Original Article

Dairy Consumption and Associations with Nutritional Status of Chinese Children and Adolescents*

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Abstract

Objective This study aimed to describe frequency and quantity of total dairy consumption of Chinese children and adolescents and explore the associations between dairy consumption and nutrition status, including stunting, wasting, overweight, and obesity.

Methods Participants included 28,250 children and adolescents aged 6-17 years old. A food frequency questionnaire (FFQ) including 100 kinds of food was used to collect information about frequency and quantity of dairy consumption. Determination of stunting was with a height cutoff value for age and gender, and determination for wasting, overweight, and obesity was with BMI for age and gender.

Results Of the total sample, 36.1% of children aged 6-17 reported consuming dairy food more than once per day (≥ 1/day). The average total dairy intake of all the participants was 126.7 g/day. For boys, dairy consumption had an inverse correlation with stunting and wasting after controlling for confounders. For girls, dairy consumption was negatively associated with stunting and obesity after controlling for confounders as above.

Conclusion Dairy consumption in Chinese children and adolescents was relatively lower than that in developed countries, and was negatively associated with stunting and wasting for boys and with stunting and obesity for girls.

Key words: Dairy consumption; Children and adolescents; Nutrition status; Association; China

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INTRODUCTION

Dairy products such as milk, cheese, yogurt and powdered milk are a good source of several macronutrients and micronutrients including protein, fat, calcium, riboflavin, phosphorus, potassium, magnesium, zinc, vitamin A and vitamin B_{12}[1,2]. For example, dairy products contribute 53%, 25%, 24%, 29%, and 38% to the total calcium, zinc, vitamin A, vitamin B_{12}, and vitamin B_2 intake respectively among children and adolescents aged 3-17 years in France[3]. However, according to the data from the Chinese Nutrition and Health Surveillance (CNHS) 2002, dairy foods contributed only 4.3%, 1.0%, 2.1%, and 3.0% to the total calcium, zinc, vitamin A and vitamin B_2 intake respectively among Chinese residents aged 2-70[4]. Recent papers and reports have indicated that dairy consumption of Chinese residents is at a relatively low level[5]. In China, no referable data

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concerning children exist in publications in recent years.

Nutrients in dairy food play an important role in the physical development of children and adolescents. Adolescence is a critical stage for bone mineral accrual, and therefore adequate calcium intake is necessary for increasing bone density and maximizing peak bone mass[6]. Studies of China, South Africa, America and Gambian all revealed similar findings[7-10]. Dairy food is also an important source of high-quality protein and lipids, and both provide energy[11]. Peptides and bioactive actors in dairy products may have specific effects on body growth. Adding cow's milk to the diet of stunted children is likely to improve linear growth and thereby reduce morbidity and adding cow's milk to the diet of well-nourished children can lead to higher levels of IGF-I in circulation or an increase in the velocity of linear growth[12].

As the rate of obesity is increasing[13,14], the association between dairy consumption and adiposity has recently become an important topic. For adults, observational studies on this association showed inconsistent results. Some studies have suggested that dairy intake is a dietary risk for obesity, while other studies have shown that dairy consumption has a potential protective effect against obesity[15,16]. Most studies concerning children and adolescents reported null or inverse association, which might result from the specificity of children's physical development[17-19]. On the other hand, dairy food, especially milk, could improve the health status of malnourished children[20,21]. However, few papers have focused on the association between dairy consumption and nutritional health status of Chinese children and adolescents who have lower dairy consumption.

The Chinese Nutrition and Health Surveillance (CNHS) is an ongoing national survey series that aimed to explore how social, economic and demographic changes in China affected health and dietary behaviors. This program has been conducted for four rounds beginning at 1959, 1982, 1992, and 2002, and is one of the most representative surveys in China. The fifth round began at 2010 and covered about 2,000,000 people. By analyzing data from the 2010-2012 CNHS, this study was to explore dairy products intake and its relationship with nutritional status including stunting, wasting, overweight and obesity of Chinese children and adolescents aged 6-17.

MATERIALS AND METHODS

Subjects

The data in this study were from the CNHS 2010-2012. A multi-stage stratified cluster randomization proportional to population size sampling method selected the participants. In a total of 150 monitoring sites in 31 provinces, four kinds of places of different development levels were chosen, including 34 big cities (metropolis), 41 middle-sized and small cities, 45 rural areas and 30 poor rural areas. Six neighborhood communities each with 75 households were selected at each site. If less than 20 persons were recruited in each age group of 6-17 years old from the households, samples from the junior and middle school in the same communities served as supplements. Basic demographic information, including name, age, gender, race, education, marital status, occupation and average annual household income, was collected through the household survey questionnaires. The details of the CNHS have been described elsewhere[22]. Outliers, incomplete data and illogical data were eliminated by data cleaning and a total of 28,250 children and adolescents aged 6-17 years old were included in this analysis.

Dietary and Physical Development Data

Dietary intakes were assessed using a food frequency questionnaire (FFQ) including 100 kinds of food adapted specially for use in this program. The FFQ was based on the 2002 round of CNHS, which had been tested by comparing with data obtained by a six repeated 24-hour recalls for 3 consecutive days[23]. Participants needed to fill the consumption frequency according to four different time-periods including times per day, times per week, times per month and times per year, and consumption quantity each time. Twenty-five households in each neighborhood community were randomly selected to fill out the FFQ questionnaire. The questionnaire was administered through face-to-face interviews by well-trained investigators. With the investigator, persons more than 6 years of age in each home completed a unified FFQ questionnaire. With the help of their parents and the investigator, children under 12 years of age completed the questionnaire.

The dairy foods on the FFQ questionnaire included full-fat milk, skimmed and low-fat milks, milk powder, yogurt and cheese. Investigators provided several dairy products which were common

in local market and help the participants recall their dairy intake consumption frequency and quantity. We also have some drawings of different kinds of food which can help participants recall their consumption quantity each time.

