Contribution of fresh fruit consumption to the micronutrient intake in Zagreb region adults

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Summary

Data from National Food Consumption Survey were used to assess intake of selected vitamins and minerals from fresh fruit in adult population. A number of 165 adults from the Zagreb region in Croatia were selected for this purpose. To assess dietary intake, the 24-hour recall method was used and participants were separated according to age in 3 groups (19–30 years, 31–50 years and 51–64 years), as well as according to gender. Data are presented as the average daily intake and compared to the Dietary Reference Intakes (DRI) values. The results showed that, in male population, intake of Na, K, P, Fe and Zn was higher in older population, while intake of Ca and Cu was higher in middle-aged population. Intake of vitamins in male population for thiamin and pyridoxine was higher in middle-aged population, and intake of riboflavin and niacin was higher in older population. Vitamin C intake was lower and similar in middle-aged and older population, respectively, compared to the youngest population. Regarding female population, the highest intake of almost all vitamins and minerals was in the youngest population, except for sodium and iron. Significant differences in daily intake of minerals and vitamins were observed between female subgroups.

Keywords

vitamins; minerals; fresh fruit; 24 h recall; adults

Minerals, and especially vitamins, are unevenly distributed in various types of foods and the contribution of particular food to their intake depends not only on their content in food, but also on the frequency of consumption, size of serving and food preparation methods [1]. Plant foods contain almost all of the mineral nutrients established as essential for human nutrition [2]. Fruits are generally considered to be good sources of potassium, but they also contribute to the intake of calcium, phosphorus and magnesium, while trace elements copper and iron are the most represented [3]. Regarding vitamins, fruits are generally considered as good sources of vitamin C, thiamine, riboflavin and niacin [1].

Recommended amounts of energy and nutrients are adjusted to the needs of people of different ages and genders. Specific needs for various population subgroups are defined in standards issued by the Food and Nutrition Board of the US Academy of Sciences [4–9]. Until recently, values of Recommended Dietary Allowance (RDA) were used, but with technological progress, new scientific findings on the biological value of the food and the requirements of individuals and populations, new guidelines on reference values of nutrient intake called Dietary Reference Intake (DRI) have been proposed. These are the values that represent the quantitative assessment of nutrient intake and, on the basis of these values, diet of healthy people can be planned [10]. DRI values are used in Croatia and implemented into national legislation [11].

Due to the fact that data on the intake of fruits and vegetables in Croatian population are scarce, and their contribution to the micronutrient intake was not studied previously, the aim of this paper was to estimate micronutrient intake from fresh

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fruits in adult population from a part of Croatia. Additionally, the aim was to estimate contribution of fruit micronutrient intake to DRI values prescribed for different gender and age subgroups.

MATERIALS AND METHODS

To determine dietary habits of the general adult population, Croatian Food Agency conducted National Food Consumption Survey in Croatia. The survey was carried out in accordance with EFSA (European Food Safety Agency) guidance [12]. According to the guidance, the survey was conducted in the adult population (18–64 years) in two repetitions (1st part in autumn 2011, 2nd part in summer 2012, to cover seasonal variations) on a representative sample of 2002 respondents. Study participants were grouped based on the geographical location in 6 regions. A 24-hour recall method was used and, in each repetition, the survey was conducted on two non-consecutive working days (with an interval of at least two weeks between them) and on one day of weekend. Data were collected by three face-to-face interviews at participants' homes.

The interviews were conducted by trained personnel. Once they got the starting address, if conducted in the city, the interviewer visited every third house on the same side of the street, while in the buildings they visited every sixth apartment. In smaller settlements, like villages, interviewers divided the village into four sections and visited the same number of respondents in each section. After the participants agreed to interview, the interviewer searched in the household for a respondent who met the criteria set for a representative sample of the whole country. It was allowed to interview a maximum of two subjects in the same household.

The representative sample covered different socio-demographic parameters (regional coverage, the ratio of rural-urban environment, level of education, monthly income, employment and family status, level of physical activity, body weight and height). Additionally, for each consumed food recorded in the 24-hour recall, participants were asked to indicate the frequency of consumption, with classification from several times a day to once a year (divided to 10 levels). The purpose of this information was to facilitate determination of the chronic exposure.

The manual from Senta et al. [10] was used to help participants to specify the amount of the consumed food. The household measurement and then weighing of particular food were used for food that was not included in the manual. All participants were also asked to describe food and drink they consumed (place of consumption, where the food was bought, way of preparation, brand and origin of food) in order to help to specifically identify food and drinks in classification.

