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Relation Between Lipid Peroxidation and Body Mass Index(BMI), Percentage Body Fat (PBF) and Visceral Fat Area (VFA)

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Abstract

Reactive oxygen derivatives and oxidative stress mediated by these compounds play important role in cancer, some neurological diseases, cardiovascular pathologies like atherosclerosis and some inflammatory diseases, obesity and aging.

Obesity is known to be a very common condition. It has been shown that obesity is not only related with genetics and excessive food consumption, but also related with the increase in fat area and fat mass together with an increase in body mass index because of the insertion of reactive oxygen derivatives into lipid structures in the body. For that purpose, malondialdehyde (MDA) analysis has been used in scientific researches to determine the oxidative stress triggered by reactive oxygen derivatives which reveal lipid peroxidation products by being inserted in lipid structures. In this study, we have investigated the relationship between serum MDA levels and some important parameters of body composition analyzer in participants. Results of our study revealed a correlation between serum MDA levels and lean body mass (LBM), body mass index (BMI), percent body fat (PBF), visceral fat mass (VFM) and visceral fat area (VFA); however this correlation was statistically significant in females but not in men.

In conclusion, results of our study show that, there is a correlation between the above parameters and oxidative stress which increase in obesity and trigger some pathological conditions, and this correlation is more significant in females compared to men.

Key Words: MDA, obesity, body composition analyzer, body mass index, percentage body fat

1. Introduction

Oxygen is a very important element that has the ability to obtain energy. However, its reactive functionality is too high so it plays an important role in the formation of many impurities which are called ` free radicals`(1, 2). Free radicals contain an unpaired electron so they can easily exchange electrons with other molecules. Therefore they are very active atoms, molecules and ions in chemical reactions(1, 3). Substantially, free radicals can also be found in the form of reactive oxygen species (ROS), reactive nitrogen species (RNS) and reactive sulphur species (RSS). In their reactive forms, they cause various crucial diseases. Moreover, this condition which can cause various abnormalities in the body can induce obesity as well.

One of the most important reasons of obesity and oxidative stress is the molecular structure of the adipose tissue (4,5). The reactive oxygen species that enter the structure of the adipose tissue lead to lipid peroxidation and damage the chemical structure of the lipids so they are switched to aldehydes. One of the end products of lipid peroxidation is the malondialdehydes(MDA).

Lipid peroxidation turns the phospholipids, glycolipids, glycerides and steroids which make up the polyunsaturated fatty acids into toxic molecules such as alcohol, aldehyde and hydroxyacids. This conditions which is not enzymatic or induced in the biological system that is under the enzymatic control is commonly leads to cell damage or cell death.

Obesity causes a systemic oxidative stress. The indicatives (biomarkers) of the oxidative stress are higher in the obese individuals and this is directly correlated to the body fat index and fat percentage. On the other hand, the fat amount in the body reminds one the negative correlation between central adipose and the antioxidant capacity.

The relationship between the oxidative stress – obesity which depends on high carbohydrate and fat diet involves several processes. An increase in the fat concentration: increased energy storage, mitochondrial oxidative of food, ROS and the cellular defense system against ROS are some of the stages of these processes (6). Obesity-induced oxidative stress, on the other hand, and oxidative stress that contributes to the development of obesity and metabolic syndrome has been shown to be associated with the formation of adipose tissue (8). A good example of this is the lipid peroxidation of free radicals. Aldehydes are one of the most important cytotoxic products that are formed due to lipid peroxidation. One of the products is the malondialdehyde (MDA) that is formed due to oxidative decomposition of the non-enzymatic lipid peroxides. Since MDA is able to pass easily from the cell membrane it disturbs the structure of cell organelles and leads to their deformation (8).

Due to the correlation between the obesity and the increased oxidative stress, the metabolic and mechanic workload on myocardium increases. The negative result of the oxygen consumption at myocardium is the increase of aerobic respiration and among this the formation of free radicals (7). Another result is that the large body index which causes pressure reveals progressive and total cell injury. The cell injury causes the release of various cytotoxins (tumor necrosis alpha) and this leads to the formation of the reactive oxygen species.

