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Fruit, vegetable, and dietary antioxidant intake and age-related cataract risk: A case-control study

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ABSTRACT

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Aim: This study was done to evaluate the relationship between dietary intake of some macronutrients, carotenoids, vitamins C, E, and A, and selenium and the risk of cataract.

Methods: In this case-control study, dietary intakes of 97 cataract patients and 198 controls were assessed using a valid semi-quantitative food frequency questionnaire. Cataract was diagnosed using a slit-lamp examination and defined as any lens opacity in either eye. The associations between cataract incidence and quartiles of macronutrient and micronutrient intakes were investigated using logistic regression models.

Results: After adjusting for the effects of confounding variables, the risk of cataract was significantly low in the highest nutrient intake quartile relative to the lowest quartile for fruits (OR = 0.15; 95% CI = 0.05-0.30) and vegetables (OR= 0.20; 95% CI = 0.08-0.40). We found significant, inverse associations of cataract with high dietary intake of vitamin C (OR = 0.22; 95% CI = 0.09-0.54), alpha-carotene (OR = 0.24; 95% CI = 0.10-0.58), beta-carotene (OR = 0.15; 95% CI = 0.05-0.39), lutein/zeaxanthin (OR = 0.19; 95% CI = 0.08-0.45), and beta-cryptoxanthin (OR = 0.05; 95% CI = 0.01-0.15).

Conclusion: High daily intakes of fruits and vegetables and some dietary antioxidants might be associated with a decrease in cataract risk in Tehran, Iran.

key words:
Cataract,
Carotenoids,
Fruit,
Vegetables,
Antioxidant

Introduction

Cataract is responsible for half of the 32 million cases of blindness in the world (1). Visual impairments resulting from cataract have increased dramatically in developed and developing countries (1). In Europe, cataract is a major cause of visual impairment and is responsible for 60% to 65% of cases of blindness (2). There is no exact statistics on the prevalence of cataract in Iran, but it seems that one-fifth of the population over 40 years of age in Tehran, mostly including women, have cataract (3). Cataract prevalence increases with age, so it is an important issue in the elderly population (5). However, if the age of onset is delayed by 10 years, the need for surgery will be reduced by 45% (6). Identifying the factors that potentially could slow down cataract progression or prevent it is a key strategy in reducing the incidence of this disease. These strategies have the potential to improve quality of life and reduce enormous costs induced by surgery (5). Various hypotheses concerning the causes of cataract indicate an involvement of oxidative damage to lens proteins (7, 8). The oxidative hypothesis of

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cataract development states that the oxygen free radicals damage proteins and cell membrane of the lens, and micronutrients with antioxidant capacity can protect the lens against these changes (9). Therefore, different aspects of diet may reduce the risk of cataract by reducing oxidative stress or systemic inflammation (2). The protective effect of antioxidants against cataract has been observed in animal and in vitro studies, yet this impact has not been well identified in human epidemiological studies (10). Many recent studies have examined the relationship between the risk of age-related cataract and at least one dietary antioxidant such as vitamin C (11), vitamin E (12), and carotenoids (5, 12, 13). However, apparently, none of these studies show a constant relationship between cataract risk and these antioxidants intake. Lack of this relationship may be a result of differences in the populations studied and also the methods used in these studies. Most studies evaluating the association of dietary factors with age-related cataract have been carried out in European and American countries (14). Little research has been done in this area in Asian countries, especially Iran with different lifestyle patterns and dietary habits. Therefore this study aimed to investigate the relationship between antioxidant macronutrients and micronutrients and the risk of cataract in people over 40 in Tehran.

Methods

Subjects

The study protocol was approved by the Research Ethics Committee of Shahid Beheshti University of Medical Sciences and was conducted according to the principles of the Helsinki Declaration. Written informed consent was obtained from all patients. This case-control study was conducted between October 2013 and June 2014 in the capital of Iran (Tehran). In this research, 101 cases with cataract admitted to an ophthalmology referral hospital (Farabi Hospital) and 202 age- and sex-matched controls were recruited via convenience sampling. The sample size was calculated using the following formulas, based on odds ratio from a similar study of the relationship between cataract and vitamin C (14).

