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DIETARY INTAKE OF ANTIOXIDANT VITAMINS IN HEALTHY ADULTS IN RELATION TO CURRENT RECOMMENDED INTAKE

Beata Jabłonowska-Lietz[1], Agnieszka Jarosz[1], Grażyna Nowicka[2]

[1] Promotion Centre of Healthy Nutrition and Physical Activity, National Food and Nutrition Institute, Warsaw, Poland
[2] Medical University of Warsaw, Warsaw, Poland

ABSTRACT

Background. The health benefits arising from antioxidant vitamins A, C and E are well recognised and their recommended dietary intake for the general population have been established. However, there is still a need for assessing antioxidant vitamin intake in different population groups.

Objective. To assess intake of antioxidant vitamins: A, C, E and β-carotene, and to identify their major sources in the diets of healthy subjects.

Material and methods. The study group consisted of 182 adults; both men and women from polish population. Antioxidant vitamin dietary intake was assessed by individual 3-day records. Data were analysed using updated "Polish Food Composition Tables" and 'Dieta 5' Software.

Results. The average daily intake of antioxidant vitamins was: 1076 mg for vitamin A (including 46% of retinol and 55% of β-carotene), 107 mg for vitamin C and 9 mg for vitamin E. Higher dietary intake of these vitamins was observed in men compared to women.

Conclusions. The average intake of antioxidant vitamins was found to be in recommended range, however, significant differences were observed between the lowest and the highest intake. They were related to differences in the consumption of food products recognized as major sources of vitamins A, C, E and β-carotene in study population.

Key words*: antioxidant vitamins, dietary intake, food sources*

STRESZCZENIE

Wprowadzenie. W dobie nieustannego narażenia organizmu na działanie wolnych rodników, prawidłowe działanie układu antyoksydacyjnego, a tym samym dostarczanie wraz z dietą witamin oksydacyjnych w ilościach odpowiadających zapotrzebowaniu, odgrywa kluczową rolę w zapobieganiu licznych chorób cywilizacyjnych.

Cel badań. Celem pracy była ocena spożycia witamin antyoksydacyjnych, ze szczególnym uwzględnieniem witamin A, C i E oraz β-karotenu, a także wskazanie ich źródeł w diecie badanych.

Materiał i metody. Badania przeprowadzono w grupie 182 dorosłych osób. Oceny spożycia witamin dokonano w oparciu o trzydniowe zapisy spożycia. Dane analizowano przy użyciu programu komputerowego „Dieta 5" oraz Tabel składu i wartości odżywczej żywności.

Wyniki. Średnie dzienne spożycie witamin antyoksydacyjnych wyniosło: dla witaminy A - 1076 µg, (z czego 46% z retinolu a 55% z β-karotenu), dla witaminy C - 107 mg, oraz dla witaminy E - 9 mg, przy wyższych poziomach spożycia u mężczyzn niż u kobiet.

Wnioski. Średnie spożycie witamin antyoksydacyjnych odpowiadało zaleceniom, jednak sszczegółowa analiza wyników wykazała istnienie dużych rozbieżności między niskim a wysokim poziomem spożycia tych witamin, związanych z istotnymi różnicami w zakresie konsumpcji produktów będących głównymi źródłami witamin A, C i E oraz β-karotenu.

Słowa kluczowe: *witaminy antyoksydacyjne, spożycie, źródła pokarmowe*

INTRODUCTION

The human body is constantly subjected to the action of free radicals arising from either metabolism or the environment. It is therefore paramount that the antioxidant system functions correctly in order to prevent development of any pathological processes caused by free radicals, that may lead to many diseases including cardiovascular diseases and cancer [14, 15]. Antioxidant vitamins together with enzymes and endogenous

Corresponding author: Beata Jabłonowska-Lietz, Promotion Centre of Healthy Nutrition and Physical Activity, National Food and Nutrition Institute, Powsińska str. 61/63, 02-903 Warsaw, Poland, phone: +48 22 55 09 711, fax: +48 22 842 11 03, e-mail: bjablonowska@izz.waw.pl

antioxidants contribute in halting harmful oxidative processes and to forestall lipid peroxidation as well as oxidation of protein and nucleic acids.

