

## Original Article

# Trends in nutrient and dietary intake among adults and the elderly: from NAHSIT 1993-1996 to 2005-2008

Shin-Jiuan Wu MS<sup>1</sup>, Wen-Harn Pan PhD<sup>2,3,4</sup>, Nai-Hua Yeh MS<sup>2</sup>, Hsing-Yi Chang PhD<sup>2</sup>

<sup>1</sup>Department of Food and Nutrition, Chung Hwa University of Medical Technology, Tainan, Taiwan, ROC

<sup>2</sup>Nutrition Medicine Research Program, Division of Preventive Medicine and Health Services Research, Institute of Population Health Sciences, National Health Research Institutes, Miaoli, Taiwan, ROC

<sup>3</sup>Institute of Biomedical Science, Academia Sinica, Taipei, Taiwan, ROC

<sup>4</sup>Department of Biochemical Science and Technology, National Taiwan University, Taipei, Taiwan, ROC

The aim of this study was to investigate trends in nutrients and sources of dietary intake for Taiwanese people from the Nutrition and Health Survey in Taiwan (NAHSIT) 1993-1996 to 2005-2008. Twenty-four hour dietary recall data were obtained from the 2005-2008 NAHSIT. The results showed that intake of cereals and grains, and dietary fiber has decreased, whereas intake of carbohydrate rich convenience foods has increased. As a result, 10-20 g of dietary fat is now obtained from carbohydrate rich foods. A greater proportion of Taiwanese are choosing low-fat meat products, however, excessive intake of meat by men and women aged 19 to 64 years is resulting in excessive intakes of protein, cholesterol and saturated fat. Men and women aged 19 to 30 years had insufficient intakes of fruit and vegetables. Consumption of fruit, dairy/products, and nuts was low in all age groups. We recommend strengthening public nutrition education and changing diet related environment to improve dietary quality and food group distributions. Issues of concern include excessive intakes of energy and the soybean/fish/meat/eggs food group in all subjects, high amount of processed foods and refined-carbohydrate rich foods in men aged 19 to 64 years and women aged 19-30 years, as well as intakes below the DRI for a variety of nutrients in elderly persons.

**Key Words:** 24-hour recall, dietary intake, food sources, nutrients, Nutrition and Health Survey in Taiwan (NAHSIT)

## INTRODUCTION

Nutrition and dietary habits are influenced by the environment and level of economic development.<sup>1</sup> The current environment of rapidly changing consumerism with an emphasis on healthy eating, coupled with sedentary lifestyles and the growth of convenience foods has the potential to change individuals' dietary patterns. These influences on dietary intake determine an individual's consumption of particular food groups and nutrients, with a resulting impact on health, as insufficient intake of particular nutrients and foods is an important risk factor for many chronic diseases. The 2005-2008 Nutrition and Health Survey in Taiwan (NAHSIT, 2005-2008) found that the prevalence of overweight and obesity in Taiwan has clearly increased. The prevalence of BMI $\geq$ 24 in men is now greater than 50% and the prevalence of hypertriglyceridemia, diabetes and the metabolic syndrome are also rising.<sup>2</sup> Examination of ten year trends in nutritional health and dietary habits in Taiwan is of vital importance as it will aid in the development of dietary recommendations for the public and the development of appropriate nutrition health policies. This study analyzes household recipes and 24 hour dietary recall data from the 2005-2008 survey for adults aged 19 years and above, and compares it to that from the 1993-1996 survey (for adults aged 19-64 years) and the 1999-2000 survey (for elderly persons aged 65 years and over), on changes in nutrient

intakes and food sources. We will examine whether intakes of the six major food groups and associated nutrients is appropriate for adults and the elderly by comparison to the recommended Dietary Reference Intakes (DRI). Examination of this data will enable a better understanding of the basis of dietary problems in Taiwan, enabling the development of recommendations regarding dietary sources of nutrients and appropriate serving sizes, thereby reducing unhealthy dietary habits, improving nutritional health, and reducing risk factors for chronic disease in Taiwan.

## MATERIALS AND METHODS

### Data source

Data used in the study were those from 24 hour dietary recalls,<sup>3</sup> obtained from Nutrition and Health Survey in Taiwan 2005-2008 (NAHSIT 2005-2008). The survey

**Corresponding Author:** Dr Wen-Harn Pan, Division of Preventive Medicine and Health Services Research, Institute of Population Health Sciences, National Health Research Institutes, Miaoli, Taiwan, ROC.

Tel: 011-886-37-246166-36300; Fax: 011-886-37-586-261

Email: panwh@nhri.org.tw

Manuscript accepted 1 May 2011.

adopted a multi-staged, stratified and clustered probability design with five mutually-exclusive strata (Northern 1, Northern 2, Central, Southern and Eastern strata), and three extra- strata for specific population groups (Hakka areas, Penghu Islands and Mountainous areas). Details have been provided elsewhere.<sup>4</sup>

#### **Dietary data analysis**

The 24 hour dietary recall data were first analyzed using the Taiwan Food Nutrient Database and associated software (FNDB971205), the USDA National Nutrient Database, and the Food Composition Database of Sugiyama University. SAS and SUDAAN statistical software were then used to weight the sample and estimate means and standard deviations of nutrient intakes by age and sex.<sup>5</sup> Sources of dietary intake were based on 24 hour dietary recall data. Nutrients and food sources were divided into 12 major and 47 minor items in order to assess nutrient intakes from each food group. The 47 minor food items were grouped into six major food groups based on their relative composition of the three major nutrients (Table 1). Intake levels of each of these six food groups were then estimated.

Nutrient and six major food group intakes of those aged 19-30 years and 31-64 years from the present survey (2005-2008) were compared to data from the 1993-1996 survey.<sup>6</sup> Dietary and nutrition data from elderly persons aged 65 years and over were compared to that from the 1999-2000 survey.<sup>7</sup> The appropriateness of intakes of the six major food groups was estimated. Nutrient intakes were compared to recommended DRI<sup>8</sup> levels for each age and sex group. The proportion of people not meeting DRI levels were also compared. Sources of nutrients were assessed and recommendations made regarding how to improve nutrient intake through changing food sources.

To assess the prevalence of imbalanced intake of various nutrients, we derived the true distribution of nutrient intake levels by removing intra-individual variation of 24-hour recall data. With triplicate, three-season balanced 24-hour recall data, mean Pearson's correlation coefficients ( $r$ ) were calculated from all possible pairs of nutrient measurements and the ratio of within to between individual variance (intra-variability/inter-variability) was estimated as: ratio =  $[(1-r)/r]$ . The variance of the true distribution was obtained by dividing the original variance by  $(1+ratio)$ . Then, the true distribution was used to estimate the percentage of people under or above the cut-off point, according to Chang's method.<sup>9</sup>

## **RESULTS AND DISCUSSION**

### ***Changes in energy intake and percentage energy intake provided by the three major nutrients (Table 2)***

In the 2005-2008 survey, men aged 19-64 years and women aged 19-30 years had energy intakes higher than recommended DRI levels for those with a 'low activity' physical activity level. Compared to the 1993-1996 survey, energy intakes of men aged 31 to 64 years have increased by an average of 250 kcal and those of women aged 19-30 years have shown an even greater average increase of 387 kcal. Only women aged 31-64 have not shown a great increase in energy intake with mean intakes reaching only 92.8% of recommendation for those with

low physical activity. In contrast, both elderly men and women have lower energy intakes than those observed in the 1999-2000 survey (a decrease of 119 kcal in men and of 157 Kcal in women) with elderly men reaching only 83-90% of recommended DRI levels and elderly women reaching only 73-80% of recommended intake levels for those with low physical activity.

When comparing the percentage energy provided by the three macro nutrients by age, it was found that the younger the age the greater the percentage energy provided by fat. In men and women aged 19-64 years, 30% of energy intakes were provided by fat and in men from mountainous areas this percentage was as high as 39.2% (Table 3). In contrast, the percentage of energy provided by carbohydrates in men aged 19-64 years and women aged 19-30 years was less than 50%. In persons aged 65 years and over, 29.0% of energy intake in men came from fat and 27.8% of energy in women came from fat.

Adults protein intakes in the present survey was also higher than that of the previous survey. About 16-17% of energy intake came from protein in adult men and women in each age group. Total protein intake is composed of animal sources (such as poultry/products, meat/products, fish and seafood/products, eggs/products, and dairy/products) and plant sources of protein (such as cereals, grains, tubers and roots, vegetable oil, nuts/products, soybean/products, fruit and vegetables). The ratio of the animal to the plant sources of protein was compared between the two surveys across different age groups. It was found that the ratio of animal to plant sources changed from 1.5 to 2.3 in men aged 19-30 years, from 1.2 to 1.5 in men aged 31-64 years, and from 1.4 to 1.3 in men aged 65 years and over. In women, this ratio changed from 1.4 to 1.8 in those aged 19-30 years, from 1.2 to 1.4 in those aged 31-64 years, and from 1.2 to 1.0 in those aged 65 years and over. Therefore, in the past decade, consumption of animal sources of protein have increased in adults and decreased in elderly persons. In addition, the data suggest that the younger the age of the person, the greater the intake of animal protein. Intake of animal protein was also greater in men compared to women.

