RESEARCH COMMUNICATION

Development of a Semi-quantitative Food Frequency Questionnaire for Dietary Studies - Focus on Vitamin C Intake

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Abstract

The present work aimed to provide a basis for examination of intake of selected food items determined with a semi-quantitative food frequency questionnaire (SQFFQ) and planned-food selection (PFS). From February to July of 2003, ninety one cancer patients and 90 matched (sex and age ± 5 years) non-cancer patients were directly interviewed by trained interviewers using the designed questionnaire at the inpatient-department of Viet Duc hospital, Ha Noi City, Viet Nam. Study subjects consumed more SQFFQ-food items than PFS-food items, so that the latter method might not accurately reflect dietary habits regarding estimation of nutrient intake, especially vitamins. Because these are beneficial factors acting against cancer development at many sites, the absence of food items selected by SQFFQ may result in a poor database regarding possible confounding factors. For futher clarification we then focused on vitamin C contributions of Vietnamese food and analyzed data of the National Nutritional Household Survey in 2000: 7,686 households throughout the country (vitamin C intake status) and 158 households with 741 persons of the population of Hanoi city (individual food items contributing to vitamin C). Direct interview using a validated questionnaire with an album of current Vietnamese food items-recipes and weighing checks was conducted to obtain information regarding all types of food intake over the last 24-hours. Contribution analysis using the Nutritive Composition Table of Vietnamese Foods, revision 2000, and stepwise regression analysis was applied. Average intake adjusted by ages of vitamin C per person per day was estimated. In total, the study subjects were found to currently consume 184 food items. Average intake of vitamin C was 72.5 mg per person per day at the national level: 57.9% from leafy vegetables, 33.4% from fresh fruits, and 6.4% from non-leafy vegetables. For vitamin C contribution, the highest 25 food items contributed to a cumulative 95.3% of vitamin C intake with a cumulative R2=0.99.

Key Words: Dietary influence - semi-quantitative food frequency questionnaire - vitamin C - sources - Viet Nam

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Introduction

The relation of diet to cancer has long been highlighted (Bulkley, 1914) and during the 1980s about 35% of human cancers were estimated to be due to dietary factors (Doll & Peto, 1981). However, our knowledge of mechanisms linking diet to cancer are still limited, largely because quantitation is very difficult. We earlier found that frequent intake of fried foods increased the risk of developing stomach cancer as much as four fold, based on follow-up of 25 selected food items in 586 Japanese foodstuffs (Ngoan et al., 2002; Tokudome et al., 1998).

To select food items for epidemiological studies on dietary habits and cancer there are two generally applied methods: semi-quantitative food frequency questionnaire (SQFFQ); and the other is a planned-food selection (PFS). These two methods have major differences in principles and ways of choosing food items, including the designed questionnaires. Selection of food items by SQFFQ is based on nutrient contributions by food intake whereas by PFS it is based on the investigator's hypothesis for a possible relationship with specific food items. Very few studies have been performed to address advantages and disadvantages of these two methods. Therefore the present work was performed focusing on the diet of Viet Nam.

It has been hypothesized that vitamin C may reduce the risk of developing stomach cancer by about 50% (Balansky et al., 1986). Vitamin C contribution by daily

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Table 1. Proportions of Study Subjects Consuming Food Selected by the SQFFQ

