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Major dietary patterns in relation to age-related cataract

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SUMMARY

Background and aims: Dietary pattern (DP) may play an important role in the formation of Age-related cataract (ARC). The objective of the study was to investigate the association between DP and ARC.
Methods: Participants (120 cases and 240 controls) aged 50–80 years were selected from the ophthalmology clinic of Urmia Imam Khomeini Educational Hospital in the Northwest of Iran by the simple random sampling method between 2017 and 2018. Participants in matched case–control study were free of diabetes, autoimmune diseases and cancer. Factor analysis method was used to identify the major DPs. The association between participants' DPs and ARC were evaluated using logistic regression analysis in SPSS20.
Results: Four major DPs were found and nominated: “Unhealthy”, “Healthy”, “Salty foods” and “Mixed” patterns. In continues model the Unhealthy pattern was positively associated with the risk of ARC disease (odds ratio in adjusted model was 5.71; 95% CI: 3.68–8.87, $P_{trend} < 0.001$). The Healthy pattern was inversely associated with the ARC (odds ratio in adjusted model was 0.48; 95% CI: 0.34–0.67, $P_{trend} = 0.02$). The Salty foods pattern was associated with ARC (odds ratio in adjusted model was 1.45; 95% CI; 1.04–2.02, $P_{trend} = 0.03$). The association between ARC disease and Mixed patterns was not statistically significant.
Conclusion: The results indicate that Unhealthy and Salty foods patterns were associated with increased risk of ARC. Further prospective studies are needed to confirm such an association.

1. Introduction

Cataract is a clouding of the eye's lens preventing the passage of light that can eventually cause loss of vision, if left untreated. Age-related cataract (ARC) is the major cause of low vision responsible for 51 percent of blindness among adults aged 50 and more worldwide [1]. Since life expectancy has increased globally, the number of patients with ARC has grown dramatically too. Consequently, loss of vision has become one of the biggest fears of the elderly [1,2].

Today, the most common ARC treatments are surgery and lens replacement, which can lead to a tremendous burden on public health, as well as and post-operative complications such as inflammation [3]; therefore, a 10 year postpone for ARC onset can be considerably important to health and economy [4].

Recently, some researchers have shown interest in studying the relationship between ARC and nutrition [5]. Higher dietary intake of carbohydrate or foods with higher glycaemic index (GI) may be associated with the increased risk of cortical and nuclear ARC, respectively [6]. Some studies have reported eating foods rich in some vitamins and minerals [7]such as vitamin C and E [8] or carotenoid, xanthophylls, lutein and zeaxanthin [9,10] have protective effects on ARC. A large cohort study has reported that an adverse association exists between the total antioxidant capacity of dietary intake and the risk of ARC among middle-aged and elderly women [11].

Abbreviations: ARC, Age related cataract; DP, Dietary pattern; FFQ, Food Frequency Questionnaire; PUFA, Poly unsaturated fatty acid; GI, Glycemic index; PCA, Principal component analysis; OR, Odd ratio; Q, Quartile.

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In spite of single nutrient, dietary pattern (DP) analysis considers overall food intakes consumed in complex nutrient combinations likely to have multiple synergistic or interactive effects with each other [12]. This case–control study is designed to assess the relationship between DPs and ARC disease.

