Research Article
Volume 09:04, 2024

Clinical Gastroenterology Journal

Open Access

The Relationship between Dietary Total Antioxidant Capacity and Inflammatory Bowel Disease: A Case-Control Study

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Abstract

Diets rich in fruits and vegetables, seeds and nuts play an important role in reducing inflammatory bowel disease. Consumption of dietary antioxidants reduces inflammatory bowel disease. In the present study, the relationship between Dietary Total Antioxidant Capacity (DTAC) and inflammatory bowel disease was studied in Golestan Hospital, Ahvaz, Iran. This study was performed on 86 individuals in the healthy group and 86 patients with inflammatory bowel disease. A 147-item food frequency questionnaire was used to collect data. Ferric ion Reducing Antioxidant Power (FRAP) values were used to calculate the DTAC. Data were analyzed using SPSS software version 23. The mean age was 33.4 ± 7.4 for the healthy group and 36.5 ± 10.7 for the patient group ($P<0.05$). The control group had a higher dietary antioxidant capacity compared to the patient group (the healthy group received higher antioxidant vitamins including alpha-carotene, lycopene, vitamin C, vitamin A) (P=0.001). In the original model and modified logistic regression models, individuals in the highest quartile of DTAC had a lower risk of IBD (OR: 1.78, 95% CI:(0/51-6.21); P: 0/001). High levels of DTAC were associated with reduced IBD risk. It seems that a diet with high antioxidant capacity can prevent IBD.

Keywords: Diet • Dietary total antioxidant capacity • Inflammatory bowel disease

Introduction

Inflammatory Bowel Disease (IBD) is one of the most common diseases of the gastrointestinal tract. Chronic inflammation of the intestine occurs in Ulcerative Colitis (UC) and Crohn's disease. In UC, inflammation is limited to the colon and rectum, whereas Crohn's disease affects the entire tract from the mouth to the anus, eventually damaging bowel function. IBD is most prevalent in Europe and the United States [1]. Every year, 2 million people in Europe get IBD. The annual incidence of IBD per 100,000 people in Asia is approximately 1.37. Although the prevalence of IBD in Iran has not been studied in detail, Iran is mentioned as a country with an increasing rate of IBD. This disease is also more common in urban communities than in rural areas and urbanization is a potentially effective factor in IBD. UC is more common in men, while Crohn's disease is more common in women.

The exact cause of these diseases has not yet been determined. However, various factors were suggested for the etiology of these diseases, including the role of environmental factors, genetic abnormalities, immune responses, and westernization of lifestyles such as diet change, smoking, and geographical location. Diet is an important factor in IBD and has a direct effect on the host's metabolism or immune response. The dietary mechanisms that cause IBD include the direct effect of dietary antigen, alteration of gene expression, alteration of intestinal flora compounds, and the effect on the gastrointestinal mucosa or immune system. The dietary factors of Crohn's disease include the amount and quality of fat, total protein, and energy intake. Crohn's patients consume more sugar and carbohydrates than healthy individuals. Linoleic and omega-6 essential fatty acids in red meat, cooking oils and margarine were associated with an increased risk of UC. Diets rich in vegetables and fruits, olive oil, fish, seeds, and nuts reduce the risk of IBD. Several studies have shown an association between increased oxidative stress and the western diet pattern, refined sugar, and high-fat foods [2]. High and frequent consumption of these foods increases the inflammatory status by producing reactive oxygen species. Oxidative stress plays an important role in the pathogenesis of Crohn's disease and is probably an effective mechanism in tissue injury. Oxidative

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Received: 30 May, 2023, Manuscript No. CGJ-23-100632; **Editor assigned:** 02 June, 2023, PreQC No. P-100632 ;**Reviewed:** 16 June, 2023, QC No. Q-100632; **Revised:** 23 August, 2024, Manuscript No. R-100632;**Published:** 30 August, 2024, DOI: 10.37421/2952-8518.2024.9.268

stress is associated with the increased production of reactive oxygen species. The gastrointestinal tract is a major source of prooxidants. Several enzymatic and non-enzymatic antioxidants are involved in eradicating free radicals in the intestinal tract. Evidence suggests that consumption of antioxidants from fruits and vegetables reduces the risk of chronic diseases such as IBD.

