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Seasonality in Iranian Fruit and Vegetable Dietary Intake

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Background: Increased intake of fruits and vegetables may reduce the prevalence of certain chronic diseases. Seasonality, may affect the availability and quantity of fruit and vegetable diet.
Objectives: We aimed to assess the seasonal fluctuations in intake of fruit and vegetable as well as vitamin A and C among Iranian households.
Materials and Methods: We analyzed the existing data of the latest Iranian household food pattern study, collected by three consecutive 24 hours recalls. Totally 7158 Iranian households were selected by Iranian statistic center by a systematic cluster random sampling method. Calculation of energy and nutrients consumptions were made by an access program designed using Iranian food composition table and Modified by USDA and database. Cooking coefficient has been considered for vitamin C. Data were expressed as mean and SE. Intakes during different seasons were compared by one-way ANOVA test. A Newman-Keuls post hoc analysis was used to locate statistical significance in seasons, when an ANOVA was significant.
Results: The highest consumption of vegetables was seen in summer (289 ± 3.4 g/day) while the lowest was in winter (224 ± 3.2 g/day) ($P < 0.1$). Fruit consumption showed a more dramatic variation, with a peak in summer (263 ± 6/1 g/day) ($P < 0.1$) and the lowest level in spring (143 ± 5.0). Energy intake showed a significant but not sharp variation ($P < 0.01$). Vitamin C had a dramatically significant variation ($P < 0.01$), with the lowest in the spring. Seasonal variations were not significant in vitamin A intake.
Conclusions: Due to seasonal variations in fruit and vegetable dietary intakes, the interventional and case-control studies should consider seasonality. Educational and price controlling programs may control such observed seasonality in the intake of fruit and vegetables.

Keywords: Fruit; Vegetable; Dietary; Intake

1. Background

In recent years, the role of fruits and vegetables in reducing prevalence of chronic diseases such as cancer, coronary heart disease (CHD), stroke, diabetes and arthritis has received a great deal of attention (1-3). Epidemiologic data strongly suggest that increasing fruit and vegetable consumption has protective effects against several neopelasia, especially neopelasia of intestine and respiratory tract (4). It is believed that protective effects of fruit and vegetable is partly due to antioxidants such as vitamin C and carotenoids which protect cells against lipid peroxidation and oxidative damage (5). The "At least five portions a day" was a slogan used by Europe against-cancer program and adopted by several European countries and medias (6-8). A 'Decent sized' portion of fruit and vegetable is about 80 gram; therefore, at least three portions of vegetables and two portions of fruits corresponds to 250 g/d vegetables and 150 g/d fruits (4). However in a survey among ten European countries, consumption was less than the recommended measures in more than fifty percent of the investigated countries (4). A variety of factors affect the rate of fruit and vegetable consumption such as physical and financial accessibility, social and demographic conditions including marital status, psychological stresses and cultural factors, household income as well as housing and neighborhood conditions (9).

The seasonal food shortage that happens in pre-harvest season (10, 11) may reduce the availability and raise the price of food. Adapting to such situation, households may change their eating pattern by modifying quantity and quality of some food groups (12-14) including nutrient intake of vitamins and minerals (15). In this regard, seasonal fluctuation in serum nutrient levels has been established in several investigations. Although some of

Implication for health policy/practice/research/medical education:
With regard to the seasonal variation in fruit and vegetable intakes of Iranian households, pre and post-intervention evaluations should not be performed during different seasons. Moreover, in case of case-control studies, cases and controls should be recruited in the same seasons to reduce the bias caused by seasonal variations. Increasing the availability of fruits and vegetables by price controlling programs, subsiding some food items and proper food storage are among the strategies that may reduce the seasonal fluctuations observed in the intake of fruits and vegetables.

this fluctuation is due to environmental factors (i.e. sun exposure), an important part may be explained by the seasonal alterations in food intake (11, 16-21). In fact, seasonal variation in the quantity of fruit and vegetable consumption has been documented in several previous epidemiologic investigations (16, 22-25). It is more common in agricultural communities, although it has been demonstrated in developed countries as well. Several studies have shown that even in modern societies, seasonality may affect the intake of nutrients such as calcium, potassium, riboflavin and more significantly vitamin A and C (26-28).

