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### Dietary Quality Comparison of the School and Home Lunches Consumed by Chinese School-Age Children and Adolescents: Analysis of the 2011 China Health and Nutrition Survey

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#### ABSTRACT

**Objectives:** The number of schools offering school lunches has increased in China. This study examined the dietary quality of the lunches consumed by Chinese school-age children and adolescents, with a focus on comparing school lunches with home lunches.

**Methods:** The first weekday 24-hour dietary recall data of 6~17-year-old students (n=1,084) from the 2011 China Health and Nutrition Survey were analyzed. The subjects were divided into the school lunch group and the home lunch group, and the dietary quality of lunches was compared between the two groups among 6~11-year-old students (n=634; 177 in the school lunch group and 457 in the home lunch group) and 12~17-year-old students (n=450; 144 in the school lunch group and 306 in the home lunch group), respectively. Frequently consumed foods, amount of food group intake, food group intake pattern, Dietary Diversity Score (DDS), and Dietary Variety Score (DVS) were examined.

**Results:** The most frequently consumed foods in both lunch groups were rice and pork. An excessive intake of meat and insufficient intake of seafood were noted in both lunch groups. The school lunch group showed a lower level of vegetable consumption than the home lunch group ( $P=0.017$  in 6~11-year-old students,  $P=0.003$  in 12~17-year-old students). Although more students ate meals with a better dietary pattern in the school lunch group than the home lunch group, there were no significant differences in DDS and DVS between the two groups.

**Conclusions:** Overall, the dietary quality of lunches was not superior in the school lunch group compared to the home lunch group. This suggests that much room remain for improving dietary quality of school lunches in China.

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**KEY WORDS** nutrition survey, foodservice, school meal, school lunch program, diet quality

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## Introduction

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School lunches play an essential role in improving the students' nutritional status, learning capacity, and school attendance [1]. As of 2012, school lunches were provided to approximately 368 million students on a typical school day worldwide, covering most countries around the world [2]. In China, the school lunch service was first launched in a few coastal cities in the 1980s [3]. The school lunch service was expanded and covered 90% of large cities, 70% of middle and small-sized cities, and 20% of rural areas in 2010 [4]. Since 2011, the Chinese government has undertaken the Nutrition Improvement Program for Rural Compulsory Education Students, which focused on building new school cafeterias and providing school meal allowances in underdeveloped rural areas in China [5]. The aim of the Nutrition Improvement Program was to improve the nutritional status of rural students and to decrease the gap between urban and rural populations [6].

As the number of schools offering school lunches has increased in China, considerable attention has been paid to quality aspects such as menu composition and serving size. Although school cafeterias provided seasonal menu items and periodically updated menus [7, 8], unbalanced menu composition and a lack of food variety were revealed as the main problems [4]. The current nutrition guidelines of school lunches in China specified six food groups and their recommended amounts to be included in one meal for the respective age groups. The food groups are grains, fruits-vegetables, fish-meat-eggs, milk-soybeans-nuts, vegetable oil, and salt [9]. However, the majority of school lunches appeared to not having included recommended amount of foods. In general, school lunches in China offered too much meat [10-12], but not enough fruit, vegetables, or dairy products [11]. Among 9,346 elementary and middle schools in rural areas where the Nutrition Improvement Program was implemented, more than 70% of the schools offered vegetables and dairy products below the recommended amount [5].

Since the 1990s, the Chinese dietary pattern has experienced a drastic transformation from a traditional carbohydrate-rich diet into a westernized high-fat, low-

carbohydrate diet [13]. The rate of obesity in Chinese students started to increase in the 1990s and has increased rapidly since the 2000s [14]. In 2010, approximately 10% of Chinese students were overweight, and 5% were obese, and the estimation represented 30 million in total [15]. At the same time, undernutrition among children and adolescents was another problem that China was facing. The rates of stunting and wasting in China were approximately 3% and 9%, respectively. Moreover, the rates were as high as 25% (stunting) and 40% (wasting) in some poor areas in northwestern and southwestern China [16]. Therefore, the food environment needs to be changed to promote healthy food choices and prevent the further prevalence of youth obesity. Furthermore, it is equally important that sufficient nutrients be provided to children and adolescents in poor areas through healthy diets.