2. Methods

2.1. Participant and study design

In this case–control study, 360 individuals aged 50–80 from both sexes were selected from the ophthalmology clinic of Imam Khomeini Educational Hospital, Urmia, Iran. The cases (n = 120) and controls (n = 240) were recruited between September 2017 and May 2018. All participants from both case and control groups received eye examination by an ophthalmologist for cataract diagnosis. Cases were included in the study if they were diagnosed with a specific type of cataract (nuclear, cortical or posterior subcapsular) at least in one eye, their visual acuity were less than 0.6, had no previous ocular surgery (except cataract surgery in the other eye); had no other eye diseases (e.g. cornea opacities, age-related macular degeneration or other macular or optic nerve pathology, glaucoma and previous history of retinopathy). Cases and controls were excluded if suffering from pre-diabetes, diabetes, autoimmune diseases (rheumatoid arthritis, lupus and multiple sclerosis); had a history of trauma to eyes or any type of cancer; took corticosteroids; and had a specific diet like vegetarian diet, ketogenic diet and any food abstinence. Controls were selected from healthy referees who needed glasses after an eye examination or patient's companions who were eligible criteria for entering the study. The controls were matched with cases based on sex and age. Cases and controls were selected through individuals that refer to ophthalmologist. The study was approved by the ethics committee of Urmia University of Medical Sciences (IR.umsu.rec.1396.152). Written informed consents were obtained from all participants after explaining the aims of the study. The participants were free to withdraw from the study at any time.

2.2. Assessment of dietary intake and lifestyle variables

We used a validated semi-quantitative food frequency questionnaire (FFQ) includes 139 items for assessing dietary intakes after the eye examination in each case and control groups [13,14]. Participants reported their consumption frequency of a serving of each food item during the last year with nine possible frequency responses ranging from "never" to "more than two times a day". Daily intake of food items (gram/day) were calculated using United States Department of Agriculture national nutrient database for standard reference, release 28 [15]. For example, the calculation of a cup of milk three times a week was done as: $3 \times 244/7 = 104.5$ gr/day. To identify DPs, first we categorized 139 food items into 36 predefined food groups based on similarities between food items. Then, daily intake of each food item (as g/day) were entered into the Nutritionist IV Diet Analysis software (1997, First DataBank Inc., San Bruno, CA) was used to calculate dietary energy intake (kcal/day). Nutritionist IV Diet Analysis software was used to calculate dietary intake of polyunsaturated fatty acid (PUFA); vitamin E, C, and A, and β-carotene as mediators factors, as these micronutrients are associated with ARC [9,16–18]. The weight and height of each case and control were measured after removal of heavy clothes and shoes. The Body Mass Index (BMI) was calculated as the ratio of weight (kg) to squared height (m^2). Additional covariate information regarding smoking habits, physical activity [19], educational level, residence, using caps, using sunglasses, parents'cataract history, medical history, and current use of medications and vitamin supplements were obtained using questionnaires. The sample size was calculated according to Ghanavati et al. [20]in which Odds ratio (OR) equaled 0.39 and prevalence of cataract were 33% as reported by WHO(1), with 95% CI and power of 90%.

2.3. Statistical analysis

Factor analysis was used with principal component analysis (PCA) to identify the major DPs based on the 36 food groups (Table 1). Factors were rotated by varimax rotation. The number of components retained were determined using a combination of the eigenvalues (>1.6) and Scree plot. Subsequently, four factors were considered as major DPs and were labeled based on our interpretation of the data and earlier literature. Factor scores of DPs for each participant were calculated by summing food intakes weighted by their factor loading. We categorized participants by DP scores quartiles. Pearson's chi-square test or Fisher's Exact test was used to compare categorical variables and Independent Kruskal–Wallis test in continuous variables across the DP scores quartiles. The association between DP scores as continuous and ARC disease was investigated by logistic regression in two crude and multivariable-adjusted models. Statistical analyses were performed using IBM

Table 1
Food groups used in factor analysis.

