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Investigation on Dietary Lutein Intake and Visual Fatigue in College Students

Yu-ping Ma, Ying-fen Hu, Ai-guo Ma, Yuan-jie Zhang, Yan-ping Wang

School of Public Health, Qingdao University, Shandong 266021, China

Abstract: Objectives: To investigate the correlation between intake of lutein and the occurrence of visual fatigue symptoms in college students. Methods: A total of 428 college students were randomly selected to answer the questionnaires in order to study the influencing factors of visual fatigue symptoms and dietary intake of lutein. Statistical methods such as Wilcoxon test and logistic regression analysis were used for data analysis Results: The median intake of lutein in students was 2.02 mg/d. Dietary lutein was mainly provided by vegetables (93.17%). The incidence rate of visual fatigue was significantly higher in female than in male ($P < 0.05$). The incidence rate of visual fatigue was 76.2%, while the incidence of bulging eyes and vision loss were respectively 46.3% and 39.7% The risk factors of visual fatigue include exposure to screen light (OR = 1.635), myopia (OR = 1.902), and unhealthy habits (OR = 3.369). The protective factors of visual fatigue include male gender (OR = 0.588), outdoor activity (OR = 0.062) and lutein intake (OR = 0.507). Conclusion: The intake of dietary lutein among the students is low, while the incidence rate of visual fatigue is high. The intake of dietary lutein is significantly correlated with the degree of visual fatigue.

Key words: Lutein; Dietary intake; Visual fatigue; College students

Lutein is an internationally recognized "eye nutrients" which cannot be synthesized in the human body. Lutein is obtained mainly through dietary intake in dark green vegetables (such as spinach and kale)[1]. Lutein is the main pigment in the human retinal macula. Besides, lutein has strong antioxidant and free radical scavenging ability. Lutein can effectively filter blue light to prevent light damage, improve the retinal macular pigment density to some extent, and maintain visual health[2]. Lutein has retina protective effect and relieves visual fatigue. Excessive use of eye will lead to excessive consumption of lutein. Insufficient lutein intake will cause eye macular pigment malnutrition, decreasing in compensatory capacity of visual organs, and then lead to bulging eyes, eye pain and a series of visual fatigue symptoms, and even cause age-related macular degeneration, blindness, cataract and other eye diseases[3].

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1. Methods

1.1 Subjects

A total of 434 questionnaires were sent out and 428 valid questionnaires (98.6%) were collected. The subjects are in cluding 277 females and 151 males, age ranged between 17–26 years old. All respondents signed the informed consent forms before investigation.

1.2 Methods

The survey was conducted from April to May of 2016. The questions included general information, eating habits, visual acuity and 3-day dietary survey. Before the survey, college caterers were interviewed to understand the production and weight of various kinds of food. A total of 29 kinds of food, including cereals, vegetables, fruits, meat and fish were purchased from college cafeterias and nearby markets. All kinds of food were weighed and taken pictures.

1.3 Quality control

Pr-survey was conducted before the formal investigation. The questionnaire was revised and several formal modifications were made. The subjects were randomly selected. The official survey combines with live presentations, food pictures and Dietary Reference Intakes to ensure the accuracy of the food intake. Questionnaires were audited and telephone follow-up were carried out if found any problem to ensure the accuracy of the survey results. Dual entry check is used for data entry to ensure accuracy and reliability of data. The objective and accuracy of survey data were controlled through questionnaire design, investigation and implementation of data consolidation and quality control of the whole process.

1.4 Statistical analysis

Excel software was used for data input. SPSS18.0 software was used for data processing and data analysis. The influencing factors of visual fatigue and the intake of lutein were analyzed by Wilcoxon rank sum test. Logistic regression analysis was used to explore the factors related to visual fatigue. $P < 0.05$ indicates the difference was statistically significant.

