COMPARISONS OF SERUM C-REACTIVE PROTEIN IN YOUNG SOCCER PLAYERS AND NON-ATHLETES

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ABSTRACT: The aim of this study was to compare the plasma concentration of high sensitive C-reactive protein (hs-CRP), white blood cells (WBC), uric acid, and total cholesterol (TC) between soccer players and non-athletes. We also intended to evaluate the relations of blood markers with $\dot{V}O_2$max and body composition variables. This cross-sectional study involved professional soccer players (n=40) and sedentary young men (n=60), aged 18-22 years. Blood markers such as CRP, WBC, uric acid, and TC were determined by laboratory tests. Cardiorespiratory fitness (VO_2max), body mass index (BMI) and fat tissue (FM) were determined by the standard test protocols. There were no significant differences between CRP levels of soccer players and non-athletes (0.32±0.13 vs. 0.34±0.19 mg/dl). CRP correlated significantly with FM among soccer players (r=0.482, p≤0.002). Our results also showed a significant correlation between TC and VO_2max in soccer players (r=0.469, p≤0.002). Our results showed that long-term soccer training may have no significant effect on the CRP level.

KEY WORDS: C-reactive protein, uric acid, VO_2max, soccer players

INTRODUCTION

An association between serum uric acid level and many cardiovascular disease (CVD) risk factors has been reported in the literature. As an example, it has been shown that the prevalence of hypertension increases with uric acid level. Serum CRP has also been identified as a new risk factor for CVD. In a study, increased CRP levels were found to be associated with the risk of myocardial infarction (MI), thromboembolic attacks, and peripheral vascular diseases [5]. Some previous reports using general population samples indicated that higher levels of physical activity are cross-sectionally associated with lower levels of inflammatory markers such as CRP and white blood cell (WBC) counts [1].

The effects of regular or chronic exercise on basal levels of inflammatory markers have been used to recommend exercise as an anti-inflammatory therapy [6,25]. On the other hand, some studies suggest that inflammatory markers such as CRP and WBC may be influenced by gender, body composition variables and the type of physical activity. For example, in the King et al. survey, jogging and aerobic dancing were associated with lower CRP levels when compared with other forms of activity including swimming, cycling and weightlifting [22]. Several studies indicate that no relationship between physical activity levels and CRP is found after adjusting for body mass index (BMI) and other risk factors [26,29]. According to this literature, we focused on CRP and WBC as inflammatory factors as well as other blood markers such as uric acid and total cholesterol. These markers were chosen because each of them has been associated with coronary heart disease (CHD) risk [1]. Therefore, the aim of this study was to compare the plasma concentration of CRP, WBC, uric acid, and TC between soccer players and non-athletes. We also intended to evaluatethe relation of determined blood markers with $\dot{V}O_2$max and body composition variables.

MATERIALS AND METHODS

Subjects. Forty young soccer players and sixty non-athletes volunteered to participate in the study. The research protocol has been approved by the Research Ethical Committee of the University of Mohaghegh Ardabili. The information sheet and consent form have been reviewed and signed by the subjects. Subjects were apparently healthy volunteers with no history of cardiovascular disease, orthopaedic problems, or other medical con-ditions that would contraindicate exercise. Characteristics of the subjects are shown in Table 1. Soccer players followed a training programme that included four sessions per week for 2 years. Subjects had to complete 100% of the training sessions to be included in the study.

Blood sampling

Venous blood samples were drawn after overnight fast for serum total cholesterol, uric acid, CRP and WBC counts. Analyses for hs-CRP were performed by means of particle-enhanced immunonephelometry using a standard CardioPhase for BNII (Dade Behring Holding GmbH, Liederbach, Germany). WBC counts were measured using a Sysmax KX21 cell counter. Serum uric acid and total cholesterol concentrations were measured by an Auto analyzer (Model UV-2100, Germany).

Measurement of body composition variables

To estimate the percentage of body fat, skin-fold measurements of four sites (triceps, abdominal, thigh and sub-scapular) were made on the right side. Measurements were taken with dry skin, and not overheated. The Lafayette standard caliper was used to measure the skin-fold thickness in millimetres. The sum of these 4 measurements (mm) and person's age were used to calculate body density in the following equation:

Body density = 0.29288 (sum of 4 sites) - 0.0005 (sum of 4 sites) 2 + 0.15845 (age in years) - 5.76377

The body fat percentage is then calculated according to the following formula (19): Body fat (%) = (((4.95/body density) - 4.50)*100).

