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Daily Dietary Intake of Micronutrients Using Duplicate Portion Sampling along with Food Composition Tables in Healthy Adult Population in Shiraz, Iran

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ABSTRACT

Background: There is growing evidence on the importance of healthy and balanced diet in human health. Many health disorders are related to inadequate or excessive intakes of micronutrients. Estimation of their daily intakes is, therefore, necessary to evaluate the risks of deficiency or toxicity. The present study aimed to investigate the dietary intakes of micronutrients by the healthy adult population of Shiraz, Iran.

Methods: Duplicate portions of all the meals (breakfasts, lunches, and dinners) prepared for patients with no dietary restriction were taken from the kitchen at Namazi Hospital in Shiraz, Iran during seven consecutive days. They were accurately weighed and broken down into their ingredients according to the kitchen recipes. The nutrient content of the food components and whole meals were calculated using US Food Composition Table (FCT). The results were then compared with their respective Recommended Daily Allowance Values (RDAs).

Results: Daily dietary intakes of potassium, calcium, magnesium, folate, biotin, and vitamin C were lower than the recommended levels. The intakes of other micronutrients were found to be close to or higher than the recommendations. The nutrients with highest intakes were manganese, iron, vitamin E, thiamine, riboflavin, niacin, and vitamin B12. Compared to the lunch and dinner, breakfast provided the lowest percentage of micronutrients.

Conclusion: Regular monitoring of nutritional intakes of adult population is helpful for identification of nutritional inadequacies, possible consequences and interventions. More precise and comprehensive studies are required to provide data on the issue which can feed into nutritional plans and policies.

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Introduction

Optimal diet composition is detrimental for both physical and mental health and well-being at different stages of the life cycle (1, 2). Habitual dietary intakes of healthy individuals should be, therefore, measured as accurate as possible. Such data are necessary to make plans on how to improve the nutritional adequacy of diets and health status of the population (3). There is still no dietary assessment method with complete accuracy (4), and various techniques with different accuracies have been used in nutrition surveys (5). In this regard, the use of Food Composition Table (FCT) in combination with individual surveys such as Food Frequency Questionnaire (FFQ), 24-hour dietary recall, and diet record appears to be the most common approach (6-8).

On the other hand, Duplicate Portion Sampling (DPS) method is considered to give the most precise results. In DPS technique, duplicate portions of all foods and beverages consumed over a specific period of time are collected and analyzed (9). The analysis of duplicate diets can be conducted using FCTs which has been reported as a rapid and low cost dietary assessment method (8, 10). In Iran, as many less developed countries, national or regional FCTs are not readily available. The Iranian FCT, developed in 1980, only includes raw materials and a few nutrients (11) which has led Iranian researchers to use foreign FCTs, especially that of USDA. The present study, therefore, aimed to estimate the dietary intakes of various micronutrients by healthy population of Shiraz, Iran using DPS method in combination with US FCT.

Materials and Methods

During seven consecutive days in February 2013, two portions of each main meal (breakfast, lunch, and dinner excluding drinking water, and beverages) prepared for patients without any dietary restriction were precisely weighed in the kitchen at Namazi Hospital in Shiraz, Iran, as recorded elsewhere (8, 10). In total, the data over 42 samples corresponding to 21 different hospital meals were collected for further analysis. The weight of each food component of the dishes was calculated based on the hospital recipes. This study was approved by the Local Ethics Committee. All the study steps were performed in accordance with the Helsinki Declaration.

The nutrient content of these components was then determined using the Nutritionist IV diet analysis software (version 3.5.2; 1994, N-Square Computing, First Data Bank Division, The Hearst Corporation, San Bruno, CA, USA). The nutrient content of complete meals was estimated by summing up the content of the individual components. The sum of the nutrient quantity of three main meals of a day was recorded as the daily intake. Mean intake values was finally calculated by averaging seven-day intakes (8, 10), which were then compared with the US Food and Nutrition Board (12-16) recommended levels. Data analysis was conducted using SPSS statistical software (version 21.0, IBM Corp., Armonk, NY, USA) and reported as mean±standard deviation (SD).

Results

The mean, minimum, and maximum intakes of micronutrients are presented in Table 1. The comparison of daily intakes with the recommended levels is shown in Table 2. For the nutrients that their RDA varied with age and sex, the percentage

Table 1: Daily dietary intake of micronutrients.

