Original Research

Nutritional Status of Middle-Aged Vietnamese in Ho Chi Minh City

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Key words: Vietnamese, middle-aged, nutritional status, undernutrition, overnutrition

Objective: To investigate the nutritional status of middle-aged Vietnamese in Ho Chi Minh City.

Methods: A cross-sectional survey in 300 Vietnamese aged 40 to 59 years (113 men, 187 women) was conducted in an urban, suburban and rural area of Ho Chi Minh City based on interviews that included a 24-hour dietary recall, food frequency questionnaire, and a short socioeconomic questionnaire. Anthropometry and blood pressure were measured, and blood was collected for serum protein and lipid analysis.

Results: A high prevalence of underweight (BMI $<$ 18.5) was observed in the rural and suburban populations (35% and 23%, respectively), and overweight (BMI $\geq$ 25) was observed in the urban population (18%). A high percentage of serum total cholesterol (TC) below 150 mg/dL was observed in the rural and suburban areas (43% and 37%, respectively). By contrast, the prevalence of TC above 220 mg/dL was twofold higher in the urban and suburban residents (13% and 12%, respectively) than in rural residents (6%). More than 80% of urban residents were of medium or high-income status, whereas 61% of suburban residents were of medium-income status and 66% of rural residents were of low-income status.

Conclusions: The nutritional status of middle-aged Vietnamese in Ho Chi Minh City was characterized by undernutrition in 35% of the low-income population and by overnutrition in 18% the high-income population. Undernutrition was still a public health problem in the rural area whereas overnutrition started to become a noteworthy problem in the urban area. The suburban area suffered from both under- and overnutrition problems. Low lipid intake was the most important problem related to undernutrition in middle-aged residents of Ho Chi Minh City.

INTRODUCTION

The relationship between dietary pattern, lifestyle and disease has long been investigated [1]. Assessing and characterizing nutritional status of populations may be helpful in controlling and preventing nutrition-related chronic diseases. In Vietnam, many studies have been done to assess nutritional status in mothers and children because they are vulnerable groups [2]. Furthermore, studies on these groups can be conducted relatively easily because many mothers may stay at home and children may stay at home or at school.

However, knowledge on the nutritional status of middle-aged Vietnamese is limited. Moreover, biochemical nutritional status data from people in this age group are not available because blood analysis is not done in community surveys in Vietnam. It is also difficult to survey people of this age because of work obligations and conflicting schedules. Many people in this age range are so busy that they do not pay much attention to their health or do not consider the consequences of their lifestyle. As the aging process continues, middle-aged people are at increasing risk for developing chronic diseases that may be slowed or prevented by dietary pattern and lifestyle.

There is a body of evidence indicating that the Vietnamese need to be concerned about an increasing prevalence of chronic diseases. According to a Vietnamese national health survey of people aged 16 and older, the prevalence of hypertension increased considerably from 1.9% in 1976 to 11.5% in 1990 [3]. Coronary heart diseases increased from 3.9% in 1992 to

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4.5% in 1996, according to the Vietnam Heart Institute [3]. Approximately 15% of Vietnamese women suffer from postmenopausal osteoporosis, a primary cause of spontaneous fracture in aging women [4]. According to recent data, 1.6% of persons aged 50 to 59 years in urban Hanoi are diagnosed diabetes [5].

Therefore, in order to promote a long life that is healthy, as well as to decrease the prevalence of chronic diseases whose treatments require tremendous financial resources, we must be concerned about nutritional status and nutrition-related diseases in middle-aged persons.

Vietnam is currently undergoing dynamic changes in its economy. As the economy improves, a shift from a traditional to a more Western lifestyle is taking place. Today, a more Western lifestyle is observed in urban areas, while the traditional style is still being preserved in rural areas. The economy has developed dramatically in urban areas of Vietnam inducing industrialization and modernization. As a result, people in urban regions do less manual labor, and their lifestyles are more sedentary than previously, i.e. their physical activity has decreased. However, people in rural areas predominately work as farmers and still do much manual labor without the assistance of mechanized equipment. As a result, there may be dietary factors and physical activities that are different between urban and rural regions and which may have dissimilar effects on nutritional status and risk for developing chronic diseases.

