Original Article

Intake levels and major food sources of energy and nutrients in the Taiwanese elderly

Shin-Jiuan Wu MS,[1] Ya-Hui Chang MS,[2,3] Ien-Lan Wei PhD,[4] Mei-Ding Kao PhD,[5] Yi-Chin Lin PhD[3] and Wen-Harn Pan PhD[3]

[1]*Department of Food and Nutrition, Chung Hwa College of Medical Technology, Tainan, Taiwan*
[2]*Office of Survey Research, Academia Sinica, Taipei, Taiwan*
[3]*Institute of Biomedical Sciences, Academia Sinica, Taipei, Taiwan*
[4]*Faculty of Nursing, Yang-Ming University, Taiwan*
[5]*Department of Food and Nutrition, Providence University, Taichung, Taiwan*

The purpose of this article is to examine dietary intake levels and major food sources of energy and nutrients for the Taiwanese elderly in order to relate nutrient intakes to food choices and to provide suggestions for dietary improvement. The data were derived from the 24-hour recalls from 1,911 subjects (955 males and 956 females) aged 65 and above, who participated in the Elderly NAHSIT carried out from 1999 to 2000. The differences in food consumption patterns between the elderly and younger adults (aged 19 to 64) were also evaluated by comparison with data obtained from NAHSIT 1993-1996. The results revealed that cereals/roots, meat, other protein-rich foods and fats/oils contributed most to daily energy intake. The energy contributions from fats/oils, poultry, meat, other protein-rich foods, refreshments/snacks, alcoholic beverages, and miscellaneous food groups were lower in elderly diets compared with those of younger adults. Meat and cereals/roots were the major food sources of protein. The main carbohydrate-contributing food group was cereals/roots, while primary lipid sources were meat and fats/oils for the elderly. The food groups with a high contribution to vitamin intake were the following: vegetables for vitamin A; meat and cereals/roots for vitamin B_1; dairy products, vegetables, cereals/roots and meat for vitamin B_2; cereals/roots, seafood and meat for niacin; meat, vegetables and cereals/roots for vitamin B_6; plant oils for vitamin E; and vegetables and fruit for vitamin C. The highest ranked food sources for minerals are listed as follows: dairy products, vegetables and seafood for calcium; dairy products and cereals/roots for phosphorous; vegetables and meat for iron; and vegetables, cereals/ roots, other protein-rich foods and seafood for magnesium. The elderly were found to consume more salt, dairy products and vegetables, but less poultry and meat than their younger counterparts. In summary, differences in consumption patterns between the elderly and younger adults was reflected in differences in common food sources of energy and specific nutrients. The dietary patterns of the elderly are in general "healthier" than that of younger adults except for higher salt intake among the elderly. Nonetheless, our elderly population needs to increase their intake of calcium, magnesium, vitamins E and B_6, and dietary fiber, and decrease their consumption of salt. Promoting the ingestion of whole-grain and nut products may be a useful strategy to improve the nutritional status of the Taiwanese elderly, aiming at increasing the percentage of energy obtained from carbohydrates and the daily intake of vitamins E and B_6, magnesium, and dietary fiber. Suitable strategies are also needed to improve the calcium status of Taiwanese elderly, particularly as a high proportion of them are either lactose intolerant or dislike dairy products.

Introduction

The elderly population is growing steadily in many developed and developing countries, including Taiwan and the nutritional status of elderly persons is a major factor affecting their health and quality of life.[1,2] Both nutritional requirements and dietary patterns may change with increasing age due to physiological alterations. Elderly persons without appropriate nutritional care may be at high risk of malnutrition. Increasingly, attention has been given to the nutrition-related needs of the elderly around the world.[3]

In order to understand the dietary and nutritional status of elderly Taiwanese and to identify their major food sources of energy and various nutrients,[4,5] we analyzed 24-hour dietary recall data collected in the Elderly Nutrition and Health Survey in Taiwan (1999-2000) (Elderly NAHSIT). We also compared the food consumption patterns of elderly people with younger adults by comparing the elderly data with data obtained from the rest of the population in NAHSIT 1993-1996.[6]

Correspondence address: Professor Wen-Harn Pan, Institute of Biomedical Sciences, Academia Sinica, 128 Sec. 2, Academia Rd., Nankang, Taipei 11529, Taiwan.
Tel.: 011-886-2-2789-9121; Fax: 011-886-2-2782-3047
E-mail: pan@ibms.sinica.edu.tw

Subjects and methods
Survey design
The survey adopted a multi-staged, stratified and clustered probability sampling scheme. The sampling frame started with thirteen strata classified according to geographical location, ethnic characteristics and population density of townships, which were the primary sampling units. Three townships, and then two villages in each township, were selected from each of the thirteen strata by two consecutive processes of probability proportional to size (PPS) sampling. This resulted in the selection of a total of 78 villages. Independent individuals aged 65 and over were randomly selected in two clusters from each village. A total of 1,937 persons participated in the survey. Twenty-six subjects with extreme intake values were deleted from the analysis, leaving data from 1,911 subjects (955 men and 956 women) for analyses.

24-hour dietary recall
Methods of 24-hour recall and nutrient computation were identical to that employed in NAHSIT 1993-1996.[7] To aid the recall process, interviewers used several tools, including food piece models, abstract food models, measuring cups, spoons, electronic weight, and Q-cards. These tools were applied to obtain household cooking recipes as well as the amount of foods individuals consumed. In order to avoid underreporting by the elderly, we cross validated the recall data with other members of the household whenever possible.

   The collected data were entered into the "Assessment of Chinese Dietary Intake" system developed cooperatively by the Institute of Biomedical Sciences and the Institute of Information Science, Academia Sinica. The system first transforms the food model data to the weights of foods consumed, then calculates amounts of seasonings (including cooking oil and spices) ingested by each individual subject in each dish, using the recipes obtained in the survey.

Nutrient database
The major nutrient databases used in this analysis were "Nutrient Composition Data Bank for Foods in Taiwan Area"[8] and "Composition of Foods Used in Taiwan".[9] Chinese herbs and dietary supplements were not included in the analysis. In addition, the loss of nutrients during food preparation and cooking of home-made dishes was not taken into account.

Data analyses
Mean daily intakes were compared with Taiwanese Daily Recommended Intakes (DRIs)[10] and Dietary Guidelines[11] recommended by the Department of Health (DOH), Executive Yuan, Taiwan. The foods consumed were categorized into 12 major food groups and 47 subgroups (see Appendix). Daily nutrient intakes for each participant, mean daily intakes of all participants, standard error of the mean and contribution percentage to nutrient intake from various food sources were calculated using SUDAAN to adjust for the design effect of the complex sampling scheme. In addition, we ranked food items by their percentage contribution to total daily energy and specific nutrient intake. The top-ranked food items

contributing to daily nutrient intake were listed. The contribution of each individual food item is presented as both the amount consumed and the percentage of total intake.