2. Results

2.1 Dietary lutein intake in college students

2.1.1 Lutein intake

Lutein intake was calculated according to the United States Food Composition Database and some research data of lutein in China. The results showed that the daily intake of lutein in the college students did not meet the normal distribution (W test: $P = 0.00 < 0.05$). The median intake of lutein was 2.02 mg/d, while the specific recommended value of lutein intake in China is 10 mg/d.

2.1.2 Sources of dietary lutein intake

Dietary lutein was mainly provided by vegetables (93.17%), followed by eggs (3.18%) and cereals (2.18%). Fruits and nuts provided less lutein. The main sources of dietary lutein were leeks (37.46%), spinach (20.09%), broccoli (13.45%), baby bokchoy (5.52%), long beans (4.18%) and eggs (3.18%). The main sources of dietary lutein in college students were analyzed. Vegetables were the main source of dietary lutein, especially leeks, spinaches and broccolis. This may be affected by seasonal factors. Daily intake of vegetables of college students are potatoes, tomatoes and

long beans. However, the unit mass of lutein content in these vegetables is low which contributes to less dietary intake of lutein in college students.

2.2 Status and related factors of visual fatigue in college students

2.2.1 Prevalence and related factors of visual fatigue

The subjects were divided into groups according to gender. The prevalence of visual fatigue in college students is 76.2%, while the incidence of bulging eyes and vision loss were respectively 46.3% and 39.7%. The incidence of bulging eyes was significantly higher in females than in males ($P < 0.05$). No significant difference was observed in other visual fatigue symptoms between males and females ($P > 0.05$).Visual fatigue was set as the dependent variable (0 = no visual fatigue symptoms, 1 = with visual fatigue symptoms). The following factors were set as the independent variables: gender (female = 1, male = 2), BMI (<18.5 = 1, 18.5 – 23.9 = 2, 24 – 27.9 = 3, >24 = 4), unhealthy habits (no = 0, yes =1), myopia (no = 0, mild = 1, moderate = 2, severe = 3), eye exercises (never = 0, occasionally = 1, often = 2), outdoor activities (<1 hour = 1, ≧ 1 hour = 2), exposure to screen light (<5 hours = 1, ≧ 5 hours = 2), sleep time (<8 hours = 1, ≧ 8 hours = 2), and lutein intake (<6 mg/d = 1, ≧ 6 mg/d = 2). Single factor logistic regression analysis was used to explore the relationship between risk factors and visual fatigue (Table 1).The main risk factors for visual fatigue were screen light exposure time (OR = 1.635), myopia (OR = 1.902), unhealthy habits (OR = 3.369). Lutein intake (OR = 0.507) and outdoor activities (OR = 0.062) were the protective factors of visual fatigue. The risk for visual fatigue is 0.588 times higher for male.

Table 1 Logistic regression analysis of visual fatigue-related factors

Variable	P	OR	95% CI
X1 Boys	0.044<0.05	0.588	(0.351, 0.985)
X2 BMI	0.755	1.063	(0.725, 1.557)
X3 Unhealthy habits	0.000<0.05	3.369	(1.957, 5.799)
X4 Myopia	0.000<0.05	1.902	(1.468, 2.464)
X5 Eye exercise	0.534	1.159	(0.728, 1.844)
X6 Outdoor activities	0.009<0.05	0.062	(0.435, 0.886)
X7 Light exposure time	0.032<0.05	1.635	(1.042, 2.566)
X8 Sleep time	0.303	1.261	(0.811, 1.961)
X9 Lutein intake	0.006<0.05	0.507	(0.314, 0.819)

2.2.2 The correlation between lutein intake level and visual fatigue

Visual fatigue symptoms were scored by semi-quantitative method: mild (1–2 times/day) = 1 point, moderate (1–3 times/day, improved after taking break) = 2 points, severe (> 3 times/day, improved after taking break) = 3 points. The eye symptoms were graded as: one symptom = Grade 1, 2 symptoms = Grade 2, 3 symptoms = Grade 3, and 4 symptoms = Grade 4. The statistical difference of visual fatigue degree of college students with different lutein intake levels was compared (Table 2).

