Original Article

Nutrition knowledge, attitude, and behavior of Taiwanese elementary school children

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The purpose of this study is to understand nutrition knowledge, attitude, and behavior in Taiwanese elementary school children, and the relationship of these various components. The results indicated that children's knowledge was fair in nutrition basics, but poor in 'the physiological function of nutrients', 'relationships between diet/nutrients and disease', and 'the daily serving requirement for different food groups'. Children in general valued the importance of nutrition, but they did not concern the health benefit of foods in food selections. Their dietary quality was not satisfactory, and the diet of most children did not meet the recommended serving requirements for milk, vegetable, fruit, and cereals and grains groups. Positive relationships were found among nutrition knowledge, attitude, caring- about-nutrition behavior and dietary quality score. The restraint or disinhibited eating behavior of 4th to 6th graders was not serious, but a large number of children already performed some self-controlling practices to avoid obesity, but not frequently. One fourth of the students skipped meals, especially breakfast, and one quarter of 4th to 6th graders prepared their own breakfast; which may have some impact on children's diet quality. A gap was found between nutrition knowledge, attitude and eating behavior, especially vegetable and fruit consumption, indicating that the attitude toward eating for health was not strong in this age group. Future nutrition education for school children should not only include food serving requirements of food groups, but also apply appropriate theories to improve the motivation for healthy eating.

Key Words: elementary school children, nutrition knowledge, nutrition attitude, nutrition behaviour, dietary quality

INTRODUCTION

The prevalence of childhood obesity has increased dramatically in Taiwan and other countries,[1-4] which has led to a great concern about food consumption patterns and dietary quality of schoolchildren. Many studies have indicated that relatively few children met the recommendations for vegetable, fruit[5-10] and dairy foods.[6,11,12] However, the intakes of unhealthy snacks, fast foods, and beverages have increased.[7,11-13] Studies have also shown that, as children get older, they tend to eat breakfast alone and less frequently.[5,11,14] Dietary practices during childhood not only play an important role in growth and development, they may also predict the occurrence of obesity, diabetes, and cardiovascular diseases in adulthood.[15,16] The development of eating behaviors is influenced by many factors. In the Knowledge-Attitude-Behavior (KAB) model, knowledge is considered as a prerequisite to the intentional performance of health-related behaviors. As knowledge in health behavior domains accumulates, changes in attitude are initiated. When changes in attitude accumulate over a period of time, it results in behavioral changes.[17,18] In order to identify important messages for school nutrition education, the purpose of the present investigation is to understand the status of nutrition knowledge, attitude, and behavior of Taiwanese elementary school children, and the relationship of these various components among one another.

MATERIALS AND METHODS

Data collection

This study used data obtained from the Department of Health sponsored Nutrition and Health Survey in Taiwan Elementary School Children (NAHSIT Children) conducted between 2001 and 2002. A multi-staged, stratified, probability sampling method was used in this study.[19] The target population was stratified into 13 strata in the original design, which comprised of 4 strata ('Hakka areas', 'Mountain areas', 'Eastern areas', 'Penghu islands') of particular geographic locations and ethnic groups, and 9 strata of the remaining areas of Taiwan.[19] For ease of comparison in this paper, the 9 strata within the 'Northern', 'Central' and 'Southern' parts of Taiwan were regrouped into 2 areas, 'Urban' and 'Rural' areas, based on population density, an indicator of urbanization.

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The cut-off points used for urban areas were: (1) Northern: greater than 3,044 persons/km^2, (2) Central: greater than 2,600 persons/km^2, (3) Southern: greater than 3,184 persons/km^2. Together with the 4 strata of particular geographic locations, there were 6 strata analyzed in this study.

The trained interviewers collected all data one-on-one, the questionnaires were completed in school but food frequency questionnaire and 24-hr recall were administered at home with both parent and child involved. A total of 2417 elementary school children completed questionnaires with a response rate of 96.8 %, which include 1199 1st to 3rd graders (654 boys and 545 girls), and 1218 4th to 6th graders (642 boys and 576 girls). Informed consent has been signed by one of the parents of all school children. The study was approved by reviewers from the Department of Health in Taiwan.

Measures

Information collected by the questionnaire included nutrition knowledge, attitude, nutrition-related eating behavior, restraint eating behavior and general eating habits. Most of the scales were developed by the authors, except that scales in restraint eating behavior were modified from the Children's Eating Attitude Test (Ch-EAT 26).[20] A handbook with written questions and response items was used by interviewers to assist school children to understand questions. Each question contains Mandarin phonetic symbols and appropriate food pictures to help low literate children and to make the interview more interesting. All scales had been reviewed by experts in order to establish content validity and then piloted with elementary school children. Examples of questions about nutrition knowledge, attitude, caring-about-nutrition behavior, and restraint eating behavior scales are shown in Appendix.

The nutrition knowledge scale included five subjects: (1) 5 items related to the major nutrients contained in food groups, for 4th to 6th graders only, (2) 5 items related to the physiological function of food groups, (3) 5 items on the relationship between diet/nutrient and disease, (4) 13 items comparing foods in terms of specific nutrient content (e.g. fat, fiber, calcium, calorie, sodium), and (5) 26 items related to the balanced diet. The last subject included 6 questions on the principles of balanced diet, 8 on the need for six food groups, 6 on the food selection skills to achieve the balance, and 6 on the daily serving requirements of different food groups (for 4th to 6th graders only). Considering reading comprehension of the children, the nutrition knowledge questions for 1st to 3rd graders and 4th to 6th graders may have the same gist but the statements were different. The formats of the scale were either true-false or multiple choices. One point was given to correct answers, zero otherwise. The total possible points of the 1st to 3rd and 4th to 6th graders were 43 and 54, respectively. Inter-item reliabilities (Cronbach's alpha coefficient) of the total scale in 1st to 3rd graders and 4th to 6th graders were 0.72 and 0.76, respectively. The test-retest reliabilities (N=45, 47) were 0.62 and 0.86, respectively.

