Original Article

Nutrition and Health Survey of Taiwan Elementary School Children 2001-2002: research design, methods and scope

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The "Nutrition and Health Survey of Taiwan's Elementary School Children (2001-2002)" was to investigate the nutritional status, influential dietary and non-dietary factors, health and development, and school performance, as well as the inter-relationships among these factors. The survey adopted a two-staged stratified, clustered probability sampling scheme. Towns and districts in Taiwan with particular ethnic and geographical characteristics were designated into 13 strata including Hakka areas, mountain areas, eastern Taiwan, the Penghu Islands, 3 northern regions, 3 central regions and 3 southern regions. Eight schools were selected from each stratum using the probabilities proportional to sizes method. Twenty-four pupils were randomly selected within each school. The survey included face-to-face interviews and health examinations. Taking seasonal effects into consideration, the face-to-face interviews were evenly allocated into each of the two semesters. A total of 2,419 face-to-face interviews and 2,475 health examinations were completed. Interview data included household information, socio-demographics, 24-hour dietary recall, food frequency, dietary and nutritional knowledge, attitudes and behaviors, physical activity, medical history, oral health, pubertal development, and bone health. Health exam data included anthropometry, blood pressure, physical fitness, bone density, dental health, and blood and urine collection. SUDAAN was used to adjust sampling design effect. There were no significant differences in sibling rank and parental characteristics between respondents and non-respondents, which indicates that our survey is representative and unbiased. The results of this survey will increase our understanding on the nutrition and health status of schoolchildren and can be used to shape public health policy in Taiwan.

Key Words: survey, schoolchildren, nutrition, diet, health

INTRODUCTION

In recent years there have been dramatic lifestyles changes in Taiwan. Although such problems as nutritional deficiencies and communicable diseases have become well controlled in the population at large, there still remain a proportion of individuals whose health and nutrition are in a state of deprivation, particularly among disadvantaged communities. In addition, new nutrition and health issues

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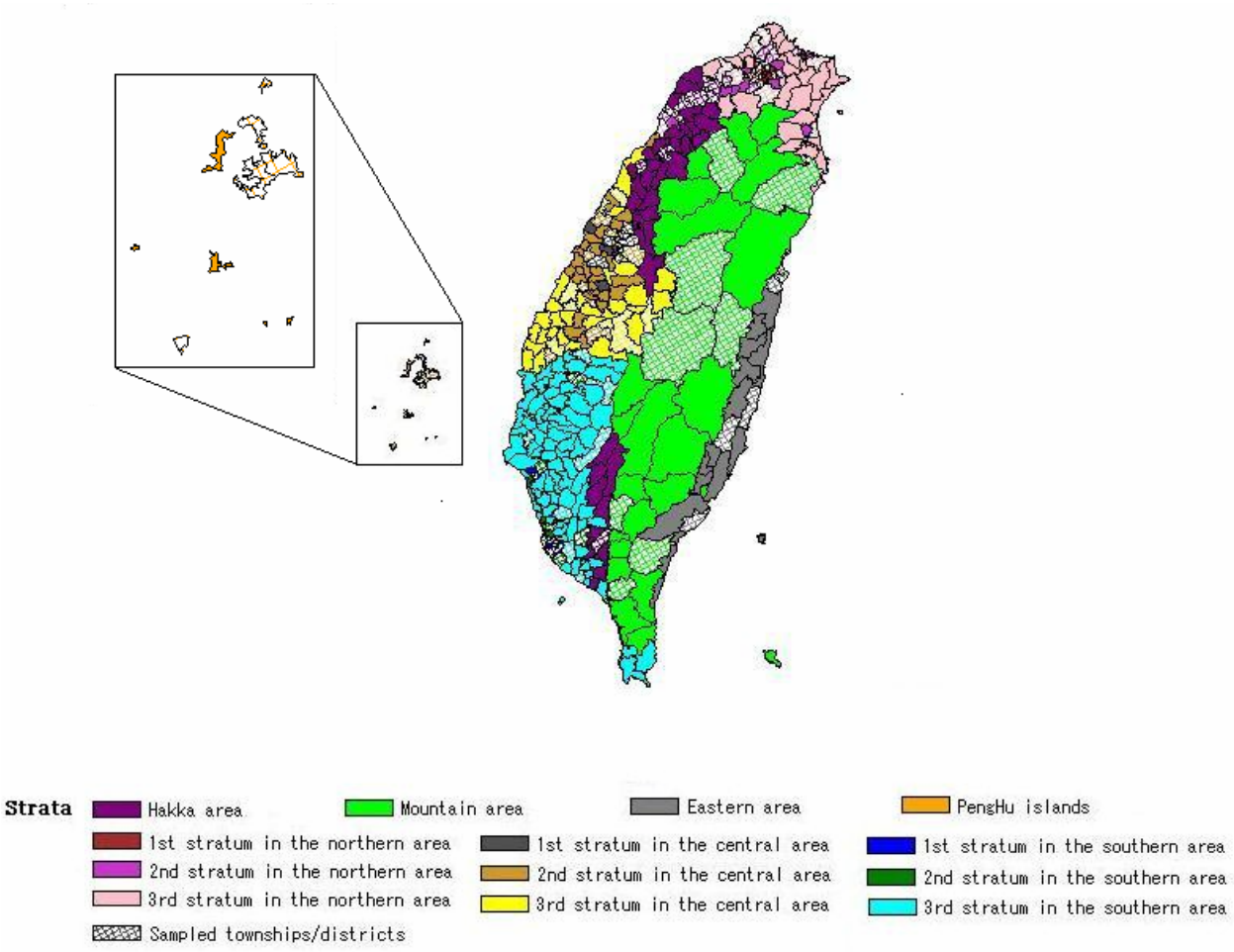

