

## DIETARY SOURCES OF LUTEIN IN ADULTS SUFFERING EYE DISEASE (AMD/CATARACTS)

*Agnieszka Sulich, Jadwiga Hamulka\*, Dorota Nogal*

Chair of Nutritional Assessment, Department of Human Nutrition, Faculty of Human Nutrition and Consumer Sciences,  
Warsaw University of Life Sciences - SGGW, Warsaw, Poland

### ABSTRACT

**Background.** Epidemiological studies indicate that by consuming 6-14 mg lutein daily, the risk of acquiring eye diseases like age-related macular degeneration (AMD) or cataracts becomes reduced. Their symptoms can also by such means be alleviated and treatment improved.

**Objectives.** To estimate dietary intakes of lutein obtained from foodstuffs and supplements along with determining its main sources in selected groups of adults suffering from eye disease and healthy controls.

**Material and Methods.** The study was performed in Warsaw and its neighbourhoods during 2008-12. Subjects were 375 adults aged 50-97 years, of whom half had been diagnosed with AMD and/or cataracts; constituting the test group. Dietary intakes of lutein were assessed by Food Frequency Questionnaire Method whilst interview questionnaires assessed the intake of supplements.

**Results.** Overall, the average dietary intake of lutein from foodstuffs was 2.5 mg daily, with the test group being significantly higher than healthy controls (2.9 vs 2.1 mg daily). Women's intakes were also higher than in men (2.9 vs 2.1 mg daily), as were those possessing higher or secondary education compared to the others with primary or vocational education (2.7 vs 2.3 mg daily). Fresh vegetables were found to be the main dietary sources of lutein that included green leafy vegetables and frozen vegetables, constituting respectively 63% and 13% of the dietary intake. Dietary supplements containing lutein were taken by 109 subjects of whom most had eye disease (over 80%); where the average daily consumption of lutein from this source was 6.5 mg.

**Conclusions.** For older people, the dietary intake of lutein from foodstuffs may be insufficient to prevent eye disease. Taking daily dietary supplements would thus be indicated to make up such deficiencies of lutein.

**Key words:** *lutein, dietary intake, foodstuffs, dietary supplements, eye disease, adults*

### STRESZCZENIE

**Wprowadzenie.** Wyniki badań epidemiologicznych wskazują, że spożycie luteiny w ilościach od 6 do 14 mg na dzień zmniejsza ryzyko wystąpienia chorób oczu typu AMD (zwyrodnienie plamki żółtej związanej z wiekiem) oraz zaćmy, jak również łagodzi ich objawy i wspomaga leczenie.

**Cel badań.** Oszacowanie spożycia luteiny z żywnością i suplementami oraz wskazanie jej głównych źródeł w diecie wybranej grupy osób dorosłych, w kontekście współwystępowania chorób oczu.

**Material i metody.** Badanie przeprowadzono w latach 2008-2012 w Warszawie i okolicach. Badaną grupę stanowiło 375 osób dorosłych w wieku 50-97 lat, przy czym połowa to osoby ze zdiagnozowanymi chorobami oczu tj. AMD i/lub zaćmą. Wielkość spożycia luteiny z produktów spożywczych określono za pomocą metody częstotliwości spożycia zaś z suplementów diety na podstawie wywiadu ankietowego.

**Wyniki.** Średnie spożycie luteiny z żywności w badanej grupie ogółem wynosiło 2,5 mg/dzień i było istotnie wyższe w grupie osób ze zdiagnozowaną chorobą oczu w stosunku do osób zdrowych (2,9 vs. 2,1 mg/ dzień), u kobiet w stosunku do mężczyzn (2,9 vs. 2,1 mg/ dzień) oraz u osób z wykształceniem średnim lub wyższym niż podstawowym lub zawodowym (2,7 vs. 2,3 mg/ dzień). Głównymi żywieniowymi źródłami luteiny były warzywa świeże, w tym: zielone warzywa liściaste, z których pochodziło łącznie 63% tego związku oraz warzywa mrożone (13%). Stosowanie suplementów diety będących źródłem luteiny zadeklarowało 109 respondentów, przy czym były to głównie osoby z chorobami oczu (80%). Średnie spożycie luteiny z suplementów diety wynosiło 6,5 mg/dzień.