The frequencies and quantities of all the dairy foods were summarized and categorized. The frequencies of total dairy products were categorized as: (1) 0/week; (2) ≤ 1/week; (3) 2-6/week; and (4) ≥ 1/day. The quantities of total dairy products consumption was expressed as grams per day, calculated by multiplying quantity of each time by times per year, and divided by 365, and then categorized as: (1) 0 g; (2) 1-99 g; (3) 100-199 g; (4) 200-299 g; and (5) ≥ 300 g. For the intake of skimmed and low-fat milk was quite low, the five kinds of dairy foods (full-fat milk, skimmed and low-fat milks, milk powder, yoghurt and cheese) were categorized into four kinds: fluid milk, yogurt, milk powder, and cheese. Dairy consumption frequencies and quantities and nutrition status of different grades of different categories were both presented as number of cases (*n*) and proportions (%). Mean value of fluid milk and yogurt intake of all the respondents were calculated.

Consumption quantities of grains, meat, and eggs per day were calculated using a method the same as that of total dairy food. Six kinds of food including rice, wheat flour, other grains, tubers, beans, and cornmeal were summarized as grains. Fourteen kinds of food including fresh or cooked pork, beef, mutton, poultry, animal viscera, other kinds of meat, etc. were summarized as meat. Fresh egg, salted duck egg and preserved egg were summarized as eggs.

The information of physical activity and sedentary time in the past week was assessed using a Physical Activity Questionnaire. Status of physical activity was defined as yes or no. Sedentary time was expressed as hours per day.

Physical Development Data

Body height and weight were measured using standard protocols by well-trained local county CDCs staff. A fasting physical examination was carried out in the morning and subjects were measured only wearing underwear. Height was measured to the nearest 0.1 cm on a column stadiometer and weight to the nearest 0.1 kg on a lever weight scale. BMI was calculated based on the formula: body weight/the square of height. Participants with BMI > 35 or < 10 were excluded from the analysis. Stunting and wasting classification was based on the Screening Standard For Malnutrition Of School-age Children And Adolescents (WS/T456-2014)[24]. If the height of one subject was less than or equal to the cutoff value of the specific age/sex group, he/she was judged to be stunting. After excluding the stunting samples, wasting classification used the BMI value and the same principle. The overweight and obesity classification was based on the Technical Standard For Physical Examination For students (GB/T26343-2010)[25]. Overweight or obesity were classified as BMI more than or equal to the cutoff value of overweight or obesity in specific age/sex group.

Statistical Analysis

Wilcoxon rank-sum test was used for the comparison of two ordered variables and *Z* value was calculated. Kruskal-Wallis *H* test was used for the comparison of multi-classed ordered variables and *H* value was calculated. Chi-square test (χ^2-test) was used for the comparison of multi-classed disordered variables. Kruskal-Wallis test was used for non-normal continuous variables. Multinomial logistic regression evaluated the association between dairy consumption and nutrition status after controlling for area, age, residential area development, average annual household income, consumption frequency of grains, meat and eggs, status of physical activity and sedentary time. All regression models were stratified by sex. The odds ratio (*OR*) and 95% confidence interval (95% *CI*) were calculated. All *P*-values were two-tailed and *P*-values < 0.05 were considered to indicate statistical significance. All statistical analyses were performed with SAS 9.3 (SAS Institute Inc., Carey, NC, USA).

RESULTS

General Characteristic of the Study Population

General characteristic of the study population and distribution of the samples are outlined in Table 1. A total of 28,250 children and adolescents aged 6-17 years old were included in this analysis, with 14,168 boys (50.2%) and 14,082 girls (49.8%) after data cleaning. Samples of the four age groups (6-8, 9-11, 12-14, and 15-17) were 6,523/23.1%, 7,090/25.1%, 7,585/26.9%, and 7,052/25.0%, respectively. Proportions of the five household income levels were significantly different, among which the proportion of household incomes of

5,000-9,999 CNY was highest (24.6%) and of 15,000-19,999 CNY lowest (12.0%).

Consumption Frequency of Dairy Products

Of the children and adolescents enrolled, 36.1% consumed total dairy food more than once per day (≥ 1/day), with decreased seen with age. This proportion in large cities, small-medium cities, general rural areas and poor rural areas were 58.9%, 39.4%, 26.9%, and 15.3%, respectively ($P < 0.05$). This proportion in the five income levels (< 5,000, 5,000-9,999, 10,000-14,999, 15,000-19,999, and ≥ 20,000) were 24.0%, 29.8%, 37.5%, 40.8%, and 48.3%, respectively ($P < 0.05$). Approximately 12.6% children did not consume dairy food (0/week). No significant differences were observed in dairy food consumption frequency between boys and girls (Table 1).

Children who consumed fluid and yogurt more than once per day (≥ 1/day) was 22.5% and 13.6%, respectively. About 41.6% children did not consume fluid milk and 29.9% children didn't consume yogurt (Table 1).

Consumption Quantity of Dairy Products

The average quantity of dairy consumption was 126.7 g/day in Chinese children and adolescents aged 6-17. Children who consumed more than 300 g/day of dairy food were 9.4%. The proportion of children consuming this level of dairy food was 18.8% in large cities and 2.7% in poor rural areas. The proportions of children consuming more than 200 g/day of dairy food were 29.9%, 27.5%, 25.7%, and 24.4% in the four age groups (6-8, 9-11, 12-14, and 15-17) and 44.9%, 29.7%, 18.8%, and 11.0% in the four area types (the large city, small-medium city, general rural area and poor rural area) ($P < 0.05$). These proportions increased with average annual household income ($P < 0.05$) (Table 2).

The average quantity of fluid milk and yogurt were only 76.4 g/day and 45.8 g/day in Chinese children and adolescents (Table 2).

Table 1. Characteristics across Categories of Frequencies of Dairy Consumption[^]