	Food item (English: Vietnamese)	Intake[#]		
Rice and cereals				
1/1	Standard polished rice: gao te may	100	100	2028
2/6	Bread: banh mi	80	77	44
3 /3	Rice - soup noodles: banh pho	71	83	68
4/4	Rice noodles: bun	83	85	47
5/5	Wheat noodles: mi tom	75	72	94
6/2	Glutinous rice: gao nep cai	89	85	53
7/*	Rice noodle: mi gao	53	52	42
Beans, tofu				
8/26	Black bean dried: dau den	67	68	32
9/*	Green beans (peas): dau xanh	86	73	37
10/27	Dried peanut seed: lac hat	82	85	56
11/43	Monordica (red): gac	40	44	2
12/25	Tofu: dau phu	97	97	126
Vegetables				
13/28	Water spinach: rau muong	98	93	140
14/29	Mustard greens: cai xanh	91	89	28
15/30	Sauropus, sp. Leaves: rau ngot	88	90	16
16/36	Malabar night shade: rau mong toi	83	82	15
17/31	Tomato: ca chua	92	93	43
18/37	Chinese cabbage: cai thia	53	58	9
19/38	Radish garden while: cu cai trang	62	64	5
20/39	Cabbage, common: cai bap	93	92	36
21/35	Winter melon: bi xanh	89	90	10
22/32	Gourd, sponge gourd: muop	89	83	9
23/33	Mungobean sprouts: gia dau xanh	82	80	36
24/40	Bamboo shoot: mang chua	62	67	8
25/41	Banana flowers: nu chuoi	27	36	2
26/42	Dried seaweed: rau cau kho	1	2	0.1
27/*	Kohlrabi: su hao	97	93	22
28/*	Cauliflower: su lo	61	72	7
29/*	Carrot: ca rot	50	65	7
30/*	Lettuce: rau diep	74	72	22
Fats and oils				
31/58	Plant oils: dau an	58	78	194
32/59	Pork fat: mo lon	64	49	154
33/*	Chicken fat: mo ga	10	10	6
Meats and eggs				
34/7	Pork lean: thit lon nac	62	72	140
35/8	Pork medium fat: ba chi	63	67	174
36/13	Grouse field chicken: thit ga	95	97	48
37/9	Beef meat grade II: thit bo loai 2	70	83	46
38/10	Pork, ribs no bone: suon lon	84	89	47
39/14	Pork, leg no bone: chan gio lon	64	72	26
40/19	Duck grade I: thit vit	71	74	12
41/22	Pork liver: gan lon	64	54	11
42/23	Chicken liver: gan ga	20	24	5
43/24	Dog meat: thit cho san	55	62	6
44/12	Hen egg: trung ga	72	82	99
45/11	Duck egg: trung vit	73	79	64
Fishes				
46/17	Carp; amur: ca tram	61	54	23
47/18	Scad, anchovy: ca nuc	36	34	27
48/21	major carp: ca troi	42	44	14
49/20	Mackerel, king fish: ca thu	15	21	5
50/*	Mullet, harder: ca diec	17	13	3
51/*	Carp: ca chep	52	64	17
52/*	Fish snack dead: ca qua	45	45	9
53/*	Climbing perch: ca ro dong	26	30	6
54/*	African carp: ca ro phi	35	28	6
55/*	Hyphophthalmichthys: ca me	40	35	9
56/*	Snail large edible: oc nhoi	45	43	4
57/*	Shrimp fields river: tom dong	73	75	26
58/*	Crab, fresh water: cua dong	61	67	35
Fruits				
59/52	Guava common: oi	35	31	4
60/51	Sugar apple, sweetsop: na	75	80	24
61/45	Orange, sweet: cam	79	75	15
62/44	Pomelo, pummelo: buoi	49	46	6
63/46	Lemon: chanh	48	52	15
64/49	Papaya ripe: du du chin	53	57	4
65/54	Tangerine, orange: quit	64	57	11
66/53	Mandarin: quat chin	7	12	3
67/47	Banana: chuoi	65	65	21
68/*	Banana-dward: chuoi tieu	60	67	39
69/48	Watermelon: dua hau	80	81	14
70/50	Pear: le	34	34	2
71/55	Star apple, cainito: vu sua	21	17	1
72/*	Litchi: vai	78	88	16
73/*	Jack fruit: mit	60	56	5
74/*	Longan: nhan	88	82	7
75/*	Plum: man	22	26	2
76/*	Apple: tao ta	43	46	11
77/*	Apple: tao tay	49	40	10
Milk and snacks				
78/15	Milk cow: sua bo tuoi	14	30	28
79/16	Soybean milk: sua dau nanh	26	53	61
80/56	Biscuits, plain: bich quy	62	62	80
81/57	Sugar crude, brown: duong cat	85	80	167
Salted food items				
82/60	Fish sauce: nuoc mam ca	98	96	503
83/*	Fermented soybean past: tuong	37	39	31
84/61	Soya bean sauce: xi dau	17	33	15
85/*	Glutamate seasoning: mi chinh	89	90	496
86/63	Seasoning salt: bot canh	91	98	554
87/*	Salted eggplant: ca muoi	60	60	24
88/*	Shredded meat: ruoc thit lon	39	43	29
89/*	Salted-dried fishes: ca kho	45	35	8
90/*	Shrimp sauces: mam tom dac	40	42	15
91/*	Salted cucumber: dua chuot muoi	9	10	3
92/*	Salted onion (Welsh): hanh muoi	45	56	10
93/34	Rape bird salted: dua cai sen	70	63	54
94/*	Other pickled vegetables: dua khac	14	22	14
95/*	Salted peanuts: lac rang muoi	48	54	45
96/*	Mince lean pork meats: gio lua	88	82	21
97/*	Mince fat pork meats: cha lon	80	73	21
98/*	Bacon: thit muoi	0	0	0
99/*	Ham: giam bong	2	3	0.4
100/*	Chinese pork sausage: lap xuong	17	15	4
101/*	Chinese braised pork: thit kho tau	50	56	21
102/*	Deep-boiled fishes: ca kho	76	82	39
103/*	Fermented beef meat: nem chua	33	39	10
Fried food				
104/*	Garlic, onion: hanh, toi	70	71	76
105/*	Fish: ca	84	88	42
106/*	Meat: thit	62	64	30
107/*	Potato, taro: khoai cu	39	30	15
108/*	Tofu: dau phu	92	89	88
109/*	Rice papers: nem ran	70	66	17
110/*	Eggs: trung	79	81	64
111/*	Special sauce: n-uoc hµng	36	45	23
112/*	Tempura: tam bot ran	24	33	4
Broiled food				
113/*	Fresh fish: ca tuoi	18	12	1
114/*/*	Dry cuttle fish: muc nuong	39	39	3
116/*	Cattle meat: gia suc	37	34	5
117/*	Poultry meat: gia cam	23	31	3
118/*	Potato, taro: khoai cu	44	24	6
119/*	Babecu: quat cha	58	60	11
Drinking habits				
120/*	Powder coffee: ca phe hoa tan	20	25	5
121/*	Coffee filter: ca phe phin	23	21	16
122/*	Tea: tra	72	62	1278
123/62	Beer: bia	62	61	93
124/*	Imported alcohol: ruou ngoai	16	10	2
125/*	Domestic alcohol: ruou noi	55	47	238
126/*	Imported wine: ruou vang ngoai	10	6	1
127/*	Domestic wine: ruou vang noi	20	19	6