Food groups	Food items
Refined grains	White bread (lavash, toaste), white flour, rice, pasta, noodles, baguette
Whole grains	whole bread (Barbary, sangak, barley), whole bread, bulgur, whole flour
legumes	beans, peas, soybeans, lentil, chickpeas
red meat	red meat, ground meat
organ meat	liver, kidney, heart,
Poultry	chicken,
Egg	Egg
Fish	fish, canned tuna fish
Fast food	pizza, burger, sausages
Low fat dairies	low- fat yoghurt, low fat milk yoghurt
High fat dairies	high fat milk, high fat yoghurt, cream, ice cream, cream cheese
Butter	Butter
Hydrogenated fat	animal fat
Non- hydrogenated fat	Non- hydrogenated fat
Olive	olive, olive oil
Potatoes	Potatoes
French fries	French fries
Cruciferous vegetables	Cabbage, broccoli
Yellow vegetables	Pumpkin carrot,
Green leafy vegetables	Lettuce, spinach
Other vegetables	Cucumber, mixed vegetables, eggplant, green bean, onion, green pepper, bell pepper, mushroom, turnip, green peas, garlic, celery
Tomatoes	Tomatoes
Fruits	Watermelon, melon, apple, apricot, fig, nectarine, peach, pear, Citrus fruit, date, kiwi, pomegranate, Persimmon, prunes, grape, strawberry, banana, berries, grapefruit, cherries, other fruits
Fruit juices	Fruit juices, fruit nectars
Mayonnaise Mayonnaise	Mayonnaise Mayonnaise
Nuts	Walnuts, almonds, other nuts, Seeds
Sweets and desserts	Puddings, cakes, cookies, cream cakes
Sugar,	sugars, sugar cube, candies, chocolate
Honey and jam	Honey and jam
Coffee	Coffee
Tea	Tea
Salty snacks	Potato Chips, corn puffs, crackers,
Soft drinks	Soda, soft drinks
Salt	Salt
Pickles	Cucumber pickle, other pickles
Broth	Broth

Table 2
Factor-loading matrix for the 4 major factors (dietary patterns) identified by principal component analysis using food consumption data from the food frequency questionnaire[a].

FFQ item	Unhealthy pattern	Healthy pattern	Salty food pattern	Mixed pattern
Sugars	0.57			
Hydrogenated fats	0.56	−0.25		
French fries	0.52		0.21	
Refined grains	0.51			
Pickle	0.51			
Tea	0.46			−0.22
Soft drinks	0.44	−0.22		
Legumes	0.41	0.22		
Salt	0.36			
Organ meat	0.32	0.22		
Potato	0.31			0.23
Butter	0.26			0.25
Cruciferous vegetables	0.21			
Sweet dessert	0.2		0.52	
Mayonnaise	0.2			
Non- hydrogenated fats	−0.25	0.22	0.23	
Whole grains cereals	−0.38	0.24		0.38
Olive	−0.38			0.41
Fruits		0.68		
Other vegetables		0.61		
Egg		0.47		
Tomato		0.46		
Fruit juice		0.42		
Fish		0.4		0.34
Low fat dairy		0.37	0.25	−0.49
Green leafy vegetables		0.33	0.2	0.28
Red meat		0.31	0.25	0.26
Nuts		0.27		0.43
Yellow vegetables		0.2		
Poultry		−0.2		
Snacks			0.73	
Broth			0.58	
Fast food			0.54	
Condiment			0.34	
High fat dairy				0.61
Coffee				0.42
% Total variance explained	8.7	7.25	6.37	5.67

[a] Foods or food groups with an absolute value for factor loading <0.20 for all factors were not listed in the table for simplicity.

SPSS Software Package for windows (version 20.0 Armonk, NY: IBM Crop) and the P-value < 0.05 was considered as statistically significant.

3. Results

In this case–control study there were significant associations between using caps, using sunglasses, parents' cataract history, education, disease history and its type with ARC in case and control groups. Compared with the controls, cases had higher prevalence of chronic diseases (50.8%), did not use caps (90.8%) or sunglasses (89.2%) and had a lower educational level (60.8%). The frequency of hypertension was higher in the case (31.7%) than the control (22.9%) groups. The frequency of no cataract history of parents was higher in control (47.5%) than case (40.8%) groups. Most of the subjects were former smokers in the case group (12.5%) as opposed to the control group (2.1%) ($P < 0.001$). Cases had significantly lower consumption of vitamin C (97.5 ± 34.3 mg/d), vitamin A (725.44 ± 332 (RE)/d) and β-carotene (400.03 ± 231.31 Ug/d); however, they showed a higher energy intake (2444.41 ± 577.49 kcal/d) compared to the controls vitamin C (112.12 ± 36 mg/d), vitamin A (874.49 ± 404.46 (RE)/d), β-carotene (558.71 ± 316.49 Ug/d) and energy intake (2302.08 ± 489.40 kcal/d) (data was not shown).