The most important sources of energy were cereals, grains, tubers and roots subgroup, and meat/products. In comparison to previous surveys (1993-1996 and 1999-2000) energy and nutrient intakes have changed in adults and elderly persons due to changing food choices (Figure 1). Energy intake from cereals, grains, tubers and roots subgroup decreased in 19-64 year olds in the present survey, whereas energy intake increased from carbohydrate rich convenience foods subgroup and simple sugars. In addition, despite an increase in meat and meat product intake by adults, as the items consumed was more likely to be low-fat, the energy provided by meat/products showed a large decrease. The energy provided by almost all of the remaining major food groups increased, and as a result the total energy intake of women aged 19-30 years and men aged 31-64 years showed a marked increase. In elderly persons aged 65 years and over, energy intake from cereals, grains, tubers and roots subgroup, and meat/products decreased, and as a result the total energy intake for this age group decreased.

**Table 1.** Number of servings of the six major food groups by age and gender

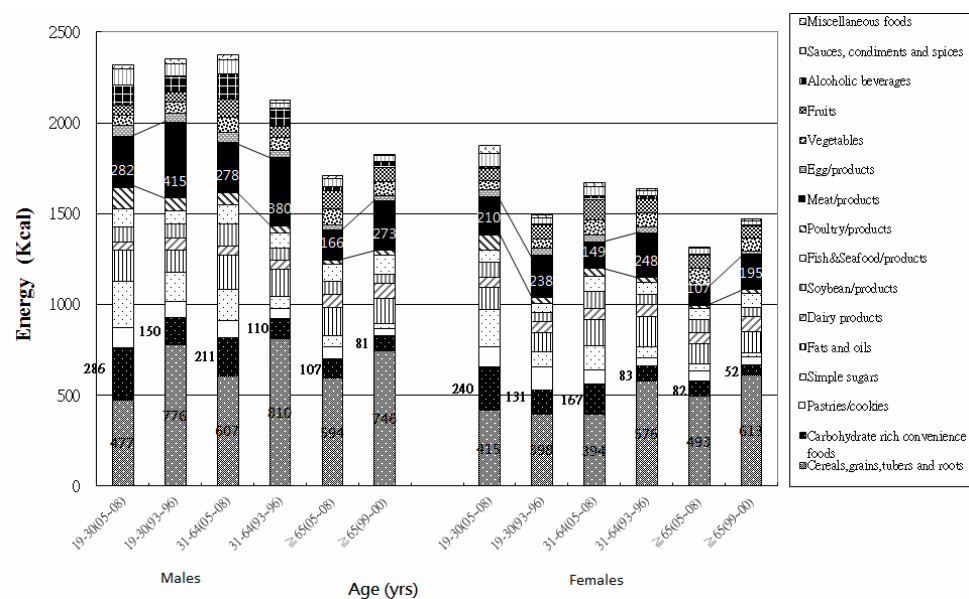
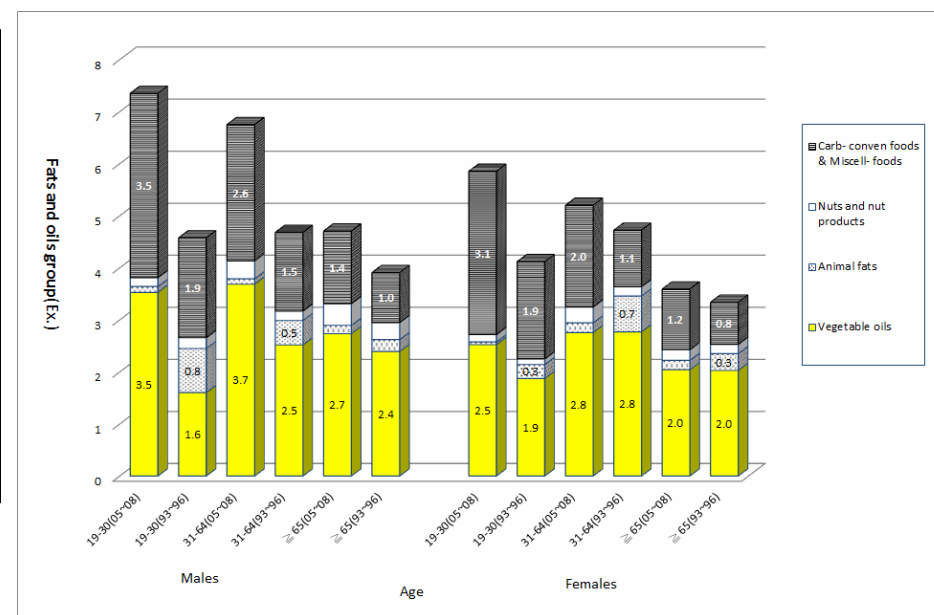
Six major food groups	Food source category (major)	Each major category covers the following minor categories	Gender			Females			
			Age	Males		19-30	31-64	≥65	
			n	19-30	31-64	≥65	19-30	31-64	≥65
Energy (Kcal)			2320	2378	1711	1878	1672	1316	
			Intake of each major category (Ex.)						
Carbohydrate rich foods	1.Cereals and grains	Cereals, grains, tubers and roots	Rice and rice products, wheat and flour product, starch-rich roots, stems, and their products, starch-rich beans, seeds, and their products	6.77	8.45	8.34	5.55	5.49	6.9
		Carbohydrate rich convenience foods	Bread, instant noodles, sandwiches, hamburgers, steamed buns, and dumplings	2.42	1.82	0.97	2.09	1.51	0.75
		Pastries/cookies	Pastries, cookies, jelly, and puddings	0.9	0.81	0.57	0.98	0.76	0.55
		Miscellaneous foods	Soups, other	0.08	0.09	0.04	0.18	0.07	0.02
		Simple sugars	Candy (chocolate), sweetened shaved ice deserts, sugary drinks, sugar-added processed juice	3.99	2.63	0.97	2.99	1.93	0.58
2.Fats and oils		Simple sugars (%)/Energy		10.3%	6.6%	3.4%	9.6%	6.9%	2.6%
		Fats and oils	Vegetable oils	3.53	3.68	2.73	2.52	2.76	2.04
			Animal fats	0.11	0.10	0.16	0.05	0.19	0.18
			Nuts and nut products	0.17	0.34	0.42	0.14	0.30	0.20
3.Soybean/fish/meat/eggs		Carbohydrate rich foods/Miscellaneous foods	Carbohydrate rich convenience foods, pastries/cookies, soups and other	3.55	2.62	1.40	3.14	1.96	1.17
		Total		7.36	6.74	4.71	5.85	5.21	3.59
		Poultry/products	Chicken and chicken products, duck and duck products, other poultry and related products	1.59	0.96	0.35	1.05	0.57	0.26
		Meat/products	Pork and pork products, beef and beef products, other meat and related products	3.35	3.11	1.82	2.62	1.8	1.12
		Fish and seafood/products	Freshwater fish (fresh), saltwater fish (fresh), fish products and fish offal, shellfish and shellfish products	1.79	2.12	1.87	1.14	1.76	1.29
		Eggs/products		0.79	0.7	0.36	0.51	0.46	0.23
		Soybean/products		1.00	1.46	0.81	0.93	1.08	0.83
4.Dairy/products		Carbohydrate rich foods/Miscellaneous foods	Carbohydrate rich convenience foods, pastries/cookies, soups and other	0.70	0.55	0.29	0.63	0.37	0.17
		Total		9.22	8.9	5.5	6.88	6.04	3.9
5.Vegetables	Dairy/products			0.22	0.39	0.69	0.31	0.44	0.65
	Vegetables	<i>dark colored vegetables</i> , light-colored vegetables, bamboo shoots, squashes, beans, mushrooms, other vegetables and their products, pickled vegetables, and seaweed	2.34	3.48	3.52	2.16	3.42	3.27	
6.Fruit	Fruit	Fresh fruit, processed fruit, fresh fruit juices	0.92	1.63	1.66	1.09	1.84	1.20	

**Table 2.** Caloric intake and trends in percentage caloric intake supplied by the three major nutrients by age and gender

	Energy (Kcal)	DRI - sedentary†	DRI -low activity †	DRI- sedentary%	DRI -low active%	Protein (g)	Animal Protein (g)‡	Lipid (g)	Carbohydrate (g)	Protein (%)	Lipid (%)	Carbohydrate (%)	
Males	19-30(05~08)	2321	1950	2250	119%	103%	94.5	54.0	85.7	275.0	16.8%	34.3%	48.9%
	19-30(93~95)	2352			-	-	90.0	46.3	82.8	297.3	15.7%	32.5%	51.8%
	31-64(05~08)	2377	1850-1750	2150-2050	129-136%	111-116%	98.1	50.8	84.0	282.8	17.2%	33.2%	49.6%
	31-64(93~95)	2125			-	-	78.7	38.1	77.7	259.3	15.3%	34.1%	50.6%
	≥65(05~08)	1711	1750-1650	2050-1900	98-104%	83-90%	72.1	35.8	55.2	231.5	16.8%	29.0%	54.1%
	≥65(99~00)	1829			-	-	75.2	40.6	61.1	239.3	16.6%	30.4%	52.9%
Females	19-30(05~08)	1878	1600	1800	117%	104%	76.7	38.9	71.4	236.0	16.2%	33.9%	49.9%
	19-30(93~95)	1491			-	-	56.2	27.8	59.0	185.6	15.0%	35.4%	49.6%
	31-64(05~08)	1671	1550-1500	1800	108-111%	92.8%	71.4	35.0	58.3	217.6	17.0%	31.2%	51.8%
	31-64(93~95)	1639			-	-	64.1	30.6	62.1	206.3	15.6%	34.1%	50.3%
	≥65(05~08)	1316	1500-1450	1800-1650	88-90%	73-80%	55.4	25.1	41.0	184.4	16.6%	27.8%	55.6%
	≥65(99~00)	1472			-	-	60.3	30.6	47.9	201.0	16.3%	29.2%	54.5%

†Comparison with the recommended 'Dietary Reference Intakes' for adults and elderly persons with a 'sedentary' or 'low activity' level of physical activity.