The nutrition attitudes scale had 18 items with 3-point Likert-type format, the response items include 'agree', 'neutral', 'disagree', and one extra item of 'I don't know'. Happy, neutral, and sad faces were used in conjunction with the words. Upon analyzing the data, the response item 'I don't know' was treated as 'neutral'. For 1st to 3rd graders, the Cronbach's alpha coefficient of the scale was 0.68, the test-retest coefficient (N=45) was 0.65. For 4th to 6th graders, the Cronbach's alpha coefficient of the scale was 0.65, and the test-retest coefficient (N=47) was 0.60.

The nutrition related eating behavior scale had 16 items with the 3-point Likert-type format. The response items included 'often', 'sometimes', 'seldom', and 'I don't know'. The response item 'I don't know' was merged with 'sometimes'. Principal axis factor analysis with varimax rotation was used to determine the number of factors. Items that loaded over 0.30 were considered part of a particular factor. The scale could be broken down into two factors, caring-about-nutrition and external/emotional-cued eating, these two factors accounted for 19.8% of total variance. Only behavior related to caring-about-nutrition was reported in this paper. The Cronbach's alpha reliabilities coefficient of the caring-about-nutrition behavior scale were 0.62 and 0.65 for 1st to 3rd grade children and 4th to 6th grade children, respectively. Restraint eating scale was adapted from ChEAT-26; due to the limitation on the length of the questionnaire, only 10 items were chosen from similar items and it was administered only to 4th to 6th graders. The scale had a 3-point Likert-type format with 'often', 'sometimes', 'seldom', and 'I don't know' as the response items. The Cronbach's alpha coefficient and the test-retest reliabilities (N=47) were 0.83 and 0.80, respectively. Other nutrition related behaviors studied were frequency of meals and source of meals.

A Food Frequency Questionnaire (FFQ) was used to measure children's food intakes. The interview of FFQ was carried out at home with parent assisting child to respond to the questions especially for young child. A total of 33 food items from all major food groups but not fat/oil group (i.e. milk, vegetable, fruit, and meat groups) and unhealthy (high fat and/or high sugar) snacks and beverages were included in the questionnaire. Information on both frequencies (days/week) and amounts (servings/day eaten) were sought for food items from 4 food groups, but only frequency (days/week) was sought for snacks and beverages. The intake of cereals and grains was measured with open-ended questions due to the complexity and variability of the cereals and grains group eaten by Taiwanese people. The frequencies and amounts of all foods in a given food group were summed up to estimate servings per day of that specific food group.

Based on the concept of dietary score,[21] the authors developed a scoring system named as Dietary Quality Score (DQS) which adopted recommendation servings specified for each of the six food groups in the Taiwanese Food Guide Recommendation (TFGR) (Table 1) as the standards of scoring, except for the milk group, where 2-3 servings/day instead of the original 2 servings/day was used as the recommendation to match the standard of other countries. A maximum of 10 points was given to each food group, if the average servings eaten per day met the standards. For the vegetable and fruit groups, 10 points was to given to both the intakes meeting and

exceeding TFGR, but for the milk, meat group and cereals and grains group, 10 points was not given to those who exceed (within the range of 0.5 servings) the TFGR due to possible risk of high fat or high calorie intake caused by the high intakes. Fewer points were given to those who failed to meet the standards. Therefore, 0 point was given to those eating fewer than 0.5 serving/day as well as those with intakes exceeding twice the amount of recommended servings per day. Beside the basic food groups, the intake of unhealthy snacks and beverages was also included in the Dietary Quality Score. The frequencies of eating all types of high fat or high sugar snacks and beverages listed in the FFQ were summed together as one food group which also accounted for 10 points. But the score was reversely related with the frequency eaten; 0 to 10 points were given proportionally to those who eat 7 day/week to 0 day/week. Details of the scoring system are provided in Table 1. To test the validity, the correlation coefficients of the DQS with various nutrients intake (adjusted for calorie intake) from 24-hr recall data of the same survey were computed and listed in Table 2; the positive correlation coefficients with most nutrients indicate that the scoring system has a satisfactory validity. The low coefficients between DQS and iron, vitamin B_1 and vitamin E intakes were partly due to the limitation of the original design of the FFQ, which did not separate high-iron and high-vitamin B_1 containing meats (i.e. beef, liver) from others (i.e. fish, poultry) and high-vitamin B_1 containing whole grains from refined grains, and did not inquire about vitamin E-rich cooking oils.

Other nutrition related behaviors measured were meal pattern and meal source. The frequency of eating 3 meals and 3 snacks were evaluated with the 5-point Likert-type format. The response items ranged from 'everyday', 'often', 'sometimes' 'seldom' and 'never'. Seven sources of meals were listed including self, family, school cafeteria/ store, contract food service center, and after-school child-care center, not applicable and others (such as classmate, babysitter, outside store) were also provided as response items.

Statistical analysis

Data were analyzed using the SAS (version 8.2) for Windows. Data were weighted to represent the Taiwanese population using the models developed by the SUDAAN Software Company, but not including data for performing Pearson product-moment correlation. One-way analysis of variance was used to compare the differences in nutrition knowledge, attitude, and behavior among schoolchildren of different grades, genders, and residing strata. The Pearson product-moment correlation coefficient was used to study the relationships between nutrition knowledge, attitude, and behavior. The significant level used was $p<0.05$.

