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Nutrition knowledge and dietary patterns in ophthalmic patients

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Clinical significance: Ophthalmic nutrition education programs and good dietary patterns are of considerable significance to ocular health outcomes.

Background: The study aimed at assessing the level of ophthalmic nutrition knowledge and to compare the dietary patterns between different ophthalmic patients.

Methods: Four hundred and ninety-two adults (mean age 54.7 ± 19.4 years) receiving care at three eye-care facilities in Ghana were surveyed: 171 had senile cataract, 162 had open-angle glaucoma, and 159 had healthy eyes. A modified food frequency questionnaire was administered to elicit ophthalmic nutrition knowledge and dietary intake information of participants over the last 30 days. The results were compared between the three groups.

Results: More than half of the participants (n = 267; 54.3 per cent) had received some form of education on food sources that are good for the eyes and vision, with healthy participants accounting for 50.6 per cent of this proportion. Television (55.1 per cent; 147/267), radio (49.1 per cent; 131/267) and the eye doctor (34.1 per cent; 91/267) were the most frequent sources of ophthalmic nutritional knowledge. Overall, less than one-quarter of the participants (n = 108; 22.2 per cent) were able to correctly identify one food source for at least four out of seven selected ophthalmic nutrients. Vitamin C was the most frequently consumed ophthalmic nutrient, whereas lycopene was the least taken across all groups. The average ophthalmic nutrients intake score for those with healthy eyes (59.16 [53.39–64.93]) was significantly greater than for both glaucoma patients (37.73 [32.01–43.44]) and cataract patients (34.81 [29.24–40.37]).

Conclusion: In addition to poor ophthalmic nutrition awareness and knowledge, both cataract and glaucoma patients, compared to those with healthy eyes, consumed a lesser amount of nutrients considered vital for eye health and vision. Ophthalmic nutrition education is needed to improve eye-health outcomes.

Key words: dietary patterns, Ghana, nutritional knowledge, ocular health, ophthalmic patients

Globally, approximately 217 million people suffer from moderate to severe visual impairment with an additional 36 million people estimated to be blind from uncorrected refractive errors, cataracts, and glaucoma.[1] Although the causes of blindness and visual impairment are universal, there are regional disparities in terms of health policy. Whereas high-income countries prioritise age-related macular degeneration and diabetic retinopathy, low-income countries tend to focus more on uncorrected refractive error, cataract and glaucoma.[2]

A recent nation-wide study conducted in Ghana[3] confirmed earlier reports[4,5] that cataract, glaucoma and uncorrected refractive errors are the leading causes of blindness and visual impairment in the country. The eye-care policy in Ghana therefore continues to focus on harnessing resources to increase cataract surgical rates and improve access to refraction and low-vision services.[3,6]

Among other factors, financial constraints remain a major hindrance to the utilisation of eye-care services in Ghana.[7,8] To deal with the rising burden of visual impairment, it is important for stakeholders to devise less expensive public health interventions to augment the conventional structures in place. One of such interventions is the implementation of a national ophthalmic nutrition sensitisation program.

The impact of good nutrition on the eye and visual system cannot be overstated, as certain vital nutrients are needed for optimal visual function and ocular health.[9] Diets rich in antioxidants, lutein, zeaxanthin and B vitamins have been reported to be protective against developing age-related eye diseases such as cataract[9–12] and macular degeneration.[13,14] Omega-3 fatty acids,[15] zinc,[16,17] lycopene[18] and vitamins A, C, and E[12,14] have been shown to mediate biochemical processes that attenuate the deleterious effects of oxidative stress in the lens and retina.

Previous reports suggest that interventions, such as healthy dietary habits and nutritional supplements, may prevent the development or slow down deterioration of visual problems.[19–22] Implementation of such interventions as an eye-health policy in Ghana must be informed by and tailored to nutrition needs of the population at stake. However, there is a paucity of information

regarding ophthalmic nutrition knowledge and dietary patterns at the population level and even at the clinic level.

