DIETARY HABITS AND DIETARY NUTRIENT INTAKE IN PATIENTS WITH AGE-RELATED MACULAR DEGENERATION: A CASE-CONTROL STUDY

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SUMMARY

Objectives: Age-related macular degeneration (AMD) is the leading cause of irreversible blindness among older adults in developed countries. Although many risk factors are known, the pathogenesis of AMD is still unclear. However, oxidative stress probably plays a vital role in the process of AMD. The increasing prevalence of AMD, risk of vision loss, limited treatment of dry form, expensive treatment of wet form, and decreased quality of life are factors that lead to considering modifiable risk factors of AMD, such as nutrition. This is the first study describing the relationship between dietary habits, dietary nutrient intake and AMD in the Czech Republic.

Methods: In this research, a total of 93 cases with AMD and 58 controls without AMD and cataracts participated. All participants were ophthalmologically examined at the Clinic of Eye Treatments at the University Hospital Brno. Data were collected using a pre-tested self-report questionnaire in a face-to-face interview. Food consumption frequency was assessed by an 18-item semiquantitative food-frequency questionnaire (FFQ). Dietary nutrient intakes were calculated from a 24-hour recall.

Results: Patients with AMD compared with controls had significantly higher consumption of legumes and lower consumption of meat products, salt and salty products. In men, we found statistically significant differences in alcohol consumption. The case group consumed alcoholic beverages more frequently (median: 2 times a week) than the control group (median: 1–3 times a month). No differences in alcohol consumption were found in women. In comparison to the case group, the control group had a significantly higher dietary intake of energy (5,783.8 vs. 4,849.3 kJ/day; $p = 0.002$), proteins (65.3 vs. 52.3 g/day; $p = 0.002$), fats (57.6 vs. 49.4 g/day; $p = 0.046$), saturated fatty acids (21.7 vs. 18.9 g/day; $p = 0.026$), carbohydrates (150.4 vs. 127.1 g/day; $p = 0.017$), dietary fibre (13.2 vs. 11.3 g/day; $p = 0.044$), vitamin B2 (1.0 vs. 0.9 mg/day; $p = 0.029$), vitamin B3 (13.9 vs. 10.0 mg/day; $p = 0.011$), pantothenic acid (3.5 vs. 2.8 mg/day; $p = 0.001$), vitamin B6 (1.3 vs. 1.0 mg/day; $p = 0.001$), potassium (1,656.5 vs. 1,418.0 mg/day; $p = 0.022$), phosphorus (845.4 vs. 718.7 mg/day; $p = 0.020$), magnesium (176.5 vs. 143.0 mg/day; $p = 0.012$), copper (1.0 vs. 0.8 mg/day; $p = 0.011$), and zinc (7.1 vs. 6.1 mg/day; $p = 0.012$) counted from a 24-hour recall.

Conclusions: According to FFQ, dietary habits in the patients with AMD and controls were similar. In men from the case group, we found statistically significant higher alcohol consumption. According to a 24-hour recall, the controls achieved recommended dietary intakes rather than cases. In comparison to the case group, the control group had a significantly higher dietary intake of energy, proteins, fats, saturated fatty acids, carbohydrates, dietary fibre, vitamin B2, vitamin B3, pantothenic acid, vitamin B6, potassium, phosphorus, magnesium, copper, and zinc.

Key words: age-related macular degeneration, food groups, dietary habits, antioxidants, oxidative stress

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INTRODUCTION

Age-related macular degeneration (AMD) is one of the main causes of visual loss in the elderly. Individuals with AMD have a decreased ability to read small letters and recognize the faces of other people. Consequently, AMD significantly influences their daily living activities and quality of life. Despite new research in prevention and therapy, the incidence is expected to increase to 300 million by 2040. One of the reasons is increasing life expectancy and population aging (1, 2). AMD has two forms, dry (atrophic) and wet (neovascular). The wet form is less common, but more serious due to rapid progression and high risk of visual loss. It can be treated with anti-vascular endothelial growth factor (anti-VEGF) injections. On the contrary, limited treatment is available for the dry form. Treatment of AMD is usually expensive and presents a high economic burden (3). The pathogenesis of AMD remains unclear. However, oxidative stress seems to play an important role. Epidemiological studies suggest the impact of nutrition on the onset and progression of AMD (4). Adequate dietary intake of omega-3 fatty acids, vitamin C, vitamin D, vitamin E, zinc, selenium, lutein, and zeaxanthin seems to be essential for healthy eyes (1). Several studies suggest that healthy diet rich in fruit, vegetables, fish, and nuts is protective against AMD (5, 6). According to a systematic review, adherence to the

Mediterranean-style eating pattern rich in antioxidants can delay the onset and progression of AMD (7). On the contrary, a Western diet pattern characterized by a higher intake of red meat, processed meat, high-fat dairy products, and fried potatoes had an increased association with AMD prevalence (8).