Most recently, the occurrence of nutritional transition has been documented in Iran, which seems to be associated with the rapid rise in the prevalence of diabetes, hyperlipidemia, cardiovascular diseases and cancer (29-34). On the other hand, food insecurity- defined as taking less than 90% of energy requirement- has been reported in 20% of Iranian households, while intake of calcium, vitamin A and riboflavin is less than recommendations (29). Also, the seasonality in Iranian fruit and vegetable consumption has not been investigated. Considering that seasonal variation should be regarded in fruit and vegetable consumption enhancing programs, we investigated the seasonal intake of fruit and vegetable as well as vitamin A and C in Iranian households.

2. Objectives

We aimed to assess the seasonal fluctuations in fruit and vegetable as well as vitamin A and C dietary intake in Iranian households.

3. Materials and Methods

We analyzed the existing data collected during 2000 - 2002 from the Iranian household food pattern study, conducted by the National Nutrition and Food Technology Research Institute and the Ministry of Agriculture (35). The participants were consisted of 7158 Iranian households selected by Iranian statistic center by a systematic cluster random sampling method (Table 1) from all provinces in both rural and urban areas. Then, our investigators Interviewed each households, and for the families that did not wish to contribute, their neighbors were assessed. In order to determine seasonal food availability, assessments were performed in four seasons and in all provinces. In this regard, one fourth of samples from each province were assessed randomly in each season. In Iran, seasonal dates are as follow: spring from March 20th to June 20th, summer from June 21st to September 21st, autumn from September 22nd to December 20th and winter from December 21st to March 19th. Considering that Iranian dietary pattern is different in Ramadan and Nowroz, assessments were not performed during these periods.

Table 1. Number of Iranian Households Participating in Iranian Household Food Consumption Survey (2000-2002) in Different Seasons

Season	Urban	Rural	Total
Spring	1173	617	1790
Summer	1265	667	1932
Autumn	1057	644	1701
Winter	1167	568	1735
Total	4662	2469	7158

Demographic, socio-economic, anthropometric and food consumption pattern data were collected from December 21th 2000 till December 21th 2002 from both rural and urban households by the same method in different seasons. It should be mentioned that food consumption data have been collected by three consecutive 24 hours recalls (24 h DR) for each household. Trained dietitians performed face to face interview with the mother or the person responsible for food preparation and cooking in the last 24 hours at home. Eating out was not considered in this study. Household measures reported in recalls were weighed to converting food consumption to gram. As bread, sugar and oil are major sources of energy, households' container of these foods were weighed every day. A trained nutritionist checked and coded questionnaires every day. Data quality was warranted by quality checks associated with the data entry process, double entry, and also by further data cleaning. Calculation of energy and nutrients consumptions were made by an access program designed using Iranian food composition table (36) and has been modified by US department of agriculture (USDA) and WHO database (36, 37). Cooking coefficient was considered for vitamin C.

Calculation of energy requirements was performed by the latest FAO/WHO recommendations (38). Comparison of vitamins' intakes with vitamin requirements was made by the FAO/WHO requirement tables (39). Seasonal intake of fruit and vegetable was reported per capita. As weight and height measures are needed in calculating energy requirements, weights and heights of family members were measured in one of the three days of assessment. Weight was measured by portable digital scales (seca) to the nearest 100 g. Subjects were weighed while wearing light clothes and without shoes. Each subject was weighed twice and the mean was recorded. Children who were less than two years old were weighed in their mothers hold by a double weighing method. Scales were checked by a control weight before weighing each family. Heights were measured by tape meters to the nearest 0.5 centimeters, without shoes. For children who were not able to stand, lengths were measured.

