Awareness of coeliac disease among chefs and cooks depends on the level and place of training

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ABSTRACT

Background and Objectives: Milk promotes the growth of children's height. However, the relationship between milk consumption and anemia or obesity remain unclear. We explored the association between milk consumption and the nutritional status of poor rural Chinese students, including anemia, height, weight, malnutrition, and overweight/obesity. **Methods and Study Design:** A total of 22,315 students aged 8–16 years were recruited. The frequency of milk consumption and other information were investigated using the questionnaire. Students' morning fasting height, weight, and whole-blood hemoglobin were measured. The children were classified as malnutrition, normal weight, and overweight/obesity according to their age-specific height and BMI. Multivariate linear and multiple logistic regression were used to analyze the association between milk consumption and nutritional status. **Results:** In total, 10.6% of students drank milk at least once a day. Compared to students who drank milk <1 time/week, The heights and weights of students who consumed milk 1–3 times/week, 4–6 times/week, and at least once per day were 0.8, 0.9, and 1.3 cm greater and 0.8, 0.6, and 1.0 kg heavier. Students who drank milk at least once a day (OR=0.817), and 1–3 times/week (OR=0.868) had a significantly lower prevalence of malnutrition. Students who drank milk 4–6 times/week (OR=0.472) had a significantly lower prevalence of anemia. However, no significant association was identified between milk consumption and overweight/obesity. **Conclusions:** Frequent consumption of milk was associated with these students having a lower risk of malnutrition and anemia, being taller, and being heavier.

Key Words: milk consumption, poor rural areas, student nutrition improvement, China, nutritional Status

INTRODUCTION

Childhood is a critical period of growth and development for the human body. The double burden of malnutrition in children is a global problem. Malnutrition severely harms the physical and mental health and cognitive intelligence of children, and it burdens families, communities, and countries.[1–5] According to a WHO report in 2017, approximately 155 million children in the world had stunted growth, 52 million children were underweight, and over 340 million children aged 5–19 years were overweight or obese. Malnutrition remains a major problem among children in poor areas of the central and western regions of China. The malnutrition rate among students in poor rural areas of China reached 17.7% in 2015, which was higher than the national average of 12.2%. Though the rate of overweight and obesity in

poor rural areas was 11.6%, which was lower than the national average rate of 16.0%, this rate rose faster in the countryside than in cities from 2002 to 2012.[6] Therefore, improving the nutritional status of children in poor rural areas of China is crucial.

Milk is a good source of calcium and high-quality protein.[7,8] The dietary guidelines of many countries recommend milk as an integral part of children's daily diet. The Chinese Dietary Guidelines for School-age Children 2016 recommends that school-age children in China drink milk (300 g or more) daily. However, the Chinese Residents' Nutrition and Chronic Diseases Report 2015 reported that only 39.2% of children and teenagers in China consumed dairy products once or more per day,[9] and that proportion in poor rural areas of China was only 13.8%.[10]

Sufficient milk intake can promote the growth of children in terms of height.[11-14] However, the results of studies on the relationship between milk consumption and childhood anemia or obesity have been inconsistent, and further investigation is necessary.[15-20] Research on a large sample of children in China is lacking, particularly for children in poor rural areas. Therefore, this study investigated the association between milk consumption and the nutritional status of poor rural students in China in 2016, including the relationship between milk consumption and anemia status, height, weight, malnutrition, and overweight/obesity among the students surveyed, to provide basic data for improving the nutritional status of children in poor rural areas of China.

MATERIALS AND METHODS

Subjects

The data used in this study were derived from the dietary and nutritional assessment of the Nutrition Improvement Programme for Rural Compulsory Education Students (NIPRCES), which was undertaken by the National Institute for Nutrition and Health of the Chinese Center for Disease Control and Prevention. The NIPRCES is a major governmental nutritional intervention in China for improving the nutritional health of rural students in China receiving compulsory education.[21]

This research is a cross-sectional study that based on the NIPRCES assessment in 2016; poor rural areas from 22 provinces in China were investigated, namely Jilin, Ningxia, Inner Mongolia, Heilongjiang, Chongqing, Jiangxi, Shanxi, Shaanxi, Hebei, Xinjiang, Hubei, Hunan, Tibet, Anhui, Henan, Guangxi, Qinghai, Gansu, Sichuan, Guizhou, and Yunnan. Multistage stratified random cluster sampling was used to select the participants. First, one to three counties from each province were randomly chosen for the study for 50 counties in total.