The fat soluble vitamin A and its provitamin, β-carotene as well as vitamin E, function as antioxidants in hydrophobic environments as found in cell membranes and plasma lipoproteins, whereas the water soluble vitamin C acts as an antioxidant in hydrophilic environments such as in the cytoplasm and extracellular fluid [2, 20]. An adequate supply of these vitamins is therefore necessary to cover an individual's requirement for antioxidants.

More and more studies demonstrate the important value of an appropriate diet being the source of natural vitamins compared to synthetic ones. Increased doses of antioxidants from natural sources have been found to significantly reduce the risk of cancer [5, 7, 8]. In contrast, enhanced intake of vitamin supplements, that are obtained synthetically, has been shown to a increase the risk of some types of cancer [1, 11, 16, 17].

The aim of the study was to assess the consumption of antioxidant vitamins: A, C, E and β-carotene and defining their dietary sources.

MATERIALS AND METHODS

Antioxidant vitamins consumption data were obtained from a survey of 182 adult volunteers, (129 women [70%] and 53 men [30%]). The study subjects did not take dietary supplements and all females were neither pregnant nor lactating.

Dietary intake was estimated through a 3day food record, that consisted of 2 non-sequential weekdays and one day from the weekend. Subjects had previously been trained by a professional dietician on how to assess the sizes of portions consumed by means of a 'Photographic album of food products and dishes"

Recorded data were analysed using computer programmes 'Dieta 4' and 'Dieta 5', based on Food Composition Tables [13]; and developed by the National Food and Nutrition Institute In performed analyses losses of vitamins incurred during food processing or cooking were accounted for. Dietary intake of antioxidant vitamins: A, C, E and β-carotene was assessed. The obtained data were compared to reference values of Estimated Average Requirement, (EAR) for vitamins A and C, and Adequate Intake (AI) for vitamin E, which had been established by the National Food and Nutrition Institute in 2008. The main dietary sources of each of these vitamins were also determined.

Dietary consumption of antioxidants were presented as arithmetic means, standard deviation, median and also in graphical form. Food sources of vitamins tested were expressed as their percentage share of the total consumption for each of these constituents.

RESULTS

Antioxidant vitamins intake

Overall, the average daily vitamin A intake was 1076μg of retinol equivalent (Table 1), of which 46% derived from retinol and 55% from β-carotene. The amount of dietary vitamin A for women was less than for men, (985 vs 1137 μg/day). A low intake of vitamin A was observed respectively in 16% and 14% of women and men, defined as being below the daily EAR reference value of 500 μg for women aged ≥ 19 yrs and 630 μg for men also aged ≥ 19 yrs, (Fig. 1). The average daily diet provided more than 700 μg vitamin A in 69% of women and over 900 μg in 62% men. Furthermore, around 17% women and 16% men daily consumed respectively more than >1400 μg and >1800 μg of this vitamin. Retinol consumption was higher in men, however consumption of β-carotene was similar in both sub-groups, (Table 1).

Consumption of vitamin C was 107 mg/day with 102mg/day for women and 117mg/day for men, (Table 1). The daily diets of 33% women and 26% men were found to contain respectively <60 mg and <75 mg vitamin C, whilst 35% women ate diets with over 120mg of which 8% consumed >200 g. Over 35% men were found to eat >150mg vitamin C daily, (Fig. 2).

The average daily consumption of vitamin E was 10mg; this being higher for men compared to women, (12.8 mg vs 9 mg), (Table 1). More than 45% women

Table 1. The average daily intake of antioxidant vitamins (standard deviations (SD) and median are also presented).