$$(C = \frac{\text{control}}{\text{case}} = \frac{2}{1} ، P_1 = 0.68 ، OR \sim 0.5)$$

$$P_2 = \frac{P_1 \times OR}{1 + P_1(OR - 1)}$$

$$P_2 = 0.51$$

$$P = \frac{P_1 + P_2}{2}$$

$$N\ \text{each group} = \frac{(1+1/C)\,(Z1\text{-}\beta + Z_{1-\alpha/2})^2 \times P(1\text{-}P)}{(P_1\text{-}P_2)^2}$$

$$\alpha = 0.05\ Z_{1-\alpha/2} = 1.96 ، \qquad \beta = 0.2\ Z_{1-\beta} = 0.84 ،$$

The inclusion criteria for the cases were the following: being 40 years and older; being an incident case of cataract (diagnosed within the past month); having cataract in at least one eye; having no serious condition causing vision loss other than cataract; and, having a visual acuity of 0.6 or worse. The controls were recruited from among patients admitted to Shariati Hospital (a general hospital near Farabi Hospital) for gastrointestinal problems, orthopedic problems, ear, nose, and throat problems, appendicitis, and general surgery. They were referred to Farabi Hospital for eye examinations and were included in the control group if they had no eye disease or eye surgery history. Subjects were excluded if they had any treatment or medical condition known to be associated with cataract or to cause eye and vision problems (e.g., age-related macular degeneration, radiation therapy, diabetic retinopathy, glaucoma, and acute or chronic uveitis) or if they were on a specific diet during the past year. Finally, 4 subjects in each group were excluded from the study because their daily calorie intakes were lower than 702 kcal or greater than 5016 kcal, reflecting a careless completion of the dietary questionnaire (below or above the mean ± 3SD for log-transformed energy). This reduced our sample size to 97 cases and 198 controls. The required information was obtained from all patients by face-to-face interviews including data on family history of cataract, history of heart disease, hypertension, hyperlipidemia, arthritis, diabetes, smoking, alcohol use, physical activity (exercises ≥ 3 times per week, ≥ 30 minutes each session), history of vitamin C and multivitamin supplement use, corticosteroids, oral contraceptives, estrogen therapy, the hours being exposed to sunlight, and using protection against the sun. The weight of the participants was measured to the nearest decimal while wearing minimal clothing, and height was measured using a tape measure with a sensitivity of 0.1 cm.

Dietary assessment

Data on usual dietary intakes of individuals over the past year (the year before diagnosis for cases and before the interview for controls) was collected through a valid and reliable semi-quantitative food frequency questionnaire (FFQ) (15, 16) including 147 food items. The amount of each food was converted to grams using household measures, and the consumed grams of each food item were calculated for each individual. Calorie and micronutrient intakes for all food items in the FFQ were calculated using the USDA food components table. Dietary factors examined in this study included total fat, protein, carbohydrates, energy consumption, fruit and vegetable intake, polyunsaturated fatty acids (PUFA), monounsaturated fatty acids (MUFA), fiber, cholesterol, and dietary antioxidants such as vitamins E, A, and C, beta- and alpha-carotene, lutein/zeaxanthin, beta-cryptoxanthin, and selenium.

Statistical methods

SPSS was used to analyze data in this study. To determine differences in the distribution of qualitative variables, the chi-square test was performed, and odds ratio (OR) of cataract and relevant confidence intervals (CI) were obtained from regression analyses. Logistic regression models were developed that controlled for age (4 age groups: 40-50 years, 50-60 years, 60-70 years, and ≥ 70 years), sex, education (4 categories: uneducated, primary, junior high school, and high school and higher), physical activity (inactive and active), family history, BMI (4 categories: underweight, normal, overweight and obese), energy intake, history of diabetes, hypertension, and the use of protection against the sun for the subjects. After applying the Bonferroni correction for 33 comparisons (including micronutrients, macronutrients, and food groups), the significance level was considered to be 0.001 (0.05/33).