Method of estimation of potential nutrient intake levels for a diet in accordance with the Taiwanese Daily Dietary Guidelines
The average nutrient intake level was estimated from the survey data for each of the six food groups (i.e. Cereals and grains, Protein-rich foods, Vegetables, Fruits, Dairy products, and Fats and Oils). The nutrient content per serving was calculated by dividing the average number of servings obtained from the survey data and then the nutrient intake according to the recommended numbers of servings was calculated by multiplying the per serving content by the recommended number of servings. Finally, the potential intake level for each nutrient was obtained by adding together the nutrient content in each of the six food groups.

Results
Intake from the six food groups
The mean daily food consumption from the 6 food groups in elderly Taiwanese men was 11.7 servings of cereals and grains (12 servings are equivalent to 3 bowls of rice), 3 servings of fats and oils, 5.4 servings of fish/meat/ eggs/ soybean, 0.8 servings of dairy, 2.9 servings of vegetables, and 1.4 servings of fruit. The distribution in elderly women was 9.7 servings of cereals and grains (equivalent to 2.5 bowls of rice), 2.5 servings of fats and oils, 3.9 servings of fish/meat/eggs/soybean, 0.9 servings of dairy, 2.9 servings of vegetables, and 1.1 servings of fruit (Fig. 1)**.** The fats and oils group only included cooking oil, peanuts, cashews, and other nuts. It did not include the visible fats in meat and poultry or added fats contained in processed foods. Therefore, the actual intake may be slightly higher than the estimated values. Compared to the Daily Dietary Guidelines published by DOH, the intake of vegetables in elderly men and women (around 3 servings) and the intake of protein-rich foods in elderly women were comparable to the recommended amounts.[11] The average intake of protein-rich foods was higher than the suggested level in elderly men. The consumption of cereals/grains, dairy, and fruit was lower than the recommended levels. Compared to the adults aged 19-64 years in NAHSIT 1993-1996, the dietary patterns of the elderly were generally more in accordance with the DOH guidelines.

Nutrient intakes
Gender-specific daily nutrient intake levels, percentage DRIs and some other relevant parameters are listed in Table 1.
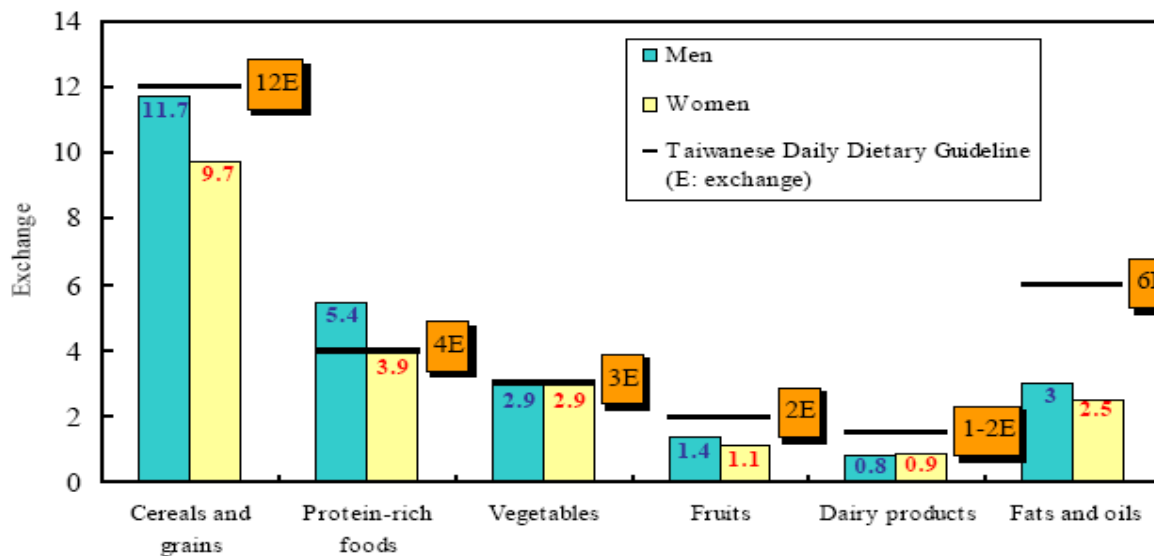
Energy
The elderly in Taiwan had a mean energy intake of 7,619 kJ (1,821 Kcal/d) and 6,104 kJ (1,459 Kcal/d) for men and women, respectively. The contributions of various food categories to the daily energy and macronutrient intakes are shown in Figure 2. The major food sources ranked from high to low were cereals/roots, meat, other protein-rich foods (soybean/soybean products, eggs/egg products) and fats/oils.

Table 1. Mean dietary nutrient intake level and % DRIs in elderly Taiwanese men and women

	Men (N = 955)			Women (N = 956)		
	Mean (SE)	% DRI		Mean (SE)	% DRI	
Energy (kcal)	1821 (68)	92.8 %		1459 (64)	85.5 %	
(kJ)	7619			6104		
Macronutrient			% Energy			% Energy
Protein (g)	75.0 (3.2)	115%	17.2%	59.5 (2.5)	108%	16.8%
Lipid (g)	60.2 (2.9)		27.3%	46.8 (3.2)		24.9%
Carbohydrate (g)	239.7 (11.2)		55.5%	201.3 (8.1)		58.3%
Vitamin						
B_1 (mg)	1.24 (0.06)	148%		0.99 (0.06)	135%	
B_2 (mg)	1.42 (0.08)	151%		1.28 (0.06)	160%	
Niacin (mg)	16.1 (0.7)	141%		11.7 (0.5)	117%	
B_6 (mg)	1.30 (0.07)	81%		1.01 (0.05)	63%	
C (mg)	151 (8)	151%		144 (9)	144%	
A (IU)	8,680 (665)	174%		9,709 (950)	231%	
E (mg α-TE)	6.4 (0.4)	54%		5.5 (0.4)	46%	
Mineral						
Calcium (mg)	622 (32)	62%		628 (33)	63%	
Phosphorus (mg)	1,038 (47)	130%		887 (42)	111%	
Iron (mg)	12.5 (0.5)	125%		10.7 (0.6)	106%	
Magnesium (mg)	249 (12)	69%		213 (11)	68%	
Sodium (mg)	4,959 (303)*			4,177 (225)**		
Potassium (mg)	2,500 (128)			2,168 (100)		
Fatty acid		Ratio			Ratio	
SFA (g)	18.5 (1.0)	1		14.3 (1.0)	1	
MUFA (g)	21.6 (1.2)	1.17		16.5 (1.4)	1.15	
PUFA (g)	17.2 (0.8)	0.93		13.8 (0.8)	0.97	
Fiber						
Dietary fiber (g)	19.8 (1.1)			18.3 (1.1)		
Crude fiber (g)	4.7 (0.3)			4.3 (0.2)		
		% upper limit			% upper limit	
Cholesterol (mg)	251 (11)	84%		172 (7)	43%	