To clarify this issue, we carried out a survey to assess the nutritional status of middle-aged Vietnamese in an urban (high-income), suburban (mixed income) and rural (low-income) region of Ho Chi Minh City.

MATERIALS AND METHODS

Approved by the Health Service of Ho Chi Minh City, the survey was carried out in January 1999 in an urban, suburban and rural region of the city. The urban area selected was Ben Thanh ward (District I), a high-income area of Ho Chi Minh City, where many residents are businesspersons, officials and workers. The suburban area was Phu Thuan village (Nha Be District) where most of residents are workers and farmers. The rural area was a remote village of Tam Thon Hiep (Can Gio District), located 60 km east of Ho Chi Minh City. This is a poor seacoast area where the majority of the residents are farmers.

To select participants for the survey, we were provided with name lists of all men and women residents aged 40 to 59 years in our specific urban, suburban and rural areas. Approximately 100 subjects were randomly selected from each region, and a total of 300 subjects (113 men and 187 women) participated.

The interviews were performed with a questionnaire to obtain information on age, gender, socioeconomic status, occupation, education and usual dietary intake. To measure dietary intake, subjects were asked to recall all foods consumed during the previous 24 hours [6]. We showed household tableware items (i.e. bowls, plates, spoons and glasses) in varying sizes to the subjects and asked them to identify which ones and sizes they used. Twenty-four hour dietary energy and nutrient intakes were calculated using Vietnamese food composition tables [7].

A food frequency questionnaire with 11 items was also obtained. Based on a list of commonly consumed foods, for each food or food group, the subjects were asked to report their frequency of consumption on average (i.e., their usual or typical intake) in the appropriate interval, such as “every day,” “4 to 6 times per week,” “1 to 3 times per week,” “1 to 3 times per month” and “less than once per month or never.”

To evaluate the household income level, the subjects were asked to indicate which items they had in their house from a list of 12 high-value household items. The checked items were counted to get a total. Individual totals were arranged into the lowest ($\leq$4), medium (from $>$ 4 to 8) or highest (from $>$ 8 to 12) tertile and classified as low, medium or high income level. This is an indirect method of measuring household income, but more practical for surveys in the community than directly asking about household income. This method has been demonstrated to be comparable with the direct method and has been applied in different settings in Vietnam [8].

Education was classified into three levels as low (completed elementary school or lower), medium (secondary to high school) and high (college, university or higher).

The subjects were measured and weighed in light clothing without shoes. Body mass index (BMI) was computed as the ratio of weight (kg) per height squared (m^2). BMI was classified into three categories as follows: $<$18.5 (underweight), 18.5–24.9 (normal weight) and $\geq$25 (overweight).

Blood pressure was measured by mercury sphygmomanometer on the left arm three times while the subjects were seated, after relaxing for at least 15 minutes in a quiet environment. The average from three measurements was applied. Hypertension was defined as blood pressure $\geq$140/90 mmHg [9]. A general health examination was also performed by a licensed physician.

A sample of venous blood was obtained and centrifuged immediately after collection. Serum samples were frozen and transported to Japan on dry ice for analysis. We analyzed serum total cholesterol (TC) and triacylglycerol (TG) by enzymatic assay kits (Wako Pure Chemical Industries, Osaka, Japan), high-density lipoprotein cholesterol (HDL-C) by enzymatic assay kits (Daiichi Pure Chemicals Co., Ltd., Tokyo, Japan) and protein and albumin by assay kits (Wako Pure Chemical Industries, Osaka, Japan).

The dietary data were analyzed statistically using SPSS for Windows [10]. Means and standard deviations of the means (SD) were calculated, and differences among the three areas were assessed by one-way analysis of variance (ANOVA). Chi-square was used to compare difference in proportion of

BMI and TC levels among urban, suburban and rural areas. *p*-values less than 0.05 were considered significant.

RESULTS

More than 80% of the urban residents were of medium or high-income status, whereas 61% of the suburban residents were of medium-income status and 66% of the rural residents were of low-income status. Approximately 72% of the urban participants were classified as having a medium level of education while 56% and 86% of suburban and rural participants, respectively, fell in the low education category.