Through conducting factor analysis, the four major DPs were identified. The eigenvalues of Unhealthy, Healthy, Salty and Mixed patterns were 3.5, 3.09, 1.82 and 1.65, respectively. Four major DPs were extracted following the food groups: the Unhealthy pattern (sugars, hydrogenated fats, French fries, refined grains, pickle, tea, soft drinks, legumes, salt, organ meat, potatoes, butter, cruciferous vegetables, sweet desserts and mayonnaise), a Healthy pattern fruits, other vegetables (cucumber, mixed vegetables, eggplant, green bean, onion, green pepper, bell pepper, mushroom, turnip, green peas, garlic, celery),eggs, tomatoes, fruit juice, fish, low fat dairy, green leafy vegetables, red meat, nuts and yellow vegetables, Salty food pattern (snacks, broth, fast foods, sweet desserts, condiments) and Mixed pattern (high-fat dairy, nuts, coffee, olive, whole grain cereals, fish, butter, potatoes, green leafy vegetables and red meat). Overall, these patterns explained 27.99% of the whole variance (Table 2).

Subjects in the upper quartile of the Unhealthy pattern, compared with those in the lowest quartile, had a lower educational level ($P = 0.001$), were less likely to live in urban areas ($P < 0.001$), wore sunglasses less ($P = 0.005$) and smoked more frequently ($P < 0.001$). Moreover, the participants in the higher quartile of Unhealthy pattern had higher energy intakes ($P < 0.001$), while subjects in the upper quartile of Healthy pattern had higher educational levels ($P < 0.001$), were more likely to live in urban areas ($P < 0.001$), had lower prevalence of hypertension ($P < 0.001$), wore sunglasses ($P < 0.001$) and caps ($P = 0.01$)in the sun more often. Furthermore, individuals in the top quartile of the Healthy

Table 3
Baseline characteristics of participants by quartiles of dietary pattern (DP) scores.