Figure 1. 13 Sampling Strata (identified by the same color) and Selected Townships or city districts (reticulate areas) in Taiwan

and their adverse effects are continually emerging. It is essential to monitor the nutritional and health status and the related knowledge, attitudes and behaviors of Taiwanese people, and to understand the relationship between diet and health and their associated factors. Public health policy and disease prevention strategies should be based on unbiased and accurate health information.

The Nutrition and Health Surveys in Taiwan (NAHSIT) 1993-1996[1] and the Elderly NAHSIT 1999-2000[2] funded by the Bureau of Food Hygiene, Department of Health (DOH), have already provided much background information for the public health community. The DOH again funded the Nutrition and Health Survey of Taiwan's Elementary School Children from 2001 to 2002. The main objectives of the survey were to investigate the children's dietary and nutritional status, to estimate the prevalence of nutritional deficiencies, over-nutrition, and related health conditions, and to investigate the relationships between associated dietary and non-dietary factors, health, development, and school performance in Taiwanese children.

MATERIALS AND METHODS

Sampling design

The survey used a stratified two-stage sampling scheme. The target population was Taiwan citizens aged between 6 and 13 years (born from September 1st, 1988 to August 31st, 1995) and formally enrolled in a public or private school that has been registered with the Ministry of Education from the year 2000. Those enrolled in cram schools, overseas schools and other special schools were not included.

Two-stage stratification. Among 359 districts and townships in Taiwan, those with specific ethnic and geographical characteristics were first designated into four strata: the Hakka areas (46 districts and townships after excluding the 10 Hakka districts and townships in Taitung County and Hualien defined by Yang);[3] the mountain areas (30 townships); the eastern stratum (21 districts/townships excluding townships in mountainous areas); and the Penghu Islands (6 townships). The remaining districts/townships were divided into northern, central and southern areas, which in turn were divided into three strata in each area based on population density (Fig 1). The cut-offs of population density determined by cluster analysis were as follows:[4]

1. Cut-offs for the three in the northern area (from Hsinchu northwards): More than 14,309 persons/km^2; 14,309 to 3,044 persons/km^2; and less than 3,044 persons/km^2.
2. Cut-offs for the three in the central areas: More than 2,600 persons/km^2; 2,600 to 875 persons/km^2; and less than 875 persons/km^2.

Table 1. Blood drawing and management flow

Tube number	Procedure
1	10 ml whole blood with no anticoagulant → centrifuged at 4°C 1 hr after drawing
	→ (away from light)
	→ serum 0.5ml→frozen→clinical chemistry
	→ serum 0.5ml→frozen→ceruloplasmin
	→ serum 0.5ml→frozen→ferritin, folate, vitamin B12, T4
	→serum 0.5ml (x4)→frozen→reserve
2	5ml whole blood in EDTA.K3 (4°C) → complete blood count
	→ centrifuge right away at 4°C → plasma → freeze → reserve
3	5ml whole blood in NaF → centrifuge right away → plasma → freeze
	→ blood glucose measurement
4	10ml whole blood in Heparin → centrifuge right away → (away from light)
	→ RBC→ RBC 0.5ml → freeze → folic acid
	→ RBC 0.5ml → freeze → vitamin B1
	→ RBC 0.5ml → freeze → vitamin B2
	→ RBC 0.5ml (x2) → freeze → reserve
	→ plasma → plasma 0.5ml → freeze → vitamin B6
	→ plasma 0.5ml →f reeze → plasma iron, UIBC/TIBC, phosphate, albumin
	→ plasma 0.5ml → freeze → vitamin A, E, β-carotene
	→ plasma 0.5ml (x4) → freeze → reserve
	→ buffy coat → freeze

3. Cut-offs for the three in the southern areas (from Chiayi southwards): More than 10,702 persons/km^2; 10,702 to 3,184 persons/km^2; and less than 3,184 persons/km^2.

Schools in each of 13 strata were ranked according to county location (north to south) and total number of enrolled students (large to small). "Year 2000 Taiwan School Student Statistics" published by the Statistics Division of the Ministry of Education was used to determine population size and school selection. Eight schools were selected from each stratum using the PPS (Probability Proportional to Sizes) sampling method, resulting in a total of 104 schools. Simple random sampling was used to select 24 students from each school which resulted in a total of 192 (24 x 8) students in each stratum.

Four students were selected from each grade. For those selected students who did not match the inclusion criteria or had moved to other schools, the next student in the student roster was included as the substitute.