Second, two primary and junior high schools from each county were selected randomly within the three feeding modes: the "school feeding," "food package," and "family feeding" modes. Then, in every school, one or two classes were randomly drawn from each grade from third to ninth grade to ensure that the number of students reached approximately 40 and that boys and girls were mostly balanced for each grade. If the number of students in a certain grade was less than 40, all students in the grade were recruited.

In this study, 23,332 students were surveyed in 2016. In total, 826 (3.5%) participants who experienced height and weight loss and 191 (0.8%) who were aged <8 or >16 years old were excluded, and 22,315 (95.7%) participants were finally included.

Measuring milk intake

The NIPRCES Nutrition and Health Monitoring Student Questionnaire was designed to collect information on students' general conditions, such as their gender, ethnicity, grade, age, parents' out-of-town employment, food intake, and dietary behavior. The frequency of weekly milk consumption was divided into less than one package per week (<1/week), one to three packages per week (1-3/week), four to six packages per week (4-6/week), or one package or more per day (≥1/d), with a package containing approximately 200 mL of milk. The milk included various milk products, such as those from cows or goats. Milk products also included yogurt and milk powder but did not include milk-containing beverages. The questionnaire was designed by the study group and revised after an expert seminar review and pre-experiment. After the trained investigators introduced the questionnaire in detail, the 8-16-year-old students who participated in the survey in Grades 3-9 filled out the questionnaire on their own, and these questionnaires were checked by trained investigators.

Covariates

Food intake, dietary behavior and basic information such as diarrhea prevalence were collected by questionnaire. In addition to milk, food intake includes meat, eggs, soy products, vegetables, and fruits. The frequencies of intake of meat, soy products and fruits was divided into less than one time per week (<1/week), one to six times per week (1-6/week) and one time or more per day (≥1/day); egg intake frequency was divided into less than one egg per week (<1/week), one to six eggs per week (1-6/week) and one egg or more per day (≥1/day); vegetable intake refered to eating several kinds of fresh vegetables every day, divided into almost did not eat (almost no), one to two kinds per day (1-2/day), 3 kinds per day (3/day). Eating behaviors included the frequency of snacks and beverage consumption. The frequency

of snack intake was divided into less than once a day (<1/day), once a day (1/day), twice a day (2/day), and 3 times or more a day (≥3/day). The frequency of beverage intake was divided into less than 3 times a week (<3/week) and 3 times or more a week (≥3/week). The prevalence of diarrhea that may affect anemia was divided into basically no (almost no), 1-2 times a year (1-2/year), 3 times or more a year (≥3/year).

Measuring nutritional status

The body height and weight of students in the fasting state in the early morning were measured by professionals. Their height was measured to the nearest 0.1 cm on a column stadiometer, and their weight was measured to the nearest 0.1 kg on a lever weight scale. A type 721 spectrophotometric colorimeter was used to measure whole-blood hemoglobin from the fingertip through the cyanide methemoglobin method, which was performed by trained professional inspectors.

Evaluation standard

We screen children's malnutrition, including stunting or being underweight, according to the National Health Industry Standard Screening for School-Age Children and Adolescent Malnutrition (WS/T456-2014)[22] in China. When a child's height was less than or equal to the age-specific height limit point, the child was considered to be stunted. When the child's BMI value was less than or equal to the age-specific BMI cut-off point, the child was considered to be underweight. Both stunting and being underweight were considered symptoms of malnutrition. According to the Chinese national standard Technical criteria for student health examination (GB/T26343-2010),[23] we screened children with overweight and obesity based on age- and gender-specific BMI. Children with BMI values higher than or equal to the age-specific BMI cut-off point were considered to be overweight or obese. On the basis of the diagnostic criteria for anemia developed by the WHO,[24] anemia was diagnosed when the altitude-adjusted hemoglobin value was less than the cut-off point.