Dietary patterns	Q1	Q2	Q3	Q4	P_{trend}
Unhealthy pattern	**(n = 90)**	**(n = 91)**	**(n = 88)**	**(n = 91)**	
Primary Education, n (%)	28 (31.1)	33 (26.3)	29 (33)	23 (25.3)	0.001[a]
Residence (Urban), n (%)	82 (91.1)	71 (78)	60 (68.2)	52 (51.1)	<0.001[a]
A bonnet cap not used, n (%)	69 (76.7)	72 (79.1)	77 (87.5)	73 (80.2)	0.3[a]
No Sun glasses used, n (%)	65 (72.2)	77 (84.6)	80 (90.9)	79 (86.8)	0.005[a]
No parents' cataract history, n (%)	41 (45.6)	33 (36.3)	41 (46.6)	48 (52.7)	0.06[a]
No diseases history, n (%)	44 (48.9)	56 (61.5)	49 (55.7)	57 (62.6)	0.22[a]
History of hypertension, n (%)	24 (26.7)	26 (28.6)	24 (27.3)	19 (20.9)	0.55[c]
Never smoked, n (%)	83 (92.2)	67 (73.6)	70 (79.5)	55 (60.4)	<0 .001[a]
Energy intake (kcal/d)	2209 ± 481.25[b]	2182.34 ± 431.02	2350.37 ± 504.61	2654.89 ± 540.16	<0.001[d]
Vitamin E (mg/d)	9.4 ± 4	12.11 ± 6.5	12.6 ± 5.3	15.7 ± 8.9	<0.001[d]
Vitamin C (mg)	113.67 ± 42.5	108.43 ± 35.48	100.77 ± 33.16	105.95 ± 31.4	0.11[d]
Vitamin A (RE)	888.26 ± 489.55	809.65 ± 358.25	795.78 ± 337.27	805.27 ± 345.03	0.63[d]
β-carotene (Ug)	556.42 ± 330.69	539 ± 326.66	474.18 ± 257.6	453.18 ± 269.58	0.16[d]
Polyunsaturated fatty acid (Gm)	60.52 ± 22.87	56.78 ± 23.16	57.94 ± 28.07	62.62 ± 25.53	0.18[d]
Healthy pattern	**(n = 90)**	**(n = 91)**	**(n = 88)**	**(n = 91)**	
Primary Education, n (%)	17 (19.1)	31 (34.1)	36 (40)	29 (32.2)	<0.001[a]
Residence (Urban), n (%)	55 (61.8)	61 (67)	69 (76.7)	80 (88.9)	<0.001[a]
A bonnet cap not used, n (%)	82 (92.1)	74 (81.3)	69 (76.7)	66 (73.3)	0.01[a]
No Sun glasses used, n (%)	85 (95.5)	80 (87.9)	74 (82.2)	62 (68.9)	<0.001[a]
No parents' cataract history, n (%)	38 (42.7)	41 (45.1)	40 (44.4)	44 (48.9)	0.07[a]
No diseases history, n (%)	46 (51.7)	48 (52.7)	55 (61.1)	57 (636.3)	0.28[a]
History of Hypertension, n (%)	35 (39.3)	23 (25.3)	20 (22.2)	15 (16.7)	<0.001[c]
Never smoked, n (%)	63 (70.8)	71 (78)	70 (77.8)	71 (78.9)	0.62[a]
Healthy pattern	**(n = 90)**	**(n = 91)**	**(n = 88)**	**(n = 91)**	
Energy intake (kcal/d)	2042.14 ± 487.03[b]	2232.52 ± 469.85	2452 ± 428.49	2669.33 ± 493.38	<0.001[d]
Vitamin E (mg/d)	11.2 ± 5.3	11.83 ± 6.7	12.9 ± 5.6	14 ± 8.9	0.002[d]
Vitamin C (mg)	79.81 ± 25.47	97.02 ± 22.79	113.66 ± 25.49	138.3 ± 39.31	<0.001[d]
Vitamin A (RE)	642.81 ± 272.53	727.6 ± 304.26	835.15 ± 347.28	1092.71 ± 451.03	<0.001[d]
β-carotene (Ug)	392.61 ± 241.98	448.91 ± 253.4	558.81 ± 342.48	622.31 ± 300.58	<0.001[d]
Polyunsaturated fatty acid (Gm)	50.8 ± 20.87	52.71 ± 20.14	62.3 ± 24.78	72.07 ± 27.75	<0.001[d]