Seasonal effect. Considering seasonal variation associated with dietary intake and nutritional status, eight schools in each stratum were randomly pooled into two groups. Each was assigned to one of the two semesters of the survey year: 1st semester of school year 2001 (September 2001 to January 2002) and 2nd semester of school year 2001 (February 2002 to June 2002). In each school, the interviews were carried out evenly during the first half of the semester (September 1st to November 15th in the first semester and February 1st to April 15th in the second semester) and the second half of the semester (November 16th to the end of the semester in January for the first semester, April 16th to the end of the semester in June for the second semester).

Survey operation and implementation

The survey included two components: the face-to-face interview and the health examination.

Face-to-face interviews. Questionnaires for the face-to-face interview included the following topics: number of family members, socio-demographics, 24-hour dietary recall (including household recipes, validity data for food models for individual subjects, and the individual dietary recall), food frequency, food preference, nutritional knowledge, attitudes and practices, smoking, betel nut chewing and tea drinking habits, level of physical activity, religious beliefs, pubertal development, bowel habits, past medical history, medication history, allergies, bone health, oral health, family medical history, and birth history. Children's parents and/or the main care-giver and main food provider were also interviewed about their socio-demographics, eating and child rearing practices (main food provider), food frequency, and nutritional knowledge and attitudes. The interviews were primarily carried out at home. However, interviewers were asked to observe the children's lunch and allowed to carry out KAP in the school. Teachers were asked to assess children's overall school performance using a modified version of the Scale for Assessing Emotional Disturbance developed by Epstein and Cullinan in 1998.[5-6] In addition, a school questionnaire covered the topics associated with school environment, including organizational structure (school size, school population density, and class size), resources for physical and health education (e.g., hours of physical and health education, athletic teams and hours of physical activity and clean-up time), school lunch service (e.g., no. of licensed cooks and nutritionists), and resources of medical and health services (no. of nurses or doctors, and health examinations).

Health examination. Apart from some newly added items, the health examination was carried out according to the protocol established for the Elderly Nutrition and Health Survey in Taiwan (1999-2000).[2] Items in the health examination included fasting blood sample drawing, overnight urine collection, anthropometry, blood pressure,

respiratory function, bone density, and physical fitness, dental health assessment, and medications taken in the previous 24 hours.

The examination was carried out in the morning in the school. Children were asked to fast for at least 8 hours. Fasting blood samples were then collected and managed as described in Table 1. Overnight urine was collected into a jar containing boric acid. The aliquoted blood-derived and urine samples were then clearly labeled, placed in the sample box, and stored immediately into liquid nitrogen. Processed samples were sent to Taipei in the tank within 2 to 3 days. The samples were then stored at -70^{o}C in freezers located in the Academia Sinica until sent to relevant laboratories for further analysis.

1. Nutritional and clinical chemistry

Complete blood counts were measured on site immediately after drawing, using a Beckman Coulter AcT 8 Analyzer (USA). Serum glucose, cholesterol, triglyceride, uric acid, SGOT, SGPT, HDL-cholesterol, CRP, and creatinine were measured within a month of biospecimen collection, using an automatic analyzer (Hitachi 747, Japan) in the clinical laboratory of the National Taiwan University Hospital. Serum magnesium was measured by colorimetric assay, using an Olympus System Reagent and an Olympus Autoanalyzer (Olympus AU640, County Clare, Ireland). Serum and RBC folate were measured by a combined system of competitive immunoassay and chemiluminesence (IMMULITE 2000 analyzer, Diagnostic Products Corporation, LA, CA). Vitamin B1 and B2 nutritional status was assessed by an erythrocyte enzyme activation test.[7] Plasma retinol,α-tocopherol, and vitamin B6 were analyzed in 2003, serum transferrin, ferritin, iron, folate and homocystein, and urinary minerals in 2004. Plasma retinol and α-tocopherol were assayed with an HPLC method as described by Cheng *et al*. and Miller *et al*..[8,9] Plasma pyridoxal 5'-phosphate (PLP) concentration was measured with an HPLC method.[10] Serum ferritin was measured with an enzyme immunoassay using heterogeneous sandwich magnetic separation (Bayer Immuno I, Bayer Co., USA) on Technicon Immuno 1® System. Serum iron and unsaturated iron binding capacity (UIBC) were measured by colorimetric assay (Olympus System Reagent) using an Olympus Autoanalyzer (Olympus AU640, County Clare, Ireland). Serum iron and UIBC were used to calculate total iron binding capacity (TIBC) and transferrin saturation. Urinary Na and K were measured with ion selective electrodes. Urinary Ca, Pi, Mg and creatinine were measured with colorimetric methods, and chromogens used were o-cresolphthalein for Ca, molybdate for Pi, xylidoyblue for Mg, and picric acid for creatinine. An Olympus AU640 autoanalyzer (Olympus AU640, County Clare, Ireland) was used for these urinary analyses. All the nutritional biochemistry measurements were carried out in 2003-2004 with both intra- and inter-assay precision controlled at CV < 10 % using commercial quality controls and blind duplicate samples. Serum vitamin B12, vitamin A, and β-carotene, as well as urinary concentrations of iodine and other biochemistry will be analyzed later on the reserved biospecimens.

