

# Adaptations in heart rate and arterial pressure induced by a specific training exercise program for elite soccer referees: a case report

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## ABSTRACT

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*Introduction: There are few studies in literature that examine the effects of specific training protocols on the improvement in the performance of soccer referee competition. The aim of our work has been to monitor the heart rate and the arterial pressure in an elite soccer referee during his physical training of 8 week length. Methods: The remarks of these parameters have been effected during the 2004/2005 competitive season of the S.C. athlete, soccer referee of the "CAN A/B Federazione Italiana calcio". The training program consisted of 17 sessions of aerobic-type, 13 sessions of anaerobic alactacid type, 19 sessions of anaerobic lactacid type and 7 sessions for the improvement of the muscular strength. Results: During the second week of training, resting heart rate underwent a decrease of about 8% and 9% compared with initial and first week rate respectively. Systolic and diastolic arterial basal pressure did not show any change in comparison to initial one. Conclusion: Training protocol did not induce any central and peripheral cardiovascular adaptation in the elite soccer referee. Therefore, we support the important role that the monitoring of the cardiac rate and arterial pressure play in the evaluation of the effectiveness of the exercise training protocols.*

**KEYWORDS:** *heart rate, arterial pressure, elite soccer referee, training exercise, adaptations*

## INTRODUCTION

The continuous techno-tactical development of soccer game imposes to the referee, the so-called twenty-third man, an always increasing technical and conditional employment. To optimize the carrying out of a soccer match is therefore necessary that also the referee is always more prepared both as regards to technical and physical aspect. In the last decades, scientific search has focused the attention on the soccer performance. In fact, a number of studies are present in literature concerning the physiological and notational (match analysis) features of the soccer player performance [1, 2, 3, 4, 5, 6, 7, 9, 10]. Unfortunately in this context the referee performance is nearly ignored. To such regard, few studies are available in literature that examine the effects of specific training protocols on the improvement in the performance of soccer referee competition [11, 12, 13,

14, 15, 16, 17]. In the past, tests effected by those people who are dealt with the physical preparation of the referees have assumed as reference the performance of the soccer player. Despite soccer player and referee are submitted to employments similar under certain aspects, nevertheless the referee generally is older than player, he cannot be replaced during the match, he does not have direct relationships with the football, he has less opportunity to recover and has to maintain a state of high attention despite rising up of exhaustion. It is evident that these subjects engage the cardiovascular apparatus in a remarkable way during their activity and it adapts to the exposure and formalities of the workload by relatively stable morpho-functional modifications. Recently, it has been reported that these adaptations are different according to the type, quantity and intensity of the muscular work and characterize the competition and

training performances. Then, to different load works correspond proportional peripheral requests and accordingly functional, central and peripheral adjustments of different degree. As regards to the cardiovascular modifications, an increase in the stroke volume, a resting bradycardia and a decrease in the resting systolic arterial pressure has been observed. The aim of our work has been to monitor the heart rate (HR) and the arterial pressure (AP) in an elite soccer referee during his physical training of 8 week length. The remarks of these parameters have been effected during the 2004/2005 competitive season of the S.C. athlete, soccer referee of the “CAN A/B Federazione Italiana Gioco Calcio”.

## MATERIALS AND METHODS

### *Remark of the anthropometric parameters of the athlete*

The S.C. athlete is masculine sex and 37 years old. He weighs 68,2 Kg and is 180cm high. Before starting the exercise training protocol, his resting HR is 68 bpm and his resting AP is 110/74 mmHg. He performed the physical preparation to the “Stadio delle Palme” in Palermo for an overall period of 8 weeks.

Three remarks for training session were effected at the same time in the afternoon at a temperature of 30°C in almost all the sessions (no rainy or cloudy).

Resting HR was measured by the Polar S710 cardiofrequenzimetro and data were processed by specific software. Maximal and minimal basal AP was determined by the PIC-BS400 digital pressure.

### *Program of exercise training*

During the period of physical preparation, the S.C. athlete has attended a training program formulated by a technical area, which is the athletic preparation section called “Associazione Italiana Arbitri”. The program consisted of 17 sessions of aerobic-type training (resistance), 13 sessions of anaerobic alactacid type training (speed), 19 sessions of anaerobic lactacid type training (resistance to the speed) and 7 sessions for the improvement of the muscular strength.

