Blood Pressure, Serum Cholesterol Concentration and Their Related Factors in Urban and Rural Elderly of Ho Chi Minh City

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Summary In Vietnam, information about blood pressure, serum lipids and their factors is limited. To obtain some of this information, a cross sectional nutrition survey was carried out in an urban and rural area of Ho Chi Minh City with 217 participants aged 60–69 y (148 females and 69 males). Anthropometry and blood pressure were measured. For three consecutive weekdays, 24 h dietary recalls were performed. Single 24 h urine was collected for sodium and potassium analysis. A fasting blood sample was taken and biochemical parameters were measured. Results indicate a high percentage of hypertension in urban (female: 35.5%, male: 43.8%) and rural areas (female: 22.2%, male: 35.1%). Blood pressure was correlated with body mass index (BMI) and 24 h urinary sodium-to-potassium (Na/K) ratio. A high prevalence of serum total cholesterol (TC) above 220mg/dL (female: 55.3%, male: 31.3%) and overweight (female: 34.2%, male: 25.0%) were observed in urban residents. By contrast, 5.6% and 24.3% of rural females and males respectively had TC below 150mg/dL and both genders had the same prevalence of underweight (32.4%). TC was positively correlated with body weight, BMI, dietary protein and dietary lipids. Overweight might be a major risk factor for hypertension in our urban elderly. A high Na/K intake ratio might be a risk factor for hypertension in both areas. The high prevalence of elevated TC in the urban area might to be related to the high lipid intake, and the high prevalence of low TC in the rural area might to be related to the low lipid intake.

Key Words nutrition survey, blood pressure, serum cholesterol, elderly, Vietnamese

Changes in lifestyle induce different types of health problems. In many developing countries, the major health problem is undernutrition. However, as the economy improves, people tend to overconsume food, especially foods that are high in fat, which often induces other types of diseases (1). In the last decade, the Vietnamese society and economy have changed dramatically, and consequently, lifestyles and dietary habits of the Vietnamese are also changing. However, these changes are different in urban compared to rural areas. In rural areas, most of the people are farmers and their income is still very low compared with those in cities. Those in cities are more affluent and have a greater variety of food choices.

Information on high serum cholesterol, which is an important risk factor for the development of atherosclerosis is limited. According to a Vietnamese national survey of people aged 16y and older, the prevalence of hypertension has considerably increased from 1.9% in 1976 to 11.5% in 1990 (2). Hypertension is considered an important risk factor for coronary heart disease (CHD) (3) and cardiovascular disease (CVD) (4). Recently, arterial hypertension was recognized as the most important risk factor for stroke in southern Vietnam (5).

Both blood pressure and cholesterol concentration usually increase progressively with age (4). Therefore, hypertension and high blood cholesterol concentration often become health problems for the elderly. However, factors relating to them in Vietnamese elderly are not yet clarified. In this study, we conducted a survey to identify the prevalence of hypertension and abnormal serum cholesterol concentration, as well as to clarify the factors relating to these problems in the urban and rural elderly of Ho Chi Minh City.

MATERIALS AND METHODS

Participants. Approved by the Health Service of Ho Chi Minh City, this study was carried out in March 2000 in two regions of the city. One was Nguyen Cu Trinh Ward, District I (in the center of Ho Chi Minh City). The other was Tan Thanh Dong Village, Cu Chi District (rural area), a remote region 20 km in north-west of Ho Chi Minh City with a population of 23,403.

Local health officers in each region listed the names of all female and male residents aged 60–69 y. Subjects were randomly selected from that name list. The local health workers then visited all selected subjects from
measured with light clothing. BMI was computed as the ratio of weight (kg) per square height (m²).

After anthropometry measurements, subjects reported their medical history to a medical doctor. During the same visit, blood pressure was measured in the left arm twice by mercury sphygmomanometer in a sitting position after subjects relaxed for at least 5 minutes in a quiet environment. The average from the two measurements was applied. Hypertension was defined by using World Health Organization (WHO) criteria: systolic blood pressure (SBP) ≥160 mmHg and/or diastolic blood pressure (DBP) ≥95 mmHg. Subjects currently taking antihypertensive medication were also included in the hypertension group. A general health examination was performed by a licensed medical doctor.