	Mean ± SD	Median
Total sample		
Vitamin A (μg) as equivalent of retinol	1076±748	913
Retinol (μg)	497±781	302
β-carotene (μg)	3606±2322	3026
Vitamin C (mg)	107±62	98
Vitamin E (mg)	10.1±5.1	9.3
Women		
Vitamin A (μg) as equivalent of retinol	985±537	848
Retinol (μg)	338±253	271
β-carotene (μg)	3698±2497	2974
Vitamin C (mg)	103±60	92
Vitamin E (mg)	9.0±4.3	8.6
Men		
Vitamin A (μg) as equivalent of retinol	1137±652	983
Retinol (μg)	487±426	387
β-carotene (μg)	3432±1854	3198
Vitamin C (mg)	117±68	102
Vitamin E (mg)	12.8±6.2	11.8

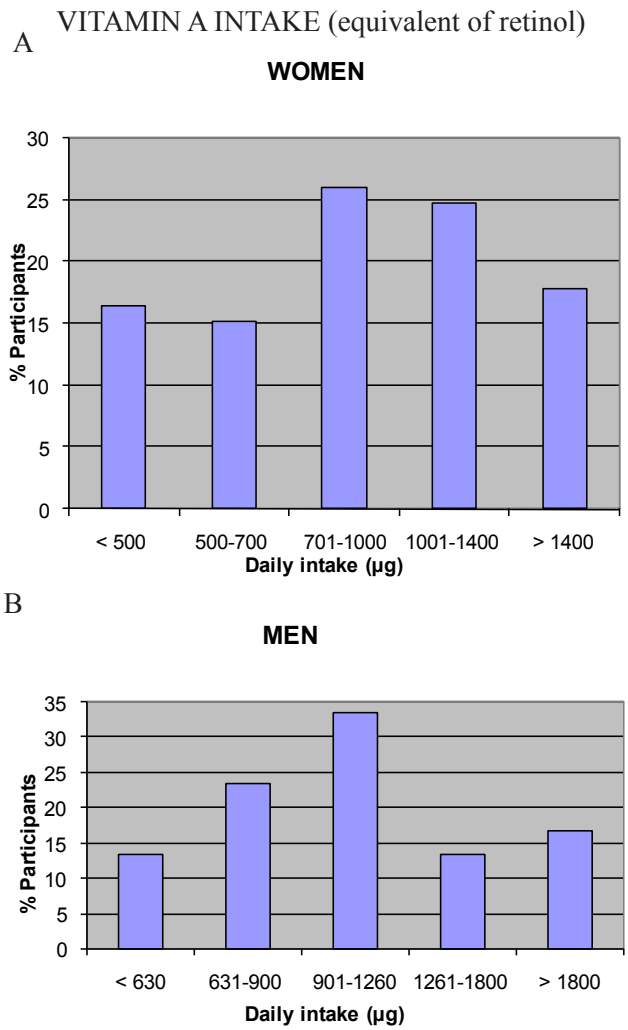

Figure 1. Distribution of dietary daily intake of vitamin A (µg) in the study group by gender: A. mong women, B. among men

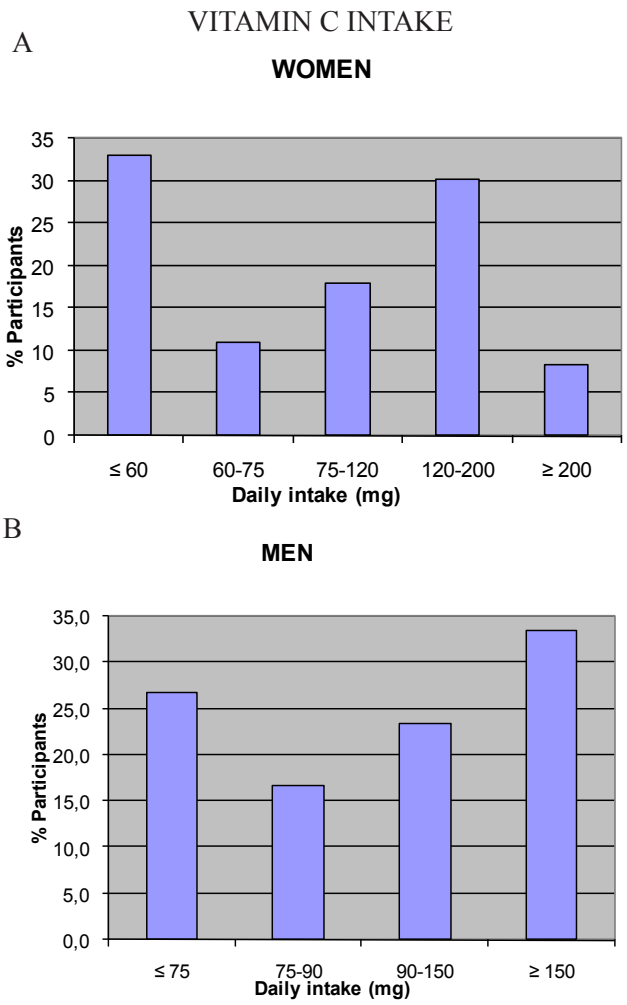

Figure 2. Distribution of dietary daily intake of vitamin C (mg) in the study group by gender: A. mong women, B. among men

