

EVALUATION OF VITAMINS A, C AND E CONTENT IN DIETS OF ADOLESCENTS LIVING IN WARSAW, POLAND

Ewa Dybkowska*, Bożena Waszkiewicz-Robak, Edyta Piekot

Faculty of Human Nutrition and Consumer Sciences, Department of Functional Foods and Commodity, Warsaw University of Life Sciences, Warsaw, Poland

ABSTRACT

Background. Antioxidant vitamins such as *alpha*-tocopherol (vitamin E), ascorbic acid (vitamin C), and *beta*-carotene (provitamin A), play a significant role in protecting the body from an excess of free radicals. The vitamin content of the diet is thus very important.

Objective. To assess whether the dietary intake of vitamins A, C and E is adequate in a selected group of adolescents living in Warsaw.

Material and methods. The mean vitamin consumption was estimated using three-day dietary records whilst vitamin contents of selected foodstuffs were obtained from Food Composition Tables. Both were related to Polish nutrition standards applied to adolescents; i.e. EAR (Estimated Average Requirement) for vitamins A and C and AI (Adequate Intake) for vitamin E.

Results. Dietary vitamin C in adolescents and vitamin E in girls were around 18-25% lower than that recommended. Diets that were deficient in vitamins C and E were recorded in 47% to 67% adolescents.

Conclusions. It is therefore necessary to increase the consumption of vegetables and fruit which provide a valuable dietary source for these vitamins.

Key words: *vitamins, antioxidants, intake, adolescents, nutrients*

STRESZCZENIE

Wprowadzenie. Witaminy antyoksydacyjne – *alfa*-tokoferol (witamina E), kwas askorbinowy (witamina C) i *beta*-karoten (prowitamina A) pełnią istotną rolę w ochronie organizmu przed wolnymi rodnikami, dlatego odpowiednia zawartość tych witamin w diecie ma istotne znaczenie.

Cel. Celem badań była ocena poziomu spożycia witamin A, C i E z produktami spożywczymi w wybranej grupie młodzieży zamieszkałej na terenie Warszawy.

Materiał i metody. Średnie spożycie witamin oszacowano na podstawie badań przeprowadzonych metodą trzydniowego bieżącego notowania spożycia produktów spożywczych oraz przy zastosowaniu tabel wartości odżywczej produktów spożywczych i odniesiono do polskich norm dla młodzieży ustalonych na poziomie średniego zapotrzebowania (EAR) dla witamin A i C oraz na poziomie wystarczającego spożycia (AI) dla witaminy E.

Wyniki. Zawartość witaminy C w diecie młodzieży oraz witaminy E w diecie dziewcząt była o około 18-25% niższa od zalecanej. Diety ubogie w witaminę C i E spożywało około 47-67% młodych osób.

Wnioski. Istnieje potrzeba zwiększenia spożycia warzyw i owoców, jako ważnych źródeł tych witamin w diecie.

Słowa kluczowe: *witaminy, antyoksydanty, spożycie, młodzież, składniki odżywcze*

INTRODUCTION

Vitamins A, C and *beta*-carotene (a vitamin A precursor) are considered as being antioxidant nutrients and are widely found in plant or plant derived foodstuffs. Their potential health promoting properties are well recognised and they play a major role in affording

the body protection against an excess of free radicals in plasma [2, 14, 32]. It is also well documented that diet-derived antioxidants have a significant impact on human health. Lowering the prevalence of some forms of cancer has been demonstrated to be another important and beneficial effect of a diet rich in fruit and vegetables containing these vitamins i.e. *alpha*-tocopherol ascorbic