### *Statistic analysis*

The results were elaborated by the GrafPad InStat software, using the student's mean t-test and values were considered significantly different at  $P < 0.05$ .

## RESULTS

### *Effects on basal heart rate of elite soccer referee induced by exercise*

Resting HR measured in the first week of exercise

training did not different compared to the initial one. By contrast, during the second week we observed a significant reduction of resting HR compared with the initial and first week rate. In particular, HR diminished for about 9% and 8% compared with the initial and first week rate respectively (fig. 1). In the next 6 weeks, we did not note any relevant variation in the basal HR respect to the second week.

Exercise training program executed by the elite soccer referee induced a reduction of his HR only after the second week and resulted ineffective in the next period of training.

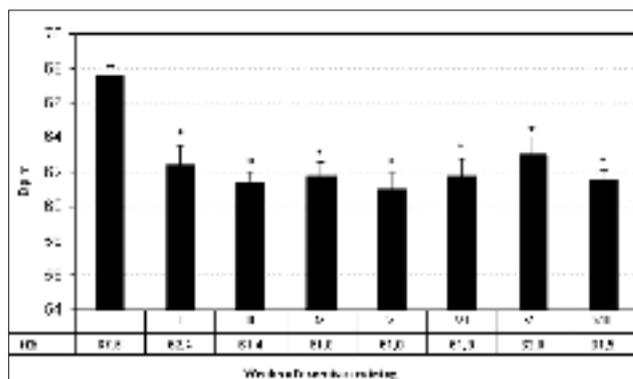


Figure 1. Graphic representation of elite soccer referee HR during 8 weeks of exercise training. Each data point corresponds to average of the daily remarks performed during one training week. (\*  $P < 0.05$  second, third, fourth, fifth, sixth, seventh, eighth week vs. initial and first week of exercise program).

### *Analysis of arterial basal systolic and diastolic pressure in elite soccer referee in response to exercise training*

Maximal initial AP did not undergo any significant difference compared with the pressure measured during the exercise weeks. Pressure preserved unchanged during all the period of physical preparation (fig. 2).

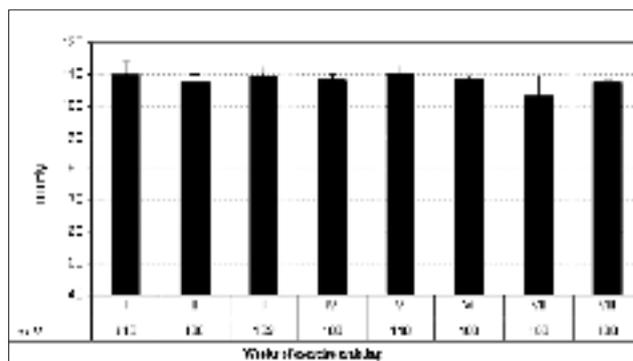


Figure 2. Visualization of systolic AP values in an elite soccer referee in response to exercise. Each data point corresponds to average and standard deviation of the daily remarks performed during one training week.

As shown in figure 3, we also did not observe any change between the arterial minimal AP before and during the training program.

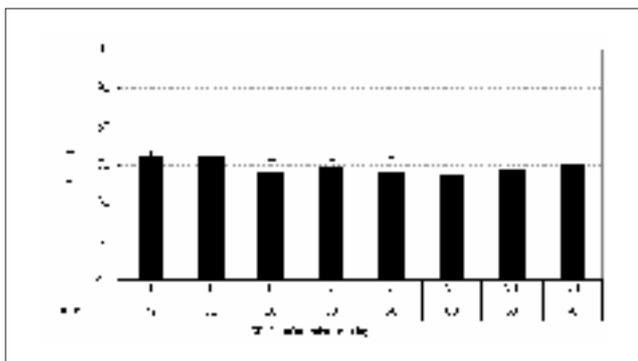


Figure 3. Analysis of diastolic AP in an elite soccer referee during training program. Each data point corresponds to average and standard deviation of the daily remarks performed during one training week.

Basal AP of the elite soccer referee did not undergo any adaptation in response to the training protocol.