The body height (cm) and weight (kg) were determined by an electronic SECA scale. Weight was measured in light clothing and bare feet to the nearest 0.1 kg. Body mass index (BMI) was calculated as the weight in kilograms divided by the height in metres squared.

$\dot{V}O_{2max}$ measurement

To measure peak oxygen uptake values ($\dot{V}O_{2max}$), the subjects performed symptom-limited graded exercise tests on the treadmill using the Bruce protocol. This protocol requires the subjects to run for as long as possible on a treadmill whose speed and slope are increased at timed intervals.

To complete the Bruce test, the subjects warmed up for 10 minutes, with the treadmill speed adjusted to 2.75 $km \cdot h^{-1}$ and an incline of 10%. Every three minutes, the speed and incline of the treadmill were increased by 0.8–1.13 $km \cdot h^{-1}$ and 2 %, respectively. The test was continued to the subjects' volitional exhaustion. Peak oxygen uptake (ml/kg/min) was defined as the highest value recorded during the test.

Statistical analysis

Descriptive statistics (mean ± SD) for age, height, and weight were calculated for the subjects. The dependent variable data at multiple time points between the two groups were compared using independent samples t-test. To allow comparison of unrelated observations, the Kruskal-Wallis test was used, which includes appropriate procedures for multiple comparisons between groups. The Pearson product-moment correlation was also used to determine the relation between selected variables. Statistical significance was set at $p \leq 0.05$.

RESULTS

Our results showed a significant difference between $\dot{V}O_{2max}$, FM, and body weight of soccer players and non-athletes (Table 1.).

Comparison of the CRP levels between soccer players and non-athletes revealed that there was no significant difference between the two groups (0.33 ± 0.13 vs. 0.34 ± 0.19 mg/dl; p =0.63). We also found no significant difference for total cholesterol, WBC and uric acid between the two groups (Table 2).

TABLE 1. DEMOGRAPHIC CHARACTERISTICS OF THE SOCCER PLAYERS AND NON-ATHLETES

Parameters	Soccer players (n=40)	Controls (n=60)
Age (years)	20 ± 1.57	21 ± 1.20
Body height (cm)	176.3 ± 4.2	176.8 ± 6.6
Weight (kg)	66.2 ± 6.2	71.5 ± 10.9*
BMI ($kg \cdot m^{-2}$)	21.4 ± 2.1	22.4 ± 3.4
Fat (%)	8.5 ± 3.7	13.6 ± 5.8**
$\dot{V}O_2$max ($ml \cdot kg^{-1} \cdot min^{-1}$)	50 ± 4	43 ± 2**
Systolic BP (mmHg)	124 ± 20	118 ± 16
Diastolic BP (mmHg)	74 ± 9	78 ± 8

Note: The values are mean ± SD; BMI = Body mass index, VO_2max = Maximal oxygen uptake, BP = Blood pressure *. Significant at p ≤ 0.05; **. Significant at p ≤ 0.01.

TABLE 2. HAEMATOLOGICAL AND BIOCHEMICAL CHARACTERISTICS OF THE SOCCER PLAYERS AND NON-ATHLETES

Parameters	Soccer players (n=40)	Controls (n=60)
WBC (cell×10^6)	6353±1170	6636±1053
hs-CRP($mg \cdot dl^{-1}$)	0.33±0.13	0.34±0.19
Uric acid ($mg \cdot dl^{-1}$)	30.15± 6.89	31.32± 3.44
Total cholesterol ($mg \cdot dl^{-1}$)	144±27	147±22

Note: The values are mean ± SD

TABLE 3. CORRELATION BETWEEN BLOOD MARKERS AND BODY COMPOSITION VARIABLES OF THE SOCCER PLAYERS

	BMI ($kg \cdot m^{-2}$)	FAT (%)	$\dot{V}O_2$max ($ml \cdot kg^{-1} \cdot min^{-1}$)
hs-CRP (mg/dl)	0.308	0.482**	-0.220
	0.053	0.002	0.172
WBC (cell×10^6)	-0.091	-0.178	0.154
	0.575	0.273	0.344
Uric acid ($mg \cdot dl^{-1}$)	-0.094	-0.093	0.012
	0.562	0.567	0.942
Total cholesterol ($mg \cdot dl^{-1}$)	-0.111	0.097	-0.469**
	0.496	0.552	0.002

Note: ** Significant at p ≤ 0.01

Results revealed a significant correlation between CRP and fat mass in the soccer players. Total cholesterol levels of the soccer players had a significant negative correlation with $\dot{V}O_2max$ (Table 3).