Table 1 shows that average age was similar in the three areas. The BMIs of urban participants were significantly higher than those in the rural area for both genders. Average blood pressures were in the normal range for both men and women. Overall, the prevalence of hypertension was 10.7%.

Table 2 shows that energy, protein and percentage of animal protein intakes were significantly higher in urban than in rural women. Significantly higher lipid intakes were observed in urban and suburban areas compared to the rural area for both genders. Protein density intake (% of total calorie intakes) in women was also higher in urban than rural areas. Lipid density intake was highest in the urban area and lowest in the rural area for both men and women. In contrast, carbohydrate composed more than 70% of total energy for both genders in the rural population. Calcium, vitamin B1, B2 and vitamin C intakes were also significantly higher in the urban than in the rural area for both genders. However, the differences became non-significant for calcium density in both genders and vitamin C density in women. Overall, energy intake was about 80% of the Vietnamese RDA [11], with the lowest percentage found in rural women (67% of Vietnamese RDA).

Table 3 shows that rural and suburban men consumed the highest amount of rice, whereas suburban women consumed the least amount among the three regions. Meat intake was higher in urban and suburban than in rural men. Milk consumption was low on average. Lard and oil and vegetable intakes were significantly higher in the urban *versus* the rural areas in both genders. Fruit intake was lowest in the rural area for both genders.

Frequency of food intakes is shown in Table 4. Most of the subjects consumed rice every day. Urban subjects consumed meat more frequently and fish less frequently than suburban and rural subjects. More than 90% of the rural subjects had never consumed milk. Condensed milk was consumed more frequently than full cream milk or skim milk in all three regions. Vegetables and fruits were consumed quite frequently.

Table 5 shows that average serum total protein, albumin and lipid concentrations in the three regions were in the normal range. TC was significantly higher in the urban than in the rural area in both men and women.

The prevalence of underweight subjects (BMI <18.5) in urban, suburban and rural areas was 7.9%, 23.0% and 35.4%, respectively. The prevalence of overweight subjects (BMI $\geq$ 25) was 17.8%, 13.0% and 6.1%, respectively.

Fig. 1 shows that the prevalence of TC <150 mg/dL was highest in the rural area (43%). The prevalence of TC ≥ 220 mg/dL was highest in the urban area (13%). Because this pattern was similar for both men and women, only the combined data is displayed in the figure.

DISCUSSION

As mentioned previously, Vietnamese society has different characteristics in urban, suburban and rural areas. Urban residents typically have higher incomes and educational levels than those in suburban and rural areas. This phenomenon is similar to the phenomenon observed in other developing countries [1]. The effect of rapid modernization in urban areas, contrasted with lingering poverty in rural areas, might be a factor. The suburban areas face both situations. From this survey, we found that the problems of under- and overnutrition coexist in Ho Chi Minh City.

Undernutrition

Overall, total energy intake was approximately 80% of the Vietnamese RDA and was lowest in the rural women (Table 2).

Table 1. Anthropometry and Blood Pressure by Region in Men and Women

	Men			Women		
	Urban (n = 33)	Suburban (n = 41)	Rural (n = 39)	Urban (n = 68)	Suburban (n = 59)	Rural (n = 60)
Age (years)	47.9 ± 5.7	46.6 ± 5.0	46.4 ± 4.8	47.5 ± 5.3	47.7 ± 6.5	47.4 ± 6.0
Height (cm)	162.9 ± 6.6	164.4 ± 5.9	164.3 ± 5.2	151.9 ± 4.5	151.8 ± 5.4	152.9 ± 5.3
Weight (kg)	59.7 ± 8.9[a]	57.4 ± 9.5[a]	52.6 ± 5.7[b]	51.9 ± 9.5[a]	49.4 ± 8.8	46.7 ± 7.2[b]
BMI	22.4 ± 2.7[a]	21.2 ± 3.3[a]	19.5 ± 2.4[b]	22.4 ± 3.5[a]	21.4 ± 3.8	20.0 ± 2.9[b]
SBP (mmHg)	128.5 ± 17.2	125.5 ± 21.9	125.6 ± 19.2	116.2 ± 12.1	117.2 ± 18.7	120.6 ± 16.0
DBP (mmHg)	84.8 ± 11.0	85.5 ± 13.0	84.7 ± 10.4	76.0 ± 7.9[a]	81.2 ± 11.4[b]	78.4 ± 8.8

Data are means ± SD.