This paper comprises results from the 1st part of the survey and includes only data on the consumption of fresh fruits because we wanted to see which fruits were the most consumed in this season and in which quantities. Furthermore, the paper encompasses only participants from the region of Zagreb and surroundings. Some additional boundaries were set for the purpose of this study, so from the original 254 participants who were from this region, only 165 fulfilled the requirements to enter the study. We took into consideration only consumers of fresh fruits (185 participants). Twelve participants were excluded because of incomplete data and 8 participants did not meet age criteria for which DRI values are prescribed. The micronutrient intake from fresh fruits was calculated on the basis of data obtained by a 24-hour recall form regarding fresh fruit consumption, as well as vitamin and mineral content of the edible part of the fruit obtained from national food composition tables [13]. These tables are the only available Croatian food composition tables [14]. Estimated intakes were compared with the DRI recommendation [4–9].

All results are presented for the subgroups based on gender, and within the gender group based on the age of participants. For that purpose, participants were divided into three age subgroups for which DRI values are prescribed (19–30, 31–50 and 51–64 years of age). Furthermore, results were calculated for all participants from the region (per capita) and for those who reported fruit consumption (per consumer).

Primary data analysis was carried out by MS Office Excel 2010 (Microsoft, Redmond, Washington, USA). Numerical data are described by mean, standard deviation, median and range. Normality of data distribution was tested by the non-parametric Kolmogorov-Smirnov test for the comparison of medians and arithmetic mean, and histogram plotting. The analysis revealed that data did not follow normal distribution, and consequently non-parametric tests were used for further statistical analysis. Differences between two independent groups were tested by non-parametric Mann-Whitney U test, and differences between multiple groups by non-parametric Kruskal-Wallis test. To calculate the correlation of numerical data, the Spearman correlation test was used. All statistical analyses were performed using the software system Statistica 12.0 (version 12.0; StatSoft, Tulsa, Oklahoma, USA) with a significance level of $p = 0.05$.

RESULTS AND DISCUSSION

Consumption of fruits

Recommended intake of fruits and vegetables is 5 servings or 400 g per day, and two of them should be fruits (one serving of fruit is 80 g) [15]. Our study showed that the intake of fresh fruits in the studied population ranged on average from 248.42 $g \cdot d^{-1}$ in the oldest female subgroup to 440.92 $g \cdot d^{-1}$ in the youngest female subgroup of consumers (Tab. 1), which was much higher than the recommended 160 $g \cdot d^{-1}$ (2 portions). Median values indicated skewed data distribution and lower intakes, but these were still above those recommended in all consumers subgroups. Results expressed per capita (all participants, including consumers and non-consumers) were, as expected, lower than those for consumers only, and skewed distribution of intakes was even more perceivable. As a result, although the average values indicated satisfactory intake in all observed subgroups, median values revealed insufficient intake in male population.

This result was refreshing considering the fact that intakes in most Western countries were found to be below the recommendation [16]. Consumption was higher in females than in males. Significantly lower intake of fruits in men than in woman was reported also for older adults (aged 55–64 years) from the United Kingdom, but in their case the intake was below the recommendation (1.76 servings per day for women and 1.22 servings per day for men) [17].

Most consumed fruit types in our study were water-rich fruits like mandarins, apples, bananas, grapes, pears and plums. This consumption profile was in a way expected since the study encompassed data collected in autumn. Fat-rich fruits were consumed in much smaller quantities compared to water-rich fruits and among them, most consumed were chestnuts and walnuts.

Contribution of fresh fruit consumption to the intake of minerals

Regarding minerals and male population, the results showed that the contribution of fresh fruit consumption to the intake of sodium, potassium, phosphorus, iron and zinc was somewhat higher in the older aged population (51–64 years), while contribution to the intake of calcium and copper was higher in 19–30 years old population (Tab. 2–4). Regarding female population the highest intake of almost all minerals from fresh fruits was in the youngest population (19–30 years; Tab. 2–4). The exceptions were sodium, whose intake was higher in the middle-aged population (31–50 years), and iron, whose intake was higher in the older aged population. There were no statistically significant differences in mineral intake from fresh fruits between males and females, and between age subgroups (Tab. 2–5).

Tab. 1. Structure of the subjects and mean intake of fruits in region Zagreb and surroundings according to age and gender.

		Age [years]	Number of subjects	Consumption of fruits [$g \cdot d^{-1}$]				
				Mean	*SD*	Minimum	Maximum	Median
Consumers	Males	19–30	17	360.78	277.10	4.40	1045.20	320.00
		31–50	34	282.08	329.51	9.00	1347.20	180.90
		51–64	23	323.37	266.16	8.00	968.13	236.80
	Females	19–30	20	440.92	367.26	16.00	1442.07	301.40
		31–50	43	292.90	219.48	1.05	945.20	257.92
		51–64	28	248.42	174.13	18.00	675.60	210.10
All subjects	Males	19–30	30	204.44	274.64	0.00	1045.20	77.90
		31–50	49	195.73	303.15	0.00	1347.20	79.20
		51–64	33	225.38	267.35	0.00	968.13	136.67
	Females	19–30	33	267.22	357.70	0.00	1442.07	180.00
		31–50	53	237.64	228.68	0.00	945.20	210.40
		51–64	33	210.78	183.75	0.00	675.60	180.00

SD – standard deviation.

