Nutritional Evaluation of Women in Urban Areas in Continental China

ZUO-WEN ZHANG¹, JIANG-BIN QU², CHAN-SEOK MOON¹, SHINICHIRO SHIMBO³, TAKAO WATANABE⁴, HARUO NAKATSUKA⁵, SHI-AN YIN⁶, MU-LAN HU⁷, ZHENG-QING CHEN⁸ and MASAYUKI IKEDA^{1,9}

¹*Department of Public Health, Kyoto University Faculty of Medicine, Kyoto 606-01,* ²*Department of Hygiene, Faculty of Public Health, Shandong Medical University, Jinan 250012, Shandong, China,* ³*Department of Food and Nutrition, Kyoto Women's University, Kyoto 605,* ⁴*Miyagi University of Education, Sendai 980,* ⁵*Department of Environmental Health Sciences, Tohoku University School of Medicine, Sendai 980-77,* ⁶*Institute of Nutrition and Food Hygiene, Chinese Academy of Preventive Medicine, Beijing 100050, China,* ⁷*Shanghai Institute of Labour Hygiene and Occupational Diseases, Shanghai 200003, China,* ⁸*Sanitary and Anti-epidemic Station of Guangxi, Nanning 530021, Guangxi, China,* and ⁹*Kyoto Industrial Health Association, Kyoto 604*

ZHANG, Z.-W., QU, J.-B., MOON, C.-S., SHIMBO, S., WATANABE, T., NAKATSUKA, H., YIN, S.-A., HU, M.-L., CHEN, Z.-Q. & IKEDA, M. *Nutritional Evaluation of Women in Urban Areas in Continental China.* Tohoku J. Exp. Med., 1997, **182** (1), 41-59 — In 1993-1995, a nutritional survey was conducted in China, in which 50 women each in three cities of Beijing, Shanghai and Nanning (thus 150 in total) volunteered to offer 24-hr total food duplicates and peripheral blood samples. People daily took 1,776 kcal (7,431 kJ) energy, 57 g protein, 75 g lipid, 218 g carbohydrate, 439 mg calcium, 24 mg iron, 3,398 mg sodium and 1,521 mg potassium. When compared with the recommended dietary allowance for Chinese, intakes of energy, iron and possibly vitamin C were sufficient in a majority of the participants, but not so in cases of calcium, and several vitamins. The lipid energy ratio was 38% on an average and was higher than 30% in a majority (73%) of the people. BMI, but not the lipid energy ratio, correlated with the serum triglyceride level. In accordance with high iron intake, the prevalence of anemia was low. Inter-city differences were evident in nutrient sources. Thus, Beijing people took more amounts of protein and lipid from meats (including eggs and milk), whereas plant-based foods were important sources of lipid in Shanghai

Received December 24, 1996; revision accepted for publication March 20, 1997.

Address for reprints: Prof. M. Ikeda, Kyoto Industrial Health Association, 67 Nishinokyo-Kitatsuboicho, Nakagyo-ku, Kyoto 604, Japan.

and that of protein in Nanning. Furthermore, consumption of rice was significantly lower in Beijing than in Shanghai and Nanning, whereas wheat consumption was higher in Beijing than in Shanghai and Nanning. ——— Continental China; inter-city difference; nutrition; rice intake; women in cities
Copyright © 1997 by the Tohoku University Medical Press.

An increasing attention has been paid on the nutritional status of people in China especially after economic reform in this decade of years (Popkin 1994), in terms of not only total energy intake but the quality such as sufficient intakes of protein and several minerals, as well as possible excess intake of lipid. Several survey reports have been published both on a whole country basis (Chen and Chen 1993; Ge et al. 1995, 1996; Zhai et al. 1995) and on specific local populations such as urban residents (Ma et al. 1992; Zhang et al. 1992), farmers (Gao and Bi 1991; Ma et al. 1992) and fishermen (Zhang et al. 1994; Pan et al. 1995).

The present study was initiated to examine the adequacy of intakes of various nutrients among urban populations. The targets were placed on the detection of possible inter-city differences in food custom and nutrient intake. For this purpose, food samples were collected from occupationally homogeneous populations of women working in medical institutions in three cities of Beijing, Shanghai and Nanning, in northern, central and southern China, respectively.

Fig. 1. Locations of the three cities studied in the People's Republic of China.

MATERIALS AND METHODS

Study population and study design

The survey was conducted in March, 1993 in Beijing (the capital city of China), in October, 1994 in Shanghai (the largest city in China) and in April, 1995 in Nanning (the capital city of Guangxi Autonomous Province near the border with Vietnam) in northern, central and southern China, respectively; for locations, see Fig. 1. Social occasions (e.g. birthday, family celebration, or festival days) were waived so that possible deviation from ordinary foods be excluded. Adult working women (nonsmoking and non-habitually drinking, and mostly married) were invited to participate in the study, and in practice 150 women volunteered, i.e., 50 each in Beijing, Shanghai and Nanning. They were teachers, technical staffs, nurses, etc. in medical institutions. Participation was on a voluntary basis, and no rigid strategy in sampling (e.g., random sampling) could not be taken. Women rather than men were selected, because women in China are nonsmokers and are not habitual drinkers traditionally, the two social habits being considered possible to affect dietary custom.

Food duplicate collection

The collection of 24-hr total food duplicates (Acheson et al. 1980) was conducted after the protocol previously described in detail (Shimbo et al. 1993, 1994, 1996a, b, c, 1997; Ikeda et al. 1996; Moon et al. 1997). This method was selected to take full advantage of the survey occasions, considering that the numbers of participants were limited, and that instrumental analyses of the food samples especially for metals were in schedule.

In an orientation meeting, the participants were fully informed of the study purpose, and reminded to prepare ordinary foods and no special dishes. Food duplicates in the amount and in the way as consumed (e.g. dipping in sauce, use of soya bean sauce or vinegar) were collected in metal leakage-free plastic containers (or bottles for soup and drinks). On the next morning of the collection, each participant brought her food duplicate to an examination room, where she underwent physical and anthropometrical examinations, and peripheral blood sampling in 2 to 3 hr after the breakfast.

Nutritional evaluation and other examinations

The procedures were as previously described (Shimbo et al. 1993, 1994, 1996a, b, c, 1997; Ikeda et al. 1996; Moon et al. 1997). The foods in each sample were classified into breakfast, lunch, dinner and snacks, and then were further separated into individual food items for weighing. Each food item was coded by veteran Chinese nutritionists following the Food Composition Tables for Chinese (National values, Part 1; Institute of Nutrition and Food Hygiene 1991a). The nutrient intakes in each meal and snack (and thus in an entire day as a sum) were

calculated from the code numbers and the weight records taking advantage of the Food Composition Tables (Institute of Nutrition and Food Hygiene 1991a). The tables consist of 1357 food items (raw as well as cooked materials), and in practice could cover essentially all food items. When necessary, the factors to estimate the nutrient composition for cooked materials from those of raw materials were supplemented from Department of Health (1991).