Our results showed significant positive relationships between WBC and BMI. We also found a significant negative correlation between WBC and $\dot{V}O_2max$ in non-athletes (Table 4).

TABLE 4. CORRELATION BETWEEN BLOOD MARKERS AND BODY COMPOSITION VARIABLES OF THE NON-ATHLETES

	BMI ($kg \cdot m^{-2}$)	FAT (%)	$\dot{V}O_2max$ ($ml \cdot kg^{-1} \cdot min^{-1}$)
hs-CRP (mg/dl)	0.167	0.232	0.098
	0.201	0.075	0.454
WBC (cell×10^6)	0.357**	0.246	-0.394**
	0.005	0.058	0.002
Uric acid ($mg \cdot dl^{-1}$)	-0.024	-0.034	0.220
	0.858	0.799	0.092
Total cholesterol ($mg \cdot dl^{-1}$)	0.241	-0.013	-0.215
	0.064	0.919	0.099

Note: ** Significant at $p \leq 0.01$

DISCUSSION

Our results showed no significant difference between blood markers of the two groups. CRP correlated significantly with FM in the soccer players. We also observed significant negative correlations between TC and $\dot{V}O_2max$ in the soccer players.

The review of the literature showed that regular physical activity reduces, in both sexes and at all ages, coronary and cardiovascular morbidity [16,17]. Furthermore, inverse associations have been demonstrated between regular physical activity and cardiovascular disease after adjustment for conventional risk factors [31].

Many studies have demonstrated inverse relationships between regular physical activity and serum concentration of inflammatory and thrombotic markers [1,7,29]. Geffken et al. demonstrated that lower values of serum inflammatory markers and white blood cell count are associated with higher levels of physical activity [15]. However, various exercise regimens may influence inflammatory markers differently, and there is still a lack of knowledge about the target exercise level leading to optimum anti-inflammatory efficiency [10].

The findings of this study indicated that although the measured $\dot{V}O_2max$ was significantly higher and body fat percentage was significantly lower in soccer players, there was no statistically significant difference between soccer players and non-athletes for the measured blood markers.

Although high-intensity or prolonged acute exercise increases CRP, chronic exercise has been hypothesized to reduce circulating levels of CRP and other inflammatory markers [30]. Cross-sectional studies consistently demonstrate an inverse relationship between serum CRP and both physical activity level and cardiorespiratory fitness [20]. These associations remain after controlling for potential confounders in some studies [13] although others suggest they may be influenced by factors such as gender, body composition and the type of physical activity [23]. It has also been shown that CRP is strongly associated with BMI, and BMI is inversely associated with fitness [8].

In spite of our finding, early investigators hypothesized that uric acid might be a cause of hypertension or renal disease [12]. In a recent study, moderate-high physical activity in men and light and moderate-high physical activity in women are reported to be associated with lower levels of uric acid [9]. Similarly, Ergün et al. showed that regularly exercising subjects had lower uric acid concentrations compared to sedentary controls [10]. A number of epidemiological studies have reported a relation between serum uric acid levels and a wide variety of cardiovascular conditions [12].

Our study indicated a significant correlation between CRP and FM in the soccer players. WBC had significant positive and negative relationships with BMI and $\dot{V}O_2max$ in non-athletes. This is consistent with the largest data set on obesity and CRP, which indicated that obesity conferred an increased probability ratio for increased CRP after controlling for other variables [11].

In a longitudinal study of 109 healthy men and women, BMI, but not current or previous-year physical activity, was significantly related to CRP [27]. Obesity, waist-to-hip ratio, BMI and fasting serum triglyceride are all reported to be important determinants of fasting serum uric acid. Some recent studies also suggest that cardiorespiratory fitness has a favourable effect on CRP concentration [4].

Kim et al. reported an independent association between WBC count and fitness in 8241 apparently healthy Korean men [21]. In our study, WBC was inversely associated with $\dot{V}O_2max$ in the non-athletes. Gaeini et al. reported an inverse relation between WBC and aerobic or cardiorespiratory fitness levels measured by $\dot{V}O_2max$ in children [14].

Anderssena et al. showed that low cardiorespiratory fitness is strongly associated with the clustering of CVD risk factors in children, independently of country, age and sex [3]. They conclude that cardiorespiratory fitness is an important predictor for the clustering of CVD risk.

CONCLUSIONS

In conclusion, our results showed that long-term soccer training has no significant effect on serum hs-CRP concentration. It appears that physical fitness variables are inversely associated with TC.

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