RESULTS

As indicated above, the presentation of nutrition knowledge questions to 1st to 3rd grader and 4th to 6th grader

Table 1. Dietary Quality Score (DQS) scoring system (H: 4th-6th grade, L: 1st-3rd grade)

Food group		<0.5†	1±0.5	2±0.5	3±0.5	4±0.5	5±0.5	6±0.5	≧6.5	Recommendation
Dairy		0	5	10	10	7.5	5	2.5	0	2 servings
Vegetable		0	5	10	10	10	—	—	—	H: 2 servings L: 4/3-2 servings
Fruit		0	5	10	10	10	—	—	—	2 servings
Meat	H	0	3.3	6.6	10	7.5	5	2.5	0	H: 3 servings
	L	0	5	10	10	7.5	5	2.5	0	L: 2-3 servings
Food group		<2	4±2	8±2	12±2	16±2	20±2	24±2	≧26	
Cereals and Grains	H	0	2.5	5	7.5	10	8	6	4	H:16 servings
	L	0	3.3	6.6	10	7.5	5	2.5	0	L:12 servings
Unhealthy snacks and beverages		<0.5‡ 10←							≧6.5‡ →0	

† servings per day; ‡day per week

Table 2. The Pearson correlation coefficients (r) of the DQS with various nutrient intakes (adjusted for calorie intake) from 24-hr recall (N=2398)

	Nutrient (r)							
	Protein	Fat	Carbohydrate	Calcium	Phosphorus	Iron	Vit. A	Vit.B_1
DQS	(0.134***)	(0.058**)	(-0.099***)	(0.189***)	(0.169***)	(0.010)	(0.102***)	(0.038)
	Vit.B_2	Niacin	Vit. C	SFA	USFA	Oleic acid	Cholesterol	Vit. E
DQS	(0.117***)	(0.040*)	(0.086***)	(0.077***)	(0.030)	(0.039)	(0.092***)	(0.008)
	Sodium	PUFA	Vit.B_6	Magnesium	Fiber	Potassium		
DQS	(-0.022)	(0.010)	(0.065**)	(0.119***)	(0.091***)	(0.165***)		

*$p<0.05$ **$p<0.01$ ***$p<0.001$

Table 3. Characteristics of Subjects

	1st -3rd Grade (N=1199)		4th -6th Grade (N=1218)	
	N	%	N	%
Gender				
Male	654	54.5	642	52.7
Female	545	45.5	576	47.3
Residential area				
Urban areas	455	37.9	461	37.8
Rural areas	370	30.9	375	30.8
Hakka areas	95	7.9	94	7.7
Mountain areas	92	7.7	95	7.8
Eastern areas	96	8.0	95	7.8
Penghu islands	91	7.6	98	8.0

were different, so the results of 1st to 3rd graders and 4th to 6th graders are presented separately.

Demographic characteristics of the sample

The characteristics of the subjects are listed in Table 3. The samples of 1st to 3rd graders were composed of 654 boys and 545 girls, and 4th to 6th graders were composed of 642 boys and 576 girls. In order to have a sufficient sample size of relevant ethnic groups and geographical regions, the survey over-sampled certain areas and ethnic groups and thus the data was weighted in statistical analyses.

Nutrition knowledge, attitudes and behavior in elementary school children

The mean, standard error, and percentage of correct or positive responses out of the total scale and subscales are presented in Table 4.

Nutrition knowledge. The nutrition knowledge of Taiwanese Elementary school children was fair. On average, 1st to 3rd graders and 4th to 6th graders answered 67.3% and 71.4% of the nutrition knowledge questions correctly. Most students were aware of the necessity of different food groups, the principle of balanced diet, the skill of selecting foods to achieve the balanced, and the comparison of foods in terms of specific nutrients. But 1st to 3rd graders were not knowledgeable about the relationships between diet and disease (53.2%) and the physiological function of major food groups (59.5%); 4th to 6th graders were not knowledgeable about the daily serving requirement of various food groups (47.9%) and the physiological function of these food groups (59.1%). Most children perceived that the TFGR daily servings for fruit group and vegetable group were not enough for children of his/ her age, but those for milk group, meat group and cereals and grains group were too much for children of his/ her age. Comparing the mean score, 4th to 6th graders scored higher (t-test, $p<0.05$) in most subjects than 1st to 3rd graders except that there was no difference in the scores for physiological function of food groups.

Nutrition attitudes. From the mean percentage of positive responses on the scale (Table 4), we found that elementary school children expressed favorable attitudes toward nutrition. A comparison of the mean scores of 1st to 3rd graders with 4th to 6th graders, revealed that 4th to 6th graders had more positive attitudes than 1st to 3rd graders (t-test, $p<0.05$).

More than 40% of elementary students disagreed that 'it's enough if one eat all kinds of food, there is no need for vitamins or other dietary supplements', and 25% agreed that 'only those who are overweight should limit snack intake'. About 30% of 1st to 3rd graders and 17% of 4th to 6th graders agreed that 'it's not necessary to make oneself unhappy for eating healthy'; 26% of 1st to 3rd graders and 18% of 4th to 6th graders agreed that 'it's not necessary to force oneself to eat something he or she doesn't like for health reasons'. Thus, for many elementary students, eating for health may not be an important concern as for adults.

Nutrition behaviour. From the mean percentage of

Table 4. Mean and percentage of correct or positive responses on nutrition knowledge, attitudes, behavior, and dietary quality score (DQS) scales

Scale	1st - 3rd Grade (N=1199)			4th - 6th Grade (N=1218)		
	Total score	Mean ± SE	% of correct or positive response	Total score	Mean ± SE	% of correct or positive response
Nutrition knowledge-total 1†	43	28.9± 0.3*	67.3	43	32.6±0.3*	75.8
Nutrition knowledge-total 2‡	-	-	-	54	38.5± 0.3	71.4
Nutrients in food groups	-	-	-	5	3.1± 0.1	61.4
The physiological function of food groups	5	3.0± 0.1	59.5	5	3.0± 0.1	59.1
Relationship between diet/nutrient and disease	5	2.7± 0.1*	53.2	5	3.2± 0.1*	64.8
Comparison of foods in terms of specific nutrient content	13	8.8± 0.1*	67.5	13	10.4± 0.1*	79.6
Balanced diet-the principles of balanced diet	6	4.4± 0.1*	73.6	6	5.2± 0.0*	87.4
Balanced diet-the need for six food groups	8	6.1± 0.1*	75.6	8	6.2± 0.0*	77.9
Balanced diet- the skill of selecting a balanced diet	6	4.1± 0.1*	67.4	6	4.6± 0.1*	76.2
Balanced diet- daily serving requirements for food groups	-	-	-	6	2.9±0.1	47.9
Nutrition attitude	54	44.3±0.3*	73.1	54	46.8±0.2*	80.0
Caring-about-nutrition behavior	18	10.9±0.1*	40.8	18	11.7±0.1*	47.5
Restraint eating behavior	-	-	-	30	14.1± 0.1	20.5
DQS	60	35.2±0.42*	58.6	60	33.6±0.39*	56.0