2. Anthropometry

Height, weight, waist circumference, hip circumference, wrist circumference, arm circumference, and skin-fold thickness were measured. Height and weight were measured using continuous displayed electronic scales （model HW686, Taiwan）. Participants were asked to first remove their shoes, and the weight of their clothes was estimated by categorizing them into appropriate cloth types. Waist circumference was measured by two approaches: the first approach measured horizontally at the level of the natural waist, which was identified as the level at the hollow molding of the trunk when the trunk was concaved laterally; the second measured at the level of the belly button. Hip circumference was measured horizontally at the level of the greater trochanters. Arm circumference was measured midway between the acromion and the olecranon with the arm held naturally parallel to trunk. Triceps and subscapular skinfold thickness were measured twice in mm to one decimal place by Lange skinfold calipers(Cambridge Scientific Industries, INC.cambridge, Maryland, USA) , and the averaged data were used in the analysis. Triceps skinfold measurements were taken midway between the acromion and the olecranon on the marked mid-line of the posterior surface of the right upper arm. Subscapular skinfold thickness was measured at a marked point one centimeter below the tip of the right scapular, with the arm positioned parallel to trunk. Wrist circumference was measured at the distal wrist crease using a soft ruler with a sensitivity of 0.1 mm. All measurements were required to have a degree of accuracy down to the smallest designated unit of measurement. Records were made of any measurements conducted under special circumstances such as having to perform measurements on the left arm due to injury or trauma to the right arm, or having to measure height in persons with scoliosis.

3. Blood pressure

Blood pressure was measured after the subject had rested for at least 5 minutes, using the Omega 1400 Non-Invasive Blood Pressure Monitor (Invivo Reach Inc., Orlando, Florida, USA) with cuffs of appropriate sizes. The subject's arm was placed at the same height as the heart. Two measurements were recorded. If the first and second measurements differed by more than 10mmHg, a third measurement was performed. Mean values of the two or the two closest pressures were used for data analyses.

4. Osteoporosis assessment

The Velocity of Sound (VOS) and Broadband ultrasound attenuation (BUA) of the heel were measured using machines from McCue CUBA Clinical, McCue Ultrasonics, Hanson Medical Systems, Inc., Florida, USA.

5. Peak flow

Peak flow meter (Vitalograph peak flow meter, Ireland) was used to measure peak expiratory flow rate (PEFR). After teaching and practice, the subject stood and held the peak flow meter horizontally, then took a deep breath and closed the lips firmly around the mouthpiece, then blew as hard as possible. Three measurements were recorded and the highest reading was used for analysis.

6. Muscle Strength and Trunk Flexibility[11]
Muscle strength of knee extensors and elbow flexors, and trunk flexibility were measured. For knee extensors of the right knee and left knee, the subject sat with knees over the side of a testing table or a chair. The examiner positioned a hand-held dynamometer (Power Track II, JTech Medical Industries, Utah, USA) at 5 cm proximal to the lateral malleoli (anterior surface of lower leg). The subject made a maximal effort to extend the tested knee joint at the position of knee flexion 90 degrees. The examiner held the hand-held dynamometer steady to resist the force (Ref: Damiano D.L., Abel M.). For elbow flexors of the right elbow and left elbow, the subject sat on a testing table or a chair. The examiner positioned a hand-held dynamometer (Power Track II, JTech Medical Industries, Utah, USA) just proximal to the wrist cease of the fully-supinated forearm (flexor surface). The subject made a maximal effort to flex the tested elbow joint at the position of elbow flexion 90 degrees. The examiner held the hand-held dynamometer steady to resist the force. The flexibility of the trunk and hamstring was measured by a sit-and-reach test using a trunk flexibility tester (Acuflex I, Novel Products Inc., Illinois, USA). Three trials were made for each measurement, and if the CV of the first three readings was greater than 10%, a fourth trial was performed. The mean value of the closest three readings was reported for each measurement.

Administrative structure. The Bureau of Food Hygiene, Department of Health was the highest administrative organization responsible for the survey. Face-to-face interviews were conducted by interviewers hired by the Office of Survey Research of the Academia Sinica (OSR, forerunner of the Center for Survey Research, the Research Center for Humanities and Social Sciences). Nutritionists from local public health bureaus were responsible for supervising the interviewers, checking questionnaires and entering data. A team of professional staff who were also employed by OSR traveled to each of the locations to carry out the health examinations. The nutritionists and interviewers all participated in and passed an intensive training program.

Survey implementation. Information was provided to the interviewers about the selected schools including names and addresses. Interviewers randomly selected students from school ID rosters according to the protocol provided by OSR. A list of names of eligible students was then compiled. The interviewers collected the interview data, while the examination team consisting of six professional research assistants conducted the health examinations.

The Office of Survey Research was responsible for training and supervising the interviewers, assisting the nutritionists of the local public health bureaus in their supervisory role, data entry, and local coordination of the project. The nutritionists from the local public health bureaus assisted interviewers at the local schools, communicated with the staff in OSR regularly to discuss problems or concerns, and reported to OSR on the progress of the field work.