One other reason that may occur is due to a diet. Obesity depending on the food intake is one of the leading causes of obesity. Excessive free fatty acid intake in food leads

to lipid peroxidation and therefore triggers oxidative stress (7).

2. Materials and methods

69 volunteers from the Eastern Mediterranean University staff and students between ages 22 and 40 participated in this study. There were 42 women and 27 men.

Blood samples of the participants for serum MDA analysis were collected on an empty stomach between 8 am-10:30 am. Following the centrifugation serum samples were stored in -80^{0}C deep freezer. After taking the blood samples, participants were analyzed for body mass index (BMI), lean body mass (LBM), percent body fat (PBF), visceral fat area (VFA) and visceral fat mass (VFM) by using a body composition analyzer (Jawon X-scan Plus II Body Composition Analyzer™).

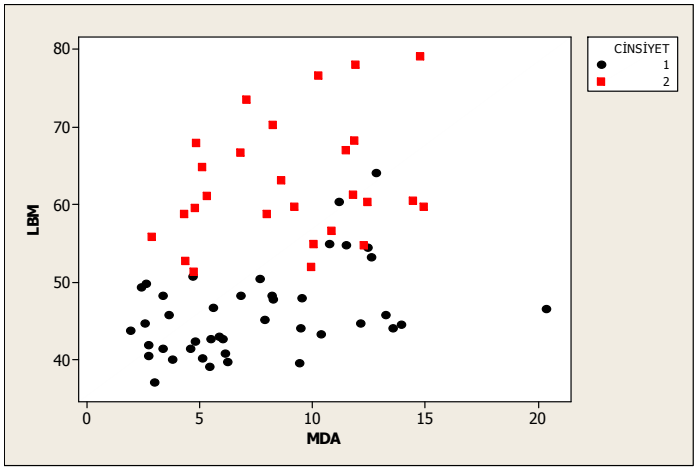
Serum MDA analysis were performed according to the method which Draper and Hadley; 1990 and Hammouda et al.; (1995) (9). used. In this method, red-pink color which occurs following a reaction between thiobarbutiric acid (TBA) and MDA in low pH is detected by spectrophotometer in 532 nm. According to this method, 2.5 ml 10% trichloric acid is added into 0.5 ml of serum. Following 15 minutes stay in 90^{0}C water bath, samples were cooled on ice for additional 15 minutes. Following centrifugation in 3000 rpm in 4^{0}C for 10 min, 2 ml of the supernatant were transferred to another tube. 1 ml of 0.675% TBA was added onto the supernatant and stayed in 90^{0}C water bath for 15 min. Samples were cooled on ice for additional 15 minutes and rested in room temperature until the samples were analyzed by spectrophotometer in 532 nm.

SPSS 19.0 used for statistical analysis. Continuous variables are given with mean, median, standard deviation, minimum and maximum values; qualitative variables are given with frequency and percent. Shapiro-Wilk test is used for normality test. Spearman correlation and partial correlation analysis are used for comparison of continuous variables. Independent samples t-test and Mann Whitney U tests are used for 2 group comparisons. For all statistical comparisons with p value below 0.05 assumed as there is a statistically significant difference.

3. Results

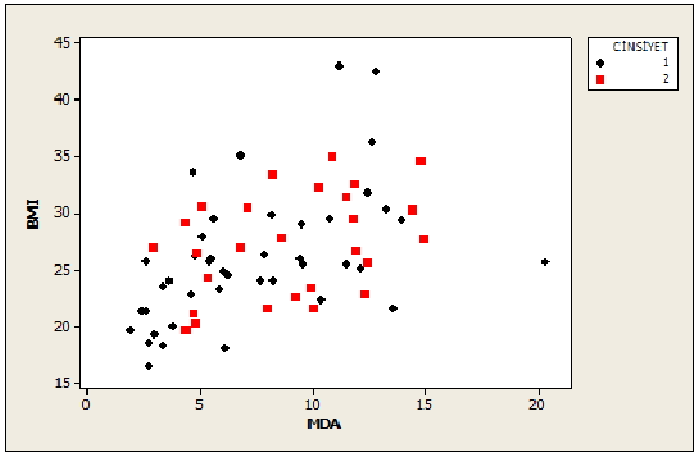
3.1. Serum MDA and Lean Body Mass (LBM)