[a,b] Means within a row in the same gender with different superscripts are significantly different at $p < 0.05$ by one way ANOVA.

BMI = body mass index, SBP = systolic blood pressure, DBP = diastolic blood pressure.

Table 2. Energy and Nutrient Intakes from 24-Hour Dietary Recall by Region in Men and Women

	Men			Women		
	Urban (n = 33)	Suburban (n = 41)	Rural (n = 39)	Urban (n = 68)	Suburban (n = 59)	Rural (n = 60)
Energy (kcal)	2340 ± 892	2458 ± 506	2148 ± 768	1932 ± 614[a]	1755 ± 677	1475 ± 617[b]
Protein (g)	92.9 ± 41.3	92.1 ± 27.9	80.6 ± 33.5	78.7 ± 30.1[a]	63.5 ± 24.3[b]	52.7 ± 25.1[b]
Animal protein (%)	51.0 ± 17.0	49.4 ± 16.5	44.8 ± 14.3	51.6 ± 15.2[a]	44.2 ± 21.5	38.1 ± 17.5[b]
Lipid (g)	53.3 ± 29.4[a]	41.7 ± 22.8[a]	24.2 ± 20.0[b]	43.4 ± 21.7[a]	35.0 ± 34.5[a]	13.7 ± 12.4[b]
Animal lipid (%)	37.3 ± 21.1	41.8 ± 21.5	46.2 ± 23.1	42.8 ± 21.8	46.6 ± 28.1	53.0 ± 27.6
Carbohydrate (g)	357 ± 156	407 ± 99	388 ± 130	294 ± 92	283 ± 109	277 ± 115
Calcium (mg)	592 ± 350[a]	554 ± 300	397 ± 178[b]	518 ± 353[a]	410 ± 252	381 ± 270[b]
Phosphorus (mg)	1102 ± 525	1118 ± 346	994 ± 397	945 ± 358[a]	751 ± 299[b]	661 ± 293[b]
Iron (mg)	14.1 ± 6.4	13.8 ± 5.0	11.5 ± 5.2	12.2 ± 4.7[a]	9.7 ± 4.9[b]	8.6 ± 5.2[b]
Vitamin B_1 (mg)	1.19 ± 0.58[a]	1.00 ± 0.38	0.78 ± 0.31[b]	0.92 ± 0.40[a]	0.69 ± 0.40[b]	0.54 ± 0.28[b]
Vitamin B_2 (mg)	0.81 ± 0.53[a]	0.70 ± 0.35	0.52 ± 0.31[b]	0.60 ± 0.29[a]	0.45 ± 0.23[b]	0.34 ± 0.20[b]
Niacin (mg)	13.7 ± 7.5	13.8 ± 5.5	11.6 ± 5.0	10.3 ± 6.1[a]	9.3 ± 5.6	7.6 ± 3.4[b]
Vitamin C (mg)	109 ± 82[a]	74 ± 49	50 ± 44[b]	112 ± 100[a]	60 ± 62[b]	51 ± 87[b]
Intakes as Percent of Total Calories						
Protein	16.2 ± 3.4	15.7 ± 4.5	15.4 ± 3.4	16.7 ± 3.5[a]	15.2 ± 4.3	14.5 ± 3.1[b]
Lipid	21.0 ± 9.0[a]	15.7 ± 7.2[b]	9.5 ± 5.3[c]	20.0 ± 7.3[a]	17.0 ± 10.6[a]	8.2 ± 6.2
Carbohydrate	62.7 ± 10.7[a]	68.6 ± 8.9[b]	75.0 ± 6.5[c]	63.3 ± 8.5[a]	67.8 ± 11.8[b]	77.4 ± 7.7[c]
Intakes as mg/1000 Calories						
Calcium	262 ± 152	228 ± 136	331 ± 588	299 ± 294	247 ± 180	384 ± 555
Phosphorus	465 ± 110	459 ± 120	461 ± 77	494 ± 122[a]	434 ± 109[b]	452 ± 102
Iron	6.12 ± 1.9	5.72 ± 2.37	5.34 ± 1.18	6.63 ± 3.31	5.59 ± 2.24	5.81 ± 2.59
Vitamin B_1	0.51 ± 0.19[a]	0.41 ± 0.11[b]	0.37 ± 0.08[b]	0.50 ± 0.28[a]	0.39 ± 0.14[b]	0.36 ± 0.09[b]
Vitamin B_2	0.35 ± 0.19[a]	0.30 ± 0.20	0.24 ± 0.10[b]	0.33 ± 0.21[a]	0.26 ± 0.12[b]	0.24 ± 0.13[b]
Niacin	5.84 ± 2.24	5.71 ± 2.26	5.45 ± 1.23	5.28 ± 2.11	5.36 ± 2.77	5.15 ± 1.31
Vitamin C	54 ± 49[a]	30 ± 20[b]	23 ± 16[b]	71 ± 138	34 ± 36	38 ± 60
Intakes as Percent of Vietnamese RDA						
Energy	86.7 ± 33.0	91.0 ± 18.8	79.6 ± 28.4	87.8 ± 27.9[a]	79.8 ± 30.8	67.3 ± 28.0[b]