* Comparing the intake level in the elderly to Dietary Reference Intakes for low physical activity levels. **12.6g of salt, *** 10.6 g of salt

Figure 1. Number of servings from the six food groups

In comparison with the results of younger adults taken from NAHSIT 1993-1996,[6] the elderly obtained more energy from cereals/roots, seafood, vegetables and fruit, but less from fats/oils, poultry, meat, other protein-rich foods (including eggs/egg products and soybean/ soybean products), refreshments/snacks, alcoholic beverages, sauces/spices and miscellaneous foods. The contribution of meat and refreshments/snacks to total energy intake was much lower in the elderly (79.7 kcal/d) than in younger adults aged 19 to 64 (164.5 mg/d).

Macronutrients
The daily intake levels of the three macronutrients are shown in Table 1. The mean protein intake was 75.0 g/d (17.2% of total energy intake) for men and 59.5 g/d (16.8%) for women, both of which were higher than the recommended level (10-14%).[12] The main food sources of protein were cereals/roots, meat, other protein-rich foods and seafood for both genders (Fig. 2).

The mean carbohydrate intake was 239.7 g/d (55.5% of total energy) for men and 201.3 g/d (58.3%) for

women, which was slightly less than and close to the recommended level (58-68%), respectively.[12] The top-ranked food sources of carbohydrate included cereals/roots, fruit and refreshments/snacks.

The mean lipid intake for men was 60.2g/d, contributing 27.3% of daily total energy intake, and the mean intake for women was 46.8g/d, contributing 24.9% of daily total energy intake. The proportion of total energy intake from lipid for both genders was below the upper limit of the recommended percentage of 30%. The major food sources of lipid for the elderly by ranked order were meat, fats/oils, and other protein-rich foods. The elderly consumed less poultry (25.0 kcal/d in the elderly, 41 kcal/d in younger adults) and meat (234 kcal/d in the elderly, 321 kcal/d in younger adults), and had a smaller percentage of energy intake from lipid than their younger counterparts.[6]

Table 2 presents the ranked order, amount and percentage contribution of food subgroups to the daily intake of protein, lipid and carbohydrate. We found that the subgroups contributing to intake of macronutrients were quite different between the elderly and younger adult population in Taiwan. Generally, the elderly obtained protein more frequently from dairy products (6.7g/d in the elderly, 3.1 g/d in younger adults) and saltwater fish (5.4 g/d in the elderly, 3.3g/d in younger adults), and less frequently from chicken/chicken products (2.5g/d in the elderly, 4.7g/d in younger adults), soybean/soybean products (3.8g/d in the elderly, 6.2g/d in younger adults) and eggs/egg products (1.9g/d in the elderly, 3.3g/d in younger adults). The contribution of refreshments/snacks to total carbohydrate intake was less in the elderly (13.7g/d in the elderly, 31.1g/d in younger adults). The percentage contributions of meat (20.2g/d in the elderly, 28.5g/d in

Table 2. Ranking of foods as sources of protein, lipid and carbohydrate in the elderly[1]: Ranking by subcategory foods

RANK	Protein			Lipid			Carbohydrate		
	Subcategory Foods	g	Cumulative[2] %	Subcategory Foods	g	Cumulative %	Subcategory Foods	g	Cumulative %
1	Pork and pork products	11.2	16.3%	Pork and pork products	19.7	35.9%	Rice and rice products	117.4	53.0%
2	Rice and rice products	10.7	32.0%	Vegetable oils	11.1	56.2%	Wheat and flour products	23.1	63.4%
3	Dairy products	6.6	41.6%	Soybean and soybean products	2.3	60.3%	Fresh fruit	17.5	71.4%
4	Saltwater fish (fresh)	5.4	49.4%	Dairy products	2.0	64.0%	Dairy products	9.1	75.5%
5	Wheat and flour products	4.1	55.3%	Saltwater fish (fresh)	1.8	67.3%	Pastries and cookies	6.5	78.4%
6	Soybean and soybean products	3.8	60.9%	Rice and rice products	1.7	70.4%	Dark-green and yellow vegetables	4.6	80.5%
7	Freshwater fish (fresh)	3.5	66.0%	Wheat and flour products	1.6	73.4%	Bread	4.2	82.3%
8	Chicken and chicken products	2.5	69.7%	Pastries and cookies	1.6	76.3%	Soybean and soybean products	3.7	84.0%
9	Dark-green and yellow vegetables	2.3	73.1%	Eggs and egg products	1.5	79.0%	Sugar	3.5	85.5%
10	Other spices	2	76.0%	Animal fats	1.4	81.5%	Light-green vegetables	3.4	87.1%
11	Eggs and egg products	1.9	78.7%	Nuts and nut products	1.3	83.9%	Starchy roots, stems and products	3.4	88.6%
12	Fish, fish organs and fish products	1.7	81.2%	Freshwater fish (fresh)	1.1	85.9%	Steamed buns and dumplings	3.1	90.0%
13	Other seafood and seafood products	1.6	83.5%	Steamed buns and dumplings	1.1	87.9%	Squash	2.5	91.1%
14	Light-green vegetables	1.2	85.2%	Chicken and chicken products	1.0	89.7%	Other spices	2.0	92.0%
15	Fresh fruit	1.2	86.9%	Other spices	0.8	91.2%	Sweetened crushed ice desserts and sugary drinks	1.7	92.7%
16	Steamed buns and dumplings	0.9	88.3%	Dark-green and yellow vegetables	0.6	92.2%	Starch-rich beans and products	1.4	93.4%
17	Bread	0.7	89.3%	Bread	0.6	93.2%	Instant noodles	1.3	94.0%
18	Nuts and nut products	0.7	90.3%	Instant noodles	0.5	94.2%	Soy sauce	1.2	94.5%

[1]There were 1911 subjects, 955 males and 956 females, aged over 65. Food categories are based on those in the appendix which are subcategories of the twelve main foods. Data are from the Nutrition and Health Survey in Taiwan, NAHSIT, 1999 -2000.