In the present study, the level of awareness and knowledge on nutrients considered by ophthalmic care seekers to be essential to the eye was considered. Second, dietary patterns were compared between healthy participants, cataract and glaucoma patients. We used a modified food frequency questionnaire, an instrument that has been used widely to investigate the diet-disease relationship, nutritional knowledge, and dietary intake over a period of time.[12,23] In Ghana, the food frequency questionnaire has been used previously in studies involving diabetic[24] and human immunodeficiency virus patients.[25]

Methods

Study design and participants

The study was a cross-sectional survey of 492 participants, purposively recruited from the eye departments of three hospitals in Ghana: Tamale Teaching Hospital (located at northern Ghana), St. Patrick's Hospital (middle Ghana), and Cape Coast Teaching Hospital (southern Ghana). Participants included healthy individuals, cataract and glaucoma patients accessing eye-care services at one of the three hospitals.

Sample size was calculated using the Cochran's formula; $N = Z^2 (1 - p)(p)/b^2$, where N is the minimum sample size, Z is the standard normal deviation, usually set at 1.96 which corresponds to the 95% confidence interval, p is the proportion in the target population assumed to have nutritional knowledge (50 per cent), and b is the degree of desired accuracy, usually set at five per cent. Subsequently, a sample size of 385 was calculated. This was adjusted to 502 participants to account for possible attrition and to allow accurate comparison between groups. Out of the 502 recruited, data for 492 were used for data analysis due to incomplete data from 10 participants.

The study was approved by the Research and Ethics Review Board of the University of Cape Coast, Ghana (ID: UCCIRB/CHAS/2017/35) and adhered to the tenets of the Declaration of Helsinki. All study centres approved the study and each participant gave written or verbal consent to participate in the study.

The eye-health records of participants were reviewed to determine their eligibility. To be eligible for the study, an enrolee had to be at least 18 years or older, with a confirmed clinical diagnosis of primary open-angle glaucoma (diagnosed based on raised intraocular pressure ≥ 21 mmHg, cup-disc ratio of ≥ 0.7 with a characteristic visual field defect) or senile cataract (opacity in the lens corresponding to a visual acuity of 6/24 or worse and were booked for surgery) in one or both eyes for at least three months. Healthy participants included persons who visited the hospitals for regular eye check-ups but with no significant vision threatening disorders and/or correctable refractive errors.

Patients with both cataract and glaucoma in at least one eye or any other vision-impairing comorbidities such as diabetic retinopathy, maculopathies and so on were excluded from the study. In addition, the presence of traumatic cataract, drug-induced cataract, angle-closure glaucoma, and secondary glaucoma were also grounds for exclusion from the study.

Data collection

A modified version of a semi-quantitative food frequency questionnaire was adopted from a previous study.[23] The questionnaire was expanded to elicit demographic data of the patients, awareness, and knowledge on food sources for selected ophthalmic nutrients. The modified food frequency questionnaire was pre-tested on 45 patients to assess its consistency and reliability (Cronbach α = 0.889). An interviewer administered the survey in English and in the local dialect of the patient with the help of an interpreter whenever necessary. The first part of the questionnaire obtained information on patient demographics: age, gender, residence, education, and income. The second part inquired into patients' awareness of the connection between nutrition and eyes, sources of that knowledge and ability to identify at least one food source for seven pre-selected ophthalmic nutrients: lutein-zeaxanthin, lycopene, zinc, omega 3, vitamins A, C and E.

Finally, participants were asked to indicate how frequent their diet comprised of food sources corresponding to each selected nutrient over the last 30 days. One month was chosen to help reduce the element of recall bias among the participants. A food chart was provided as a guide (Figure 1). The weight and height of each participant were measured and used to determine the body mass index. Data were collected from November 2017 to April 2018.

Data analysis

Ophthalmic nutrition awareness was defined as having received some form of sensitisation on specific foods and nutrients considered to be essential for healthy eyes and vision. The level of ophthalmic nutrition knowledge was assessed as correctly identifying one food source for at least four out of the seven selected nutrients. Patient demographics, level of nutrition awareness and knowledge and the sources of such knowledge were reported as frequencies. Chi-squared and logistic regression were performed to determine the relationship between the participant groups and nutrition awareness and knowledge.