Evaluation of nutrient intake was made in comparison with the nationally recommended daily dietary allowances for populations in the People's Republic of China (Chinese RDA in short; Appendix 1 in the Food Composition Tables [Institute of Nutrition and Food Hygiene 1991b]). The RDA values for adult women (with light physical exercise) are cited in Table 1 in comparison with the RDAs for counterpart Japanese women (Ministry of Health and Welfare [1994]).

TABLE 1. *Recommended dietary allowances for Chinese women by age range*

Nutrient		Age range (years)					
		Chinese				Japanese ^a	
		18-44	45-59	60-69	≥70	20-39	40-49
(Unit/day)							
Energy	(kcal)	2,100	1,900	1,700	1,600	2,000	1,950
	(MJ ^b)	8.8	8.0	7.1	6.7	8.4	8.2
Protein	(g)	65	65	60	55	60	60
Lipid energy ratio (%)		20-25	20-25	20-25	20-25	20-25	20-25
Minerals							
Calcium	(mg)	800	800	800	800	600	600
Iron	(mg)	18	12	12	12	12	12 ^d
Zinc	(mg)	15	15	15	15	—	—
Vitamins							
Vitamin A	(RE ^c μg)	800	800	800	800	600	600
Vitamin B ₁	(mg)	1.1	1.2	1.2	1.0	0.8	0.8
Vitamin B ₂	(mg)	1.1	1.2	1.2	1.0	1.1	1.1
Nicotinic acid	(mg)	11	12	12	10	13 ^e	13 ^e
Vitamin C	(mg)	60	60	60	60	50	50
Vitamin D	(μg)	5	5	10	10	2.5	2.5
Vitamin E	(mg)	10	12	12	12	7 ^f	7 ^f

Cited from Institute of Nutrition and Food Hygiene (1991b). Values are for women with lightest physical exercise. — shows not stated.

^aValues for Japanese women are cited from Ministry of Health and Welfare, the Government of Japan (1994) for comparison.

^bCalculated from values in kcal, taking a conversion factor of 1 kcal = 4.184 kJ.

^cIn retinol equivalency.

^dValue for pre-menopausal; 10 mg/day for post-menopausal.

^eIn terms of niacin.

^fIn equivalency to α-tocopherol.

Statistical analysis

A normal distribution was assumed for nutrient intake, and (arithmetic) means and standard deviations (S.D.s) were calculated as representative parameters. ANOVA, multiple comparison (Scheffe) and median test (coupled with chisquares test; Tsuji 1981) were employed to detect possible significant differences between (or among) means or medians. Multiple regression analysis was conducted utilizing a program 'HALBAU' (Takagi et al. 1994).

RESULTS

Anthropometry, hematology and serum biochemistry among the three study populations

The study participants were women mostly in middle ages, and the mean ages were about 40 years regardless of study groups (Table 2). In anthropometry, the

TABLE 2. *Age distribution, anthropometry and hematology of study participants by cities surveyed*

Parameter (Unit)	Total	City			<i>p</i> ^a
		Beijing	Shanghai	Nanning	
Number of participants	150	50	50	50	
Age (years)	39.3 ± 9.3	38.4 ± 10.5	41.8 ± 7.9	37.8 ± 8.8	0.070 ^f
Min.-Max.	20-62	20-62	23-58	23-58	
Height (H)(cm)	158.4 ± 5.7	159.7 ± 5.6*	159.2 ± 6.0*	156.1 ± 4.7	0.003 ^f
Weight (W)(kg)	55.6 ± 8.3	57.2 ± 9.1	54.8 ± 6.4	54.8 ± 8.8	0.239 ^f
BMI [(W/H ²) × 10 ⁴]	21.4 ± 3.1	21.6 ± 3.5	20.9 ± 2.6	21.6 ± 3.2	0.376 ^f
Overweight cases (%) ^a	11(7%)	6(12%)	3(6%)	2(4%)	0.279 ^g
RBC counts (× 10 ⁶ /mm ³)	4.55 ± 0.42	4.40 ± 0.30	4.51 ± 0.40	4.74 ± 0.47	< 0.001 ^f
Erythrocytopenia cases ^b (%)	2(1%)	1(2%)	1(2%)	0(0%)	0.602 ^g
Hb ^c (g/100 ml)	13.0 ± 1.1	13.2 ± 0.9	12.8 ± 1.2	13.1 ± 1.1	0.156 ^f
Hypohemoglobinemia cases ^d (%)	21(14%)	3(6%)	11(22%)	7(14%)	0.251 ^g
Hyperlipidemia cases ^e (%)	17(11%)	6(12%)	3(6%)	5(10%)	0.529 ^g

Values are mean ± s.d., unless otherwise specified. An asterisk (*) indicates that the mean values are significantly ($p < 0.05$) larger than the value for Nanning as assayed by ANOVA (Scheffe).

^aThe ratio of subjects who had BMI of ≥ 25 (Fatimah et al. 1995).

^b $< 3.80 \times 10^6$ RBC/mm³.

^cHb : Hemoglobin.

^d < 12.0 g Hb/100 ml blood.

^e > 150 mg triglyceride/100 ml.

^fThe probability, p , for difference among the three group means as assayed by ANOVA.

^gThe probability, p , for difference in prevalence among the three groups as assayed by chi-squares test.

participants in Nanning were shorter than those in Beijing and Shanghai ($p < 0.01$), whereas Beijing people tended to be heavier than others although the differences were insignificant ($p > 0.10$). Thus, no significant ($p > 0.10$) difference was detected in body mass index {body mass index (BMI) = (weight in kg/[height in cm²]) $\times 10^4$ } among the three groups. The overall prevalence of overweight cases was 7%. In hematology and serum biochemistry, the overall prevalence of erythrocytopenia (criterion: $< 3.80 \times 10^6$ RBC/mm³), hypohemoglobinemia (< 12.0 g/100 ml), and hyperlipidemia (> 150 mg triglyceride/100 ml) were 1%, 14% and 11%, respectively. There was no inter-city difference ($p > 0.10$) in the distribution of any parameter except for RBC counts ($p < 0.01$; Beijing people being the lowest). The serum levels of liver function indicator enzymes, AST (E.C. 2.6.1.1), ALT (E.C. 2.6.1.2) and γ -GTP (E.C. 2.3.2.1), stayed within normal ranges to suggest undisturbed liver function in all participants. Levels of pseudocholinesterase (E.C. 3.1.1.8) activities were also normal (data not shown).

Simple comparison among 6 parameters of BMI, serum triglyceride, age, city, total energy and the lipid energy ratio (data on the latter two parameters are to be shown below) showed that BMI correlated significantly with serum triglyceride ($p < 0.01$) with a correlation coefficient (r) of 0.325, and also with age ($r = 0.450$, $p < 0.01$), but none else. The correlation between age and triglyceride was weakly significant ($r = 0.219$, $p < 0.05$), whereas other combinations did not show significant correlation ($p > 0.05$). Multiple regression analysis taking BMI as a dependent variable and others as independent ones showed that the most influential factor was age (but with a small R^2 of 0.203) followed by triglyceride as the second most ($R^2 = 0.054$), and that others were not contributing.