Results

Table 1 presents relative and absolute frequency, demographic characteristics, and lifestyle in 97 cataract patients as cases and 198 controls. Cases and controls were not significantly different in terms of sex, age, smoking, or use of vitamin C, but there were significant differences in BMI, history of diabetes and hypertension, physical activity, use of protection against the sun, and education ($p < 0.05$). Table 2 shows adjusted ORs and 95% CIs of cataract for quartiles of selected dietary factors. After adjusting for confounders (age, sex, BMI, family history of diabetes and blood pressure, physical activity, use of protection against the sun, education, and energy intake) individuals in the highest quartile of total fruit intake (OR = 0.15; 95% CI = 0.05-0.39) and total vegetable (OR = 0.20; 95% CI = 0.08-0.47), soluble fiber (OR = 0.27; 95% CI = 0.11-0.67) a significant decrease in the risk of cataract compared with those in the lowest quartiles. This relationship remained significant after applying the Bonferroni correction ($p < 0.001$). There was also a positive relationship between the highest quartiles of carbohydrate (OR = 4.9; 95% CI = 1.54-15.80) and PUFA intake (OR = 2.7; 95% CI = 0.98-7.90) with the risk of cataract ($p < 0.05$), which was significant after the Bonferroni correction. No significant relationship was found between energy consumption, total fat, cholesterol intake, protein, saturated fat, MUFA, and total fiber consumption with the risk of cataract ($p > 0.05$). Table 3 shows adjusted ORs and CIs of cataract for quartiles of dietary antioxidants intake. There was a significant inverse relationship between age-related cataract and top quartiles of vitamin C (OR = 0.22; 95% CI = 0.09-0.54), alpha-carotene (OR = 0.24, 95% CI = 0.10-0.58), beta-carotene (OR = 0.15; 95% CI = 0.05-0.39), lutein/zeaxanthin (OR = 0.19; 95% CI = 0.08-0.45), beta-cryptoxanthin (OR = 0.05; 95% CI = 0.01-0.15), and vitamin A (OR = 0.36; 95% CI = 0.15-0.85) intakes ($p < 0.05$). Individuals in the highest quartile of vitamin C, alpha-carotene, beta-carotene, lutein/zeaxanthin, beta-cryptoxanthin, vitamin A intake (78, 76, 85, 81, 99.95, and 64, respectively) showed lower OR for cataract risk than those in the lowest quartile of these antioxidants intake. After the Bonferroni correction, this relationship remained significant for vitamin C, alpha-carotene, beta-carotene, lutein/zeaxanthin, and beta-cryptoxanthin, while it was not significant anymore for vitamin A intake. In this study, no clear relationship was observed between cataract risk and vitamin E or selenium intake.

Discussion

This study investigated the relationship between the risk of age-related cataract and dietary micronutrients and macronutrients. After adjusting for possible confounding variables, we found that a high intake of fruit and vegetable and soluble fiber can reduce the risk of cataract. Our findings regarding the high intake of fruit and vegetable reducing the risk of cataract are in line with previous studies (17). In a case-control study in Greece, a significant inverse relationship between consumption of fruit and vegetable and cataract risk was seen (2). In a cross-sectional study in Europe in 2013, Pastor-Valero et al (11) found a negative association between fruit and vegetable intake and the risk of cataract after adjusting for confounding variables. A prospective cohort study investigating the association between the intake of fruits and vegetables and the incidence of cataract found that women in the highest quintile of fruit and vegetable intake (10 serving per day) had a 10% to 15% lower risk of cataract compared with those in the lowest quintile (3.6 serving per day) (17). This inverse relationship between fruit and vegetable intake and the risk of cataract may be due to the high content of dietary antioxidants. In our study, a positive association between carbohydrate intake and cataract risk was observed, which did not remain significant after applying the Bonferroni correction. Chiu et al (18) found that individuals with the highest carbohydrate intake were more likely to develop cataract compared with those with the lowest intake. While some studies have shown the association between high carbohydrate intake and an increased risk of cataract (2, 19), others have not been able to establish such an association (20, 21).