**Twenty-four-hour dietary recalls.** Subjects were requested to maintain their normal eating habits during the survey period. Twenty-four-hour dietary recalls were collected for three consecutive days. In addition, subjects were given blank paper forms to jot down notes about foods consumed in order to aid in the recall process. On Wednesday, Thursday, and Friday of a given week, subjects were asked to recall all foods consumed in the previous 24 h (i.e. on Tuesday, Wednesday, and Thursday).

A novel approach was used in this 24-h recall. Instead of simply asking the subjects to recall foods and estimate portion sizes, we showed the subjects photographs of commonly consumed foods in various portion sizes. By looking at the photographs, the subjects gave detailed information about which and how much each food was consumed. In an attempt to capture all consumed foods, the recalls also included questions about snacks or foods not necessarily consumed at meal times.

We also showed the subjects various household tableware items (i.e. bowls, plates, spoons, and glasses) in different sizes and asked them to identify which ones and sizes they used. The approach was supplemented by measurements with a ruler (for meat, fish and cake) and count (for eggs). For rice, we offered several different sizes of rice bowls, and the subjects were asked to select the rice bowls that best matched the rice bowls used at home.

**Serving size pictures.** Most urban residents in Ho Chi Minh City eat out at least once a day, especially for breakfast and lunch. Street foods are very common. In order to create necessary tools for nutrition survey in Ho Chi Minh City, we started to take serving size photographs in November 1998 and used these in this study.

Commonly consumed foods in the urban of Ho Chi Minh City were collected and photographed. Approximately 100 kinds of food were collected, including fruits. For every food item, the foods were collected from at least three different shops. The foods were scaled soon after the collection, and the serving sizes were averaged. Photos were taken of the average from three serving sizes. Serving size measures were then converted from cooked food into raw food grams. The collection period was performed an entire year to cover seasonal foods.

**Calculation of energy and nutrient intakes.** Three days of the dietary recalls were analyzed and averaged using newly developed software. This is a modification of an existing Japanese program (6), using a Vietnamese food composition table (7).

**Urine collection.** On the first of the three days, the participants were instructed carefully how to collect 24-h urine. They were then given two wide-mouth 2-L plastic bottles for the collection. When the subjects returned the first urine bottles to researchers the following day, they were asked to confirm the accuracy of their 24-h urine collection. This urine collection was for practice purpose only. The subjects were then given two more empty bottles and told to repeat the procedure. This second urine collection was used for analysis.

The volume of urine was measured, and after mixing, approximately 15 mL was kept frozen for sodium, potassium and creatinine analysis. Sodium and potassium of urine were analyzed by atomic absorption spectrophotometry (model Z-8270, Hitachi Ltd., Tokyo, Japan). Creatinine was analyzed by using Jaffe’s reaction. Only the urine samples that had 24-h urinary creatinine (mg)/body weight (kg) ratios between 10.8 and 25.2 for females or between 14.4 and 33.6 for males were used for sodium and potassium analysis (8). Using these criteria, only 5 urine samples from female subjects (1 from urban area and 4 from rural area) were collected from urine samples that had 24-h urinary creatinine (mg)/body weight (kg) ratios between 10.8 and 25.2 for females or between 14.4 and 33.6 for males were used for sodium and potassium analysis (8).

**Blood analysis.** Ten mL of blood was collected by venipuncture during the final recall session on Friday morning after an overnight fast. We collected blood on Friday morning because dietary information was only collected for Tuesday, Wednesday, and Thursday. Blood samples were centrifuged and separated immediately after collection. Serum was kept frozen at −20°C. Serum and urine samples were frozen and transported to Japan on dry ice for analysis. We analyzed serum concentrations of total cholesterol (TC) and triacylglycerol (TG) by enzymatic assay kits (Wako Pure Chemical
Industries, Osaka, Japan), high-density lipoprotein cholesterol (HDL-C) and low-density lipoprotein cholesterol (LDL-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).