Data quality control. In addition to the quality assurance procedures described above in the training and data collection phase, the interview data collected in each district or township were put onto a disc and sent at regular intervals to OSR for missing data and logic checks and for corrections. Minimizing the number of measurers, cross-validating measurement skill, double data entry, and computerized logic checking were used to maintain the quality of health exam data. In addition, quality control of biological specimens was achieved by recording the process details on designed forms and repeating laboratory measurements on 4% split samples Furthermore, interviewer's performance was routinely measured in terms of survey response rate and questionnaire response quality. All staff members were required to undergo re-training in interviewing and testing methods every six months.

The study was approved by reviewers from the Department of Health in Taiwan. An informed consent form indicating the contents of the survey and confidentiality of the interview and health exam data was signed by one of the parents of all school children.

Data analysis

As our survey used stratified two-stage sampling rather than simple random sampling, weighting was required in order to adjust the design effect and to make the results nationally representative. The post-stratification method was used to generate weights. In each of the 13 strata, the samples were divided into two sex groups and six age groups: 6, 7, 8, 9, 10 and 11-13. This resulted in 156 subgroups (13 x 6 x 2). The number of students in each particular sex, age, and stratum subgroup was then expanded to equal the target population based on the 2001 School Year Elementary School Student Numbers from the Statistics Division of the Ministry of Education.[12] In other words, the weight for each of the 156 groups was estimated as the total population size of the subgroup divided by the sample size of the subgroup. There were four sets of weights in the study; weights for questionnaire data, for examination data, for questionnaire and examination data combined, and for teacher's data, respectively.

The results of this paper are mainly concerned with describing the sample size, response rate, and the distribution of age, parental education level, and parental ethnicity by sex and/or stratum. The response rate was calculated as follows: interview response rate = number of students interviewed ÷ number meeting the inclusion criteria. Examination response rate = number of students attending health check-up ÷ number meeting the inclusion criteria. For non-respondents, concerted attempts were made to ask children's parents about his or her sibling rank and parental education level, ethnicity and occupation. We then used SUDAAN and weight adjustment to compare the family background of respondents with that of non-respondents.

RESULTS

1. Valid case number and response rate. The final list of eligible students for our study sample included 3,285 students, taking into consideration attrition. After exclusion of students with no student ID, students on vacation and

Table 2. Number of children completing the interview and examination by sex and stratum

Stratum	Number interviewed			Number examined			Number both interviewed and examined		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
Hakka	101	88	189	104	88	192	101	88	189
Mountainous	87	101	188	88	100	188	87	99	186
Eastern	93	98	191	93	98	191	92	98	190
Penghu	105	84	189	107	84	191	105	84	189
Northern 1	87	81	168	99	93	192	87	81	168
Northern 2	99	79	178	107	84	191	99	79	178
Northern 3	107	82	189	107	82	189	106	81	187
Central 1	102	89	191	102	89	191	101	89	190
Central 2	111	89	200	120	92	212	111	88	199
Central 3	96	69	165	100	67	167	96	67	163
Southern 1	99	90	189	100	90	190	99	89	188
Southern 2	101	89	190	101	89	190	100	89	189
Southern 3	108	84	192	107	84	191	107	84	191
Total	1296	1123	2419	1335	1140	2475	1291	1116	2407

Table 3. Household interview and examination response rate by sex and stratum

Stratum	Household interview response rate (%)			Examination response rate (%)			Combined interview and examination response rate (%)		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
Hakka	73.2	75.9	73.0	75.4	75.9	74.1	73.2	75.9	72.9
Mountainous	96.7	98.1	97.4	97.8	97.1	97.4	96.7	96.1	96.4
Eastern	80.9	85.2	82.3	80.9	85.2	82.3	80.0	85.2	81.9
Penghu	94.6	92.3	93.6	96.4	92.3	94.6	94.6	92.3	93.6
Northern 1	71.9	69.2	70.0	81.8	79.5	80.0	71.9	69.2	70.0
Northern 2	71.7	72.5	70.9	77.5	77.1	76.1	71.7	72.5	70.9
Northern 3	91.5	93.2	88.7	91.5	93.2	88.7	90.6	92.1	87.8
Central 1	81.0	78.1	79.6	81.0	78.1	79.6	80.2	78.1	79.2
Central 2	78.7	84.8	81.3	85.1	87.6	86.2	78.7	83.8	80.9
Central 3	69.6	59.5	65.0	72.5	57.8	65.8	69.6	57.8	64.2
Southern 1	71.2	74.4	72.1	71.9	74.4	72.5	71.2	73.6	71.8
Southern 2	82.1	76.1	77.2	82.1	76.1	77.2	81.3	76.1	76.8
Southern 3	85.7	80.0	83.1	84.9	80.0	82.7	84.9	80.0	82.7
Total	79.9	79.3	78.8	82.3	80.5	80.7	79.5	78.8	78.4

Note: Household interview response rate = Number of students responding to the household interview /Number of eligible students on the name list; Health examination response rate = Number of students participating in the health exam /Number of students informed about the health examination.

any other students who did not meet the inclusion criteria, 3,069 students remained. After further excluding students who refused to be interviewed and those eliminated for other reasons, a total of 2,419 students completed the household questionnaire interviews (1,296 boys and 1,123 girls). This was very close to the projected sample size of 2,496. 2,475 students (1,335 boys and 1,142 girls) participated in the health examination, while 2,407 students completed both the household interviews and the health examination (1,291 boys and 1,116 girls) (Table 2). The overall response rate for the face-to-face interview was 78.8% and that for the health examination was 80.7%. The response rate for completing both the face-to-face interview and health examination was 78.4% (Table 3).