‡Summation of protein intake from poultry, meat, seafood, eggs/egg products and dairy/products.

**Figure 1.** Dietary food sources of caloric intake in adults and elderly persons by age and gender**Figure 2.** Dietary food sources of Fats and oils in adults and elderly persons by age and gender

### **Changes in intake of six major food groups**

The six major food groups include: cereals and grains, vegetables, fruit, soybean/fish/meat/eggs, dairy/products, and fats and oils group. In the present survey, only 65% intake of cereals, grains, tubers and roots subgroup in adults and elderly persons came from rice, wheat, flour, starchy roots and stems, dried beans and seeds, caryopsis and products made from cereals or starch-rich vegetables. Taking into consideration that many Taiwanese eat carbohydrate rich convenience foods (such as bread, instant noodles, sandwiches, hamburgers, steamed buns and dumplings) as a main meal, in the study, the total number of servings for the cereals and grains group was estimated by combining the intake of cereals, grains, tubers and roots subgroup with intake of carbohydrate rich convenience foods subgroup (Table 1). In contrast, as pastries/cookies and simple sugars have a low nutrient density and their regular intake is not encouraged, these foods were not categorized as cereals and grains group.

Intake of cereals and grains group in the three age groups of 19-30 years, 31-64 years and 65 years and over were compared between the present survey and that from 1993-1996 (for those aged 19-30 years and 31-64 years) and 1999-2000 (for those aged 65 years and over) as shown in Table 1. It was found that in all age groups apart from women aged 19-30 years, intake of cereals, grains, tubers and roots subgroup decreased. In addition, apart from men aged 31-64 years and men aged 65 years and over, all other age and sex groups consumed less than 8 servings (approximately 2 bowls of rice) per day and instead consumed carbohydrate rich convenience foods subgroup as a replacement. In addition, mean intakes of simple sugars in men and women aged 19-30 years accounted for 10% of total energy intake.

In regards to fruit and vegetable intake, young men and women aged 19-30 years consumed fewer servings of vegetables (about 2 servings), with less than 1 serving of *dark colored vegetables* and only 1 serving of fruit per day. In contrast, adults aged 31-64 years and elderly persons aged 65 years and over consumed about 3.2-3.5 servings of vegetables and 1.5 servings of fruit daily. There was no significant increase in consumption of fruit and vegetables compared to the previous surveys. In the United States, the consumption of fruit and vegetables has also shown very little change between 1994 and 2005.<sup>10</sup> The food frequency questionnaire survey in NHANES 2005 found that only 32.6% of adults consumed two or more servings of fruit every day and 27.2% consumed three servings of vegetables.<sup>11</sup> A report on risk factors for chronic disease by the US Behavior Risk Factor Surveillance System also found that only 14-37% of Americans eat at least 5 servings of fruit and vegetables every day.<sup>12</sup> The lowest intake of fruit and vegetables in Taiwan was observed in the 19-30 year age group, with slightly better consumption of vegetables observed in those aged 31-64 years and 65 years and over.

With regards to consumption of foods of the dairy products group, those aged 19-64 years had an intake of only 0.4 cups per day and those aged 65 years and over had an intake of only 0.6 cups per day. Intake of dairy/products by adults and elderly persons in the present survey was slightly lower than that reported in the previous

surveys. Adults aged 19-30 years are primarily consuming whole-fat dairy products (7.9 g of fat per serving), however, adults aged 31-64 years (4.8 g fat per serving) and elderly persons aged 65 years and over (2.9 g fat per serving) have already changed to low fat dairy products.

With regards to the soybean/fish/meat/eggs group, apart from elderly persons aged 65 years and over, the total number of servings from this food group increased in adults aged 19-64 years as did protein intake. Men aged 19-64 years had as many as 9 servings of soybean/fish/meat/eggs and women had about 6-7 servings. Intake of pork/products was the highest (about 3 servings every day). However, the fat contained in the consumed pork/products was much lower than that of previous surveys. As a result, the grams of protein consumed from this source increased while the energy provided from this food source decreased (Table 1).

Vegetable and fruit group intake decreased in young adults aged 19-30 years in every region, and every age group in mountainous areas (data not shown). Lin has previously found that sex, ethnicity and age can influence the choice of food sources for protein. In addition, those with higher intakes of animal protein usually have lower intakes of fruit and vegetables.<sup>13</sup>

The total intake of fats and oils group (including animal and vegetable oils used in cooking, nuts and nut products) slightly increased compared to previous surveys. Men and women consumed only 0.3 and 0.2 servings of nuts, respectively and the use of animal fats and oils decreased from previous surveys. However, consumption of carbohydrate rich convenience foods and other foods with hidden fat content increased by 2 to 3 servings, and as a result the mean intake of fats and oils reached 6 to 7 servings (Figure 2).

### **Changes in intake and food sources of nutrients**

Comparison of servings and intake of the six major food groups with previous surveys has shown that current Taiwanese dietary habits corresponds to a low consumption of grains, tubers and roots subgroup coupled with a rapid rise in consumption of carbohydrate rich convenience foods subgroup and hidden fat, increased consumption of cooking oil, low intake of nuts, but no change in the consumption of fruit, vegetables and dairy/products. In 19-30 year olds, intake of fruit, vegetables and dairy/products is insufficient, sugary drinks account for 10% of energy intake and intake of meat is excessive. In contrast, caloric intake as well as the consumption of meat/meat products of the elderly persons decreased; in addition this group also prefers low fat dairy/products. Intake of low-fat meat has increased in all age groups. The dietary changes mentioned above would impact on the intake of various nutrients. In the following section the intake of nutrients from these six major food groups will be further analyzed. Nutrient intake data of NAHSIT will be compared with those from NHANES 2005-2006<sup>14</sup> (Tables 3 and 4).

### **Decreased intake of cereals and grains group, and insufficient intake of fruit and vegetable groups**

#### *Dietary fiber*

Men and women aged 19-64 years consumed 16.7 g of

**Table 3.** Mean nutrient intakes and deviations from dietary reference intakes in adults aged 19-64years by geographic area and gender

	USA ≥20 years	DRI for men‡	Nationwide Male, n=965		USA ≥20 years	DRI for women	Nationwide Female, n=977		Hakka areas Male, n=200		Female, n=203		PengHu area Male, n=192		Female, n=192		Mountainous areas Male, n=195		Female, n=192	
			Mean	DRI(%)			Mean	DRI(%)	Mean	DRI(%)	Mean	DRI(%)	Mean	DRI(%)	Mean	DRI(%)	Mean	DRI(%)	Mean	DRI(%)
Energy (kcal)	2163	2150	2361	110%	1785	1800	1733	96%	2420	113%	1797	100%	2389	111%	1671	93%	2579	120%	1729	96%
Protein (g)	102	56.7	97.1	171%	70	48.3	73.1	151%	93.2	164%	71.8	149%	100	177%	70.6	146%	92.9	164%	64.7	134%
Protein (%)			97.1	17%/en			73.1	16.8%	93.2	16.2%	71.8	15.9%	100	17.4%	70.6	16.8%	92.9	16.4%	64.7	15.4%
Lipid (g)	100		84.5	33%/en	68.7		62.2	32.1%	85.0	33.3%	62.1	31.0%	81.5	31.8%	58.4	31.2%	98.8	39.2%	66.1	35.3%
Carbohydrate (g)	310		281	49%/en	217		223	51.2%	290	50.4%	239	53.0%	292	50.7%	219	52.0%	253	44.5%	208	49.3%
Dietary fiber (g)	17.8	25.0	16.7	67%	14.1	25.0	16.7	67%	16.3	65%	17.6	70%	16.0	64%	14.5	58%	11.8	47%	12.6	50%
Vit A (RE) (ug)	690	600	1046	174%	581	500	926	185%	1332	222%	1450	290%	832	139%	742	148%	813	136%	752	150%
Vit D (ug)		6.7	8.2	123%		6.7	7.8	116%	8.3	124%	5.2	78%	11.5	173%	7.1	106%	6.5	98%	5.8	88%V
Vit E (TE) (mg)	8.6	12.0	9.6	80%	6.5	12.0	8.1	67%	10.0	84%	8.0	67%	10.1	84%	8.4	70%	9.8	81%	7.5	62%
VitC (mg)	97.9	100	185	185%	78	100	173	173%	176	176%	162	162%	175	175%	156	156%	136	136%	143	143%
Vit B-1 (mg)	2.01	1.10	1.40	127%	1.41	0.90	1.09	121%	1.47	134%	1.16	129%	1.32	120%	1.03	114%	1.60	145%	1.10	122%
VitB-2 (mg)	2.69	1.20	1.56	130%	1.95	1.00	1.3	125%	1.54	128%	1.35	135%	1.49	124%	1.19	119%	1.30	108%	1.08	108%
Niacin (mg)	31.6	14.0	24.0	172%	20.9	12.0	19.1	159%	24.7	176%	18.6	155%	25.1	180%	17.6	146%	23.1	165%	16.4	137%
Vit B-6 (mg)	2.46	1.50	2.20	147%	1.66	1.5	1.74	116%	2.20	147%	1.70	113%	2.04	136%	1.62	108%	2.22	148%	1.65	110%
Vit B-12 (ug)	6.91	2.40	7.85	327%	4.47	2.4	6.35	265%	9.27	386%	7.37	307%	12.2	508%	5.70	238%	8.62	359%	6.10	254%
Ca (mg)	1073	1000	611	61%	858	1000	563	56%	589	59%	541	54%	552	55%	546	55%	460	46%	483	48%
P (mg)	1600	800	1307	163%	1148	800	1052	131%	1288	161%	1041	130%	1381	173%	994	124%	1195	149%	905	113%
Mg (mg)	348	360	309	86%	265	315	264	84%	299	83%	266	85%	339	94%	250	79%	256	71%	214	68%
Fe (mg)	18.9	10.0	18.3	183%	13.8	15.0	15.2	101%	17.0	170%	15.0	100%	16.0	160%	13.8	92%	15.5	155%	12.1	81%
Zn (mg)	15.5	15.0	12.0	80%	10.4	12.0	9.1	75%	12.0	80%	9.6	80%	11.4	76%	8.1	68%	11.4	76%	8.1	67%
Na (mg)	4178	2400	4514	188%	2933	2400	3519	147%	4539	189%	3624	151%	4676	195%	2961	123%	5565	232%	3544	148%
(=Salt (g))	10.4	6.0	11.3		7.3	6.0	8.8		11.3		9.1		11.7		7.4		13.9		8.9	
K (mg)	3174	4700	2951	63%	2366	4700	2584	55%	2893	62%	2613	56%	2819	60%	2333	50%	2504	53%	2126	45%
Cholesterol (mg)	358	300	411	137%	237	300	280	93%	410	137%	293	98%	437	146%	284	94%	429	143%	264	88%
		400	411	103%		400	280	70%	410	103%	293	73%	437	109%	284	71%	429	107%	264	66%
MUFA (mg)	37.3		30.8		24.9		22.6	1.12	31.7		23.1	1.15	29.6	1.13	20.9	1.15	37.4	1.11	24.5	1.00
PUFA (mg)	20.7		26.0		14.8		19.3	0.96	25.3		18.9	0.94	25.9	0.99	19.1	1.05	27.7	0.82	24.5	1.00
SFA (mg)	33.4		27.6	1.1/0.9/1.0	23.2		20.1	1.00	27.8	1.1/0.9/1.0	20.0	1.00	26.1	1.0	18.3	1.00	33.6	1.00	24.5	1.00
SFA/Energy (%)	10.5						10.5													