**Statistical analysis.** The dietary data were analyzed statistically using Statistical Programs for the Social Sciences (SPSS) (9). Student's t-test was applied to analyze significant differences in mean values between urban and rural areas. Chi-square was used to compare difference in proportion of BMI, serum lipids, and blood pressure levels between urban and rural areas. Correlations between blood pressure and relevant factors, and between serum TC and relevant factors were analyzed using Pearson's correlation. P values less than 0.05 and 0.01 were considered significant.

**RESULTS**

A percentage of 28.6% of the subjects (29.1% of females and 27.4% of males) had a history of hypertension. The other 71.4% of subjects were in normal health. Among those with hypertension, only 19.4% of them were taking antihypertensive drugs, and approximately 12.9% of them had one of following conditions: diabetes mellitus (8.1%), stroke (3.2%), and pulmonary tuberculosis (1.6%). None of the participants were suffering from renal disease.

Table 1 shows clinical characteristics of all participants. BMI was significantly higher in urban than in rural females (23.8 vs. 19.9, respectively) and males (22.4 vs. 19.4, respectively). DBP of urban females was significantly higher than that of rural females.

Table 2 shows that mean urinary sodium excretion in females was similar in both areas (approximately 7 g salt). The urinary sodium excretion was highest in rural males (3.184 mg, or about 8 g salt). This was significantly higher than that in urban males (2.334 mg, or about 6 g salt). When sodium excretion was calculated as mg/1,000 kcal, a significantly higher excretion was observed in the rural vs. the urban region for both genders. Twenty-four hour urinary potassium excretion was lower in the rural than in the urban area for both genders, with a significant difference observed in females only. However, when potassium calculated as mg/1,000 kcal, the difference became nonsignificant. Overall, the urinary Na/K ratio was 2.44 (1.07 SD). It was significantly higher in the rural area than in the urban area in females (2.78 vs. 2.14, respectively) and in males (2.93 vs. 1.88, respectively).

Table 3 shows that rural subjects consumed more rice and less meat, egg, lard and oil, and sugar than urban subjects. Significant differences were seen for rice and meat intakes in both genders; however, for egg, lard and oil, and sugar intakes significant differences were seen in females only.

In addition, significantly higher energy, protein, lipid, vitamin C and calcium intakes were observed in urban than rural area for both genders. Animal protein as percentage of total protein intake was significantly higher in the urban subjects in both genders whereas animal lipid as percentage of total lipid intake was significantly

| Table 1. Clinical characteristics of the study population by region for females and males. |
|---------------------------------------------------------------|
| **Female (n=148)**                      | **Male (n=69)**                      |
| **Urban (n=76)**        | **Rural (n=72)**        | **Urban (n=32)**        | **Rural (n=37)**        |
| Age (y)                  | 65.0±3.0                 | 64.3±2.8                | 64.2±3.2               | 64.1±2.9               |
| Height (cm)              | 149.6±5.8                | 148.2±5.9              | 161.2±6.4*             | 157.7±5.9             |
| Weight (kg)              | 53.4±8.7**               | 43.7±7.5               | 58.5±11.7**            | 48.4±7.5              |
| BMI (kg/m²)              | 23.8±3.6**               | 19.9±3.0               | 22.4±3.9**             | 19.4±2.4              |
| SBP (mmHg)               | 144±25                   | 136±27                 | 147±25                 | 143±27                |
| DBP (mmHg)               | 84±12**                  | 76±12                  | 89±13                  | 83±15                 |

BMI, body mass index; SBP, systolic blood pressure; DBP, diastolic blood pressure. Data are means±SD. Significantly different from rural area for the same gender * p<0.05; ** p<0.01.