[#]Percentage of Cases consuming, % of controls consuming and mean intake *salted/fried/broiled foods

food consumption could conceivably be a strong inhibitor against various types of carcinogens. We therefore further examined vitamin C contributions by Vietnamese foodstuffs in our SQFFQ.

Materials and Methods

Development of a database semi-quantitative food frequency questionnaire

Based on the national household survey of food consumption in 2000, the analysis was performed with surveyed data for Hanoi. A total of 158 households (5 clusters multiplying around 30 households per cluster) living in Hanoi participated in a 24- hour recall survey during September 2000. The unit of survey was the household. A 24-hour recall survey was also carried out on one weekday. Direct interviews were done in the households by 2 investigators from the National Institute of Nutrition (NIN). The total time of interview for each subject was around 45 minutes.

Based on the Vietnam Food Composition Tables, the following 17 nutrients were selected: energy, protein, fat, carbohydrate, dietary fibber, vitamins (including carotene, vitamin A, C, B1, and B2), and minerals (including calcium, phosphorus, iron and zinc). In total, 184 kinds of foodstuff were consumed by the subjects. The nutrient intake from food was computed by multiplying the food intake (in grams) with nutrient content per gram of food as listed in the Nutritive Composition Tables of Vietnamese food (revision 2000).

According to the contribution analysis and also multiple regression analysis, we choose all food/recipes with up to 90% cumulative contribution for these 17 nutrients, then foods/ recipes having apparently similar nutrient contents were grouped. Afterwards, all foods/ recipes with up to 90% cumulative contributions and 0.9 cumulative multiple regression co-efficient were included in the SQFFQ. The number of food items was 63 (see Table 1).

Planned-food selection

Our planned food items for further estimation of salt intake, cooking methods and drinking habit were rice and cereals (1), beans (1), vegetables (4), oils (1), fishes (9), fruits (7), salted food (18), fried food (9), broiled food (7), and beverages (7). A total of 127 food items are included in the same questionnaire, with the overlap noted (Table 1). From each patient, information regarding of frequent intake, size of intake unit and number of intake unit per year was obtained.

Direct interviews of cancer and non-cancer patients

From February to July of 2003, ninety one cancer patients and 90 matched (Sex and age ± 5) non-cancer patients were directly interviewed by trained interviewers at the inpatient-department of Viet Duc hospital. No missing data were found among the 181 completed questionnaires for 127 food items.