Nutrient intake by city and by age group

Intakes of the three major nutrients, minerals and vitamins are summarized in Table 3. When the participants from the three cities were combined, they took 1,776 kcal (7,431 kJ) energy, 57 g protein, 75 g lipid (with the lipid energy ratio of 38%), 218 g carbohydrate, 439 mg calcium, and 24 mg iron per day on an average (Table 3). Comparison among the four age groups showed that there were no significant ($p > 0.10$) differences in the nutrient intakes among the age groups, with two exceptions that the youngest group (aged 20 to 29 years) took more carbohydrate (although not energy because they took less lipid) and that the eldest group (the 50–62 years-old group) took more vitamin A than others.

In a sharp contrast, inter-city difference (Table 4) was significant ($p < 0.05$) in almost all nutrients (including the lipid energy ratio) with only one exception of net lipid intake ($p > 0.10$). The participants in Nanning took more energy, carbohydrate, fiber, iron, sodium and most of vitamins than others, whereas Beijing participants took more protein, calcium, phosphorus and potassium. Intakes of most nutrients by those in the Shanghai group tended to be lower than that by others except for lipid and vitamin E.

TABLE 3. *Energy and nutrient intake by age group*

Energy & nutrient	(Unit/day)	Total	Age group (years)				<i>p</i> ^a
			20-29	30-39	40-49	50-62	
Number of participants		150	25	46	53	26	
Energy	(kcal)	1,776±497	1,830±508	1,712±433	1,787±545	1,815±478	0.747
	(kJ)	7,431	7,656	7,162	7,479	7,594	
Protein	(g)	57.0±22.2	56.5±26.0	52.3±13.2	61.0±25.8	57.4±21.4	0.295
Lipid	(g)	75.4±33.6	70.4±22.7	77.2±34.8	76.0±34.4	75.5±38.0	0.876
Lipid energy ratio (%)		37.6±10.9	34.8±8.1	39.3±10.3	37.8±12.0	36.6±11.3	0.404
Carbohydrate	(g)	217.7±70.5	243.0±78.3	202.3±50.7	214.6±79.3	227.0±65.3	0.114
Crude fiber	(g)	8.7±5.9	10.4±6.4	7.7±5.7	9.0±6.3	8.3±4.4	0.313
Minerals							
Calcium	(mg)	439±282	348±259	452±236	449±334	480±240	0.347
Phosphorus	(mg)	921±437	900±470	875±379	960±485	943±386	0.792
Iron	(mg)	24.1±11.6	25.6±14.5	23.1±10.2	23.4±9.8	25.6±13.6	0.707
Sodium	(mg)	3,398±1,663	3,560±2,189	3,393±1,582	3,428±1,442	3,188±1,615	0.884
Potassium	(mg)	1,521±801	1,611±920	1,403±748	1,566±806	1,552±734	0.685
Vitamins							
Vitamin A	(RE μg)	544±554	673±712	453±453	447±341	781±761	0.290
Vitamin B ₁	(mg)	0.61±0.40	0.61±0.41	0.50±0.19	0.69±0.50	0.64±0.42	0.164
Vitamin B ₂	(mg)	0.79±0.38	0.74±0.35	0.73±0.22	0.85±0.47	0.83±0.39	0.404
Vitamin C	(mg)	65.5±44.5	71.5±47.1	66.2±39.8	60.9±47.1	68.1±43.4	0.774
Vitamin E	(mg)	31.0±22.5	25.2±13.0	29.7±21.0	32.6±21.2	35.3±31.6	0.390

Values are mean±s.d.

^aThe probability, *p*, for the differences among the four age groups as assayed by ANOVA.

Evaluation of intakes in comparison with recommended daily dietary intakes

The intakes of each nutrients by individuals were calculated (Table 5) in comparison with RDA values set by Institute of Nutrition and Food Hygiene (1991b) (Table 1); 80 to 120% RDA was considered acceptable, taking day-to-day variation (Shimbo et al. 1996b) and other variations in food intake into account. For lipid energy ratio, 30% (or 1.2 time the upper limit of the recommended range [20-25%; Institute of Nutrition and Food Hygiene 1991b]) was adopted as acceptable. This ratio (30%) was identical with the American RDA (30%; Committee on Diet and Health 1989).

The evaluation on the 150 participants as a whole showed that more than a half of the subjects took calcium and vitamins A, B₁ and B₂ insufficiently. It should be taken into account, however, that Chinese RDA values for minerals and vitamins are set at the levels generally higher than the counterpart RDA for Japanese (Table 1) although Chinese and Japanese women are more or less similar

TABLE 4. *Energy and nutrient intake by city surveyed*

Energy & nutrient	(Unit/day)	Total	City			p^a
			Beijing	Shanghai	Nanning	
Number of participants		150	50	50	50	
Energy	(kcal)	1,776 $\pm$ 497	1,746 $\pm$ 473	1,635 $\pm$ 489	1,947 $\pm$ 551**	0.006
	(kJ)	7,431	7,304	6,843	8,148	
Protein	(g)	57.0 $\pm$ 22.2	63.7 $\pm$ 22.8**	46.0 $\pm$ 13.4	61.2 $\pm$ 24.3**	<0.001
Lipid	(g)	75.4 $\pm$ 33.6	70.5 $\pm$ 30.3	81.0 $\pm$ 41.9	74.5 $\pm$ 25.9	0.295
Lipid energy ratio (%)		37.6 $\pm$ 10.9	35.8 $\pm$ 8.6	42.4 $\pm$ 12.0††	34.4 $\pm$ 10.1	<0.001
Carbohydrate	(g)	217.7 $\pm$ 70.5	214.3 $\pm$ 52.6**	181.0 $\pm$ 44.7	257.8 $\pm$ 84.7**	<0.001
Crude fiber	(g)	8.7 $\pm$ 5.9	9.6 $\pm$ 6.5**	5.9 $\pm$ 2.9	10.6 $\pm$ 6.4**	<0.001
Minerals						
Calcium	(mg)	439 $\pm$ 282	531 $\pm$ 221**	345 $\pm$ 270	440 $\pm$ 315	0.004
Phosphorus	(mg)	921 $\pm$ 437	1061 $\pm$ 557**	757 $\pm$ 213	945 $\pm$ 412	0.002
Iron	(mg)	24.1 $\pm$ 11.6	23.3 $\pm$ 9.1	20.6 $\pm$ 6.6	28.3 $\pm$ 15.8**	0.004
Sodium	(mg)	3,398 $\pm$ 1,663	2,814 $\pm$ 1,339	2,825 $\pm$ 1,303	4,554 $\pm$ 1,673††	<0.001
Potassium	(mg)	1,521 $\pm$ 801	1,810 $\pm$ 1,035††	1,143 $\pm$ 386	945 $\pm$ 412	<0.001
Vitamins						
Vitamin A	(RE μ g)	544 $\pm$ 554	607 $\pm$ 498**	223 $\pm$ 192	803 $\pm$ 680**	<0.001
Vitamin B ₁	(mg)	0.61 $\pm$ 0.40	0.67 $\pm$ 0.46	0.44 $\pm$ 0.19	0.72 $\pm$ 0.45**	<0.001
Vitamin B ₂	(mg)	0.79 $\pm$ 0.38	0.74 $\pm$ 0.26	0.68 $\pm$ 0.34	0.94 $\pm$ 0.46††	0.001
Vitamin C	(mg)	65.5 $\pm$ 44.5	64.5 $\pm$ 43.3	51.6 $\pm$ 33.2	80.5 $\pm$ 50.4**	0.005
Vitamin E	(mg)	31.0 $\pm$ 22.5	23.6 $\pm$ 11.0	42.2 $\pm$ 32.5††	27.1 $\pm$ 12.0	<0.001

Values are mean $\pm$ s.d. **show that the value is significantly ($p < 0.01$) larger than the value for Shanghai. ††show that the value is significantly ($p < 0.01$) larger than other two values.

