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# Total antioxidant capacity among diabetic patients: relationship to cardiorespiratory fitness

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**ABSTRACT: Regular physical activity is recognized as a non-pharmacological treatment in type II diabetes of metabolic syndrome. This study was designed to test whether aerobic capacity or cardiorespiratory fitness is associated with total antioxidant capacity in diabetes patients. Subjects were twenty six sedentary men aged 42.9 ± 5.5 year and body weight 90 ± 5.79 kg with type II diabetes that participated in study by voluntary. Total antioxidant capacity, glucose and insulin were measured after overnight fast, Cardiorespiratory fitness ($VO_2$max) was measured using a bicycle ergometer according to YMCA protocol. Pearson correlation was used to determine the association between variables. A P-value of $< 0.05$ was considered to be statistically significant. No significant correlation was observed between $VO_2$max and total antioxidant capacity in studied patients ($p = 0.76$, $r = 0.06$). Based on these data, it is concluded that antioxidant system can not affect cardiorespiratory fitness in diabetes patients, although future studies should examine the potential role of aerobic capacity or physical fitness in systemic inflammation or immune system in diabetes or other chronic diseases.**

**Keywords:** Immune system, Inflammation, Insulin resistance, Diabetes

## INTRODUCTION

The increasing development of chronic diseases including type 2 diabetes, asthma, insulin resistance, metabolic syndrome, blood pressure, cardiovascular diseases, and some types of cancer are somehow correlated with the increasing obesity. Therefore, the issue of obesity and its side effects has attracted the attention of many researches of basic and clinical sciences. Among obesity dependent diseases, type 2 diabetes is one of the most important chronic diseases shoes global statistics, including Iran, is increasingly growing [1, 2].

This disease has been known to be the fourth leading cause of death in developed countries [3] and according to the statistics of the diabetes international federation in 2010, more than 258 million people suffer from it around the world [4]. In addition to hyperglycemia and insulin resistance reduction, this disease is coupled with systemic inflammation and decreased immune system capacity against the presence of free radicals and oxidants [5]. Scientific references have pointed out oxidant stress and decreased antioxidants capacity in these patients [6]. In this regards, some studies have reported the decreased total antioxidant capacity in type 2 diabetics in comparison to non-diabetic healthy people [7]. Moreover, it is reported that the decreased total antioxidant capacity, or oxidative stress conditions, somehow provide the context for the development of other metabolic disorders [8] and cardiovascular diseases [9]. Therefore, important strategies have been proposed to these patients who aim to improve the metabolic profile by consuming substances containing antioxidants [10]. On the other hand, scientific references have shown the decreased cardiorespiratory fitness of these patients in contrast to healthy people [11]. Although an inactive and sedentary life style plays an important role in mitigating the cardiorespiratory fitness of these patients, it is assumed that some other external and internal stimuli are effective in the decreased cardiorespiratory fitness of these patients. Specifically, scientific references have supported a significant relationship between $VO_2$max, as a physiological index of determining the cardiorespiratory fitness, and TNF-α and IL-6 as two proinflammatory cytokines, in the obese populations [12].

These findings support the role of systemic inflammation in the level of cardiovascular fitness. However, despite these observations, few studies have followed the relationship between cardiovascular fitness and oxidant stress, oxidant levels, or antioxidant capacity of type 2 diabetics. The related work somehow points out the role of antioxidant profile in the cardiovascular fitness or aerobic capacity of these patients. Therefore, this study aims to determine the relationship of $VO_2$max, as a prominent index of physiological cardiovascular fitness and the total antioxidant capacity of male type 2 diabetics.

## METHOD AND SUBJECTS

**As previous mentioned,** the purpose of this study was to examine the relation of $VO_2$max as a good determinant of cardiorespiratory fitness or aerobic capacity with total antioxidant capacity in diabetes men. For this purpose, a total twenty six sedentary adult men with type II diabetes aged 42.9 ± 5.5 year and BMI 30 ± 2.54 kg/$m^2$ were recruited in study and underwent exercise test for measurement of $VO_2$max. Written informed consent was obtained from all participants.

Participants were included if they had not been involved in regular physical activity or diet in the previous 6 months. Exclusion criteria for the study group were: coronary artery disease, cerebrovascular disease, peripheral artery disease, asthma and chronic obstructive lung diseases. Those that were unable to avoid taking hypoglycemic drugs or insulin sensitivity-altering drugs for 12 hours before blood sampling were also barred from participating in the study.

**Anthropometry:** A medical history to retrieve information about health status, current medications and a physical examination including height, weight, waist circumference and blood pressure were performed before study. Weight was measured to the nearest 100 g using digital scales. Height of the barefoot subjects was measured to the nearest 0.1 cm. Obesity was defined as BMI kg/m2. BMI was calculated as weight (kg)/height ($m^2$). Percentage body fat was measured using body composition monitor (OMRON, Finland). Resting blood pressure (BP) levels were measured in the right arm with a cuff sphygmomanometer after a participant had been resting for 10 min.

**Cardiorespiratory Fitness and biochemistry:** Venous blood samples were obtained after overnight fast at morning (8.00 a.m.). Blood used to determine TAC by FRAP method. Maximum volume of oxygen utilization ($VO_2$max) was measured using a bicycle ergometer (Tuntury F90, made in Finland.) in a stepwise fashion according to YMCA protocol [13]. Cycling test included 5 continues stage without rest between stages and each stage lasted 3 minute.