Sample Characteristics	Sample Size, *n* (%)	Dairy Consumption Frequency, *n* (%)				*Z*/*H* Value (*P* Value)
		0/week	≤ 1/week	2-6/week	≥ 1/day	
Total dairy	28,250 (100.0)	3,568 (12.6)	4,095 (14.5)	10,380 (36.7)	10,207 (36.1)	
Gender						0.7521 (0.4520)[*]
Boys	14,168 (50.2)	1,914 (13.5)	2,016 (14.2)	5,059 (35.7)	5,179 (36.6)	
Girls	14,082 (49.8)	1,654 (11.7)	2,079 (14.8)	5,321 (37.8)	5,028 (35.7)	
Age (y)						147.0331 (< 0.0001)[#]
6-8	6,523 (23.1)	740 (11.3)	779 (11.9)	2,401 (36.8)	2,603 (39.9)	
9-11	7,090 (25.1)	840 (11.8)	924 (13.0)	2,615 (36.9)	2,711 (38.2)	
12-14	7,585 (26.9)	1,004 (13.2)	1,254 (16.5)	2,701 (35.6)	2,626 (34.6)	
15-17	7,052 (25.0)	984 (14.0)	1,138 (16.1)	2,663 (37.8)	2,267 (32.1)	
Residential area						3431.0373 (< 0.0001)[#]
Large city	6,785 (24.0)	357 (5.3)	402 (5.9)	2,033 (30.0)	3,993 (58.9)	
Small-medium city	8,131 (28.8)	886 (10.9)	829 (10.2)	3,209 (39.5)	3,207 (39.4)	
General rural area	8,353 (29.6)	1,186 (14.2)	1,542 (18.5)	3,379 (40.5)	2,246 (26.9)	
Poor rural area	4,981 (17.6)	1,139 (22.9)	1,322 (26.5)	1,759 (35.3)	761 (15.3)	
Annual family income (CNY)[a]						1035.3793 (< 0.0001)[#]
< 5,000	4,473 (21.2)	935 (20.9)	912 (20.4)	1,552 (34.7)	1,074 (24.0)	
5,000-9,999	5,196 (24.6)	748 (14.4)	962 (18.5)	1,936 (37.3)	1,550 (29.8)	
10,000-14,999	4,390 (20.8)	478 (10.9)	597 (13.6)	1,668 (38.0)	1,647 (37.5)	
15,000-19,999	2,539 (12.0)	232 (9.1)	267 (10.5)	1,004 (39.5)	1,036 (40.8)	
≥ 20,000	4,530 (21.4)	385 (8.5)	354 (7.8)	1,604 (35.4)	2,187 (48.3)	
Fluid milk	28,249 (100.0)	11,752 (41.6)	3,425 (12.1)	6,725 (23.8)	6,347 (22.5)	
Yogurt	28,224 (100.0)	8,455 (29.9)	7,695 (27.2)	8,260 (29.2)	3,834 (13.6)	

Note. [^]Values are number (percentage) unless otherwise indicated; [a]The sample size with completed frequency and income information was 21,128; [*]*Z* value for the Wilcoxon Test; [#]*H* value for the Kruskal-Wallis H Test; CNY, China Yuan.

Table 2. Characteristics across Categories of Amount of Dairy Consumption[^]

Sample Characteristics	Sample Size, *n* (%)	Amount (g)	*n* (%) by Distribution of Dairy Consumption Amounts					*Z*/*H* Value (*P* Value)
			0 g	1-99 g	100-199 g	200-299 g	≥ 300 g	
Total dairy	28,210 (100.0)	126.7	3,568 (12.6)	11,532 (40.9)	5,544 (19.7)	4,918 (17.4)	2,648 (9.4)	
Gender								0.4311 (0.6664)[*]
Boys	14,114 (50.1)	128.2	1,914 (13.5)	5,645 (39.9)	2,694 (19.0)	2,550 (18.0)	1,341 (9.5)	
Girls	14,066 (49.9)	125.2	1,654 (11.8)	5,887 (41.9)	2,850 (20.3)	2,368 (16.8)	1,307 (9.3)	
Age (y)								69.4352 (< 0.0001)[#]
6-8	6,509 (23.1)	135.1	740 (11.4)	2,544 (39.1)	1,277 (19.6)	1,343 (20.6)	605 (9.3)	
9-11	7,088 (25.1)	127.8	840 (11.9)	2,809 (39.6)	1,486 (21.0)	1,328 (18.7)	625 (8.8)	
12-14	7,572 (26.8)	124.6	1,004 (13.3)	3,169 (41.9)	1,453 (19.2)	1,234 (16.3)	712 (9.4)	
15-17	7,041 (25.0)	122.9	984 (14.0)	3,010 (42.7)	1,328 (18.9)	1,013 (14.4)	706 (10.0)	
Residential area								3082.6510 (< 0.0001)[#]
Large city	6,770 (24.0)	190.1	357 (5.3)	1,819 (26.9)	1,557 (23.0)	1,766 (26.1)	1,271 (18.8)	
Small-medium city	8,117 (52.8)	138.5	886 (10.9)	3,030 (37.3)	1,790 (22.1)	1,593 (19.6)	818 (10.1)	
General rural area	8,344 (29.6)	99.8	1,186 (14.2)	3,994 (47.9)	1,591 (19.1)	1,147 (13.7)	426 (5.1)	
Poor rural area	4,979 (17.6)	66.2	1,139 (22.9)	2,689 (54.0)	606 (12.2)	412 (8.3)	133 (2.7)	
Annual family income (CNY)[a]								815.3618 (< 0.0001)[#]
< 5,000	4,469 (21.2)	93.1	935 (20.9)	2,050 (45.9)	632 (14.1)	567 (12.7)	285 (6.4)	
5,000-9,999	5,192 (24.6)	107.8	748 (14.4)	2,416 (46.5)	883 (17.0)	785 (15.1)	360 (6.9)	
10,000-14,999	4,385 (20.8)	129.6	478 (10.9)	1,811 (41.3)	842 (19.2)	887 (20.2)	367 (8.4)	
15,000-19,999	2,533 (12.0)	139.7	232 (9.2)	968 (38.2)	558 (22.0)	514 (20.3)	261 (10.3)	
≥ 20,000	4,518 (21.4)	160.1	385 (8.5)	1,482 (32.8)	1,048 (23.2)	979 (21.7)	624 (13.8)	
Fluid milk	28,249 (100.0)	76.4	11,752 (41.6)	7,867 (27.8)	3,382 (12.0)	4,455 (15.8)	793 (2.8)	
Yogurt	28,244 (100.0)	45.8	8,455 (29.9)	15,156 (53.7)	2,915 (10.3)	1,443 (5.1)	275 (1.0)	

Note. [^]Values are number (percentage) unless otherwise indicated; [a]The sample size with completed amount and income information was 21,097; [*]*Z* value for the Wilcoxon Test; [#]*H* value for the Kruskal-Wallis H Test; CNY, China Yuan.