MATERIALS AND METHODS

This case-control study design was conducted to investigate dietary habits and dietary nutrient intake in patients with AMD. The research was approved by the Ethics Committee of Masaryk University. Patients were recruited during the period of 2020–2021 at the Clinic of Eye Treatments at the University Hospital Brno. All participants were ophthalmologically examined and gave informed consents. A total of 93 cases with AMD and 58 controls without AMD and cataracts were included.

Data Collection

Data collection was performed in a face-to-face interview. A questionnaire with FFQ and a 24-hour recall was originally designed by professionals from Masaryk University. The participants self-reported their socioeconomic status, health status, lifestyle behaviours, and nutritional status. The participants completed an 18-item FFQ on a 9-point frequency scale ranging from "more than 5 times a day" to "never". Each food group was specified by a serving size. The 24-hour recall was assessed from 73 cases (78%) and 55 controls (95%). These nutritional data were obtained continuously throughout the year.

Statistical Analysis

Dietary nutrient intakes were completely calculated by the nutritional program Nutripro Expert. A statistical analysis was conducted in Statistica 12 software using a nonparametric Mann-Whitney test with a 5% significance level ($\alpha = 0.05$).

RESULTS

Table 1 shows the basic characteristics of the study sample. The mean age was 76 years in the case group and 73 years in the control group. In the control group there were more men than women. BMI was calculated as weight divided by height squared (kg/m^2). In comparison to controls, AMD cases had a slightly higher mean body mass index (BMI).

Table 1. *Basic characteristics of the study sample*

Characteristics	Cases n = 93	Controls n = 58
Age (years), mean (SD)	76 (5.5)	73 (5.6)
Male gender, n (%)	30 (32)	31 (53)
Height (cm), mean (SD)	166.5 (8.5)	170.4 (9.8)
Weight (kg), mean (SD)	77.2 (13.8)	78.0 (13.8)
BMI (kg/m^2), mean (SD)	27.8 (4.5)	26.8 (3.9)

Patients with AMD compared with controls had significantly higher consumption of legumes and lower consumption of meat products, salt and salty products. No differences were observed in the consumption of grains, fruit, vegetables, nuts and seeds, eggs, fish and fish products, white meat, red meat, milk and dairy products, sugar and sweets, fat and oils. Similarly, no differences were observed in liquid intake of water, sweet beverages, tea, and coffee. No statistically significant associations were found between food groups and AMD. However, in men, we found statistically significant differences in alcohol consumption. The case group consumed alcoholic beverages more frequently (median: 2 times a week) than the control group (median: 1–3 times a month). No differences in alcohol drinking were found in women. In this research, more women than men reported lifetime alcohol abstinence.

The results of FFQ conflicted with the results from the 24-hour recall. The 24-hour recall was obtained from 73 cases (78%) and 55 controls (95%). According to the 24-hour recall, the consumption of vegetables, food containing proteins (meat, eggs, legumes, nuts), milk and dairy products was significantly higher in the control group. Table 2 shows mean food servings from the 24-hour recall.

Table 3 shows the mean macronutrient intake counted from the 24-hour recall in the cases and controls. In comparison to the case

Table 2. *Mean food servings from 24-hour recall in cases and controls*

Food groups	Mean food servings		p-value
	Cases n = 73	Controls n = 55	
Grains	3.1	3.1	0.924
Fruit	1.1	1.1	0.840
Vegetables	1.9	2.6	0.019
Meat, egg, legumes, nuts	1.8	2.2	0.011
Milk and dairy products	1.2	1.5	0.040
Sugar, salt, fats	1.1	1.0	0.527

Table 3. *Mean macronutrient intake per day from 24-hour recall in cases and controls*

Variable (per day)	Cases n = 73	Controls n = 55	p-value
Energy (kJ)	4,849.3	5,783.8	0.002
Proteins (g)	52.3	65.3	0.002
Fats (g)	49.4	57.6	0.046
MUFA (g)	10.2	11.0	0.405
PUFA (g)	5.5	5.4	0.539
SAFA (g)	18.9	21.7	0.026
Trans fatty acids (g)	0.4	0.4	0.261
Omega-3 fatty acids (g)	0.5	0.4	0.685
Omega-6 fatty acids (g)	2.2	2.8	0.172
Carbohydrates (g)	127.1	150.4	0.017
Sugar (g)	34.5	41.8	0.079
Dietary fibre (g)	11.3	13.2	0.044
Cholesterol (mg)	220.8	267.3	0.054
Phytosterols (mg)	22.3	25.6	0.632

group, the control group had a significantly higher dietary intake of energy (5,783.8 vs. 4,849.3 kJ/day; p=0.002), proteins (65.3 vs. 52.3 g/day; p=0.002), fats (57.6 vs. 49.4 g/day; p=0.046), saturated fatty acids (21.7 vs. 18.9 g/day; p=0.026), carbohydrates (150.4 vs. 127.1 g/day; p=0.017), and dietary fibre (13.2 vs. 11.3 g/day; p=0.044).