Data are means ± SD.

[a,b,c] Means within a row in the same gender with different superscripts are significantly different at $p < 0.05$ by one way ANOVA.

Table 3. Food Intakes Calculated from 24-Hour Dietary Recall by Region in Men and Women

	Men			Women		
	Urban (n = 33)	Suburban (n = 41)	Rural (n = 39)	Urban (n = 68)	Suburban (n = 59)	Rural (n = 60)
Rice (g)	369 ± 165[a]	463 ± 127[b]	468 ± 172[b]	338 ± 146[a]	307 ± 135[b]	320 ± 159[c]
Meat (g)	166 ± 120[a]	118 ± 114[a]	58 ± 82[b]	139 ± 102	92 ± 104	32 ± 67
Fish (g)	80 ± 113	129 ± 144	151 ± 120	83 ± 97	77 ± 80	90 ± 75
Egg (g)	19.0 ± 30.1	12.2 ± 25.2	4.6 ± 16.2	12.7 ± 22.6[a]	3.1 ± 11.7[b]	2.8 ± 10.6[b]
Milk (g)	40.8 ± 94.1	63.9 ± 94.3	43.3 ± 82.2	23.3 ± 66.3	24.0 ± 62.4	15.7 ± 48.9
Lard & Oil (g)	13.9 ± 11.2[a]	13.6 ± 11.2[a]	5.0 ± 7.0[b]	14.7 ± 10.7[a]	11.9 ± 17.7[a]	2.6 ± 4.4[b]
Vegetables (g)	323 ± 215[a]	289 ± 168[a]	171 ± 122[b]	291 ± 204[a]	208 ± 156[b]	156 ± 134[c]
Fruits (g)	81 ± 132	80 ± 157	46 ± 108	139 ± 162[a]	93 ± 138	68 ± 177[b]

Data are mean ± SD.

[a,b,c] Means within a row in the same gender with different superscripts are significantly different at $p < 0.05$ by one way ANOVA.

Energy requirements for middle-aged Vietnamese depend on three levels of activity (light, medium and hard labor) [11]. Because physical activity level was not measured in our survey, the energy required for a moderately active person was used in our analysis. Based on this assumption, energy requirements for our subjects would be 2,700 kcal for men and 2,200 kcal for women [11].

However, these values might be too high for people living in urban areas and too low for rural residents because people in rural areas often engage in more physically strenuous labor than those in urban areas. Thus, the deficiency of energy intake might be more severe in the rural population than initially estimated.

