. But during the short burst of physical effort, subjects' heart rates reached above anaerobic threshold using anaerobic energy source. At the beginning of activities, subjects used high energy phosphates and followed through the partial breakdown of carbohydrates to lactic acid.

In conclusion, most types of ball games officiating represent more or less intermittent work with frequent-interchanges of short, burst of physical effort, interspaced with brief pauses. For this reason, refereeing required physical endurance or dominantly aerobic power. Then referee should participate in aerobic conditioning program on regular basis and the activities during the course of training should be include acceleration and deceleration, changes of direction and angled runs.

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