Nutrients	Mean±SD	Range	
		Minimum	Maximum
Sodium (mg)	1424.4±695.0	558.1	2577.6
Potassium (mg)	2314.3±270.3	2062.4	2703.8
Iron (mg)	19.0±2.8	13.5	22.0
Calcium (mg)	887.9±181.0	574.6	1156.9
Magnesium (mg)	243.5±42.6	172.7	316.0
Manganese (mg)	13.2±5.8	5.7	22.2
Vitamin A (µg)	745.0±335.8	293.9	1118.3
Vitamin E (mg)	47.3±27.2	22.8	105.5
Thiamin (mg)	2.2±0.2	1.8	2.4
Riboflavin (mg)	1.6±0.2	1.3	2.1
Niacin (mg)	31.2±4.5	24.1	37.3
B5 (mg)	5.0±1.1	3.2	6.1
Pyridoxine (mg)	1.7±0.2	1.3	1.9
Folate (µg)	164.9±53.5	122.9	264.0
Biotin (µg)	8.1±4.8	2.4	17.0
B12 (µg)	3.2±0.7	2.7	4.4
Vitamin C (mg)	36.9±10.9	23.6	51.2

Table 2: The percentage of RDA[a] fulfillment.

Nutrientsy	Females		Males	
	RDA	TDI[b]/RDA (%)	RDA	TDI/RDA (%)
Potassium (mg)	4700	49	4700	49
Manganese (mg)	1.8	733	2.3	574
Vitamin A (µg)	700	106	900	83
Vitamin E (mg)	15	315	15	315
Thiamin (mg)	1.1	200	1.2	183
Riboflavin (mg)	1.1	145	1.3	123
Niacin (mg)	14	223	16	195
B5 (mg)	5	100	5	100
Folate (µg)	400	41	400	41
Biotin (µg)	30	27	30	27
B12 (µg)	2.4	133	2.4	133
Vitamin C (mg)	75	49	90	41

[a]Recommended Dietary Allowance (RDA) values for adults (19 years and over) proposed by the US Food and Nutrition Board (1998; 2000; 2001; 2005). TDI, The daily intake.

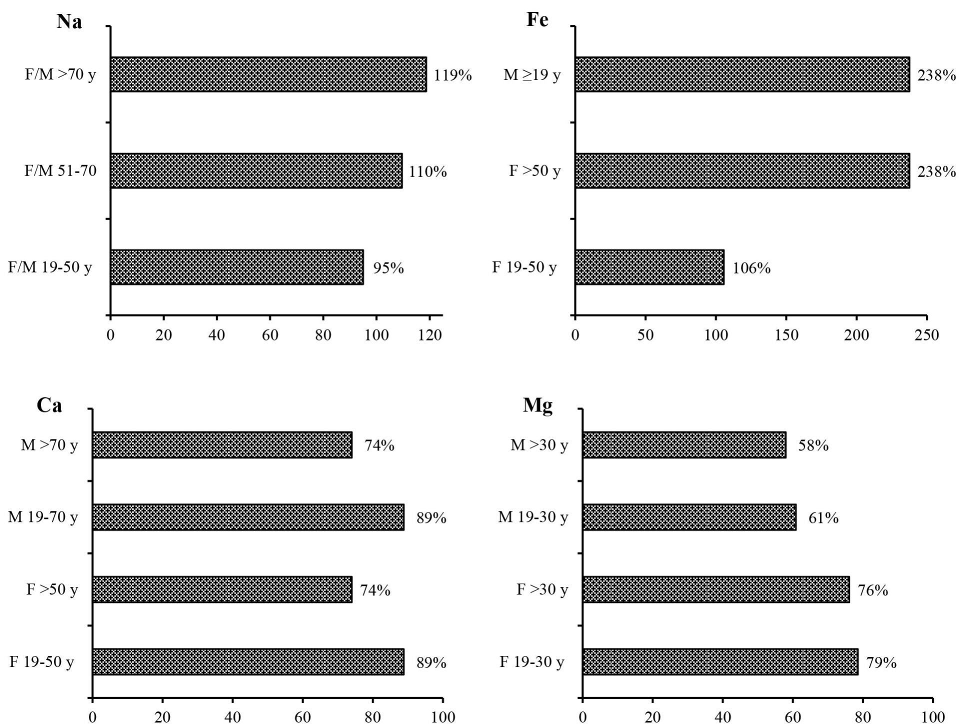

Figure 1: The percentage of RDA fulfillment for different sex/age groups. Recommended Dietary Allowance (RDA) values for adults (19 years and older) proposed by the US Food and Nutrition Board.

of RDA fulfillment is indicated in Figure 1. The dietary intakes of all micronutrients were close to or higher than the recommendations except for potassium, calcium, magnesium, folate, biotin, and vitamin C. The contribution of three main meals to dietary intakes of different nutrients is demonstrated in Table 3.

Discussion

Inadequate or excessive intakes of micronutrients can lead to some health problems. In the present study, the dietary assessment of hospital meal plan using a combination of DPS method and food composition tables (FCT) revealed that served dishes are not sufficient to supply the requirements for some nutrients; as, the intakes of potassium, calcium, magnesium, folate, biotin, and vitamin C were lower than the RDA levels. Lower potassium intake has long been associated with higher rate of vascular diseases including hypertension (HTN), stroke, coronary heart disease (CHD), and cardiovascular diseases (CVD) (17).

