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DSX 935 No. of Pages 4

ARTICLE IN PRESS

Diabetes & Metabolic Syndrome: Clinical Research & Reviews xxx (2018) xxx–xxx

Contents lists available at ScienceDirect

Diabetes & Metabolic Syndrome: Clinical Research & Reviews

journal homepage: www.elsevier.com/locate/dsx

Original Article

Relationship between serum levels of oxidative stress and metabolic syndrome components

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ARTICLE INFO

Article history:
Available online xxx

Keywords:
Oxidative stress
Metabolic syndrome
Metabolic syndrome components

ABSTRACT

Aims: This study aimed to investigate the relationship between the total antioxidant capacity (TAC) and Malondialdehyde (MDA) with number of metabolic syndrome (Mets) components on the personnel working in Shahroud University of Medical Sciences.
Methods: This cross-sectional study was conducted on 167 personnel aged 30–60 years old. ATP III criteria were used to diagnose patients with MetS. Oxidative stress indicators were measured. The data was analyzed via one-way ANOVA, and Pearson and Spearman correlation coefficients.
Results: The result showed that TAC had a significant positive correlation with HDL and a significant negative correlation with abdominal obesity. In addition, there was a significant positive association between the level of MDA and age, BMI, abdominal obesity, diastolic blood pressure, triglycerides, and LDL; however, it had a negative significant correlation with HDL.
Conclusions: The measurement of TAC and MDA biomarkers can increase the early diagnosis of patients at risk of developing Mets.

1. Introduction

Metabolic syndrome (Mets) is consisted of a group of disorders including abdominal obesity, hypertension, dyslipidemia, and insulin resistance [1]. Adult Treatment Panel (ATP III) is one of the most common and reliable standard methods used for the clinical diagnosis of the syndrome [2]. In addition to the risk factors outlined by the ATP III criteria, several studies have reported the role of oxidative stress in the pathogenesis of metabolic disorders associated with this syndrome [3–5]. Oxidative stress is caused by the imbalance between free radicals (prooxidants) and antioxidant systems; it can play an important role in the pathophysiology of diabetes, cardiovascular diseases, and hypertension [6]. On the other hand, some of the Mets factors such as hyperglycemia and inflammation can lead to increased production of reactive oxygen species (ROS); the reactive oxygen species have toxic effects which lead to peroxidation of membrane lipids and produce malondialdehyde (MDA) [7]. To deal with the reduction of oxidative stress, several antioxidant defense systems are developed which act both via their enzymatic and non-enzymatic effects. Non-enzymatic antioxidant defense system includes molecules such as glutathione, beta-carotene, vitamin C, A, E, and enzymatic antioxidant defense system includes important intracellular antioxidant enzymes such as catalase (CAT), glutathione reductase (GR), glutathione peroxidase (GPx), and superoxide dismutase (SOD) [6].

The measurement of the total antioxidant capacity (TAC) is taken into consideration as a useful tool for diagnosis and medical treatment of diseases such as cardiovascular diseases and diabetes mellitus [8]. In addition, the TAC level is used as one of the biological markers for monitoring oxidative stress in humans [9]. Although several studies have been conducted on the relationship between oxidative stress and Mets [3,10,11], there are still limited information on the relationship between oxidative stress and components of the syndrome. As a result, this study was conducted on the personnel working in Shahroud University of Medical Sciences and aimed to investigate the relationship between the number of Mets components and the indicators of oxidative stress (TAC and MDA as the marker of lipid peroxidation).

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https://doi.org/10.1016/j.dsx.2018.03.015
1871-4021/

Please cite this article in press as: M. Abbasian, et al., Relationship between serum levels of oxidative stress and metabolic syndrome components, Diab Met Syndr: Clin Res Rev (2018), https://doi.org/10.1016/j.dsx.2018.03.015

1.1. Subjects

This cross-sectional study was conducted on 167 employees aged 30–60 years old who were working in Shahroud University of Medical sciences in 2005.

2. Materials and methods

Based on our inclusion criteria, only the personnel aged over 30 years old who were interested in participating in the project were enrolled in the study. On the other hand, pregnant and lactating women, smokers, and those with a history of taking lipid lowering drugs and vitamin supplements were excluded from the study. The people participating in the project after signing informed consent, filled out a checklist containing eight questions about demographic information and five questions about their anthropometric characteristics. After obtaining the written consent, the participants' blood pressure and abdominal circumference were measured and recorded. Abdominal circumference was measured at the upper part of the iliac crest using a non-stretchable tape measure. Mercury sphygmomanometer was used to measure blood pressure. The participants' blood pressures were measured at the right hand in a sitting position and after resting for at least ten minutes. Blood pressures were measured twice, with at least ten minutes interval, and finally the mean blood pressure was recorded for every participant.