[2]The cumulative percentage is the percentage contribution of the food item to total daily intake of protein, lipid or carbohydrate.
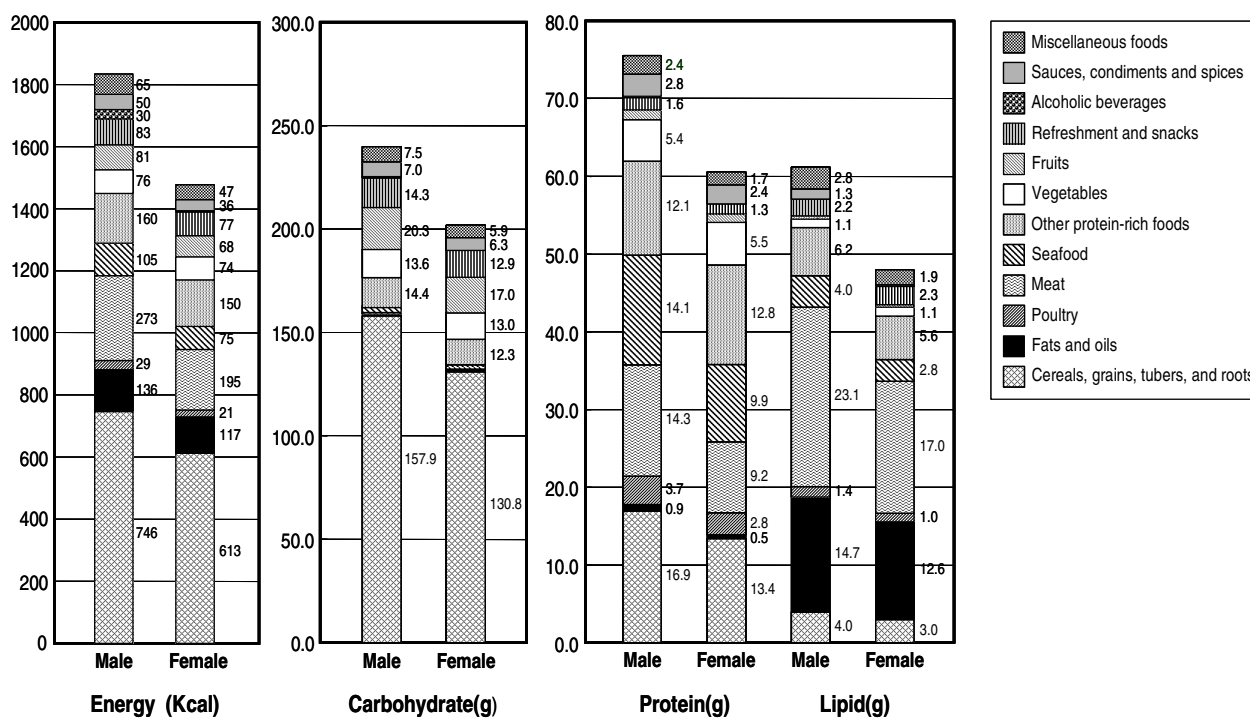
Figure 2. The contribution of various food categories to daily energy and macronutrients intake in the elderly

younger adults), poultry (1.2g/d in the elderly, 2.0g/d in younger adults), and other protein-rich foods (5.9g/d in the elderly, 8.6g/d in younger adults) to lipid intake were also lower, but that of seafood (3.5g/d in the elderly, 2.3g/d in younger adults) was higher in the elderly than in younger adults.

Fiber

The mean intake of dietary fiber in the elderly was 19.8 g/d and 18.3g/d for men and women, respectively, which were close to the lower end of the recommended range, 20-35g/d.[13]   The top ranked food sources for dietary fiber in the elderly diet included fresh fruit (4.1g/d, 21.3% of total intake), rice/rice products (3.8g/d, 19.6%), and dark green/yellow vegetables (3.4g/d, 17.9%), which together accounted for 60% of daily dietary fiber. The mean crude fiber intakes were 4.7g/d and 4.3g/d for elderly men and women, respectively. The top ranked food sources and the amount and percentage of total crude fiber intake they contributed were as follows: fresh fruit (1.1g/d, 23.3%); dark green/yellow vegetables (1.0g/d, 21.1%); light-green vegetables (0.47g/d, 10.3%); and squash (0.35g/d, 7.69%). Rice/rice products provided 3.75g/d (19.6%) of dietary fiber, but only 0.2g/d (4.8%) of crude fiber which doesn't include soluble dietary fiber.

Cholesterol

Cholesterol intake in the elderly was 251mg/d for males and 172mg/d for females, which were lower than the intakes of younger adults (325mg/d for males 245mg/d for females).[6] The primary dietary sources of cholesterol were eggs/egg products (67.1g/d), pork/pork products, (53.5g/d) and saltwater fish (21.3g/d). These sources

provided 30.9%, 24.7% and 9.8% of daily intake, respectively, and taken together accounted for 65.4% of total intake. The most significant difference between the elderly and younger adults in food sources of cholesterol was the contribution of egg products (67.1g/d in the elderly, 116.7g/d in younger adults). On average, an elderly man consumed 0.3 exchanges and an elderly woman consumed 0.2 exchanges of eggs/egg products per day. This was only half that consumed by younger adults.

Vitamins & Minerals
Vitamin A
The mean vitamin A intake (9194 IU/d) of the elderly was much higher than the DRI. Dark-green and yellow vegetables were ranked first as sources of vitamin A, followed by starchy roots/stems and dairy products, contributing 63.7% (5,820.2 IU), 7.4% (672.7 IU) and 7.4% (671.8 IU), respectively, to mean daily vitamin A intake (Table 3). Vegetables, cereals/roots and dairy products provided more vitamin A for the elderly, whereas meat and poultry provided more vitamin A for younger adults.[14]

Vitamins B_1, B_2 and Niacin
The mean intakes of vitamins B_1, B_2, and niacin were around 141-151% of DRIs. The major food sources of vitamin B_1 in the elderly were pork/pork products (0.38mg, 33.3%) and rice/rice products (0.16mg, 14.0%), which was similar to younger adults.[14] Dairy products were the most predominant source of vitamin B_2, providing 0.52mg per day (38.5%), followed by pork/pork products (0.12mg, 8.9%), wheat/flour products (0.11mg, 8.1%) and fresh fruit (0.1mg, 7.4%). The contribution of dairy products (0.52mg/d in the elderly, 0.22mg/d in younger adults) and cereals/roots (0.16mg/d in the elderly,

Table 3. Ranking of foods as sources of vitamins and minerals in the elderly[1]: Ranking by subcategory foods