| Table 2. Twenty-four-hour urinary sodium and potassium excretion by region for females and males. |
|---------------------------------------------------------------|
| **Female (n=143)**                      | **Male (n=69)**                      |
| **Urban (n=75)**        | **Rural (n=68)**        | **Urban (n=32)**        | **Rural (n=37)**        |
| Sodium (mg/24 h)         | 2.764±1.221             | 2.624±1.327             | 2.334±1.178*            | 3.184±1.662            |
| Sodium (mg/1,000 kcal)   | 2.220±1.202**           | 3.180±2.350             | 1.347±0.547**           | 2.377±1.437            |
| Potassium (mg/24 h)      | 1.369±0.594**           | 0.995±0.475             | 1.302±0.521             | 1.154±0.547            |
| Potassium (mg/1,000 kcal)| 1.104±0.561             | 1.154±0.665             | 766±271                | 846±457               |
| Na/K ratio               | 2.14±0.86**             | 2.78±1.08               | 1.88±0.91**             | 2.93±1.17              |

Na/K, sodium-to-potassium. Data are means±SD. Significantly different from rural area for the same gender * p<0.05; ** p<0.01.
Table 3. Daily food, energy, and nutrient intakes estimated by 24 h-dietary recalls for three consecutive days for females and males.

| Food intakes          | Female (n=148) | Male (n=69) |
|-----------------------|----------------|-------------|
|                      | Urban (n=76)   | Rural (n=72) | Urban (n=32) | Rural (n=37) |
| Rice (g)              | 123±49**       | 158±71      | 187±49**     | 243±88       |
| Meat (g)              | 60.8±54.3**    | 33.0±43.6   | 93.7±80.5*   | 52.8±65.2    |
| Fish (g)              | 47.2±44.8      | 38.7±38.6   | 65.2±46.9    | 62.3±63.7    |
| Egg (g)               | 7.6±12.3*      | 3.7±7.4     | 14.0±18.4    | 8.7±16.2     |
| Lard and oil (g)      | 8.50±5.83**    | 4.45±4.09   | 9.11±4.90    | 7.23±6.07    |
| Sugar (g)             | 14.4±14.3**    | 7.21±7.19   | 12.9±11.5    | 9.92±7.70    |

Absolute nutrient intakes

|                  | Female (n=148) | Male (n=69) |
|------------------|----------------|-------------|
| Energy (kcal)    | 1.33±390**     | 959±353     | 1.70±404*    | 1.46±497     |
| Protein (g)      | 54.2±18.7**    | 35.4±15.6   | 69.6±22.0**  | 54.2±21.9    |
| Animal protein (%)| 52.4±18.5*     | 44.9±17.3   | 57.5±10.1*   | 49.0±17.2    |
| Lipid (g)        | 32.7±15.6**    | 15.8±9.3    | 42.2±17.8**  | 26.3±20.0    |
| Animal lipid (%) | 50.4±22.3      | 45.4±22.4   | 61.2±12.6*   | 49.7±23.2    |
| Carbohydrate (g) | 201.4±54.2**   | 166.6±62.6  | 246.0±62.9   | 239.1±77.4   |
| Vitamin C (mg)   | 97.7±80.1**    | 37.9±28.3   | 80.8±60.3*   | 50.0±34.6    |
| Calcium (mg)     | 512±347**      | 246±104     | 486±228**    | 347±127      |

Data are means±SD. Significantly different from rural area for the same gender *p<0.05; **p<0.01.

Table 4. Metabolic characteristics of the study population by region for females and males.

|                  | Female (n=148) | Male (n=69) |
|------------------|----------------|-------------|
|                  | Urban (n=76)   | Rural (n=72) | Urban (n=32) | Rural (n=37) |
| Protein (g/DL)   | 7.9±0.59       | 7.83±0.64   | 7.88±0.48    | 7.65±0.47    |
| Albumin (g/DL)   | 4.10±0.30      | 4.04±0.28   | 4.16±0.30*   | 3.98±0.31    |
| Total cholesterol (mg/DL) | 235±43**   | 195±33      | 206±38**     | 168±25       |
| HDL-C (mg/DL)    | 49.2±11.4**    | 44.3±9.3    | 48.6±10.9    | 43.6±12.2    |
| LDL-C (mg/DL)    | 142.9±32.1**   | 127.2±27.5  | 124.1±33.5*  | 102.2±20.5   |
| LDL-C/HDL-C      | 3.01±0.78      | 2.95±0.74   | 2.69±0.94    | 2.49±0.72    |
| Triacylglycerol (mg/DL) | 184±120** | 137±72      | 159±113      | 129±85       |