^aThe probability, p , for the differences among the three cities as assayed by ANOVA.

in body size. The people with the lipid energy ratio in excess of the 30% limit accounted as many as 73%. Comparison among the three cities (the central part in Table 5) showed that the prevalence of insufficient intake (excess intake in case of the lipid energy ratio) varied depending on the city ($p < 0.05$) with two exceptions of vitamin C and iron insufficiency ($p > 0.10$ for both). Iron intake was uniform ($p > 0.10$) among the three cities, but the overall insufficiency ratio was rather low (11% on an average) throughout the three cities. No difference among age groups were detected ($p > 0.10$ in most cases, except for vitamin A [$p = 0.016$] and vitamin B₁ [$p = 0.022$]; the right part in of Table 5).

Intakes of total foods, energy, and rice and wheat by three meals and snack

It was further attempted to examine possible inter-city difference in food custom. Thus, total food intake (by weight) and energy intake by three meals

TABLE 5. *Excess or insufficient intake of energy and nutrients, by city and by age*

Energy & nutrient	Excess or insufficiency	No. of cases (%)	Prevalence(%)by city			<i>p</i>	Prevalence (%) by age				<i>p</i>
			Bei.	Sha.	Nan.		20s	30s	40s	50s ^d	
Number of participants		150(100%)	50	50	50		25	46	53	26	
Energy	Excess ^a	15(10%)	6	8	16	0.211	8	4	11	19	0.230
Energy	Insufficient ^b	67(45%)	48	56	30	0.028	32	52	49	35	0.246
Protein	Insufficient	77(51%)	34	78	42	<0.001	52	59	45	50	0.615
Lipid	Excess ^c	110(73%)	70	84	66	0.102	68	80	75	62	0.318
Calcium	Insufficient	120(80%)	64	94	82	<0.001	88	76	81	77	0.651
Iron	Insufficient	16(11%)	12	10	10	0.932	8	15	13	0	0.199
Vitamin A	Insufficient	111(74%)	70	96	56	<0.001	64	85	79	54	0.016
Vitamin B ₁	Insufficient	126(84%)	82	94	76	0.044	76	98	92	81	0.022
Vitamin B ₂	Insufficient	109(71%)	74	86	58	0.007	84	78	62	73	0.156
Vitamin C	Insufficient	59(39%)	44	46	28	0.130	44	35	43	35	0.744

The prevalence shows the number of cases over the number of participants for the total population (150 people), for each city of Beijing (Bei.), Shanghai (Sha.) and Nanning (Nan.), and by four age groups. The probability, *p*, is by chi-squares test.

^aMore than 120% RDA. For RDA, see Table 2.

^bLess than 80% RDA.

^cThe lipid energy ratio (or the ratio of lipid over total nutrients in terms of energy) is >30%, as 1.2 time the upper limit of RDA (20-25%) by Institute of Nutrition and Food Hygiene (1991b).

^dIncluding one woman each at the age of 61 and 62 years, respectively.

and snack (Table 6) as well as intakes of rice and wheat (Table 7) were compared among the three cities. Comparison was made also among different age groups.

Snack was generally very light with an account of 7% in energy intake (Table 6), and that breakfast was the lightest meal of the day. Lunch was almost as substantial as dinner when compared in terms of food weight and energy. When compared among cities, Beijing and Shanghai participants took smaller breakfast and smaller lunch, respectively, than others ($p < 0.05$ for both cases), although dinner was equally substantial among the three cities.

Of particular interest was the fact that there were significant differences in consumption of rice and wheat among the three cities (Table 7). Thus, Beijing people took significantly less rice and more wheat ($p < 0.01$ for both cases) than the people in other cities. Whereas energy intakes from cereals varied among the three cities and Nanning people took significantly ($p < 0.01$) more cereals than those in other cities when intakes of rice and wheat were combined on an energy basis, the relative weight of rice as the cereals-based energy source was significantly ($p < 0.01$) lower in Beijing than in other cities. It should be added that consumption of cereals other than rice and wheat (e.g., barely, millet and corn) was essentially nil in the three cities surveyed.

Comparison among age groups showed no age-dependent differences in gen-

TABLE 6. *Total food intake and energy intake by three meals and snack, and by city surveyed*

Item Meal and snack (Unit/day)	Total	City			p^a
		Beijing	Shanghai	Nanning	
Number of participants	150	50	50	50	
Total food intake					
Whole day (g)	1,242 $\pm$ 328(100)	1,337 $\pm$ 374(100)**	1,131 $\pm$ 289(100)	1,259 $\pm$ 278(100)	0.006
Breakfast (g)	274 $\pm$ 155(22)	298 $\pm$ 206(22)	284 $\pm$ 114(25)	240 $\pm$ 122(19)	0.157
Lunch (g)	407 $\pm$ 127(33)	404 $\pm$ 126(30)	372 $\pm$ 115(33)	444 $\pm$ 128(35)	0.016
Dinner (g)	437 $\pm$ 159(35)	460 $\pm$ 215(34)	385 $\pm$ 104(34)	464 $\pm$ 121(37)	0.020
Snack (g)	125 $\pm$ 173(10)	175 $\pm$ 191(13)	90 $\pm$ 86(8)	110 $\pm$ 123(9)	0.035
Energy intake					
Whole day (kcal)	1,776 $\pm$ 497(100)	1,746 $\pm$ 437(100)	1,635 $\pm$ 489(100)	1,947 $\pm$ 511(100)	0.006
(kJ)	7,431	7,304	6,843	8,148	
Breakfast (kcal)	373 $\pm$ 210(21)	372 $\pm$ 154(21)	323 $\pm$ 155(20)	425 $\pm$ 281(22)	0.050
(kJ)	1,562	1,556	1,351	1,780	
Lunch (kcal)	630 $\pm$ 216(35)	577 $\pm$ 212(33)	618 $\pm$ 220(38)	696 $\pm$ 199(36)	0.019
(kJ)	2,638	2,414	2,586	2,914	
Dinner (kcal)	646 $\pm$ 240(36)	592 $\pm$ 262(34)	647 $\pm$ 230(40)	699 $\pm$ 212(36)	0.087
(kJ)	2,704	2,479	2,709	2,923	
Snack (kcal)	126 $\pm$ 183(7)	204 $\pm$ 215(12)**	47 $\pm$ 79(3)	127 $\pm$ 189(7)	<0.001
(kJ)	528	855	197	531	

Values are mean $\pm$ s.d. (%), taking the whole day value as 100). **show that the value is significantly ($p < 0.01$) larger than the value for Shanghai.

