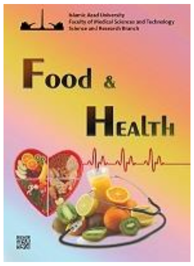

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The relationship between oxygen radical absorbance capacity (ORAC) index and elevated blood pressure in overweight or obese subjects compared to normal-weight subjects

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ABSTRACT

Obesity is an important preventable disease and increases the chance of developing some chronic diseases like hypertension which is related to many factors including oxidative stress. Dietary antioxidants protect the body against oxidative stress. The purpose of this study was to evaluate the potential association of dietary oxygen radical absorbance capacity (ORAC) index with blood pressure in overweight or obese subjects compared to normal-weight subjects. In a cross-sectional study on 157 adult females and males from students and staff of Science and Research Branch of Islamic Azad University (SRBIAU) of Tehran that classified in two groups of normal weight and overweight or obese were evaluated. Demographic and validated food frequency questionnaires (FFQ) were completed and individuals' weight and height information were measured using the BIA. The systolic and diastolic pressure was recorded by the Automatic Blood Pressure monitor. Dietary antioxidant was estimated based on the ORAC index of selected foods reported by the Nutrient Data Laboratory of the United States Department of Agriculture (USDA). The results showed that there was a significant difference between the normal and overweight or obese groups in terms of body mass index, systolic and diastolic pressure (p=0.0001). Also, the ORAC index was higher in normal individuals than the case group, but it was not significant (p=0.222). There was also an inverse correlation between dietary ORAC, systolic and diastolic pressure in both groups, and only in the normal weight group, the association between systolic pressure and the dietary ORAC index was significant (p=0.04). The findings of the present study suggested that the dietary ORAC index was inversely associated with systolic and diastolic pressure in both subjects.

1. Introduction

Obesity is a public health concern affecting all age groups in the world (1). It is a complex disease and has multifactorial etiology and is the second most common cause of preventable death after smoking (2). The worldwide prevalence of overweight and obesity has doubled since 1980 to an extent that nearly a third of the world population is now classified as overweight or obese (3). Also, at least 2.8 million people dying each year as a result of being overweight or obese (4). Many studies have shown that obesity is associated with cardiovascular disease, dyslipidemia, and insulin resistance, in turn, causing diabetes, stroke and fatty liver. It has also been shown to alter the renin-angiotensin system (RAS) causing increased salt retention and elevated blood pressure (2). Obese individuals have demonstrated markers indicative of oxidative stress, including elevated measures of reactive oxygen species (ROS) (5) and diminished antioxidant defense, which is associated with lower antioxidant enzymes (6). Obesity-related oxidative stress, the imbalance between pro-oxidants and antioxidants (e.g., nitric oxide), has been linked to metabolic and cardiovascular disease, including endothelial dysfunction and atherosclerosis (7). Oxidative stress has gained attention as one of the fundamental mechanisms

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responsible for the development of hypertension. ROS has an important role in the homeostasis of the vascular wall, hence they could contribute to hypertension through inducing contraction and endothelial dysfunction or cause hypertrophic remodeling in blood vessels and myocardium (8-10). Many epidemiological studies have demonstrated an inverse association between a diet rich in fruit and vegetables and the occurrence of hypertension (11-12). According to the USDA database, ORAC is a preferable indicator that measures the antioxidant power of foods and other chemicals in the laboratory. Recent studies have shown that fruits and vegetables with high ORAC such as spinach and blueberries prevent chronic diseases (13-15). Therefore, the aim of this study was to evaluate the potential associations between dietary ORAC and elevated blood pressure in overweight or obese compared to normal-weight subjects.

2. Materials and methods

This study was a cross-sectional descriptive-analytic case-control study. The subjects were normal weight and overweight or obese adults who were randomly selected from among the students and staff of the Science and Research Branch of Islamic Azad University (SRBIAU) of Tehran. Based on a sample size formula, 64 volunteers were required for each group and with a 10% probability of drop-in each group, 70 individuals in each group were considered. The inclusion criteria were: BMI>18.5 and age range 18-65 years. Exclusion criteria included pregnancy, menstruation, using drugs effective on blood pressure as well as unwillingness to cooperate during the study and leaving more than 50% of the food frequency questionnaire empty. At first, the eligible subjects were thoroughly explained the purpose of the study and the method of its implementation and then were asked to sign a written consent if they wish to cooperate. On the day of referral to the SRBIAU Clinic, information about basic characteristics including age, sex, and smoking were obtained through face-to-face interviews by valid questionnaires. Weight was measured using the INBODY Model 270 bioelectric impedance analyzer and height was measured using a digital freestanding stadiometer BSM-170. Dietary data were collected using a validated semi-quantitative food frequency questionnaire (FFQ) with 148 food items (16). Both systolic and diastolic blood pressure (SBP and DBP) was recorded by the INBODY Automatic Blood Pressure Monitor model BPBIO320 based on the protocol (17). Dietary total antioxidant capacity (TAC) was estimated based on the ORAC index of selected foods reported by the Nutrient Data Laboratory of USDA and expressed as µmol of Trolox Equivalents per 100 grams of foods (µmolTE/100 g) (13). Independent T-test or nonparametric test, the Mann-Whitney test was used to compare the mean of quantitative outcomes between the two groups. Correlation models were used to compare the main variables of the study in case of a need for control over the main variables of the study. SPSS software version 25 was used for data analysis and p-value<0.05 was considered statistically significant.