†USA≥20 years, Data from: Food Surveys Research Group, Beltsville Human Nutrition Research Center. What we eat in America, NHANES 2005-2006. Internet: [http://www.ars.usda.gov/SP2UserFiles/Place/12355000/pdf/0506/Table\\_1\\_NIF\\_05.pdf](http://www.ars.usda.gov/SP2UserFiles/Place/12355000/pdf/0506/Table_1_NIF_05.pdf)

‡Calculated in accordance with the recommended dietary reference intake for adults and elderly persons with a 'low activity' level of physical activity.

SFA: saturated fatty acids; MUFA: monounsaturated fatty acids; PUFA: polyunsaturated fatty acids.

**Table 4.** Mean nutrient intakes and deviations from dietary reference intakes in elderly persons aged 65 years and over by geographic area and gender

	60-69years† men in USA	DRI for men	Nationwide		60-69years women in USA	DRI for women	Nationwide		Hakka areas		PengHu area		Mountainous areas							
			Male, N=481 Mean	DRI(%)			Female, N=485 Mean	DRI(%)	Male, N=98 Mean	DRI(%)	Female, N=93 Mean	DRI(%)	Male, N=101 Mean	DRI(%)	Female, N=102 Mean	DRI(%)	Male, N=89 Mean	DRI(%)	Female, N=96 Mean	DRI(%)
Energy (kcal)	2202	1975	1,711	87%	1598	1,725	1,316	76%	1,637	83%	1,363	79%	1,691	86%	1,222	71%	1,518	77%	1,093	63%
Protein (g)	88.3	56	72.1	129%	63.5	48.5	55.4	114%	73.3	131%	57.8	119%	69.5	124%	53.6	110%	58.9	105%	44.6	92%
Protein (%)				17%				17%		18%		17%		17%		17%		16%		
Lipid (g)	84.2		55.2	29%	63.1		41.1	28%	54.2	30%	39.5	26%	51.8	29%	32.9	24%	54.0	33%	32.5	27%
Carbohydrate (g)	258		231	54%	194		184	56%	212	52%	195	57%	221	54%	180	58%	188	51%	154	57%
Dietary fiber (g)	17.5	25	17.2	69%	14.3	25	14.5	58%	16.7	67%	15.7	63%	12.3	49%	11.1	44%	10.9	44%	10.4	41%
Vit A (RE) (ug)	687	600	1,270	212%	597	500	1,105	221%	1,396	233%	1,040	208%	761	127%	742	148%	684	114%	728	146%
Vit D (μg)		10	8.56	86%		10	7.01	70%	8.61	86%	6.16	62%	9.64	96%	8.17	82%	4.21	42%	4.22	42%
Vit E (TE) (mg)	7.7	12.0	8.1	68%	6.5	12	6.19	52%	7.41	62%	6.19	52%	7.81	65%	6.13	51%	6.16	51%	5.33	44%
VitC (mg)	99.3	100	175	175%	79.7	100	134	134%	155	155%	133	133%	141	141%	119	119%	133	133%	121	121%
Vit B-1 (mg)	1.85	1.00	1.15	115%	1.30	0.85	0.87	102%	1.31	131%	1.07	126%	0.89	89%	0.72	85%	1.12	112%	0.69	81%
VitB-2 (mg)	2.50	1.05	1.40	133%	1.83	0.95	1.15	121%	1.48	141%	1.3	137%	1.17	111%	1.04	109%	0.94	90%	0.81	85%
Niacin (mg)	27.2	12.5	18.1	145%	18.7	11.5	13.1	114%	16.5	132%	14.7	128%	16.3	130%	12.4	108%	13.3	106%	9.1	79%
Vit B-6 (mg)	2.18	1.6	1.78	111%	1.56	1.6	1.37	86%	1.74	109%	1.46	91%	1.56	98%	1.15	72%	1.40	88%	1.09	68%
Vit B-12 (ug)	6.62	2.4	5.42	226%	4.69	2.4	3.79	158%	4.8	200%	2.8	117%	5.3	221%	4.05	169%	3.8	158%	3.01	125%
Ca (mg)	963	1000	673	67%	783	1000	592	59%	742	74%	591	59%	546	55%	515	52%	489	49%	459	46%
P (mg)	1434	800	1,073	134%	1061	800	847	106%	1,058	132%	890	111%	953	119%	780	98%	805	101%	619	77%
Mg (mg)	324	360	279	77%	258	315	227	72%	274	76%	227	72%	227	63%	180	57%	180	50%	152	48%
Fe (mg)	17.9	10	13.8	138%	12.8	10	11.2	112%	13.7	137%	11.3	113%	10.0	100%	7.71	77%	9.2	92%	8.8	88%
Zn (mg)	15	15	9.36	62%	10	12	7.24	60%	9.67	64%	7.83	65%	7.19	48%	5.62	47%	8.18	55%	6.01	50%
Na (mg)	3738	2,400	3,078	128%	2606	2400	2513	105%	3,138	131%	2,442	102%	2,763	115%	2,101	88%	2,749	115%	2,147	89%
(=Salt (g))	9.3	6.0	7.7		6.5	6.0	6.3		7.8		6.1		6.9		5.3		6.9		5.4	
K(mg)	3077	4,700	2,798	60%	2376	4700	2257	48%	2,750	59%	2,346	50%	2,174	46%	1,936	41%	1,990	42%	1,699	36%
Cholesterol (mg)	314	300	231	77%	224	300	155	52%	263	88%	149	50%	210	70%	152	51%	218	73%	187	62%
		400	231	58%		400		39%		66%		37%		53%		38%		54%		47%
MUFA (mg)	30.7		20.8	1.22	22.9		15.2	1.18	20.9	1.19	14.7	1.23	18.1	1.09	11.6	1.15	20.2	1.12	11.5	1.22
PUFA (mg)	18.2		17.4	1.03	13.8		12.9	1.00	15.7	0.90	12.9	1.08	17.0	1.02	11.2	1.11	15.7	0.87	11.5	1.22
SFA (mg)	27.9		17.0	1.00	21.0		12.9	1.00	17.5	1.00	11.9	1.00	16.7	1.00	10.1	1.00	18.0	1.00	9.46	1.00
SFA/Energy (%)	11.40%		8.94%		11.83%		8.84%		9.64%		7.85%		8.86%		7.42%		10.7%		7.79%	

†USA 60-69 years, Data from: Food Surveys Research Group, Beltsville Human Nutrition Research Center. What we eat in America, NHANES 2005-2006. Internet: [http://www.ars.usda.gov/SP2UserFiles/Place/12355000/pdf/0506/Table\\_1\\_NIF\\_05.pdf](http://www.ars.usda.gov/SP2UserFiles/Place/12355000/pdf/0506/Table_1_NIF_05.pdf)

dietary fiber (67% of recommended DRI level). In those aged 65 years and over, fiber intake was 17.2 g in men and 14.5 g in women (reaching 69% and 52% of the recommended DRI levels, respectively). Fiber intake in all age groups were lower than the 25-35 g recommended by the Department of Health.<sup>15</sup> Fiber intake was the lowest in men and women aged 19-30 years and women aged 65 years and over, where it reached only 13-14 g (data not shown). The largest proportions of individuals not meeting dietary requirements for fiber intake were observed in the 19-30 years group and those aged 71 years and over, where more than 90% of people had intakes below recommended DRI levels (Table 5). When analyzed by region, fiber intake was the lowest in mountainous regions with intake levels for men and women reaching only 47% and 50%, respectively of the lower end of recommended DRI levels. Moreover, intake levels in elderly persons in mountainous areas reached only 40% of the recommended levels.