† included questions used in both grade groups. ‡ questions used in 4th-6th grades only. *significant difference between 1st-3rd graders and 4th-6th graders (t-test, $p<0.05$)

positive responses on the scale (Table 4), we found that elementary school children performed relatively poorly in the 'caring-about-nutrition' behavior. Comparing the mean scores, 4th to 6th graders performed better than 1st to 3rd graders. While looking at individual behaviors, almost half of the elementary students seldom or never 'paid attention to the nutrition information on TV, radio, in newspapers or books' or 'chose foods based on one's weight status'. Almost half of the 1st to 3rd graders and one third of the 4th to 6th graders seldom or never 'used the information on food labels to make food choices'. More than 30% seldom or never 'chose foods based on its health benefits', or 'asked people which food is good for health'. In addition, one fourth of the students usually 'chose foods based on preference'. These results indicate that considerable proportion of Taiwanese elementary students used innate taste preference but not health concern regarding food choice.

Restraint eating behaviour. The restraint eating behavior scale was only administered to 4th to 6th graders. From the mean percentage of positive responses (20.5%) on the scale (Table 4), we found that the restraint or disinhibited eating behavior of 4th to 6th graders was not serious. One-fourth of the students were always 'afraid of being obese', 17.4% were always 'trying to lose weight', 10.7% always 'selected foods that were not fattening due to fear of being obese'. But fewer than 5% of 4th to 6th graders performed severe restraint eating behavior, e.g. vomiting; not eating when hungry; avoiding high starch foods; nor did they have disinhibited eating behavior, such as: overeating to the extent that one cannot stop, regret after eating. However, over 30% of 4th to 6th graders stated that they sometime, but not frequently, performed 5 specific kinds of restraint eating behaviors among the 10 listed to avoid obesity.

Dietary quality. The Taiwanese Food Guides provide serving size recommendations for 6 food groups, but the intake of the fat and oil group was not assessed as a part of FFQ, therefore, only the daily intakes (Data not shown) of 5 food groups and snacks/beverages of elementary school children were used for DQS calculation. Details of the DQS scoring system is provided in Table 1.

According to the TFGR – 1994, the percentages of children meeting the requirement or ingesting more than

Table 5. Mean scores of nutrition knowledge, attitudes, and behaviors by demographic characteristics of elementary school children

Variable	N	Mean ± SE				
		Nutrition knowledge-total	Nutrition attitude	Caring-about-nutrition behavior	Restraint eating behavior	DQS
1st - 3rd Grade						
Gender						
(1) male	654	28.9±0.4	44.1±0.3	10.9±0.1	-	35.6±0.49
(2) female	545	28.9±0.4	44.5±0.4	10.9±0.1	-	34.7±0.56
		n.s.	n.s.	n.s.		n.s.
Residential area						
(1) urban areas	455	29.4±0.5	44.7±0.3	10.8±0.2	-	35.9±0.57
(2) rural areas	370	28.3±0.5	43.7±0.5	11.1±0.2	-	34.0±0.73
(3) Hakka areas	95	29.2±1.4	44.9±0.9	10.9±0.2	-	36.2±1.74
(4) mountain areas	92	24.9±0.8	39.8±0.6	10.4±0.4	-	30.6±0.55
(5) eastern areas	96	28.0±1.0	42.7±1.6	10.6±0.4	-	34.2±1.19
(6) Penghu islands	91	27.2±0.6	42.6±0.7	9.8±0.4	-	34.8±1.45
Summary of result of Scheffe test*		(1)>(6)>(4) (2)(3)(5)>(4)	(1)(3)>(6)>(4) (2)>(4)	(1)(2)(3)>(6)		(1)(2)(3)(5)(6)>(4)
4th - 6th Grade						
Gender						
(1) male	642	38.7±0.4	46.7±0.2	11.6±0.2	14.2±0.2	34.0±0.49
(2) female	576	38.4±0.4	47.0±0.3	11.9±0.2	14.1±0.2	33.3±0.52
		n.s.	n.s.	n.s.	n.s.	n.s.
Residential area						
(1) urban areas	461	38.9±0.4	46.8±0.3	11.7±0.2	14.0±0.2	34.3±0.54
(2) rural areas	375	38.0±0.6	46.9±0.3	11.6±0.2	14.2±0.2	32.8±0.65
(3) Hakka areas	94	39.0±1.4	47.5±0.6	12.2±0.2	14.7±0.4	33.4±1.42
(4) mountain areas	95	33.9±0.6	43.8±0.4	11.5±0.2	14.4±0.6	29.7±0.86
(5) eastern areas	95	38.0±0.8	45.0±1.5	11.7±0.4	14.7±0.5	33.0±1.56
(6) Penghu islands	98	37.5±1.1	45.9±0.9	10.8±0.5	12.9±0.5	33.1±1.23
Summary of result of Scheffe test*		(1)(2)(3)(5)(6)>(4)	(1)(2)(3)(6)>(4)	(3)>(2)(4)(6)	(1)(2)(3)(4)(5)>(6)	(1)(2)(3)(6)>(4)

* $p<0.05$

the recommended amounts of vegetables (V) and fruits (F) were 9.1% and 21.2%, respectively in 1st to 3rd graders (TFGR is 4/3~2 servings per day for V and 2 per day for F), and 15.2%, 26.4% in 4th to 6th graders (TFGR is 2 servings per day for both V and G). For the milk group, there were 15.7% of the 1st to 3rd graders and 14.7% of the 4th to 6th graders meeting the recommendation (TFGR is 2 servings per day) or not exceeding 3 servings. For the meat group, there were 50.3% of the 1st to 3rd graders (TFGR is 2~3 servings per day) and 16.8% of the 4th to 6th graders (TFGR is 3 servings per day) falling within the range. For the cereals and grains group, there were 26.7% of the 1st to 3rd graders (TFGR is 12 servings per day) and 6.5% of the 4th to 6th graders (TFGR is 16 servings per day) falling within the range.