and 36% men ate less than the recommended AI of 8 mg/day for women and 10 mg/day for men. About 40% women, however, consumed >10 mg of vitamin E daily, of which 5% exceeded 16 mg; the corresponding figures for men consuming >15 mg were 30%, of which 15% were above 20 mg (Fig. 3).

Dietary sources of antioxidants

Above all else, the presence of dietary vitamin A is linked to its precursor β-carotene, (Fig. 4) which is mainly found in vegetables thus accounting for over 80% of its consumption , (Fig. 6). In contrast, 50% of Retinol originates from offal or chacuterie products (Fig. 5); the most of course being found in the liver. Another important source are fats which supply about 20% of retinol intake as well as milk/dairy products (12%), and eggs (10%). Within the fats category, the most retinol is found in hard and soft margarines, (respectively 33% and 31%), butter (28%) and cream (nearly 5%).

Vitamin E comes mainly from fats (40%) of which 20% are vegetable oils and almost 20% from margarine, (Fig. 7). Other significant sources are also vegetables (15%), and grain products (>10%); the rest, around 10%, are derived from nuts, seeds and fruit.

Vegetables constitute the key dietary source of vitamin C; 50% of that consumed, (Fig. 8), together with fruit (25%). The remainder are found in potatoes and fruit juices, (both at 10%). Indeed, many studies confirm that fruit and vegetables are by far the main dietary source of this vitamin (Fig. 8B and C).

DISCUSSION

The study results were referenced to recommendations made by the National Food and Nutrition Institute on antioxidant vitamins intake; these being similar to other studies conducted in Poland and Europe. Vitamin A consumption levels were found to be lower in both women and men when compared to a National Health Survey in Poland, (WOBASZ - *Wieloośrodkowego Ogólnopolskiego Badania Stanu Zdrowia Ludności)*, conducted during 2003-2005 on a representative group

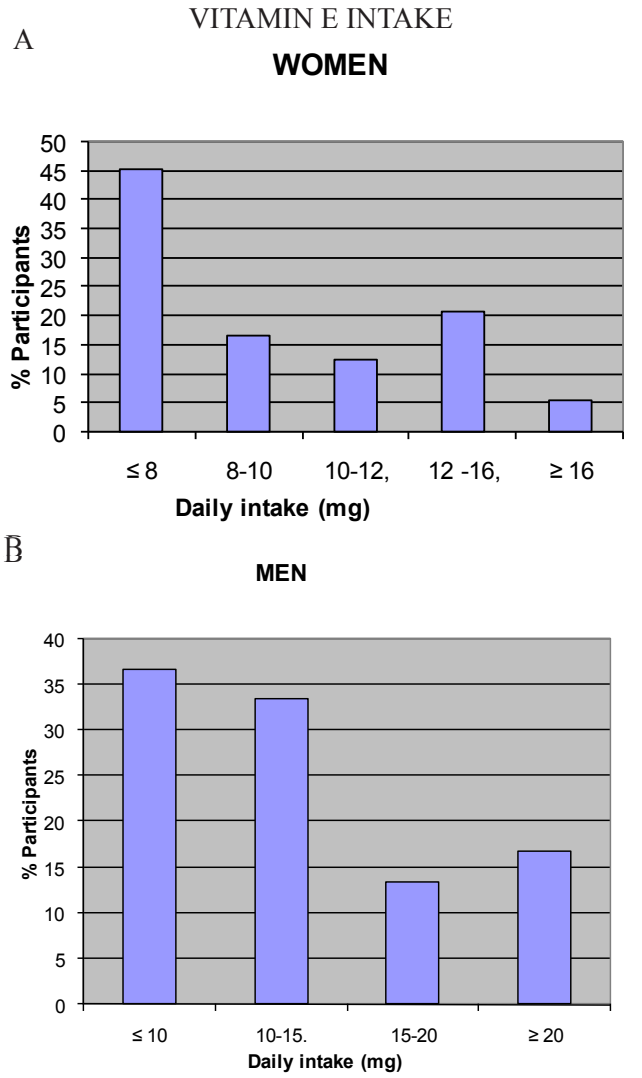

Figure 3. Distribution of dietary daily intake of vitamin E (mg) in the study group by gender: A. among women, B. among men