^aThe probability, p , for the differences among the three cities as assayed by ANOVA.

TABLE 7. *Energy intake from rice- and wheat-based food intake, and the ratio of rice over sum of rice and wheat, by city surveyed*

Item	(Unit/day)	Total	City			p^a
			Beijing	Shanghai	Nanning	
Number of participants		150	50	50	50	
A. Rice-based food	(kcal)	496 ± 242	330 ± 164 ^{††}	522 ± 194	638 ± 250	<0.001
B. Wheat-based food	(kcal)	276 ± 228	360 ± 191 ^{**}	171 ± 147	292 ± 283	<0.001
A + B	(kcal)	772 ± 269	691 ± 208	697 ± 193	929 ± 315 ^{**}	<0.001
A/[A + B] ratio	(%)	65 ± 24	49 ± 21 ^{††}	74 ± 21	71 ± 21	<0.001

Values are mean ± s.d. A/[A + B] ratio was calculated first for individuals, from which mean ± s.d. was then calculated. ^{**}show that the value is significantly ($p < 0.01$) larger than other two values, whereas ^{††} show that the value is significantly ($p < 0.01$) smaller than other two values by multiple comparison test.

^aThe probability, p , for the differences among the three cities as assayed by ANOVA.

eral (Tables 8 and 9). There were no significant differences among the four age groups in intakes of total foods (by weight) and energy (Table 8) in three meals or snack, except that the youngest group tended to take more energy from snack than other groups ($0.05 < p < 0.10$). Age-dependent difference in consumption of rice and wheat, as well as in relative weight of rice and wheat as cereals-based energy sources were also insignificant ($p > 0.10$; Table 9).

The effects of city and age on energy, rice and wheat intake were examined by multiple regression analysis in which energy intake, rice intake, or wheat intake was taken as a dependent variable, and city and age as two independent variables. As the PC program employed (Takagi et al. 1994) accepts only two categories in a nominal scale (e.g., city), the analysis was repeated for three cases taking two cities out of the three (thus three pairs). Following the procedures previously described (Shimbo et al. 1996b), the medians of the partial correlation coefficients, three each for city and age, were subjected to median test (in combination with chi-squares test; Tsuji 1981) to examine if any one of the two independent parameters was more influential than the other. The analysis failed to show any specifically influential factor except that age would be more influential than city ($p < 0.05$) in determining rice and wheat intake in form of snack, although not via three meals.

Animal- and plant-based foods as sources of protein and lipid

Efforts were made to identify the relative weight of the animal- and plant-based foods as the sources of protein and lipid (Table 10). About one third of protein (33%) and lipid (35%) was of animal origin, and fish and shellfish played only limited roles as the protein (5%) or lipid source (1%). When compared among cities (Table 10), Beijing people took more amounts of protein and lipid

TABLE 8. *Total food intake and energy intake by three meals and snack, and by age*

Item Meal and snack (Unit/day)	Total	Age group (years)				p^a
		20-29	30-39	40-49	50-62	
Number of participants	150	25	46	53	26	
Total food intake						
Whole day (g)	1,242 ± 328(100)	1,251 ± 391(100)	1,223 ± 283(100)	1,216 ± 324(100)	1,322 ± 329(100)	0.565
Breakfast (g)	274 ± 155(22)	268 ± 256(21)	268 ± 130(22)	263 ± 127(22)	313 ± 104(24)	0.563
Lunch (g)	407 ± 127(33)	430 ± 142(34)	405 ± 121(33)	404 ± 127(33)	393 ± 116(30)	0.767
Dinner (g)	437 ± 159(35)	427 ± 192(34)	437 ± 162(34)	430 ± 142(35)	459 ± 147(35)	0.878
Snack (g)	125 ± 173(10)	127 ± 132(10)	113 ± 149(9)	119 ± 122(10)	157 ± 270(12)	0.763
Energy intake						
Whole day (kcal)	1,776 ± 497(100)	1,830 ± 508(100)	1,712 ± 433(100)	1,787 ± 545(100)	1,815 ± 478(100)	0.747
(kJ)	7,431	7,656	7,162	7,479	7,594	
Breakfast (kcal)	373 ± 210(21)	418 ± 232(23)	347 ± 188(20)	360 ± 218(20)	404 ± 195(22)	0.460
(kJ)	1,562	1,750	1,453	1,507	1,690	
Lunch (kcal)	630 ± 216(35)	631 ± 185(35)	613 ± 216(36)	653 ± 243(37)	615 ± 182(34)	0.807
(kJ)	2,638	2,462	2,565	2,731	2,573	
Dinner (kcal)	646 ± 240(36)	589 ± 250(32)	676 ± 214(39)	634 ± 208(35)	672 ± 311(37)	0.469
(kJ)	2,704	2,465	2,829	2,653	2,813	
Snack (kcal)	126 ± 183(7)	191 ± 242(10)	76 ± 222(4)	140 ± 204(8)	124 ± 164(7)	0.072
(kJ)	528	799	316	588	519	

Values are mean ± s.d. (%), taking the whole day value as 100).

^aThe probability, p , for the differences among the four age groups as assayed by ANOVA.

TABLE 9. *Energy intake from rice- and wheat-based food intake, and the ratio of rice over sum of rice and wheat, by age*

Item	(Unit/day)	Total	Age group (years)				p^a
			20-29	30-39	40-49	50-62	
Number of participants		150	25	46	53	26	
A. Rice-based food	(kcal)	496±242	537±288	459±236	494±234	535±202	0.487
B. Wheat-based food	(kcal)	276±228	333±284	250±202	278±209	262±235	0.532
A + B	(kcal)	772±269	870±303	709±193	769±278	797±297	0.111
A/[A+B] ratio	(%)	65±24	62±27	64±27	64±22	69±19	0.784

Values are mean±s.d. A/[A+B] ratio was calculated first for individuals, from which mean±s.d. was then calculated.

^aThe probability, p , for the differences among the four age groups as assayed by ANOVA.

TABLE 10. *Protein and lipid sources by city surveyed*

Nutrient	Source	Total	City			p^a
			Beijing	Shanghai	Nanning	
Number of participants		150	50	50	50	
Protein (g/day)						
Meats, eggs and milk		18.8(33%)	22.3(36%)	16.3(36%)	17.7(30%)	0.023
Fish and shellfish		2.6(5%)	3.1(5%)	2.2(5%)	2.6(4%)	0.477
Animals ^b		21.4(38%)	25.4(41%)	18.5(41%)	20.4(34%)	0.014
Plants		36.3(62%)	37.2(59%)**	26.7(59%)	39.0(66%)**	<0.001
Lipid (g/day)						
Meats, eggs and milk		26.5(35%)	31.7(45%)	24.5(30%)	23.2(31%)	0.083
Fish and shellfish		0.5(1%)	0.4(1%)	0.4(1%)	0.5(1%)	0.845
Animals ^b		27.0(36%)	32.3(46%)	25.0(31%)	23.7(32%)	0.078
Plants		49.2(64%)	38.1(54%)††	56.1(69%)	50.4(68%)	0.006

Values are means (percentages). **show that the value is significantly ($p < 0.01$) larger than the value for Shanghai. †† show that the value is significantly ($p < 0.01$) smaller than the value for Shanghai.