Examining the distribution data of the ingested foods, we found that those who did not meet the recommendations were mainly under the recommended servings for all 5 food groups; particularly in the vegetable, fruit and milk groups, there were 73.6% to 90.9% of the children who did not meet the recommendations. From the distribution of the frequency (day/week) of eating snacks/beverages, we found that most elementary school children eat or drink snacks/beverages 1~2 day per week.

The mean dietary quality scores calculated from 5 food groups and snacks/beverages were 35.2 and 33.6 for 1st to 3rd graders and 4th to 6th graders, respectively (Table 4). The scores accounted for only about 58.6% and 56% of the full score (60), which indicates that the quality of the diet was not satisfactory for both groups. This result is consistent with the low percentage of children meeting the recommendations.

Other nutrition related behaviors

Meal pattern. More than 92.1% of participants stated that they ate lunch and dinner every day, but the percentages of eating breakfast every day were only 82.4% and 77.2%, respectively for 1st to 3rd and 4th to 6th graders (Data not shown). Only 75.9% and 72.4% regularly ate three meals a day, meaning one fourth of the students skipped meals, especially breakfast. Many students (31.8% and 21.2% for 1st to 3rd and 4th to 6th graders, respectively) often or almost everyday ate snacks in the afternoon, but fewer in the morning or at night. Around 11.1% of 1st to 3rd graders and 5.9% of 4th to 6th graders ate snacks in the morning, and 5.4% and 6.5% at night.

Meal source. The major source of lunch was school for both grade groups, either school cafeteria (51.7%, 58.5% for 1st to 3rd graders and 4th to 6th graders, respectively) or contracted food service center (13.5%, 29.5% for 1st to 3rd grader and 4th to 6th graders, respectively); only 25.3% of 1st to 3rd grade and 10.4% of 4th to 6th grade student's lunch were prepared by family members. Other meals and snacks were prepared mainly by family members (Data not shown). Almost 90% of the 1st to 3rd graders' breakfast was prepared by family members, but one forth of the 4th to 6th graders (25.6%) and 10.5% of the 1st to 3rd graders prepared their own breakfast. The afternoon snack of the 4th to 6th graders was mainly prepared by family members (37.1%) and themselves (30.0%), and some (10.2%) were provided by after-school child-care centers. The dinner was mainly prepared by family members for both 1st to 3rd graders (97.4%) and 4th to 6th graders (96.5%).

Nutrition knowledge, attitudes, behavior and restraint eating behavior by demographic characteristics of elementary school children (Table 5)

Nutrition knowledge. No statistically significant differences were found between genders for nutrition knowledge. Compared with those living in mountain areas, elementary school children living in other areas (urban, rural, Hakka, eastern and Penghu islands) were more knowledgeable about nutrition. Besides, the 1st to 3rd graders who lived in urban areas had better nutrition knowledge than those lived in the Penghu islands. This phenomenon was not seen for the 4th to 6th graders.

Nutrition attitudes. There were no statistically significant differences between genders for nutrition attitudes. All school children who lived in urban areas, rural areas, Hakka areas and Penghu islands expressed more positive nutrition attitudes than those lived in mountain areas. Specifically for 1st to 3rd graders, those living in urban areas and Hakka areas showed more positive nutrition attitudes than those living in the Penghu islands.

Nutrition behaviour. No difference was found in caring-about-nutrition behavior between genders. For across stratum comparison, the results for the 1st to 3rd graders and for the 4th to 6th graders were not consistent. In the 1st to 3rd graders, those who lived in urban areas, rural areas, and Hakka areas performed caring-about-nutrition behavior more frequently than those who lived in Penghu islands. As for 4th to 6th graders, only those who lived in Hakka areas performed such behavior more frequently than those lived in rural areas, mountain areas, and Penghu islands. No statistically significant difference was observed among other strata.

Restraint eating behaviour. No statistically significant differences were found between genders for restraint eating behavior in the 4th to 6th graders. Compared with those living in the Penghu islands, the 4th to 6th graders living in Taiwan as a whole (including urban areas, rural areas, Hakka areas, mountain areas and eastern areas) restrained their diets more frequently.

Dietary quality. As for dietary quality score, the only difference found was that children who lived in mountain areas scored lower than those lived in other areas; no difference was found between genders. When examining the proportions of children meeting the recommended intakes (data not shown), the average daily intakes of mountain areas' children were almost the lowest among 6 areas for the vegetable group (4.8% and 7.8%) and for the fruit group (10.2% and 8.9%) for the two grade groups, but the proportions meeting the recommended intakes for the meat group and cereals and grains group were more comparable with other residential areas. Therefore, we anticipated that the lower DQS was mainly due to the lower intake of vegetables and fruits in the mountainous stratum.

Table 6. Pearson correlation coefficients between nutrition knowledge, attitudes, behavior, and dietary quality score (DQS) of elementary school children

Variable	Pearson correlation coefficients			
	Nutrition knowledge-total	Nutrition attitude	Caring-about-nutrition behavior	DQS
1st - 3rd Grade (N=1199)				
Nutrition knowledge-total	1.000	0.542***	0.210***	0.210***
Nutrition attitude		1.000	0.147***	0.185***
Caring–about-nutrition behavior			1.000	0.102***
DQS				1.000
4th - 6th Grade (N=1218)				
Nutrition knowledge-total	1.000	0.379***	0.195***	0.269***
Nutrition attitude		1.000	0.205***	0.188***
Caring-about-nutrition behavior			1.000	0.246***
DQS				1.000

*** $p<0.001$ ** $p<0.01$ * $p<0.05$

Relationship between nutrition knowledge, attitudes and behavior

The correlation coefficients (r) for nutrition knowledge, attitudes, and caring-about-nutrition behavior and dietary quality score are reported in Table 6. Significant positive correlations were found among almost all variables with the strongest relation (as shown by r value) existing between knowledge and attitude (r=0.542 and 0.379 for G1-3 and G4-6, respectively). Weaker but significantly positive relations were found between knowledge and behavior/dietary quality (r=0.195-0.269) and between attitude and behavior/dietary quality (r=0.147-0.205). The results indicate that children having better nutrition knowledge also expressed more positive nutrition attitude, caring-about-nutrition behavior more frequently, and also have a better quality diet.