Dark colored vegetables, fresh fruit, and soybean and soybean products were the most important sources of dietary fiber for adults aged 19-64 years and elderly persons aged 65 years and over. Dietary fiber intake has decreased across all age groups compared to previous surveys, mainly due to the decreased consumption of foods of the cereals and grains group, combined with a lack of increase in the fiber from fruit and vegetables. As a result, increased intake of whole grain foods should be encouraged, in particular unrefined cereals and grains, as well as improved intake of fruit and vegetables. The new dietary guidelines recommend that at 1/3 of daily vegetable intake should consist of dark colored vegetables (including dark green, yellow and red vegetables). In addition, at least 1/3 of cereals and grains group intake should consist of unrefined whole grains and roots. Following these recommendations should result in an increase in fiber intake to sufficient levels (21-30 g) and will help prevent the development of chronic disease.<sup>16-20</sup>

#### Vitamins A and C

Mean intakes of vitamins A and C in middle-aged and elderly men and women were all above recommended DRI levels (Tables 3 and 4). Despite this, about 20% of those aged 19-30 years had intakes of vitamins A and C below the recommended DRI levels and 14% of women aged 71 years and over had insufficient vitamin A intakes and 30% had insufficient vitamin C intakes (Table 5).

More than 60% of dietary vitamin C came from fresh fruit, dark colored vegetables and light colored vegetables. In the UK nutrition survey, the major source of vitamin C was drinks (providing 27% of intake) and young women received even a greater proportion of vitamin C in their diet from drinks compared to elderly women.<sup>21</sup> In the present survey, men aged 19-30 years had lower intakes of fruit and vegetables and higher intakes of sugary drinks, particularly in the mountainous areas, Hakka areas and the Penghu Islands. As a result, in these areas drinks were an important source of vitamin C for young people and provided more than 1/4 of vitamin C in the diet (data not shown). The low vitamin A and C intakes of men and women aged 19-30 years and of women aged 71 years and over requires continued attention.

#### Magnesium

Mean intakes of magnesium in 19-64 years olds were 309 mg in men and 264 mg in women. Mean intakes of magnesium in elderly persons aged 65 years and above were 279 mg in men and 227 mg in women (Tables 3 and 4). Magnesium intake has increased in both men and women compared to the previous surveys, with mean intakes reaching about 85% of DRI levels. The lowest intakes of magnesium were found in adults aged 19-30 years and elderly persons aged 71 years and over, where about 90% of people had insufficient intakes. When analyzed by region, magnesium intake was the lowest in mountainous areas in both adults and elderly persons. Intake was particularly low in elderly people in mountainous areas

**Table 5.** Percentages of people with insufficient DRI levels of various nutrients by age and gender

Age/gender	19~30 years		31~50 years		51~70 years		71 years	
	Male	Female	Male	Female	Male	Female	Male	Female
Insufficient (%)								
Energy (Kcal)	42	43	32	76	42	82	72	92
Protein (g)	18	5	0	3	2	6	22	37
Dietary fiber (g)	95	96	87	88	83	86	91	99
Vit A (RE) (µg)	18	21	5	5	6	2	2	14
Vit D (µg)	24	46	21	23	66	65	64	89
Vit E (TE) (mg)	82	97	76	96	80	90	88	100
Vit C (mg)	16	22	10	8	7	6	12	30
VitB-1 (mg)	22	22	21	23	15	28	14	26
Vit B-2 (mg)	24	29	24	28	22	26	16	18
Niacin (mg NE)	8	3	16	2	3	10	8	20
Vit B-6 (mg)	23	38	10	27	18	46	40	78
Vit B-12 (µg)	2	0	0	0	0	0	8	0
Ca (mg)	96	100	92	96	84	88	82	94
P (mg)	6	15	5	14	7	19	17	50
Mg (mg)	86	90	68	77	68	73	87	93
Fe (mg)	5	49	4	50	3	10	18	46
K	98	100	96	100	95	95	97	100
Zn (mg)	84	90	76	84	86	86	96	98

†Comparison with the recommended dietary reference intake level for adults and the elderly with a 'low activity' level of physical activity



where mean intake levels reached only 79% of DRI levels in men and 68% of DRI levels in women. The proportion of people not reaching DRI levels was higher than that observed in the United States across all age groups.<sup>22</sup>

Adults and elderly persons received magnesium from all of the major food groups although the most important source was dark colored vegetables. Other plant foods also provided some magnesium intake. As Taiwanese have insufficient intakes of cereals, grains, tubers and roots, *dark colored vegetables*, and nuts/products, appropriate increases in the consumption of these foods could improve intake of magnesium in Taiwan.

#### *Potassium*

Mean intake of potassium in 19-64 yr olds was 2951mg (75.7 mmol) in men and 2584 mg (66.3 mmol) in women. In elderly persons, mean potassium intake was 2798 mg in men and 2257 mg in women. Intake of potassium in the present survey is higher across all age groups than previous surveys. As the Department of Health has not established recommended intake levels for potassium, we used the level of 4.7 g (120 mmol/day) from the Dietary Approaches to Stop Hypertension diet (DASH diet) and U.S. recommendations for Adequate Intake (AI) for adults.<sup>23</sup> Based on this level, men aged 19-64 years had potassium intakes that reached 62.8% of the recommended level and women's intakes reached 55.0% of the recommended intake level. In the elderly, men's intakes reached 59.5% of the recommended level and women's intakes reached 48.0% of the DASH or US AI level. The intake levels observed in the present study are similar to those found in the United States where adult intake levels of 3174 mg (72 to 84 mmol) in men and 2366 mg in women have been reported (also lower than the recommended intake level). When analyzed by region, the lowest intakes of potassium in the present study were observed in Penghu and mountainous areas. Intake levels were particularly low in elderly women in mountainous areas, where intake levels reached only 36% of the recommended level. In every age group more than 95% of people failed to reach the recommended intake level of 4.7 g.

The most important source of potassium in the diet was dark colored vegetables, followed by fresh fruit, pork/products, and dairy/products. Epidemiological research has found that a mean potassium intake of 4.7 g helps maintain low blood pressure, reduces the negative effect of sodium chloride on blood pressure, reduces the risk of kidney stones, and reduces bone resorption and loss of calcium. In addition, potassium obtained from fruit and vegetables is rich in a bicarbonate precursor that helps balance the acid produced in the body from dietary sources.<sup>24</sup>

#### *Vitamin B-6*

Mean intakes of vitamin B-6 reached DRI levels in all age groups apart from that in women aged 65 years and over. Women in general (compared to men) and men aged 71 years and over were less likely to reach DRI levels. As many as 78% of women aged 71 years and over had insufficient vitamin B-6 intake (Table 5). Intake of vitamin B-6 was particularly low in elderly women in

Penghu and mountainous areas, where intake reached only 72% and 68% of the recommended 1.6 mg, respectively.

Vitamin B-6 was obtained from all of the major food groups with fruit and vegetables as the most important sources. Vitamin B-6 intake increased in all age groups compared to the previous surveys.<sup>6,7</sup>

#### **No improvement in intake of dairy products**

##### *Calcium and phosphorus*

Mean intake of calcium in 19-64 year olds was 611 mg in men and 563 mg in women, which are both higher than the intakes of 504 mg in men and 496 mg in women observed in the previous survey. In elderly people, mean intake of calcium was 673 mg in men and 592 mg in women, compared to 622 mg and 635 mg, respectively, in the previous survey. As usual, calcium intake was lower in women compared to men across all age groups. Calcium intake in adults and elderly people in Taiwan reached only 50-70% of recommended DRI levels and as many as 80-100% of people had insufficient intakes. When analyzed by region, calcium intake was lowest in mountainous areas, where it was less than 500 mg in both adults and elderly people. The same problem of low calcium intake has been observed in the United States where large numbers of men and women do not have Adequate Intakes (AI) of calcium, particularly those aged 51 years and over. However, even in young people that are taking calcium supplements, 84% of adolescent girls, 64% of men and more than 70% of pregnant or breastfeeding mothers do not have adequate calcium intake.<sup>25</sup>

The most important source of calcium for Taiwanese adults aged 19-64 years is *dark colored vegetables* (provides 17% of intake), followed by dairy/products (only provides 99 mg of calcium or 17% of intake). The most important dietary source of calcium for those aged 65 years and over is dairy/products (provides 200 mg or 32% of intake), followed by *dark colored vegetables* (provides 21% of intake). The increase in calcium intake in adults aged 19-64 years observed in the present survey is not due to an increased intake of dairy products or dark colored vegetables. Rather, the increased calcium intake is due to increased intake of rice/ products, iced deserts, sugary drinks, fish/products, soybean/products and other minor food groups. In 19-30 year olds, iced deserts and sugary drinks provide about 50 mg of calcium (about 10% of intake) (data not shown). This is a new finding compared to the previous survey and indicates that in young men and women, part of dietary calcium intake is coming from drinks that contain dairy products. Finding these new sources of dietary calcium suggests a possible alternative approach to improve calcium intake. Weaver found that in addition to physiological intolerance, dietary preferences are an important reason for consuming or not consuming dairy products.<sup>26</sup> The problem of disliking dairy products per se could be alleviated by encouraging people to mix dairy products with other foods, making their consumption more acceptable.