2. Descriptive statistics on age of the children, parental ethnicity and parental education level. The participation rates in the face-to-face interview and/or health examination were similar across six age groups of school boys and girls (Table 4). In general, those aged 11-13 had the highest percentage of participation, while boys and girls aged six had the lowest participation rate. The participation rates for the rest of the children from seven to ten years old were about 16% to 18%. Girls aged 10-13 tended to have a higher participation rate than boys in the same age groups. Among those aged seven to nine, there were more boys than girls participating in the face-to-face interview and/or health examination.

Due to a slight difference in age distribution in the face-to-face interviews and health examinations for both boys and girls, parental ethnicity and parental education level associated with response rate were examined for those who participated in both the face-to-face interview and health examination. For both boys and girls, more than 70% of parents were Fukienese, followed by Hakka (Table 5). Less than ten percent of parents were Mainlanders. Around 37 percent of fathers had 12 years of formal education, while more than 45 percent of mothers (48.8% for boys and 46.4% for girls) had nine years of formal education (Table 6).

3. Comparison between respondents and non-respondents. Respondents and non-respondents were compared on the basis of the child's sibling rank, number of children in the family, and parental age, education level and occupation. Except for father's age, there were no significant

Table 4. Age distribution of children completing the interview, examination, both the interview and examination by sex (%)

	Age	Interview		Examination		Both	
		N	%	N	%	N	%
Boys	6	115	8.9	112	8.4	114	8.8
	7	221	17.1	244	18.3	221	17.1
	8	210	16.2	227	17.0	209	16.2
	9	216	16.7	213	16.0	216	16.7
	10	222	17.1	223	16.7	221	17.1
	11-13	312	24.1	316	23.7	310	24.0
Girls	6	98	8.7	100	8.8	98	8.8
	7	187	16.7	182	16.0	185	16.6
	8	179	15.9	190	16.7	178	15.9
	9	181	16.1	190	16.7	181	16.2
	10	194	17.3	196	17.2	192	17.2
	11-13	284	25.3	282	24.7	282	25.3

Table 5. Distribution of paternal, maternal ethnicity, for children completing both the interview and examination by sex (%)

	Ethnicity	Paternal		Maternal	
		N	%	N	%
Boys	Fukienese	919	72.5	910	71.4
	Hakka	152	12.0	136	10.7
	Mainlander	94	7.4	108	8.5
	Indigenous and other	102	8.1	121	9.5
Girls	Fukienese	752	69.2	753	68.4
	Hakka	125	11.5	131	11.9
	Mainlander	99	9.1	94	8.5
	Indigenous and other	110	10.1	123	11.2

Note: self-reported with ethnicity of Fukienese, Hakka, mainlander, indigenous residents, or others. Such classification is different from that in sampling strata simply because of different purposes. Self-reported ethnicity considered more accurate to estimate ethnicity in the population.

Table 6. Distribution of paternal and maternal education level for children completing both the interview and examination by sex (%)

	education level (years of formal education)	Paternal	Maternal
		%	%
Boys	Primary school and below (=< 6 years)	9.6	10.3
	Junior high school (9 years)	26.0	24.1
	Senior high school (12 years)	37.3	48.8
	Sergeant school, College, Military specialist classes (14 years)	15.2	9.1
	University or Technical institute, Military officer academy (16 years)	10.0	7.1
	Graduate school and above (>=18 years)	2.0	0.6
Girls	Primary school and below (=< 6 years)	9.3	11.1
	Junior high school (9 years)	25.1	24.5
	Senior high school (12 years)	37.7	46.4
	Sergeant school, College, Military specialist classes (14 years)	15.4	10.6
	University or Technical institute, Military officer academy (16 years)	10.2	6.9
	Graduate school and above (>=18 years)	2.3	0.6

differences between respondents and non-respondents in other variables including sibling rank, number of children per family, mother's age, parental education level, and parental occupation for both the face-to-face interview and the health examination ($p > 0.05$) (Tables 7,8,9). There was a slightly higher percentage of fathers in the younger (<29.9 years old) and in the older age (>45 years old) categories for non-respondents as compared to the respondents.

DISCUSSION

Ideally a nutrition survey should provide information about the status of important nutrition and health problems, demonstrate the relationship between nutrition and disease, and define influential factors on current nutritional status and related diseases. Nutrition surveys should improve our understanding of the relationship of societal and environmental factors to nutritional status, and provide guides to design nutritional policy for nutritional education and disease prevention.