Salty food pattern	**(n = 90)**	**(n = 92)**	**(n = 90)**	**(n = 88)**	
Primary Education, n (%)	28 (31.1)	32 (34.8)	29 (32.2)	24 (27.3)	<0.001[a]
Residence (Urban), n (%)	55 (61.1)	61 (66.3)	79 (87.8)	70 (79.5)	<0.001[a]
A bonnet cap not used, n (%)	70 (77.8)	78 (84.8)	75 (83.3)	68 (77.3)	0.46[a]
No Sun glasses used, n (%)	83 (92.2)	76 (82.6)	73 (81.1)	69 (78.4)	0.06[a]
No parents' cataract history, n (%)	42 (46.7)	44 (47.8)	43 (47.8)	34 (38.6)	0.73[a]
No diseases history, n (%)	55 (61.1)	51 (55.4)	45 (50)	55 (62.5)	0.3[a]
History of Hypertension, n (%)	23 (25.6)	28 (30.4)	22 (24.4)	20 (22.7)	0.1[c]
Never smoked, n (%)	66 (73.3)	68 (73.9)	72 (80)	69 (78.4)	0.93[a]
Energy intake (kcal/d)	2194.78 ± 484.25	2218.09 ± 493.72	2335.73 ± 475.69	2659.3 ± 515.88	<0.001[d]
Vitamin E (mg/d)	13.8 ± 8.8	11.8 ± 5.6	11.31 ± 5	13.03 ± 7.01	0.02[d]
Vitamin C (mg)	99.71 ± 31.03	102.41 ± 36.61	109.31 ± 33.25	117.89 ± 40.46	0.002[d]
Salty food pattern	**(n = 90)**	**(n = 92)**	**(n = 90)**	**(n = 88)**	
Vitamin A (RE)	824.47 ± 364.36	817.7 ± 423.2	827.13 ± 353.12	830.19 ± 411.96	0.93[d]
β-carotene (Ug)	511.8 ± 314.54[b]	537.74 ± 336.64	516.25 ± 298.9	455.66 ± 237.89	0.75[d]
Polyunsaturated fatty acid (Gm)	48.19 ± 18.46	53.24 ± 21.25	63.29 ± 26.03	73.65 ± 25.84	<0.001[d]
Mixed pattern	**(n = 90)**	**(n = 90)**	**(n = 90)**	**(n = 90)**	
Primary Education, n (%)	34 (37.8)	34 (37.8)	22 (24.4)	23 (25.6)	<0.001[a]
Residence (Urban), n (%)	63 (70)	57 (63.3)	69 (76.7)	76 (84.4)	0.01[a]
A bonnet cap not used, n (%)	75 (83.3)	71 (78.9)	75 (83.3)	70 (77.8)	0.7[a]
No Sun glasses used, n (%)	82 (91.1)	82 (91.1)	73 (81.1)	64 (71.1)	<0.001[a]
No parents' cataract history, n (%)	46 (51.1)	36 (40)	38 (42.2)	43 (47.8)	0.93[a]
No diseases history, n (%)	54 (60)	54 (60)	44 (46.9)	54 (60)	0.33[a]
History of Hypertension, n (%)	22 (24.4)	25 (27.8)	29 (32.2)	17 (18.9)	0.45[c]
Never smoked, n (%)	60 (66.7)	71 (78.9)	70 (77.8)	74 (82.2)	0.08[a]
Energy intake (kcal/d)	2302.47 ± 467.04	2131.52 ± 450.2	2354.45 ± 543.66	2609.66 ± 521.72	<0.001[d]
Vitamin E (mg/d)	11.55 ± 6.3	11.15 ± 4.9	13.2 ± 5.3	14 ± 9.5	0.002[d]
Vitamin C (mg)	102.46 ± 29.24	99.41 ± 36.45	112.98 ± 43.27	114.12 ± 31.85	0.002[d]
Vitamin A (RE)	789.98 ± 350.72	738.01 ± 344.84	832.89 ± 439.66	938.33 ± 386.5	0.001[d]
β-carotene (Ug)	464.43 ± 256.76	514.59 ± 304.78	492.57 ± 314.76	551.68 ± 318.04	0.33[d]
Polyunsaturated fatty acid (Gm)	53.57 ± 20.71	51.61 ± 20.89	58.63 ± 20.71	74.09 ± 30.11	<0.001[d]