The daily intake score for each nutrient was determined based on weights assigned for the frequency of intake of corresponding food sources. A weight of 0.0 was assigned for no intake, 0.07 for once per week, 0.29 for two to three times weekly, 0.71 for four to six times weekly, 1.0 for once daily, 2.5 for two to three times daily and 4.5 for four or more times daily.[26] The overall ophthalmic nutrients intake score was calculated as the sum of the daily intake scores for all seven nutrients shown in Figure 1. Therefore, the minimum and maximum intake scores were 0.0 and 31.5, respectively.

The mean ophthalmic nutrients intake score was compared between the different participant groups using one-way analysis of variance. Statistical analyses were performed with the Statistical Package for the Social Sciences (SPSS Version 25.0; IBM, Armonk, NY, USA) and the level of significance was set at $p < 0.05$.

Results

Patient characteristics

Of the 492 participants surveyed, 159 (32.3 per cent) had healthy eyes, 162 (32.9 per cent) had open-angle glaucoma and 171 (34.8 per cent) had a cataract. The overall mean age was 54.2 ± 19.3 years with healthy participants being relatively younger. The majority (57.1 per cent, n = 281) were female. Table 1 summarises the socio-demographic characteristics of the study participants.

Level of ophthalmic nutrition awareness and knowledge

More than half of the participants (n = 267; 54.3 per cent) had received some form of sensitisation on the linkage