Tab. 2. Intake of vitamins and minerals from fresh fruits compared to DRI recommendation [4–9] for 19–30 year old participants.

Minerals and vitamins	Result presented	Males [a]			Females [b]			p
		DRI [mg·d-1]	Intake [mg·d-1]	Percentage of DRI [%]	DRI [mg·d-1]	Intake [mg·d-1]	Percentage of DRI [%]	
Na	per consumer	1500 [c]	10.58 ± 21.95	0.7	1500 [c]	7.14 ± 6.55	0.5	0.9699
	per capita		6.00 ± 17.16	0.4		4.33 ± 6.17	0.3	0.4623
K	per consumer	4700 [c]	641.54 ± 541.90	13.7	4700 [c]	777.57 ± 677.53	16.5	0.7057
	per capita		363.54 ± 516.30	7.7		471.26 ± 649.17	10.0	0.3420
Ca	per consumer	1000	53.90 ± 47.47	5.4	1000	61.08 ± 65.44	6.1	0.8799
	per capita		30.55 ± 44.51	3.1		37.02 ± 58.83	3.7	0.4957
Mg	per consumer	400	27.41 ± 34.34	6.9	310	42.52 ± 44.31	13.7	0.2650
	per capita		15.33 ± 29.00	3.8		25.77 ± 40.14	8.3	0.2431
P	per consumer	700	45.56 ± 48.04	6.5	700	58.10 ± 54.06	8.3	0.6779
	per capita		25.81 ± 42.43	3.7		35.21 ± 50.66	5.0	0.3330
Fe	per consumer	8	0.74 ± 0.63	9.3	18	1.05 ± 0.96	5.8	0.5970
	per capita		0.42 ± 0.60	5.3		0.63 ± 0.90	3.5	0.3068
Zn	per consumer	11	0.26 ± 0.32	2.4	8	0.38 ± 0.47	4.8	0.5709
	per capita		0.15 ± 0.27	1.4		0.23 ± 0.40	2.9	0.3666
Cu	per consumer	0.9	0.22 ± 0.21	24.4	0.9	0.28 ± 0.30	31.1	0.8799
	per capita		0.12 ± 0.19	13.3		0.17 ± 0.27	18.9	0.4825
Vitamin A	per consumer	900 [d]	23.23 ± 26.33 [d]	2.6	700 [d]	53.90 ± 75.73 [d]	7.7	0.1861
	per capita		13.16 ± 22.80 [d]	1.5		32.67 ± 64.19 [d]	4.7	0.2049
Thiamin	per consumer	1.2	0.11 ± 0.09	9.2	1.1	0.14 ± 0.13	12.7	0.9699
	per capita		0.06 ± 0.09	5.0		0.09 ± 0.12	8.2	0.4623
Riboflavin	per consumer	1.3	0.08 ± 0.07	6.2	1.1	0.11 ± 0.10	10.0	0.5209
	per capita		0.05 ± 0.07	3.9		0.07 ± 0.10	6.4	0.2821
Niacin	per consumer	16	0.85 ± 1.20	5.3	14	1.06 ± 1.15	7.6	0.5457
	per capita		0.48 ± 0.99	3.0		0.64 ± 1.03	4.6	0.2902
Pyridoxine	per consumer	1.3	0.31 ± 0.35	23.9	1.3	0.43 ± 0.35	33.1	0.1992
	per capita		0.17 ± 0.30	13.1		0.26 ± 0.34	20.0	0.1675
Vitamin C	per consumer	90	36.56 ± 33.00	40.6	75	42.67 ± 40.75	56.9	0.8502
	per capita		20.72 ± 30.66	23.0		25.86 ± 37.87	34.5	0.3895

Data are presented as mean ± standard deviation. DRI – Dietary Reference Intake; p – significance level obtained by the Mann-Whitney U test.
a – consumers (n = 17), all subjects (n = 30); b – consumers (n = 20), all subjects (n = 33); c – values represent Adequate Intake, the rest values represent Recommended Dietary Allowances; d – intake of vitamin A is expressed in micrograms of retinol equivalents per day.

In general, contribution of fruit consumption to the daily intake of minerals ranged from 0.4% in the older female subgroup up to 31.1% in the younger female subgroup. The contribution was the highest for copper, while sodium intake with fruits was very low. This is the result of fruit pattern consumptions that are not presented in this paper, but revealed that most of the participants consumed exclusively water-rich fruits, and only a few of them fat-rich fruits.