RANK	Vitamin A Subcategory Food	Daily mean, IU (Cumulative %)	Vitamin B₁ Subcategory Food	Daily mean, mg (Cumulative %)	Vitamin B₂ Subcategory Food	Daily mean, mg (Cumulative %)	Vitamin B₆ Subcategory Food	Daily mean, mg (Cumulative %)
1	Dark green and yellow vegetables	5,820.2 (63.7)	Pork and pork products	0.38 (33.3)	Dairy products	0.52 (38.5)	Pork and pork products	0.21 (18.4)
2	Starchy roots, stems, and products	672.7 (71.0)	Rice and rice products	0.16 (47.4)	Pork and pork products	0.12 (47.4)	Rice and rice products	0.08 (25.4)
3	Dairy products	671.8 (78.4)	Dairy products	0.09 (55.3)	Wheat and flour products	0.11 (55.6)	Wheat and flour products	0.08 (32.5)
4	Fresh fruits	500.2 (83.9)	Wheat and flour products	0.08 (62.3)	Fresh fruit	0.1 (63.0)	Fresh fruit	0.08 (39.5)
5	Light green vegetables	282.5 (87.0)	Soybean and soybean products	0.08 (69.3)	Dark green and yellow vegetables	0.08 (68.9)	Dairy products	0.07 (45.6)
6	Pork and pork products	235.6 (89.5)	Fresh fruit	0.06 (74.6)	Eggs and egg products	0.07 (74.1)	Soy sauce	0.07 (51.8)
7	Wheat and flour products	230.5 (92.1)	Dark green and yellow vegetables	0.04 (78.1)	Rice and rice products	0.04 (77.0)	Other spices	0.07 (57.9)
8	Squash	229.3 (94.6)	Light green vegetables	0.03 (80.7)	Saltwater fish (fresh)	0.04 (80.0)	Freshwater fish (fresh)	0.06 (63.2)

RANK	Niacin Subcategory Food	Daily mean, mg (Cumulative %)	Vitamin C Subcategory Food	Daily mean, mg (Cumulative %)	Vitamin E Subcategory Food	Daily mean, mg (Cumulative %)	Ca Subcategory Food	Daily mean, mg (Cumulative %)
1	Rice and rice products	2.3 (16.2)	Fresh fruit	59.1 (39.9)	Vegetable oils	2.4 (30.2)	Dairy products	257.5 (41.0)[2]
2	Pork and pork products	2.01 (30.4)	Light green vegetables	31.7 (61.3)	Dark green and yellow vegetables	1.0 (42.9)	Dark green and yellow vegetables	109.0 (58.4)
3	Soybean and soybean products	1.27 (39.3)	Dark green and yellow vegetables	29.2 (81)	Wheat and flour products	0.6 (50.5)	Light green vegetables	40.0 (64.7)
4	Wheat and flour products	1.2 (47.8)	Squash	8.6 (86.8)	Fresh fruit	0.5 (56.7)	Soybean and soybean products	35.7 (70.4)
5	Saltwater fish (fresh)	1.03 (55.0)	Sweetened crushed ice desserts and sugary drinks	3.7 (89.3)	Soybean and soybean products	0.4 (62.2)	Fish, fish organs and fish products	28.6 (75.0)
6	Freshwater fish (fresh)	0.71 (60.0)	Dairy products	3.3 (91.5)	Sweetened crushed ice desserts and sugary drinks	0.3 (66.5)	Wheat and flour products	24.3 (78.8)
7	Dark green and yellow vegetables	0.64 (64.5)	Wheat and flour products	2.1 (92.9)	Rice and rice products	0.3 (70.4)	Fresh fruit	21.0 (82.2)
8	Fresh fruit	0.6 (68.7)	Starchy roots, stems, and products	1.8 (94.1)	Saltwater fish (fresh)	0.3 (73.8)	Seaweed	12.9 (84.2)

0.09mg/d in younger adults) to total vitamin B₂ intake was higher in the diets of elderly people than that of younger adults.[14] Important food sources for niacin intake included rice/rice products (2.3mg, 16.2%) and pork/pork products (2.0mg, 14.2%).

Vitamin B₆
Vitamin B₆ in the elderly diet was provided by a wide range of food sources. Pork/pork products were a notable source of vitamin B₆ (0.21mg, 18.4%). Other foods such as wheat/flour products (0.08mg, 7.0%), rice/rice products (0.08mg) and fresh fruit (0.08mg) were also important vitamin B₆ sources for the elderly. The mean daily intake of vitamin B₆ was 1.30mg for elderly men and 1.01mg for

elderly women, which corresponds to 81% and 63% of DRIs, respectively. Based on food choices made by Taiwanese, a diet following the Taiwanese Daily Dietary Guidelines would provide an estimated 1.26mg and 1.12mg of vitamin B₆, i.e 78.5% and 69.7% of DRIs, for elderly men and women, respectively, which is still less than 80% of DRIs.

Vitamins E and C
The mean intake of vitamin E for the elderly did not reach DRIs, and was 54% and 46% of DRIs for males and females, respectively. Vegetable oils were the primary source of vitamin E intake, providing 30.2% of total intake (2.4 mg α-TE), followed by dark-green and yellow

Table 3. Ranking of foods as sources of vitamins and minerals in the elderly[1]: Ranking by subcategory foods (Cont.)

	P		Fe		Mg		Na		K	
RANK	Subcategory Food	Daily mean,mg (Cumulative%)	Subcategory Food	Daily mean,mg (Cumulative %)	Subcategory Food	Daily mean,mg (Cumulative%)	Subcategory Food	Daily mean,mg (Cumulative%)	Subcategory Food	Daily mean,mg (Cumulative %)
1	Dairy products	195.8 (20.1)	Dark green and yellow vegetables	2.25 (19.2)	Rice and rice products	33.5 (14.4)	Salt	2260.5 (49.0)	Dark green and yellow vegetables	300.9 (15.7)
2	Rice and rice products	149.8 (35.4)	Pork and pork products	1.55 (32.3)	Dark green and yellow vegetables	29.6 (27.1)	Other spices	451.1 (58.7)	Dairy products	273.3 (29.9)
3	Pork and pork products	87.5 (44.4)	Soybean and soybean products	0.78 (39.0)	Dairy products	22.3 (36.6)	Soy sauce	402.7 (67.4)	Saltwater fish (fresh)	178.3 (39.2)
4	Saltwater fish (fresh)	52.8 (49.8)	Wheat and flour products	0.69 (44.9)	Fresh fruit	16.6 (43.7)	Soups	185.5 (71.5)	Light green vegetables	148.3 (47.0)
5	Dark green and yellow vegetables	50.1 (55.0)	Rice and rice products	0.63 (50.2)	Wheat and flour products	14.3 (49.9)	Pickles	174.4 (75.2)	Rice and rice products	138.2 (54.2)
6	Soybean and soybean products	48.4 (59.9)	Other spices	0.55 (54.9)	Pork and pork products	14.1 (55.9)	Wheat and flour products	144.6 (78.4)	Salt	138.0 (61.4)
7	Wheat and flour products	47.2 (64.8)	Fresh fruit	0.43 (58.6)	Soybean and soybean products	12.3 (61.1)	Pork and pork products	116.7 (80.9)	Fresh fruit	134.6 (68.4)
8	Freshwater fish (fresh)	37.0 (68.5)	Chicken and chicken products	0.38 (61.8)	Seaweed	11.9 (66.3)	Soybean and soybean products	108.9 (83.3)	Starchy roots, stems, and products	70.8 (72.1)