It is noteworthy that our study was in fact a reanalysis of the existing data. In the original study, mothers or the persons responsible for food preparation were thoroughly explained about the aims of the study. Also, they could reject investigators at any stage of the study. Moreover, household information was kept anonymous and confidential. For data analysis, mean values of food, energy and nutrient intakes over three consecutive days per person were used. Statistical analysis was performed using SPSS for windows version 11.0. Data were checked for normality by Kolmogorov-Smirnov test. Intakes during different seasons were compared by one-way ANOVA test. A Newman-Keuls post-hoc analysis was used to locate statistical significance in seasons, when an ANOVA was significant. P values< 0.05 were considered to be significant.

4. Results

In general, 35924 subjects from 7158 households participated in this study (4662 urban and 2496 rural subjects). Of them, 47.2% were 19 - 50 year old, 25.7% were 10 - 18 years old and less than 30% were in other age groups. Frequency of Illiteracy was 20.6% in men and 54.5% in women, while illiterate but under bachelor were 72.8% and 38.6% among men and women respectively. Also, only 6.2% of men and 0.8% of women had Masters or postgraduate degrees. Although energy intakes were in desirable levels, calcium, iron and riboflavin intakes were below desirable levels (35). Both fruit and vegetable intakes showed a seasonal trend ($P < 0.01$). The highest level of vegetables consumption was seen in summer followed by spring, and the lowest level was in winter (Table 2). This seems to be due to the low consumption of non-leafy vegetables in winter. Except dried and canned vegetables and onion, vegetable subgroups revealed seasonal fluctuations ($P < 0.05$). As expected, potato and roots were consumed more in autumn and winter ($P < 0.01$), while onions' fluctuation was non-significant.

Table 2. Seasonal Consumption of Vegetables (Gross Gram/Person/day) among Iranian Households (2000 - 2002)

Season	Vegetable Group[a]							
	Potato	**Onion**	**Root**	**Leafy**	**Non- Leafy**	**Dried**	**Canned**	**Total**
Spring	63 ± 1.4	32 ± 0.7	4 ± 0.3	53 ± 1.5	128 ± 2.6	0.42 ± 0.1	0.22 ± 0.1	281 ± 3.8
Summer	63 ± 1.3	31 ± 0.6	5 ± 0.3	37 ± 1.1	152 ± 2.6	0.56 ± 1	0.21 ± 0.1	289 ± 3.4
Autumn	72 ± 1.5	31 ± 0.6	7 ± 0.5	42 ± 1.3	111 ± 2.5	0.28 ± 0.0	0.37 ± 0.1	264 ± 3.6
Winter	70 ± 1.5	30 ± 0.6	9 ± 0.6	48 ± 1.4	67 ± 1.9	0.41 ± 0.0	0.09 ± 0.0	224 ± 3.2
Total	68 ± 1	32 ± 1	7 ± 1	58 ± 1	121 + 1.4	0.42 ± 1	0.22 ± 1	286 ± 2.0
P value[b]	0.000	0.000	0.000	0.00	0.000	0.085	0.106	0.000

[a] Data are shown as mean ± SE.
[b] One way ANOVA test.

Seasonal variations of fruit intake were more dramatic. Considering a non-seasonal availability for canned and cooked fruits, their intakes were not seasonal. Citrus fruits intake showed a substantial increase in winter ($P < 0.01$) (Table 3), and consequently a great increase in the intake of vitamin C was evident (Table 4). As expected, consumption of melons showed a seasonal trend, being more during summer and autumn ($P < 0.01$). Totally, it could be implied that fruits consumption was more seasonal than vegetables and their variations were significant. Moreover, seasonal variation of energy intake was not sharp but significant ($P < 0.01$); however, it was always close to its requirements (Table 4). Vitamin A intake did not change dramatically or significantly (Table 4). Vitamin C showed a considerably significant seasonal variation with the highest and lowest amounts in winter and spring, respectively ($P < 0.01$). It is worthy to mention that intakes were always over requirements (Table 4). Requirements of energy, vitamin A and C did not change seasonally, which means that subjects were comparable in different seasons.