^aThe probability, p , for the differences among the three cities as assayed by ANOVA.

^bSum of meats, eggs, milk, fish and shellfish.

from meats (including eggs and milk) than those in other two cities, whereas plant-based foods were important sources of lipid in Shanghai and Nanning, and that of protein in Nanning. No significant ($p > 0.10$) age-dependent difference was observed in protein and lipid sources (data not shown).

DISCUSSION

Overall, the study participants took 1,776 kcal (7431 kJ) energy, 57 g protein,

TABLE 11. *Intake of major nutrients, as reported in literature*

Reference	Daily intake ^a						Remarks
	Energy (kcal)	Protein (g)	Lipid (g)	Carbohydrate (g)	Ca (mg)	Fe (mg)	
The present study	1,776	57.0(13%) [21.4]	75.4(38%) [27.0]	217.7(49%)	439	24	Women in cities
Wu et al. (1989)	1,781	55.4(12%) [—]	44.9(23%) [—]	292 (65%)	409.6	22.8	Mostly retirees
Zhang (1990)	2,157	69.7(13%) [—]	72.6(30%) [—]	306.2(57%)	866	47	Middle-aged intellectual women
Gao and Bi (1991)	2,734	70.1(10%) [—]	70.4(24%) [—]	449.4(66%)	718.3	60.3	Farmers, men and women combined
Ma et al. (1992)	2,602	67.4(10%) [15.0]	44.3(15%) [33.5]	— (—%)	539.3	35.8	Jiangsu in 1985–7, men and women combined?
Zhang et al. (1992)	2,497	68.5(11%)	70.2(25%) [16.1]	395.7(64%) [35.5]	674.0	36.3	Urban population, men and women combined?
Huang et al. (1994)	1,996	64.5(13%) [—]	— (—%) [—]	— (—%)	619	12	Middle-aged women
Zhang et al. (1994)	2,665	84 (11%) [31]	91 (28%) [—]	454 (61%)	810	27.5 ^b	Men and women in a fishing village
Ge et al. (1995)	2,438	75.1(13%) [31.5]	77.7(29%) [38.7]	— (—%)	457.9	25.5 ^c	Urban population, based on reviewing
Pan et al. (1995)	2,280	64.3(11%) [44.8]	51.0(20%) [64.1]	391.0(69%)	127.7	40.7	Men and women combined
Zhai et al. (1995)	2,602	78 (12%) [16]	54 (19%) [43]	— (—%)	—	—	Values in 8 provinces, men and women combined
Ge et al. (1996)	2,395	75.1(13%) [—]	77.7(29%) [—]	340.5(58%)	457.9	25.5	Urban population, men and women combined

Values are mean intake (the account in % in total energy intake, calculated on energy basis) [the amount of animal protein or lipid; — shows not reported]. In some cases, the percentages are calculated by the present authors. ? shows assumption because the gender was not stated in the original paper.

^aMethods used are food (raw) weight recording, except for the present study in which the food duplicate method was employed. For details, see the Materials and Methods section and the Discussion section.

^b14.4% of women had less than 11 g hemoglobin/100 ml blood.

^c22–25% of women were anemic; the prevalence varied depending on age and urban-rural residence.

75 g lipid (lipid energy ratio; 38%), 218 g carbohydrate, 439 mg calcium, and 24 mg iron a day (Table 3). The intake of 3,398 mg sodium (equivalent to 8.5 g NaCl when the sodium is considered to be solely attributable to NaCl) may not be reliable and probably is an underestimation, because correct estimation of sodium intake by the food duplicate method is hard to achieve, especially due to non-quantifiable use of salted seasonings, etc.

Literature survey shows that 11 articles (Wu et al. 1989; Zhang 1990; Gao and Bi 1991; Ma et al. 1992; Zhang et al. 1992, 1994; Huang et al. 1994; Ge et al.

1995, 1996; Pan et al. 1995; Zhai et al. 1995) have been published in this decade of years on nutrient intake in continental China. The major findings reported in these 11 articles are summarized in Table 11, in which efforts were made to cite urban values, if available, for better comparison with the present observation in the three cities. The report by Ge et al. (1996) is on a nation-wide nutritional survey conducted by the Government involving more than 2,500 households, and therefore the largest; the article by Ge et al. (1995) appeared to be a summary of that by Ge et al. (1996).

The present observation on energy intake of 1,776 kcal/day appears to be smaller than the values reported by others. It should be taken into account, however, that many authors (Gao and Bi 1991; Zhang et al. 1994; Pan et al. 1995; Zhai et al. 1995; Ge et al. 1996) gave the values for a combination of men and women, and such values should be inevitably larger than the values for women only, because men used to take more foods than women (Chiang and Huang 1986, 1987). When the values for women (Zhang 1990; Huang et al. 1994) are selected, the differences from the present results are much smaller.

Intake of protein, 57 g/day, in the present study is essentially at the level comparable to others. Lipid consumption in the present study (75.4 g/day) is however the third highest among the values ever reported (Table 11), with the value (91 g/day) by Zhang et al. (1994) as the highest followed the value (77.7 g/day) by Ge et al. (1995, 1996), to which the present value is close. The lipid energy ratio observed in the present study is highest, partly because total energy intake is smaller than others.

Bearing in mind that excess intake of lipid (animal-originated one in particular) is among the well established nutritional risk factors of cardiovascular diseases (Expert Committee 1982), it is worthy to note that more than 70% of the present study participants took lipid in excess when the lipid energy ratio is evaluated (Table 5). The observation on the order of the ratio (i.e., 42% in Shanghai, 36% in Beijing and 34% in Nanning [Table 4]) is in a good agreement with the observation in a national survey (Ge et al. 1995, 1996) that people in Beijing (92.9 g/day for a hypothetical standard man) and Shanghai (86.4 g/day) took more lipid than urban people in Guangxi Autonomous Region (72.1 g/day) in which Nanning is the capital. It is also in an accordance with previous experiences in Japan that people in urban areas usually take more protein and lipid than those in rural areas (Ikeda et al. 1988; Nakatsuka et al. 1988).

It should also be noted, however, that such excess lipid intake was not associated with high prevalence of lipidemia or excess BMI (Table 2). Serum triglyceride level was the secondmost influential factor, next to the age in determining BMI in multivariate analysis, and BMI correlated significantly ($p < 0.01$) with triglyceride. Nevertheless, no correlation was observed between BMI and the lipid energy ratio ($p > 0.05$). It is worthy to note in this connection that the majority (i.e., 54 to 69%) of the lipid consumed were plant-based (Table 10),

which would contribute to this absence of correlation.