To assess the antioxidant activity of foods and beverages, Dietary Total Antioxidant Capacity (DTAC) was used. DTAC is an important tool for assessing the association between antioxidant intake and the prevalence of oxidative stress-related diseases. The data suggest that DTAC is an effective dietary predictor of antioxidant intake. In a recent study, the relationship between DTAC and UC was shown in Tabriz, Iran. In the present study, the relationship between DTAC and Crohn's disease and UC in Ahvaz, Iran with a high prevalence of these diseases is investigated.

Materials and Methods

Study design and population

The present study was performed from January 2020 to September 2020 as a case-control study on patients with newly diagnosed UC and Crohn's disease (less than 6 months after diagnosis). 86 IBD patients were selected from the gastrointestinal section of Golestan Hospital, Ahvaz, Iran and 86 healthy individuals from companions of patients in other sections of the hospital were selected as the control group. Exclusion criteria were a history of autoimmune, inflammatory or infectious diseases, and cancer. The healthy group in this study had no history of IBD, gastrointestinal diseases, or other diseases and showed no symptoms. IBD patients and the healthy group were in the age range of 18-65 years.

Nutritional evaluation and calculation of dietary total antioxidant capacity

Nutritional data were collected using a 147-item food frequency questionnaire. Participants were asked about the average food intake per day, week, month, and year. Data were converted to average daily consumption. Ferric ion Reducing Antioxidant Power (FRAP) values were used to calculate the DTAC. FRAP measures the dietary antioxidant capacity to reduce ferric ions to ferrous ions for one milligram per 100 grams of the food. Dietary antioxidant levels were multiplied by food intake (grams per day) and all items were added together to obtain DTAC for each participant.

Evaluation of other variables

Weight was measured in a standing position with minimum clothes and no shoes. Height was measured in a standing position without shoes. A demographic information questionnaire (age, gender, smoking, level of education) was also completed.

Statistical analysis

One-way ANOVA was used to compare quantitative demographic data between different quartiles of dietary total antioxidant capacity. The Chi-square test was used for qualitative variables. Food intakes between case and control groups were compared by independent t-test. The odds of developing IBD among dietary TAC determined by binary logistic regression in different models. In the first model, the effect of age, gender, body mass index (BMI), and smoking status were adjusted. In the second model, energy intake, total fat intake, trans fatty acid, protein, fiber, and sodium were adjusted in addition to the variables of the first model. A P value of 0.05 was considered as statistically significant.

Results

86 patients with newly diagnosed IBD and 86 healthy individuals participated in this study. Demographic and anthropometric characteristics of the subjects and their comparison in the case and control groups are presented. There was no significant difference between the two groups in terms of gender, smoking and education level, whereas the mean age, weight and BMI of the patients were significantly higher than the control group (P ≤ 0.03). Also, the mean DTAC in the control group was significantly higher than in the case group (P=0.01) (Table 1).

Variable	Mean ± standard deviation		P-value
	Cases (n=86)	Controls (n=86)	
Age (year)	7.01 5.63	4.7 4.43	0.03
Weight (kg)	1.01 1.17	1.01 3.56	0.01
BMI (kg/m2)	1.3 0.52	2.2 2.32	0.01
Dietary total antioxidant capacity	9.2 2.01	8.3 0.31	0.01
Gender	50(40)	62 (60)	
Male female	36 (60)	24 (40)	0.08
Smoking	3 (3.5)	0 (0)	0.24
Education	21 (21.4)	77 (78.6)	
University education High school diploma or lower	65 (78.6)	9 (21.4)	0.06

Table1. Demographic and anthropometric characteristics of the participants.