Abbreviation: Q, quartile.
[a] *P* values are for person chi-square test to compare categorical variables across the DP scores quartiles.
[b] *P* values are presented as Mean ± SD.
[c] *P* values are for fisher's exact test to compare categorical variables across the DP scores quartiles.
[d] *P* values are for Independent kruskalwallis test to compare continuous variables across the DP scores quartiles.

pattern had higher dietary intakes of vitamin C (mg), vitamin A (RE), β-carotene (Ug), PUFA (Gm) and energy intake (kcal) (P-values<0.001). Compared with those in the lowest quartile, individuals in the upper quartile of Salty food pattern had a lower educational level (P < 0.001) and were more likely to live in urban areas (P < 0.001). Higher energy intakes (kcal) (P < 0.001), vitamin C (mg) (P = 0.002) and PUFA (Gm) (P < 0.001) were seen among those in top quartile of Salty food pattern. Subjects in the top

Table 4
Logistic regression for the association between dietary pattern scores with age-related cataract disease.

Dietary patterns		Dietary pattern score in the case and control group (mean ± SE)[b]	OR	95% CI	P_{trend}
Unhealthy pattern	Crude model	Case(0.71 ± 0.08)	3.88	(2.8–5.36)	<0.001
	Adjusted model[a]	Control (-0.35 ± 0.05)	5.71	(3.68–8.87)	<0.001
Healthy pattern	Crude model	Case(-0.34 ± 0.1)	0.56	(0.44–0.72)	<0.001
	Adjusted model	Control (0.17 ± 0.05)	0.48	(0.34–0.67)	0.02
Salty food pattern	Crude model	Case(0.2 ± 0.13)	1.36	(1.05–1.75)	0.02
	Adjusted model	Control (-0.1 ± 0.04)	1.45	(1.04–2.02)	0.03
Mixed pattern	Crude model	Case (−0.06 ± 0.07)	0.91	(0.73–1.13)	0.41
	Adjusted model	Control (0.03 ± 0.06)	0.93	(0.72–1.2)	0.59

Abbreviation: OR, Odds Ratio.
[a] Adjusted for education, residence, cap used, sunglasses used, parents' cataract history, diseases history, type of diseases history, smoking status and energy intake.
[b] Calculated using independent sample T-test.

quartile of Mixed pattern had a lower educational level ($P < 0.001$), were more likely to live in urban areas ($P = 0.01$), and were more likely to wear sunglasses ($P < 0.001$). Individuals in the upper quartile of Mixed pattern had higher energy intake (kcal) ($P < 0.001$), vitamin C (mg) ($P = 0.002$), vitamin A (RE) ($P = 0.001$) and PUFA (Gm) ($P < 0.001$), compared to those in the lowest quartile (Table 3).

In logistic regression, the scores (obtained from PCA method) of Unhealthy, Healthy and Salty food patterns were significantly associated with ARC. Thus, for the adjusted model to education; residence; cap use, sunglasses use; parents'cataract history; diseases history and its type; smoking status and energy intake, per unit increase in DPs score, the OR was 5.71, $P_{trend} < 0.001$ for Unhealthy pattern and the OR was 0.48, $P_{trend} < 0.001$ for Healthy pattern. Also, in Salty food pattern, per unit increase in score the OR after adjusted the variables, was 1.45, $P_{trend} = 0.03$ (Table 4).

4. Discussion

In the current study, four distinct DPs were identified: Unhealthy, Healthy, Salty foods and Mixed patterns. Our findings showed that the Healthy DP was inversely related with ARC, whereas the Unhealthy and Salty food DPs increased the risk of ARC and Mixed pattern, was not significantly associated with ARC. Epidemiologic evidence for DPs and the risk of ARC is fairly limited. The findings indicate that DPs may play a role in the etiology of ARC. To date, several studies have focused on the association between nutrients and ARC disease. Our study showed that the Unhealthy pattern includes many kinds of unhealthy food items (sugars, hydrogenated fats, French fries, refined grains, soft drinks, salt, butter and sweet dessert, etc.) and Salty food pattern includes (snacks, broth, fast foods, sweet desserts, condiments) increase ARC risk; while the Healthy pattern includes healthy food items (fruits, vegetables, eggs, fish, low fat dairy, etc.) that decrease ARC risk. However, some healthy food items like legumes and cruciferous vegetables were also observed in Unhealthy pattern that could interact with other foods in the pattern to counteract their effect on ARC. The results from current study agree with previous studies on the association between ARC risk and intakes of salt, butter, fruits, vegetables, carbohydrates, saturated fat and cholesterol, antioxidants, proteins and n-3 PUFAs [6,11,21–25].