Adequate Intake (AI) for sodium is 1300–1500 mg·d-1, depending on age and gender [8]. Sodium intake from fruits ranged from 5.30 mg·d-1 to 18.68 mg·d-1 and did not contribute significantly to dietary sodium intake. AI for potassium is 4700 mg·d-1 [8]. Potassium intake from fruits in the studied group ranged from 495.23 mg·d-1 to 777.57 mg·d-1, which represented approx. 14% of AI. RDA for calcium is 1000–1200 mg·d-1, depending on age and gender [9]. Calcium intake from fruits ranged from 40.03 mg·d-1 to 61.08 mg·d-1, which represented approx. 5% of RDA. RDA for magnesium is 310–420 mg·d-1, depending on age and gender [4]. Magnesium intake from fruits ranged from 22.45 mg·d-1 to 42.52 mg·d-1 and represent-

Tab. 3. Intake of vitamins and minerals from fresh fruits compared to DRI recommendation [4–9] for 31–50 year old participants.

Minerals and vitamins	Result presented	Males[a]			Females[b]			p
		DRI [mg·d⁻¹]	Intake [mg·d⁻¹]	Percentage of DRI [%]	DRI [mg·d⁻¹]	Intake [mg·d⁻¹]	Percentage of DRI [%]	
Na	per consumer	1 500[c]	8.90 ± 19.79	0.6	1 500[c]	18.68 ± 79.63	1.3	0.2727
	per capita		6.17 ± 16.92	0.4		15.16 ± 71.94	1.0	0.2374
K	per consumer	4 700[c]	500.59 ± 544.00	10.7	4 700[c]	580.28 ± 474.20	12.4	0.1584
	per capita		347.35 ± 507.73	7.4		470.79 ± 483.90	10.0	0.1687
Ca	per consumer	1 000	49.13 ± 63.84	4.9	1 000	47.92 ± 43.94	4.8	0.3313
	per capita		34.09 ± 57.67	3.4		38.88 ± 43.79	3.9	0.2698
Mg	per consumer	420	33.04 ± 33.01	7.9	320	35.76 ± 42.88	11.2	0.8263
	per capita		22.93 ± 31.40	5.5		29.02 ± 41.05	9.1	0.4675
P	per consumer	700	44.26 ± 46.88	6.3	700	56.46 ± 79.35	8.1	0.3010
	per capita		30.71 ± 43.99	4.4		45.81 ± 74.72	6.5	0.2532
Fe	per consumer	8	0.72 ± 0.78	9.0	18	0.83 ± 0.70	4.6	0.1778
	per capita		0.50 ± 0.73	6.3		0.68 ± 0.71	3.8	0.1811
Zn	per consumer	11	0.23 ± 0.26	2.1	8	0.33 ± 0.61	4.1	0.3606
	per capita		0.16 ± 0.24	1.5		0.27 ± 0.56	3.4	0.2089
Cu	per consumer	0.9	0.20 ± 0.25	22.2	0.9	0.19 ± 0.14	21.1	0.3858
	per capita		0.14 ± 0.23	15.6		0.15 ± 0.15	16.7	0.2382
Vitamin A	per consumer	900[d]	27.15 ± 31.01[d]	3.0	700[d]	24.60 ± 22.16[d]	3.5	0.8304
	per capita		18.84 ± 28.65[d]	2.1		19.96 ± 22.16[d]	2.9	0.3868
Thiamin	per consumer	1.2	0.12 ± 0.14	10.0	1.1	0.11 ± 0.09	10.0	0.2819
	per capita		0.08 ± 0.12	6.7		0.09 ± 0.09	8.2	0.2426
Riboflavin	per consumer	1.3	0.09 ± 0.11	6.9	1.1	0.10 ± 0.09	9.1	0.2025
	per capita		0.06 ± 0.10	4.6		0.08 ± 0.09	7.3	0.1964
Niacin	per consumer	16	0.69 ± 0.88	4.3	14	1.07 ± 2.93	7.6	0.2636
	per capita		0.48 ± 0.79	3.0		0.87 ± 2.67	6.2	0.2323
Pyridoxine	per consumer	1.3	0.33 ± 0.37	25.4	1.3	0.32 ± 0.27	24.6	0.6383
	per capita		0.23 ± 0.35	17.7		0.26 ± 0.28	20.0	0.4284
Vitamin C	per consumer	90	31.02 ± 43.26	34.5	75	27.73 ± 27.32	37.0	0.3634
	per capita		21.52 ± 38.67	23.9		22.50 ± 26.88	30.0	0.2467

Data are presented as mean ± standard deviation. DRI – Dietary Reference Intake; p – significance level obtained by the Mann-Whitney U test.
a – consumers (n = 34), all subjects (n = 49); b – consumers (n = 43), all subjects (n = 53); c – values represent Adequate Intake, the rest values represent Recommended Dietary Allowances; d – intake of vitamin A is expressed in micrograms of retinol equivalents per day.