* **Corresponding author:** Ewa Dybkowska, Department of Functional Foods and Commodity, Chair of Functional Food and Commodities, Faculty of Human Nutrition and Consumer Sciences, Warsaw University of Life Sciences (SGGW), Nowoursynowska street 159C, 02-776 Warsaw, Poland, phone: +48 22 5937040, e-mail: ewa_dybkowska@sggw.pl

acid and beta-carotene [9, 14, 15]. Furthermore, effective antioxidant action has been shown to be dependent on the concentrations and different combinations of these vitamins present [2]. It is therefore vital, that appropriate doses of these substances are consumed from the diet. Most early studies in Poland have yielded inconsistent results, where findings have differed according to region [21, 26]. These suggested that vitamin C intake was deficient in some of these regions [18, 21], however the vitamin E data was conflicting [18, 21, 26]. It had also been suggested that the dietary content of such vitamins depended on the region, nutritional habits/behaviour and financial status of those subjects studied. The presented study thus aimed to extend this research in order to gain a clearer and more complete picture. Study objectives were to assess the dietary content of the antioxidant vitamins (i.e. A, C and E) in a selected group of adolescents residing in Warsaw as well as determining the dietary sources of these vitamins.

MATERIAL AND METHODS

Dietary vitamin intakes were estimated from 3-day dietary records. Volunteer pupil subjects were recruited from junior high schools (middle schools) and high schools in various districts of Warsaw (i.e. Mokotów, Ursynów and Bielany). Pupils from each school were divided into 4 age groups and also by gender. The study was performed during the autumn and winter. The survey was anonymous and 360 questionnaires were distributed, of which 96 replies were received; 17 were however rejected because of being incorrectly filled in. The total sample was thus 78 subjects who were aged 13-18 years. Of these there were 62% girls and 38% boys and the largest group were girls aged 16-18 years constituting 33% of total. Table 1 provides the anthropometric data for the girl and boy pupils.

Table 1. The anthropometric characteristic of girl and boy subjects (mean \pm standard deviation)

Parameters	Girls (n = 48)	Boys (n = 30)
Age [years]	15.21 \pm 1.53	15.63 \pm 1.52
Body weight [kg]	52.27 \pm 8.63	68.58 \pm 10.24
Height [cm]	164.38 \pm 7.08	177.07 \pm 10.41
BMI [kg/m ²]	19.29 \pm 2.50	21.85 \pm 2.60

Table 2. The nutrient intake in daily diets of girl and boy subjects (mean \pm standard deviation) and Nutritional Standards for vitamins for the Polish population for girls and boys aged 13-18

Component	Girls	EAR / AI	Boys	EAR/AI
Energy [kcal]	1603.16 \pm 469.16		2369.87 \pm 713.61	
Vitamin A* [μ g]	634.77 \pm 347.61***	490	871.08 \pm 518.97***	630
Vitamin E** [mg]	6.59 \pm 2.52***	8	10.63 \pm 5.47***	10
Vitamin C* [mg]	41.48 \pm 26.79	55	52.44 \pm 35.04	65

* Estimated Average Requirement (EAR)

** Adequate Intake (AI)

*** p<0.001

The mandatory proportion of working days to holidays were observed in all cases. Food Composition Tables were used to calculate vitamin content. The observed dietary intakes were related to ratios, derived from Polish Nutritional Standards applied to the adolescent population, of the EAR for vitamins A and C and the AI for vitamin E (Table 2). The observed weighted-mean vitamin intakes in the adolescent subjects were compared to Polish Nutritional Standards from which 90% of the EAR/AI ratios were determined and found to be borderline [11]. The percentage of subjects consuming vitamin deficient diets (i.e. below 90% of the EAR/AI) were also compared to the Standards. In addition, the main dietary sources of the test vitamins are presented as estimated from analysing the dietary composition of the subjects' menu.

RESULTS

The average dietary content of vitamin A in girls was found to be 634.77 μ g whilst that for boys was 871.08 μ g (Table 2). These both exceeded the average requirement by 29.5% and 38.3% respectively (Figure 1).