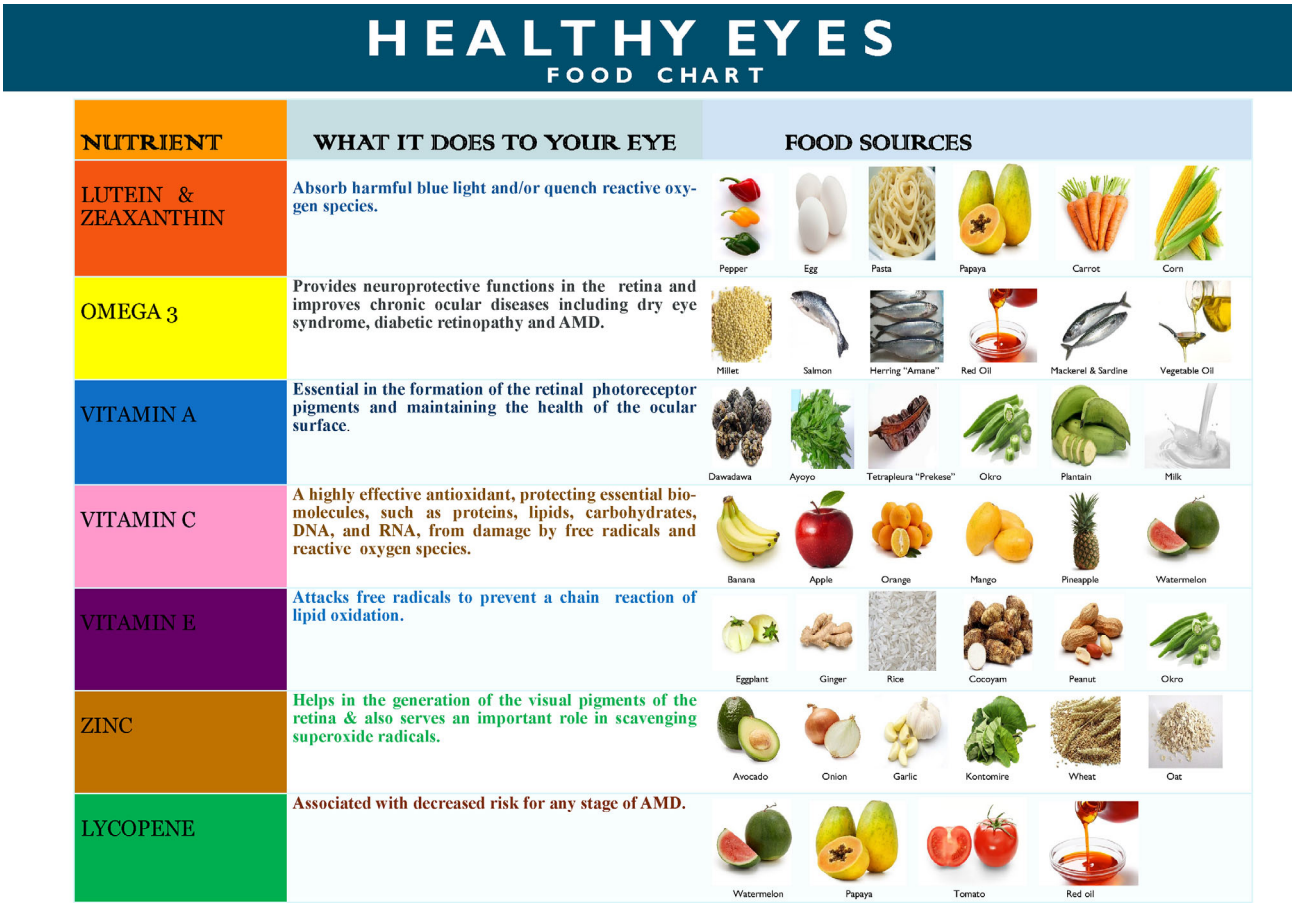

Figure 1. Food chart showing examples of sources of specific ophthalmic nutrients

between nutrition and eye health and vision. Of the 267 participants who were aware of ophthalmic nutrition, 135 (50.6 per cent) had healthy eyes, 70 (26.2 per cent) had glaucoma and 62 (23.2 per cent) had a cataract. From the nine possible sources of information shown in Figure 2, the television (55.1 per cent; 147/267), radio (49.1 per cent; 131/267) and the eye doctor (34.1 per cent; 91/267) were the most common sources of ophthalmic nutrition education.

Overall, only 22.0 per cent of all patients (108 out of 492) were able to provide a food source for a minimum of four out of the seven selected nutrients. Of this proportion, the majority (80 participants) had healthy eyes, 19 had glaucoma and nine had cataracts. Table 2 presents the proportion of participants, within each group, who correctly identified one food source for each nutrient.

Association between participant groups and ophthalmic nutrition awareness and knowledge

Gender, residence, hospital location, participant group, education, occupation, and income showed statistically significant associations with both ophthalmic nutrition awareness and knowledge (χ^2 = 7.024–137.645, $p < 0.010$). The multivariate analysis with logistic regression showed that only education and participant group were significant predictors of ophthalmic nutrition awareness.

The odds for having heard about ophthalmic nutrition was at least 67 per cent higher for participants who had received tertiary education than those with lower levels of education. For nutrition knowledge (knowing food sources that provide specific nutrients), the variables found to be significant predictors were increasing age, education and income. Details of the relationship between patient characteristics and nutrition awareness and knowledge are presented in Table 3.

Differences in ophthalmic nutrients intake between healthy, cataract and glaucoma patients

Among-group comparisons showed that the mean ophthalmic nutrients intake scores were different from the three participant groups ($F_{(2,489)}$ = 20.88, $p < 0.010$). The mean ophthalmic nutrients intake scores (with 95% CI) were 59.16 (53.39–64.93) for healthy participants, 37.73 (32.01–43.44) for glaucoma patients and 34.81 (29.24–40.37) for cataract patients. Tukey's post hoc test revealed that the mean ophthalmic nutrients intake score was significantly higher for healthy patients than for both glaucoma and cataract patients (mean difference = 21.43–24.35, $p < 0.010$). However, there was no