Total Dairy Consumption & Stunting and Wasting Rate

The proportions for stunting and wasting children were 2.2% and 7.6% in Chinese children and adolescents, respectively, with higher proportions in boys (2.4% and 8.8%) than in girls (2.0% and 6.4%) ($P < 0.05$). The 15-17 years old group had the highest stunting and wasting percentage with 2.9% and 8.1%, respectively ($P < 0.05$). The stunting and wasting proportions decreased with the development of cities and the increase of income level ($P < 0.05$). Proportions of stunting and wasting both decreased with the dairy consumption frequency ($P < 0.05$). These two proportions with a consumption of '≥ 1 /day' were 1.6% and 6.5%, while that with no dairy consumption ('0/week') were 3.9% and 9.3%. These trends in the quantity were almost the same as that in frequency ($P < 0.05$) (Table 3).

After adjustment for area, age, residential area development, average annual household income, consumption frequency of grains, meat and eggs, status of physical activity and sedentary time, dairy consumption frequency was negatively associated with stunting and wasting for boys, and only with stunting for girls. The relative risk (*OR* with 95% confidence interval) of stunting with total dairy consumption frequency of ≥ 1/day among boys was 0.616 (0.417-0.912) compared to 0/week. The relative risk of wasting was 0.738 (0.590-0.924) among boys in the ≥ 1/day frequency group. For the frequency of 2-6/week group and the quantity of 1-99 g group among girls, the relative risk of stunting was 0.570 (0.376-0.862) and 0.560 (0.379-0.830). There were no significant association between wasting and total dairy consumption among girls (Table 4).

For boys, the consumption frequency of fluid milk was negatively associated with stunting, and the relative risk of stunting with consumption frequency of fluid milk of 2-6/week was 0.663 (0.461-0.951) comparing to 0/week (Supplementary Table 1 available in www.besjournal.com). The consumption of yogurt was negatively with stunting for girls, and with wasting for boys (Supplementary Table S2 available in www.besjournal.com).

Total Dairy Consumption & Overweight and Obesity Rate

Of this study population of children, 10.7% were overweight and 5.9% obese. The proportion of boys who were overweight (12.6%) or obese (7.8%) were both higher than that of girls who were overweight (8.8%) or obese (4.0%) ($P < 0.05$). In the 9-11 age group, 12% were overweight, which was the most within the four age groups (6-8, 9-11, 12-14, and 15-17). The highest proportion of obesity was 9.6% and within the 6-8 age group. As the development of cities expanded and income of families increased, the proportion of overweight and obese children rose ($P < 0.05$). The proportion of obese children went up with the frequency of dairy food consumption. Obesity proportions within the four age groups for dairy consumption frequency were 5.1%, 5.2%, 5.6%, and 6.8%, and that of the five quantity groups were 5.1%, 5.4%, 6.4%, 6.5%, and 6.8% ($P < 0.05$). The overweight proportion with quantity followed the same trend (Table 3).

Logistic regression analysis showed that the association between total dairy consumption and obesity among boys and girls were significant after controlling for area, age, residential area development, average annual household income, consumption frequency of grains, meat and eggs, status of physical activity and sedentary time. The relative risk of obesity with the consumption quantity of 200-299 g in boys were 0.738 (0.555-0.981), and the relative risk of obesity with the consumption quantity of ≥ 300 g in girls was 0.561 (0.350-0.899) (Table 4). Similar relationship were found in the consumption of fluid milk in girls (Supplementary Table S1). There was no significant association between dairy consumption with overweight.

DISCUSSION

This paper analyzed the data from 2010-2012 Chinese National Nutrition and Health Surveillance (CNHS), and indicated the relatively lower dairy consumption frequency and quantity of Chinese children and adolescents aged 6-17. Moreover, dairy consumption was associated with lower prevalence of stunting and wasting in boys, and only with lower prevalence of stunting in girls. Prevalence of obesity was negatively associated with total dairy consumption both in boys and girls.

In the Dietary Guidelines of Chinese School-aged Children, the recommendation of dairy intake was no less than 300 grams per day (or an equivalent dairy food)[26]. The average dairy intake in this study was only 126.7 grams per day, which was much lower than the recommendation. The total dairy consumption

Table 3. Nutritional Characteristics of the Different Study Groups[^]

Sample Characteristics	Sample Size, *n* (%)	*n* (%) by Nutritional Status					χ^2 Value[*]	*P* Value
		Normal	Stunting	Wasting	Overweight	Obesity		
Total	27,720 (100.0)	20,407 (73.6)	606 (2.2)	2,107 (7.6)	2,964 (10.7)	1,636 (5.9)		
Total dairy								
Frequency							162.2186	< 0.0001
0/week	3,502 (100.0)	2,529 (72.2)	135 (3.9)	326 (9.3)	332 (9.5)	180 (5.1)		
≤ 1/week	4,019 (100.0)	2,999 (74.6)	115 (2.9)	335 (8.3)	362 (9.0)	208 (5.2)		
2-6/week	10,168 (100.0)	7,547 (74.2)	200 (2.0)	790 (7.8)	1,064 (10.5)	567 (5.6)		
≥ 1/day	10,031 (100.0)	7,332 (73.1)	156 (1.6)	656 (6.5)	1,206 (12.0)	681 (6.8)		
Amount (g/d)[a]							131.1018	< 0.0001
0	3,502 (100.0)	2,529 (72.2)	135 (3.9)	326 (9.3)	332 (9.5)	180 (5.1)		
1-99	11,313 (100.0)	8,445 (74.6)	242 (2.1)	889 (7.9)	1,125 (9.9)	612 (5.4)		
100-199	5,441 (100.0)	3,987 (73.3)	104 (1.9)	393 (7.2)	608 (11.2)	349 (6.4)		
200-299	4,829 (100.0)	3,524 (73.0)	99 (2.1)	314 (6.5)	577 (11.9)	315 (6.5)		
≥ 300	2,596 (100.0)	1,901 (73.2)	26 (1.0)	182 (7.0)	310 (11.9)	177 (6.8)		
Fluid milk								
Frequency							102.3213	< 0.0001
0/week	11,523 (100.0)	8,549 (74.2)	318 (2.8)	903 (7.8)	1,132 (9.8)	621 (5.4)		
≤ 1/week	3,369 (100.0)	2,505 (74.4)	53 (1.6)	288 (8.5)	355 (10.5)	168 (5.0)		
2-6/week	6,593 (100.0)	4,861 (73.7)	125 (1.9)	505 (7.7)	717 (10.9)	385 (5.8)		
≥ 1/day	6,234 (100.0)	4,491 (72.0)	110 (1.8)	411 (6.6)	760 (12.2)	462 (7.4)		
Amount (g/d)[a]							92.1576	< 0.0001
0	11,523 (100.0)	8,549 (74.2)	318 (2.8)	903 (7.8)	1,132 (9.8)	621 (5.4)		
1-99	7,719 (100.0)	5,706 (73.9)	131 (1.7)	605 (7.8)	839 (10.9)	438 (5.7)		
100-199	3,325 (100.0)	2,448 (73.6)	62 (1.9)	256 (7.7)	363 (10.9)	196 (5.9)		
200-299	4,373 (100.0)	3,132 (71.6)	90 (2.1)	289 (6.6)	539 (12.3)	323 (7.4)		
≥ 300	779 (100.0)	571 (73.3)	5 (0.6)	54 (6.9)	91 (11.7)	58 (7.4)		
Yogurt								
Frequency							113.0272	< 0.0001
0/week	8,314 (100.0)	6,029 (72.5)	255 (3.1)	718 (8.6)	855 (10.3)	457 (5.5)		
≤ 1/week	7,567 (100.0)	5,632 (74.4)	173 (2.3)	582 (7.7)	789 (10.4)	391 (5.2)		
2-6/week	8,068 (100.0)	5,940 (73.6)	137 (1.7)	574 (7.1)	878 (10.9)	539 (6.7)		
≥ 1/day	3,765 (100.0)	2,804 (74.5)	41 (1.1)	231 (6.1)	441 (11.7)	248 (6.6)		
Amount (g/d)[a]							92.0490	< 0.0001
0	8,314 (100.0)	6,029 (72.5)	255 (3.1)	718 (8.6)	855 (10.3)	457 (5.5)		
1-99	14,853 (100.0)	10,976 (73.9)	289 (1.9)	1,106 (7.4)	1,583 (10.7)	899 (6.1)		
100-199	2,864 (100.0)	2,113 (73.8)	45 (1.6)	172 (6.0)	353 (12.3)	181 (6.3)		
200-299	1,414 (100.0)	1,082 (76.5)	17 (1.2)	93 (6.6)	140 (9.9)	82 (5.8)		
≥ 300	269 (100.0)	205 (76.2)	-	16 (5.9)	32 (11.9)	16 (5.9)		

