Original Article

Design and sample characteristics of the 2005-2008 Nutrition and Health Survey in Taiwan

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The Nutrition and Health Survey in Taiwan (NAHSIT) 2005-2008 was funded by the Department of Health to provide continued assessment of health and nutrition of the people in Taiwan. This household survey collected data from children aged less than 6 years and adults aged 19 years and above, and adopted a three-stage stratified, clustered sampling scheme similar to that used in the NAHSIT 1993-1996. Four samples were produced. One sample with five geographical strata was selected for inference to the whole of Taiwan, while the other three samples, including Hakka, Penghu and mountainous areas were produced for inference to each cultural stratum. A total of 6,189 household interviews and 3,670 health examinations were completed. Interview data included household information, socio-demographics, 24-hour dietary recall, food frequency and habits, dietary and nutritional knowledge, attitudes and behaviors, physical activity, medical history and bone health. Health exam data included anthropometry, blood pressure, physical fitness, bone density, as well as blood and urine collection. Response rate for the household interview was 65%. Of these household interviews, 59% participated in the health exam. Only in a few age subgroups were there significant differences in sex, age, education, or ethnicity distribution between respondents and non-respondents. For the health exam, certain significant differences between participants and non-participants were mostly observed in those aged 19-64 years. The results of this survey will be of benefit to researchers, policy makers and the public to understand and improve the nutrition and health status of pre-school children and adults in Taiwan.

Key Words: Nutrition and Health Survey in Taiwan (NAHSIT) 2005-2008, sample design, response rates, weighting, Computer Assistant Personal Interview (CAPI)

INTRODUCTION

Society has undergone rapid change in recent times, with increasing innovations to food processing. The change in dietary habits in Taiwan has resulted in a growing prevalence of unbalanced dietary intakes and steady rises in obesity and chronic diseases, such as cardiovascular disease and the metabolic syndrome.[1] Regular assessment of the population's nutrition and health status has become an important aspect of public health in Taiwan. The Bureau of Food Sanitation, Department of Health (DOH), therefore, began to commission regular nutrition and health surveys in 1992. Several surveys funded by the DOH have been conducted including the Nutrition and Health Survey in Taiwan (NAHSIT) 1993-1996 on those aged 4 years and over,[2] the NAHSIT 1999-2000 on the elderly,[3] and the NAHSIT 2001-2002 on the elementary school children.[4]

These surveys have established a pattern of cooperation between nutrition and health researchers, and produced extensive background data on health and nutrition in Taiwan, on which government policy for recommended nutritional intake, health promotion and disease prevention can be based. With the same purpose, the NAHSIT 2005-2008, for aged 0-6 years and 19 years and above, has been carried out since 2005. This article aims to present sample design, survey contents, survey process, sample response, weighting and representativeness as an important guide for future study and policy makers to do accurate analysis and reporting of the survey findings.

MATERIALS AND METHODS

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Study design and sampling

NAHSIT 2005-2008 used a stratified three-staged probability sampling design to assess the health and nutrition status of the Taiwanese, with regard to particular geographical regions, ethnic-, age- and sex groups, as well as the overall Taiwanese population (Figure 1). An eligible individual's probability of being selected was based on their registered area of residence, sex and age. The target population included Taiwanese nationals aged 0-6 years (0 years was defined as aged from birth to less than 1 year) and 19 years and over. Excluded are citizens residing in military units, hospitals, nursing homes, schools, vocational training centers, dormitories, and correctional facilities, pregnant women, breastfeeding women, older people with dementia who lost communication ability, and those with a notifiable infectious disease or a serious illness including those who are not independent or have a serious and irreversible illness that necessitates altered food intake such as cancer, renal dialysis, a vegetative state, or past intestinal surgery. Both registered and unregistered individuals were included, as were blood-relatives and non-blood relatives (including foreign spouses). The final sample size was 6,144 persons over three years. Actual sample size by age group and sex across areas is shown in Table 1 and elaborated in later sections.

Stratification

The 358 townships and city districts in Taiwan were divided into five sampling strata based on geographical location and population density. These strata included the first northern stratum (Taipei City and Taipei County), the second northern stratum (the area north of Hsinchu and Yilan excluding Taipei City and County), the central stratum (the area south of Miaoli and north of Chiayi), the southern stratum (the area south of Chiayi and the Penghu Islands), and the eastern stratum (Hualien and Taitung). National estimates of health and nutrition were based on the five strata.

Based on 2004 population data from the Ministry of the Interior,[5] the number of townships and city districts and the population in each stratum were as follows: 6,722,908 residents in 48 townships and city districts in the first northern stratum; 3,169,511 residents in 41 townships and city districts in the second northern stratum; 5,700,922 residents in 106 townships and city districts in the central stratum; 6,432,444 residents in 134 townships and city districts in the southern stratum; and 589,522 residents in 29 townships and city districts in the eastern stratum.