HDL-C, high-density lipoprotein-cholesterol; LDL-C, low-density lipoprotein-cholesterol. Data are means±SD. Significantly different from rural area for the same gender *p<0.05; **p<0.01.

higher in the urban males only. When protein, lipids and carbohydrates were adjusted for energy intake, the rural elderly consumed more carbohydrates (approximately 70% of total energy) than those in the urban area (about 60%). Overall, average energy intakes for females and males were approximately 64% and 83% of the Vietnamese RDA (10), respectively. For urban and rural areas, the intakes were 78% and 66% of the Vietnamese RDA, respectively.

Metabolic characteristics in Table 4 show that averages of serum protein, albumin and lipid are in normal range. Serum TC, HDL-C, LDL-C and TG were significantly higher in urban than rural females. Urban males had significantly higher concentrations of albumin, TC and LDL-C than rural males. No difference was seen in LDL/HDL-C ratio in either gender.

Because only 4 persons were obese (BMI ≥30) overall, we divided BMI into 3 subgroups: <18.5 (underweight), 18.5–24.9 (normal weight), and ≥25 (overweight and obese). In Table 5a and 5b, more overweight persons were observed in the urban area (34.2% of females and 25.0% of males) whereas a greater percentage of underweight was observed in the rural area (32.4% for both genders). This difference was significant in females. The prevalence of TC ≥220 mg/dL was significantly higher in the urban than in the rural eld-
### Table 5a. Comparison of proportion of BMI, serum lipid, and blood pressure levels between urban and rural areas for females.

|                | Urban | Rural | Test     |
|----------------|-------|-------|----------|
|                | n     | %     | n        | %     | Chi-square |
| **BMI**        |       |       |          |       |            |
| <18.5          | 7     | 9.2   | 23       | 32.4  | 24.536     |
| 18.5–24.9      | 43    | 56.6  | 44       | 62.0  | p=0.000    |
| ≥25            | 26    | 34.2  | 4        | 5.6   | p=0.000    |
| **Total cholesterol (mg/dL)** |   |       |          |       |            |
| ≤149           | 0     | 0     | 4        | 5.6   | 15.286     |
| 150–219        | 34    | 44.7  | 49       | 68.1  | p=0.000    |
| ≥220           | 42    | 55.3  | 19       | 26.4  | p=0.000    |
| **Triacylglycerol (mg/dL)** |   |       |          |       |            |
| ≤200           | 55    | 72.4  | 63       | 87.5  | 5.238      |
| <200           | 21    | 27.6  | 9        | 12.5  | p=0.022    |
| **LDL-C (mg/dL)** |   |       |          |       |            |
| ≤150           | 49    | 64.5  | 58       | 80.6  | 4.774      |
| ≥150           | 27    | 35.5  | 14       | 19.4  | p=0.029    |
| **HDL-C (mg/dL)** |   |       |          |       |            |
| ≤35            | 7     | 9.2   | 15       | 20.8  | 3.947      |
| >35            | 69    | 90.8  | 57       | 79.2  | p=0.047    |
| **LDL-C/HDL-C ratio** |   |       |          |       |            |
| ≤5             | 75    | 98.7  | 70       | 97.2  | 0.398      |
| >5             | 1     | 1.3   | 2        | 2.8   | p=0.528    |
| **Blood pressure** |   |       |          |       |            |
| Normotension   | 49    | 64.5  | 56       | 77.8  | 3.175      |
| Hypertension*  | 27    | 35.5  | 16       | 22.2  | p=0.075    |

BMI, body mass index; LDL-C, low-density lipoprotein-cholesterol; HDL-C, high-density lipoprotein-cholesterol.
* Included subjects who were diagnosed with hypertension and taking antihypertensive drugs.