ed approx. 9% of RDA. RDA for phosphorus is 700 mg·d^{-1} [4]. Phosphorus intake from fruits ranged from 38.28 mg·d^{-1} to 58.10 mg·d^{-1} and represented approx. 7% of RDA. RDA for iron is 8 mg·d^{-1} for males and the oldest subgroup of females, and 18 mg·d^{-1} for females in reproductive age [7]. Iron intake from fruits ranged from 0.68 mg·d^{-1} to 0.85 mg·d^{-1} for males and the oldest subgroup of females, which represented approx. 9% of RDA, and from 0.83 mg·d^{-1} to 1.05 mg·d^{-1} for females in reproductive age, which represented approx. 5 % of RDA. RDA for zinc is 8–11 mg·d^{-1}, depending on age and gender [7]. Zinc intake from fruits ranged from 0.23 mg·d^{-1} to 0.38 mg·d^{-1}, which represented approx. 3% of RDA. RDA for copper is 0.9 mg·d^{-1} [7]. Copper intake from fruits ranged from 0.14 mg·d^{-1} to 0.28 mg·d^{-1}, which represented approx. 23% of RDA and did contribute significantly to the dietary copper intake.

According to the results of the study that Mandić et al. [18] conducted in Croatia, intake of all minerals was higher in male population, and also was higher in older population (> 30 years). Our results show that the intake of minerals was higher in the oldest male subgroup and the youngest female subgroup. The differences in results

Tab. 4. Intake of vitamins and minerals from fresh fruits compared to DRI recommendation [4–9] for 51–64 year old participants.

Minerals and vitamins	Result presented	Males [a]			Females [b]			p
		DRI [mg·d^{-1}]	Intake [mg·d^{-1}]	Percentage of DRI [%]	DRI [mg·d^{-1}]	Intake [mg·d^{-1}]	Percentage of DRI [%]	
Na	per consumer	1300 [c]	11.97 ± 29.16	0.9	1300 [c]	5.30 ± 4.78	0.4	0.5358
	per capita		8.34 ± 24.82	0.6		4.50 ± 4.80	0.4	0.5116
K	per consumer	4700 [c]	691.00 ± 640.82	14.7	4700 [c]	495.23 ± 365.38	10.5	0.5465
	per capita		481.61 ± 621.55	10.3		420.20 ± 381.00	8.9	0.5043
Ca	per consumer	1000	43.63 ± 39.62	4.4	1200	40.03 ± 47.20	3.3	0.6467
	per capita		30.41 ± 38.65	3.0		33.96 ± 45.74	2.8	0.4245
Mg	per consumer	420	25.29 ± 32.66	6.0	320	22.45 ± 33.17	7.0	0.9102
	per capita		17.63 ± 29.54	4.2		19.05 ± 31.54	6.0	0.3625
P	per consumer	700	46.38 ± 56.01	6.6	700	38.28 ± 49.60	5.5	0.6583
	per capita		32.32 ± 51.23	4.6		32.48 ± 47.64	4.6	0.4348
Fe	per consumer	8	0.85 ± 0.81	10.6	8	0.68 ± 0.72	8.5	0.4842
	per capita		0.59 ± 0.78	7.4		0.58 ± 0.71	7.3	0.5486
Zn	per consumer	11	0.27 ± 0.36	2.5	8	0.25 ± 0.37	3.1	0.7293
	per capita		0.19 ± 0.32	1.7		0.21 ± 0.35	2.6	0.4750
Cu	per consumer	0.9	0.19 ± 0.19	21.1	0.9	0.14 ± 0.14	15.6	0.5145
	per capita		0.13 ± 0.18	14.4		0.12 ± 0.14	13.3	0.6190
Vitamin A	per consumer	900 [d]	27.06 ± 36.94 [d]	3.0	700 [d]	19.50 ± 35.24 [d]	2.8	0.3883
	per capita		18.86 ± 33.13 [d]	2.1		16.54 ± 33.14 [d]	2.4	0.7912
Thiamin	per consumer	1.2	0.10 ± 0.09	8.3	1.1	0.08 ± 0.06	7.3	0.7661
	per capita		0.07 ± 0.09	5.8		0.07 ± 0.06	6.4	0.3774
Riboflavin	per consumer	1.3	0.10 ± 0.10	7.7	1.1	0.08 ± 0.11	7.3	0.4167
	per capita		0.07 ± 0.10	5.4		0.06 ± 0.10	5.5	0.6026
Niacin	per consumer	16	0.90 ± 1.65	5.6	14	0.52 ± 0.45	3.7	0.7661
	per capita		0.63 ± 1.43	3.9		0.44 ± 0.45	3.1	0.3774
Pyridoxine	per consumer	1.7	0.28 ± 0.37	16.5	1.5	0.20 ± 0.20	13.3	0.7784
	per capita		0.19 ± 0.33	11.2		0.17 ± 0.20	11.3	0.1735
Vitamin C	per consumer	90	25.76 ± 21.89	28.6	75	19.08 ± 16.76	25.4	0.5045
	per capita		17.95 ± 21.77	19.9		16.19 ± 16.89	21.6	0.5148

Data are presented as mean ± standard deviation. DRI – Dietary Reference Intake; p – significance level obtained by the Mann-Whitney U test.
a – consumers (n = 23), all subjects (n = 33); b – consumers (n = 28), all subjects (n = 33); c – values represent Adequate Intake, the rest values represent Recommended Dietary Allowances; d – intake of vitamin A is expressed in micrograms of retinol equivalents per day.

may be caused by considering only mineral intake from fresh fruits, and by undertaking the study in a different region.