Chronic suboptimal intake of potassium, mainly due to inadequate consumption of natural foods

Table 3: Contribution of different meals (breakfast, lunch, and dinner) to daily intakes of micronutrients.

Nutrients	Breakfast			Lunch			Dinner		
	N	Mean±SD	TDI%	N	Mean±SD	TDI%	N	Mean±SD	TDI%
Sodium (mg)	14	328.6±189.5	23	14	548.2±361.5	38	14	547.6±481.0	38
Potassium (mg)	14	303.9±181.1	13	14	1011.8±184.0	44	14	998.6±477.0	43
Iron (mg)	14	3.8±0.5	20	14	7.8±1.7	41	14	7.4±1.8	39
Calcium (mg)	14	327.1±155.6	37	14	297.4±98.1	33	14	263.4±146.7	30
Magnesium (mg)	14	31.3±18.7	13	14	118.5±21.6	49	14	93.8±53.8	38
Manganese (mg)	14	0.18±0.2	1	14	12.0±4.8	91	14	1.0±1.2	8
Vitamin A (µg)	14	133.3±63.7	18	14	277.5±334.8	37	14	334.1±338.1	45
Vitamin E (mg)	14	0.3±0.3	1	14	31.7±14.2	67	14	15.3±20.9	32
Thiamin (mg)	14	0.6±0.1	27	14	0.8±0.2	36	14	0.8±0.1	36
Riboflavin (mg)	14	0.5±0.2	31	14	0.6±0.2	38	14	0.5±0.3	31
Niacin (mg)	14	7.1±0.9	23	14	10.9±3.3	35	14	13.2±2.2	42
B5 (mg)	14	0.9±0.5	18	14	2.7±0.9	54	14	1.5±1.0	30
Pyridoxine (mg)	14	0.2±0.1	12	14	0.7±0.3	41	14	0.8±0.3	47
Folate (µg)	14	24.2±13.0	15	14	65.5±20.5	40	14	75.1±65.8	46
Biotin (µg)	14	4.2±4.4	52	14	2.1±1.0	26	14	1.8±1.2	22
B12 (µg)	14	0.9±0.4	28	14	1.2±0.6	38	14	1.1±0.7	34
Vitamin C (mg)	14	4.0±3.2	11	14	13.6±6.2	37	14	19.3±12.6	52

TDI: The daily intake

including fresh fruits, vegetables, and cereals seems not to be a new issue. A review on the potassium intake in 21 different countries across the world indicated intake levels ranging from 1.7 to 3.7 g/day which were all lower than the RDA of 4.7 g/day (18). Insufficient intake of calcium during adulthood may cause an increase in metabolic syndrome, obesity, HTN, CVD, osteoporotic facture, and kidney stone risks (19-22). Inadequate daily intake of calcium has been previously reported in healthy adult Australians (570 mg/d) (23), American-Indians (men: 680 mg/d and women: 610 mg/d), African-American women (600 mg/d) (24), and Québec, Canadian women (860 mg/d) (25).

The inadequacy of the diet in meeting the recommended intake for magnesium can contribute to an increased risk of diabetes (26), and lower bone mass density (BMD) (27). Lower folate, and consequently higher homocysteine levels were traditionally considered as common risk factors of CVD (28). One possible explanation for folate and magnesium deficiency is limited quantities of green vegetables in meals which is mainly due to microbiological quality of these food products. While sufficient dietary intake of vitamin C, available in substantial amounts in many fruits and vegetables, is required for proper pulmonary- and cognitive function, the nutrient insufficiency may be accompanied by CVD and neoplastic risks and cataract (29-31).

On the other hand, the daily intakes of some nutrients exceeded the recommended levels. The nutrients with highest intakes were manganese, iron, vitamin E, thiamine, riboflavin, niacin, and vitamin B12. The food preparation using vegetable oils is the main reason of high vitamin E content of the meals. The meat and its animal-origin alternates could be responsible for high intakes of iron and vitamin B12. The thiamine content of white bread and rice is lower than that of whole grain (32).

These products are, however, the staple foods of Iranians. High consumption of refined grain products might, therefore, play a key role in high intake of the nutrient. Iranians used to consume the majority of their daily food intake at lunch and dinner. As expected, these two meals were the main contributors to intakes of a majority of the nutrients analyzed. It is noteworthy to mention that in the current study the wastage of meal samples was not taken into account to estimate the dietary intakes of adults. It might in turn lead to overestimation.

Conclusion

The current study demonstrated that the intakes of some nutrients are poor in adult population. Thus, the improvement of dietary intakes should be a priority in adult public health. In order to address the problem more comprehensively, further studies are, however, required which should mainly focus on the major reasons for unbalanced diet and likely interventions.

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Conflict of Interest

None declared.

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