Demographics	Healthy (n = 159)	Cataract (n = 171)	Glaucoma/primary open-angle glaucoma (n = 162)
Age, years	32.4 ± 9.7	67.5 ± 9.3	61.4 ± 14.9
Gender			
Female	75 (47.2%)	112 (65.5%)	94 (58.0%)
Male	84 (52.8%)	59 (34.5%)	68 (42.0%)
Location of hospital			
Northern	35 (22.0%)	32 (18.7%)	34 (21.0%)
Middle	61 (38.4%)	66 (38.6%)	66 (40.7%)
Southern	63 (39.6%)	73 (42.7%)	62 (38.3%)
Body mass index			
Normal, 18.5–25 kg/m^2	101 (63.5%)	136 (79.5%)	126 (77.8%)
Overweight, 25 kg/m^2 and above	58 (36.5%)	35 (20.5%)	36 (22.2%)
Residence			
Urban	151 (95.0%)	112 (65.5%)	117 (72.2%)
Rural	8 (5.0%)	59 (34.5%)	45 (27.8%)
Education			
None	2 (1.3%)	62 (36.3%)	43 (26.5%)
Basic	5 (3.1%)	46 (26.9%)	48 (29.6%)
Secondary/vocational/technical	45 (28.3%)	50 (29.2%)	52 (32.1%)
Tertiary (Diploma, Bachelor's degree and postgraduate)	107 (67.3%)	13 (7.6%)	19 (11.7%)
Income			
< 500 GHS (107 USD)	96 (60.4%)	131 (76.6%)	119 (73.5%)
500–1,000 GHS (107–214 USD)	37 (23.3%)	33 (19.3%)	33 (20.4%)
> 1,000 GHS (214–428 USD)	26 (16.4%)	7 (4.1%)	10 (6.2%)
Occupation			
Skilled	90 (56.6%)	19 (11.1%)	25 (15.4%)
Unskilled	24 (15.1%)	95 (55.6%)	80 (49.4%)
Unemployed	45 (28.3%)	40 (23.4%)	45 (27.8%)
Retired	0 (0.0%)	17 (9.9%)	12 (7.4%)

Table 1. Socio-demographic characteristics of participants

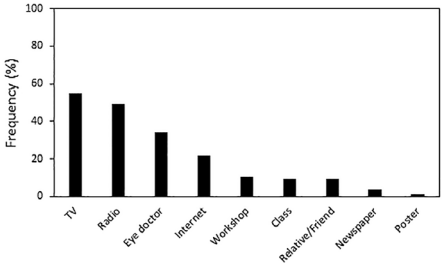

Figure 2. Bar graph showing the proportion of participants utilising the various sources of ophthalmic nutrition education

difference in ophthalmic nutrients intake scores between glaucoma and cataract patients.

For all participant groups, vitamin C was the most frequently consumed ophthalmic nutrient followed by zinc, whereas lycopene was the least taken. The average daily intake score for each nutrient for the three participant groups is shown in Figure 3.

Discussion

In an era of preventive medicine, practising healthy dietary habits is viewed as an important step to achieve positive health outcomes and overall wellbeing. Dietary adjustments and nutrient supplementation are notable interventions in the management of most chronic diseases including sight-threatening disorders such as age-related macular degeneration, diabetic retinopathy, glaucoma, and so on.[20,27]

In the current study, awareness and knowledge of patients in respect of the linkage between nutrition and eye health was assessed, and a comparison was made of their intake of eye- and vision-related nutrients. Overall, only a little over half of the study participants (majority being healthy participants) had been educated about ophthalmic nutrition, mainly from television, radio and eye doctors (Figure 2). However, approximately 78 per cent of the study participants (mostly glaucoma and cataract patients) could not identify a single food source for at least four out of the seven vision-related nutrients. In addition, participants with healthy eyes recorded significantly higher ophthalmic nutrients intake scores than both glaucoma and cataract patients.

As expected, education was found to be a significant predictor of ophthalmic nutrition awareness. When asked to identify food sources of specific ophthalmic nutrients (Table 3), participants with tertiary education performed better than those who had relatively lower levels of education. Similarly, participants with healthy eyes had higher odds of identifying correct food sources of ophthalmic nutrients than counterparts who had cataract and glaucoma. These observations may reflect a general gap in nutrition knowledge among persons seeking eye care.