Continued

Sample Characteristics	Sample Size, *n* (%)	*n* (%) by Nutritional Status					χ^2 Value*	*P* Value
		Normal	Stunting	Wasting	Overweight	Obesity		
Demographic characteristics								
Gender							425.5956	< 0.0001
Boy	13,887 (100.0)	9,500 (68.4)	333 (2.4)	1,216 (8.8)	1,752 (12.6)	1,084 (7.8)		
Girl	13,833 (100.0)	10,907 (78.8)	273 (2.0)	888 (6.4)	1,212 (8.8)	552 (4.0)		
Age (y)							497.4865	< 0.0001
6-8	6,406 (100.0)	4,440 (69.3)	147 (2.3)	466 (7.3)	737 (11.5)	616 (9.6)		
9-11	6,959 (100.0)	4,940 (71.0)	143 (2.1)	489 (7.0)	834 (12.0)	553 (7.9)		
12-14	7,458 (100.0)	5,683 (76.2)	117 (1.6)	590 (7.9)	772 (10.4)	296 (4.0)		
15-17	6,897 (100.0)	5,344 (77.5)	199 (2.9)	562 (8.1)	621 (9.0)	171 (2.5)		
Residential area							571.1912	< 0.0001
Large city	6,669 (100.0)	4,760 (71.4)	78 (1.2)	374 (5.6)	905 (13.6)	552 (8.3)		
Small-medium city	7,946 (100.0)	5,877 (74.0)	94 (1.2)	608 (7.7)	876 (11.0)	491 (6.2)		
General rural area	8,222 (100.0)	6,111 (74.3)	176 (2.1)	688 (8.4)	815 (9.9)	432 (5.3)		
Poor rural area	4,883 (100.0)	3,659 (74.9)	258 (5.3)	437 (8.9)	368 (7.5)	161 (3.3)		
Annual family income (CNY)[b]							181.1299	< 0.0001
< 5,000	4,384 (100.0)	3,256 (74.3)	141 (3.2)	413 (9.4)	385 (8.8)	187 (4.3)		
5,000-9,999	5,109 (100.0)	3,759 (73.6)	140 (2.7)	420 (8.2)	503 (9.8)	287 (5.6)		
10,000-14,999	4,311 (100.0)	3,174 (73.6)	84 (1.9)	320 (7.4)	466 (10.8)	267 (6.2)		
15,000-19,999	2,485 (100.0)	1,807 (72.7)	37 (1.5)	179 (7.2)	277 (11.1)	184 (7.4)		
≥ 20,000	4,443 (100.0)	3,181 (71.6)	68 (1.5)	263 (5.9)	584 (13.1)	347 (7.8)		
Other food[&]								
Grains (g/d)	254.7 (163.1)	254.7 (165.1)	269.3 (153.7)	263.5 (161.7)	252 (155.7)	243 (153.8)	13.3477#	0.0097
Meat (g/d)	94.0 (118.0)	92.8 (117.1)	70.5 (78.6)	91.5 (123.1)	104.2 (125.4)	102 (118.0)	23.3559#	0.0001
Eggs (g/d)	38.3 (39.1)	38.0 (39.4)	30.6 (32.7)	35.2 (37.9)	41.7 (38.8)	42.4 (38.2)	39.8028#	< 0.0001
Activity characteristics								
Physical activity							75.8162	< 0.0001
Yes	11,099 (100.0)	8,125 (73.2)	168 (1.5)	777 (7.0)	1,296 (11.7)	733 (6.6)		
No	16,400 (100.0)	12,128 (74.0)	423 (2.6)	1,311 (8.0)	1,643 (10.0)	895 (5.5)		
Sedentary time (hrs/d)[‡]	2.9 (1.5)	2.9 (1.5)	2.8 (1.3)	2.9 (1.4)	2.9 (1.4)	2.8 (1.4)	3.8379#	0.4284

Note. ^Values are number (percentage) unless otherwise indicated; [&]Values are mean ± SD of the average consumption per day; [‡]Values are mean ± SD of the average time per day; [a]The sample size with completed quantity information was 27,681; [b] The sample size with completed income information was 20,732; *Chi square test for multiple unordered categorical variables; #Kruskal-Wallis test for non-normal continuous variables; CNY, China Yuan.