Substantial inter-city differences were observed in various nutrient intakes (Tables 4, 5 and 6) as well as sources of important nutrients such as protein and lipid (Table 10). Inter-city difference was found also in the consumption of staple foods like rice and wheat (Table 7). China has a long history in cooking, and it is well-known that variations in cooking (not only food materials but the use of seasonings and spices) depending on localities within China, counting at least four major schools in cuisine. However, no nutritional science-based evaluation of the inter-city difference in cooking has ever been published in academic journals, and the present paper might be the first to address this point. It is quite worthy from public nutritional health viewpoints to realize that there exists local differences not only in the way of cooking but the amounts of nutrients taken by common people.

The intakes of nutrient minerals and vitamins show wide variations in literature. Two minerals of calcium and iron are shown in Table 11 as examples of elements of nutritional importance. The reported values for calcium range from 128 mg/day (Pan et al. 1995) as the lowest value to 866 mg/day (Zhang 1990) as the highest. Similarly, iron intake ranges from 12 mg/day (Huang et al. 1994) to 60 mg/day (Gao and Bi 1991). The values obtained in the present study (439 mg Ca and 24 mg Fe per day) fall in the middle of both ranges and close to the national survey values (Ge et al. 1995, 1996).

The question critical to the use of the food composition tables for estimation of element intakes, especially that of nutrient minerals, is the reliability of the values given in the food composition tables. Tables used to give single value for each nutrient element, whereas it is quite conceivable that the mineral contents in vegetables, for example, will vary in reflection of element contents in the soil where they are grown for harvest. Our group (Shimbo et al. 1996a) has observed that the table-based estimation of daily intake may be close to the values reported in literature only when the intake is relatively large, whereas the discrepancy is substantial for elements of smaller intake. Furthermore, we have reported (Moon et al. 1996) that the table-based values even for major nutrient minerals differ from the values determined by modern analytical instruments to the extent that the difference cannot be ignored from nutritional viewpoints. A systematic survey is currently in progress in this study group to measure various nutrient minerals (including calcium and iron in particular, because of potential high risk of insufficient intake among many Asian populations) in collected food duplicate samples by ICP-mass spectrometry to examine reliability of various food composition tables used in Asia (e.g., in continental China [Institute of Nutrition and Food Hygiene 1991a], in Taiwan, China [Department of Health 1991], in Japan [Resources Council 1983, 1992], in Korea [Rural Nutrition Institute 1991] and in Malaysia [Tee et al. 1988]) as tools for the estimation of intakes of important nutrient minerals.

Acknowledgments

We are grateful to the Directors and staffs of Institute of Occupational Medicine, Chinese Academy of Preventive Medicine (CAPM), Beijing, China, Institute of Nutrition and Food Hygiene, CAPM, Beijing, China, Shanghai Institute of Labour Hygiene and Occupational Diseases, Shanghai, China, and Sanitary and Anti-epidemic Station of Guangxi, Nanning, China for their interest in and support to this work. Thanks are also due to Miss K. Higashikawa, Kyoto Industrial Health Association, Kyoto, Japan, for her skillful technical assistance in statistical analysis. This work was supported in part by a research grant for international field survey (No. 06041068: Principal Investigator; M. Ikeda) from the Ministry of Education, Science, Sports and Culture, the Government of Japan to M.I., S.S., and T.W.

References

- 1) Acheson, K.J., Campbell, I.T., Edholm, O.G., Miller, D.S. & Stock, M.J. (1980) The measurement of food and energy intake in man—An evaluation of some techniques. *Am. J. Clin. Nutr.*, **33**, 1147–1154.
- 2) Chen, J.-S. & Chen, X.-S. (1993) Changes in dietary intake of Chinese population and the guidelines. *Chin. J. Prev. Med.*, **27**(5), 266–269. (in Chinese)
- 3) Chiang, A.-N. & Huang, P.-C. (1986) Studies on energy intake and nitrogen balance of Chinese young men and women. *J. Formosan Med. Assoc.*, **85**, 741–747. (in Chinese with English abstract)
- 4) Chiang, A.-N. & Huang, P.-C. (1987) Studies on energy expenditure of Chinese young men and women. *J. Formosan Med. Assoc.*, **86**, 505–511. (in Chinese with English abstract)
- 5) Committee on Diet and Health, U.S. National Research Council (1989) *Diet and Health*. National Academy Press, Washington, D.C. pp. 671–672, 673–674.
- 6) Department of Health (1991) *Guidelines for Civilian Nutrition*. Department of Health, Taipei, pp. 153–178. (in Chinese)
- 7) Expert Committee, World Health Organization (1982) *Prevention of Coronary Heart Disease*. WHO Tech. Rep. Ser. 678. World Health Organization, Geneva.
- 8) Fatimah, A., Md. Idris, M.N., Romzi, M.A. & Faizah, H. (1995) Perception of body weight status among office workers in two government departments in Kuala Lumpur. *Mal. J. Nutr.*, **1**, 11–19.
- 9) Gao, X.-N. & Bi, P.-M. (1991) Dietary and nutritional survey of farmers in Xiuning county. *Chin. J. Publ. Health*, **7**(1), 9–10. (in Chinese)
- 10) Ge, K.-Y., Zhai, F.-Y., Yan, H.-C., Cheng, L. & Wang, Q. (1995) The dietary and nutritional status of Chinese populations in 1990s. *Acta Nutr. Sinica*, **17**(2), 123–134. (in Chinese with English abstract)
- 11) Ge, K.-Y., Zhai, F.-Y. & Yan, H.-C. (1996) *The Dietary and Nutritional Status of Chinese Populations—1992 National Nutrition Survey*, Vol. 1. People's Medical Publishing House, Beijing. (in Chinese with English translation)
- 12) Huang, Z.-N., Li, S.-H., Ni, S.-H., Zhou, L.-M., Li, C.-D. & Wei, J. (1994) Investigation of diet and humoral immunity levels in the middle-aged and older people. *J. Hyg. Res.*, **23**(4), 228–230. (in Chinese with English abstract)
- 13) Ikeda, M., Watanabe, T., Kasahara, M. & Nakatsuka, H. (1988) Nutrient intake of women in rural and urban areas in Japan. *Asia-Pacific J. Publ. Health*, **2**, 28–32.
- 14) Ikeda, M., Zhang, Z.-W., Moon, C.-S., Imai, Y., Watanabe, T., Shimbo, S., Ma, W.-C., Lee, C.-C. & Guo, Y.-L.L. (1996) Background exposure of general population to cadmium and lead in Tainan city, Taiwan. *Arch. Environ. Contam. Toxicol.*, **30**, 121–126.