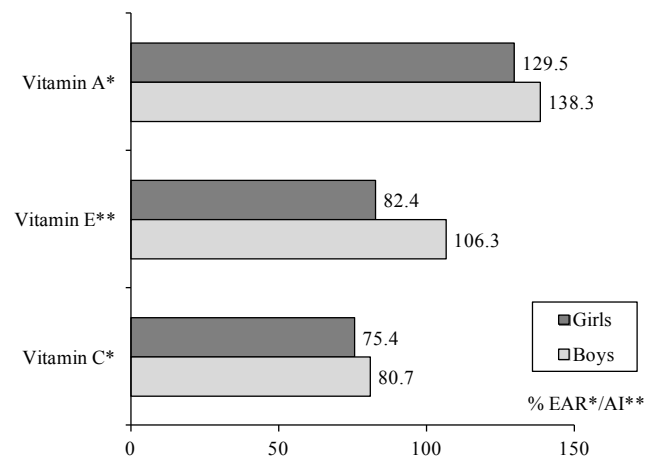


Figure 1. Average content of dietary vitamins in adolescent subjects surveyed in Warsaw as compared to EAR*/AI** standards

The average dietary intake of vitamin E in girls was 6.59 mg which was therefore 17.6% less than the AI. For boys, the corresponding value was 10.63 mg which

was sufficiently close to be adequate. A low intake of vitamin C was observed when the subjects' menus were analysed; 41.48 mg for girls (i.e. 24.6% below the EAR) and 52.44 mg for boys (19.3% below the EAR).

In general, the girl subjects consumed significantly less vitamin A and E than boys (Table 2), however there were no trends observed for vitamin C. The percentage of subjects eating vitamin deficient diets are shown in Figure 2. Here it was found that 67% of all subjects consumed vitamin C deficient diets below the 90% EAR and that 60% girls and 47% boys ate vitamin E deficient diets below 90% of the AI.

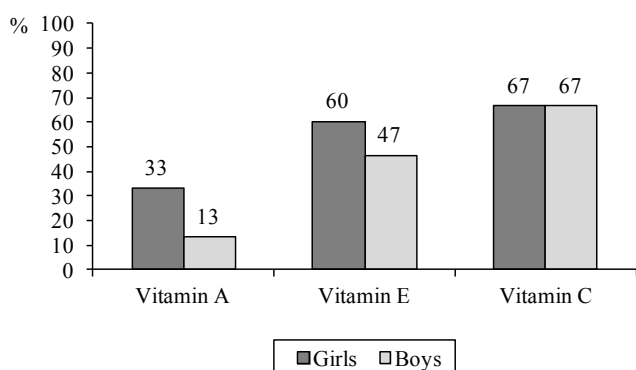


Figure 2. The percentage of adolescent subjects with vitamin-deficient diets

Vegetables were found to be the main dietary source of vitamin C (53%), followed by fruit (31%), with other foodstuffs supplying the remaining 16%. Dietary vitamin E was derived from fats (26%), vegetables (21%), meat and its products (15%), fruit (12%), confectionery (12%) and other products (14%). Vitamin A in the diet originated from vegetables (39%), milk and dairy products (18%), fats (12%), meat and its products (11%), whilst other foodstuffs such as eggs, fruit and cereals supplied the remainder (20%). The low dietary intakes of vitamin C observed was from consuming not nearly enough vegetables or fruit of any kind. The high dietary levels of vitamin E seen in boys was due to high fat consumption. Nevertheless, the relatively high vitamin A intakes were mostly derived from a substantial consumption of fats, offal and vegetables rich in beta-carotene.

In summary, the presented study indicated a significant variation amongst a sample of adolescent pupils in their dietary intake of the studied antioxidant nutrients vitamins A, C and E. Excluding vitamin C, gender was found to be an important factor in determining the observed trends. Nonetheless, the intake of vitamin C, via its main dietary source of fruit and vegetables, should be increased because of its crucial role in maintaining the body's health.