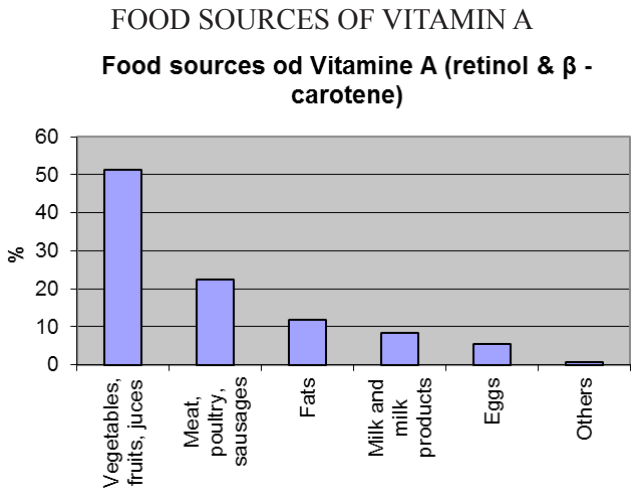

Figure 4. Product groups as a food sources of vitamin A (including retinol and β-carotene)

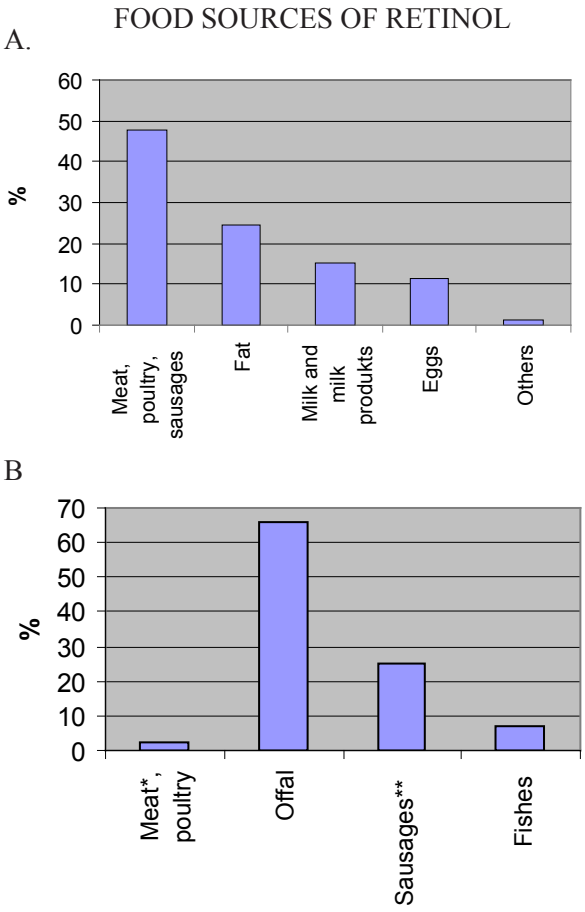

Figure 5. Product groups as a food sources of retinol (as an important source of vitamin A)
* Lamb, pork, veal, beef, rabbit meat, horse
** Mainly the liver here

of adults; respectively, 985 µg vs 1217 µg in women and 1137 µg vs 1411 µg for men. Corresponding results, however, showed that in present study vitamin C intake was higher in both genders, (107 vs 87 mg, 117 vs 80 mg), whereas no difference in vitamin E intake was observed (9,0 vs 11,6 mg, 12,8 vs 12,7 mg) [18]. Comparable results were nonetheless found in a French study also carried out on a representative sample of the adult population [9].