To enable analysis of particular lifestyle and dietary habits of ethnic minority groups in Taiwan, additional three strata, including Hakka areas, mountainous areas and

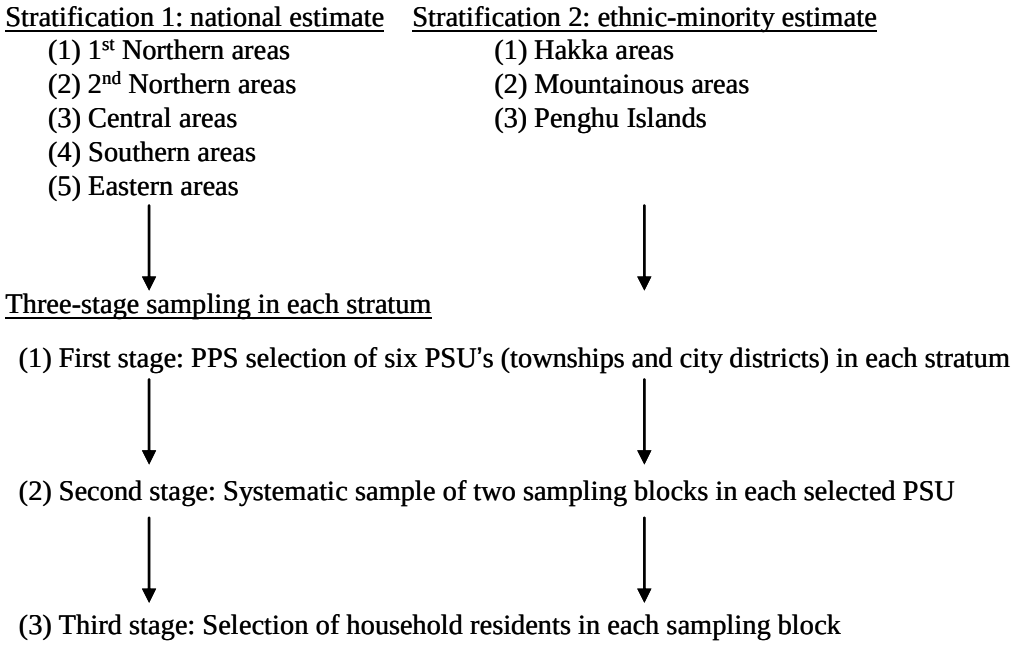

Figure 1. Sample design: stratified and three-staged sampling in the Nutrition and Health Survey in Taiwan 2005-2008

Table 1. Expected sample size by age and sex in the Nutrition and Health Survey in Taiwan 2005-2008

	Number of sampling units in each stratum			3 yr sample size in each stratum			Total 3 yr sample size		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
Age group, yrs									
0-3	8	8	16	48	48	96	384	384	768
4-6	8	8	16	48	48	96	384	384	768
19-30	8	8	16	48	48	96	384	384	768
31-44	8	8	16	48	48	96	384	384	768
45-64	16	16	32	96	96	192	768	768	1536
65+	16	16	32	96	96	192	768	768	1536
Total	64	64	128	384	384	768	3072	3072	6144

Penghu Islands were created. The estimates of health and nutrition parameters in each minority group are independent of the national estimates of the five strata defined earlier.

The Hakka areas include 49 townships and city districts with 2,167,68 residents in which there are more than 50% Hakka residents, based on the broad definition of the Hakka ethnic group in Taiwan developed by the Council for Hakka Affairs, Executive Yuan in 2004 in the National Survey of the Hakka Population.[6] A total of 30 rural townships with 199,095 persons were included in the mountainous areas based on the definition of indigenous townships in mountainous areas developed by the Council of Indigenous Peoples, Executive Yuan. The Penghu Islands included six townships and cities. As the population on Penghu Islands is predominantly concentrated in Makung city, Makung was further divided into four districts, resulting in a total of nine townships and city districts with 94,780 residents.

The distribution of the five strata for national estimates and the sampled townships and city districts are shown in Figure 2. With regard to the strata for minority estimates, the distribution of the stratum of Penghu Islands is shown in Figure3; and the strata of the Hakka areas and mountainous areas are shown in Figures 4 and 5, respectively. The predicted sample size by sex and age in each stratum is shown in Table 1. The actual number of respondents by age in each stratum is shown in Table 2.

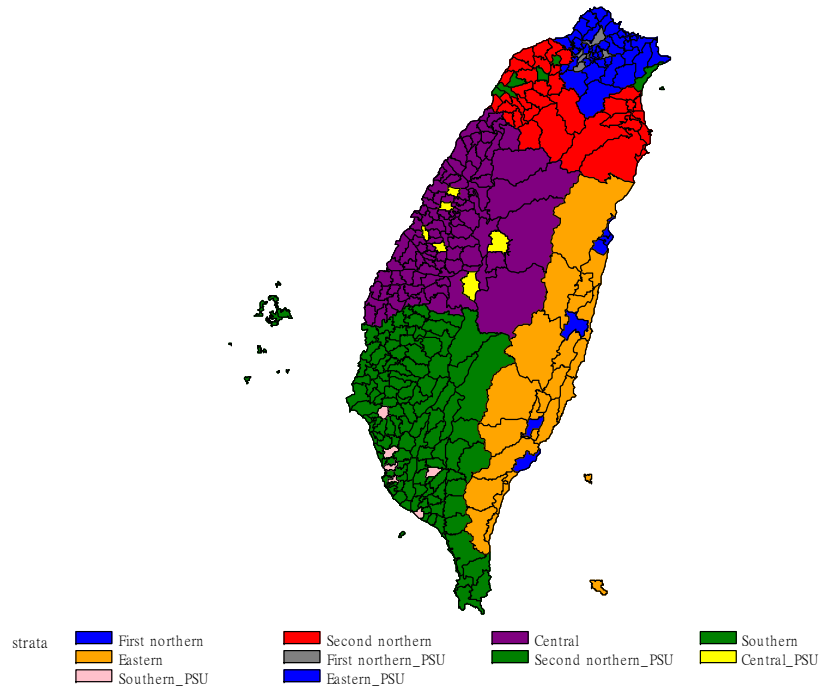

Figure 2. Distribution of five geographical strata and selected primary sampling units (PSUs) in mainland Taiwan in the Nutrition and Health Survey in Taiwan 2005-2008