Table 2 Levels of lutein intake and visual fatigue in college students

	Level	<6 mg/d	≧ 6mg/d	P Value

1	No of cases	133	36	0.012<0.05
	Medium (P25, P75)	2 (1, 2)	1 (1, 2)	
	Rank average	89.54	68.22	
	Z Value	-2.515		
2	No of cases	81	18	0.001<0.05
	Medium (P25, P75)	3 (2, 4)	2 (2, 3.25)	
	Rank average	54.28	30.75	
	Z Value	-3.281		
3	No of cases	31	10	0.002<0.05
	Medium (P25, P75)	6 (4, 7)	4 (3, 4.25)	
	Rank average	24.24	10.95	
	Z Value	-3.092		
4	No of cases	9	9	0.052<0.1
	Medium (P25, P75)	9 (7.5, 10)	7 (6, 8)	
	Rank average	11.89	7.11	
	Z Value	-1.944		

The scores of visual fatigue symptoms of college students increased with the accumulation of eye symptoms. At the test level of $\alpha = 0.05$, there were 1 to 3 visual fatigue eye symptoms, lutein intake level and visual fatigue symptoms were statistically significant differences in $\alpha = 0.1$ test level. The lutein intake and visual fatigue symptoms showed statistically significant difference when emergence of 4 or more visual fatigue eye symptoms.

3. Discussion

Lutein could protect visual function in some degree. It could be observed of the increase of retinal macular pigment density if the lutein intake reaches at 6 mg/d for adults[4]. According to the risk assessment of lutein carried out by the European Food Safety Authority (EFSA) in 2009, the minimum amount of lutein for eye and skin health should be 6 mg/d and 10 mg/d respectively. The results of this study were lower than those of Wang et al. [5] which studied 541 residents aged over 45 years in Beijing and found out that the intake of Xanthophyll in summer and autumn was 10.2 ± 12.9 mg/d. In 2012, Zhang et al. [6] conducted a quantitative food frequency questionnaire survey of 314 Shanghai residents over the age of 40 and found out that the lutein intake was 7.77 ± 2.10 mg/d. This result is close to study of Ma [7], 3-day 24-hour dietary recall survey of 308 urban and rural residents in Qingdao over the age of 18 and found out that the lutein intake was 2.7 mg/d. An American scholar survey of 1297 American from 19 to 30 year olds showed that the mean of lutein intake was 671 ± 55 μg/d [8]. A Spanish scholar carried out 3-day 24-hour dietary recall survey of 54 Spanish from 20 to 35 year olds and found out that the lutein intake was 339.2 μg/d [9]. The lutein intake survey results are quite different, may be due to difference in the survey method, regional, seasonal and other factors.

Long-term exposure to computer screen light may cause visual impairment. Daily exposure to computer screen light is linearly correlated to physical health symptoms, including visual impairment. Logaraj et al. [10] found that the risk of dry

eyes was higher of college students who spent 4-6 hours in computer than those who spent less than 4 hours every day. The present study shows that the average daily screen light exposure time, myopia and unhealthy habits are risk factors of visual fatigue. The incidence rate of visual fatigue was 76.2%, among which 47.0% were bulging eyes, 39.7% were visual acuity, and the incidence of vision loss and dry eyes were also higher. Portello et al. [11] found that eye fatigue in females is much higher than that in males. Logaraj et al. [10] found that the risk was higher for women than men of suffering from computer headache as well as neck and shoulder pain. computer works lead to headache, neck and shoulder pain, and the incidence was significantly higher in women than in men. Han et al. [12] also found that the prevalence of female visual fatigue was higher than male due to the physique of female and the pressure of study and employment.

In conclusion, college students face the dual pressures of learning and employment with long time use of vision. Thus, the incidence of visual fatigue symptoms is higher. College students should consume more lutein-rich food to relieve visual fatigue symptoms, in addition to factors such as the environment and body. This study provides a reference for college students to increase supplement of dietary lutein and to improve the eye health of college students.

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