- 15) Institute of Nutrition and Food Hygiene, Chinese Academy of Preventive Medicine, ed. (1991a) *Food Composition Tables (Nation-wide values, Part 1)*. People's Hygiene Press, Beijing. (in Chinese)
- 16) Institute of Nutrition and Food Hygiene, Chinese Academy of Preventive Medicine, ed. (1991b) *Food Composition Tables; Appendix I*, People's Hygiene Press, Beijing. (in Chinese)
- 17) Ma, F.-L., Cai, F.-M., Zhong, C.-Y., Mo, B.-Q. & Nang, Y.-M. (1992) Investigation of the dietary pattern and nutritional levels of the inhabitants in Jiangsu Province. *Acta Nutr. Sinica*, **14**(4), 380-389. (in Chinese with English abstract)
- 18) Ministry of Health and Welfare, the Government of Japan (1994) *Recommended Dietary Allowance for the Japanese (5th revision)*. Dai-ichi Shuppan Press, Tokyo. (English version)
- 19) Moon, C.-S., Zhang, Z.-W., Shimbo, S., Hokimoto, S., Shimazaki, K., Saito, T., Shimazu, A., Imai, Y., Watanabe, T. & Ikeda, M. (1996) A comparison of the food composition table-based estimates of dietary element intake with the values measured by inductively coupled plasma atomic emission spectrometry: An experience in a Japanese population. *J. Trace Elem. Med. Biol.*, **10**, 237-244.
- 20) Moon, C.-M., Zhang, Z.-W., Imai, Y., Shimbo, S., Watanabe, T., Moon, D.-H., Lee, B.-K., Lee, S.-H. & Ikeda, M. (1997) Nutritional status of women in urban and rural areas in Korea as assayed by total food duplicate method. *Tohoku J. Exp. Med.*, **181**, 245-265.
- 21) Nakatsuka, H., Kasahara, M., Watanabe, T., Hisamichi, S., Kato, K. & Ikeda, M. (1988) Urban-rural differences in food habits in north-eastern Japan. *Ecol. Food Nutr.*, **21**, 77-87.
- 22) Pan, Z.-H., Feng, J.-G., Yu, J.-Y. & He, C.-H. (1995) Comparison of dietary intake of people in a fishing village between 1984 and 1989. *J. Hyg. Res.*, **21**(4), 255-256. (in Chinese)
- 23) Popkin, B.M. (1994) The nutrition transition in low-income countries; an emerging crisis. *Nutr. Rev.*, **52**, 285-298.
- 24) Resources Council, Science and Technology Agency, the Government of Japan (1983) *Standard Tables of Food Composition in Japan, 4th revised edition*. Ministry of Finance Printing Bureau, Tokyo. (in Japanese with English translation)
- 25) Resources Council, Science and Technology Agency, the Government of Japan (1992) *Standard Tables of Food Composition in Japan—Minerals (magnesium, zinc and copper)*, Finance Printing Bureau, Tokyo. (in Japanese with English translation)
- 26) Rural Nutrition Institute, Rural Development Administration, the Government of the Republic of Korea (1991) *Food Composition Tables*, 4th ed. Rural Nutrition Institute, Seoul. (in Korean)
- 27) Shimbo, S., Imai, Y., Yasumoto, M., Yamamoto, K., Kawamura, S., Kimura, K., Watanabe, T., Sato, R., Iwami, O. & Ikeda, M. (1993) Quantitative identification of sodium chloride sources in Japanese diet by 24-hour total food duplicate analysis. *J. Epidemiol.*, **3**, 77-82.
- 28) Shimbo, S., Kawamura, S., Yamamoto, K., Kimura, K., Imai, Y., Yasumoto, M., Watanabe, T., Iwami, O. & Ikeda, M. (1994) Reduced carbohydrate intake in past 10 years in two rural areas in Japan. *Ecol. Food Nutr.*, **33**, 123-130.
- 29) Shimbo, S., Hayase, A., Murakami, M., Hatai, I., Higashikawa, K., Moon, C.-S., Zhang, Z.-W., Watanabe, T., Iguchi, H. & Ikeda, M. (1996a) Use of food composition database to estimate daily dietary intake of nutrient or trace elements in Japan with reference to its limitation. *Food Add. Contam.*, **13**, 775-786.
- 30) Shimbo, S., Higashikawa, K., Hatai, I., Murakami, M., Hayase, A., Watanabe, T., Moon, C.-S., Zhang, Z.-W. & Ikeda, M. (1996b) Chronological changes and inter-regional differences in dietary fiber intakes among middle-aged Japanese women. *Tohoku J. Exp. Med.*, **180**, 1-15.

- 31) Shimbo, S., Moon, C.-S., Zhang, Z.-W., Watanabe, T., Noor Hassim, I., Romzi M.A., Md. Idris, M.N., Nakatsuka H. & Ikeda, M. (1996c) Nutritional status of Malay women in Kuala Lumpur as studied by total food duplicate method. *Tohoku J. Exp. Med.*, **180**, 99-114.
 - 32) Shimbo, S., Moon, C.-S., Zhang, Z.-W., Watanabe, T., Guo, Y.-L.L., Ma, W.-C., Lee, C.-C., Nakatsuka, H. & Ikeda, M. (1997) Nutritional status of Chinese women in Tainan, Taiwan. *Tohoku J. Exp. Med.*, **181**, 339-352.
 - 33) Takagi, H., Saiki, K. & Nakai, S. (1994) *Data Analysis with a PC Program 'HALBAU (Version 4)'*. Gendai-sugaku-sha Publishers, Kyoto. (in Japanese)
 - 34) Tee, E.S., Ismail, M.N., Mohd. Nasir, A. & Khatijah, I. (eds.) (1988) *Nutrient Composition of Malaysian Foods*. Asean Food Habits Project National Sub-Committee on Protein: Food Habits Research and Development, Malaysia. Kuala Lumpur, p. 131.
 - 35) Tsuji, T. (1981) *Statistical Analysis*. Kanehara Publishers, Tokyo. pp.172-173. (in Japanese)
 - 36) Wu, L.-Q., Wen, Z.-M., Shun, G.-J., Zhu, X.-Y., Xie, D.-H., Wang, P., Xu, Z.-Y. & Shun, Y.-J. (1989) A nutritional investigation on 186 retirees in Nanjing city. *J. Hyg. Res.*, **18**(1), 27-30. (in Chinese)
 - 37) Zhai, F.-Y., Jin, S.-G., Ge, K.-Y., Ma, H.-J., Wang, J.-M., Hereward, M., Zhang, X.-P. & Popkin, B.-M. (1995) Dietary intake and nutritional status of Chinese adults with different socio-economic levels. *J. Hyg. Res.*, **24**(1), 40-43. (in Chinese with English abstract)
 - 38) Zhang, H.-J. (1990) A survey on dietary intake of 90 middle-aged intellectuals. *J. Hyg. Res.*, **19**(4), 35-36. (in Chinese)
 - 39) Zhang, L.-F., Zhang, Y.-Z. & Zhang, Q.-L. (1992) Dietary intake and nutritional status of general populations in Anyang city. *J. Hyg. Res.*, **21**(1), 39-42. (in Chinese)
 - 40) Zhang, C.-L., Xu, G.-F., Wang, L., Liu, S.-G., Huang, S.-Q., Qu, J.-B., Gong, Y.-Y., Zhao, C.-F., Wang, J.-J. & Xing, Z.-S. (1994) Survey and analysis of nutritional status and food constitution of Dayugao's inhabitants. *J. Hyg. Res.*, **23**(5), 294-297. (in Chinese with English abstract)
-