Despite the seemingly satisfactory average dietary intakes of antioxidant vitamins seen in this study, a more detailed analysis reveals a large variance in the consumption of food products which have been recognized as major sources of of vitamins A, C, E and *beta*-carotene thus significantly impacting on their intake. The consumption of vitamin C by over 40% of studied women and 30% of studied men was high and almost twice the recommended intake. In addition, the diets of more than 30% of the subjects contained less vitamin A than those of the EAR.

Current findings indicate that, equally, a deficit as well as an excess of β-carotene in the diet may result in serious health risks. The CARET study, (β-carotene and Retinol Efficacy Trial) demonstrated that a high exposu-

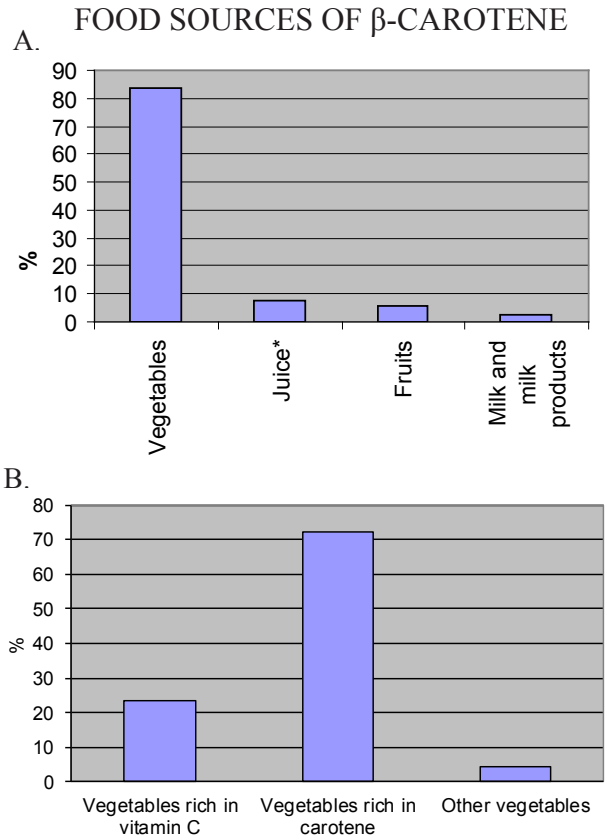

Figure 6. Product groups as a food sources of β-carotene: A – total, B - vegetables, as a source of β-carotene
* Fruit-, vegetable-, fruit and vegetable juices

re to synthetic β-carotene, (30 mg/day) in combination with vitamin A, (25 IU/day), over 4 years increases both lung cancer morbidity by 28% and mortality by 17%; the latter reaching mortality levels seen in smokers [1, 16]. When treating eye disease/disorders, studies from Bangladesh have demonstrated that supplementation with vitamin A and β-carotene had no effect on either reducing maternal or infant mortality [19].

The presented study also showed a wide variance in vitamin C consumption, where over 30% women and 25% men ate diets low in vitamin C, (below recommended doses), but 38% women and 33% men consumed