Table 7. Distribution of sibling rank and number of children per family for respondents and non-respondents

		Household interview						Health examination					
		Respondents		Non-respondents		χ^2	*p*-Value	Respondents		Non-respondents		χ^2	*p*-Value
		N	%	N	%			N	%	N	%		
Sibling rank	No. 1	528	41.5	116	42.3	2.4	0.499	528	41.5	116	42.7	3.7	0.304
	No. 2	491	39.0	88	36.4			495	39.1	84	35.8		
	No. 3	212	15.6	48	14.5			214	15.6	46	14.6		
	No. 4 or more	68	3.9	17	6.7			68	3.8	17	7.0		
Number of children	1	93	7.6	24	8.2	2.1	0.562	92	7.5	25	8.7	2.5	0.478
	2	565	45.4	108	42.0			571	45.7	102	40.0		
	3	455	36.4	97	33.3			456	36.2	96	34.2		
	4	184	10.6	39	16.5			184	10.6	39	17.2		

Table 8. Parental age, education level and occupation for respondents and non-respondents of the household interview

		Fathers						Mothers					
		Respondents		Non-respondents		χ^2	*p*-Value	Respondents		Non-respondents		χ^2	*p*-Value
		N	%	N	%			N	%	N	%		
Age	29.9 yrs and below	64	5.6	32	9.1	9.7	0.063	101	6.2	38	11.0	6.9	0.160
	30-34.9 yrs	109	7.4	23	10.4			277	18.1	52	19.5		
	35-39.9 yrs	408	29.4	77	26.5			524	42.8	106	36.0		
	40-44.9 yrs	498	40.4	93	32.0			321	26.1	60	24.2		
	45 yrs and above	229	17.2	60	22.1			85	6.8	29	9.3		
Educational level	Primary school and below	124	6	26	10.3	2.1	0.564	146	7.3	31	12.9	3.6	0.354
	Junior high	326	23.2	65	25.3			312	20.9	59	22.9		
	Senior high	466	40.7	97	38.9			575	52.3	123	49.1		
	College and above	337	30.1	67	25.5			223	19.6	37	15.1		
Occupation	Agriculture, forestry, fishing, animal husbandry / mining	168	6.9	27	8.5	3.4	0.508	49	2	7	2.1	1.3	0.855
	Water and electricity / construction / manufacturing	297	26.9	65	26.4			107	11.3	22	9.1		
	Commerce / Transport and communications / Finance / Business	424	39.4	80	33.4			268	24.3	55	22.9		
	Service industries	264	20.1	53	22.2			220	16.8	47	18.9		
	Other	82	6.7	27	9.6			595	45.6	118	47.1		

The children surveys of greatest scope in the literature are the US NHANES surveys (the third National Health and Nutrition Examination Survey[13] and the Hispanic Health and Nutrition Examination Survey),[14] the UK National Diet and Nutrition Survey,[15] and the Nutrition Survey of Finnish Rural Children.[16] Other nutritional surveys such as Chile's Metropolitan Region Survey 1986-1987[17] and the Haitian National Nutrition Survey[18] have also published several reports. Many of these surveys, apart from assessments of nutritional status, have investigated the relationships between diet and nutrition and health. Examples include research into the relationship between various obesity indices, body fat distribution and blood lipids,[19] the relationship between sugary foods, toothbrushing, socioeconomic status and dental caries,[20] the relationship between diet and blood cholesterol,[16] and the relationship between blood lead, anthropometric indices and calcium nutrition.[21-22] Research has also been conducted into the relationship between nutrition and learning,[17] and the mutual relationships between diet and nutritional status, health behaviors and socioeconomic status. Further examples include research into the influence of paternal occupation on children's health knowledge and nutritional behaviors[23] and the influence of watching television on body weight and physical fitness.[24] Overall there is not a great volume of research about the relationships among aspects of children's physical and psychological health and nutrition, and a comprehensive understanding of this area is greatly needed. Moreover, data from Asia are particularly sparse. As a result, our survey of Taiwanese children is of timely importance.

Experts from a variety of different fields were brought together for the design of our survey and a team approach was used in the development of the survey direction and detailed content. As a result, the survey contents are quite comprehensive. With regards to the assessment of diet

Table 9. Parental age, education level and occupation for respondents and non-respondents of the health examination