\*Corresponding author: Jadwiga Hamulka, Chair of Nutritional Assessment, Department of Human Nutrition, Faculty of Human Nutrition and Consumer Sciences, Warsaw University of Life Sciences – SGGW, Nowoursynowska 159c, 02-776 Warsaw, Poland, phone: +48 22 59 37 112, e-mail: [jadwiga\\_hamulka@sggw.pl](mailto:jadwiga_hamulka@sggw.pl)

**Wnioski.** W grupie osób starszych spożycie luteiny z żywności może być niewystarczające w prewencji chorób oczu. Stąd też, zasadne jest włączenie do ich całodziennej racji pokarmowej suplementów diety będących źródłem luteiny w celu wyrównania jej niedoborów.

**Słowa kluczowe:** luteina, spożycie, żywność, suplementy diety, choroby oczu, osoby dorosłe

## INTRODUCTION

Lutein is one of the most important xanthophylls found in the human body and possesses the unique feature of being able to accumulate in the eyeball, especially the lens and macula. Due to its antioxidant and photo-protectant properties, it shields the eye from oxidative changes and degeneration as well as affording the human body protection against the development of various chronic diseases [1, 3, 16, 23]. Because lutein cannot be synthesised by the human body, a sufficient intake from the diet is essential; whether from foodstuffs or supplements. Many studies have demonstrated that serum lutein concentrations are related to its dietary intake [4, 15, 22]. Furthermore, high lutein tissue levels is a contributing factor for reducing the risk of contracting various diseases, including AMD and cataracts together with affecting visual acuity and alleviating the aforementioned conditions [3, 17, 20].

Despite high dietary intakes being beneficial to health, it is often the case that a low-variety diet poor in vegetables and fruit, particularly in the elderly, does not provide sufficient amounts of lutein. It is therefore important to find out the reason for such deficiencies and the factors affecting the amounts of lutein consumed. In Poland, there is hardly any scientific data published on dietary sources of lutein for adults, especially any that are linked to eye disease (AMD/cataracts), thus the presented study is aimed to address this issue through evaluating lutein dietary intakes from foodstuffs and supplements.

## MATERIAL AND METHODS

The study surveyed 375 adult subjects, aged 50-97 years (mean age  $67 \pm 10$  years) during 2008-2012 who were residing in Warsaw and its environs. The test group consisted of 189 patients (50.4%) attending the Warsaw Clinical Eye Hospital that had been diagnosed with AMD and/or cataracts. Controls were 186 subjects without such disease and who were considered at work as being healthy. In all, there were 207 women (55%) and 168 men (45%). All subjects expressed their approval for taking part in the survey.

Lutein consumption was assessed by means of the food frequency questionnaire method concerning the

month preceding the study day. Average dietary intakes of this carotenoid and the contributing foodstuffs were thereby determined by also using published data of lutein content in foodstuffs [6, 7, 9, 14, 19, 21]. Subjects were additionally requested to complete a questionnaire concerning gender, age, place of residence, education, (ie. demographics), whether lutein containing supplements were taken and their state of health. The dietary supplement data was thus combined with that from the foodstuffs to calculate the joint dietary intakes of lutein daily. Statistical analyses were performed on the Statistica ver. 10 software. The *Shapiro-Wilk* test was used to assess for normality. Significant differences were evaluated between groups by the *Mann-Whitney U* test for two unrelated variables and the *Kruskal-Wallis* test when more than two unrelated variables were considered. A level of  $p \leq 0.05$  was adopted as demonstrating significance.