Stevens et al.[28] in a survey of 158 patients with age-related macular degeneration, found that only 55 per cent were aware of the connection between diet and ocular health. Although different subsets of ophthalmic patients were studied, the overall level of awareness found in our study (54.3 per cent) is comparable to that reported in Stevens et al.[28] However, in the current study a lower level of nutrition awareness was found for cataract patients and glaucoma patients: 36.3 per cent (62 out of 171) and 43.2 per cent (70 out of 162), respectively. The higher level of nutrition awareness reported for the patients with age-related macular degeneration in the study by Stevens et al.[28] can be attributed to the fact that, unlike cataract and glaucoma, management of age-related macular degeneration includes nutritional supplementation.[11] As a result, age-related macular degeneration patients may seek and acquire more nutrition knowledge than cataract and glaucoma patients.

It is conceivable that knowing the connection between nutrition and health may translate into a higher intake of essential nutrients and a healthier dietary pattern.[29,30] Consequently, this study found that the ophthalmic nutrients intake score for participants who had been educated regarding ophthalmic nutrients was, on average, 42.8 per cent

Ophthalmic nutrients	Healthy (n = 159) n (%)	Cataract (n = 171) n (%)	Glaucoma (n = 162) n (%)
Lutein, zeaxanthin	31 (19.5)	1 (0.6)	1 (0.6)
Omega-3	109 (68.6)	10 (5.9)	24 (14.8)
Vitamin A	97 (61.0)	12 (7.0)	31 (19.1)
Vitamin C	112 (70.4)	17 (9.9)	38 (24.5)
Vitamin E	77 (48.4)	12 (7.0)	21 (13.0)
Zinc	63 (39.6)	2 (1.2)	12 (7.4)
Lycopene	35 (22.0)	0 (0.0)	1 (0.6)

Table 2. Proportion of participants who correctly identified food sources for each ophthalmic nutrient

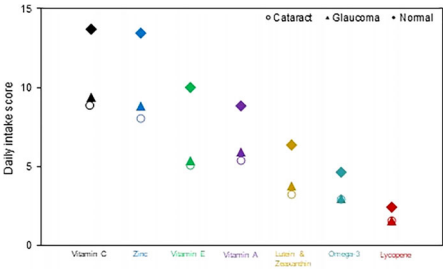

Figure 3. Mean daily intake scores of ophthalmic nutrients for the different participant groups

higher than for those without such exposure. Similarly, the ophthalmic nutrients intake score was, on average, 57.3 per cent higher for participants who correctly identified food sources of ophthalmic nutrients than those who could not. Moreover, a larger proportion of the healthy participants constituted those who knew about nutrition and ophthalmic health (50.6 per cent) and those who could identify food sources rich in ophthalmic nutrients (74 per cent).

Taking the above into account, it is not surprising that the mean ophthalmic intake score for participants with healthy eyes was significantly higher than for both glaucoma and cataract patients. Consistent with the present results, a study conducted in Nigeria reported that a higher percentage of healthy controls consumed more food sources rich in ophthalmic nutrients than cataract patients.[31]

Previous reports suggest that development of senile cataract can be controlled by the intake of diets rich in vitamin C, lutein/zeaxanthin, B vitamins, omega-3 fatty acids, multivitamins, and carbohydrates.[10,22,32] While there is no cogent evidence for or against the role of nutrition in preventing or slowing down glaucoma, Giaconi et al.[33] demonstrated that diets rich in vitamins A and C and carotenoids may have a protective trend against glaucoma. The Rotterdam study[34] also suggested that increased intake of retinol and vitamin B1 may lower the risk of developing glaucoma. The fact that both cataract and glaucoma patients, in the present study, recorded lower daily intake of all seven ophthalmic nutrients may be indicative of nutritional deficits in patients with chronic eye diseases.