In China, home lunches have remained a big part of all lunches consumed by elementary and secondary school students. Students attending schools not serving school lunches return to schools after eating lunches at home. A survey conducted in six major cities in China in 2009 showed that approximately 26% of 6-13-year-old students had lunches at home during the school year [17]. The 2015 National Report on Chinese Resident's Chronic Disease and Nutrition also showed that approximately 31% of 12-17-year-old students had lunches at home [18]. In general, home food is relatively difficult to change in the short term because it reflects the food preference of the family and daily routine of family members. Therefore, improving the quality of school lunches can provide a more effective path to healthier dietary intake and dietary habits among students.

A recent study has shown that higher proportions of livestock and poultry meat and low intake of vegetables were integral problems in the school lunch programs in China [19]. In the study, the amount of livestock and poultry meat provided via school lunches was almost 5 to 8 times of the recommended amount. Another study reported that the average protein intake from school lunches by elementary school students reached 40% of estimated average requirement (EAR), while thiamine, riboflavin, vitamin C, calcium, selenium, and other nutrients were seriously inadequate [20].

Examining the quality of dietary intake from school

lunches has remained an understudied area in China. In particular, there are no reports on a comparison of the dietary quality between school lunches and home lunches in China. This study examined the dietary quality of school lunches in China using the 2011 China Health and Nutrition Survey, with a focus on comparing school lunches with home lunches.

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## Methods

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### 1. Data source and subjects

This study analyzed the data from the 2011 China Health and Nutrition Survey, which was conducted in nine provinces and three municipalities that varied substantially in geography, level of economic development, public resources, and health indicators. A multistage, random cluster process was used to draw the samples [21]. In the Survey, each participant has provided a written informed consent, and the study was approved by the institutional review boards at the University of North Carolina at Chapel Hill and the National Institute of Nutrition and Food Safety [21]. The current study used only the individual level dataset, and therefore was exempted for further IRB approval based on the guidelines for the data use of the China Health and Nutrition Survey [22].

Among 23,149 subjects in the 2011 China Health and Nutrition Survey, this study initially selected the first weekday's data of 24-hour dietary recall of 1,412 subjects, who were between 6 and 17 years of age and enrolled in elementary, middle, or high schools. Twenty-nine subjects were excluded for skipping lunches. Another 29 subjects were excluded because they ate lunches in multiple locations. One hundred sixty-five subjects were excluded because the preparation and consumption of lunches were not in the same location. Thirty-five subjects were excluded because the locations of lunch consumption were neither a school nor home. Finally, 70 subjects were excluded because of missing values in the important variables such as age and household income. A final sample of 1,084 subjects consisted of 634 students aged 6~11 years and 450 students aged 12~17 years. They were classified into either the home lunch group or the school lunch group for analysis.

### 2. Dietary quality measurements

#### 1) Frequently consumed foods

Three hundred fifty-nine individual food codes were rearranged into 167 food codes by referring to the Chinese Food Composition Table 2002 and 2004 [23, 24]. If one kind of food was reported in different food codes due to different cooking or processing methods, the food codes were combined into a single code. Four food codes (21199, 45419, 141999, and 152599) not existing in the Chinese Food Composition Table were excluded. The foods consumed frequently in lunches were ranked for the school lunches and the home lunches, respectively.

#### 2) Amount of food group intake

All foods were classified into ten major food groups according to the Chinese Food Guide Pagoda in the 2016 Chinese Dietary Guidelines as follows [25]: grains/tubers/legumes (excluding soybean), vegetables, fruits, meats, seafood, eggs, dairy products, soybean/nuts, salt, and oils. Condiments such as sugar was not classified into any of these food groups. Soybean paste was the only sauce appeared in the 24 recall data of this study and classified into the soybean/nuts group. To determine if each food group intake was sufficient, the reported food group intakes except for salt and oils were compared with the reference values for school lunches (i.e., 40% of the recommended daily values for those whose energy requirement was 1600~2400 kcal) [26].