Table 3. Seasonal Consumption of Fruits (Gross Gram/Person/day) among Iranian Households (2000 - 2002)

Season	Fruit Group[a]				
	Citrus	**melons**	**Other Raw Fruit**	**Cooked and Canned**	**Total**
Spring	17 ± 1.3	82 ± 4.2	42 ± 2.0	0.98 ± 0.3	143 ± 5.0
Summer	2 ± 0.3	156 ± 5.3	105 ± 2.9	0.41 ± 0.1	263 ± 6.1
Autumn	40 ± 2.1	47 ± 3.6	122 ± 3.4	0.48 ± 0.2	210 ± 5.4
Winter	125 ± 3.4	0.25 ± 0.1	51 ± 1.8	0.38 ± 4.7	177 ± 4.3
Total	45 ± 1.2	74 ± 2.0	82 ± 1.4	0.56 ± 0.1	202 ± 2.7
P value[b]	0.00	0.00	0.00	0.092	0.00

[a] Data are shown as mean ± SEM.
[b] One way ANOVA test.

Table 4. Energy, Vitamin A and C Intakes and Requirements in Different Seasons among Iranian Households (2000 - 2002)

Nutrient/Energy		Season[a]					P Value[b]
		Spring	Summer	Autumn	Winter	Total	
Energy, kcal/person/day	Intake	2597 ± 15.7	2548 ± 15	2609 ± 17.1	2637 ± 16.2	2596 ± 8	0.001
	Requirement	2363 ± 6.4	2360 ± 6.3	2351 ± 6.4	2370 ± 6.4	2361 ± 3.2	0.238
Vitamin A, retinol equivalent/person/day	Intake	666 ± 19.3	662 ± 19	633 ± 19.8	670 ± 21.4	658 ± 9.9	0.543
	Requirement	538 ± 1.1	539 ± 1.0	537 ± 1.1	539 ± 1.1	538 ± 0.5	0.420
Vitamin C, mg/person/day	Intake	47 ± 0.9	57 ± 1.1	51 ± 1	75 ± 1.4	57 ± 0.6	0.000
	Requirement	43 ± 0.1	43 ± 0.1	42 ± 0.1	43 ± 0.1	43 ± 0.0	0.109

[a] Data are shown as mean ± SEM.
[b] One way ANOVA test.

Table 5 shows vegetable and fruit contribution to energy, vitamin A and C intakes. According to the table they provide little amounts of energy, but their role in providing vitamin A and C is considerable. Also, they provide more than half of these two vitamins' intakes and the role of vegetables is more than twofold of fruits.

Table 5. Vegetable and Fruit Contribution (%) to Energy, Vitamin A and C Intake in Different Seasons

Energy/ Vitamin	Food Group							
	Vegetable				Fruit			
	Spring	Summer	Autumn	Winter	Spring	Summer	Autumn	Winter
Energy	4	4.1	4.1	3.8	1.7	4.1	3.7	2.8
Vitamin A	47.8	46.3	48.2	42.4	6.4	9.9	9.2	12.1
Vitamin C	54.9	48.3	46.1	31.5	18.4	32.2	26.2	43.2

5. Discussion

This study was conducted using existing data from national Iranian households' food consumption patterns during 2000 - 2002. It is the latest nationwide food consumption pattern study. This study revealed that Iranian households consumed more vegetable in summer and spring and more fruit in summer. High consumption of citrus fruits in winter could be considered as the reason for high vitamin C intake in this season. Also, requirements of energy and vitamin A and C were similar in different seasons.

As mentioned before, consumption of 250 g/d of vegetables and 150 g/d of fruits is recommended. Except winter, Iranian households' intakes of vegetables were adequate with regard to three portions suggested by European against-cancer program. However, it should be mentioned that potato was included in vegetable group. Although consumption of fruits is below desirable levels in spring, Iranian population seems to eat enough fruits during the year. In this regard, the mean year-round intake of vegetables and fruits are over the recommendations, but enough intakes in all seasons should be supported by educational programs.