The ratio of calcium to phosphorus intake in the present survey was not better than those observed in the previous surveys. In those aged 19-64 years, the ratio of calcium to phosphorus intake was 1:2.1 in men and 1:1.8 in

women. In elderly people, this ratio was 1:1.6 in men and 1:1.4 in women. The high intake of phosphorus coupled with an already low intake of calcium makes positive changes to the calcium to phosphorus ratio difficult.

#### *Vitamin B-2*

In those aged 19-64 years, intake of vitamin B-2 was 1.56 mg in men and 1.25 mg in women, which are both higher than that of 1.29 mg and 1.13 mg reported in the previous survey, respectively. In the elderly, vitamin B-2 intake was 1.40 mg in men and 1.15 mg in women, which are both lower than that of 1.42 mg and 1.31 mg, respectively, observed in the previous survey. When analyzed by region, intakes were the lowest in mountainous areas where they were only 0.9 mg in men and 0.8 mg in women. However, mean vitamin B-2 intakes were higher than DRI levels in all age groups and geographic areas.

The most important source of vitamin B-2 was dairy/products. However, as consumption of dairy/products is low, this only provided 13.7% of intake in those aged 19-64 years and 32.3% of intake in elderly persons. Other sources of vitamin B-2 included pork/products, eggs/products, dark colored vegetables, and wheat and flour products. However, despite mean intakes being above DRI levels, about 20-30% of people in each age and sex group had inadequate intakes of vitamin B-2 (Table 5). Greater intake of dairy/products and whole grain foods as suggested by the new dietary guideline could help improve vitamin B-2 intake in Taiwan.

#### **Excessive intake of the soybean/fish/meat/eggs group in adult men**

##### *Vitamin B-1*

Intake of vitamin B-1 in those aged 19-64 years was 1.40 mg in men and 1.09 mg in women, which are similar to the intakes of 1.37 mg in men and 1.08 mg in women reported in the previous survey. In those aged 65 years and older, mean intake was 1.15 mg in men and 0.87 mg in women, which are slightly lower than the intakes of 1.25 mg in men and 1.02 mg in women reported in the previous survey. Mean intakes reached DRI levels in all age groups, however, 20-30% of women across all age groups and of both men and women aged 71 years and over had inadequate vitamin B-1 intake.

Pork/products were the most important source of vitamin B-1 for both adults and elderly persons, and provided more than 30% of dietary vitamin B-1. Other important sources of vitamin B-1 were *dark colored vegetables*, fresh fruit, rice and rice products, and wheat and flour products in that order. These dietary sources differ greatly from those observed in the United Kingdom where most vitamin B-1 is provided from breakfast cereals and grains and roots.<sup>27</sup>

When analyzed by region, intake of vitamin B-1 was lowest in elderly men and women in Penghu and elderly women in mountainous areas. This is possibly because intake of pork/products is lower in these particular groups. As a result, in instances where pork/products are not the main sources of vitamin B-1, it is recommended that the consumption of whole grain foods should be encouraged to avoid inadequate vitamin B-1 intake.

##### *Iron*

Mean intakes of iron in each age and sex group were all above DRI levels. However, as many as 50% of women aged 19-50 years and 71 years and over had inadequate iron intake. In addition, in Penghu and mountainous areas mean intakes of iron in women aged 19-64 years were below the recommended DRI level of 15 mg. Iron intake in women in mountainous areas was only 12.1 mg (only 81% of DRI levels). Iron intake in elderly residing in Penghu and mountainous areas was also below the recommended DRI level of 10 mg. Iron intake in elderly women in Penghu reached only 77% of the recommended DRI level.

The most important source of iron for adults and elderly persons was dark colored vegetables which provided 14.3% of dietary iron in those aged 19-64 years and 27% of dietary iron in those aged 65 years and over. The next most important iron sources were protein rich foods such as soybean/products, eggs/products, and pork/products. Iron intake slightly increased compared to the previous surveys. In 19-64 year olds, this increase in iron intake was the result of increased iron from pork/ pork products, and egg/ egg products. However, in elderly persons this increase in iron intake came from the iron provided from vegetables, whereas intake of heme iron (iron from poultry, meat and fish) greatly decreased. Intake of heme iron decreased from 3.6 mg to 2.0 mg in elderly men (represents 14.8% of total iron intake) and from 2.3 mg to 1.2 mg in elderly women (represents 10.8% of total iron intake). In contrast, intake of heme iron in 19-64 year olds slightly increased.

Dietary factors influencing the absorption of iron include the chemical form of the iron ingested and vitamin C content of the diet. To encourage those in need of iron to consume foods rich in vitamin C may be considered in order to increase iron absorption.

##### *Cholesterol*

In the 1993-1996 survey, the mean cholesterol intake in men aged 19-30 years exceeded 400 mg and that of men aged 31-64 years was about 300 mg. In contrast, intake of cholesterol in women aged 31-64 years was less than 300 mg. In the present survey, mean cholesterol intake of men aged both 19-30 years and 31-64 years exceeded 400 mg, and cholesterol intake in women was about 300 mg. In addition, about 80% of men and 45% of women had daily intakes of cholesterol greater than 400 mg.

The major sources of cholesterol for adults and elderly people were eggs/products, pork/products, shellfish/products, salt-water fish (fresh), and fish/products. Although the intake of meat did increase in men, as this was predominantly low fat meat, it didn't result in a substantial increase in cholesterol intake. This increase in cholesterol intake in men, particularly in aged 31-64 years, is mainly due to increased intake of eggs/products, fish and seafood/products. Therefore, adults in men need to pay attention to the intake in the soybean/fish/meat/eggs food group and ensure that it is appropriate.

Intake of cholesterol in elderly men and women was clearly lower than that of adults aged less than 65 years. Cholesterol intake in elderly persons was also slightly lower than the previous survey at about 250 mg.

##### *Saturated fat*

In both men and women aged 19-64 years intake of saturated fat represented about 10.5% of total energy intake. This is similar to the percentage caloric intake of 10.4% in men and 10.7% in women due to saturated fat, reported in the previous survey. In elderly persons, saturated fat intake represented only 8.9% of energy intake in men and 8.8% of intake in women, which are both less than 10% of energy intake. This is also fairly similar to the 9.3% in men and 8.5% in women in the previous survey. In mountainous areas, saturated fat accounted for 11.7% of total energy intake in men aged 19-64 years, 12.8% in women aged 19-64 years, and 10.7% of intake in men aged 65 years and over (Tables 3 and 4).

The most important sources of saturated fat in adults and elderly persons were pork/products, vegetable oil, and dairy/products, followed by pastries and cookies, steamed buns and dumplings, instant noodles, bread and condiments. The above listed foods provided about 20-30% of saturated fat intake. Therefore, in order to decrease intake of saturated fat, in addition to decreasing intake of pork/products, it is also necessary to reduce consumption of the other above mentioned processed foods. No major changes were observed in regard to the ratio of monounsaturated to polyunsaturated fat intake.

### The impact of dietary changes on sodium intake

Sodium intake was 4578 mg (about 11.4 g of salt) in men and 3567 mg (about 8.0 g of salt) in women aged 19-64 years, which is higher than that observed in the United States. In each age group, sodium intake in men was greater than that in women. Sodium intake was the highest in mountainous areas where it reached 5565 mg (equivalent to 13.9 g salt) in men (Table 2). Mean intakes were above 4000 mg in men and women aged 19-30 years, and men aged 31-64 years. Sodium intakes in adults in the present survey were much greater than those observed in the previous survey and were also higher than current intakes in elderly persons. Sodium intake in women aged 31-64 years and in elderly persons was lower than those observed in the 1993-1996 and 1999-2000 surveys. Sodium intake was 3130 mg (equivalent to 7.8 g

of salt) in elderly men and 2597 mg (equivalent to 6.5 g of salt) in elderly women, which approach current Taiwanese Department of Health recommendations of 6 g for daily salt intake.

Excessive sodium intake is closely related to elevated blood pressure, and therefore an understanding of food sources of sodium is important for developing effective intervention strategies. In Europe and North America, processed foods are the major source of sodium in the diet. Important sources of salt in the United States and Canada include yeast-based breads, pizza, and processed meats and are the reason behind the excessive salt intakes in those countries.<sup>28-30</sup> However, in Japan and China the major source of sodium is salt or soy sauce added to home prepared stir-fries<sup>29</sup>. In the present survey, there are two major sources of sodium for Taiwanese people. The first is the addition of extra salt, soy sauce or other condiments when cooking or eating. The second major source is the sodium contained in processed foods in each major food group.