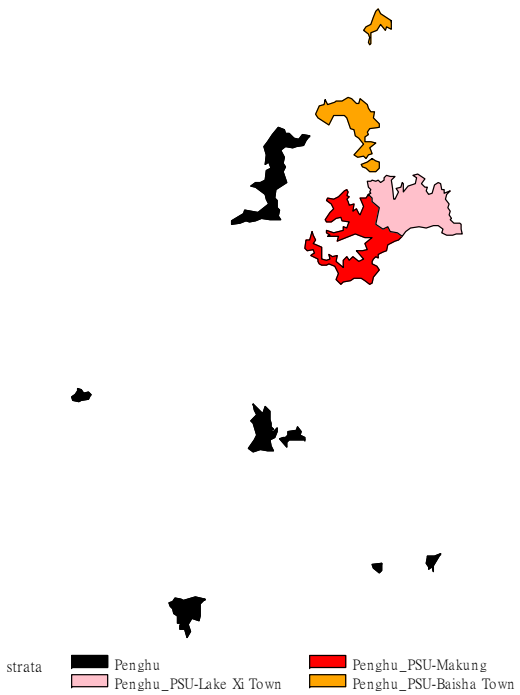

Figure 3. Distribution of selected primary sampling units in the Penghu Island stratum

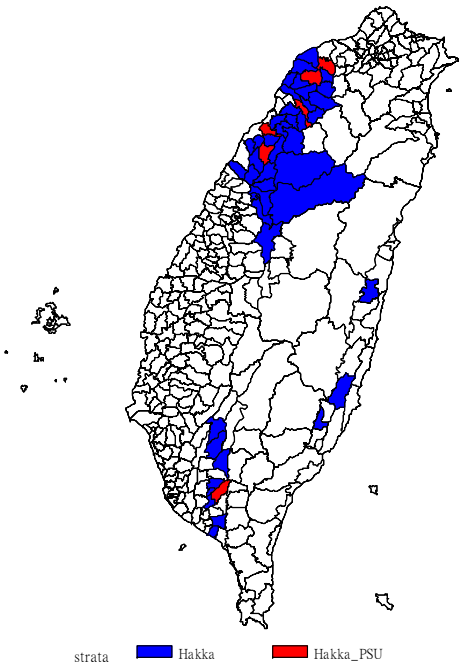

Figure 4. Distribution of selected primary sampling units in the Hakka stratum

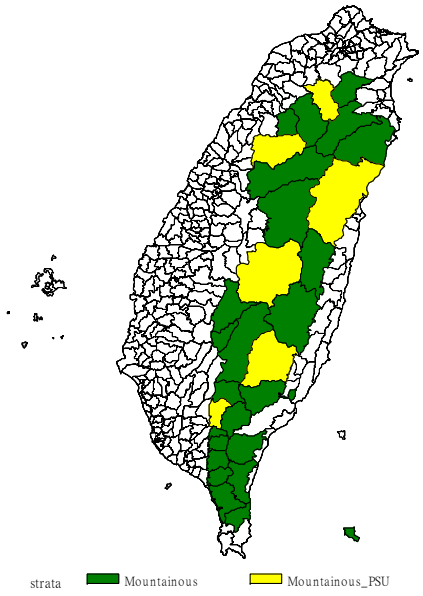

Figure 5. Distribution of primary sampling units in the mountainous areas stratum

Table 2. Actual sample size by age and sex in the Nutrition and Health Survey in Taiwan 2005-2008

Stratum	Age group, yrs														
	0-6			19-44			45-64			65 and over			Total		
	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total
Expected sample	96	96	192	96	96	192	96	96	192	96	96	192	384	384	768
First northern	92	92	184	98	100	198	96	101	197	96	96	192	382	389	771
Second northern	94	92	186	97	96	193	96	98	194	99	102	201	386	388	774
Hakka	98	97	195	102	104	206	98	99	197	98	93	191	396	393	789
Central	95	96	191	98	97	195	96	98	194	95	96	191	384	387	771
Southern	94	96	190	96	98	194	97	95	192	96	96	192	383	385	768
Penghu	97	95	192	96	96	192	96	96	192	101	102	203	390	389	779
Eastern	96	96	192	96	97	193	96	97	193	96	96	192	384	386	770
Mountainous	97	97	194	99	97	196	96	96	192	89	96	185	381	386	767
Total	763	761	1524	782	785	1567	771	780	1551	770	777	1547	3086	3103	6189

Three-stage sampling

Three-stage probability sampling was used to select the sample within each stratum. The first stage was for the selection of six primary sampling units (PSU, in terms of townships and city districts) using probability proportional to size (PPS) sampling methods. The selected PSU's from each of the eight strata are 48 townships or city districts.

The second stage was to select two sampling blocks from each of the selected townships or city districts. The two sampling blocks were derived from two addresses systematically sampled among registered households in the township or city district supplied by the Ministry of the Interior. The sampling block was defined as the selected address plus several neighboring households, and was decided upon inspection of the suitability of the neighborhood environment surrounding the selected address. Selected households in a sampling block were required to be actual physical neighbors and not just sequential address numbers on the household registry.

In principle, all of the selected households in a sampling block should be entirely located within a particular district and not separated by geographical landmarks such as a river or mountain. The neighborhood environment surrounding the selected household was not considered suitable if it included a cemetery, farmland, factory or other structures with a low population density. This was to enable interviewers to use a simple route to collect data from neighboring households within a sampling block. If the surrounding environment of the selected household was found to be unsuitable, the back-up household was used and the process of examining the suitability of the surrounding environment repeated until an appropriate sampling block was confirmed.