Table 1. Socio-demographic and lifestyle characteristics of cases and controls

Characteristics	Cases (97)		Controls (198)		p value*
	N	%	N	%	
Age group (y)					
40-50	25	(25.8)	50	(25.3)	0.95
50-60	36	(37.1)	79	(39.9)	
60-70	28	(28.9)	52	(26.3)	
≥70	8	(8.2)	17	(8.6)	
Age (y), mean (SD)	57.8 (9/3)		57.4 (9.1)		
Sex					
Men	33	(34)	67	(33.8)	0.97
Women	64	(66)	131	(66.2)	
BMI group (kg/m^2)					
≤18.5	0	(0)	1	(5)	0.001
18.5-25	28	(28.9)	101	(51)	
25-30	37	(38.1)	64	(32.3)	
≥30	32	(33)	32	(16.2)	
Education					
Illiterate	42	(43.3)	29	(14.6)	<0.001
Primary school	23	(23.7)	69	(34.8)	
Secondary school	17	(17.5)	39	(19.7)	
Higher education	15	(15.5)	61	(30.8)	
Cataract Family history					
Yes	53	(54.6)	81	(40.9)	0.026
No	44	(45.4)	117	(59.1)	
Hypertension†					
Yes	53	(54.6)	81	(40.9)	0.026
No	44	(45.4)	117	(59.1)	
Smoking status					
Never	81	(83.5)	178	(89.0)	0.28
Former	2	(2.1)	3	(1.5)	
Current	14	(14.4)	17	(8.5)	
Diabetes††					
Yes	27	(27.8)	23	(11.6)	<0.001
No	70	(72.2)	175	(88.4)	
Regular use of vitamin c supplement					
Yes	12	(12.4)	16	(8.1)	0.23
No	85	(87.6)	182	(91.9)	
Post-menopausal status					
Yes	55	(83.3)	97	(72.9)	0.10
No	11	(16.7)	36	(27.1)	
Ever used oral contraceptives					
Yes	13	(13.4)	27	(13.6)	0.95
No	84	(86.6)	171	(86.4)	
Physical activity‡					
Inactive	83	(85.5)	140	(70.7)	0.005
Active	14	(14.5)	58	(29.3)	
Used of protection against the sun‡‡			57	(28.8)	
Yes	9	(9.3)	141	(71.2)	<0.001
No	88	(90.7)			

* *P value from χ2 or the Fisher exact test for qualitative data and t test for quantitative data.*
† *Defined as systolic blood pressure > 160 mm Hg, diastolic blood pressure > 100 mm Hg, or the use of antihypertensive medication.*
††*Defined as fasting blood glucose ≥126 mg/dl*
‡ *Defined as ≥3 times per week, ≥30 minutes per session.*
‡‡ *Wearing sunglasses or hats*

In the present study, no significant association between total fat and cholesterol intake and the risk of age-related cataract was seen, which is in line with previous studies (22, 36). Also, we found that an increase in PUFA intake was associated with an increased risk of cataract, although the relationship was not significant after the Bonferroni correction. Since PUFAs tend to become oxidized (24), high concentrations of these fatty acids in the membranes of eye lens may have pathological effects in the lens similar to other tissues (25). A cohort study found a strong positive relationship between PUFA and the risk of cataract (22).

Our results indicated a significant inverse relationship

Table 2. Odds ratio (OR) and 95% confidence interval (CI) of all types of cataract for quartiles of energy and nutrients

Food intake Adjusted OR (95% CI)†	Q1	Q2	Q3	Q4	P for trend‡
Energy intake (kcal/d)	<2412	2412-2728	2728-3129	≥3129	
Adjusted OR (95% CI)	1.00 (ref)	0.50 (0.23- 1.08)	0.90 (0.46-1.76)	1.41(0.58- 2.23)	0.39
Total fat (g/d)	<84.2	84.2-99.5	99.5-139.3	≥139.3	
Adjusted OR (95% CI)	1.00 (ref)	0.65 (0.27- 1.59)	1.81 (0.74- 4.41)	0.50 (0.16- 1.51)	0.58
Protein (g/d)	<76.9	76.9-88.3	88.3-104.3	≥104.3	
Adjusted OR (95% CI)	1.00	0.58 (0.24-1.35)	0.45 (0.17-1.18)	1.40 (0.49-4.00)	0.72
Carbohydrates (g/d)	<303.8	303.8-362.3	362.3-417.7	≥417.7	
Adjusted OR (95% CI)	1.00 (ref)	1.62 (0.66- 4.00)	1.43 (0.52-3.94)	4.94 (1.54-15.80)	0.01
Cholesterol (mg/d)	<195	195-252	252-334	≥334	
Adjusted OR (95% CI)	1.00 (ref)	0.58 (0.25-1.33)	1.15 (0.52-2.53)	0.88 (0.35-2.19)	0.08
Saturated fatty acids(g/d)	<24.2	24.2-29.6	29.6-39.7	≥39.7	
Adjusted OR (95% CI)	1.00 (ref)	0.86 (0.37-1.98)	0.97 (0.39-2.37)	0.30 (0.09-0.94)	0.08
PUFA (g/d)	<16.5	16.5-20.3	20.3-29.4	≥29.4	
Adjusted OR (95%CI)	1.00 (ref)	1.35 (0.51-3.57)	3.54 (1.38-9.05)	2.79 (0.98-7.90)	0.02
MUFA (g/d)	<28.3	28.3-34	34-47.6	≥47.6	
Adjusted OR 95%CI	1.00 (ref)	0.66 (0.28-1.57)	1.41 (0.60-3.20)	0.42 (0.15-1.16)	0.28
vegetables (g/d)	<422.2	422.2-498	498-605.2	≥605.2	
Adjusted OR (95%CI)	1.00 (ref)	0.25 (0.11-0.56)	0.31(0.1-0.6)	0.20 (0.08-0.47)	<0.001
Fruits (g/d)	<318.2	318.2-449.3	449.3-608.7	≥608.7	
Adjusted OR (95%CI)	1.00 (ref)	0.48 (0.22-1.04)	0.15 (0.06-0.37)	0.15 (0.05-0.39)	<0.001
Total fiber (g/d)	<36.8	36.8-44.4	44.4-59.3	≥59.3	
Adjusted OR (95%CI)	1.00 (ref)	1.07 (0.46-2.50)	1 (0.41-2.45)	2.63 (1.01-6.82)	0.07
Soluble fiber (g/d)	<0.32	0.32-0.47	0.47-0.72	≥0.72	
Adjusted OR (95%CI)	1.00 (ref)	0.93 (0.44-1.94)	0.39 (0.17-0.93)	0.27 (0.11-0.67)	0.001