Statistical analysis

Data were collected using the unified network platform NNIPRCS Nutrition and Health Condition Monitoring and Evaluation System. Students' heights and weights were described using mean ± standard deviation. The t test and analysis of variance were used to compare the mean across groups. Milk consumption and the nutritional status of students were described as the number of cases (n) and their proportion (%). The rates across groups were compared

using the chi-squared test (χ^2 test) and the rank sum test. The Bonferroni method was used to compare the ratios between groups. The relationship between milk consumption and height and weight were analyzed through multiple linear regression, and the relationships between milk consumption and anemia, malnutrition, and overweight/obesity were analyzed through multiple logistic regression analysis after confounding factors were controlled for, including gender, grade, ethnicity, age, and parents' out-of-town employment. All information was collected from the questionnaires. The OR and 95% CI were calculated. All p values were two-tailed, and p values < 0.05 indicated statistical significance. All statistical analyses were performed using SAS 9.3 (SAS Institute Inc., Carey, NC, USA).

RESULTS

General characteristics of the study population

The general characteristics of the study population are presented in Table 1. A total of 22,315 students aged 8–16 years were analyzed, including 11,273 (50.5%) boys and 11,042 (49.5%) girls. Of the students, 7960(35.7%) were in the central region, 14,355(64.3%) were in the western region. 6440 (28.9%) were in Grades 3 or 4 of primary school, 6989 (31.3%) were in Grades 5 or 6 of primary school, and 8886 (39.8%) were in junior high school. Furthermore, 15,053 (67.5%) of the students were Han Chinese, and the rest (32.5%) were members of ethnic minorities (e.g., Tibetan, Zhuang, and Mongolian students). Details of the sample distribution are presented in Table 1.

Milk intake frequency

The frequency of milk consumption was mainly 1–3 times/week, which accounted for 45.8% of students. Only 10.6% of students drank milk at least once a day, and 25.8% of students drank milk <1 time/week. The proportion of students who consumed milk at least once a day in Grades 3 and 4 of primary school (14.1%) was higher than that of children in Grades 5 and 6 of primary school (11.9%; p<0.0001) or in junior high school (7.0%; p<0.0001). The percentage of boys (11.2%) who consumed milk at least once a day was higher than that of the girls (10.0%; p<0.0001; Table 2).

Characteristics of height, weight, anemia, malnutrition, overweight, and obesity

Height and weight increase with age, and the boys were taller than the girls at all ages, except for students aged 10, 11, and 12 years (Table 3). The proportions of students with malnutrition or overweight/obesity were 11.0% or 10.0%, respectively, and the proportions

were higher in boys (13.6% and 11.4%) than in girls (8.4% and 8.4%; $p<0.0001$); however, both rates dropped with grades. The proportion of students with anemia was 6.5%. It was higher in girls (7.1%) than in boys (5.9%; $p<0.005$), and increased with grades (Table 4).

Associations of milk consumption with height and weight

The relationships between weekly frequency of milk consumption and students' height and weight were analyzed after area, gender, age, ethnicity, parental employment, frequency of meat, eggs, soy products, vegetables, fruits, snacks and beverage consumption were controlled for as confounding factors. The heights and weights of students who consumed milk 1–3 times/week, 4–6 times/week, and at least once per day were 0.8, 0.9, and 1.3 cm greater and 0.8, 0.6, and 1.0 kg heavier than those who consumed milk <1 time/week ($p<0.05$; Table 5).

Associations of milk consumption with malnutrition, overweight/obesity, and anemia

Students who consumed milk at least once a day and 1–3 times/week were significantly associated with a lower prevalence of malnutrition than that of students who consumed milk <1 time/week (the OR values were 0.817 and 0.868, respectively) after confounders were controlled for (Table 6). Students who consumed milk 4–6 times/week was significantly associated with a lower prevalence of anemia than that of students who consumed milk <1 time/week (the OR values was 0.472) after confounders were controlled for (Table 6). The weekly frequency of milk consumption was not related to overweight/obesity ($p>0.05$).