### Table 5b. Comparison of proportion of BMI, serum lipid, and blood pressure levels between urban and rural areas for males.

|                | Urban | Rural | Test     |
|----------------|-------|-------|----------|
|                | n     | %     | n        | %     | Chi-square |
| **BMI**        |       |       |          |       |            |
| <18.5          | 6     | 18.8  | 12       | 32.4  | 5.878      |
| 18.5–24.9      | 18    | 56.3  | 23       | 62.2  | p=0.053    |
| ≥25            | 8     | 25.0  | 2        | 5.4   | p=0.006    |
| **Total cholesterol (mg/dL)** |   |       |          |       |            |
| ≤149           | 2     | 6.3   | 9        | 24.3  | 10.262     |
| 150–219        | 20    | 62.5  | 26       | 70.3  | p=0.006    |
| ≥220           | 10    | 31.3  | 2        | 5.4   | p=0.006    |
| **Triacylglycerol (mg/dL)** |   |       |          |       |            |
| ≤200           | 27    | 84.4  | 33       | 89.2  | 0.351      |
| >200           | 5     | 15.6  | 4        | 10.8  | p=0.554    |
| **LDL-C (mg/dL)** |   |       |          |       |            |
| ≤150           | 23    | 71.9  | 36       | 97.3  | 8.949      |
| ≥150           | 9     | 28.1  | 1        | 2.7   | p=0.003    |
| **HDL-C (mg/dL)** |   |       |          |       |            |
| ≤35            | 2     | 6.3   | 11       | 29.7  | 6.187      |
| >35            | 30    | 93.8  | 26       | 70.3  | p=0.013    |
| **LDL-C/HDL-C ratio** |   |       |          |       |            |
| ≤5             | 32    | 100   | 37       | 100   | p=0.054    |
| >5             | 0     | 0     |          |       | p=0.054    |
| **Blood pressure** |   |       |          |       |            |
| Normotension   | 18    | 56.3  | 24       | 64.9  | 0.535      |
| Hypertension*  | 14    | 43.8  | 13       | 35.1  | p=0.465    |

BMI, body mass index; LDL-C, low-density lipoprotein-cholesterol; HDL-C, high-density lipoprotein-cholesterol.
* Included subjects who were diagnosed with hypertension and taking antihypertensive drugs.
erly in both females (55.3% vs. 26.4%, respectively) and males (31.3% vs. 5.4%, respectively), whereas approximately 5.6% and 24.3% of rural females and males respectively had TC 149 mg/dL. Urban females had significantly higher prevalence of high TG than that in rural females (27.6% vs. 12.5%). The percentage of persons with high levels of LDL-C and HDL-C were significantly higher in the urban than in the rural area in both genders. However, LDL-C/HDL-C ratio was almost similar in both groups. Overall, the prevalence of hypertension (defined as SBP 160 mmHg and/or DBP 90 mmHg; 7 subjects having SBP <160 mmHg and DBP <90 mmHg and taking antihypertensive drugs were included) was 32.3%. The prevalence of hypertension was not different between the two regions, although slightly higher in the urban area than in the rural area in both females (35.5% vs. 22.2%, respectively) and males (43.8% vs. 35.1%, respectively).

Pearson correlation coefficients between blood pressure and anthropometry, 24 h urinary sodium and potassium, serum lipids, and dietary macronutrient density are shown in Table 6. Because the parameters used in Table 6 did not differ by gender in definition, we did not separate the data for females and males. The results show that SBP and DBP were significantly correlated with BMI, urinary Na/K ratio (in SBP only), and serum TG.

Table 6 shows that, in both genders, TC was positively correlated with body weight, BMI, protein and animal protein, lipid and animal lipid, and meat, whereas negative associations between TC and carbohydrate density and rice intake were also observed.