The dietary intake of micronutrients and macronutrients in the subjects is given. The control group received higher antioxidant vitamins of alpha-carotene, lycopene, and vitamin A (P=0.001). They also had significantly higher intakes of vitamin D and vitamin B5 (P ≤ 0.04) (Table 2).

Variable	Mean ± standard deviation		P-value
	Cases (n=86)	Controls (n=86)	
Energy (kcal)	1.916 01.2	9.675 12.2	0.47
Protein (gr/d)	51.2 07	61.2 9.18	0.86
Total fat (gr/d)	2.22 6.37	5.81 5.37	0.82
Cholesterol (mg/d)	7.67 50.2	6.39 1.2	0.01
Saturated fatty acid (g/d)	6.8 1.42	8.6 5.42	0.01

MUFA (g/d)	7.6	21.9	50.7	22.6	0.71
PUFA (g/d)	8.3	14.1	8.3	14.05	0.57
Vitamin A RAE (mcg)	8.731	3	7.192	3.5	0.001
Beta-carotene (Mg/d)	1.875	4.9	7.7362	2.3	0.001
Alpha-carotene (Mg/d)	1.712	7.2	7.362	2.3	0.001
Lutein (Mg/d)	6.312	2.5	2.9692	70.2	0.001
Lycopene (Mg/d)	8.147	3.1	12.91	3	0.001
Vitamin C (mg/d)	2.41	9.93	3.24	4.99	0.001
Vitamin D (Mg/d)	75.0	69.0	1.1	4.1	0.004
Vitamin E (mg/d)	8.2	4.9	8.3	9.9	0.04
Alpha-tocopherol (mg/d)	0.2	2.6	5.2	8.6	0.19
Thiamin (mg/g)	56.0	0.2	16.0	1.2	0.84
Vitamin B5 (mg)	2.1	8.3	6.1	3.5	0.004

Table2. Comparison of macronutrient and micronutrient in takes between the two groups.

The general characteristics of the participants in the DTAC quartiles are shown. The level of education of the participants between the DTAC quartiles was significantly different. In the higher quartiles of DTAC, the highest percentage of education level was lower than high school diploma, and in the lower quartiles, most of the participants had a university education (P=0.02). Age, weight, BMI, gender, and smoking were not significantly related to DTAC (Table 3).

	Dietary total antioxidant capacity quartiles				P-value
Variable	Q1 (<9.61, n=43)	Q2 (9.62-11.2, n=43)	Q3(11.3-13 .4, n=43)	Q4 (>13.5, n=43)	
Age	34.6 ±10.7	37.1 ±10.1	33.8 ±8.1	34.4 ±8.1	0.37
Weight (kg)	68.1 ±26.1	69.5 ±8.8	68.2 ±12.3	67.1 ±12.0	0.78
BMI (kg/m^2)	24.9 ±3.8	23.9 ±2.1	23.9 ±2.8	23.7 ±3.18	0.28
Male	13 (21.7)	21 (35)	15 (25)	11 (18.3)	0.13
female	29 (26.1)	22 (19.8)	28 (25.2)	32 (28.8)	0.002
Education High school diploma or lower	17 (17.5)	19 (19.6)	32 (33)	29 (29.9)	
University education	25 (33.8)	24 (32.4)	11 (14.9)	14 (18.9)	0.29
Smoking	0 (0)	2 (66.7)	0 (0)	1 (33.3)	

Table3. Demographic and anthropometric characteristics in the dietary total antioxidant capacity quartiles.