At the third stage, the usual residents of households in each sampling block were selected, stratified by sex and age group. Residents in one household with the same registered name were considered to be one household. The households registered with different names at the same address were considered different households. Eligible households included family dwellings, shared accommodation, or a combined family business and home. A door to door visit was conducted to get informed consent from the residents and to carry out interviews. Every eligible resident was contacted until the number of the age and sex groups was reached. We expected to interview 64 persons in each sampling block, which would result in a sample of 128 residents for the two sampling blocks in each PSU (64 male and 64 female including 32 aged 0-6 years, 32 aged 19-44 years, 32 aged 45-64 years, and 32 aged 65 years and above) (Table 1).

Seasonal effect

Seasonal effects were taken into account by allocating data collection over three periods of four months each (November to February, March to June, and July to October) to control seasonal variation which would affect dietary consumption and nutritional status. The Latin square design was used to ensure that the questionnaire, 24-hour dietary recall, and health exam data were collected in three different seasons over the 48 townships and city districts across the three-year period. In each year, a circuit was made of 16 townships and city districts, while household interviews were conducted in order, across seasons. Complete data were available for the six townships and city districts in each stratum, collected across three periods at the end of the three-year period.

Taking the second northern stratum as an example, the survey was conducted in July to October 2005 in Toucheng, followed by Chupei in November to Feburary 2006 and Hukou in March to June 2007. For the other strata, the same principle of sequential data collection over the six townships and city districts was followed. By the end of the three-year period, data collection was completed for two PSUs of each stratum in each season. For example, in the second northern stratum, surveys were carried out in Toucheng and Pinzhen in July to October, in Chubei and Taoyuan in November to February, and in Hukou and northern Hsinchu in March to June.

Survey contents and procedures

The survey implementation and instruments were approved by the Institutional Review Board from Academia Sinica, which conducted the survey, and by reviewers from the Department of Health in Taiwan. Informed consent forms, which indicate the contents and confidentiality of the survey and health exam data, were distributed to household members and signed by those who agree to be interviewed or who were willing to participate in the health examination. Respondents who completed socio-demographics, household information, and the 24-hour dietary recall in the household interview were considered successful cases and were invited to participate in the health exam.

The survey operation was similar to that in the 1993-1996 survey.[2,7] Twelve full-time interviewers were trained to create two teams of interviewers that then traveled to the 48 townships and city districts selected for the study sample. The household was the basic unit of data collection. Data were collected by face-to-face interview and a health exam.

Face-to-face interview

Questionnaires for the household interview included: 1) household information; 2) socio-demographics; 3) 24-hour dietary recall (including household recipes, the individual dietary recall and individual validity data for food models); 4) food frequency; 5) dietary habits (including the types of meat and dairy products consumed and intake of sugary drinks and fast-foods); 6) dietary supplements; 7) nutritional knowledge, attitudes and practices; 8) medical history (including medical history, medication history, anorexia nervosa, brief symptom rating scale, weight loss, irritable bowel syndrome, angina, use of tobacco, alcohol and betel nut, bone density, childbirth, transient ischemic attacks, and prostatic hypertrophy); 9) physical and psychological functioning scales (SPMSQ cognitive function scale, SF-36 quality of life scale); 10) physical activity scale; and 11) other physical and psychological health questionnaires. The specific content of questionnaires differed somewhat between age groups.

Computer-Assisted Personal Interview (CAPI)

In contrast to the previous NAHSIT from 1993 up to 2002, the present survey designed a Computer-Assisted Personal Interview (CAPI) software system to carry out data collection. This has made data collection more efficient and has reduced recording errors by data collectors.

The CAPI software system has several functions including a question bank, question editing module, name list creation module, questionnaire interview module and user interface. The software enables the compiling of different questionnaires for different age groups, skipping of particular questions, and logic checking for data errors. Data files are encrypted, thereby ensuring individual privacy protection. The software includes three main components: a management interface, work station interface and interviewer interface.

The management interface includes the functions of interviewer management, household sample selection, question bank construction (including single or multiple response questions, open-ended questions, scales and demonstration items), questionnaire design (including skipping of particular questions and setting of response ranges for open questions), sending of encrypted data, and decryption of data. The work station interface includes the functions of computerized data collection by the interviewer, estimation of population statistics for interviewed respondents, and production of name lists for the health exam (including printing of a list of names and an information sheet that facilitates communication with participants prior to the health exam). The interviewer interface includes the sections of screening sampled household and sampled individuals, questionnaires, and survey response editing (including the ability to search responses for every item, and report on sections already completed, unanswered items, and exempt items).

Health examination

The health exam mainly included the following items, with minor differences between 0-6 year respondents and adults. The procedures used for collection of the health exam data were the same as the protocol established for the previous national nutrition surveys in Taiwan from 1993 to 2002.[7-9] Specific health exam software was developed for managing physical assessments and biospecimen via a barcode system and uses double data entry system for data accuracy.