Table 4 shows the mean micronutrient intake counted from the 24-hour recall in the cases and controls. In comparison to the case group, the control group had a significantly higher dietary intake of vitamin B2 (1.0 vs. 0.9 mg/day; p=0.029), vitamin B3 (13.9 vs. 10.0 mg/day; p=0.011), pantothenic acid (3.5 vs. 2.8 mg/day; p=0.001), vitamin B6 (1.3 vs. 1.0 mg/day; p=0.001), potassium (1,656.5 vs. 1,418.0 mg/day; p=0.022), phosphorus (845.4 vs. 718.7 mg/day; p=0.020), magnesium (176.5 vs. 143.0 mg/day; p=0.012), copper (1.0 vs. 0.8 mg/day; p=0.011), and zinc (7.1 vs. 6.1 mg/day; p=0.012).

DISCUSSION

This case-control study has provided a better understanding of dietary habits and dietary nutrient intake in patients with a diagnosis of AMD in the Czech Republic. The patients with AMD compared with the controls had significantly higher consumption of legumes and lower consumption of meat products, salt and salty products. However, no differences were observed in the consumption of grains, fruit, vegetables, nuts and seeds, eggs, fish and fish products, white meat, red meat, milk and dairy products, sugar and sweets, fat and oils. No statistically significant associations were found between food groups and AMD. These results of FFQ conflicted with the results from the 24-hour recall. According to the 24-hour recall, the consumption of vegetables, food containing proteins (meat, eggs, legumes, nuts) and dairy products was significantly higher in the control group. These differences can be explained by the used methods. Food consumption was counted from the 24-hour recall only, no longer period. Moreover, in FFQ underestimating and overestimating of food group's consumption is a frequent case.

Our findings conflicted with other similar studies. Braakhuis et al. proved protective associations on AMD with higher consumption of fruit, vegetables, vitamin C, and β-carotene. Moreover, harmful associations were observed with higher consumption of meat/nuts and cholesterol (9). According to a systematic review, higher consumption of red and processed meat was associated with a higher risk of AMD. Low dietary intake of calcium and low consumption of dairy products probably increased the progression of late-stage AMD (8).

Furthermore, according to a prospective study, a diet of 200 grams of vegetables per day, fruit two times per day, and fish two times per week was associated with a significantly reduced risk of AMD (10). According to a cohort study from 2014, a dietary pattern high in fruit, vegetables, chicken, and nuts and a pattern low in red meat seemed to be associated with a lower prevalence of advanced AMD. No particular food pattern seemed to be associated with the prevalence of the earliest stages of AMD (5). In a Chinese study of 43,672 participants from 2022, a high-salt intake increases the risk of early AMD, whereas intake of meat decreases the risk (11).

However, in a cross-sectional Irish Nun Eye Study involving 1,233 older women no associations between dietary patterns and AMD were observed. In this study, two dietary patterns were identified: a 'healthy' pattern characterized by high consumption of oily fish, wholegrains, vegetables and fruit; and an 'unhealthy' pattern characterized by high consumption of high-fat dairy products, sugar, sweets, and chips (12). Moreover, in a prospective study of 1,278 individuals, no associations were found between dietary habits and any form of AMD (13).

In a meta-analysis of Dinu et al., a total of 211,676 subjects and 7,154 cases of AMD were included. By comparing the highest and lowest consumption, no significant associations were found with AMD for vegetables, fruit, nuts, grains, dairy products, and fats. Only fish consumption determined a significant reduction of an early and late AMD risk. Moreover, high meat consumption was associated with a significantly increased risk of early, but not late AMD. High alcohol consumption was also associated with an increased risk of AMD. In conclusion, this meta-analysis showed a significant 18% reduced risk associated with fish consumption and a 20% increased risk related to alcohol consumption (4). In men, we found statistically significant differences in alcohol consumption. The case group consumed alcoholic beverages more frequently (median: 2 times a week) than the control group (me-