[1] There were 1911 subjects, 955 males and 956 females, aged over 65. Food categories are based on those in the appendix which are subcategories of the twelve main foods. Data are from the Nutrition and Health Survey in Taiwan, NAHSIT, 1999 -2000.
[2] The value in parentheses indicates the cumulative percentage of the contribution of the food item to total daily intake of vitamins and minerals.

vegetables (1.0mg α-TE, 12.7%), wheat/flour products (0.6mg α-TE, 7.6%), fresh fruit (0.5mg α-TE, 6.2%) and soybean/soybean products (0.4mg α-TE, 5.5%). The contribution of soybean/soybean products to vitamin E intake was lower in the elderly compared with younger adults (0.7mg/d in younger adults).[14]

The mean intake (148mg) of vitamin C for all participants was higher than the DRIs. Vitamin C intake in the elderly diet came from three major food categories: fresh fruit (59.1mg, 39.9%), light green vegetables (31.7mg, 21.4%) and dark-green and yellow vegetables (29.2mg, 19.7%). These food sources provided more than 80% of daily vitamin C intake. The percentage contribution of sweetened crushed ice desserts and drinks (3.7mg in the elderly, 17mg in younger adults), was significantly lower in the elderly compared with their younger counterparts.[14]

Calcium and Phosphorus
Dairy products (257.5mg, 41%) and dark green/yellow vegetables (109.0mg, 17.4%) were the two most common sources of calcium among the food items listed (Table 4). Due to the higher consumption of dairy products, the total daily calcium intake in the elderly was higher than the younger population from NAHSIT 1993-1996 in both genders; 622mg *vs.* 503.9mg for males and 628mg *vs.* 496.1mg for females.[15] Although the elderly had higher calcium intake than younger adults, the mean total intake reached only 62% and 64% of DRIs for elderly men and women, respectively. With current dietary practices,

calcium intake could potentially reach 971.2mg (97.1% DRIs) in men and 1019.7mg (102.0%) in women if the recommended upper limit for dairy products is followed, which would involve consuming 2 servings of dairy products per day. Dairy products contribute to 30% of calcium intake with an animal to plant calcium ratio of 1.7:1. Elderly men can still receive 842.2mg of calcium daily (82.4% DRIs), and elderly women 868.1mg (86.8% DRIs), even when they consume only 1.5 servings per day, which is the mid-point of the recommended range (1 to 2 cups) for dairy products. Phosphorus was provided by a wide range of food sources in the elderly diet. Dairy products (195.8mg, 20.1%) and rice/rice products (149.8mg, 15.3%) were the greatest sources of phosphorus. The percentage contribution from dairy products (195.8mg in the elderly, 88.9mg in younger adults) was twice as much as that in younger adults who received more phosphorus from pork/pork products (87.5g in the elderly, 103.5mg in younger adults).[15]

Iron and Magnesium
The mean daily intake of iron was 12.5mg in men and 10.7mg in women, which was slightly higher than the DRIs. The major food groups contributing to iron were dark green/yellow vegetables (2.25mg, 19.2%) and pork/pork products (1.55mg, 13.1%). The top-ranking sources of magnesium were rice/rice products (33.5mg, 14.4%) and dark green/yellow vegetables (29.6mg, 12.7%). The mean daily intake of magnesium was 249mg in men and

213mg in women, which was 69% and 68% of DRIs, respectively. Taking into account current food consumption patterns, an elderly person who follows the Dietary Guidelines and consumes 12 exchanges of cereals/ roots, will obtain an estimated magnesium intake of only 73.1% and 79.7% of DRIs for men and women, respectively.

Sodium and Potassium

The mean daily intake of sodium for the elderly was 4,959mg in men and 4,177mg in women. The ratio of Na/K was 3.3-3.4. Sodium intake level was much higher than that of the American elderly (2,940mg).[16] It is recommended in The Handbook for Hypertension in Taiwan that the consumption of sodium should be less than 100mmol (2,300mg) per day.[17] More specifically, the level of sodium intake should be less than 1mmol/kg, and the ratio of Na/K should be close to one.[17] As expected, salt was the highest ranked provider of sodium, contributing around 50% of total sodium (5.7g of salt). The amount of sodium consumed by the elderly was greater than that by younger adults whose mean consumption was only 2.7g per day.[15] Other spices and soy sauce were the second and third-ranked sources of sodium, providing 451mg and 403mg to daily intake, respectively. Differences between the diet of elderly persons and younger adults were observed in the contribution of miscellaneous foods (including commercial products such as instant noodles, sandwiches, hamburgers, steamed buns, dumplings and soups). Soups provide 185.5mg (4.1%) of sodium in the elderly diet, which was higher than that in diets of younger adults. The contribution of pickles (174.4mg, 3.8%) was similar in both groups, but the contribution of instant noodles was lower in the elderly. The mean daily intake of potassium was 2,500mg and 2,168mg in men and women, respectively. Dark green/yellow vegetables were the greatest sources of potassium, contributing 300.9 mg (15.7%) to daily intake. Dairy products (273.3mg) and fresh saltwater fish (178.3 mg) were other primary food sources of potassium in the elderly diet.

Discussion

This study was conducted to investigate the food consumption patterns and food sources for energy and various nutrients in the Taiwanese elderly. Several conclusions have been drawn from the results of this study.

Dietary patterns and nutrient intakes

According to the recommendations by DOH, ideal daily intake of calories for the general population from protein, lipid and carbohydrates would be 10-14%, 20-30%, and 58-68%,[12] respectively. The results of our survey showed that the intake of carbohydrates (55.5-58.3%) in the elderly was close to or slightly lower than this recommended level, whereas the caloric intake from protein (16.8-17.2%) was higher than the recommended level, and the intake of calories from lipid (24.9-27.3%) was in the ideal range. In addition, the mean intakes of most nutrients in the elderly were close to or even higher than the recommended levels, nationally or internationally, with the exception of calcium, magnesium, potassium, vitamin E,

and vitamin B_6. However, sodium intake was found to be too high.

The percentage of lipid intake in the Taiwanese elderly was lower than that of the same age group in the United States[16] and those residing in metropolitan areas of China (32.8%).[18] In terms of carbohydrates, the intakes among the elderly in Taiwan and China (59.8%) were higher than that of the same age group in the United States. As for protein, the intakes among Taiwanese and American elderly were both high, but more so in the Taiwanese elderly. The intake of protein in China was similar between those residing in cities and farming villages (~12%).[18] The distribution of intake of the three macronutrients in farming villages in China in 1997 was similar to that in previous years, with a low lipid, moderate protein and high carbohydrate diet.[18] Deficiency in vitamin B_6 is known to be associated with high levels of homocysteine which in turn may contribute to the development of ischemic strokes,[19] loss of memory[20,21] and anemia[22] in the elderly. There is also an elevated risk of cardiovascular disease and cancer related to insufficient vitamin E intake, which needs to be discussed further.