- Body measurements: length (0-2 yrs), head circumference (<3 yrs), height, weight, waist circumference, hip circumference, wrist circumference, upper arm length, upper arm circumference, thigh length, thigh circumference, and skinfold thickness [8,9]
- Blood pressure: using an Omega 1400 automatic electronic blood pressure monitor (Non-Invasive blood pressure monitors, Invivo Research Laboratories Inc.) [8.9]
- Pulse and electrocardiogram for adults aged 19 yrs and above
- Clinical biochemistry: serum cholesterol (including total cholesterol, LDL-C and HDL-C), triglycerides, blood glucose, uric acid, CRP, creatinine, liver function tests, amylase, complete blood count, vitamins, minerals, serum pH, pCO_2, pO_2, iron and ferritin, TIBC, phospholipid, homocysteine, BUN, alkaline phosphatase, PTH, and DNA from white blood cells for genetic analysis [9]
- Urine test: assessment of urinary sugar, urinary protein, vitamins, minerals, and markers for smoking and passive smoking exposure [8,9]
- Osteoporosis assessment: calcaneal ultrasound bone densitometry,[8,9] Dual Energy X-ray Absorptiometry (DEXA) bone densitometry (including lumbar spine, bilateral femurs, left forearm, right forearm, whole body composition). This is the first time that extensive DEXA measurements have been carried out on a population scale in Taiwan to increase the precision of measurements of body composition, whole body bone density, and bone density at sites prone to osteoporosis (wrist, lumbar spine, and hip).
- Measurement of mineral nutritional status from toenail clippings
- Physical performance assessments: sit and reach test, grip strength, and pinch strength [9]
- Respiratory function [9]

Data entry and quality control

Quality assurance procedures were incorporated into interview and health exam data collection. Before field work started, the interviewers were given a two-week training course including sampling procedure, questionnaire contents, interviewing techniques, CAPI system, 24-hour recall data entry, operation of the health exam, and data entry and double keying of health data.

The validity and accuracy of data collection in questionnaires, except for 24-hour recall, improved from that of previous national nutrition surveys from 1993 to 2002 due to the use of a Computer-Assisted Personal Interview (CAPI). Previous surveys used a paper questionnaire that then needed to be coded and entered into a database. The data involved double key-in entry, followed by examination and correction of errors.

For other questionnaires, the use of CAPI by interviewers enables participants' responses to be directly entered into the computer at the time of interview. The computerization of the interview data allows for timely detection of errors and rapid communication with the interviewer, enabling immediate correction of mistakes. This timely correction of data errors and data tracing improves the quality of the collected interview data.[10.11]

Cross-validating measurement skill and computerized logic checking were also used to maintain the quality of health exam data. For the nutritional and clinical biochemical test, systematic random selection of 5% of the blood and urine samples were repeated on split samples to ensure data quality. High repeatability of tests on the split sample indicates potential high quality.[7,8]

All the interview and health exam data, which were logic-checked by software and staff members, were also cleaned by using a statistical package (SAS) to keep logic errors to a minimum.

Weighting and analysis

As the present survey used unequal probability sampling, the likelihood of an individual being selected for the sample in each sampling block varied with age and sex in each stratum. When examining response rates and participation rates for the questionnaire interview and health exam, it was necessary to first weigh each sample to ob-

tain representative estimates. Weight derivation was carried out using the post-stratification method based on the distribution of age and sex across areas. The eight geographical strata of the sample were further divided into two gender and 19 age groups (0, 1, 2, 3, 4, 5, 6, 19-24, 25-29, 30-34, 35-39, 40-44, 45-49, 50-54, 55-59, 60-64, 65- 69, 70-74, 75 and above) which resulted in a total of 304 strata (8x2x19). Appropriate weights for each stratum were estimated based on the total population for the stratum, based on the registered household population in Taiwan (2006) and divided by the selected sample size. This weighting was used in all analyses of characteristics of participants in the questionnaire interview and health examination. Separate weights were made available for questionnaire data and health examination data.

RESULTS

A total of 9,570 persons were selected for the sample, and 6,189 agreed to participate in the questionnaire interviews, resulting in a response rate of 65%. Out of those agreeing to the household interview, a total of 3,670 persons agreed to participate in the health exam, giving a participation rate of 59%. The response rates for the household interview and participation rates for the health exam by sex and age groups in each geographical stratum are provided in Tables 3 and 4.

Household interview response rate

Regardless of age-group and gender difference, the total response rates for the household interview were more than 70% in the eastern and mountainous areas but less than 60% in the two northern areas (right panel in Table 3). Response rates were highest in children aged 0-6 years (84%), followed by the oldest group aged 65 years and over (65%) (total at the bottom of Table 3). The highest response rate, found in the youngest group, appeared in each stratum. Looking into response rate in each age group across areas regardless of gender difference, response rates were highest in the 0-6 year sample in the mountainous, eastern and southern areas (more than 90%), followed by the first northern, Penghu, and Hakka areas (81-84%). The higher response rates in the mountainous, eastern and southern areas were also in those aged 65 and over, and the 19-44 year group. A response rate of more than 80% was obtained in both genders aged 0-6 in most strata, except for the second northern and central areas. However, response rates of less than 50% were obtained in both genders aged 19 to 44 in the first northern stratum, males aged 19 to 44 in the central stratum, and males aged 45-64 in the two northern strata.

As for gender differences, the response rate was higher among females than among males in most of the strata except for the first northern, Hakka and central areas (right panel in Table 3). The trend of gender difference in

Table 3. Questionnaire interview participation rate (%) by age and sex in each stratum in the Nutrition and Health Survey 2005-2008

Stratum	Age group, yrs														
	0-6			19-44			45-64			65 and over			Total		
	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total
First northern	87	84	85	48	47	47	47	54	50	64	60	62	58	58	58
Second northern	79	76	78	52	58	55	45	56	50	59	63	61	56	62	59
Hakka	80	81	81	56	62	59	59	55	57	66	58	62	64	62	63
Central	77	75	76	48	54	51	56	53	55	67	63	65	60	60	60
Southern	82	93	87	58	67	62	57	56	57	61	69	65	63	69	66
Penghu	82	83	83	56	64	60	58	59	58	60	60	60	63	65	64
Eastern	87	93	90	62	69	65	67	73	70	69	71	70	70	76	73
Mountainous	93	98	96	76	78	77	74	78	76	75	79	77	79	82	81
Total	83	85	84	56	61	58	57	59	58	65	65	65	63	66	65