Contribution of fresh fruit consumption to the intake of vitamins

Intake of vitamins from fresh fruits in male population within the age-based subgroups was slightly different than the intake of minerals. Contribution of fresh fruit consumption to intake of vitamin A was the same in middle-aged and older aged population. Intake of thiamin and pyridoxine from fresh fruits was higher in middle-aged population (31–50 years), and intake of riboflavin and niacin was higher in older aged population (51–64 years). Contribution of fruits to the intake of vitamin C decreased from 40.6% of DRI in the youngest subgroup to 28.6% of DRI in the oldest subgroup.

Regarding female population, the highest intake of almost all vitamins from fresh fruits was in the youngest population (19–30 years), while the lowest intake was in the older population (51–64 years; Tab. 2–4). There were no statistically significant differences ($p \leq 0.05$) in vitamin intake from fresh fruits between males and females

(Tab. 2–4) and between male age-based subgroups (Tab. 5), while in females vitamin A and pyridoxine intake varied significantly (Tab. 5).

Fruit consumption contribution to vitamins intake was higher than the contribution to the intake of minerals. In our study, water-rich fruits were mostly consumed and these are consumed fresh, which means without loss of vitamins due to thermal degradation. Vitamins that were included in this study were mostly water soluble vitamins and therefore their higher intake was expected.

RDA for vitamin A is 700–900 $\mu g \cdot d^{-1}$, depending on gender [7]. Vitamin A intake from fruits ranged from 19.50 $\mu g \cdot d^{-1}$ to 53.90 $\mu g \cdot d^{-1}$ (expressed as retinol equivalents, RE), which represented approx. 4% of RDA. Study conducted in 18–60 year old Dutch subjects showed that mean daily intake of vitamin A ranged the 0.65 $mg \cdot d^{-1}$ in the group of subjects with low fruits and vegetables intake (low tertile) up to 0.84 $mg \cdot d^{-1}$ in the subgroup of subjects with the highest fruits and vegetables intake (high tertile) [19]. RDA for thiamin is 1.1–1.2 $mg \cdot d^{-1}$, depending on gender [5]. Thiamin intake from fruits ranged from 0.08 $mg \cdot d^{-1}$ to 0.14 $mg \cdot d^{-1}$, which represented approx. 10% of RDA. RDA for riboflavin is 1.1–1.3 $mg \cdot d^{-1}$, depending on gender [5]. Riboflavin intake from fruits ranged from 0.08 $mg \cdot d^{-1}$ to 0.11 $mg \cdot d^{-1}$, which represented approx. 8% of RDA. RDA for niacin is 14–16 $mg \cdot d^{-1}$, depending on gender [5]. Niacin intake from fruits ranged from 0.52 $mg \cdot d^{-1}$ to 1.07 $mg \cdot d^{-1}$, which represented approx. 6% of RDA. RDA for pyridoxine is 1.3–1.7 $mg \cdot d^{-1}$, depending on age and gender [5]. Pyridoxine intake from fruits ranged from 0.20 $mg \cdot d^{-1}$ to 0.43 $mg \cdot d^{-1}$, which represented approx. 23% of RDA and contributed significantly to dietary pyridoxine intake. Study conducted in 18–60 year old Dutch subjects showed that mean daily intake of vitamin B6 ranged from 19 $\mu g \cdot kg^{-1}$ protein daily in the group of subjects with the low fruits and vegetables intake (low tertile) up to 21 $\mu g \cdot kg^{-1}$ protein daily in the subgroup of subjects with the highest fruits and vegetables intake (high tertile) [19]. RDA for vitamin C is 75–90 $mg \cdot d^{-1}$, depending on gender [6]. Vitamin C intake from fruits ranged from 19.08 $mg \cdot d^{-1}$ to 42.67 $mg \cdot d^{-1}$, which represented approx. 37% of RDA and contributed significantly to dietary vitamin C intake. The study conducted with 18–60 year old Dutch subjects showed that mean daily intake of vitamin C ranged from 44 $mg \cdot d^{-1}$ in the group of subjects with the low fruits and vegetables intake (low tertile) up to 107 $mg \cdot d^{-1}$ in the subgroup of subjects with the highest fruits and vegetables intake (high tertile) [19]. Results of a previous study conducted in adults in Croatia indicated that the intake of all vitamins was higher in male population and intake of almost all vitamins, except for vitamin C, was higher in the younger population (≤ 30 years) [14]. In our study, the vitamins intake by male population was higher in middle-aged and oldest subgroups, while the intake of vitamins by female population was highest in the youngest subgroup.