#### 3) Food group intake pattern

Food group intake pattern was examined to evaluate the presence or absence of each food group at the lunch intakes. For the five food groups, including dairy products (excluding butter and cream products), meats (including meats, fish, eggs, legumes, and nuts and seeds), grains (excluding cake, cookies, pastries, and pies), fruits (including raw, dried, and canned fruits and fruit juices, but excluding fruit drinks), and vegetables (including raw, cooked, frozen, dried, and canned vegetables and vegetable juice) (DMGFV), number 0 and 1 indicated the absence and presence of the food group, respectively [27]. Soybean paste, the only sauce appeared in the data, was classified into meats.

The indicated number 1 means that a minimum amount or more of food belonging to the food group was consumed according to Kant's method [28]. To evaluate the presence or absence of each food group at the lunch intakes, one-third of the minimum amounts for each food group that was set in the Kant's study [28] were used. Therefore, in the meat, fruit, and vegetable groups, a minimum amount for indicating number 1 was 10 g for all solid foods with a single ingredient and 20 g for all liquids and mixed dishes. In the dairy and grain groups, 5 g for all solid foods with a single ingredient and 10 g for all liquids and mixed dishes were set as the minimum amounts.

#### 4) Dietary Diversity Score

Dietary Diversity Score (DDS) suggested by Kant [28] was calculated for the lunches consumed by students. For the same five food groups as used for the food group pattern analysis, one point was counted for each food group in which the consumption amount was at or more than the minimum amount. To calculate DDS for lunch intake, one-third of the minimum amounts for each food group that was set in the Kant's study [28] were used for point allocation.

#### 5) Dietary Variety Score

The Dietary Variety Score (DVS) was calculated for the

lunches consumed by students. The DVS indicated the number of food items consumed in a certain amount over a given period [29]. One additional point was added whenever a different food item was consumed.

### 3. Statistical Analysis

Statistical analysis was performed using the SAS (Ver. 9.4, SAS Institute Inc., Cary, NC, USA). The significance level was set to 0.05 for all analyses. The difference between the two lunch groups was analyzed by  $\chi^2$  test or ANCOVA using gender, household income, and residential area as covariates.

## Results

### 1. Sociodemographic characteristics of the study subjects

Among the 6~11-year-old students, 177 belonged to the school lunch group, and 457 belonged to the home lunch group. Among the 12~17-year-old students, 144 were classified into the school lunch group, and 306 were classified into the home lunch group. Approximately 27.9% of 6~11-year-old students and 32.0% of 12~17-year-old students ate school lunches. Table 1 lists the sociodemographic characteristics of the two lunch groups.

Significant differences were observed in the utilization of

**Table 1.** Sociodemographic characteristics of the study subjects

	6~11-year-old students			12~17-year-old students		
	School lunch group (n=177)	Home lunch group (n=457)	P-value <sup>1)</sup>	School lunch group (n=144)	Home lunch group (n=306)	P-value <sup>1)</sup>
Gender						
Male	45.8	49.2	0.486	52.8	51.0	0.799
Female	54.2	50.8		47.2	49.0	
Household income <sup>2)</sup>						
Low	32.2	43.8	0.001	24.3	36.0	0.041
Middle	57.6	52.3		68.8	56.9	
High	10.2	3.9		6.9	7.2	
Residential area						
City	40.1	9.2	< 0.001	52.1	11.4	< 0.001
Suburban	14.1	16.6		15.3	14.7	
Town	20.3	14.9		16.0	20.6	
Village	25.4	59.3		16.7	53.3	
Total	27.9	72.1		32.0	68.0	

%

1) By  $\chi^2$  test

2) Classified according to the '2012 China statistical yearbook'