The participants' heights, without shoes, were measured using a non-stretchable tape measure. Finally, their weights were measured using a digital scale and their BMIs were calculated. In this study people with a $BMI \leq 18$ were considered as underweight, those with BMI = 18–24 were considered as normal, people with a $25 < BMI \leq 30$ were classified as overweight, and those with a $BMI \geq 30$ were defined as obese [12].

2.1. Laboratory evaluation

After 12 h of fasting, venous blood samples were taken from all the participants and the serums were stored at 70° below zero. Enzymatic assay method and Pars Azmoon Kits were used to perform all the required tests including fasting blood glucose, triglycerides, TC, HDL, and LDL. ATP III criteria were diagnosed to diagnose the people with Mets; according to this definition, a person with the syndrome must have at least three cardiovascular risk factors simultaneously [2]. Part of the serum samples were stored in a freezer at a temperature of −70 and were used to measure oxidative stress markers (TAC and MDA).

2.2. Oxidative stress markers

2.2.1. MDA level

In an acidic environment and high temperatures, MDA reacts with thiobarbituric acid and makes a pink color whose maximum optical absorption is obtained at a wavelength of 532 nm. To perform the test, 0.1 ml of serum sample was added to 0.9 ml of distilled water. Then, 0.5 ml of TBA reagent (which contains 100 ml of distilled water, 0.5 g of NaOH, 0.67 g of thiobarbituric acid, and 100 ml of glacial acetic acid) was added to the diluted sample for and was stored at 100° C Celsius for 1 h. After cooling the samples, they were centrifuged for 10 min at 4000 rpm. At the last stage, the supernatant was removed and the optical absorption rates of the samples were recorded using a spectrophotometer at a wavelength of 534 nm [13].

2.3. Serum total antioxidant capacity (TAC)

The assay measures antioxidant capacity using the ORAC (oxygen radical absorbance capacity). This method is based on the ability Azo-initiators are considered to produce the peroxyl radical by heating. TAC was measured at a wavelength of 450 Using Elisa methods.

2.4. Statistical methods

Using SPSS software, data analysis was performed at a significant level of 0.05.The data was analyzed via descriptive statistics, one-way analysis of variance (ANOVA), and Pearson and Spearman correlation coefficients.

This study was approved by the ethics committee of Shahroud University of Medical Sciences (ethics code: IR.SHMU.REC.1394.02).

3. Results

Of the total 167 people who participated in the study, 49 individuals had zero components, 67 persons had 1 or 2 components, and 51 persons had three or more components of the Mets. In this study, the prevalence of Mets was 30.5% with a confidence interval of 23.5–37.6.

According to the results of the study, there was a statistically significant difference between mean age, BMI, and syndrome risk factors (abdominal obesity, blood pressure, fasting blood glucose, triglycerides, and HDL) in terms of the number of syndrome components, so that people with three components or more had higher mean values than the other two groups. In addition, with increasing the number of components, mean HDL decreased (Table 1).

The evaluation of the relationship between oxidative stress and components of Mets, age, and BMI showed that TAC had a significant positive correlation with HDL and a significant negative correlation with abdominal obesity. In addition, there was a significant positive association between the level of MDA and age, BMI, abdominal obesity, diastolic blood pressure, triglycerides, and LDL; however, it had a negative significant correlation with HDL (Table 2).

This study also investigated the relationship between the mean levels of TAC and MDA in terms of the number Mets components. The results indicated with increasing the number of Mets components, the level of MDA was significantly increased. In addition, with increasing the number of Mets components, the level of TAC decreased significantly (Figs. 1 and 2).

4. Discussion

In this study, with increasing the number of Mets components, the level of MDA increased. In view of that, the level of MDA in people with more than three components was significantly higher than that in people with zero, one, or two components. In addition, with increasing the number of Mets components, the level of TAC significantly decreased. Yubero-Serrano et al.'s study [14] showed that with an increase in the number of Mets components, there was an increase in the level of lipid peroxidation products (LPO) and they observed a higher level of oxidative stress [14]. Sánchez-Rodriguez et al.'s study [15] also indicated a significant correlation between the increases in the number of Mets components and the exacerbation of oxidative stress [15]. Other similar studies have also reported an increase in oxidant parameters and a decrease in antioxidant parameters in patients with Mets [16–18].

According to the results of our study there was a significant positive correlation between the level of MDA and BMI and abdominal obesity while there was a reverse correlation between TAC level and abdominal obesity; these relationships suggested a change in the cellular antioxidant system and were also indicative of higher level of active free radicals in obese people [19]. The results of Bitla et al.'s study [17] also suggested a significant positive association between the MDA level and abdominal