Serum MDA values of all participants were 8.04 ± 4.00 (women: 7.47 ± 4.20; men: 8.93 ± 3.57). LBM of all 69 individuals were detected as 52.57 ± 10.54, where men showed higher LBM values (women: 46.03 ± 5.78; men: 62.74 ± 7.84). Serum MDA levels were in statistically significant correlation with LBM values in all individuals (r = 0.394, p = 0.001) whereas this correlation was significant in women but not in men (women: r = 0.384, p = 0.012; men: r = 0.295, p = 0.135) (Figure 1).



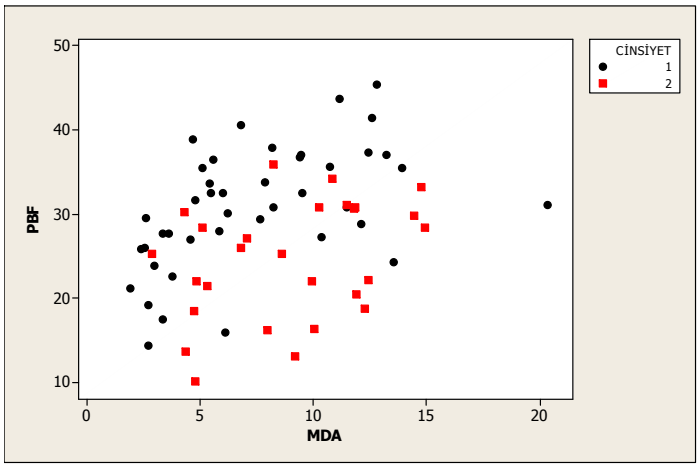
3.2. Serum MDA and Body Mass Index (BMI)

69 individuals participated in the study had BMI values of 26.52 ± 5.41, where BMI values were similar in men and women (women: 26.05 ± 5.90; men: 27.23 ± 4.55). Serum MDA levels were statistically significant correlated with BMI values in all individuals (r = 0.501, $p < 0.001$) where this correlation was significant in women but not in men (women: r = 0.564, $p < 0.001$; men: r = 0.363, $p = 0.06$) (Figure 2).



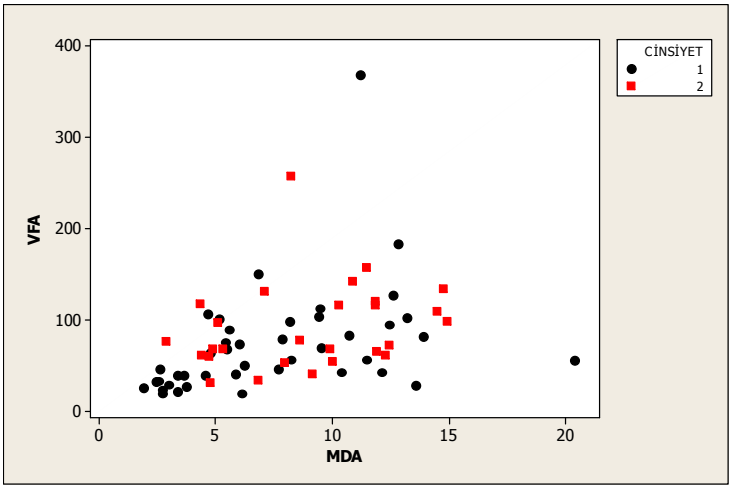
3.3. Serum MDA and Percent Body Fat (PBF)