		Fathers						Mothers					
		Respondents		Non-respondents				Respondents		Non-respondents			
		N	%	N	%	χ^2	*p*-Value	N	%	N	%	χ^2	*p*-Value
Age	29.9 yrs or below	65	5.6	31	9.2	10.4	0.049	101	6.2	38	11.4	7.3	0.144
	30-34.9 yrs	110	7.4	22	10.6			278	18.2	51	19.2		
	35-39.9 yrs	409	29.5	76	26.1			526	42.8	104	35.8		
	40-44.9 yrs	500	40.5	91	31.5			323	26.1	58	24.2		
	45 yrs or above	230	17.1	59	22.7			86	6.8	28	9.4		
Educational level	Primary school or below	124	6.1	26	9.9	2.1	0.550	145	7.2	32	13.6	4.8	0.205
	Junior high	329	23.3	62	24.9			314	20.8	57	23.6		
	Senior high	465	40.5	98	40.3			578	52.3	120	48.7		
	College or above	341	30.2	63	24.9			225	19.7	35	14.2		
Occupation	Agriculture, forestry, fishing, animal husbandry / mining	169	6.9	26	8.6	5	0.304	49	2	7	2.1	0.6	0.962
	Water and electricity / construction / manufacturing	297	26.8	65	26.9			107	11.2	22	9.6		
	Commerce / Transport and communications / Finance / Business	427	39.4	77	33.1			269	24.2	54	23.4		
	Service industries	267	20.4	50	20.8			223	17.1	44	17.5		
	Other	80	6.5	29	10.6			597	45.5	116	47.4		

and nutrition, we have included both the 24-hour dietary recall component, which can be used to accurately estimate mean nutrient intakes, and the food frequency method, which was designed to estimate long-term dietary intakes. A number of blood tests and urine sample analyses of nutritional biochemical indices (including vitamins and minerals) were also undertaken. In regards to factors influencing nutritional status, we not only included child and parental (or the main care provider) socio-demographic information, but also included assessments of child and parental (or main care provider) nutritional knowledge, attitudes and behaviors. In the health and well-being aspects, in addition to including assessments of anthropometric parameters for appraising body fatness and growth, and risk factors for cardiovascular diseases and metabolic syndrome, we also included a pubertal development scale, dental health, respiratory function, bone density, physical fitness, school performance, and other health indices. Aggregate variables about school environments were also included. In the future, this data can be used to analyze the relationship between nutrition, health, and larger environment, using multilevel analysis. Such information can advance our understanding of multiple determinants of physical and psychological health.

The response rate for the face-to-face interview was 78.8% and that for the health examination was 80.7%. This is higher than that of the Elderly Nutrition and Health Survey in Taiwan (response rates of 55% for the face-to-face interview) and that of the 1993-1996 First Nutrition and Health Survey in Taiwan (response rate of 74%). The main reason for the higher response rate is that the survey sampling structure was based on the Ministry of Education's school system as opposed to census data. As the survey participants were children, the most important factor for responding or not responding was the parents' attitudes. Therefore, comparison of respondents and non-respondents focused on the socio-demographic characteristics of parents and took into consideration the child's sibling rank. We found that there was no significant difference in the parental characteristics and sibling rank between respondents and non-respondents. The sole significant difference was observed in the age of fathers between respondents and non-respondents for the health examination. Fortunately, analysis was carried out using SUDAAN and weighting for adjusting sampling effects. That is, children in the survey sample were divided into subgroups based on sex, age, and stratum structure and then the size of these groups was weighted to the national population. Following this adjustment, the difference in father's age distribution between respondents and non-respondents was quite small (data not shown), indicating that the survey results are likely to be nationally representative and unbiased.

One of the limitations of our survey is that during summer and winter breaks children were not interviewed. Foods consumed during breaks were, therefore, less represented and we are not able to compare eating patterns and behaviors between school periods and break periods.

Data from our survey can provide information on Taiwanese children's nutritional status, the relationships between children's nutrition and health, and factors influencing childhood nutrition. This information is important for the development of public health nutrition policy

leading to improvement in the nutrition and health status of elementary school students in Taiwan.

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AUTHOR DISCLOSURES

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Original Article

Nutrition and Health Survey of Taiwan Elementary School Children 2001-2002: research design, methods and scope

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臺灣地區國小學童營養健康狀況調查(2001-2002)：研究設計、方法及內容

臺灣地區國小學童營養健康狀況調查(2001-2002)目的在探討國小學童飲食與營養狀況，影響營養狀況之飲食及非飲食因素，學童健康及發展狀況與在校表現，及這些因素相互關係。採分層兩段集束取樣法，將臺灣地區各鄉鎮市區按特殊族群與地理位置分成 13 層：客家、山地、東部、澎湖，北部、中部及南部地區各 3 層。每一層以等比例抽樣原則(Probabilities proportional to sizes: PPS)抽取 8 所學校，抽中學校再簡單隨機抽出 24 位學生。本調查包含面訪與身體健康檢查兩部分。考慮季節效應後，面訪在一學年兩個學期中的每一學期分成上半與下半學期進行，最後共完成面訪 2,419 人。身體檢查部份完成 2,475 人。面訪資料包括：家戶及社會人口背景資料、24 小時飲食回憶、飲食頻率、營養知識、態度與行為、體能活動量、疾病與藥物史、口腔保健、青春期發展量表與骨質健康。體檢項目包括：人體測量、血壓、體溫、體適能、骨質密度、牙齒健康、抽空腹血與收尿。以 SUDAAN 調整抽樣設計效應，發現調查回應者與不回應者間在家中排行及父母親人口特徵上無明顯差異，顯示本調查之代表性應無偏差。此調查結果有助於瞭解臺灣地區國小學童的營養與健康狀況，以及制訂公共衛生營養政策。

關鍵字：調查、學童、營養、飲食、健康。