†OR adjusted for age, sex, BMI, family history of diabetes and blood pressure, physical activity, use of protection against exposure to the sun, education, and energy intake

‡ The p for trend was calculated using the linear regression coefficient for the quartiles of macronutrient intake. After applying the Bonferroni correction, the significance level was considered to be 0.001 instead of 0.05.

Table 2. Odds ratio (OR) and 95% confidence interval (CI) of all types of cataract for quartiles of energy and nutrients

Antioxidant intake Adjusted OR (95% CI)†	Q1	Q2	Q3	Q4	P for trend‡
Vitamin c (mg/d)	<139.4	139.4-180.4	180.4-226.3	≥226.3	
Adjusted OR (95% CI)†	1.00	0.43 (0.20- 0.94)	0.21(0.09- 0.47)	0.22 (0.09-0.54)	<0.001
Vitamin E (g/d)	<15	15-21.5	21.5-27.2	≥27.2	
Adjusted OR (95% CI)	1.00	2.92 (1.26- 6.73)	1.73 (0.73-4.11)	0.57 (0.19-1.68)	0.16
Vitamin A(REA) (mg/d)	<607.7	607.7-746.7	746.7-978	≥978	
Adjusted OR (95% CI)	1.00	0.26 (0.11- 0.58)	0.43 (0.19- 0.93)	0.36 (0.15-0.85)	0.02
B-caroten (mcg/d)	<3923.4	3923.4-5373.4	5373-6828.8	≥6828.8	
Adjusted OR (95% CI)	1.00	0.44 (0.21-0.94)	0.27 (0.12-0.61)	0.15 (0.05-0.39)	<0.001
A-caroten (mg/d)	<597	597-992.8	992.8-1316.2	≥1316.3	
Adjusted OR (95% CI)	1.00	0.60 (0.29-1.21)	0.23 (0.10- 0.55)	0.24 (0.10-0.58)	<0.001
Lutein/zeaxanthin (mcg/d)	<1958.4	1958.4-2481.2	2481.2-3488.3	≥3488.3	
Adjusted OR (95% CI)	1.00	0.17 (0.07-0.40)	0.26 (0.12-0.57)	0.19 (0.08-0.45)	<0.001
Selenium (mg/d)	<93.6	93.6-121.5	121.5-156	≥156	
Adjusted OR (95% CI)	1.00	2.07 (0.82- 5.18)	2.38 (0.95-5.98)	2.44 (0.87- 8.00)	0.09
B-cryptoxanthin (mcg/d)	<236.2	236.2-323.9	323.9-433.7	≥433.7	
Adjusted OR (95% CI)	1.00	0.26 (0.12-0.58)	0.15 (0.06-0.36)	0.05 (0.01-0.15)	<0.001

†OR adjusted for age, sex, BMI, family history of diabetes and blood pressure, physical activity, use of protection from exposure to the sun, education, and energy intake.