Table 4. Association between Total Dairy Consumption and Nutrition Status in Boys and Girls[^]

Characteristics	Stunting			Wasting			Overweight			Obesity		
	n	*OR* (95% *CI*)	*P*	*n*	*OR* (95% *CI*)	*P*	*n*	*OR* (95% *CI*)	*P*	*n*	*OR* (95% *CI*)	*P*
Boys												
Frequency	333			1,218			1,752			1,084		
0/week	83	Ref.		211	Ref.		201	Ref.		112	Ref.	
≤ 1/week	62	0.690 (0.468-1.016)	0.0600	203	0.791 (0.624-1.003)	0.0526	198	0.831 (0.647-1.068)	0.1482	137	1.105 (0.825-1.481)	0.5018
2-6/week	108	0.555 (0.390-0.791)	0.0011	443	0.748 (0.608-0.919)	0.0056	593	0.938 (0.764-1.152)	0.5443	373	0.825 (0.639-1.065)	0.1390
≥ 1/day	80	0.616 (0.417-0.912)	0.0154	361	0.738 (0.590-0.924)	0.0080	760	0.979 (0.792-1.210)	0.8465	462	0.772 (0.593-1.005)	0.0547
Amount (g/d)	333			1,216			1,748			1,082		
0	83	Ref.		211	Ref.		201	Ref.		112	Ref.	
1-99	137	0.584 (0.421-0.809)	0.0012	504	0.738 (0.605-0.899)	0.0026	638	0.921 (0.753-1.126)	0.4205	387	0.913 (0.712-1.170)	0.4724
100-199	53	0.677 (0.442-1.037)	0.0732	225	0.826 (0.651-1.048)	0.1160	343	0.966 (0.771-1.210)	0.7620	240	0.909 (0.690-1.199)	0.5012
200-299	47	0.756 (0.494-1.157)	0.1977	182	0.788 (0.616-1.007)	0.0568	369	0.993 (0.793-1.244)	0.9520	214	0.738 (0.555-0.981)	0.0364
≥ 300	13	0.438 (0.210-0.915)	0.0281	94	0.706 (0.509-0.979)	0.0370	197	0.992 (0.762-1.292)	0.9524	129	0.909 (0.658-1.258)	0.5659
Girls												
Frequency	273			889			1,212			552		
0/week	52	Ref.		115	Ref.		131	Ref.		68	Ref.	
≤ 1/week	53	0.707 (0.451-1.108)	0.1303	132	0.841 (0.624-1.132)	0.2528	164	0.940 (0.711-1.243)	0.6662	71	0.839 (0.572-1.230)	0.3688
2-6/week	92	0.570 (0.376-0.862)	0.0078	347	0.847 (0.656-1.094)	0.2039	471	0.987 (0.779-1.251)	0.9133	194	0.787 (0.571-1.084)	0.1428
≥ 1/day	76	0.760 (0.484-1.187)	0.2280	295	0.841 (0.640-1.105)	0.2128	446	0.900 (0.701-1.154)	0.4057	219	0.730 (0.522-1.022)	0.0664
Amount (g/d)	273			888			1,204			551		
0	52	Ref.		115	Ref.		131	Ref.		68	Ref.	
1-99	105	0.560 (0.379-0.830)	0.0038	385	0.876 (0.684-1.121)	0.2931	487	0.927 (0.735-1.170)	0.5232	225	0.858 (0.629-1.169)	0.3319
100-199	51	0.727 (0.446-1.186)	0.2017	168	0.796 (0.592-1.069)	0.1296	265	0.977 (0.752-1.268)	0.8607	109	0.709 (0.495-1.017)	0.0619
200-299	52	1.100 (0.689-1.757)	0.6890	132	0.805 (0.594-1.093)	0.1644	208	0.875 (0.666-1.149)	0.3356	101	0.705 (0.488-1.018)	0.0620
≥ 300	13	0.797 (0.408-1.554)	0.5047	88	1.084 (0.766-1.533)	0.6488	113	0.885 (0.643-1.219)	0.4547	48	0.561 (0.350-0.899)	0.0163

Note. [^]Models adjusted for age, residential area, average annual family income, intake of meat, grains, eggs, physical activity and sedentary time.

frequency identified in this study was quite low with only 36.1% of children consuming dairy food more than one time per day. The fluid milk (76.4 g/day) and yogurt (45.8 g/day) were the two main sources of dairy products consumed by the sampled children and adolescents. Compared with an earlier study in China, the dairy consumption of Chinese children and adolescent has improved slightly. According to the earlier 2002 CNHS, the average consumption rate of milk of Chinese children aged 7 to 18 then was 10.3%, which was significantly lower than the 58.4% identified in this paper[4]. Other study approached similar result[27]. The increase of dairy consumption of Chinese children may result from the development of economy and we indeed found in this study that dairy consumption frequency and quantity increased with the annual family income and development improvement in the located region. Moreover, the increase might also related to the milk promotion program conducted by the government, such as the 'School Milk Program' launched in 1999[28,29]. However, in some studies about developed countries with higher dairy consumption, dairy food consumption decreased in different degrees over time[30-32]. The DONALD study of Germany demonstrated that from 1986 to 2001, the fluid milk intake of children aged 1 to 13 decreased between 6.3 and 2.8 g/day each year[33].

This study observed that the consumption of dairy food decreased with age in Chinese children and adolescents. A US survey containing 2,371 girls found a steady trend of decreasing milk consumption between 9-10 and 19 years of age[34]. Several cross-sectional studies indicated similar trends[19]. The decrease in dairy might be due to an increase in consumption of juice, sugar-sweetened beverages or regular soda in the older adolescents[35-39]. In this paper, dairy consumption frequency and intake increased with the increase of annual family income and with development improvements in that region. Other studies of China have also indicated that dairy consumption increased with increases in income and development improvement[40-42]. Sun Yi etc. and Shi Haibo etc. indicated that, from the perspective of economics, income and dairy price have a significant influence on the dairy consumption in China, a finding in agreement with the results of our study[43,44]. While we did not found any gender trend in consumption of total dairy, other studies have indicated that males consume greater quantities of dairy products than females[45-49]. This difference might be due to physiological needs of adolescents in developed regions. Female adolescents may intentionally reduce milk intake for weight control[50].