**Table 2.** Foods frequently consumed at school lunches and home lunches by Chinese students

Rank	6~11-year-old students			12~17-year-old students		
	School lunch group (n = 177)	Home lunch group (n = 457)		School lunch group (n = 144)	Home lunch group (n = 306)	
1	Rice 162 (91.5)	Rice 390 (85.3)		Rice 121 (84.0)	Rice 262 (85.6)	
2	Pork 76 (42.9)	Pork 186 (40.7)		Pork 79 (54.9)	Pork 130 (42.5)	
3	Chinese cabbage 62 (35.0)	Chinese cabbage 117 (25.6)		Egg and egg products 36 (25.0)	Chinese cabbage 69 (22.5)	
4	Potato 48 (27.1)	Wheat flour 79 (17.3)		Potato 35 (24.3)	Egg and egg products 57 (18.6)	
5	Egg and egg products 42 (23.7)	Potato 74 (16.2)		Chicken 34 (23.6)	Wheat flour 48 (15.7)	
6	Tofu 28 (15.8)	Egg and egg products 71 (15.5)		Chinese cabbage 32 (22.2)	Tofu 44 (14.4)	
7	Chicken 23 (13.0)	Green pepper 68 (14.9)		Tomato 18 (12.5)	Green pepper 39 (12.7)	
8	Tomato 20 (11.3)	Tofu 43 (9.4)		Wheat flour 14 (9.7)	Potato 38 (12.4)	
9	Starches 15 (8.5)	Tomato 39 (8.5)		Tofu 14 (9.7)	Tomato 38 (12.4)	
10	Wheat flour 13 (7.3)	Water spinach 34 (7.4)		Carrot 11 (7.6)	Water spinach 37 (12.1)	
11	Winter melon 12 (6.8)	Eggplant 30 (6.6)		Green pepper 11 (7.6)	Eggplant 28 (9.2)	
12	Cabbage 11 (6.2)	Pumpkin 29 (6.3)		Cabbage 11 (7.6)	Cowpea 20 (6.5)	
13	Laver 11 (6.2)	Kidney bean 27 (5.9)		Starches 9 (6.3)	Pumpkin 20 (6.5)	
14	Beef 9 (5.1)	Dalton 22 (4.8)		Celery 9 (6.3)	Cucumber 15 (4.9)	
15	Carrot 8 (4.5)	Cowpea 22 (4.8)		Rape 8 (5.6)	Chicken 15 (4.9)	

n (%)

school lunches and home lunches according to household income ( $P = 0.001$  in 6~11-year-old students and  $P = 0.041$  12~17-year-old students, respectively) and residential area ( $P < 0.001$  in both 6~11-year-old students and 12~17-year-old students). Students from low-income households accounted for 32.2% and 24.3% of the school lunch group in the 6~11 and 12~17-year-old students, respectively, while it appeared to be 43.8% and 36.0% in the home lunch group. In terms of the residential area, students living in cities accounted for the most (40.1%, 52.1%) in the school lunch group, whereas students living in villages accounted for the most (59.3%, 53.3%) in the home lunch group in both age groups.

## 2. Foods frequently consumed at lunches

Regardless of the age group, the most frequently consumed food in both the school lunch group and home lunch group was rice, followed by pork. Fruits and dairy products did not appear in the top 15 list of the frequently consumed foods in both lunch groups. The types of vegetables consumed in the school lunch group were less diverse than the ones consumed in the home lunch group in both age groups. In contrast, the types of meats consumed in the school lunch group were more diverse than those consumed in the home lunch group. Various kinds of meats, such as pork, chicken, and beef, appeared in school lunches, whereas pork appeared to be the only major type

of meat in home lunches (Table 2).

## 3. Amount of Food group intakes at lunches

Table 3 shows the amount of lunch intakes for each food group. When 40% of the daily recommended intake in the Chinese Food Pagoda was taken as a reference, the over intake of meats and insufficient intake of seafood were observed in both lunch groups. The intakes of fruits and dairy products were almost zero. In terms of vegetable intake, both lunch groups among 6~11-year-old students consumed less than the recommended amount. However, the school lunch group (87.4 g) showed significantly lower consumption than the home lunch group (99.6 g) ( $P = 0.017$ ). Among the 12~17-year-old students, the home lunch group (121.2 g) met the standard for vegetable intake, whereas the school lunch group (96.2 g) did not ( $P = 0.003$ ).