DISCUSSION

The presented vitamin A results demonstrate that dietary vitamin A deficiency is relatively rare, consistent with other Polish studies of a similar nature. In both these cases, average intakes exceeded those recommended. Indeed, high dietary contents of vitamin A have been extensively observed in adolescent pupils [13, 31, 18, 20, 25], students [6, 8, 10, 22, 29] and adults [1, 3, 4, 7, 21, 29, 30]. Other related studies conducted on Warsaw students [8] and schoolchildren [31] (both females and males) also showed close agreement for dietary intakes of vitamin A compared to the presented results. It was generally found that the average dietary content of this vitamin, in girls and women of all ages, had exceeded recommended intakes by 20 - 50% [1, 6, 8, 18, 25, 29], however other studies have demonstrated even higher levels of vitamin A consumption in women [3, 7, 10, 22, 30] that exceeded 1000µg. Furthermore, studies conducted on men and boys also showed a high dietary vitamin A content, often surpassing 1000 µg [3, 6, 13, 18, 20, 22, 25]. In contrast to these findings, a study performed by *Smorzewska-Czupryńska* et al. [26] found that the diets of adolescents living in the Białystok region of Poland had low vitamin A levels in their diets.

The current study showed that the diets of girls were deficient in vitamin E, consistent with other reported studies [5, 25, 26, 27, 29]. However, similar studies indicate that the diet of girls and women sufficiently covers vitamin E requirements [1, 3, 6, 7, 13, 18, 20, 21, 22]. It was found that boys obtained enough vitamin E from their diets according to requirements, which was confirmed in previous studies on the nutrition of schoolchildren [13, 18] and students [6, 22].

Deficient dietary vitamin C intakes have been demonstrated in some studies [4, 21], however other findings have been equivocal [6, 13, 18, 23, 27, 28]. A study by *Wolnicka* and *Taraszevska* confirmed high dietary vitamin deficiencies in children, where over half were discovered to be at risk from vitamin E and C deficiencies [31].

Results from other countries gave similar results. Significant dietary deficiencies in vitamin C were observed in Warsaw adolescents whereas in other EU countries the dietary content of vitamin C was much higher [12, 16, 17, 19, 24]. In the case of dietary vitamin E, girls from Germany consumed higher amounts than Polish girls from Warsaw, however there was no difference between boys [24]. Adolescent diets in Greece, generally showed a relatively high content of this vitamin. Compared to Polish adolescents from Warsaw, those in the United States, Germany, Greece and Turkey demonstrated higher contents of Vitamin A [12, 17, 19,

24], whilst lower contents were observed in diets of equivalent subjects from Korea [19].

It is well recognised that dietary antioxidants derived from plants play an active role in affording protection against cancer and arteriosclerosis [9]. An adequate dietary intake of vitamins A, C and E has been shown to limit the harm caused by pro-oxidative processes and so may prevent various disease [9, 14]. Inadequate dietary intakes of these vitamins may thus significantly contribute towards an increased risk of cardiovascular disease and cancer. It is therefore important that diets contain sufficient quantities of these vitamins.

CONCLUSIONS

1. A dietary deficiency of antioxidant nutrients was observed in Polish adolescent subjects under study, especially for vitamin C and E. These surveyed diets were all deficient in C, and dietary vitamin E in girls was lower than the Polish Nutritional Standard values. Vitamin A intakes were found to be 29 - 38% higher than those recommended.
2. Dietary vitamin E deficiencies were observed in a significant number of subjects (ranging 47 - 67 %).
3. The observed dietary deficit in vitamin C resulted from a too low consumption of fruit and vegetables.
4. The dietary consumption of vitamins C and E needs to be increased.

Conflict of interest

The authors declare no conflict of interest.