A major limitation of the present study is that the healthy participants were on average 30 years younger than the cataract and glaucoma cohorts (Table 1). To ascertain whether age impacted nutrient intake scores, their

Participant characteristics	Awareness Odds (95% CI)	p-value	Knowledge Odds (95% CI)	p-value
Age	0.996 (0.977, 1.015)	0.695	0.970 (0.946, 0.995)	**< 0.020**
Gender				
Female				
Male*	0.965 (0.621, 1.499)	0.874	0.663 (0.384, 1.145)	0.140
Participant group				
Cataract	0.391 (0.167, 1.917)	**0.031**	0.515 (0.161, 1.641)	0.265
Glaucoma	0.456 (0.207, 1.003)	0.051	0.719 (0.303, 1.707)	0.454
Normal*				
Education				
None	0.109 (0.048, 0.250)	**< 0.001**	0.035 (0.004, 0.280)	**0.002**
Basic	0.086 (0.035, 0.210)	**< 0.001**	0.000 (0.000, 0.000)	0.996
Secondary	0.331 (0.163, 0.672)	**0.002**	0.473 (0.255, 0.876)	**0.017**
Tertiary*				
Income				
< 500 GHS	0.791 (0.459, 1.366)	0.401	0.677 (0.357, 1.283)	0.232
> 1,000 GHS	0.923 (0.331, 2.570)	0.878	3.008 (1.251, 7.914)	**0.014**
500–1,000 GHS*				

Bold indicate statistical significance.
*Indicates reference category.

Table 3. Multivariate analysis of the association between participant characteristics and ophthalmic nutrition awareness and knowledge

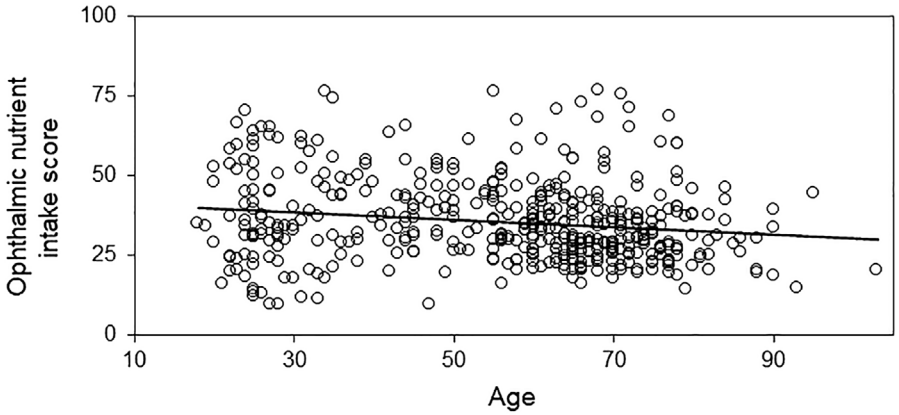

Figure 4. Relation between age (horizontal axis) and ophthalmic nutrient intake score (vertical axis)

correlation was determined for each participant group. Pearson's correlation (r) between age and nutrient intake score was 0.131 ($p = 0.141$) for healthy participants, –0.075 ($p = 0.329$) for cataract patients and –0.233 ($p = 0.003$) for glaucoma patients. The weak and statistically not significant correlation observed for both healthy participants and cataract patients indicates that other factors other than age difference may account for the difference in nutrient intake scores between the participant groups (Figure 4).

It is also worth noting that the study participants were enrolled from relatively well-resourced hospitals and may have received prior nutrition education, and therefore may be well motivated. In this regard, the results from the study may not be generalisable to the entire ophthalmic patient population as would have been in the case of a randomised population-based assessment.

In conclusion, patients with cataract and glaucoma knew very little about ophthalmic nutrition compared to respondents with healthy eyes. This inadequate knowledge resulted in a lower intake of nutrients known to prevent or delay the development of chronic eye diseases. These findings suggest the need to pursue a wide-reaching nutritional sensitisation program on a national scale. Whereas surveys using the food frequency questionnaire work well to obtain snapshot information about dietary patterns of patients, further studies need to adopt objective means of quantitating dietary patterns.

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