Assessment of vitamin C intake sources

We analyzed data of the National Nutritional Household Survey in 2000: 7,686 households throughout the country (vitamin C intake status) and 158 households with 741 persons of the population of Hanoi city (individual food items contributing to vitamin C intake). Direct interviews using a validated questionnaire with an album of current Vietnamese food items-recipes and weighing check were conducted to obtain information regarding all types of food intake during the last 24-hour. Contribution analysis using the Nutritive Composition Table of Vietnamese Foods, revision 2000 and stepwise regression analysis was applied (National Institute of Nutrition, 2000; Tokudome et al., 1998). Average intake adjusted by age of vitamin C per person per day was estimated. Correlation analysis as Pearson Correlation Coefficients and a regression formula was calculated for the average amount intake of foods and vitamin C intake for the eight regions of Viet Nam.

Results

In total, 12 food groups and beverages are used by Vietnamese people at present. All 63 food items that were chosen by the method of SQFFQ were consumed by all patients. Ordinary polished rice intake by all study subjects was about 5.5 intake units per day. Among 64 food items that were chosen by the method of planned-food selection, no-one consumed bacon, a salted food (see Table 1).

The proportion of cancer patients who consumed 63 food items selected by SQFFQ was ranked from 1 to 100%, with a mean of 64% that was higher than the 47% for 64 food items selected by PFS, ranked from zero to 97%. Similarly, the proportions of non-cancer patients who consumed 63 food items selected by SQFFQ were ranked from 2 to 100% and the mean of 66% was higher than the 47% found for 64 food items selected by PFS, ranked from zero to 93%.

Average amount intake of vitamin C was 72.5 mg per person per day at the national level. In total, the study subjects currently consumed 184 food items. The contributions of 53 items accounting for 97.7% of the total intake are listed in Table 2. Approximate proportions of vitamin C contribution were 57.9% for leafy vegetables, 33.4% for fresh fruits, and 6.4% for nopn-leafy vegetables. The highest 25 items contributed a cumulative 95.3% of intake with a cumulative R2=0.99 (see Figure 1).

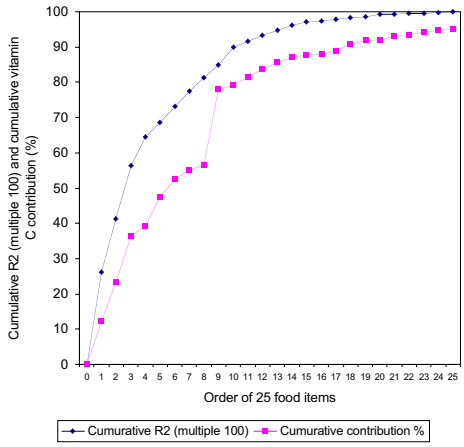

Figure 1. Cumulative R2 and Vitamin Contribution

Table 2. Vitamin C Contributions of Individual Items

	English name	Vietnamese name	Code*	(%)
Fruits				
1	Guava common	oi	5040	10.98
2	Sugarapple, sweetsop	na	5034	8.24
3	Orange, sweet	cam	5002	5.01
4	Pomelo, pummelo	buoi	5001	2.90
5	Lemon	chanh	5003	1.98
6	Papaya ripe	du du chin	5017	1.29
7	Tangerine, orange	quit	5047	0.69
8	Banana	chuoi (cac loai)	5006-07	0.63
9	Mandarin	quat chin	5046	0.51
10	Watermelon	dua hau	5011	0.28
11	Apple	tao (cac loai)	5050-51	0.27
12	Dragons eyes	thanh long	5044	0.19
13	Pear	le	5023	0.14
14	Starapple, cainito	vu sua	5054	0.08
15	Cucumber	dua chuot	4027	0.08
16	Persimmon kaki	hong do	5020	0.05
17	Carambola, Star fruit	khe	4045	0.04
18	Ohia, Malaya roseapp	gioi	5018	0.04
	Sub – total for fruit	33.40		
Leaves				
19	Water spinach, water convol	rau muong	4082	21.40
20	Mustard greens	cai xanh	4016	13.09
21	Sauropus (Leaves)	rau ngot	4085	12.31
22	Malabar night shade	rau mong toi	4079	2.71
23	Jute potherb	rau day	4069	2.36
24	Chinese cabbage	cai thia	4015	1.87
25	Cabbage, common	cai bap	4010	1.23
26	Onion, Welsh (leaves)	hanh la	4038	0.97
27	Amaranth, White	rau ren trang	4073	0.60
28	Mungobean sprouts,	gia dau xanh	4036	0.52
29	Celery, Chinese	can tay	4018	0.37
30	Sweat marjoram	rau kinh gioi	4076	0.17
31	Parsley, curley	rau mui tau	4081	0.13
32	Basil sweat leaves, raw	rau hung	4074	0.07
33	Dill	thia la	4099	0.05
34	Limnophila aromatic	rau ngo	4084	0.02
35	Lettuce	rau xa lach	4089	0.01
36	Balm - mint	tia to	4100	0.01
37	Polygonum odoratum	rau ram	4087	0.01
	Sub – total for leaves	57.90		
Tubers				
38	Tomato	ca chua	4005	2.13
39	Radish garden while, raw	cu cai trang	4021	1.55
40	Winter melon	bi xanh	4002	0.85
41	Gourd, sponge gourd	muop	4054	0.77
42	Bamboo shoot	mang chua	4050	0.32
43	Chili pepper	ot vang to	4061	0.16
44	Balsam - pear	muop dang	4055	0.14
45	Aubergine	ca tim	4009	0.11
46	Cow - peas, yard long	dau dua	4030	0.11
47	Potato, White	khoai tay	2014	0.08
48	Banana flowers	banana flower	4043	0.04
49	Momordica	gac	4034	0.04
50	Carrots	ca rot	4007	0.04
51	Taro tuber	khoai so	2013	0.03
52	Ginger root fresh	gung tuoi	13003	0.02
53	Pumpkin squash	bi dao	4003	0.01
	Sub – total for tubers	6.40		