REFERENCES

1. Bronkowska M., Biernat J., Sadowska B.: Assessment of contents of vitamins in daily food rations of postmenopausal women. *Bromat Chem Toksykol* 2009;42:18-23 (in Polish).
2. Chen J., Shi J., Macnaughton L., Kakuda Y., Xue S.J., Ma Y., Zhang M., Jiang Y.: The scavenging capacity of combinations of lycopene, β -carotene, vitamin E, and vitamin C on the free radical 2,2-diphenyl-1-picrylhydrazyl (DPPH). *J Food Biochem* 2009;33: 232-245.
3. Czapska D., Ostrowska L., Stefańska E., Karczewski J.: Assessment of selected vitamins content in daily food rations of obese patients. *Rocz Panstw Zakl Hig* 2009;60:381-383 (in Polish).
4. Dybkowska E., Świdorski F., Waszkiewicz-Robak B.: Vitamin intake in an average diet of Warsaw adult inhabitants. *Rocz Panstw Zakl Hig* 2007;58:211-215 (in Polish).
5. Gacek M.: Estimation of the level of nourishing ingredients intake in a group of young women doing fitness as recreation. *Rocz Panstw Zakl Hig* 2009;60:375-379 (in Polish).
6. Gil M., Głodek E., Rudy M.: Evaluation of the dietary intake of vitamins and minerals in the daily food rations by the students of the Rzeszów University. *Rocz Panstw Zakl Hig*, 2012;63:441-446 (in Polish).
7. Górna I., Drabowicz E., Przysławski J.: Assessment of chosen vitamins and minerals content in daily food rations groups of women with fertility. *Bromat Chem Toksykol* 2012;45:1060-1064 (in Polish).
8. Górnicka M., Pindral J., Hamulka J., Wawrzyniak A.: Evaluation of antioxidant vitamins intake by students of Warsaw University of Life Science. *Rocz Panstw Zakl Hig* 2011;62:357-468 (in Polish).
9. Grajek W.: Role of antioxidants in reducing the occurrence risk of cancer and cardiac vascular diseases. *Zywn Nauk Technol* 2004;38:3-11 (in Polish).
10. Harton A., Myszkowska-Ryciak J.: The assessment of dietary intake of female students of Warsaw University of Life Sciences. *Bromat Chem Toksykol* 2009;42:610-614 (in Polish).
11. Jarosz M., Stoś K., Walkiewicz A., Stolińska H., Wolańska D., Gielecińska I., Wierzejska R., Kłys W., Przygoda B., Iwanow K.: Vitamins. In: Polish Dietary Reference Intakes (new). Ed. M. Jarosz, National Food and Nutrition Institute, Warsaw 2012 (in Polish).
12. Klimis-Zacas D. J., Kalea A. Z., Yannakoulia M., Matalas A. L., Vassilakou T., Papoutsakis-Tsarouhas C., Yiannakouris N., Polychronopoulos E., Passos M.: Dietary intakes of Greek Urban adolescents do not meet the recommendations. *Nutr Res* 2007;27:18-26.
13. Kolmaga A., Godala M., Trafalska E.: The assessment of the intake of vitamins and minerals from the diet and dietary supplements in a group of 12-13-year-old children from the Lodz schools. *Żyw Człow Matab* 2009;36:40-47 (in Polish).
14. Lobo V., Patil A., Phatak A., Chandra N.: Free radicals, antioxidants and functional foods: Impact on human health. *Pharmacogn Rev* 2010;8:118-126.
15. Markowska A., Mardas M., Stelmach-Mardas M.: The influence of nutritional factors on cancer development, *Onkol Pol* 2010;13:191-195 (in Polish).
16. Matthys Ch., De Henauw S., Maes L., De Bacquer D., Verbeke W., De Backer G.: Adolescents' education and their diet by 7-day food record. *Soz Preventiv Med* 2006;51:80-90.
17. Oner N., Vatanserver U., Garipagaoglu M., Karasalioglu S.: Dietary intakes among Turkish adolescent girls. *Nutr Res* 2005;25:377-386.
18. Ostrowska A., Szewczyński J., Gajewska M.: Nutritive value of daily food rations of students of secondary schools in mazowieckie province. Part II. Mineral elements and vitamins. *Żyw Człow Matab* 2003;30:367-371 (in Polish).
19. Park S., Paik H., Skinner J. D., Spindler A. A., Park H. R.: Nutrient Intake of Korean-American, Korean, and American Adolescents. *J Am Diet Assoc* 2004;104:242-245.
20. Piotrowska E., Mikołajczak J., Biernat J., Żechalko-Czajkowska A.: Assessment of food intake of 16-18 year-old girls living in Wrocław and its neighbourhood with reference to the risk of developing diet-related diseases.