## 4. Patterns of food group intake at lunches

Table 4 shows the food group intake patterns of the school lunch and home lunch groups. The pattern found most frequently in both lunch groups was the one with meats, grains, and vegetables (DMGFV = 01101), which accounted for more than 70% in the school lunch group and more than 50% in the home lunch group in both age groups. Diets only composed of grains and vegetables (DMGFV = 00101) were 13.6% and 6.9% in the school

**Table 3.** Amount of food group intake at school lunches and home lunches by Chinese students

Food group <sup>1)</sup>	6~11-year-old students			12~17-year-old students			Recommended values <sup>3)</sup>
	School lunch group (n=177)	Home lunch group (n=457)	P-value <sup>2)</sup>	School lunch group (n=144)	Home lunch group (n=306)	P-value <sup>2)</sup>	
Cereals/tubers/legumes excluding soybean (g)	111.6 ± 5.3	120.3 ± 3.3	0.873	135.6 ± 6.9	152.2 ± 5.9	0.921	100~160
Vegetables (g)	87.4 ± 5.7	99.6 ± 4.3	0.017	96.2 ± 7.8	121.2 ± 5.3	0.003	120~200
Fruit (g)	1.2 ± 1.2	0.0	0.024	0.0	0.0	–	80~140
Meats (g)	47.3 ± 4.0	30.9 ± 2.2	0.347	60.6 ± 4.4	40.7 ± 3.8	0.722	16~ 30
Seafood (g)	4.2 ± 1.8	6.4 ± 1.2	0.449	2.6 ± 1.2	9.4 ± 2.2	0.074	16~ 30
Eggs (g)	12.2 ± 2.3	8.9 ± 1.0	0.994	13.8 ± 2.6	11.7 ± 1.7	0.782	10~ 20
Milk/dairy products (g)	0.3 ± 0.3	0.0	0.055	0.0	0.0	–	120
Soybean/nuts (g)	9.2 ± 1.8	7.2 ± 1.1	0.155	9.6 ± 2.4	12.1 ± 1.7	0.661	10~ 14

Mean ± SE

1) Classified according to the 'Chinese Food Guide Pagoda' excluding salt and oil

2) By ANCOVA with gender, household income and residential area as covariates

3) 40% of the daily recommended intakes presented at 'Chinese Food Guide Pagoda' for those whose energy requirement is 1,600~2,400 kcal

**Table 4.** Chinese students' food group intake patterns at school lunches and home lunches

DMGFV <sup>1)</sup>	6~11-year-old students				12~17-year-old students				
	School lunch group (n=177)		Home lunch group (n=457)		School lunch group (n=144)		Home lunch group (n=306)		P-value <sup>2)</sup>
01101 (M+G+V)	126	(71.2)	247	(54.1)	105	(72.9)	177	(57.8)	
00101 (G+V)	24	(13.6)	138	(30.2)	16	(6.9)	78	(25.5)	0.004
01100 (M+G)	9	(5.1)	39	(8.5)	10	(11.1)	31	(10.1)	
00100 (G)	10	(5.6)	24	(5.3)	4	(2.8)	11	(3.6)	
00000	3	(1.7)	7	(1.5)	7	(4.9)	6	(2.0)	
Others <sup>3)</sup>	5	(2.9)	2	(0.4)	2	(1.4)	3	(1.0)	

n (%)

1) DMGFV = dairy, meat, grain, fruit, and vegetable groups. 1 = A minimum amount or more of food belonging to the food group was consumed, 0 = A minimum amount of food belonging to the food group was not consumed. For meat, fruit, and vegetable groups, a minimum amount is 10 g for all solid foods with a single ingredient and 20 g for all liquids and mixed dishes. For dairy and grain groups, 5 g for all solid foods with a single ingredient and 10 g for all liquids and mixed dishes are the minimum amounts.

2) By  $\chi^2$  test

3) Others were 00001, 01001, 10101, or 01111 among 6~11-year-old students and 00001 and 01001 among 12~17-year-old students.