**DISCUSSION**

Although the percentage of the participation in the rural area was 80%, it was only 40% in the urban area. In Vietnam, blood drawing is not common and most people are very afraid of it. Furthermore, the dietary survey for 3 d and the 24 h urine collections for 2 d were perceived as a too much of an inconvenience by many urban residents. Therefore, the 60% refusal rate in the urban area was explainable. The contrasting high percent of participation in the rural area could be because the rural participants perceived benefits such as having the chance to consult doctors regarding their health. Another reason might be the strong human relationships in the rural area. Our results may be representative of the urban population in general, despite the low percentage of urban participation in our survey because the average age and gender distribution were similar to those in the original list.

We were also careful about the interpretation of the results in male subjects whose sample size was small. We used the male results as a reference for our discussion. However, in the cases where there are no differences in the definition of abnormal values between males and females, such as blood pressure, BMI, and serum lipids, the results of both genders were combined (Table 6).

**BLOOD PRESSURE**

**Hypertension prevalence.** Hypertension is an established major risk factor underlying the epidemic of coronary and cardiovascular diseases in most developed countries, and it has been shown to be a public health...
problem in many developing countries since the 1970s (11). In this study, our data showed that the prevalence of hypertension was 32.3%, with a slightly higher prevalence in the urban than in the rural region (Table 5a, 5b). This was higher than the prevalence of hypertension in Japan for the same age range. A Japanese national nutrition survey in 1998 showed 23% of women and 28% of men aged 60–69 y as hypertensive (12). Japan has been noted as one of the countries with highest prevalence of hypertension (13). Therefore, our finding of such a high prevalence of hypertension in our elderly participants of both urban and rural areas in Ho Chi Minh City might be a noteworthy problem.

**Sodium and potassium intakes.** We did not use 24 h dietary recall data to calculate the sodium and potassium intake because Vietnamese use so many ingredients high in sodium (fish sauce, soy sauce, pickles) and consume commercially available processed foods, especially those in urban areas. Most of the participants did not cook for themselves; therefore it was difficult to estimate the exact salt consumption from discretionary sources. However, urinary sodium and potassium excretion is well correlated with dietary sodium and potassium intakes in carefully performed balance studies in subjects consuming self-selected diets (14). Average urinary excretions of sodium and potassium are reported to reflect 86% and 77% of total sodium and potassium intakes, respectively (14). High sodium intake is generally regarded as an important factor for developing hypertension (15). In contrast, high potassium intake is suggested as an important factor in preventing elevated blood pressure (16). Lowering the sodium intake in conjunction with increasing the potassium intake more closely related to blood pressure than either urinary sodium or potassium excretion alone, especially in a higher level of urinary sodium excretion (16). In the subjects in this survey, blood pressure significantly related to urinary Na/K ratio but not with urinary sodium or potassium excretion (Table 6). The average urinary Na/K ratio of the subjects was 2.44. It was highest in rural females (2.78) and lowest in urban males (1.88) (Table 2), and greatly exceeded the optimal range of 0.25 to 0.50 suggested by Filer (17).

Overall, average sodium intake was estimated to be somewhat higher than the urinary output of 2,725 mg (approximately 7 g salt). It might be slightly lower than the sodium intake of US adults (about 3,900 mg sodium or 10 g salt) but higher than the current US dietary guideline for sodium intake (less than 2.4 g/d or 6 g salt/d) (18). The sodium intake in Vietnamese subjects was lower than in the Japanese population from the National Nutrition Survey 1998 (12.7 g) (12). From these results we may be able to conclude that the sodium intake of our subjects was not too high.