## RESULTS

The mean dietary intake of total lutein for all subjects amounted to 2.5 mg daily ranging widely between 0.2 to 12.4 mg. In subjects suffering from AMD and/or cataracts (ie. the test group), such intakes were significantly higher than controls; on average by 35% (Table 1). In terms of gender, significantly more women consumed dietary lutein than men (2.9 vs 2.1 mg daily). It was also observed that subjects possessing secondary and higher education significantly consumed more lutein originating from foodstuffs than those others ( $p=0.01$ ). There were however no significant differences observed, when groupings were made according to the other demographic factors, for example age, place of residence etc. It was nevertheless noticed that subjects aged 65-74 years consumed 24-27% more lutein compared to those below 65 years and above 75 years. Dietary supplements were taken by 109 subjects (around 30%) of whom in the test group this constituted 50% but only 10% in the controls. The mean dietary consumption of lutein delivered by supplements was 6.5 mg daily and ranged between 0.3 to 20.0 mg daily (Table 2). In addition, those persons taking lutein containing supplements also ate significantly more of the foodstuffs rich in lutein than those who did not (3.1 vs 2.3 mg daily). Lutein consumption from jointly foodstuffs

Table 1. Effect of demographics on subjects' dietary lutein intake from foodstuffs

Variable	Lutein intake (mg/day)				P-value
	Mean ± SD	P10	P50	P90	
Population in total (n=375)	2.50 ± 1.98	0.71	1.80	5.45	-
Eye diseases:					
Yes (n=189)	2.13 ± 1.80	0.69	1.43	4.66	<0.001*
No (n=186)	2.88 ± 2.09	0.83	2.35	5.93	
Gender:					
Women (n=207)	2.87 ± 2.12	0.79	2.31	5.94	<0.001*
Men (n=168)	2.05 ± 1.70	0.68	1.42	4.37	
Age:					
50 - 64 years (n=153)	2.32 ± 1.95	0.70	1.62	5.10	NS**
65-74 years (n=128)	2.88 ± 2.20	0.85	2.14	6.23	
≥ 75 years (n=94)	2.27 ± 1.64	0.59	1.83	4.80	
Place of residence:					
City >100 thousand inhabitants (n=257)	2.55 ± 1.94	0.82	1.97	5.38	NS*
City < 100 thousand inhabitants (n=118)	2.40 ± 2.07	0.59	1.63	5.80	
Education:					
Primary and vocational (n=171)	2.28 ± 1.92	0.63	1.6	5.14	0.01*
Secondary and higher (n=204)	2.68 ± 2.03	0.81	2.11	5.70	

SD - standard deviation; P10 - 10th percentile; P50 - 50th percentile; P90 - 90th percentile

\*Mann-Whitney U test; \*\*Kruskal-Wallis test (p≤0.05)

and supplements amounted to a mean of 9.6 mg daily, of which 68% were derived from supplements. Other factors like eye disease, gender, age, place of residence and education were also found to significantly affect the level of dietary lutein consumption from supplements.

The many dietary foodstuff sources of lutein were fresh vegetables (63%), including green leafy vegetables; Table 3. Apart from these vegetables, another significant source of this xanthophyll were frozen and processed vegetables, respectively 13% and 5%. The remaining foodstuffs such as fruit, fruit products, cereal products and eggs delivered significantly less lutein; in total up to 6% of the daily dietary intake. When accounting for persons suffering from both eye diseases (ie. AMD and cataracts), then they consumed significantly more lutein derived from fresh vegetables, (mainly from green leafy vegetables and fruit), compared to controls, (mean 2.0 vs 1.4 mg daily). The healthy controls however ate significantly more lutein derived from cereal products and eggs than those with eye disease; 0.4 vs 0.3 mg daily.