Table 4. Health examination participation rate (%) by age and sex in each stratum in the Nutrition and Health Survey in Taiwan 2005-2008[†]

Stratum	Age group, yrs														
	0-6			19-44			45-64			65 and over			Total		
	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total
First northern	50	47	48	53	59	56	64	57	60	66	53	59	58	54	56
Second northern	57	47	52	52	57	54	67	60	63	70	66	68	61	58	60
Hakka	47	62	54	47	56	51	59	67	63	72	57	65	56	60	58
Central	57	55	56	49	61	55	58	71	65	71	74	72	59	65	62
Southern	59	47	53	58	61	60	56	64	60	55	60	58	57	58	58
Penghu	69	64	67	59	63	61	63	64	63	70	62	66	65	63	64
Eastern	57	57	57	43	45	44	47	67	57	66	54	60	53	56	55
Mountainous	69	56	62	38	52	45	55	49	52	75	78	77	59	59	59
Total	58	54	56	50	57	53	58	62	60	68	63	66	59	59	59

[†]The physical examination participation rate = the actual number of participants attending the physical examination divided by the number of questionnaire respondents.

response rates was also found in most of the age groups (bottom in Table 3). In terms of gender difference across age groups by strata, response rates were higher in women than in men among most of the age groups and areas. There was a difference of more than 6% in the southern and eastern areas among 0-6 year-old respondents, in the second northern, Hakka, central, southern and eastern strata among 19-44 year-old respondents, in two northern areas and the eastern stratum among those aged 45-64, and in the southern stratum among the older group (Table 3). Such a trend in gender difference was found to be statistically significant among the 0-6 year olds in the southern stratum and the 45-64 year olds (at the 0.05 significance level, not shown in the Table). In contrast, response rates were higher for males than for females in most age groups in the first northern and central areas, and in older groups in the Hakka stratum (figure in each row by gender across age group in Table 3).

Examination of adult response rates by education revealed statistically significant differences in response rates across four levels of education (elementary school and below, junior high school, high school, or university and above) in those aged 19 to 44 in the central stratum, those aged 45 to 64 in the central and Hakka strata, and those aged 65 and over in the eastern stratum (at 0.05 significance level; data not shown in Table 3).

Health exam participation rate

The health exam participation rates of those responding to the questionnaire by age, sex, and geographical stratum are shown in Table 4. Overall participation rates regardless of gender difference were from 55% to 64%. The highest was in the Penghu area, while the lowest around 55-56% were in the first northern and eastern strata (right panel in Table 4). The total participation rates among five age groups were from 53% to 66% with the highest in the oldest group and the lowest in those aged 19-44 (bottom in Table 4). Break down by age and strata, the overall participation rate was more than 70% in the central and mountainous areas, among those aged more than 65. Participation from 60% to 70% was found in most remaining areas among the respondents aged 65 years and older, the second northern, Hakka, central and Penghu strata in the age group between 45 to 64 years old, Penghu among those aged 19-44 and 0-6, and the mountainous area among children aged 0-6. However, health exam participation rates of less than 50% were obtained in the first northern stratum (48%) among those aged 0-6 years, and the eastern stratum (44%) as well as the mountainous areas stratum (45%) among those aged 19-44 (total % in each cell in Table 4).

Taking gender into account, the participation rates were more than 60% in both genders in most strata among the oldest participants, the second northern and Penghu strata among the participants aged 45-64, and Penghu among the youngest age group. The highest participation rate (78%) was found in females from the mountainous areas, while the lowest participation rate (38%) was found in males from the eastern stratum among those aged 19-44. Participation rates were 40% to 50% in females aged 0-6 years in the first northern, second northern and southern strata, males aged 0-6 years in the Hakka stratum, men aged 19-44 years in the Hakka, central and eastern strata, women aged 19-44 years in the eastern stratum, and men aged 45-64 yrs in the eastern stratum.

When comparing both genders, the overall participation rates were higher in females than in males in the two age groups from 19 to 64 year olds from most of the strata. Participation rates were higher in women than in men in those aged 19-44 years from all strata and those aged 45 to 64 years from most of the strata. Statistical significance for this gender difference was found in the 19-44 year-old group from the central and mountainous areas and the 45-64 year-old group from the eastern area (at the 0.05 significance level; data not shown in Table 4). Conversely, participation rates were higher in males than in females among the children aged 0-6 years and older people aged 65 years and above, from most strata. A statistically significant difference was found among those aged more than 65 years from the Hakka stratum (at the 0.05 significance level).

In addition, there was a statistically significant difference in health exam participation rates by education (as categorized into four levels, namely elementary school or below, junior high school, senior high school, and university and above) in those aged 19-44 years from the central, southern and Hakka strata, those aged 45-64 years from the Hakka stratum, and those aged more than 65 years in the first northern stratum (data not shown).

Comparison between respondents and non-respondents

The analyses described below were conducted using SUDAAN statistical software to account for the complex sampling design used in the survey. Age, sex, education level and ethnicity were compared between respondents and non-respondents in the household interview and between participants and non-participants in the health exam. The comparative analysis was done for each subsample from the five age groups as defined in Tables 2-4.