* Nutritive composition table of Vietnamese foods, revision 2000. Total contribution of vitamin C is 97.7% by 53 food items

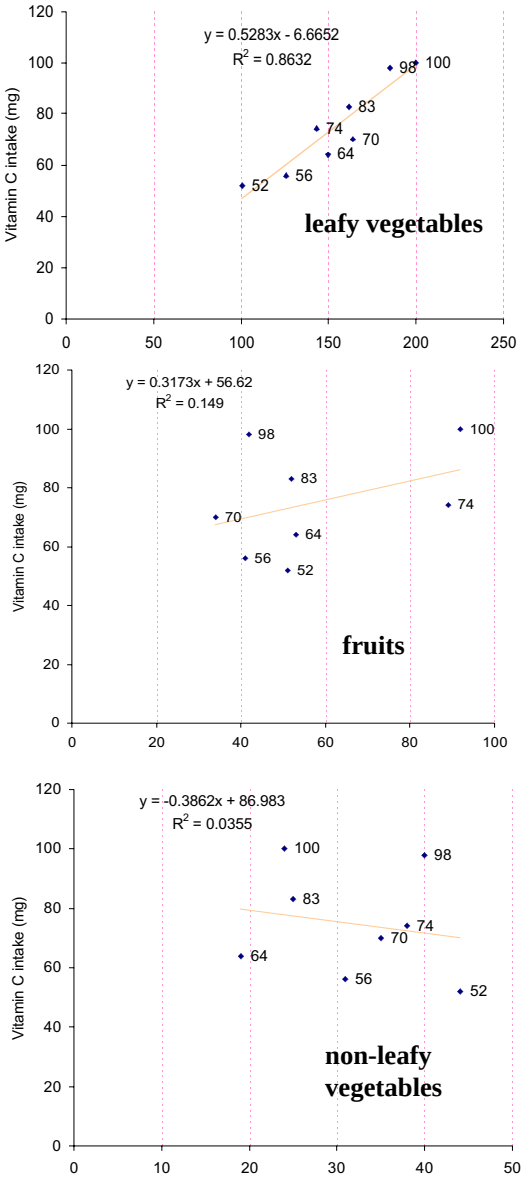

Figure 2. Correlations Between Vitamin C Intake and Consumption of Foodstuffs

A significant strong positive relationship between the average amount intake of vitamin C was found across the eight regions of Viet Nam (R2= 0.86) with average intake of leafy vegetables but not with average intake of fruit (R2= 0.15) or non-leafy vegetables (R2= 0.04) (see Figure 2).

Data from various sources for vitamin C intake in Viet Nam are summarized in Table 3.