Our results also indicated that boys with higher dairy intake had lower prevalence of stunting and wasting, and for girls, higher dairy intake was just associated with lower prevalence of stunting after controlling the demographic characteristics and the major calorie and protein offering food in the FFQ food list. Milk might have a positive impact on linear growth with the nutrients and growth-regulating factors (IGF-1). From the early 1900s, a number of intervention and observational studies have demonstrated the positive effect of dairy foods in linear growth[51,52]. Hopper C. demonstrated that the addition of milk to the diets of populations with poor nutritional status likely supplied the nutrients essential for growth[12]. A study in Vietnam demonstrated that, after 6 months of milk interventions, the weight-for-age and height-for-age significantly improved and underweight and stunting dropped by about 10%[21]. The improvement effect on malnutrition was verified through an RCT (randomized controlled trial) study in which milk was used as a therapeutic food on malnourished children[20]. The different improvement effect between boys and girls in this study may be due to differences in status of growth and development, dietary intake, etc[53]. In addition, different choices of dairy food may play a role. The supplementary data demonstrated that the reduction effect of stunting prevalence in boys mainly due to intake of fluid milk, while the reduction effect of stunting prevalence in girls and wasting prevalence in boys mainly due to the intake of yogurt.

A negative association between obesity and dairy intake was found in girls in this study. Moreover, an obvious dose-response relationship between higher dairy consumption and lower prevalence of obesity of girls was demonstrated in this result. Most other studies have suggested an inverse association between dairy products and overweight or obesity of children, and some studies reported no significant association[16,54]. In addition, a few studies found evidence of the protective effect of dairy consumption and the risk of suffering overweight and obesity[55]. Several factors may influence the results, including the obesity assessment method, the types of dairy products (high-fat or low-fat), the study design, the calcium and calories intake and physical

activity. Different studies have controlled different factors, which may be account for differing conclusions[7,56,57]. Indeed, further studies are needed to explore the possible causes of this result for Chinese children.

This study has several limitations. (1) The cross-sectional study design is also a limitation and as a result only associations between dairy consumption and nutrition status, but not causal relationships, were drawn. (2) Because of using a FFQ but not a 24 hours recall method, we controlled the mainly calorie and protein offering food in the FFQ food list but not the total calories in the logistic regression model. (3) A recall bias may be a factor in any research that uses data from a FFQ. However, this limitation may have been reduced because the FFQ was administered by highly-trained interviewers. (4) Dairy consumption data was based on the consumption of the past one year. For older children, the body size and nutrition status of children may be influenced by the diet pattern and dairy consumption of 2-4 years[58].

The current study has many strengths. This was the latest study with such a large sample size concerning the dairy consumption and its relationship with nutrition status of Chinese children and adolescents. This study established a foundation for further research concerning Chinese children, the roles of different kinds of dairy foods, and showed the need for specific recommendations concerning dairy foods with different total energy and nutritional components that would benefit Chinese children and adolescent. We suggest that dairy consumption is useful to help control malnutrition and improve the physical qualities of Chinese children and adolescents.

CONCLUSION

In conclusion, although the dairy consumption of Chinese children and adolescents has improved in recent years, the frequency and quantity of total dairy consumption were lower compared with developed countries. There were age, residential area and household income trends in different categories of frequency and quantity. Dairy consumption frequency and intake were both higher in the lower age groups. Children in areas of higher household income and better economic development had a relatively higher consumption frequency and greater quantity consumption of dairy food intake. Increase in the frequency and quantity of dairy consumption was associated with a significant decrease in stunting or wasting for boys, while only with a decrease in stunting for girls. Higher dairy consumption might have a negative relationship with girls' obesity.

AUTHOR CONTRIBUTIONS

Conceptualization, XU Pei Pei; Funding acquisition, ZHANG Qian, ZHAO Wen Hua, and HU Xiao Qi; Investigation, XU Pei Pei, LI Li, XU Juan, YANG Ti Ti, CAO Wei, and GAN Qian; Methodology, XU Pei Pei; Project administration, ZHANG Qian, LI Li, and XU Juan; Resources, ZHANG Qian, HU Xiao Qi, and PAN Hui; Software, ZHANG Qian; Supervision, PAN Hui; Validation, XU Pei Pei, YANG Ti Ti, and GAN Qian; Visualization, XU Pei Pei and CAO Wei; Writing -original draft, XU Pei Pei; Writing-review & editing, ZHANG Qian.

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CONFLICTS OF INTEREST

The authors declare no conflicts of the interest.

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Supplementary Table 1. Association between Fluid Milk Consumption and Nutrition Status in Boys and Girls^