Household interview

In the sample of children aged 0-6 years old, there were no significant differences in sex and ethnicity distribution between respondents and non-respondents (Table 5). A significant difference was observed in the proportion of children aged 0-3 years and 4-6 years (at the 0.05 significance level) between respondents and non-respondents. The proportion of respondents aged 0-3 years is higher than that of those aged 4-6 years. In the samples of two age groups, respectively 19-44 year olds and 45-64 year olds, there were no significant differences in age, sex, ethnicity, and education distribution between respondents and non-respondents. In the sample aged 65 years and over, response rates significantly differed by education (at the 0.05 significance level). The proportion of non-respondents is greater than that of respondents among those with junior high school and primary school education. Those with higher education had a higher response rate. There were no statistically significant differences in the distribution of other background characteristics among the elderly.

Health exam

There were no statistically significant differences in the

Table 5. Comparison of education level and ethnicity between respondents and non-respondents by age and sex in the Nutrition and Health Survey in Taiwan 2005-2008

	0-6 years old			19-44 years old			45-64 years old			65 years old and over		
	Respondents (%)	Non-respondents (%)	*p* value	Respondents (%)	Non-respondents	*p* value	Respondents (%)	Non-respondents (%)	*p* value	Respondents (%)	Non-respondents (%)	*p* value
	%			%			%			%		
Sex												
Male	51.4	55.6	0.34	49.0	52.9	0.08	48.3	51.4	0.15	49.5	49.4	0.99
Age												
0-3 yrs	52.8	44.2	0.009	-	-		33.3	33.9		-	-	
4-6 yrs	47.2	55.8		-	-		31.2	28.8	0.64	-	-	
19-24 yrs	-‡	-		20.9	21.9		22.0	22.6		-	-	
25-29 yrs	-	-		19.2	22.5		13.5	14.7		-	-	
30-34 yrs	-	-		19.9	17.7	0.37	-	-		32.5	31.8	
35-39 yrs	-	-		19.3	18.9		-	-		26.9	23.6	0.19
40-44 yrs	-	-		20.7	19.0		-	-		24.9	23.6	
							-	-		15.7	21.0	
Education												
Primary school and below	-	-		2.7	4.6		37.0	40.9		73.9	78.9	
Junior high school	-	-		14.4	15.7	0.12	16.0	17.2	0.09	8.4	9.5	0.036
Senior high school	-	-		58.9	59.3		37.9	32.9		13.7	8.4	
University	-	-		24.0	20.4		9.1	9.0		4.0	3.2	
Ethnicity												
Fukienese	77.7	79.3		78.1	82.3		77.5	81.0		72.0	76.4	
Hakka	12.5	10.9	0.99	12.9	8.2	0.46	13.4	13.1	0.16	13.4	10.5	0.24
Mainland†Chinese	8.5	7.2		7.8	8.6		8.0	5.0		14.1	12.9	
Indigenous	1.3	2.6		1.2	0.9		1.1	0.9		0.5	0.2	

†Mainland is the mainland Chinese who are post-World War II immigrants. ‡"–" in the cell means not applicable.

Table 6. Comparison of education level and ethnicity between participants and non-participants in the health examination by age and sex in the 2005-2008 Nutrition and Health Survey in Taiwan

	0-6 years old			19-44 years old			45-64 years old			65 years old and over		
	Participants (%)	Non-participants (%)	*p* value	Participants (%)	Non-participants %	*p* value	Participants	Non-participants %	*p* value	Participants	Non-participants %	*p* value
Sex												
Male	54.4	50.7	0.30	46.2	52.8	0.006	46.9	51.1	0.095	49.8	49.2	0.83
Age												
0-3 yrs	48.7	52.8	0.24	-	-		32.8	33.9		-	-	
4-6 yrs	51.3	47.2		-	-		27.8	31.3	0.25	-	-	
19-24 yrs	-‡	-		15.9	23.9		25.1	20.9		-	-	
25-29 yrs	-	-		20.5	20.8		14.3	13.9		-	-	
30-34 yrs	-	-		19.4	18.7	0.001	-	-		34.2	30.9	
35-39 yrs	-	-		21.5	18.0		-	-		27.8	24.2	0.16
40-44 yrs	-	-		22.7	18.6		-	-		22.5	25.6	
Education												
Primary school and below	-	-		1.9	4.3		35.6	40.2		73.0	77.4	
Junior high school	-	-		11.3	16.9	0.000	16.3	16.5	0.049	8.0	9.3	0.052
Senior high school	-	-		59.8	58.6		38.1	34.7		14.8	9.8	
University	-	-		27.0	20.2		10.0	8.6		4.2	3.5	
Ethnicity												
Fukienese	77.6	78.1		79.6	79.8		75.9	80.6		71.6	74.8	
Hakka	12.2	12.3	0.77	9.9	11.6	0.76	14.6	12.5	0.21	13.2	11.9	0.38
Mainland†Chinese	8.3	8.2		9.9	7.2		8.7	5.7		14.9	12.8	
Indigenous	1.9	1.4		0.6	1.4		0.8	1.2		0.3	0.5	

†Mainland is the mainland Chinese who are post-World War II immigrants. ‡ "–" in the cell means not applicable.

distribution of age, sex and ethnicity between participants and non-participants in two samples aged 0-6 years and 65 years old and above (Table 6). In the 19-44 year age group, significant differences in sex, age, and education were observed between participants and non-participants (at the 0.05 significance level). The proportion of participants was lower among men than among women. Among the five age groups, the greatest difference between participation rate and non-participation rate was in those aged 19-24 and 35-44 years. The proportion of those aged 19-24 years was 8% higher in non-participants compared to participants. In contrast, the proportions of those aged 35-39 and 40-44 years were about 3% higher in participants compared to non-participants. In the sample aged 45-64 years, no significant difference in the distribution of sex, age, and ethnicity between participants and non-participants were found (at the 0.05 significance level). Health exam participation rates were higher in those with a senior high school and above degree of education, particularly those with a university or higher level of education. In contrast, rates of non-participation were about 3-5% higher in those with a junior high school or lower degree of education.