3. Results

After calculating the sample size and simple random sampling, 180 adults, 90 obese and 90 normal weight were enrolled based on inclusion and exclusion criteria. Of these, 23 subjects were excluded because of incomplete questionnaires (more than half of the items were not completed) and more or less food reporting cases. Finally, the study began with 71 normal weight and 86 overweight and obese volunteers. Basic Characteristics of the two groups are presented in Table 1. As results showed, the difference in weight between overweight or obese group and the normal-weight group was about 18 kg (p<0.01).

Table1. Characteristics of the two groups.

Variable	Normal weight	Overweight or obese	p-value
N	71	86	
Sex(M/F)	60/11	67/19	0.731
Age(year)	38.90±10.976	38.60±9.394	0.854
Smoking	2.66±2.338	1.00±0.123	0.200
Anthropometric characteristic, mean±SD			
Weight (Kg)	73.45±10.66	90.05±13.22	0.0001*
Height (Cm)	172.54±7.58	172.20±8.33	0.789
BMI (Kg/m2)	24.57±2.32	30.28±3.16	0.0001*
Blood pressure, mean±SD			
Systolic pressure	121.17±13.03	131.02±15.18	0.0001*
Diastolic pressure	76.90±11.13	84.21±11.43	0.0001*

BMI, systolic and diastolic pressure were significantly higher in the overweight or obese group than the normal group (p<0.01). In Table 2, the intake of individuals from different food groups is shown. The consumption of vegetable and fruits in the normal weight group was higher than another group which significant differences in fruits consumption was found. Also, the dietary ORAC was higher in normal-weight subjects than another group, but this difference was not significant (p=0.222). The correlations between systolic and diastolic pressure and ORAC index are shown in Table 3. According to table 3, ORAC was correlated inversely with systolic and diastolic pressure in both groups, but the strongest correlation was seen for ORAC with systolic pressure in the normal weight group (CC=-0.216, p<0.05).

Table 2. Comparison of dietary intake and ORAC in two groups of normal and overweight or obese.

Variable	*Normal weight(n=71)*	*Overweight or obese* (n=86)	*p-value*
Cereals	29.214±4.448	36.660±4.070	0.219
Beans	4.540±0.795	6.039±0.728	0.166
Meats	10.933±1.073	13.925±1.173	0.042*
Fast food	11.75±2.174	13.437±1.989	0.569
Guts	0.106±0.052	0.253±0.048	0.039*
Dairy	69.593±6.857	57.113±6.274	0.181
Vegetable	14.116±1.713	13.529±1.872	0.817
Condiments	3.179±0.414	3.032±0.379	0.794
Fruits	18.943±2.515	15.781±2.302	0.035*
Nuts	5.778±1.994	8.061±1.825	0.400
Oils	3.550±0.812	4.693±0.743	0.030*
Sugar	4.248±0.633	4.722±0.580	0.582
Tea	320.216±28.325	340.057±25.917	0.606
Salt	2.052±0.335	2.184±0.366	0.791
Junk Food	4.698±1.454	3.493±1.330	0.542
Spice	0.715±0.089	0.743±0.081	0.817
ORAC	46002.65±14651.20	17747.27±8049.51	0.222

Table 3. The correlation coefficient between systolic and diastolic pressure with dietary ORAC index.

	Variable	*CC*	*p-value*
Normal weight (n=71)	Systolic pressure	-0.816	0.04*
	Diastolic pressure	-0.043	0.71
Overweight or obese (n=86)	Systolic pressure	-0.028	0.80
	Diastolic pressure	-0.050	0.60

4. Discussion

To our knowledge, this is the first study exploring the relations between dietary ORAC index and elevated blood pressure in normal-weight and overweight or obese people. In this present study, we showed that the dietary ORAC was higher in the normal weight group than the overweight or obese group. Similar to available data in this study, higher dietary ORAC was introduced better diet quality and was related to higher consumption of fruits and vegetables (18-20). The favorable effects of these antioxidant-rich foods on the improvement of systolic and diastolic pressure have been investigated in some studies. An inverse relationship between plasma levels of vitamin C, and carotenoids and blood pressure has been observed (21-22). Align with our results, some studies demonstrated that the consumption of fruits, vegetables, and dietary antioxidants have shown impressive blood pressure lowering results in various populations (23-25). A large prospective cohort study in France showed an inverse association between the dietary TAC and the risk of hypertension (26). Excessive fat accumulation can lead to obesity and hypertension. Macrophages in adipose tissue are capable to produce large amounts of peroxide (27). Thus, adipose tissue represents an important source of reactive oxygen species (ROS). ROS may contribute to the development of obesity-associated disorders like hypertension and diabetes (28). Lipid peroxidation is a biomarker of oxidative stress. Also, Oxidative stress results from the excessive production of oxygen free radicals, or the decrease of the concentration of antioxidants in the body. It has been suggested that Oxidative stress causes imbalanced production and bioavailability of molecules that are useful for endothelial functions, so hypertension appears (29-30) and hypertension could indirectly result from a state of imbalance between antioxidants and free radicals (31). Some studies proved that obesity and diabetes are usually associated with hypertension, chronic oxidative stress is responsible (32-34). As was mentioned earlier, there is a strong association between blood pressure and some oxidative stress (35). In conclusion, our findings suggest that total antioxidant derived from food consumption data, assessed by the food-frequency questionnaire, was inversely associated with systolic and diastolic pressure in both subjects. This study provided evidence that a diet high in antioxidants from vegetables and fruits may reduce the risk of hypertension.

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