Further analysis was carried out to look at the increase in sodium intake in young people and the decrease in sodium intake in elderly people. It was found that women aged 31-64 years and elderly persons aged 65 years and over have decreased the addition of extra salt, soy sauce or other condiments when cooking or eating and decreased their intake of pickled vegetables (data not shown). Sodium intake from salt in elderly men has also decreased by about 50% (from 6.2 g of salt to 2.6 g) (Figure 3). As a result, the 2.6 g intake of salt observed in elderly men and the 1.9 g intake of salt in elderly women does not differ greatly from the intake of 2.0 g in men aged 19-30 years and 2.2 g in women aged 19-30 years. In men and women aged 19-30 years and men aged 31-64 years, total sodium intake exceeds 4000 mg, as in addition to sodium intake through salt, soy sauce and other condiments, this group has a large intake of sodium hidden in processed foods (such as chicken and pork and related processed products, instant noodles, soups, steamed buns, dumplings, and wheat and flour products). These foods provided young men and women aged 19-30 years

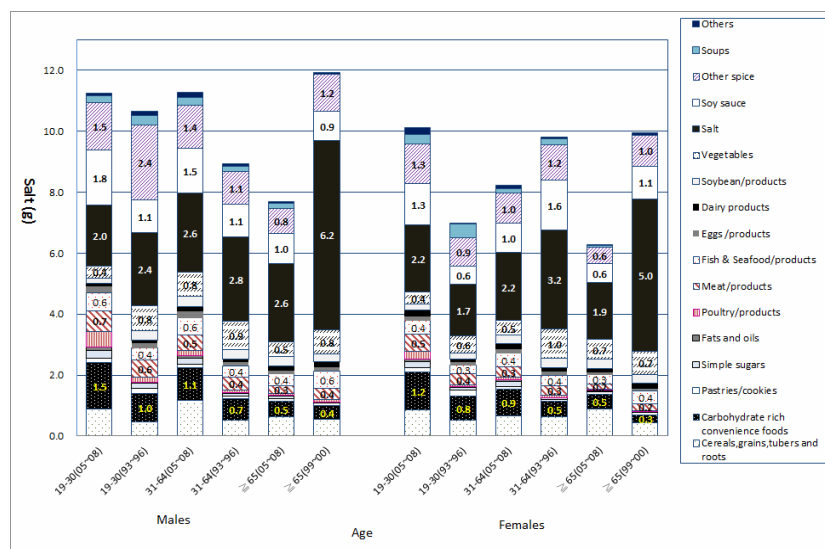


Figure 3. Trends in salt (sodium) intake by gender

with the equivalent of 5 g of salt (46% of total sodium intake for this age group), men aged 31-64 years with 4.9 g and women aged 31-64 years with 3.4 g of salt (43% and 41% of total sodium intake in men and women, respectively). In contrast, these kinds of foods provide elderly persons with less than 3 g of salt (35% and 45% of total sodium intake in men and women, respectively).

As a result, a reduction in sodium intake in Taiwan requires not only reducing the use of soy sauce and other condiments, but also reduced consumption of the easily neglected sodium hidden in processed foods in the daily diet. Consumption of more natural products should be encouraged, and when processed foods are consumed, attention should be paid to the sodium content indicated on food labels in order to maintain a daily intake of salt of that is less than 6 g (100 mmol). Public education on how to correctly interpret nutritional information on food labels should be provided as a means to help reduce intake of sodium and oils.<sup>31-34</sup> Government policy that establishes standards for the sodium content of processed foods<sup>30,35</sup> would also help improve the quality of diets in Taiwan.

## RECOMMENDATIONS

Based on the changes in nutrient intakes and sources of foods in adults and elderly persons in Taiwan between the 1993-1996- and the present survey, we have developed the following recommendations for dietary habits and a healthy food environment in Taiwan:

### *Improving patterns of dietary intake in Taiwan*

#### **To encourage greater consumption of nutrient dense natural foods**

Mean energy intakes of men aged 19-64 years and women aged 19-30 years exceed the recommended DRI levels for those with a low physical activity level. In addition, young men and women aged 19-30 years have the greatest intakes of carbohydrate rich convenience foods and simple sugars, and have the lowest intakes of vegetables, fruit and dairy products. In contrast, elderly persons aged 65 years and over have much lower food consumption than adults under 65 years, and elderly women are particularly likely to have nutrient intakes that fall below DRI levels. Finally, the nutrient consumption patterns in mountainous areas and the Penghu Islands are comparatively worse. As a result, we recommend greater consumption of nutrient dense natural foods in Taiwan such as whole grains, fruit and vegetables, low fat dairy products and nuts. Increased consumption of these foods will improve the intake of dietary fiber, vitamin E, calcium, magnesium, zinc and potassium.

#### **To pay attentions to the appropriate protein sources and issues concerning saturated fat, cholesterol, and iron bioavailability**

The total number of servings of the soybean/fish/meat/eggs food group is high in men aged 19-64 years and women aged 19-30 years. Even though the Taiwanese are selecting low fat meat products, it is still important to avoid excessive intake. People should be encouraged to have a balanced intake of animal and vegetal protein and to avoid excessive intake of protein, cholesterol and satu-

rated fat. Iron content should be considered for women of child-bearing age when selecting protein-rich foods.

#### **To increase intake of fruit and vegetables particularly in young adults**

Both men and women aged 19-30 years need to increase their intake of fruit and vegetables, and particularly that of dark colored vegetables. Men and women of all age groups should also increase their intake of fruit. Consumption of fruit and vegetables could be improved via nutrition education interventions and by establishing an environment where it is economical and convenient to access and consume these types of foods.

#### **To increase intake of dairy products and provide useful measures to deal with lactose intolerance and taste preference**

Men and women across all age groups should increase their intake of dairy products, and men and women aged 19-30 years should be educated to be conscious about fat content of dairy products. As many Taiwanese are unwilling to consume dairy products presumably due to lactose intolerance and taste preference, alternative ways of improving calcium intake via mixed drinks or recipes containing dairy products, food processing to lower lactose content, or other calcium-rich foods should be considered.

#### **To strengthen the use of nutrition labels for hidden fat and sodium content in processed foods**

Processed foods often contain large amounts of hidden fat and sodium and are the main reason that the energy intake from fat is more than 30% and high sodium containing diet in Taiwanese men and women. As a result, the government should actively engage in nutrition education on food labels so that excessive intakes of energy, fat and sodium may be avoided.

#### ***Creating a healthy eating environment and implementing relevant nutritional education***

From the dietary changes observed between household nutrition surveys, it is evident that Taiwanese people are already consuming more low fat meat and dairy/products. However, the promotion of greater consumption of dairy products and fruit and vegetables has not been successful. In addition, the consumption of carbohydrate rich convenience foods, pastries and cookies, and sodium remains high. Increased intake of processed foods because of their convenience has led to excessive intake of fat and sodium and associated nutritional problems. Intake of simple sugars and animal protein has also increased and are a further reflection of the unhealthy eating habits that are present in Taiwan. Based on these observed dietary changes we recommend:

- To develop positive eating habit from a young age: parental education should be provided early on with respect to childhood nutrition. School policy should be made not only to focus on improving nutrition education to students, but also to make healthy foods available in schools. Integrated efforts are needed to involve parents, health professionals, school, and neighborhoods, to ensure the efficacy.

- To actively create healthy eating environments. Changing lifestyles have led to the increased use of take away foods, and therefore it is of vital importance to actively encourage the food and beverage industry and restaurant proprietors to create healthy eating environments, such as: to provide consumers with convenient and reasonably priced healthy food choices that are high in fruit and vegetables and adequate in meat content. Supermarkets and convenient stores should be encouraged to sell fruit, vegetables, nuts that are reasonably priced, in individualized portions, and in a format readily eaten and convenient to carry. Restaurant proprietors can provide more innovative new healthy dishes with adequate portions of meat to help decrease excessive meat intake in Taiwan.
- To reduce excessive intake of sugary drinks. It is time to educate the public about the harms of sugary drink and how to turn away from these products. Alternative healthy drinks can be made available at home and by manufacturers and proprietors.

For optimal nutritional health in Taiwan to be realized, the efforts of nutrition workers as well as those by manufacturers and proprietors, and the general public need to be combined with effective policies and the creation of healthy eating environments.

#### ACKNOWLEDGEMENTS

Data analyzed in this paper (article) were collected by the research project "2004-2008 Nutrition and Health Survey in Taiwan (NAHSIT 2005-2008)" sponsored by the Department of Health in Taiwan (DOH94-FS-6-4). This research project was carried out by the Institute of Biomedical Sciences of Academia Sinica and the Research Center for Humanities and Social Sciences, Center for Survey Research, Academia Sinica, directed by Dr. Wen-Harn Pan and Dr. Su-Hao Tu. The Center for Survey Research of Academia Sinica is responsible for data distribution. The assistance provided by the institutes and aforementioned individuals is greatly appreciated. The views expressed herein are solely those of the authors.

#### AUTHOR DISCLOSURES

Shin-Juan Wu, Wen-Harn Pan, Nai-Hua Yeh, and Hsing-Yi Chang, no conflicts of interest.