DISCUSSION

The Nutrition and Health Survey in Taiwan 2005-2008 is the second nutritional survey of a representative sample of a wide range of age groups across the whole of Taiwan. This survey adopted a multi-staged, stratified, clustered sampling scheme and surveyed 6,189 subjects aged 0-6 years, and 19 years and above. Those of elementary school, junior high school or senior high school age were, however, not included, and will be surveyed separately using school-based sampling schemes. In the sampling design, we had one sample of 3854 subjects from five geographical strata. An additional three strata including the Hakka area, Penghu Island, and mountainous area were also created to separately estimate the nutritional and health status in each of the three strata in which the residents are supposed to have a special diet. It is adequate to achieve sample representation in the final estimate of this national survey based on the sample of five geographical strata in which the sampling frame already contained residents from Hakka, Penghu, and mountainous areas.

It was the first time in NAHSIT history that we used a CAPI system to collect survey data, and health exam software to manage physical assessment. This has made data collection more efficient and has reduced recording errors by data collectors. It was also the first time DEXA was adopted to collect more data on bone density of the whole body and body composition, which provided more information about the nutritional and health status of the Taiwanese population.

The response rate was highest in children compared to the three adult age groups for the household interview, followed by older people aged 65 years and older. Response rates were generally higher in women compared to men. The participation rate for the health examination was highest in older people aged 65 years and over, followed by those aged 45-64 years. Trends in participation rates by sex differed between age groups.

Comparison of the distribution of background characteristics between interview respondents and non-respondents showed that there was only a statistically significant difference in age distribution between respondents and non-respondents in the 0-6 year age group. In addition, a statistically significant difference in level of education between respondents and non-respondents was only found in those aged 65 years or over. Therefore, the study sample is in general likely to be representative, in terms of sex, age, education level and ethnicity. Moreover, apart from age in the 0-6 year age group and education level in the older age group, the characteristics of survey respondents are likely to be similar to those who were selected but did not respond to the questionnaire.

There were more significant differences in characteristics between participants and non-participants in the health exam compared to respondents and non-respondents to the questionnaire survey. Several statistically significant differences between participants and non-participants were observed in the 19-44 years age group. Although participation rates did not differ by ethnicity, participation rates were lower in men, those aged 19-24 years, and those with a junior high school or lower degree of education. In the 45-64 years age group, participation rates were lower in those with a junior high school or lower degree of education.

According to the survey design, only those who responded to the household questionnaire interview would be included in the health exam. Therefore, as shown in the present analysis, the representativeness of the health exam sample was altered by the response or lack of response to the household interview, resulting in greater distortion of baseline characteristics. Furthermore, the majority of those with low participation rates in the health exam are men who are expected to need to work or who work longer hours, young people, or those with a lower degree of education. In the present survey, the dates of the health exam were limited to a small number of specified days. Although it is designed to be carried out within the neighbourhood of the participants' homes, the shortness of stay of the health examination team could have prevented some people from participating.

In summary, the results of the analysis of the sample characteristics imply that inference can be made not only to the whole Taiwanese population in the five geographical strata, but also to three cultural strata using two sets of weights derived from the household interview and health exam. We expect that the data from this survey will help to further our understanding of nutritional and health status, the relationship between nutritional status and health, and factors associated with nutritional status and health among the Taiwanese population aged 0-6 years, and 19 years and above. A vast amount of information collected by the present survey will provide the basis for policy makers to promote the nutrition and health of adults and pre-school children in Taiwan.

AUTHOR DISCLOSURES

Su-Hao Tu, Cheng Chen, Yao-Te Hsieh, Hsing-Yi Chang, Chih-Jung Yeh , Yi-Chin Lin, Wen-Harn Pan, no conflicts of interest

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Original Article

Design and sample characteristics of the 2005-2008 Nutrition and Health Survey in Taiwan

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2005-2008 臺灣營養健康調查的調查設計與樣本特質分析

為了持續檢測臺灣人民之營養健康狀況，在行政院衛生署的補助下，於 2005-2008 年以家戶為單位，進行了國民營養健康狀況調查，針對 6 歲(含)以下嬰幼兒、以及 19 歲(含)以上成人各年齡層。本次調查的抽樣方式與 1993-1996 年的營養調查接近，皆是分層三段集束法，分別抽出四套樣本。其中一套包含五個地理分層，用來推估全臺灣這些年齡層民眾的營養健康狀況。其他三套樣本分別針對客家人、澎湖人與原住民，當作獨立推估這三類族群的營養健康狀況。總共回收了 6,189 份問卷以及 3,167 筆體檢資料。問卷資料包含家戶資料、社會人口基本資料、二十四小時飲食回憶、飲食頻率與習慣、營養知識態度與行為、體能活動量、家族疾病史與骨骼健康情形。體檢資料包括人體測量、血壓、體適能、骨質密度、抽血與驗尿。問卷回應率為 65%，在回答問卷的受訪者中，參與體檢的有 59%。經統計檢定問卷與體檢回應與非回應者間特徵的差異後發現，僅有少數年齡層樣本在問卷回應上具有性別、年齡、教育程度與省籍的明顯差異。而體檢參與與否有明顯差異者多發生在 19-64 歲樣本。本調查結果可提供相關領域學者、決策單位與大眾瞭解與改進臺灣之學齡前孩童與成人之營養健康狀況的參考。

關鍵字：臺灣營養健康調查 2005-2008、抽樣設計、回應率、加權、電腦輔助面訪調查(CAPI)