The relationship between DTAC and IBD is shown. In the original model, individuals at the highest level of DTAC had a lower risk of developing IBD (OR: 1.4, 95% CI: (0/55-3.85); P=0.001). In the first model (adjusted for age, gender, smoking, and BMI) a significant negative relationship was observed between DTAC and IBD (OR: 1.57, 95%.CI: (0/57-4.33); P=0.001). In the second model, after adjusting the confounding variables (energy, protein, total fat, trans fatty acid, sodium, and total fiber) in addition to the first model, a significant relationship was observed between the DTAC and the odds of developing IBD (OR: 1.78, 95% CI: (0/51-6.21); P=0/001)(Table 4).

	Dietary total antioxidant capacity quartiles				P-value
Variable	Q1 (<9.61)	Q2 (9.62-11.2)	Q3(11.3-13 .4)	Q4 (>13.5)	
Case/ control	21/22	20/23	22/22	21/22	
Original model	1	7.2(2.1-79. 9)	7.5(2.8-19. 5)	1.4(0.55-3. 85)	0.001
Model 1	1	8.1(2.8-22. 9)	8.2(2.9-23. 3)	1.5(0.57-4. 33)	0.001
Model 2	1	21.7(5.05-9 3.6)	11.7(3.2-42 .6)	1.7(0.51-6. 21)	0.001

Table4. Odds ratio and confidence interval for inflammatory bowel disease in dietary total antioxidant capacity quartiles.

Discussion

The purpose of this case-control study was to compare the DTAC in IBD patients and healthy individuals. The mean DTAC in the control group was significantly higher than in the case group [3]. The control group had a significantly higher intake of antioxidant vitamins including alpha-carotene, lycopene, vitamin C, and vitamin A. After adjusting the confounders, a significant relationship was observed between the DTAC and the odds of developing IBD.

After adjusting for confounding variables, an inverse relationship was observed between DTAC and IBD. Only one study investigated DTAC and IBD, and the results showed that subjects in the upper quartile of DTAC had a lower chance of developing UC. In a study in Turkey, higher levels of oxidative stress in IBD patients were reported compared to the control group which was associated with increased inflammation and higher C Reactive Protein levels in IBD patients. In various studies, the relationship between IBD and serum levels of antioxidants or the level of erythrocyte antioxidants was observed.

An initial defect in intestinal mucosa appears to be responsible for oxidative stress in the development of UC. Serum or plasma concentrations of antioxidants were used as biomarkers of oxidative stress. On the other hand, it was observed that the levels of antioxidants, including mucosal metallothionein and superoxide dismutase, are severely reduced in IBD patients. Decreased antioxidant levels in IBD patients can be due to several reasons among which dietary intake are the most important factor [4]. For instance, UC patients eat less fruits and vegetables than the control group. The researchers claimed that an important cause could be a decrease in TAC level. Other mechanisms such as malabsorption and increased need for vitamins may also be involved. DTAC may protect against IBD or improve disease symptoms by reducing ROS and the production of inflammatory cytokines. This survey is the first study on the relationship between DTAC and newly diagnosed IBD

(Crohn's disease and UC) in Ahvaz, Iran. Numerous confounding factors were considered [5]. However, there were some limitations including using a food frequency questionnaire to assess normal food intake which increases the chance of higher or lower reporting of specific food groups and energy along with the possibility of recalling errors in using this questionnaire. In addition, although we adjusted the effect of several potential confounding variables in this study, there are still unknown confounders, including stress and genetics and their effect were not adjusted in our analysis.

Conclusion

High levels of DTAC were associated with a reduced risk of IBD. It seems that a diet with high antioxidant capacity can prevent IBD. It is recommended that people be encouraged to use nutrients with a high antioxidant capacity to prevent IBD. Prospective and controlled studies in this field are recommended.

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How to cite this article: Shekari, Soheila, Jafari Asal Ataie, Abadi Mahmood Mahmoodi Majd, Eghtesadi Shahryar and Seyedian Seyed Saeed . "The Relationship between Dietary Total Antioxidant Capacity and Inflammatory Bowel Disease: A Case-Control Study." *Clin Gastro J* 9 (2024): 168.