**Statistical analysis:** Data were analyzed by computer using the Statistical Package for Social Sciences (SPSS) for Windows, version 15.0. Normality of distribution was assessed by Kolmogorov-Smirnov test. The association between $VO_2$max and total antioxidant capacity was assessed using Pearson's correlation coefficient. A probability level of $p<0.05$ was used to indicate statistical significance.

## RESULTS

The association of total antioxidant capacity and $VO_2$max in adult men with type II diabetes was determined in present study. Anthropometric, clinical and physiological characteristics of the study participants are described in Table 1. Data of statistical analysis showed that all subjects were obese or overweight.

Based on Pearson correlation coefficient test, total antioxidant capacity was not correlated with $VO_2$max in studied patients ($p = 0.76$, $r = 0.06$, Fig. 1, Table 2). On the other hand, cardiorespiratory fitness is not associated with antioxidant system in type II diabetes patients.

**ble 1: Anthropometric, clinical and physiological characteristics of the study participants.**

| | Mean | Std. Deviation |
|---|---|---|
| Age (year) | 42.88 | 5.501 |
| Height (cm) | 173.12 | 4.448 |
| Weight (kg) | 90.42 | 7.590 |
| Systolic blood pressure (mmHg) | 12.62 | 1.856 |
| Diastolic blood pressure (mmHg) | 8.35 | .846 |
| Abdominal (cm) | 103.04 | 7.291 |
| Hip (cm) | 102.81 | 3.225 |
| AHO | 1.0015 | .05304 |
| BMI (kg/m2) | 30.1950 | 2.54020 |
| Body fat (%) | 29.2538 | 2.00524 |
| Total antioxidant capacity (mmol/L) | .3635 | .21639 |
| VO2max (ml/kg/min) | 32.31 | 10.773 |
| insulin (IU/mL) | 8.545 | 3.8366 |
| Insulin resistance (HOMA-IR) | 4.2400 | 1.68155 |
| Insulin sensitivity (HOMA-IS) | .5292 | .08508 |
| Glucose (mg/dl) | 206.50 | 57.422 |

**Table 2: Correlation of Total antioxidant capacity and VO2max in studied subjects**

| | | Total antioxidant capacity (mmol/L) | VO2max (ml/kg/min) |
|---|---|---|---|
| Total antioxidant capacity (mmol/L) | Pearson Correlation | 1 | .064 |
| | Sig. (2-tailed) | | .757 |
| | N | 26 | 26 |
| VO2max (ml/kg/min) | Pearson Correlation | .064 | 1 |
| | Sig. (2-tailed) | .757 | |
| | N | 26 | 26 |

## DISCUSSION

The main finding of this research is that the cardiovascular fitness level of type 2 diabetics is not related to the antioxidant profile. In other words, this research has proved that although for type 2 diabetics, VO2max variations, as a cardiovascular fitness index is in line with the total antioxidant capacity, however, their relationship is not statistically significant; while, these patients present lower levels of both these variables in contrast to non-diabetic healthy people. In other words, type 2 diabetics have lower cardiovascular fitness and total antioxidant capacity in comparison to healthy people.

The oxidant imbalance of antioxidants, including undesirable biochemical changes in diabetes, plays an important role in the development and spread of vascular side effects in diabetes patients [5]. Specifically, the weakening of the antioxidant system, the depletion of antioxidant reserves, decreased activity of antioxidant defense enzymes, including catalase, peroxidase, superoxide dismutase and glutathione peroxidase, and finally the total antioxidant capacity of diabetics lead to a faulty antioxidant defense system and the activation of stress sensitive intracellular signaling routes, increased expression of genes involved in inflammation and tissue injuries [7, 14].

Oxidant stress is effectively increased in both type 1 and 2 diabetes [15]. This occurs in response to the imbalance between produced free radicals of oxygen and the antioxidant defense. Many studies have reported the relationship between high blood sugar and the activation of oxidant stress [16]. Several factors are effective in high levels of free radicals, including the decreased antioxidant capacity due to the increased blood sugar. Specifically, researches have pointed out the decreased antioxidant capacity and levels of some antioxidants, e.g. Glutathione and Superoxide dismutase, in diabetics in comparison to non-diabetics [7]. Although, so far, few studies have reported a relationship between cardiovascular fitness and antioxidant defense in diabetics. However, some studies have pointed out the relationship between total antioxidant capacity and inflammatory cytokines, e.g. CRP or TNF-α [17, 18, 19]. On the other hand, the increasing effect of these inflammatory cytokines, e.g. TNF-α, on blood sugar levels and insulin resistance is frequently reported [20]. These findings somehow support the role of oxidant stress or antioxidant capacity in blood sugar levels and other determinants of diabetes. Moreover, the relationship between inflammatory mediators affecting the antioxidant defense, e.g. IL-1B, IL-6, and TNF-α, which were mentioned earlier, and cardiovascular fitness levels of various populations have been reported by several studies [21]. These findings support the effect of systemic inflammation on the cardiovascular fitness or the aerobic capacity. Furthermore, scientific references have pointed out the increased total antioxidant capacity [22, 23] and the aerobic capacity or cardiovascular fitness [24, 25, 26] of diabetics or other healthy or patient populations [27]. This means that the response of both these variables to regular exercise is in line and follows a natural pattern. Therefore, we can conclude that the total antioxidant capacity and cardiovascular fitness directly affect one another. Despite these statements, this study finds no relationship between these variables for type 2 diabetes. On the other hand, their insignificant relationship can be explained by the low number of failed samples which is a constraint of this research. This is also probable that the total antioxidant capacity and the aerobic capacity, each affect one another indirectly or through other hormonal and metabolic mediators.

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