Characteristic	Stunting			Wasting			Overweight			Obesity		
	n	*OR* (95% *CI*)	*P*	*n*	*OR* (95% *CI*)	*P*	*n*	*OR* (95% *CI*)	*P*	*n*	*OR* (95% *CI*)	*P*
Boys												
Frequency	333			1,218			1,752			1,084		
0/week	191	Ref.		527	Ref.		645	Ref.		396	Ref.	
≤ 1/week	26	0.429 (0.263-0.699)	0.0007	175	1.066 (0.863-1.317)	0.5558	213	0.926 (0.755-1.136)	0.4604	109	0.920 (0.714-1.186)	0.5208
2-6/week	63	0.663 (0.461-0.951)	0.0258	288	1.002 (0.833-1.206)	0.9822	400	0.910 (0.774-1.070)	0.2556	254	0.872 (0.716-1.063)	0.1754
≥ 1/day	53	0.790 (0.541-1.153)	0.2216	228	0.942 (0.769-1.154)	0.5663	494	0.973 (0.828-1.143)	0.7353	325	0.893 (0.733-1.088)	0.2623
Amount (g/d)	333			1,218			1,752			1,084		
0	191	Ref.		527	Ref.		645	Ref.		396	Ref.	
1-99	64	0.477 (0.334-0.680)	<.0001	349	0.967 (0.816-1.146)	0.6972	480	0.931 (0.799-1.085)	0.3599	275	0.920 (0.763-1.109)	0.3820
100-199	32	0.918 (0.592-1.422)	0.7007	154	1.215 (0.968-1.526)	0.0932	204	0.878 (0.715-1.078)	0.2142	141	0.838 (0.654-1.047)	0.1620
200-299	42	0.886 (0.591-1.328)	0.5592	157	0.956 (0.767-1.193)	0.6913	360	1.030 (0.866-1.224)	0.7406	231	0.875 (0.706-1.084)	0.2209
≥ 300	4	0.381 (0.092-1.576)	0.1830	31	0.810 (0.489-1.340)	0.4115	63	0.988 (0.702-1.390)	0.9436	41	1.035 (0.686-1.564)	0.8683
Girls												
Frequency	273			889			1,212			552		
0/week	127			376			487			225		
≤ 1/week	27	0.815 (0.515-1.292)	0.3846	113	0.987 (0.764-1.274)	0.9174	142	0.989 (0.786-1.246)	0.9284	59	1.024 (0.744-1.409)	0.8854
2-6/week	62	0.911 (0.617-1.345)	0.6381	217	0.931 (0.754-1.149)	0.5042	317	1.044 (0.873-1.249)	0.6387	131	0.916 (0.711-1.181)	0.4991
≥ 1/day	57	1.465 (0.989-2.171)	0.0567	183	1.057 (0.846-1.321)	0.6242	266	0.969 (0.798-1.175)	0.7458	137	0.876 (0.670-1.145)	0.3324
Amount (g/d)	273			889			1,212			552		
0	127	Ref.		376	Ref.		487	Ref.		225	Ref.	
1-99	67	0.818 (0.570-1.174)	0.2754	256	0.971 (0.799-1.179)	0.7645	359	1.049 (0.887-1.241)	0.5731	163	1.067 (0.846-1.344)	0.5851
100-199	30	1.139 (0.695-1.866)	0.6061	102	0.951 (0.723-1.251)	0.7183	159	0.980 (0.779-1.232)	0.8599	55	0.664 (0.465-0.949)	0.0248
200-299	48	1.742 (1.164-2.607)	0.0070	132	1.083 (0.849-1.383)	0.5208	179	0.881 (0.709-1.096)	0.2559	92	0.874 (0.651-1.173)	0.3701
≥ 300	1	0.337 (0.046-2.449)	0.2824	23	1.261 (0.768-2.069)	0.3598	28	1.011 (0.652-1.566)	0.9619	17	0.736 (0.366-1.478)	0.3888

Note. ^: Models adjusted for age, residential area, average annual family income, intake of meat, grains, eggs, physical activity and sedentary time.

Supplementary Table 2. Association between Yogurt Consumption and Nutrition Status in Boys and Girls[^]

Characteristic	Stunting			Wasting			Overweight			Obesity		
	n	*OR* (95% *CI*)	*P*	*n*	*OR* (95% *CI*)	*P*	*n*	*OR* (95% *CI*)	*P*	*n*	*OR* (95% *CI*)	*P*
Boys												
Frequency	333			1,218			1,751			1,083		
0/week	143	Ref.		451	Ref.		519	Ref.		298	Ref.	
≤ 1/week	92	0.775 (0.566-1.063)	0.1135	347	0.869 (0.731-1.033)	0.1122	474	1.035 (0.882-1.215)	0.6733	259	1.115 (0.912-1.363)	0.2867
2-6/week	75	0.810 (0.579-1.134)	0.2205	299	0.775 (0.643-0.932)	0.0069	507	1.050 (0.896-1.231)	0.5479	371	1.257 (1.036-1.526)	0.0205
≥ 1/day	23	0.614 (0.364-1.037)	0.0684	121	0.785 (0.608-1.015)	0.0647	251	1.058 (0.868-1.291)	0.5758	155	1.038 (0.808-1.334)	0.7712
Amount (g/d)	333			1,218			1,751			1,083		
0	143	Ref.		451	Ref.		519	Ref.		298	Ref.	
1-99	160	0.786 (0.586-1.007)	0.0559	610	0.842 (0.724-0.978)	0.0248	919	1.044 (0.909-1.198)	0.5452	604	1.216 (1.024-1.444)	0.0257
100-199	23	0.876 (0.528-1.455)	0.6100	102	0.740 (0.558-0.980)	0.0358	217	1.175 (0.953-1.448)	0.1218	116	1.098 (0.840-1.436)	0.4940
200-299	7	0.525 (0.227-1.218)	0.1336	46	0.776 (0.538-1.118)	0.1732	80	0.919 (0.684-1.234)	0.5745	53	0.886 (0.604-1.298)	0.5339
≥ 300	-	-	0.9411	9	0.537 (0.213-1.356)	0.1885	16	0.964 (0.534-1.739)	0.9027	12	1.142 (0.563-2.317)	0.7132
Girls												
Frequency	273			887			1,212			552		
0/week	112	Ref.		267	Ref.		336	Ref.		159	Ref.	
≤ 1/week	81	0.767 (0.548-1.078)	0.1271	235	0.863 (0.700-1.063)	0.1664	315	0.907 (0.752-1.094)	0.3065	132	0.816 (0.625-1.065)	0.1341
2-6/week	62	0.618 (0.428-0.908)	0.0142	275	0.892 (0.723-1.102)	0.2895	371	0.943 (0.783-1.135)	0.5325	168	0.948 (0.734-1.225)	0.633
≥ 1/day	18	0.290 (0.271-0.885)	0.0180	110	0.850 (0.643-1.124)	0.2536	190	0.954 (0.758-1.201)	0.6892	93	0.991 (0.723-1.359)	0.9566
Amount (g/d)	273			887			1,212			552		
0	112	Ref.		267	Ref.		336	Ref.		159	Ref.	
1-99	129	0.679 (0.499-0.922)	0.0132	496	0.905 (0.755-1.084)	0.2790	664	0.926 (0.787-1.088)	0.3485	295	0.904 (0.723-1.131)	0.3786
100-199	22	0.791 (0.458-1.364)	0.3986	70	0.744 (0.541-1.025)	0.0702	136	0.872 (0.674-1.127)	0.2945	65	0.972 (0.689-1.453)	0.8698
200-299	10	0.731 (0.346-1.545)	0.4119	47	1.001 (0.689-1.453)	0.9973	60	0.810 (0.575-1.140)	0.2261	29	0.715 (0.433-1.181)	0.1899
≥ 300	-	-	0.9438	7	0.743 (0.308-1.789)	0.5070	16	1.227 (0.673-2.236)	0.5042	4	0.435 (0.104-1.815)	0.2534

Note.[^]: Models adjusted for age, residential area, average annual family income, intake of meat, grains, eggs, physical activity and sedentary time