The distribution of intake of foods in the six food groups by elderly Taiwanese corresponds well with deficiencies or excess of certain nutrients. In comparison with the Daily Dietary Guidelines established by DOH, the 3 daily servings of vegetables consumed by the elderly (matching the recommended number) corresponds with their more than adequate dietary levels of vitamins A and C. Lower than ideal levels of intake of cereals and grains, mostly in the polished form, resulted in poor intake of dietary fiber and minerals such as magnesium and potassium. Intake of dairy products was much lower than that of western countries, but higher than that in other age groups in Taiwan. The elderly demonstrated the highest dietary calcium intake in all age-sex groups, but a low % DRI. The higher than recommended level of protein rich foods, particularly for men and in the form of pork, corresponds to 150% of DRIs for vitamin B_1,B_2, and niacin and a dietary protein level 30% higher than the DRI. In comparison with adults aged 19-64 years surveyed in NAHSIT 1993-1996, dietary patterns of the elderly in the current survey were less indulgent and closer to recommended intakes for most aspects, with the exception of high sodium intake.

Food sources for energy and macronutrients

The food contribution patterns for macronutrients differed between the elderly and younger adults in the following ways. The elderly consumed less pork/pork products, meat, soybean/soybean products and eggs/egg products, but consumed more seafood and dairy products than younger adults. These patterns may contribute to lower lipid intakes in the elderly, especially for males. The percentage contribution of refreshments/snacks to energy intake was significantly lower in the elderly than in younger adults. As a result, the energy contribution of added simple sugars was also lower in the elderly. The consumption of vegetables was higher in the elderly, but the mean intake of dietary fiber did not reach the minimum cut-off of 20g/d for the recommended range. A diet

following the Taiwanese Daily Dietary Guidelines, consisting of 3 servings of vegetables, 2 servings of fruit, 4 servings of fish/ meat/eggs/soybean (1 each), 1 serving of dairy products and 12 servings of cereals/roots would provide a total of 22.9 g/d and 23.5 g/d of dietary fiber for elderly men and women, respectively. A study in elderly women aged 55 to 69 demonstrated that total mortality and the incidence of chronic diseases were inversely associated with whole grain intake, but positively associated with refined grain intake.[23] Substitution of whole grains for polished grains in one of the daily meals can lower the incidence of chronic diseases, such as cardiovascular disease and cancer. Therefore, the elderly in Taiwan should be advised to increase their consumption of whole grains to achieve sufficient intake of dietary fiber and other nutrients.

Vitamins and their food sources

The mean intakes of vitamin A, vitamin B_1, vitamin B_2, niacin and vitamin C for the elderly were near or higher than DRIs. Vegetables were the greatest sources of vitamin A in the elderly diet. Similar to the diet of younger adults, pork/pork products and rice/rice products were the first - and second - ranked sources of vitamin B_1. The most important sources of vitamin B_2 were dairy products, followed by pork/pork products. The consumption of dairy products was higher in elderly people than younger adults. Rice/rice products and pork/pork products were the major sources of niacin. The two main food sources of vitamin C in elderly diets were vegetables and fruit. Refreshments/snacks contributed only a small amount to total vitamin C intake.

The intake of vitamin B_6 and vitamin E are important for the elderly as part of degenerative disease prevention. A wide range of food categories may provide vitamin B_6, however, for our population pork/pork products were among the most important sources. The mean vitamin B_6 intake in elderly women was only 64% of the DRI. It should also be noted that the intake of vitamin B_6 by our elderly population would be less than 80% of the DRI, even when they follow the current Daily Dietary Guidelines. Manore[21] found that cereals/roots such as breakfast cereals, and fruit such as bananas, were the most valuable sources of vitamin B_6. In order to improve vitamin B_6 status, the elderly should not only follow the current Daily Dietary Guidelines, but also pay attention to selecting food items that are high in vitamin B_6, such as wheat germ, oatmeal, coarse rice, small red beans, mung bean, peanuts, sunflower seeds, cucumbers and bananas. Therefore, the importance of increasing intake of whole grains and cereals is further emphasized.

Vegetable oils were a major source of vitamin E. The mean intake of vitamin E in the elderly was only 60% of the DRI. Elderly persons, regardless of gender, would obtain an estimated vitamin E intake of 94% of the DRI if they follow the current Daily Dietary Guidelines which involves the consumption of 6 exchanges of oil per day. However, it is challenging to simultaneously promote vitamin E status and decrease total lipid consumption. The key is to reduce the amount of lipid obtained from red meat either by selecting lean meat or by increasing the number of servings of soy, poultry and fish. In addition, elderly persons should increase their consumption of vitamin E rich nuts and seeds (almonds, walnuts, sesame seeds etc) which were previously consumed as traditional Chinese desserts but have been replaced by western sweets in recent years.

Minerals and their food sources

The mean intake of both phosphorus and iron in the elderly reached DRIs. The intake of phosphorus was probably too high in terms of its absolute amount and the Ca/P ratio. Similar to younger adults, the elderly obtained their iron from both plant sources: vegetables (especially dark green/yellow vegetables) and animal sources: meat (especially pork/pork products). Calcium and magnesium were two major minerals that had insufficient intake by the elderly.

Food items that were major sources of calcium included dairy products and dark green/yellow vegetables. The intake of calcium was higher in the elderly than younger adults resulting in an increased calcium/phosphorous ratio. Although the mean intake of calcium was higher than the value from the previous RDNA, it was still only 63% of the current DRI. Daily intake of calcium would be less than 80% of the DRI if intake of dairy products is limited to 1 cup per day as per the Taiwanese Daily Dietary Guidelines. The elderly may need to consume at least 1.5cups of dairy products in order to achieve 80% of the DRI for calcium. However, the daily energy distribution for protein would be more than 14% in the elderly if they consumed 1.5 cups of dairy products in addition to 4 exchanges of meat/fish/eggs/beans. Therefore, there is a need for further evaluation of the most optimal strategy to increase calcium intake in the elderly.

The major food sources of magnesium were rice/rice products, and dark green/yellow vegetables. The mean intake of magnesium was below 80% of the DRI. The elderly should therefore consume more cereals/roots, vegetables and soybean products in their diet. The consumption of salt by the elderly was 5.5g per day, which was twice the amount ingested by younger adults. The main reason for this is the high consumption of spices, soy sauce and salty soups by the elderly. Salt was the first-ranked source of sodium in the elderly diet, followed by other spices and soy sauce. Unlike younger adults, the elderly did not obtain a significant amount of sodium from instant noodles, a convenience food. Therefore, strategies to reduce sodium consumption in the elderly should focus on cooking methods and a gradual approach to changing their salty preferences.