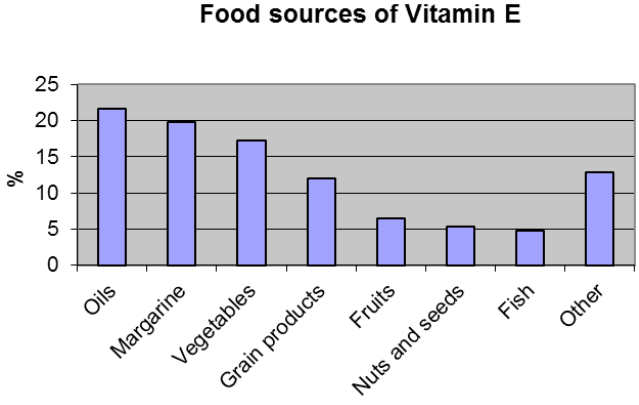

Figure 7. Product groups as a food sources of vitamin E

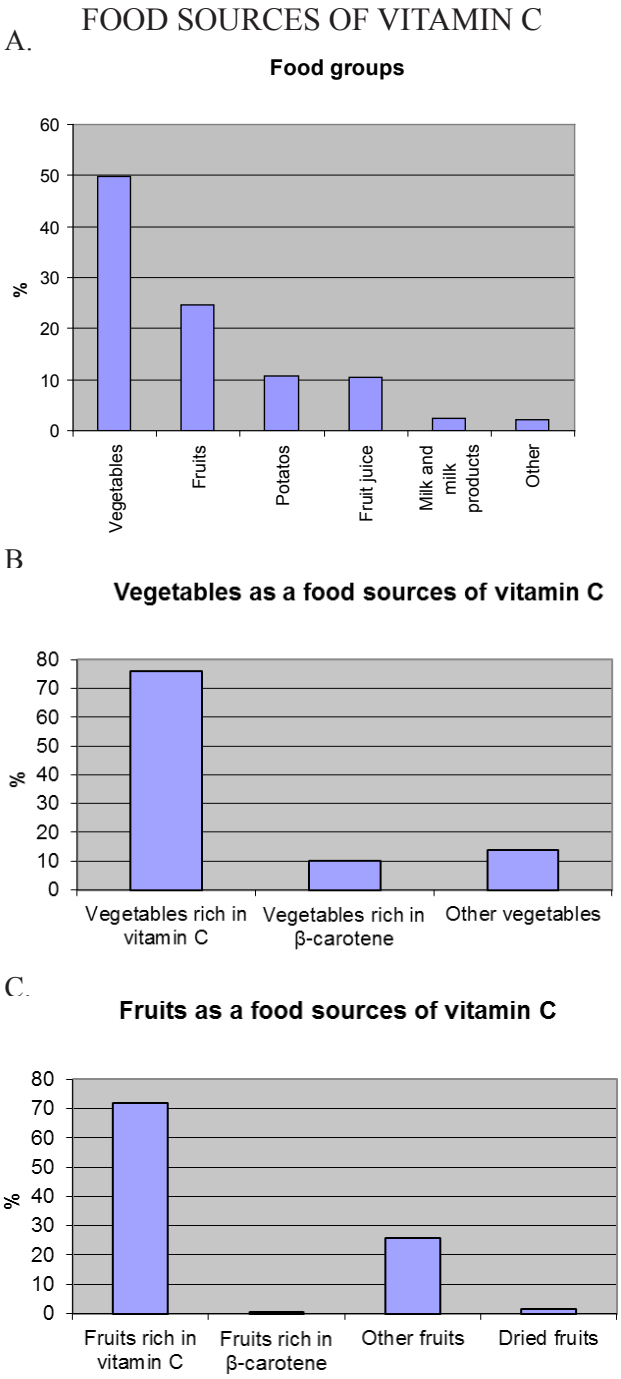

Fig. 8. Product groups as a food sources of vitamin C

diets high in this vitamin; in many cases more than twice the recommended value.

The consumption of vitamin E was also variable. More than 45% women and nearly 37% men consumed vitamin E at levels below those recommended, (≤ 8 mg/day and ≤10 mg/day). A fat solubility permits vitamin E to exert its role in protecting DNA structure stability; preventing any damage that might be caused by free radicals and also in assisting the removal of already damaged DNA from the cell [4]. Double the recommended vitamin E intake (AI) was seen in 5% women and 17% men.

The analysis of diet records showed, that vegetables and fruit were the main sources of vitamins A and C together with these being one of the most important vitamin E sources. Current findings categorically indicate that consuming fruit and vegetables is inversely associated with the risk of cancer and cardiovascular disease [3, 4, 12], and the total daily amount of vegetables and fruit consumed by the study subjects was 513 g. It is also worthwhile noting that apart from antioxidant vitamins, fruit and vegetables contain other substances documented as being beneficial to health, including dietary fibre, flavonoids and minerals.

CONCLUSIONS

1. The average daily intake of antioxidant vitamins consumed by the study participants ostensibly fulfil dietary requirements.
2. Due to wide margins of variation in subject responses, consumption of foods constituting the major sources of vitamins A, C, E and β-carotene lay significantly beyond recommended levels, (both above and below).
3. The study results demonstrate the need for continuous public education on nutrition to limit the wide variation seen in the range of the consumption of antioxidant vitamins.

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