Inadequate energy intake in the rural population might be a

Table 4. Frequency of Food or Food Group Intakes

	Everyday			4–6 Times per Week			1–3 Times per Week			1–3 Times per Month			Less than Once per Month or Never		
	U	S	R	U	S	R	U	S	R	U	S	R	U	S	R
Rice	97	100	100	3	0	0	0	0	0	0	0	0	0	0	0
Pork & Beef	52	29	17	48	60	41	0	6	27	0	5	13	0	0	1
Poultry	4	4	4	55	24	12	21	24	30	18	37	39	2	11	14
Fish & Shellfish	15	31	41	71	62	55	12	5	3	2	2	1	0	0	0
Tofu	10	6	7	48	30	36	19	26	28	17	19	18	6	18	10
Full Cream Milk	6	1	0	13	3	1	3	2	1	14	18	6	64	76	92
Skim Milk	1	0	0	1	0	0	0	0	0	3	3	2	95	97	98
Condensed Milk	12	17	10	14	19	17	3	8	6	11	12	19	60	44	48
Green Vegetables	47	40	41	53	57	56	0	2	2	0	0	1	0	0	0
Other Vegetables	49	36	28	49	56	57	1	4	8	1	2	5	0	2	2
Fruits	39	24	15	50	51	59	5	13	14	5	10	10	1	2	2

Data are percentage of food intakes.

U = urban area, S = suburban area, R = rural area.

Table 5. Serum Protein and Lipid by Region in Men and Women

	Men			Women		
	Urban (n = 33)	Suburban (n = 41)	Rural (n = 39)	Urban (n = 68)	Suburban (n = 59)	Rural (n = 60)
Total Protein (g/dL)	6.65 ± 1.20	6.30 ± 1.43	6.64 ± 0.81	6.45 ± 0.76	6.18 ± 1.44[a]	6.84 ± 0.94[b]
Albumin (g/dL)	4.06 ± 0.72	3.70 ± 0.86	3.99 ± 0.47	3.90 ± 0.43[a]	3.56 ± 0.76[b]	3.96 ± 0.56[a]
TC (mg/dL)	182 ± 38[a]	166 ± 56	153 ± 35[b]	177 ± 33[a]	165 ± 43	160 ± 33[b]
TG (mg/dL)	171 ± 182	130 ± 84	114 ± 77	110 ± 72	99 ± 58	89 ± 64
HDL-C (mg/dL)	39.4 ± 9.9	40.9 ± 13.9	38.2 ± 12.3	41.6 ± 9.1	39.8 ± 12.1	37.8 ± 8.7

Data are means ± SD.

[a,b] Means within a row in the same gender with different superscripts are significantly different at $p < 0.05$ by one way ANOVA.

TC = total cholesterol, TG = triacylglycerol, HDL-C = high-density lipoprotein cholesterol.

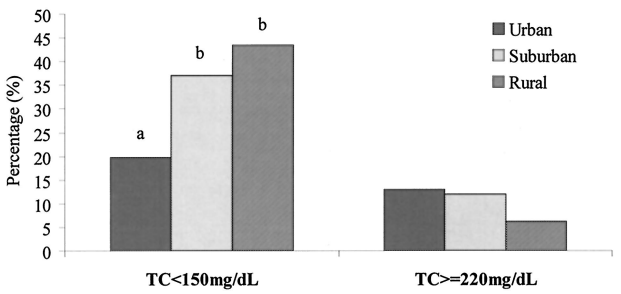

Fig. 1. Percentage of low and high TC (serum total cholesterol) by region. Bars in the same low or high TC group with different letters are significantly different at $p < 0.05$.

factor for the highest prevalence of underweight or chronic energy deficiency (CED) in this area (35%). CED is the condition of inadequate total energy intake, often coupled with insufficient protein. It is sometimes expressed as "protein-energy deficiency." However, CED in our subjects had a different pattern, with a seemingly adequate protein intake, but a substantially low lipid intake.

For both genders, the lipid intake in the rural area was substantially low (Table 2), and the lipid density (percent of total energy) was only half of the appropriate level suggested by the Vietnamese RDA (18% to 20% of total energy intake) [11]. The low lipid intake in the rural population might account for the highest prevalence of low TC in this area (43%).