Table 4. *Mean micronutrient intake from 24-hour recall in cases and controls*

Variable (per day)	Cases n = 73	Controls n = 55	p-value
Vitamin A (μg)	437.1	322.6	0.595
Vitamin D (μg)	1.9	2.6	0.125
Vitamin E (mg)	2.2	2.4	0.572
Vitamin K (μg)	72.1	77.4	0.384
Vitamin B1 (mg)	0.8	1.0	0.487
Vitamin B2 (mg)	0.9	1.0	0.029
Vitamin B3 (mg)	10.0	13.9	0.011
Pantothenic acid (mg)	2.8	3.5	0.001
Vitamin B6 (mg)	1.0	1.3	0.001
Folates (μg)	126.7	100.4	0.620
Folic acid (μg)	41.7	32.7	0.941
Vitamin B12 (μg)	3.3	2.7	0.660
Vitamin C (mg)	46.0	64.1	0.325
Choline (mg)	66.6	74.8	0.419
β-carotene (μg)	1,267.1	1,439.4	1.000
Potassium (mg)	1,418.0	1,656.5	0.022
Phosphorus (mg)	718.7	845.4	0.020
Magnesium (mg)	143.0	176.5	0.012
Natrium (mg)	2,152.8	2,277.2	0.464
Calcium (mg)	422.1	466.0	0.079
Mangan (mg)	1.6	2.2	0.052
Copper (mg)	0.8	1.0	0.011
Selenium (μg)	37.5	39.8	0.914
Zinc (mg)	6.1	7.1	0.012
Iron (mg)	7.0	7.7	0.320

dian: 1–3 times a month). No differences in alcohol consumption were found in women. In this research, more women than men reported lifetime alcohol abstinence.

Furthermore, we counted dietary nutrient intakes from a 24-hour recall. In comparison to the case group, the control group had a significantly higher dietary intake of energy (5,783.8 vs. 4,849.3 kJ/day; p=0.002), proteins (65.3 vs. 52.3 g/day; p=0.002), fats (57.6 vs. 49.4 g/day; p=0.046), saturated fatty acids (21.7 vs. 18.9 g/day; p=0.026), carbohydrates (150.4 vs. 127.1 g/day; p=0.017), dietary fibre (13.2 vs. 11.3 g/day; p=0.044), vitamin B2 (1.0 vs. 0.9 mg/day; p=0.029), vitamin B3 (13.9 vs. 10.0 mg/day; p=0.011), pantothenic acid (3.5 vs. 2.8 mg/day; p=0.001), vitamin B6 (1.3 vs. 1.0 mg/day; p=0.001), potassium (1,656.5 vs. 1,418.0 mg/day; p=0.022), phosphorus (845.4 vs. 718.7 mg/day; p=0.020), magnesium (176.5 vs. 143.0 mg/day; p=0.012), copper (1.0 vs. 0.8 mg/day; p=0.011), and zinc (7.1 vs. 6.1 mg/day; p=0.012). Gopinath et al. in their case-control study found a statistically significant lower dietary intake of vitamin E, vitamin C, β-carotene, folates, and vegetables and a higher dietary intake of zinc in the case group in comparison to the controls (14).

According to the 18-item FFQ, dietary habits were not so different between the case and control groups. However, dietary intakes of most nutrients counted from the 24-hour recall were higher in the control group. The control group rather than the case group met the dietary nutrient recommendations.

In conclusion, the results of studies exploring the impact of dietary habits and dietary nutrient intake on AMD are inconsistent and present various conclusions. These differences can be explained by the research location, various types of study, and methodology. The studies also suggest different impacts of nutrition depending on the form of AMD (wet or dry; early or late). Moreover, AMD is a multifactorial disease with many risk factors including increasing age, family history, smoking, etc. Further research is needed to draw any definite conclusions regarding the impact of nutrition on AMD.

Limitations

The first limitation of this study is the small sample size and unbalanced sample groups in age and gender because of the higher age of participants and high prevalence of cataracts in the elderly. Secondly, most data were self-reported and could be distorted due to the higher age of participants. Thirdly, food consumption frequency was obtained from FFQ with only 18 items. Dietary nutrient intakes were calculated only from a single 24-hour recall, which may not correspond to a normal diet. However, due to the higher age of participants, a multiday dietary record was not possible and appropriate to use.

CONCLUSION

In conclusion, patients with AMD compared with the controls had significantly higher consumption of legumes and lower consumption of meat products, salt and salty products. In men, we found statistically significant differences in alcohol consumption between the case and control groups, but no differences were found in women. The case group consumed alcohol beverages more frequently (median: 2 times a week) than the control group (median: 1–3 times a month). Furthermore, dietary intakes of energy, proteins, fats, saturated fatty acids, carbohydrates, dietary fibre, vitamin B2, vitamin B3, pantothenic acid, vitamin B6, potassium, phosphorus, magnesium, copper, and zinc were significantly higher in the control group compared with the cases.

Conflicts of Interest

None declared

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