**Table 5.** Dietary Diversity Score of school lunches and home lunches consumed by Chinese students

Dietary Diversity Score <sup>1)</sup>	6~11-year-old students			12~17-year-old students		
	School lunch group (n=177)	Home lunch group (n=457)	P-value <sup>2)</sup>	School lunch group (n=144)	Home lunch group (n=306)	P-value <sup>2)</sup>
0-1	7.9	6.8	< 0.001	7.6	6.2	0.002
2	19.8	39.2		19.4	36.0	
3	71.8	54.0		72.8	57.8	
4-5	0.6	0.0		0.0	0.0	
	2.6 ± 0.1	2.5 ± 0.0 <sup>3)</sup>	0.738	2.6 ± 0.1	2.5 ± 0.0 <sup>3)</sup>	0.818

% or Mean ± SE

1) For meat, fruit, and vegetable groups, a minimum amount for allocating 1 point in Dietary Diversity Score is 10 g for all solid foods with a single ingredient and 20 g for all liquids and mixed dishes. For dairy and grain groups, 5 g for all solid foods with a single ingredient and 10 g for all liquids and mixed dishes are the minimum amounts.

2) By  $\chi^2$  test or ANCOVA with gender, household income and residential area as covariates

3) It is the value rounded to one decimal place.

**Table 6.** Dietary Variety Score of school lunches and home lunches consumed by Chinese students

Dietary Variety Score	6~11-year-old students			12~17-year-old students		
	School lunch group (n=177)	Home lunch group (n=457)	P-value <sup>1)</sup>	School lunch group (n=144)	Home lunch group (n=306)	P-value <sup>1)</sup>
0	0.6	0.0	0.020	0.0	0.0	0.607
1	2.3	4.2		5.6	3.6	
2	7.9	19.0		11.1	17.0	
3	31.1	32.0		29.2	30.1	
4	30.5	22.3		23.6	22.9	
5	19.2	14.7		17.4	13.7	
6	6.2	5.3		9.0	7.2	
7	1.7	2.0		4.2	4.3	
8	0.0	0.2		0.0	1.0	
9	0.6	0.4		0.0	0.3	
	3.8 ± 0.1	3.5 ± 0.1	0.551	3.8 ± 0.1	3.7 ± 0.1	0.422

% or Mean ± SE

1) By  $\chi^2$  test or ANCOVA with gender, household income and residential area as covariates

lunch group, and 30.2% and 25.5% in the home lunch group for the 6~11-year-old students and 12~17-year-old students, respectively. Diets including all five food groups (DMGFV = 11111) didn't exist. The food group intake patterns showed significant differences in distribution between the school lunch and home lunch groups among 6~11 year-old students ( $P < 0.001$ ) as well as 12~17 year-old students ( $P = 0.004$ ).

### 5. Dietary diversity and variety of lunches

Tables 5 and 6 present the results of the DDS and DVS analyses, respectively. Regardless of the age group, score 3 was found most frequently, followed by scores 2, 0-1 among DDS scores in both school lunch and home lunch groups. According to the results of DVS analysis, the subjects consumed as many as nine different foods within a single meal. Approximately 50% of students consumed 3~4 different food items. On the other hand, there was no significant difference in the means of DDS and DVS between the two lunch groups after adjusting for gender, household income, and residential area.

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## Discussion

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The results of Chinese students' overconsumption of meat and underconsumption of fruits and dairy products from school lunches seem to be due to the school lunch operations not following the nutritional guidelines of school meals. The overconsumption of meats from school lunches was because Chinese school lunches were generally composed of one meat dish and one meat-vegetable mixed dish [9]. According to an analysis of Chinese students' meat consumption during 1991~2011, the percentage of students who overconsumed meats increased from 32.9% in 1991 to 59.8% in 2011 [30]. Such a trend also reflects the increasing preference for low-carbohydrate, high-fat diets among students. As the proportion of students being either overweight or obese reached 15% in China [15], it is necessary to modify school lunch menus to decrease the amount of meats provided in school lunches.

Since 2000, China has provided milk in elementary and middle schools [31]. Approximately 22.4 million students received milk at schools in 2014 [32], which accounted for

about 10% of the total number of elementary and middle school students in China [33]. However, this number was not reflected in this study because the level of dairy product consumption was approximately zero. Milk might be provided at other times than lunch, but including milk in school lunches remains a high priority on the agenda for the school lunch program [34].