DISCUSSION

It is paramount to develop and reinforce lifestyle behaviors that encourage the maintenance of appropriate weight, foster good health, and prevent disease during the childhood and adolescent years.[22] With the increasing prevalence of obesity, diet-related diseases and problematic eating behaviors of Taiwanese children,[1,23] this study aimed to assess the nutrition knowledge, and to understand the nutrition related attitude and behaviors of Taiwanese children in order to identify the most important messages for school nutrition education.

Results showed that the majority of elementary students were aware of the necessity to ingest from different food groups, the principle of balanced (adequate and varied) diet, the skill of selecting foods for such a diet, and the differences in major nutrients of foods, but scored low on 'the physiological function of food groups', 'the relationships between diet/nutrient and disease', and 'the daily serving requirements of six food groups'. Elementary school children expressed favorable attitudes toward nutrition as a whole, but they did not think the health benefit of food was an important concern for food selection. They did not often care about for nutrition in daily life based on the nutrition attitude scale and the caring-about-nutrition scale. The physiological function of food groups was considered as basic nutrition knowledge and taught in the health class of elementary school. But children' knowledge was found weak in an earlier study[24] and also in the present study. As for 'the relationships between diet/nutrient and disease', and 'the daily serving requirement of six food groups', the result was similar to the Taiwanese adolescent study[25] and the Elderly Nutrition and Health Survey in Taiwan.[26] 'Balanced diet' (food choice from each of the six Taiwanese food groups on a daily basis) is one of the core themes of nutrition education, which is emphasized in dietary guidelines, and in the daily serving requirements of six food groups.

The survey results showed that although children understood the Taiwanese concept of a balanced diet, they do not have an in-depth understanding of how many food servings are needed daily by children; this may become the obstacle for practicing balanced diet. Lack of knowledge on 'the relationships between diet/nutrient and disease' may explain why some of school children seldom or never 'choose foods based on its health benefits'. But previous researches stated that knowledge or skill of instrumental or 'how-to' nature only works for those who wish to eat healthfully, knowledge partially mediates a relationship between goal setting and self-efficacy but is not related to changes in the behavior, knowledge by itself can lead to behavioral change only among the 'right' (motivated) people.[27,28] Therefore, even if children have the knowledge, if they were not committed to healthy eating as indicated by their responses in some items in nutrition attitude scale and caring-about-nutrition behavior scale, they may not have the motivation to practice a healthy and balanced diet. Therefore, nutrition education should not only include food serving requirements of food groups in the future, but also apply appropriate theories to improve the motivation of healthy eating of children.

Despite the high proportion of correct responses in regard to the principle of balanced diet, almost half of the school children considered they should take dietary supplements daily, similar to the result found in the Taiwanese adolescent study.[25] Survey results indicated about 21.9% and 22.3% of Taiwanese boys and girls, respectively, and 13% to 17% of adolescents use dietary supplements.[29,30] Children probably are not the persons who

make the decision about taking dietary supplements, many mothers provide their children with dietary supplements to ensure their health.[31,32] In recent years, a large variety of healthy or functional food products are available on the market in Taiwan. The exaggerated claims about the functions of those foods spread quickly through mass media and direct selling. These facilitate the increased consumption of dietary supplements.

From the Dietary quality score, we found that the diet quality of children was poor, and most children's intakes of milk, vegetable, fruit and cereals and grains groups were severely below the recommendation; this result was consistent with the analyses of 24-hr recall in the same survey which reported that the average intakes of children were 10.5, 1.8, 1, 6, 0.7 and 3 servings for the cereals and grains, vegetable, fruit, meat, milk and fat/oil groups respectively.[33] The price of dairy products is relatively high compared with other foods and thought to be an obstacle to the promotion of dairy products in Taiwan. But there are plentiful and various kinds of fresh fruits and vegetables in Taiwan, available at low cost most of the time except in the Typhoon season (summer and early autumn). Usually vegetable dishes and/or mixed dishes of meat and vegetable are provided at lunch and dinner. Therefore, it is surprising that children's intakes of fruit and vegetable are so low. This is similar for American children. Melnik et al reported the mean consumption of fruits and vegetables were 1.2 and 1.9 servings daily for 2nd graders and 1.5 and 2.0 servings daily for 5th graders from New York City; very few children consume five servings of fruits and vegetables per day.[9] Rafiroiu et al found 16% to 33% of 3rd and 5th graders from South Carolina in the United States meeting the Food Guide Pyramid recommendations for fruits and vegetables.[34] McPherson et al stated that on average, American children consume only about half of the recommended number of servings of fruits and vegetables per day.[8] In the USA 1996 Food Guide Pyramid, the recommended servings of fruit and vegetable for children were 3 and 4 servings per day for children older than 6 yr which is similar but a little higher than the 1994 Taiwanese Food Guide recommendation (TFGR). From the above studies, we found Taiwanese children ate similar amount of fruits and vegetable with their American counterpart, but potato was categorized in cereals and grains group (the full name is grain and starchy tubers group) in Taiwan which may have some effect on the results.