Mineral and trace element content in fruits and vegetables decreased for the last 30 years and, therefore, average daily mineral and trace element intakes also decreased [20]. Food composition tables [13] that we used in this study were issued 24 years ago, and development of new food composition tables is strongly recommended to facilitate more accurate dietary intake estimation.

Before reaching a conclusion, certain limita-

Tab. 5. *p*-Value between male and female age groups.

Minerals and vitamins	Result presented	*p*	
		Males	Females
Na	per consumer	0.4186	0.8081
	per capita	0.5545	0.5085
K	per consumer	0.2946	0.6623
	per capita	0.4177	0.6931
Ca	per consumer	0.4837	0.5397
	per capita	0.7187	0.6400
Mg	per consumer	0.4074	0.0512
	per capita	0.4289	0.7490
P	per consumer	0.7465	0.2984
	per capita	0.5921	0.7634
Fe	per consumer	0.6332	0.3639
	per capita	0.4209	0.7170
Zn	per consumer	0.8512	0.5340
	per capita	0.6497	0.8089
Cu	per consumer	0.7153	0.1973
	per capita	0.7613	0.7569
Vitamin A	per consumer	0.9501	0.0395 [a]
	per capita	0.5340	0.8031
Thiamin	per consumer	0.6682	0.2261
	per capita	0.6133	0.6794
Riboflavin	per consumer	0.5948	0.1452
	per capita	0.4788	0.8621
Niacin	per consumer	0.6117	0.2113
	per capita	0.6650	0.9607
Pyridoxine	per consumer	0.4860	0.0422 [a]
	per capita	0.5170	0.9529
Vitamin C	per consumer	0.4104	0.2137
	per capita	0.7267	0.9608

p – significance level obtained by the Kruskal-Wallis test, a – statistically significant difference.

tions of the study should be taken into account, such as the study sample, which was considerably small because only data from 1st part of the survey were utilized and included participants from only one region of Croatia. Also, the data regarded only fresh fruits and, in particular, those consumed in one season (autumn) when the intake is highest, while average annual intake would most probably be lower. Furthermore, non-Gaussian distribution of data on fruit consumption was obvious, indicating that medians, rather than average values, were a more useful indicator of the effect of consumption of fresh fruits on the intake of minerals and vitamins.

In conclusion, fresh fruit consumption by consumers was generally higher than recommended, while for all subjects the intake was lower than recommended for male population, with the domination of water-rich types of fruits. Despite the general opinion that fruits are the most important contributor to the vitamin and mineral intake, our results showed that the real contribution was relatively low for all analysed compounds except for vitamin C, pyridoxine and copper. Representation of the fruit types was typical for autumn, and therefore results should be considered with caution, taking into account seasonal variations in fruit selection with consequences regarding the intake of vitamins and minerals. Furthermore, it should be considered that fruits are, although very important, just one source of vitamins and minerals, and the complete diet has to be analysed to facilitate conclusion on the adequacy of the intake of vitamins and minerals.

Further analysis of all data collected in the National Food Consumption Survey will broaden the insight into the dietary patterns of Croatian adults in all regions regarding the intake of fruits, as well as consumption of other food groups. These data will facilitate nutritional policy development and nutritional risk assessment on the national level.