Consistent with the results of this study, Tehran Lipid and Glucose Study (TLGS) indicated 5.6 ± 3.4 daily portions of fruits and vegetables intake among families that live in Tehran (40). In a cross-sectional study of adult female teachers in Tehran, mean daily fruits and vegetables intakes were 228 ± 79 g/d and 186 ± 88 g/d, respectively (41).

Cultural and climate conditions may cause different seasonal variations in dietary patterns of countries. Many studies have shown seasonal variations in vegetables and fruit intakes even in modern societies, where access does not change vigorously. Seasonal rise of prices or alteration in appetite to some food items has been documented in developed areas and could be considered as the reasons for the seasonal intake patterns (42). A systematic review indicated that an inverse relationship exists between winter and vegetable intake in developed societies; however, fruits intake did not show seasonal variation (9). On the contrary, Ziegler and colleagues (22) showed that vegetables are generally (except summer squash) eaten year-round, whereas some fruits (cantaloupe,watermelon, peaches, nectarines) are eaten primarily in a specific season. However, most people consume apricot (canned and dried), canned peach and pink grape fruit year round. Locke E. and colleagues reported significantly higher consumption of apples, pears, plums, peaches and apricots in harvest season. Frequency of individuals consuming higher than the median annual intake of orange was greatest in winter and spring. Asparagus, carrots, peppers, maize, pumpkins, squash and cucumbers consumptions were greater in harvest season and green beans, tomatoes and onions were consumed year round (15). In a study in children of Bennie, vegetable consumption and vitamin C intake showed seasonal pattern (13). In china, variations in intakes of vitamin A and C were significantly different in different seasons (42).

The effects of seasonal variation in fruit and vegetable intake -which affect intakes of vitamin A and C- on the prevention of diseases, could be considered in two ways. First, considering the relation between vitamin A and C with the incidence of diseases, seasonal variations may probably increase the risk of some diseases in some seasons (16). Moreover, seasonal reduction in consumption will result in lower year round intake. Fruit and vegetable subsides or price controlling strategies should be considered in high risk areas during scare seasons. Second, as type and quantity of fruit and vegetable consumed vary across seasons, epidemiologic studies that rely on dietary data collected cross-sectionally may be biased (25, 43). Failure to account for such variability may obscure associations between dietary consumption and risks of diseases. Food records and 24 hour recalls are even more problematic (43). Querying certain foods for in-season intake pattern may help to prevent subjects from making errors in converting season-specific intake to a year round average. Also, the seasonal variations in dietary intakes are in part attributable to the eating behaviors, food habits and to the accessibility of foods (25). Therefore, seasonal variation of food consumption should be studied locally in order to more reliably study the relationships between diseases incidence and dietary patterns.

In this study, we used the 24-hour dietary recalls in three consecutive days which is the gold standard approach of dietary assessment (44). Moreover, household measures reported in recalls were weighed, and container of main energy source (bread, rice and oils) was also weighed every day which increased the accuracy of our data. Additionally, we studied a large sample representing all rural and urban Iranian citizens living in different provinces. It is noteworthy that the nationwide food consumption pattern study was done twice in Iran, and we analyzed the data of the second study. Considering that nowadays the food price has changed dramatically in Iran, assessing the impact of such raise on seasonal fluctuation of food intake requires further studies. Assessments of nutrient blood levels as well as the incidences of diseases are also recommended for future studies. Lack of an updated food composition table in Iran affects the accuracy of all nutrient intake studies among the Iranian community.

With regard to the seasonal variations in fruit and vegetable intakes of Iranian households, pre and post-intervention evaluations should not be performed during different seasons. Moreover, in case of case-control studies, cases and controls should be recruited in the same seasons (43) to reduce the bias caused by seasonal variations. Increasing the availability of fruits and vegetables by price controlling programs, subsiding some food items and proper food storage are among the strategies that may reduce the seasonal fluctuations observed in the intake of fruits and vegetables.

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Authors Contribution

Original assessment was conducted by the National Nutrition and Food Technology Research Institute. All authors except Ms. Ebrahimpour were involved from initial to the end of this research. Ms. Ebrahimpour helped in drafting the article.

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All authors hereby declare that they have no conflict of interest.

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