A previous meta-analysis study indicated that higher carbohydrate intake and foods with high glycemic index (GI) significantly increased ARC risk [6]. Several studies, consistent with our findings, suggested that high total fat and cholesterol intakes will elevate the risk of all cataract subtypes [23,25]. Tavani et al. [24], in a case–control study, suggested that high intakes of butter and salt significantly increased the risk of ARC. Furthermore, high intakes of fruits and vegetables decreased this risk. Results from European Prospective Investigation into Cancer and Nutrition showed that high levels of saturated fat and cholesterol are positively associated with increased risk of any cataract type [21]. Excessive sodium intake is related to high blood pressure and subsequent cataract development [22]. Rautiainen et al. [11] focused on TAC, considering the capacity of all antioxidants in diets and their synergic effect, indicating dietary TAC was inversely associated with risk of ARC. A previous cross-sectional study, indicated higher dietary intakes of protein and n-3 PUFAs decreased risk of cataract [16].

As to mechanisms, effects of these nutrients and food groups on ARC are interpretable. Glucose is taken up relatively slowly from plasma into the aqueous, the fluid that provides nutrients to the lens [26]. Prolonged exposure of lens proteins to elevated glucose condensations results in immense glycation and precipitation of modified lens proteins [27]. In cataractous conditions, cation (Na^+/K^+ electrolyte) imbalance in the aqueous humor increases the extracellular sodium concentration; therefore, it would be difficult for sodium pumps to maintain low levels of intracellular sodium required for lens transparency [22]. Accumulation of free radicals and other reactive species damages lens proteins and antioxidants which can be endogenous (eg, antioxidant enzymes) or obtained exogenously (dietary). The lens may be protected against oxidative stress through several mechanisms [28]. The main dietary sources of multiple types of antioxidants (such as carotenoid, xantophylls, lutein, zeaxanthin, vitamin C, vitamin E and β-carotene) were from vegetables, fruits and egg yolks. Moreover, synergistic effects among these antioxidants to reduce cataract risk, should be taken into account [9,17]. Protein in the form of albumin may play a critical role in controlling the osmotic status of the lens. Specific amino acids may play a crucial role in slowing pathophysiologic process of cataract formation [29]. The defense mechanism of n-3 PUFA against cataract formation is unclear, but it might be associated with positive effects on cholesterol through promoting serum levels of high-density lipoprotein [30–32]. Vitamin E is the major antioxidant present in high-density lipoprotein, which shortens oxidation process [33].

The complex nature of Mixed pattern includes healthy food items like nuts, olives, whole-grain cereals and leafy greens, one would anticipate detecting a positive and inverse association between Mixed patterns with ARC. The reason for lack of association between this pattern with ARC risk is unrevealed, since we regarded overall diets, not single nutrients or food groups.

This study had some limitations. First, the case–control nature of the study is limited in defining causality. Second, ARC is a disease occurring over a long period of time, and in the current study, the dietary changes over that period were overlooked. Third, due to the retrospective nature of case–control studies, the results are susceptible to recall bias. Fourth, several decisions in conducting factor analysis including the consolidation of food items into food groups, number of extracted factors, method of rotation and labeling of the components are made subjectively or arbitrarily [34].

In conclusion, the results of this case–control study in the Northwest of Iran suggest that a DP with high intakes of healthy foods may be associated with a lower ARC risk. Moreover, as epidemiological evidence on this topic is extremely limited, further investigations with well-designed case–control and prospective cohort studies are required.

Author contributions

EAMM and RZ had full access to all of the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.

Concept and design: EAMM, RZ, GhM, PA.

Acquisition, analysis, or interpretation of data: EAMM, RZ, PA.

Drafting of the manuscript: EAMM, RZ, PA.

Critical revision of the manuscript for important intellectual content: RZ.

Statistical analysis: PA.

Obtained funding: RZ.

Administrative, technical, or material support: RZ, GhM.

Supervision: RZ.

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Declaration of competing interest

All authors have completed and submitted the ICMJE form for disclosure of potential conflict of interest and none was reported.

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