Adolescents' intake of fruits has increased continuously in China since 2010, but a study reported in 2016 showed that a half of the students still did not consume fruits daily [13]. Previous studies claimed that fruits were not provided as a part of school lunches in China [11, 35], but the reason was not given. In China, meals are generally not accompanied by fruits, which may partially explain this problem. Nevertheless, providing fruits at school lunches is needed to increase fruit consumption, as well as to raise awareness of the importance of eating fruits daily.

Unbalanced meal composition may cause nutrition problems. Although there has been considerable improvement in the daily diets accompanied by China's significant economic development, the inadequate intake of several nutrients still remains as problems. According to several empirical studies in China, deficiency of several nutrients, such as calcium, iron, and vitamin D, was related to the inadequate intake of fruits, vegetables, and dairy products [36, 37]. The results of the present study revealed similar problems of an unbalanced food group intake from both school and home lunches.

In 1998, the Ministry of Health in China established a standard suggesting school lunches to provide 40% of the Dietary Reference Intakes (DRIs) and presented nutrient-based and food-group based amounts for school lunches [26]. On the other hand, these standards only served as guidelines for foodservice personnel rather than being compulsory and enforced by the government [38]. This may partially explain the inconsistency in the quality of school lunches in China. The standard was revised in 2017 and renamed as Nutrition Guidelines of School Meals [9].

Japan and South Korea, China's neighboring countries, enacted the School Meals Act and legislated nutritional standards [39]. Both countries implemented nutrient-based standards that were revised periodically to be consistent with the reference values of the DRIs. It seems to be



essential for China to make the nutritional standards for school lunches compulsory in school lunch services to reduce the nutritional quality gap among them.

This study focused on the analysis of students' reported food intake from both school and home lunches. The actual food intake is generally influenced by the dietary guidance by parents or school food service personnel and provision of school lunches, as well as the students' personal preference. The results of this study showed that both school and home lunches lacked dietary diversity. On the other hand, some elementary school lunches provided foods from an even smaller number of food groups than home lunches. Several studies revealed similar problems [7, 11, 40], but an inferior quality of school lunches in some schools compared to home lunches was not reported before this study.

Previous studies showed that parents could positively influence children's food choices when dining together at home [41, 42]. The result of the current study showed students in the home lunch group consumed a wider variety of vegetables than those in the school lunch group, which may reflect the parents' positive influence at home [43]. Most schools in China currently do not have dietitians [44], which may have resulted in the absence of this kind of dietary guidance at schools. Countries, such as South Korea and Japan, have redefined the roles and responsibilities of school dietitians. For example, South Korea adopted the Nutrition Teacher System in 2006 and had nutrition teachers replace school dietitians. Nutrition teachers play dual roles as teachers on nutrition as well as managers of school food operations [45]. Japan also implemented a school-based nutrition education program and started the Nutrition Teacher System [46].

Compared to 6~11-year-old students, the advantage of home lunches was not observed in 12~17-year-old students. The students at this age range developed personal preferences on taste. They tended to choose unhealthy foods due to a lack of nutrition knowledge [47]. Hence, improving nutrition knowledge could lead to a change in dietary behavior [48]. Nutrition education targeting students at this age range could play an important role in forming healthy dietary habits.

This study has several limitations. The data from the

2011 China Health and Nutrition Survey were collected mainly in fall and winter during a year. Therefore, the dietary intake data used in this study may be biased by seasonality and may not reflect the usual dietary intakes [30]. As this study only analyzed the food intakes rather than nutrient intakes, future research will be needed to analyze the nutrient intakes from both school lunches and home lunches.

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## Conclusions

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The dietary quality of Chinese students' lunch consumed at schools did not appear to be superior to that of the students' lunch consumed at home in general. To improve the quality of school lunches in China, the balance and diversity of the menu composition should be considered. In particular, school lunch menus should be planned to reduce the amount of meats, increase the amount of vegetables, and include dairy products and fruits. In addition, it would be helpful to consider adopting compulsory nutritional standards and employing dietitians, whose main roles are to manage school lunch services. The school lunch service in China has much room to improve compared to school lunches in other advanced countries. The efforts in revising school meals in China will become a driving force for improving the nutrition and health of children and adolescents in the future.

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