Discussion

Study subjects were found to consume more SQFFQ-food items than PFS, that is, 64% verses 47% of cancer patients and 66% verses 47% of non-cancer patients who have consumed these food items. These results suggest that information obtained by PFS might not reflect the real dietary habits of study subjects regarding estimation of nutrient intake, especially proteins and vitamins. Because these latter are beneficial factors against developing cancer at many sites, therefore, an absence of

Table 3. Average Intake of Vegetables and Fruits (g) and Vitamin C (mg) in Viet Nam by Time Period

Population Time	Source	Study subjects	Method	Veg/fruits (g)	Vit C (mg)
All populations	WHO 1990	Estimation	Estimation	400	100
Viet Nam, 2000,	Present study	7,686 households	24-hour recall + double methods*	241	72.5
Viet Nam 1996	(Giay et al., 1996)	4,216 households	24 - hour recall**	166	19-55
Viet Nam, 1987-89	(Mai et al., 2001)	12,000 households	24 - hour recall**	196	53
HCM City, 1999	(Kieu et al., 2002)	300 individuals	24 - hour recall**	235	76
Hanoi City, 1996	(Anh et al., 2001)	299 individuals	24 - hour recall**	197	66

NS, not stated; HCM, Ho Chi Minh City. * Double methods: food record and weighing check before cooking, processing, and preserving for meal at the level of 1 gram; ** Face to face direct interviews

food items that are selected by PFC may result a poor database regarding possible confounding factors. It was earlier confirmed that FFQ results are in good accord with 3day-weighed diet records (Tokudome et a., 2005).

Regarding principles and methods of SQFFQ-food selection, semi-quantitative food frequency questionnaire covers about 90% or more nutrients intake. This information will be a basic of dietary habit of the study population. Validity and reproducibility with the SQFFQ has been verified in Japan (Date et al., 2005) and the same approach has also been applied in Korean (Kim et al., 2004). Reproducibility and validity of a food frequency questionnaire among Vietnamese in Ho Chi Minh City have also been reported (Kusama et al., 2005). However, by following these principles and methods, some possible planned-food items will not be selected. Therefore, additional food items that are chosen by PFS in the designed questionnaire should be considered as following the researcher's hypothesis.

A database of SQFFQ for vitamin C was developed in the present study and some 25 food items contributing up to 95.3% of total vitamin C intake were selected. A similar approach for calcium intake was very recently reported (Khan et al., 2008).

From 1987 to 2000, Vietnamese intake of vitamin C was found to range from 19 to 76 mg per day, and therefore lower than the 100 mg per day recommended by the WHO to prevent against cancer in humans (World Health Organization, 1990). Similarly it was earlier found that large numbers of Vietnamese subjects demonstrate very low serum concentrations of beta-carotene and tocopherol (Kieu et al., 2002b). In both urban and rural groups, more than 50% and 20% of children showed beta-carotene and tocopherol levels in the range of severe deficiency (Ta et al., 2003). Viet Nam is a tropical country and produces abundant vegetables and fruits, but people consume less than 400 gram of vegetables and fruits resulting a low vitamin C and other antioxidant intake. In fact, wild vegetables may contribute significantly to the overall micronutrient intakes, mostly carotene, vitamin C and calcium intakes (Ogle et al., 2001). Health education to promote consumption of vegetables and fruits should be conducted. Paradoxically, a low fat intake and low serum cholesterol may also be a problem in some sections of the populace (Anh et al., 2001).

Here we found two variables of the cumulative R2 and cumulative vitamin C contribution are parallel in the same direction, Figure 1. Therefore, variable of the cumulative R2 should be an indicator in selecting food items for our study on the relation of diet to cancer (Tokudome et al., 1998). Due to the fact that fruits are only available in season and may be expensive at other times, Vietnamese usually only prepare fruits for people suffering from health problems. By this custom, there was a weak correlation between the average amount intakes of fruits with the average amount intake of vitamin C. A similar observation was seen for non-leafy vegetables because these are also seasonal in Viet Nam. To improve vitamin C intake, leafy vegetables are the best way because these food items are produced in all four seasons in Viet Nam.

In recognition of the continuing shift in dietary patterns in Viet Nam, largely dependent on the socieconomic groups (Dien et al., 2004) new guidelines have been prepared for Recommended Dietary Allowances (RDAs) (Khan and Hoan, 2008). In adults in Vietnam, undernutrition may still be a public health problem in rural areas whereas overnutrition has started to become noteworthy in the urban context (Hanh et al., 2001). A consensus on the need for regional collaboration and harmonization of RDAs was recently reached by participants from Indonesia, Malaysia, Philippines, Singapore, Thailand and Vietnam (Barba and Cabrera, 2008) and it is to be hope that further research will provide the evidence base for rational nutrition planning in this region of the world.

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