## DISCUSSION

The presented study demonstrates that those suffering from eye disease (AMD/cataracts) consumed significantly more dietary lutein from foodstuffs than the healthy controls. Analogous findings were reported by *Khachik et al.* [15], where subjects afflicted by AMD consumed 29% more lutein compared to healthy persons (3.0 vs 2.0 mg daily). Lower dietary intakes of lutein from defined foodstuffs in Polish subjects, (estimated as 1.78 mg daily), were however noted from a study using data from the Central Statistical Office in Poland [10]. Nonetheless, a subsequent study on n=512 Polish adults found average dietary intakes of lutein to be somewhat

Table 2. Dietary intakes of lutein from foodstuffs and supplements according to presence/absence of eye disease

Subject	Lutein intake (mg/day)			P-value
	total population	no eye diseases	eye diseases	
Foodstuffs without supplements:				
	(n=266)	(n=170)	(n=96)	
Foodstuffs	2.28 ± 1.82 <sup>1</sup>	2.08 ± 1.79	2.64 ± 1.83	0.001*
	1.64	1.38	2.15	
	0.21 - 8.84	0.27 - 8.64	0.21 - 8.84	
Foodstuffs with supplements				
	(n=109)	(n=19)	(n=90)	
Foodstuffs	3.05 ± 2.25	2.62 ± 1.89	3.14 ± 2.32	NS
	2.55	1.89	2.60	
	0.32 - 12.43	0.50 - 7.62	0.32 - 12.43	
Supplements	6.52 ± 5.23	6.60 ± 6.85	6.50 ± 4.93	NS
	6.00	3.00	6.00	
	0.25 - 20.00	0.25 - 20.00	0.25 - 20.00	
Together	9.57 ± 5.80	9.21 ± 7.09	9.64 ± 5.53	NS
	7.82	7.03	8.03	
	1.41 - 32.43	2.19 - 24.37	1.41 - 32.43	

<sup>1</sup> Mean ± standard deviation, median, range; \*Mann-Whitney U test (p≤0.05)

Table 3. Sources of dietary lutein from foodstuffs according to presence/absence of eye disease

Products	Study population						P-value <sup>2</sup>
	total population (n=375)		no eye diseases (n=189)		eye diseases (n=186)		
	Lutein intake						
	mg/day	%	mg/day	%	mg/day	%	
Fresh vegetables, sub-divided:	1.58 ± 1.48		1.27 ± 1.29		1.89 ± 1.59		<0.001
	1.06	63.2	0.74	59.9	1.50	65.7	
green leafy vegetables	0.87 ± 1.16		0.64 ± 0.98		1.11 ± 1.27		<0.001
	0.38	34.9	0.19	30.0	0.68	38.7	
other vegetables	0.62 ± 0.54		0.54 ± 0.49		0.70 ± 0.58		0.005
	0.46	24.7	0.39	25.4	0.53	24.1	
potatoes	0.09 ± 0.07		0.10 ± 0.07		0.08 ± 0.06		NS
	0.08	3.6	0.08	4.5	0.07	2.9	
Frozen vegetables	0.32 ± 0.76		0.23 ± 0.67		0.40 ± 0.84		NS
	0.0	12.7	0.0	10.9	0.0	14.1	
Processed vegetables	0.12 ± 0.18		0.11 ± 0.20		0.13 ± 0.17		NS
	0.03	4.8	0.02	5.2	0.05	4.5	
Legume seeds	0.03 ± 0.10		0.04 ± 0.13		0.02 ± 0.06		NS
	0.0	1.1	0.0	1.7	0.0	0.7	
Fruit	0.12 ± 0.18		0.10 ± 0.16		0.14 ± 0.20		<0.001
	0.07	4.7	0.05	4.6	0.09	4.7	
Processed fruit	0.04 ± 0.09		0.03 ± 0.06		0.05 ± 0.11		NS
	0.01	1.6	0.0	1.6	0.01	1.7	
Cereal products	0.16 ± 0.10		0.17 ± 0.11		0.13 ± 0.09		0.001
	0.13	6.0	0.15	7.9	0.11	4.5	
Eggs	0.15 ± 0.14		0.18 ± 0.16		0.12 ± 0.10		0.001
	0.11	5.9	0.13	8.2	0.11	4.1	
	0.0 - 0.88		0.0 - 0.88		0.0 - 0.80		

<sup>1</sup> Mean ± standard deviation, median, range; \*Mann-Whitney U test (p<0.05)

higher at 2.7 mg daily [12]. Studies from abroad have yielded a wide range of such values, lying from 1.4 to 3.3 mg daily, which were dependent on the location, study duration, dietary habits and socio-demographic factors [2, 18]. In our study, the factors that significantly differentiated the subjects into groups were found to be gender and education.