Overall, the dietary patterns of the elderly in Taiwan are more in line with that recommended by the Taiwanese Daily Dietary Guidelines than those of adolescents and younger adults. However, our data indicate that dietary guidelines should not only address adequate numbers of servings but also favorable food choices in each food group and cooking methods. This would help to reduce dietary lipid and sodium, increase complex carbohydrates and dietary fiber, and ensure sufficient intakes of nutrients such as calcium, magnesium, potassium, vitamin B_6 and vitamin E in our population.

References
1. Position of the American Dietetic Association. Nutrition, aging and the continuum of care. J Am Diet Assoc 2000; 100: 580-595.
2. Chernoff R. Meeting the nutritional needs of the elderly in the institutional setting. Nutr Rev 1994; 52: 132-136.
3. Russell RM, Rasmussen H and Lichenstein A. Modified Food Guide Pyramid for people over seventy-years of age. J Nutr 1999; 129: 751-753.
4. Pan WH, Chang YH, Wu SJ, Chang HY, Wei IL, Lee M.S, Kao MD, Hang CM. Elderly Nutrition and Health Survey in Taiwan (NAHSIT II) 1999-2000: dietary nutrient intakes assessed by 24-hour recall. In: Department of Health, ed. The status of nutrition in the elderly. Taiwan: DOH, 2004; 21-33.
5. Wu SJ, Chang YH, Wei IL, Kao MD, Pan WH. Elderly Nutrition and Health Survey in Taiwan (NAHSIT II) 1999-2000: Food sources of weight, calories, and nutrients in the elderly in Taiwan. In: Department of Health, ed. The status of nutrition in the elderly. Taiwan: DOH, 2004; 47-80.
6. Wu SJ, Chang YH, Fang CW and Pan WH. Food sources of weight, calories, and three macro-nutrients – NAHSIT 1993-1996. Nutr Sci J 1999; 24: 41-58.
7. Pan WH, Chang YH, Chen JY, Wu SJ, Tzeng MS and Kao MD. Nutrition and health survey in Taiwan (NAHSIT) 1993~1996: Dietary nutrient intakes assessed by 24-hour recall. Nutr Sci J 1999; 24: 11-39.
8. Department of Health. Nutrient Composition Data Bank for Foods in Taiwan Area. Taiwan: DOH, 1998.
9. Huang, P.C. Composition of Foods Used in Taiwan. Nutr Sci J , 1978; 3: 11-39
10. Department of Health. Taiwanese Daily Recommended Intakes (DRIs). Taiwan: DOH, 2002.
11. Department of Health. Daily Dietary Guidelines in Taiwan. Taiwan: DOH, 1995.
12. Department of Health. Handbook for Dietary in the Republic of China. Taiwan: DOH, 1997.
13. Marlett JA, McBurney MI, Slavin JL. Position of the American Dietetic Association: Health implications of dietary fiber. J Am Diet Assoc 2002; 102 (7): 993-1000.
14. Wu SJ, Chang YH, Chang HY and Pan WH. Food sources of dietary Vitamin A, Vitamin B_1, Vitamin B_2, Vitamin C, Vitamin E, and Niacin: Results from a Nutrition and Health Survey in Taiwan (NAHSIT) 1993~1996. Nutr Sci J 2001; 26: 213-229.
15. Wu SJ, Chang YH, Chang HY and Pan WH. Food sources of dietary Calcium, Phosphorus, Iron, and Sodium-NAHSIT 1993~1996. Nutr Sci J 2001; 26: 142-158.
16. Wright JD, Wang CY, Kennedy-Stephenson J and Ervin RB. Dietary intake of ten key nutrients for public health, United States: 1999–2000. Advance data from vital and health statistics; no. 334. Hyattsville, Maryland: National Center for Health Statistics. 2003/06/12; Available at http://www.cdc.gov/nchs/data/ad/ad334.pdf.
17. Department of Health. Handbook for Hypertension in Taiwan. Taiwan: DOH, 1995.
18. Du SF, Zhai FY and Yang XG. The final report of Nutrition and Health Survey in China. Database of Nutrition and Health Survey, Beijing. 2003/06/12; Available at http://www.infh.ac.cn/result/report/report.doc.
19. Gariballa SE. Nutritional factors in stroke. Br J Nutr 2000; 84(1): 5-17.
20. Miller AL. The methionine-homocysteine cycle and its effects on cognitive diseases. Altern Med Rev 2003; 8 (1): 7-19.
21. Solfrizzi V, Panza F and Capurso A. The role of diet in cognitive decline. J Neural Transm 2003; 110 (1): 95-110.
22. Fishman SM, Christian P and West KP. The role of vitamins in the prevention and control of anaemia. Public Health Nutr 2000; 3(2): 125-50.
23. Jacobs Jr. DR, Meyer KA, Kushi LH and Folsom AR. Is whole grain intake associated with reduced total and cause-specific death rates in older women The Iowa Women's Health Study. Am J Public Health 1999; 89: 322-329.
24. Manore MM, Vaughan LA, Lehman WR. Contribution of various food groups to dietary vitamin B-6 intake in free-living, low-income elderly persons. J Am Diet Assoc 1990; 90: 830-4.

Appendix: Subcategories of the twelve main food groups

Fats and oils	Meat	Fruit	Alcoholic beverages
Vegetable oils; Animal fats; Nuts and nut products	Pork and pork products; Beef and beef products; Other meat products	Fresh fruit, processed, fresh juices	Alcoholic beverages
Cereals, grains, tubers, roots	Seafood	Vegetables	Refreshments and snacks
Rice and rice products; Wheat and flour products; Starchy roots, stems and products; Starchy roots, stems and products; Starch-rich beans and products	Freshwater fish (fresh); Saltwater fish (fresh); Fish, fish organs and fish products; other seafood and seafood products	Dark-green and yellow Vegetables; Light-green vegetables; Bamboo shoots; Squash; Beans; Mushrooms; Pickles; Seaweed	Bread; Pastries and cookies; Candy (including chocolate); Sweetened crushed ice desserts; sugary drinks; Processed juices; Others e.g. jellies, puddings.
Poultry	Other protein-rich foods	Sauces, condiments and Spice	Miscellaneous foods
Chicken and chicken products; Duck and duck products; Other related poultry products	Eggs and egg products; Dairy products; Soybean and soybean products	Sugar; salt; soy sauce;other spices	Instant noodles; Sandwiches, hamburgers Steamed buns and dumplings; Soups; Other