#### REFERENCES

1. Thornton LE, Crawford DA, Ball K. Neighbourhood-socioeconomic variation in women's diet: The role of nutrition environments. *Eur J Clin Nutr.* 2010;64:1423-32
2. Department of Health. Nutrition and Health Survey in Taiwan: The status of metabolic syndrome in 2005-2008. [cited 2010/02/22]; Available from: <http://nahsit.nhri.org.tw/node/21>
3. Pan WH, Chang YH, Chen JY, Wu SJ, Tzeng MS, 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.
4. Tu SH, Chen C, Hsieh YT, Chang HY, Yeh CJ, Lin YC, Pan WH. Design and sample characteristics of the 2005-2008 Nutrition and Health Survey in Taiwan. *Asia Pac J Clin Nutr.* 2011;20:225-37.
5. Shah BV, Barnwell BG, Bieler GS. SUDAAN user's manual: Release 7.5. Research Triangle Park, North Carolina: Research Triangle Institute; 1997.
6. Wu SJ, Chang YH, Fang CW, Pan WH. Food sources of weight, calories, and three macro-nutrients: NAHSIT1993-1996. *Nutr Sci J.* 1999;24:41-58.
7. Wu SJ, Chang YH, Wei IL, Kao MD, Lin YC, Pan WH. Intake levels and major food sources of energy and nutrients in the Taiwanese elderly. *Asia Pac J Clin Nutr.* 2005;14:211-20.
8. Department of Health. Daily Reference Intakes, DRI. [cited 2010/02/22]; Available from: [http://food.doh.gov.tw/chinese/libary/libary2\\_2\\_1.htm](http://food.doh.gov.tw/chinese/libary/libary2_2_1.htm)
9. Chang HY, Suchindran CM, Pan WH. Using the overdispersed exponential family to estimate the distribution of usual daily intakes of people aged between 18 and 28 in Taiwan. *Stat Med.* 2001;20:2337-50.
10. Blanck HM, Gillespie C, Kimmons JE, Seymour JD, Serdula MK. Trends in fruit and vegetable consumption among U.S. men and women, 1994-2005. *Prev Chronic Dis.* 2008;5:A35.
11. Centers for Disease Control and Prevention (CDC). Fruit and vegetable consumption among adults-- United States, 2005. *MMWR Morb Mortal Wkly Rep.* 2007;56:282.
12. Chowdhury P, Balluz L, Town M, Chowdhury FM, Bartolis W, Garvin W et al. Surveillance of certain health behaviors and conditions among states and selected local areas - Behavioral Risk Factor Surveillance System, United States, 2007. *MMWR Surveill Summ.* 2010;59:1-220.
13. Lin PH, Miwa S, Li YJ, Wang Y, Levy E, Lastor K, Champagne C. Factors influencing dietary protein sources in the PREMIER Trial Population. *J Am Diet Assoc.* 2010;110:291-5.
14. Food Surveys Research Group, Beltsville Human Nutrition Research Center. What we eat in America, NHANES 2005-2006. [cited 2010/02/22]; Available from: [http://www.ars.usda.gov/SP2UserFiles/Place/12355000/pdf/0506/Table\\_1\\_NIF\\_05.pdf](http://www.ars.usda.gov/SP2UserFiles/Place/12355000/pdf/0506/Table_1_NIF_05.pdf)
15. Network of Food Information. High fiber diet, c2006. [cited 2010/02/22]; Available from: <http://food.doh.gov.tw/foodnew/Files/Health/P04.pdf>
16. Slavin JL. Position of the American Dietetic Association: Health implications of dietary fiber. *J Am Diet Assoc.* 2008;108:1716-31.
17. Good CK, Holschuh N, Albertson AM, Eldridge AL. Whole grain consumption and body mass index in adult women: An analysis of NHANES 1999-2000 and the USDA pyramid servings database. *J Am Coll Nutr.* 2008;27:80-7.
18. Newby PK, Maras J, Bakun P, Muller D, Ferrucci L, Tucker KL. Intake of whole grains, refined grains, and cereal fiber measured with 7-D diet records and associations with risk factors for chronic disease. *Am J Clin Nutr.* 2007;86:1745-53.
19. American Dietetic Association. Position of the American Dietetic Association: Health implications of dietary fiber. *J Am Diet Assoc.* 2008;108:1716-31.
20. Williams PG, Grafenauer SJ, O'Shea JE. Cereal grains, legumes, and weight management: A comprehensive review of the scientific evidence. *Nutr Rev.* 2008;66:171-82.
21. Office for National Statistics. The National Diet & Nutrition Survey: Adults aged 19 to 64 years. London: TSO. C2003. [cited 2010/02/22]; Available from: <http://www.food.gov.uk/multimedia/pdfs/ndns3.pdf>
22. Food Surveys Research Group, Beltsville Human Nutrition Research Center. What we eat in America, NHANES 2005-2006. [cited 2010/02/22]; Available from: [http://www.ars.usda.gov/SP2UserFiles/Place/12355000/pdf/0506/usual\\_nutrient\\_intake\\_vitD\\_ca\\_phos\\_mg\\_2005-06.pdf](http://www.ars.usda.gov/SP2UserFiles/Place/12355000/pdf/0506/usual_nutrient_intake_vitD_ca_phos_mg_2005-06.pdf)
23. National Agricultural Library. Potassium, In: Dietary Reference Intakes for water, sodium, chloride, potassium, and

- sulfate. Washington, D.C.: The National Academies Press; c2005. [cited 2010/02/22]; Available from: [http://www.nal.usda.gov/fnic/DRI//DRI\\_Water/186-268.pdf](http://www.nal.usda.gov/fnic/DRI//DRI_Water/186-268.pdf)
24. Morris RC Jr, Schmidlin O, Frassetto LA, Sebastian A. Relationship and interaction between sodium and potassium. *J Am Coll Nutr*. 2006;25(S3):262S-70.
  25. Bailey RL, Dodd K, Gahche J, Dwyer J, McDowell M, Sempos C et al. Dietary calcium and vitamin D intakes in the United States: Data from the National Health and Nutrition Examination Survey (NHANES) 2003-2006. *J Am Diet Assoc*. 2009;109;S1:A15.
  26. Weaver CM. Role of dairy beverages in the diet. *Physiol Behav*. 2010;100:63-6.
  27. Office for National Statistics. The National Diet & Nutrition Survey: Adults aged 19 to 64 years. [cited 2010/02/22]; Available from: <http://www.food.gov.uk/multimedia/pdfs/ndnsv3.pdf>
  28. US Department of Agriculture, US Department of Health and Human Services. Dietary guidelines for Americans, 2005. Washington, DC: U.S. Government Printing Office, 2005. [cited 2010/02/22]; Available from: <http://www.health.gov/dietaryguidelines/dga2005/document/pdf/dga2005.pdf>
  29. Fischer PW, Vigneault M, Huang R, Arvaniti K, Roach P. Sodium food sources in the Canadian diet. *Appl Physiol Nutr Metab*. 2009;34:884-92.
  30. Brown IJ, Tzoulaki I, Candeias V, Elliott P. Salt intakes around the world: implications for public health. *Int J Epidemiol*. 2009;38:791-813.
  31. Loria CM, Obarzanek E, Ernst ND. Choose and prepare foods with less salt: Dietary advice for all Americans. *J Nutr*. 2001;131:(2S-1):536S-51.
  32. Post RE, Mainous AG, Diaz VA, Matheson EM, Everett CJ. Use of the nutrition facts label in chronic disease management: Results from the National Health and Nutrition Examination Survey. *J Am Diet Assoc*. 2010;110:628-32.
  33. Lewis JE, Arheart KL, LeBlanc WG, Fleming LE, Lee DJ, Davila EP et al. Food label use and awareness of nutritional information and recommendations among persons with chronic disease. *Am J Clin Nutr*. 2009;90:1351-7.
  34. Webster J, Dunford E, Huxley R, Li N, Nowson CA, Neal B. The development of a national salt reduction strategy for Australia. *Asia Pac J Clin Nutr*. 2009;18:303-9.
  35. Anderson CA, Appel LJ, Okuda N, Brown IJ, Chan Q, Zhao L et al. Dietary sources of sodium in China, Japan, the United Kingdom, and the United States, women and men aged 40 to 59 years: the INTERMAP study. *J Am Diet Assoc*. 2010;110:736-45.

## Original Article

## Trends in Nutrient and Dietary Intake among Adults and the Elderly: From NAHSIT 1993-1996 to 2005-2008

Shin-Jiuan Wu MS<sup>1</sup>, Wen-Harn Pan PhD<sup>2,3,4</sup>, Nai-Hua Yeh MS<sup>2</sup>, Hsing-Yi Chang PhD<sup>2</sup>

<sup>1</sup>Department of Food and Nutrition, Chung Hwa University of Medical Technology, Tainan, Taiwan, ROC

<sup>2</sup>Nutrition Medicine Research Program, Division of Preventive Medicine and Health Services Research, Institute of Population Health Sciences, National Health Research Institutes, Miaoli, Taiwan, ROC

<sup>3</sup>Institute of Biomedical Science, Academia Sinica, Taipei, Taiwan, ROC

<sup>4</sup>Department of Biochemical Science and Technology, National Taiwan University, Taipei, Taiwan, ROC

### 臺灣成人與老人營養素及食物攝取來源之變遷趨勢： 由 NASHIT 1993-1996 到 2005-2008

本研究之目的在探討臺灣 1993-1996 至 2005-2008 年，成人與老人的營養素及其食物攝取來源之變遷趨勢，以提供營養健康相關決策之參考。研究對象與資料分析來源是以 2005-2008 年(19 歲以上)「臺灣營養健康狀況調查」(NAHSIT III)中，不同性別、年齡及地區的成人與老人 24 小時飲食回憶資料。該資料運用四個主要食品成分資料庫及 SAS 與 SUDAAN 統計軟體進行分析，並進一步與 1993-1996 年(19-64 歲)、1999-2000 年(65 歲以上)的調查結果相比較。研究結果發現：成人與老人對「穀類與富含澱粉植物性食品」的攝取量減少，以至於膳食纖維攝取量降低；但對「富含醣類便利食品」的攝取量卻增加，並提供了 10-20 g 的脂肪。此外，已有較多人會選用脂肪含量較低的家畜類及其製品，但 19-64 歲男、女性對肉類的攝取量分別高達 9 與 6 份，而致蛋白質、膽固醇與飽和脂肪酸的攝取過量。19-30 歲男、女性的蔬菜類攝取都不足。各年齡層對水果、乳製品、堅果的攝取量低，對各類加工食品所含的潛在脂肪與鈉攝取量過高等問題，應予重視，因此建議加強教育民眾避免攝取過量。此外，也應留意 19-64 歲男性、19-30 歲女性對熱量、肉魚豆蛋類、加工食品、含糖飲料的攝取是否過量；並留意老人有多種營養素攝取量低於 DRI 的問題。

**關鍵字：** 24小時回憶法、食物來源、飲食攝取、營養素、臺灣營養健康狀況變遷調查