‡ P for trend values was calculated using the linear regression coefficient for the quartiles of macronutrient intake. After the Bonferroni correction, the significance level considered to be 0.001 instead of 0.05.

between vitamin C intake and the risk of cataract such that individuals in the highest quartiles of vitamin C intake showed a 78% reduction in the risk of cataract compared with those in the lowest quartile of intake. The retina and lens of the eye are constantly exposed to the damage caused by light and different forms of oxygen radicals. Some of these damages are countered by antioxidant enzymes such as superoxide dismutase, catalase, glutathione reductase, and peroxidase, which convert active oxygen into less harmful species. A direct protective effect by antioxidants has been proposed (vitamins C and E and carotenoids). Along with aging, antioxidant concentration in some tissues decreases and catalytic capacity of some antioxidant enzymes are reduced, which result in damage to the eye tissue. If the proteolytic activity is sufficient, damaged proteins will break down into their amino acids; otherwise, these damaged proteins will be accumulated and deposited in the eye. The lens of the elderly shows less proteolytic activity. Antioxidants can protect proteins and proteases against damage (26, 27). The results of our study regarding the effective role of vitamin C in reducing cataract are in line with previous studies in this field (11, 13, 28). The results of a prospective cohort investigation showed that the prevalence of central opacity of the eye lens in the highest quintile of vitamin C intake was lower than that in the lowest quintile and that there was a significant, negative relationship between central lens opacity prevalence and duration of vitamin C supplementation (29). However, two trials reported no beneficial effect of vitamin C or other antioxidants supplementation after 5 to 6 years of their intake (30, 31).

In this study, a strong significant, inverse relationship was found between alpha- and beta-carotene intakes and the risk of cataract, which is in line with the results of previous studies (2, 11). A meta-analysis proposed a protective role for beta-carotene in decreasing the risk of cataract (23). However, the Age-Related Eye Disease Study found no relationship between the risk of cataract and carotene intake (30).

In the present study, lutein and zeaxanthin intake showed a significant negative relationship with the risk of cataract. Available evidence demonstrates that lutein and zeaxanthin are widely distributed in a number of body tissues and are uniquely concentrated in the retina and lens. The biological mechanisms for the protective effects of these carotenoids may include powerful blue-light filtering activities and antioxidant properties (32). Numerous studies have identified lutein and zeaxanthin to be essential components for eye health. A meta-analysis showed that high blood lutein and zeaxanthin are significantly associated with a decrease in the risk of nuclear cataract (33). Another meta-analysis reported that dietary lutein and zeaxanthin intake is associated with a reduced risk of age-related cataract (34). However, one study found no significant association of lutein and zeaxanthin intake with 5-year changes in lens opacity (35). In two studies using data from the FFQ, it was found that high cryptoxanthin intake reduces the risk of cataract (5, 9), which is in line with the results of our study.

To conclude, our study found a significant inverse relationship between dietary antioxidants and the risk of age-related cataract. The overall results of this study support previous studies on the role of antioxidants in the prevention of age-related cataract. The results suggest that a diet rich in fruits and vegetables may reduce the risk of age-related cataract because of its antioxidants. These findings can be used as dietary guidelines to delay the onset of cataract and reduce health costs for the public.

This study has several limitations. First, like other case-control studies, recall bias and selection bias were inevitable. In case-control studies, there is the possibility that cases may recall their diets differently after cataract diagnosis. However, our participants had little knowledge about the association of diet and nutrients with the cataract risk, which could have reduced the possibility of recall bias. Moreover, using hospital controls and administering validated FFQs by trained interviewers in a hospital setting might have further reduced the recall bias and improved the comparability of the information from cases and controls (37). With regard to the selection bias, high participation rates (90%) in this study minimized the potential for selective participation according to lifestyle practices (such as diet). Another limitation of the current study was using a semiquantitative FFQ, which, despite being commonly used for identifying the habitual dietary intakes, is well recognized for its weakness in characterizing dietary intakes. Using a semiquantitative dietary assessment tool limits our conclusions mostly to comparisons between cases and controls. Hence, the results are relative and should be interpreted with caution because these types of comparisons generally overestimate or underestimate the true relationship between exposure and outcome (38). The other limitation of this study is the small sample size. The strengths of our study are the careful selection of participants, using a slit lamp, a participation rate of above 90%, using the validated questionnaires, and the low possibility of recall bias.

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Conflict of interest

Ghanavati M, None; Alipour M, None; Khodaparast-zavareh M, None; Sarli R, None; Moradi B, None; Rashidkhani B, None.

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