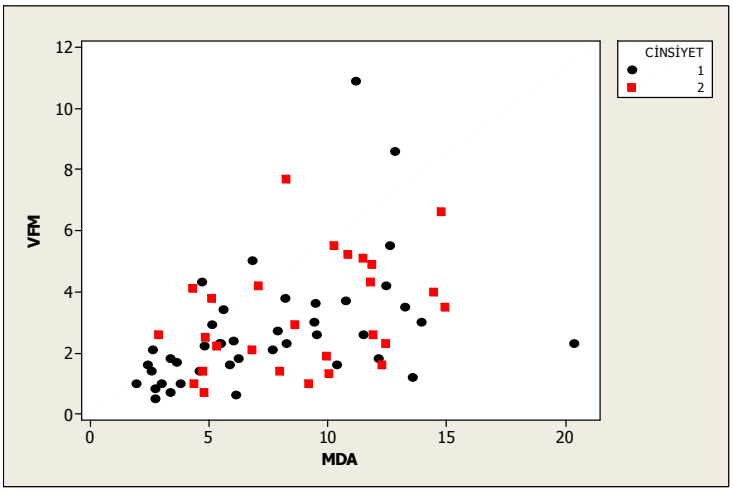
PBF values of 69 serum samples were 28.32 ± 7.72; where it was 30.77 ± 7.23 in women and 24.50 ± 6.96 in men. Similar to the correlation of serum MDA levels with LBM and BMI, serum MDA levels were statistically significant correlated with PBF values in all individuals (r = 0.377, p = 0.001) where this correlation was significant in women but not in men (women: r = 0.573, p < 0.001; men: r = 0.365, p = 0.061) (Figure 3).



3.4. Serum MDA, Visceral Fat Area (VFA) and Visceral Fat Mass (VFM)

VFA and VFM values of all participants were 80.65 ± 55.83 and 2.89 ± 1.94; consecutively. In women, VFA values were 73.07 ± 59.82 where VFM values were 2.69 ± 2.00. VFA values in men were 92.44 ± 47.67 where VFM were 3.20 ± 1.82. Statistically significant correlation were found between the serum MDA levels and VFA in all participants (r = 0.512, p < 0.001) like the VFM values (r = 0.516, p < 0.001). This correlations were statistically significant in women (VFA: r = 0.563, p < 0.001; VFM: r = 0.592, p < 0.001) but not in men (VFA: r = 0.313, p = 0.112; VFM: r = 0.367, p = 0.060) (Figure 4).





4. Discussion

Results from all individuals revealed a statistically significant correlation between the body mass index (BMI) and serum MDA levels which was in good accordance with the previous results (10, 11). Interestingly, this correlation was statistically significant in females whereas it was not in males. Previous studies showed that blood MDA levels have been found higher in men than women (12, 13). Our results show that gender play role in the relationship between the body mass index and lipid peroxidation.

Other finding from our study is the statistically significant existence of the correlation between the percentage of body fat (PBF) and the serum MDA levels although it was not as prominent as the relationship between the serum MDA and BMI. This finding can be explained by the highest susceptibility of lipids to free radicals among all the nutrients (14). Our results are in good accordance with the findings revealing that high-fat diet may result with the increases in MDA levels in the hepatocyte mitochondria (15). and obese individuals have higher MDA levels

compared with the non-obese individuals (16,17,18). The effect of the gender on the correlation between the PBF and serum MDA was found similar with the correlation between the BMI and serum MDA where it was statistically significant in women but not in men.

In accordance with the relationship between the serum MDA and above parameters, same results have been found between the visceral fat area (VFA) and visceral fat mass (VFM) including the gender differences where it was statistically significant in women but not in men. Accumulating data show that excess fat storage and related increased oxidative stress lies under many obesity related conditions (7). Increased mechanical workload of heart leading increased oxygen consumption by cardiac cells will increase the production of reactive oxygen derivatives (7, 19, 20). Additionally, pressure occurred by the big body mass will trigger the intense and continuous cell damage leading secretion of cytokines and the production of reactive oxygen species (7, 21, 22).

MDA levels are the indicator of the lipid peroxidation in the tissues. Lipid peroxidation diminishes the structure and viscosity of cell membrane, damages the cell and eventually leading the formation of atherosclerotic plaques inside the blood vessels (23, 24). As a result, the findings of our study claim that serum MDA levels can be used as a parameter in terms of cardiovascular disease risk assuming that all above parameters which the relationship between the serum MDA levels have been shown in this study carry a risk factor for cardiovascular diseases at the same time. Additionally, the results of our study show that this situation is more obvious in women than men.

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