Very low TC may contribute to the development of a fragile cerebral vascular endothelium, eventually leading to the development of angionecrosis and cerebral hemorrhage in the presence of hypertension [12]. The overall prevalence of high blood pressure was not so high in our subjects (10.7%). However, increased blood pressure with age [13] might lead to intracerebral hemorrhaging later in life in those with low TC.

In addition to low energy and lipid consumption, vitamin and mineral intakes were also low in the rural population. While the urban and suburban populations had adequate calcium intakes of at least 500mg/day, the rural population consumed approximately 70% of this level (Table 2). This could be a result of the rural population's low consumption of calcium-rich foods. More than 90% of rural subjects answered that they had never consumed full cream or skim milk (Table 4). Other sources of calcium for this population are tofu and fish. The rural population consumed tofu and fish far more frequently than milk, yet the quantity of these items was still not adequate

to reach the recommended 500mg/day. This chronically low calcium intake in the rural population might render its population more susceptible to bone loss in old age, especially for women, who may develop postmenopausal osteoporosis [14]. Iron intake was adequate for men, but women consumed less than half of the Vietnamese RDA (24mg/day for women aged 18 to 60) in all three areas. Vitamin C intake was also low in the rural population.

The low socioeconomic conditions combined with the low educational level in the rural population may render residents who were in energy and nutrient deficits more susceptible to infectious disease. The net effect of these conditions might be CED that is more severe and more costly to treat, with a devastating cycle of malnutrition, disease and poverty.

Overnutrition

Overnutrition is rapidly becoming a major public health problem in developing countries, especially in affluent segments of society [15]. However, while the problems of undernutrition are discussed intensively, issues of dietary excess in developing countries are largely ignored [1]. The prevalence of overweight in our data was not so high, and the highest rate observed was in the urban population (18%). However, in light of the modernization and Westernization of urban areas, this prevalence of overweight might increase.

The difference in BMI of our subjects in the three areas might be due to the differences in the composition of the diet (protein, lipid and carbohydrate density ratio) more than to the absolute energy intake. In fact, the energy intake was similar for men in the three regions. However, differences in lipid density and carbohydrate density were observed in the three areas for both genders. The lipid intake density in the urban population (approximately 20% of total energy) was at the high limit of the Vietnamese RDA, yet it was lower than the lipid intake in many developed countries [16]. However, the experience of dietary changes in Japan after World War II is an example. The proportion of energy from lipids in Japan increased from 8.7% in 1946 to 24.8% in 1987 [17], with differences in dietary patterns between younger Japanese, who consume a more Western-style diet, and older persons who still cling to the more traditional pattern. Some other Asian countries such as China and Thailand have changed their dietary patterns even more rapidly than Japan [1]. Therefore, at the high limit of lipid intake, the urban population should maintain and not exceed the appropriate level of lipid intake in order to avoid the problems associated with overnutrition.

In our study, the urban population had a twofold higher prevalence of high TC than the rural population. The relationship between high TC and CHD has long been investigated. The contribution of TC to this increased risk has been determined by its partition in the various lipoprotein fractions. A relatively large amount of cholesterol in the low-density lipoprotein fraction is atherogenic, whereas that in the high-density fraction appears protective. Urban subjects had higher TC than rural subjects. However, HDL-C, understood as a protective factor, was similar in both regions.

With the highest prevalence of overweight and high TC in the urban area, these residents need to pay more attention to overnutrition problems. Tackling the problem of overnutrition in the early stages of economic change is important so that it does not become a public health problem that is out of control.

CONCLUSION

The nutritional status of middle-aged persons in Ho Chi Minh City was characterized by undernutrition in the low-income, rural region and overnutrition in the high-income, urban region. The suburban region faced both under- and overnutrition problems. Undernutrition was still a public health problem in the rural area, and residents there with low energy, lipid, calcium, and vitamin C intakes might be at increased risk for chronic and infectious diseases. Increasing lipid intake might be the most important factor in preventing CED in middle-aged people in this area.

To grapple with the noteworthy problem of overnutrition in the urban area, demonstrated by a higher prevalence of overweight and high TC compared to the rural region, middle-aged persons in Ho Chi Minh City should be acutely concerned not only with undernutrition, but also with overnutrition problems in this economic transition period.

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