With regard to nutrition knowledge, although elementary school children understood the principle of balanced diet, (the necessity of 6 food groups in daily diet), they didn't know the daily servings needed for each food group, and they tended to underestimate their need for the milk group, meat group and cereals and grains group but overestimate the need for the fruit group and vegetable group. If this was true, lack of knowledge may be truly the obstacle for implementing a balanced diet even if they have the desire to perform a balanced diet. But the results is contradictory, since their conception about the daily requirements for the vegetable group and fruit group are higher than the recommended servings, but their daily intakes of these two food groups were much lower than recommended servings. A study done in France found that French children could list healthy and unhealthy foods but their list of the healthiest 10 foods did not show much overlap with their preferred 10 foods, indicating children understand what foods are healthy, however, they don't like to eat them.[2] It is urgent to further understand the gap between knowledge, attitude and eating behavior related to vegetable and fruit consumption of school children. These researchers suspect that it may due to the lack of taste preference for fruits and vegetables and the attitude toward eating for health is not strong in this age group.

Dieting or restrained eating behavior is a common and widespread practice among adolescents, especially girls.[35,36] But research indicated that there is increasing incidence of weight dissatisfaction, weight control or dieting in preadolescent or children.[37-40] Based on the score of ChEAT-26 ($\geq$ 20), Lee and Lin[41] concluded that 13.8% of the Taiwanese 3rd-6th graders have the risk of an eating disorder. But according to the result of this survey the restraint eating behavior of 4th to 6th graders seems not serious. Fewer than 5% of 4th to 6th graders performed severely restraint eating behavior, e.g. vomiting, not eating when hungry, avoiding high starch foods, nor do they have severe disinhibited eating behavior due to dieting, e.g. overeating to the extent that one cannot stop, regret after eating. However, over 30% of 4th to 6th graders stated that they 'sometime' performed the 5 of the restraint eating behaviors among 10 asked, which indicated that a large number of children already expressed some restraint practice to avoid obesity, although it was not frequent. The dieting behavior of children has been reported: Rafiroiu et al[34] found 8% of 3rd graders and 5% of 5th graders from South Carolina in the United States reported they made themselves vomit and/or took diet pills to control their weight, and they were more likely to have less nutrition knowledge, fewer positive attitudes toward nutrition, stronger social influence, and more eating concerns. Therefore, we should pay more attention to eating practices among children.

The present study explored differences in nutrition knowledge, attitudes and behavior of elementary school children by grade levels, genders and residing strata. As many studies[24,42,43] have found, the performance of nutrition knowledge, attitudes and behavior is improves with age except for the elderly. This may mainly due to the effect of education but also the life-related experiences. The survey results exhibited whether 1st to 3rd grade or 4th to 6th grade, there is mostly no difference in nutrition knowledge, attitudes and caring about nutrition behavior between genders. Many studies pointed out that females were more knowledgeable than males except for the elderly,[26,44,45] but the outcome was not in accordance with behavior.[25,46-49] Different assessment tools of surveys may result in different outcomes. It was often thought that the difference in nutrition knowledge and attitudes between males and females may be due to the difference in social expectation of the sexual roles: females tended to be more concerned about issues related to diet/nutrition since they hold the so-called 'gatekeeper' role in the family, but it may not be the case for children since they are young. This may also imply a change in the perception of sexual roles for diet/nutrition issues, but further studies are

needed to draw any such conclusion.

Schoolchildren living in mountain areas were poorer in nutrition knowledge, attitudes, caring-about-nutrition behavior and dietary quality than others. The surveys in Taiwan during 1993-1996 and 1999-2000 found similar results.[42] This may result from lower family socioeconomic status and insufficient resources. The majority of residents living in mountain areas in Taiwan are aborigines: surveys indicate that the family education resource of aborigines was insufficient, as judged by social capital, economic capital and cultural capital, which may result in low academic achievement of aboriginal children.[50,51] It may also be the reason for the low achievement in nutrition knowledge, and thus affect attitude and behavior of children from mountain areas. Besides providing free school lunch as it is now, nutritional personnel could pay particular attention to improve the possible mediating factors (knowledge, attitude, motivation, self-efficacy, etc.) of healthful eating of mountainous children to improve the quality of their diet. As for the restrained eating behavior, those 4th to 6th graders living in the Penghu islands restrained their diets less frequently than children living in 5 other areas which all are on the main island of Taiwan. Although the transportation was inconvenient, the mass communication system was popular for most Penghu islands, so culture isolation or segmentation with Taiwan island need not happen, but the results from the Elderly Nutrition and Health Survey (1999-2000) indicated that the elderly of the Penghu islands retain more Chinese traditions, therefore we suspect the effects of a slim body image and dieting behavior may be less for children living in the Penghu islands.

More than 90% of school children ate lunch and dinner everyday, however, only 80% of them ate breakfast, which was similar with the outcome of the Nutrition and Health Survey in Taiwan carried out from 1993 to 1996.[13] In addition, the present study also showed that 4th to 6th graders ate breakfast less frequently than 1st to 3rd graders. As other researchers found, as children get older, they go to school without breakfast,[5,11,14,52] which may result in as few as 45.4% of adolescents consuming breakfast.[25]

The manual of childhood nutrition published by the Taiwanese Department of Health[53] suggests elementary school children eat snacks between meals to complement the insufficient intakes of meals, especially between breakfast and lunch (morning snack), and between lunch and dinner (afternoon snack). The survey results showed that many students (31.8% and 21.2% for 1st to 3rd and 4th to 6th graders, respectively) ate afternoon snack, but less morning snack. Night snack was usually not suggested, but a few elementary school children ate the night snack (5.4% 1st-3rd grader, 6.5% 4th-6th grader), the percentage of eating night snack increased compared with the previous study (2% for age 7-12) of 1993 to 1996.[11] This may imply a change in life style which may increase energy intake and obesity prevalence.