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REFERENCES

1. Combs, G. F. Jr: The vitamins. Fundamental aspects in nutrition and health. Third edition. Burlington: Elsevier Academic Press, 2007. ISBN 13: 978-0-12-183493-7.
2. Gupta U. C. – Gupta S. C.: Sources and deficiency diseases of mineral nutrients in human health and nutrition: A review. Pedosphere, *24*, 2014, pp. 13–38. DOI: 10.1016/S1002-0160(13)60077-6.
3. Mandić, M. L.: Znanost o prehrani: hrana i prehrana u čuvanju zdravlja. Osijek : Sveučilište Josipa Jurja Strossmayera u Osijeku, 2007. ISBN: 953-7005-00-3.
4. Dietary reference intakes for calcium, phosphorous, magnesium, vitamin D, and fluoride [online]. Washington, D.C.: National Academies Press, 1997 [cit. 02. 12. 2013]. ISBN: 0-309-06350-7, ISBN: 0-309-06403-1. <http://www.nap.edu/openbook.php?record_id=5776&page=R1>
5. Dietary reference intakes for thiamin, riboflavin, niacin, vitamin B6, folate, vitamin B12, pantothenic acid, biotin, and choline [online]. Washington, D.C.: National Academies Press, 1998 [cit. 02. 12. 2013]. ISBN: 0-309-06554-2, ISBN: 0-309-06411-2. <http://www.nap.edu/openbook.php?record_id=6015&page=R1>
6. Dietary reference intakes for vitamin C, vitamin E, selenium, and carotenoids [online]. Washington, D.C.: National Academies Press, 2000 [cit. 02. 12. 2013]. ISBN: 0-309-06949-1, ISBN: 0-309-06935-1. <http://www.nap.edu/openbook.php?record_id=9810&page=R2>
7. Dietary reference intakes for vitamin A, vitamin K, arsenic, boron, chromium, copper, iodine, iron, manganese, molybdenum, nickel, silicon, vanadium and zinc [online]. Washington, D.C.: National Academies Press, 2001 [cit. 02. 12. 2013]. ISBN: 0-309-07279-4, ISBN: 0-309-07290-5. <http://www.nap.edu/openbook.php?record_id=10026&page=R1>
8. Dietary reference intakes for water, potassium, sodium, chloride, and sulfate [online]. Washington, D.C.: National Academies Press, 2005 [cit. 02. 12. 2013]. ISBN: 0-309-09158-6, ISBN: 0-309-09169-1, ISBN: 0-309-53049-0. <http://www.nap.edu/openbook.php?record_id=10925&page=R1>
9. Dietary reference intakes for calcium and vitamin D [online]. Washington, D.C.: National Academies Press, 2011 [cit. 02. 12. 2013]. ISBN: 978-0-309-16394-1, ISBN: 978-0-309-16395-8. <http://www.nap.edu/openbook.php?record_id=13050&page=R1>
10. Senta, A. – Pucarin-Cvetković, J. – Doko Jelinić, J. Kvantitativni modeli namirnica i obroka. Zagreb: Medicinskanaklada, 2004. ISBN: 953-176-252-X.
11. Pravilnik o hrani za posebne prehrambene potrebe. In: Narodne novine [online], *78/04*, 2004, pp. 1–32. ISSN 1333-9273. <http://narodne-novine.nn.hr/clanci/sluzbeni/2010_04_41_1062.html>
12. General principles for the collection of national food consumption data in the view of pan-European dietary survey. In: EFSA Journal [online], *7*(12), 18. 12. 2009 [cit. 16. 12. 2013]. DOI: 10.2903/j.efsa.2009.1435.
13. Kaić-Rak, A. – Antonić, K.: Tablice o sastavu namirnica i pića. Zagreb : Zavod za zaštitu zdravlja SR Hrvatske, 1990. 46 pp.
14. Mandić, M. L. – Primorac, L. J. – Kenjerić, D. – Mandić-Puljek, M. – Perl Pirički, A.: Intake of vitamins among clinically healthy adults from continental Croatia estimated by 24-h recall. International Journal of Food Sciences and Nutrition, *59*, 2008, pp. 457–464. DOI: 10.1080/09637480701425635.
15. Diet, nutrition and the prevention of chronic diseases.

Report of a Joint WHO/FAO Expert Consultation: Technical Report Series No. 916. Geneva: World Health Organization, 2003. ISBN: 92 4 120916 X.
16. Baker, A. H. – Wardle, J.: Sex differences in fruit and vegetable intake in older adults. Appetite, *49*, 2003, pp. 269–275. DOI: 10.1016/S0195-6663(03)00014-X.
17. Antoine, J. M. R. – Hoo Fung, L. A. – Grant, C. N. – Dennis, H. T. – Lalor, G. C.: Dietary intake of minerals and trace elements in rice on the Jamaican market. Journal of Food Composition and Analysis, *26*, 2012, pp. 111–121. DOI: 10.1016/j.jfca.2012.01.003.
18. Mandić, M. L. – Kenjerić, D. – Perl Pirički, A.: Intake of some minerals in healthy adult volunteers from eastern Croatia. International Journal of Food Sciences and Nutrition *60*(S5), 2009, pp. 77–87. DOI: 10.1080/09637480802438313.
19. Löwik, M. R. H. – Hulshof, K. F. A. M. – Brussaard, J. H.: Patterns of food and nutrient intakes of Dutch adults according to intakes of total fat, saturated fatty acids, dietary fibre, and fruit and vegetables. British Journal of Nutrition, *81*, 1999, pp. S91–S98. DOI: 10.1017/S0007114599001774.
20. Ekholm, P. – Reinivuo, H. – Mattila, P. – Pakkala, H. – Koponen, J. – Happonen, A. – Hellström, J. – Ovaskainen, M.L.: Changes in the mineral and trace element contents of cereals, fruits and vegetables in Finland. Journal of Food Composition and Analysis, *20*, 2007, pp. 487–495. DOI: 10.1016/j.jfca.2007.02.007.

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