## DISCUSSION

The necessity to develop more and more specific programs of exercise training induces the modern methodology of training to the realization of always precise performance models. In the recent past, the model of the arbitration performance was little known and the reference used for the realization of physical conditioning programs was that of the soccer player. The arbitration activity at high-levels sets a meaningful physiological employment to the competition officer soliciting in important way the aerobic mechanism [18]. During a match, an elite soccer referee covers an average of 11469 $\pm$ 983m, his physical activity is of intermittent type and the covered meters are nearly identical in the first and in the second time [12]. It has been seen that individual differences of maximal oxygen uptake in positive or negative influence the performance of elite soccer referee, both for the total covered meters and for the optimal positioning in the game field [13]. The level of the aerobic performance positively influence the technical performance understood as quality of the positioning in the game field during the match [14]. From these studies emerges that soccer referees need a specific physical preparation to be able carrying out in optimal way the competition course.

It is known that an exercise training protocol results to be effective if it induces those adaptations in the organism that determine an improvement in the sporting performance, therefore the objective of the present work has been to examine the effects of the training program formulated by the technical area, athletic preparation section of the "Associazione Italiana Arbitri" on the HR and AP of an elite soccer referee.

A training of the resistance sufficiently intense determines a cardiac hypertrophy due to an

enlargement of the heart chambers and a myocardium hypertrophy. Consequently, some events occur including an increase in the systolic output that leads to an increment of the cardiac flow and the ability of oxygen uptake necessary for the performances of resistance. An elevated systolic output has the advantage to make an economic cardiac work possible both in resting conditions or under load, makes possible. A diminution of the heart rate of 10 bpm produces a 15% energy saving.

Numerous studies have shown that athletes trained to the resistance show a cardiac rate both in rest and during submaximal exercise inferior in comparison to sedentary subjects of peer age [19, 20, 21]. It is known that the subjects trained to the resistance have a HR of around 40-50 bpm (untrained subjects around 70 bpm) and a systolic volume of around 105 ml (untrained subjects 60-70 ml).

In our study, we have noticed a reduction in the HR of the elite soccer referee S.C. only after the first week of training since this parameter doesn't undergo any variation in the following sessions of training. This datum could be due to the fact that in the following weeks the workload of the training program has not been such to induce significant adaptations in the cardiac rate.

Heart dimensions or volume are tightly correlated not only with the systolic volume, cardiac flow, oxygen pulse, maximal oxygen uptake and, therefore the ability of resistance performance, but also in narrow relationship with the global blood volume and total haemoglobin, capillarization of the musculature involved in the exercise, as also with the dimensions of the liver, as principal organ of the metabolism. Such relationships underline that, with the training, all the parameters that participate in the production of the sporting performance are harmonically developed and reciprocal influence themselves.

As regards to the monitoring of the resting arterial pressure in elite soccer referee that we have examined, is resulted that neither the minimal nor the maximal arterial pressure undergo meaningful variations during the whole period of physical preparation.

In literature numerous studies have shown that subjects that have an active style of life possess a pressure, both systolic and diastolic, smaller in comparison to the sedentary ones [22]. In addition, it has been reported that physical activity of intermittent type, performed for a relatively long period with elevated intensity, reduces notably the risk of arterial hypertension [23] unlike the power activity that determines a raising of the basal arterial pressure [24]. Generally, subjects who result in good physic form with the ergonomic test, have smaller pressures in comparison to those who reach scarce results. An improvement of the blood

pressure has been also underlined in coronaropatic hypertensive patients subsequently to aerobic-type training of the 3-8 month length; such remark has not been observed in the control group.

The mechanism responsible for the diminution in the arterial pressure that follows the physical conditioning is well known, but a big role is played by the reduction of the sympathetic activation and therefore concomitant decrease of the circulating hormone concentration (catecholamine) that involves, in turn, a diminution of the peripheral resistances. Another mechanism could be the increase of the sodium urinary excretion induced by the exercise, that leads to a reduction in the volume of the bodily liquids and therefore of the arterial pressure [22, 23, 25].

In our work, we have not observed remarkable cardiovascular adaptations neither to central nor peripheral level during the training period of the S.C elite soccer referee and these data result to be in contrast with the reports above mentioned. Naturally, this study is preliminary since further analyses will be carried out on a meaningful number of samples to obtain unquestionably valid results.

The interesting aspect of our work is that in literature there are no other reports in which these physiological parameters have been analyzed during the period of physical preparation of a category of sporting judges as that of the soccer referees having the responsibility of the competition result.

In conclusion, from our data it comes out the important role that the monitoring of the cardiac rate and arterial pressure play in the evaluation of the effectiveness of the exercise training protocols.

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