Women consumed 38% more lutein than men. A USA study showed similar results for 98 subjects aged 45-73 years, where women consumed 20% more lutein than men (1.8 vs 1.5 mg daily) [5], whilst those with secondary and higher education consumed 18% more than the others. The impact of education was also observed by Hamulka et al. [12] with subjects possessing higher education consuming 23% more lutein than those with primary education. Such differences could have arisen from the higher educated group being more aware of nutritional issues.

Fresh or processed vegetables were found to be the main source of dietary lutein (80%) of which the most was supplied by fresh green leafy vegetables (35%) and the other remaining vegetables (25%). Related studies in Poland showed similar findings. According to Hamulka et al. [10], vegetables were the principal dietary source of lutein (at 64%) daily. A USA study by Bermudez et al. [2] demonstrated spinach, broccoli and iceberg lettuce as being the main dietary sources of lutein. Both our study and others, however indicate that fruit, cereal products and eggs were of less importance as dietary sources of lutein; constituting no more than 8% of its total dietary intake [10, 12].

The average lutein intake in subjects derived from taking dietary supplements was 9.6 mg daily with single lutein doses most commonly being 3 or 6 mg. Those with AMD or cataracts predominantly took the following supplements, as recommended by their opticians;



‘OcuVite Lutein’, ‘Nutrof’ and ‘VitaLux plus’. Like findings were observed by *Hamulka and Nogal* [11] where the main reason for taking such supplements were because of opticians’ advice, usually recommending 6 mg single doses. Nevertheless, most other studies don’t take into account the dietary lutein intake derived from supplements. There are however many studies devoted to the effect of dietary lutein from supplements on concentrations of lutein in the serum and eye macula, together with determining the efficacy of various supplements. Studies by *Rosenthal et al.* [22] and *Khachik et al.* [15] reported a proportionally higher increase in blood lutein when taking large doses of lutein from supplements. Similar results were demonstrated by *Bone et al.* [4] which revealed a positive dependence between lutein doses taken from supplements (5 to 20 mg) with blood concentrations and optical density of pigment in the eye macula.

Despite many studies showing the beneficial effects of lutein on the human body, standard daily intakes have not yet been established nor have the upper safety limits been set [13]. Nonetheless, epidemiological studies indicate that taking 6 to 14 mg of lutein in the daily diet decreases the risk of eye diseases such as AMD or cataracts as well as in alleviating their symptoms if present [1, 8, 24]. It would seem from both our study and in others, that a diet with little variation, especially in the elderly, leads to lutein deficiency. For this reason it becomes necessary for lutein to be delivered from supplements, thus making up any deficiencies, particularly in high risk groups ie. those in whose families suffer from AMD and/or cataracts, in the elderly or persons actually diagnosed with the aforesaid eye conditions.

## CONCLUSIONS

1. Overall, dietary intakes of lutein from foodstuffs were 2.5 mg daily, but were significantly higher in subjects suffering from AMD and/or cataracts as well as in women and those possessing secondary or higher education.
2. The main dietary sources of lutein were fresh vegetables, including green leafy vegetables (supplying 63%) and frozen vegetables (at 13%).
3. Dietary food supplements containing lutein were mainly taken by those subjects diagnosed with AMD and/or cataracts. Their average daily consumption being 6.5 mg; constituting 68% of the dietary intake.
4. Dietary intakes of lutein may be deficient in the elderly for preventing eye disease, especially AMD and cataracts. It is therefore necessary to make up any dietary deficiencies for high risk groups by daily taking suitable supplements.

## Conflict of interest

*The authors declare no conflict of interest.*

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