- Part II: Vitamins and mineral components. *Bromat Chem Toksykol* 2012;45:49-58 (in Polish).
21. *Przybyszewska J., Waluś A., Jaworowska A.*: An evaluation of the level of intake of selected vitamins among students in Poznan on the background of other studies. *Żyw Człow Matab* 2005;32:339-345 (in Polish).
 22. *Przysławski J., Bolesławska I., Kaźmierczak A.*: An evaluation of the level of intake of selected vitamins among students in Poznan on the background of other studies. *Bromat Chem Toksykol* 2012;45:1183-1189 (in Polish).
 23. *Reguła J., Woźniewicz M.*: Nutritive value of diets and nutritional status in girls and boys aged 12-15 years from region Wielkopolska. *EJPAU*, 2008;11:10.
 24. *Sichert-Hellert W., Kersting M., Manz F.*: Changes in time-trends of nutrient intake from fortified and non-fortified food in German children and adolescents – 15 year results of the DONALD Study. *Z Ernährungswiss* 2001;40:49-55.
 25. *Sitko D., Wojtaś M., Gronowska-Senger A.*: Food patterns of youth from gymnasium and lyceum. *Rocz Panstw Zakl Hig* 2012;63:319-327 (in Polish).
 26. *Smorzewska-Czupryńska B., Ustymowicz-Farbiszewska J., Karczewski J., Lach J.*: Comparison of the content of antioxidative vitamins in the diets of primary schoolchildren from Białystok and its vicinity, *Rocz Panstw Zakl Hig* 2003, 54, 409-415 (in Polish)
 27. *Stefańska E., Ostrowska L., Czapska D., Karczewski J.*: Assessment of vitamin content in daily food rations of women with normal body weight, overweight and obesity. *Zywn Nauk. Technol. Ja* 2009;65:286-294 (in Polish).
 28. *Terlikowska K. M., Dobrzycka B., Witkowska A., Zujko M. E.*: The assessment of intake of chosen vitamins and minerals provided with the diet among women aged 40-73 in relation to the risk of cardiovascular diseases. *Bromat Chem Toksykol* 2013;46:27-32 (in Polish).
 29. *Ustymowicz-Farbiszewska J., Smorzewska-Czupryńska B., Broż K., Wierzbicka J., Karczewski J.*: Content analysis of fat-soluble vitamins in daily food rations (DFR) of female students at Faculty of Health Sciences of Medical University of Białystok. *Bromat Chem Toksykol* 2011;44:453-458 (in Polish).
 30. *Waśkiewicz A., Sygnowska E.*: Nutrient intake in diet of polish women in reproductive age. *Rocz Panstw Zakl Hig* 2009;60:275-278 (in Polish).
 31. *Wolnicka K., Taraszewska A.*: Assessment of the vitamin and mineral content in the daily food intake of pupils from primary schools in Warsaw. *Probl Hig Epidemiol* 2012;93:408-413 (in Polish).
 32. *Zabłocka A., Janusz M.*: The two faces of reactive oxygen species. *Post Hig Med Dosw* 2008;62:118-124 (in Polish).

Received: 09.10.2013

Accepted: 14.12.2013