However, our data showed that the diet of the subjects was too high in sodium density. The reason for the low sodium excretion might be due to the low energy intakes. Overall, average energy intakes for females and males were approximately 64% and 83% of the Vietnamese RDA, respectively. For urban and rural areas, the intakes were 78% and 66% of the Vietnamese RDA, respectively. These results in our participants were comparable to data on elderly subjects in urban Hanoi (19) and Thai elderly living in Bangkok (20). The average sodium density of our elderly subjects was similar to that in Japan for the same age group (2,611 mg/1,000 kcal in females, 2,990 mg/1,000 kcal in males) (12). Urinary potassium excretion in our participants was substantially low, especially in the rural population (approximately 1,300 mg/d in urban area and 1,000 mg/d in rural area). Taking the rate of potassium excretion from total intake into account, the estimated potassium consumption in rural subjects was still very low. It was lower than the safe and adequate range of dietary potassium of 1.6–3.5 g/d suggested by the US Food and Nutrition Board (18). Our present results suggested that slightly high sodium and substantially low potassium intake might cause the Na/K ratio to become high enough to induce hypertension in our subjects. The present results also suggest that not so high sodium excretion in our subjects reflects the low energy intake, and if consumption had reached the Vietnamese RDA, the sodium excretion might have been much higher.

**Body mass index (BMI).** In our data, blood pressure was correlated with BMI. This correlation was in accordance with a multiethnic population study among White, Japanese, Filipino and Hawaiian Americans (21). In the nationwide Community Hypertension Evaluation Clinic (22), screening of more than 1 million people showed an increase in frequency of hypertension in overweight persons aged 20–39 y and 40–64 y by 100 and 50%, respectively. Overweight might be the major factor for the increased prevalence of hypertension in our urban subjects, because a high prevalence of overweight was observed in this population.

**Serum cholesterol concentration**

**Prevalence of abnormal serum total cholesterol concentration.** From this study, we identified that the percentage of high serum TC was quite high in urban subjects (55.3% in females and 31.3% in males). By contrast, the prevalence of low TC in rural subjects (5.6% in females and 24.3% in males) was observed which was approximately 4-fold higher than that of the urban subjects. High TC is an important factor contributing to atherosclerosis, which induces the high prevalence of CVD. Mean TC in urban females and males was comparable to White Americans noted as high risk for atherosclerosis (23). The percentage of high TC in urban subjects was also comparable to that of the Japanese at the same age group (51.1% in females and 28.5% in males) (12). In addition to the effect of high TC on atherosclerosis, the low TC is reported as a risk factor for intracerebral hemorrhage, a phenomenon that was first identified in Japan (13). Low serum TC may contribute to the development of a fragile cerebrovascular endothelium, eventually leading to the development of angioneerosis and cerebral hemorrhage in the presence of hypertension (24). In the multiple risk factor intervention trial, mortality from hemorrhage stroke was in-
versely correlated with the serum TC level in middle-aged American men (25). Mean TC in our rural elderly was observed to be lower than that in Chinese reported to be more at risk for intra cerebral hemorrhage (23). Therefore, our elderly subjects might need to be concerned about the consequences of serum TC concentrations that are either too high or too low.

**Dietary factors of abnormal TC (Food and macronutrient intakes).** Serum TC was observed positively correlated with animal food source (meat) intake and its nutrients (fat and protein). Lipid intake in urban subjects was at the high limit of the Vietnamese RDA (18–20% of total energy intake), and was comparable to the lipid intake of Japanese in the same age group (12). However, our urban subjects had a fish intake that was 2-fold lower than their Japanese counterparts, and a 2-fold higher meat intake (12). Therefore, the high prevalence of high TC in our urban subjects in spite of their relatively low energy intake might be partly related to their high consumption of meat and fat. The low serum TC in rural residents might be in part related to the typical Asian diet that is characteristically high in carbohydrates and low in lipids and animal protein (13, 23). Lipid intake as percentage of energy in rural females and males was only 14.3% and 15.4%, respectively (Table 4). It was lower than the appropriate level suggested by the Vietnamese RDA.

**Conclusion**
A high prevalence of hypertension was observed in our elderly subjects living in both urban and rural areas of Ho Chi Minh City. Overweight might be a major risk factor for hypertension in our urban elderly. A high Na/K intake ratio might be a risk factor for hypertension in both areas. The high prevalence of elevated TC in the urban area might be related to the high lipid intake, and the high prevalence of low TC in the rural area might be related to the low lipid intake.

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