Most of the breakfasts and dinners of elementary school children were prepared by family members, but the lunch was mainly bought at school, either at the school cafeteria or contract food service center. Notably, about 10% of 1st to 3rd graders and 25% of 4th to 6th graders prepared their own breakfast. One study administered in America showed that 17.3% of 2nd graders and 35.2% of 5th graders prepared meals by their self or other child.[9] Thereafter, when elementary school children get older, the percentage of eating breakfast declined, at meantime the percentage of self-prepared breakfast increased. The increments in convenient store, breakfast shop/stand and bakery in both urban and rural areas may reflect the change of eating pattern of Taiwanese people, i.e. less people cook their own breakfast. Both traditional and western style breakfast foods, e.g. milk, soy milk, bread, steamed bun, were bought in the previous days, in the morning or on the way to school/office. As a result, we found increased percentage of children preparing, mainly packing, their own breakfast. Lin et al indicated that Taiwanese children who ate breakfast alone would increase soft drinks' consumption.[11] The contribution of breakfast to daily nutrient intake is important for children: skipping breakfast not only causes reduction of nutrients intake[54] but also influences the development of elementary school children. Children who eat breakfast everyday have better health and have better school performance.[6,14,52] Kelder et al[52] found that skipping meals is associated with trying to lose weight in 4th to 11th graders from a focus group study in central Texas; it may also be the reason for some Taiwanese children since the survey results do show that one-fourth of the students are always 'afraid of being obese', 17.4% always 'try to lose weight', 10.7% always 'select foods that were not fattening due to fear of being obese', but further study would be necessary to understand the reason for skipping meals.

In conclusion, we identify the strengths and limitations of the study and also propose suggestions for future research and education.

The strengths of this study are large representative samples and comprehensiveness of study variables. A limitation of this study is that questionnaires were administered by interviewers; social expectation may diminish the validity of responses, especially in regard to restraint eating behavior.

The study found that school children lacked knowledge of 'the relationships between diet/nutrient and disease' and they did not know the daily servings needed for each food group. Children tended to underestimate their need for the milk group, meat group and cereals and grains group but overestimate the need for the fruit group and vegetable group. What's interesting is although they overestimate the need for the fruit group and vegetable group, their intake were lower than recommendations. The results show that lack of knowledge may be the obstacle for implementing a balanced diet even if they have the desire to perform a balanced diet, but there is a gap between nutrition knowledge, attitude and eating behavior, especially for fruit and vegetable. It may due to the attitude toward eating for health is not strong in this age group. As suggested by many researchers, nutrition education should not only include instrumental knowledge, such as food serving requirements of food groups, but also apply appropriate theories to improve the motivation of eating foods which were thought to be good for health but may not be children's preferences. Emphasis on health attributes of a food may be a 'turn off' for children.[55] Future studies should explore what motivates

children to eat more healthful diets.

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AUTHOR DISCLOSURES

Wei Lin, Hsiao-Chi Yang, Chi-Ming Hang, and Wen-Harn Pan, no conflicts of interest.

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Appendix. Examples of questions of the nutrition knowledge, attitudes, caring about nutrition behavior, and restraint eating behavior scales

Nutrition knowledge
Subscale 1.The nutrients in food groups
How can we acquire the energy body needed?
(1) from exercise (2) from wearing clothes (3) from eating
Subscale 2. The physiological function of food groups
What is the main physiological function of cereals and grains group foods (e.g. rice, noodles, steamed bun, etc.)?
(1) provide energy (2) make bones strong (3) making blood
Subscale3. The relationship between diet/nutrient and disease
Which of following condition can cause heart disease?
(1) eat too much fat (fatty meat) † (2) eat too much dietary fiber (fruits) (3) eat too much vitamins (rice)?
† Items in parentheses are used in G1-3.
Subscale 4. The comparison of foods in terms of specific nutrient content(e.g. fat, fiber, calcium, calorie, sodium)
Which of the following foods contains more fat than the others?
(1) roasted drumstick (2) deep-fried drumstick (3) stewed drumstick
Subscale 5-1. Balanced diet- the principles of balanced diet
As long as one eat enough, he won't have nutrition-related problem
Subscale 5-2. Balanced diet- the need for six food groups
Do you think that children should eat cereals and grains food every day?
Subscale 5-3. Balanced diet- the skill of selecting a balanced diet
Henry, Rob and Sandy (children of your age) had lunch in the following places yesterday, whose lunch is healthier than others?
(1) Henry: ate one bowl of instant noodles, one glass of black tea, one cup of jelly, and one half of guava at home
(2) Rob: ate a piece of fried chicken, medium French fries, one corn on the cob, and one glass of soda in fast food restaurant
(3) Sandy ate one bowl of cooked rice, stir-fried meat with vegetable, stir-fried tomato with egg, and one apple in cafeteria
Subscale 5-4 Balanced diet-the daily serving requirements of different food groups
John (child of your age) ate one apple and one orange, is that enough for a day?
Nutrition attitudes
It's not necessary to force oneself to eat something he doesn't like for health reasons
Only those who are overweight should limit snack intake
Caring about nutrition behavior
You pay attention to the nutrition information on TV, radio, in newspapers or books
You will ask people which food is good for health
Restraint eating
You are afraid of being obese
You will select foods that are not fattening due to fear of being obese

Original Article

Nutrition knowledge, attitude, and behavior of Taiwanese elementary school children

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臺灣國小學童的營養知識、態度及行為

本研究為瞭解臺灣國小學童的營養知識、態度、行為現況以及其間的關係。結果顯示，學童的基礎知識尚可，但欠缺營養與疾病，六大類食物每日需要量等知識。學童肯定營養的重要性，但在選食時並不以食物對健康的益處作考量，且大多沒有達到奶類、蔬菜、水果和五穀根莖類的每日建議攝取量。四至六年級學童節制飲食行為情形尚不嚴重，但已有相當比例者因怕胖而採取一些節制行為。約 1/4 學童經常略餐，尤其是早餐，1/4 的 4-6 年級學童自己準備早餐。營養知識、態度、選食與關心營養行為及飲食品質分數兩兩間皆有顯著正相關。研究顯示學童營養知識、態度及行為間存在落差。建議未來營養教育不僅需教導學童食物的需要量，也需利用適當理論來提昇其實踐健康飲食行為的動機。

關鍵字：國小學童、營養知識、營養態度、飲食行為、飲食品質。