DISCUSSION

In this cross-sectional study of 22,315 students in primary and middle schools in poor rural areas of China who were aged 8–16 years, children with very low milk consumption had relatively high rates of malnutrition and anemia. The weekly frequency of milk consumption was related to height, weight, malnutrition and anemia status. Compared with students with a low milk consumption frequency, those with a high milk consumption frequency had a lower prevalence of malnutrition and anemia and were taller and heavier. However, the weekly frequency of milk consumption was not related to overweight/obesity.

The proportion of children who drank milk in poor rural areas in China was very low. According to this survey, only 10.6% of primary and middle school students drank milk at least once per day (with approximately 200 mL per package of milk), which was far lower than this proportion among children in urban areas[25,26] and the national average in China[9]

(39.2%) and in other countries.[27] To reach the recommended daily milk intake of 300 mL, milk consumption in poor rural areas of China must increase.

In this study, students with a higher frequency of milk consumption were associated with being taller. Studies have revealed that drinking milk can promote height growth in children in a dose–response relationship because higher milk consumption is associated with height growth.11–14,[28,29] In 2001, Zhang et al conducted a milk intervention (330 mL) experiment for 757 Chinese girls with an average age of 10.1 years and discovered that the height of the children in the intervention group increased by 0.7%–0.8%, and their sitting height increased by 0.7%–1.2% compared with the control group.[11] In 2009, Berkey et al conducted a relatively long-term (7 years) prospective cohort study of 5101 American girls with an average age of 9 years and found that girls who consumed 3 servings of milk daily were 0.28 cm taller than girls who consumed 1 serving of milk daily a year later,[13] and this result was the same as that from Ricardo's study of Swedish children.[14] The mechanism by which milk promotes the height growth of children may be related to calcium, insulin growth factor 1, and high-quality proteins in milk. These active ingredients may promote bone and height growth.[30–34]

Malnutrition and overweight and obesity affect children's health and development and even have adverse effects on the national economy.[35,36] Malnutrition may seriously affect the survival of children in low-income countries,[33] and overweight and obesity can increase the risk of chronic diseases in adults.[1,5,37,38] In our study, we discovered that children with a higher frequency of milk consumption were associated with being heavier but were not associated with overweight/obesity. Whether increasing the consumption of dairy products affects children's weight remains unclear. Reviews conducted by Zemel[39] and Teegarden[40] revealed that milk may help prevent weight gain, which was consistent with studies by Pereira et al and Astrup et al.[18,20] Louie et al systematically reviewed prospective cohort studies of children aged 2–14 years and suggested that milk intake had no effect on children's weight.[19] Therefore, the relationship between milk consumption and children's weight merits further research. Some studies have reported that milk may be useful for treating malnourished children.[15,16] Our study also found that higher milk consumption was associated with lower prevalence of malnutrition, thus, sufficient milk that consumed among poor rural children may improve malnutrition.

Anemia is a worldwide nutritional problem, particularly among school-aged children. It can reduce learning and immune functions in children and increase abnormal behavior.[41,42] The proportion of students surveyed with anemia was only 6.5%, Irrational diet emerged as the

mostly likely contributor to this finding. The relevance of menarche, haematinic nutrients intakes, and intestinal helminthiasis needs further research. Our finding that students with a higher frequency of milk consumption had a lower risk of anemia was similar to that of Hu YM's research.[43] Furthermore, Lien et al. conducted a 6-month milk intervention trial on 454 rural Vietnamese children aged 7 to 8 years in 2009 and observed that the incidence of anemia decreased in the milk intervention group.[17] Similarly, a milk intervention trial in China indicated that the hemoglobin values in children in the intervention group were significantly higher than those in the nondrinking group, which suggested that drinking milk may help prevent anemia. Children in these poor areas have relatively low dairy intake, and increasing their milk consumption can improve their protein nutritional status and reduce the risk of anemia.[44,45] However, studies have indicated that high dairy intake is not conducive to preventing anemia. Milk contains low iron and no heme iron, which may inhibit the absorption of iron in children, according to some studies.[46-48] In 2004, Levycosta et al studied 584 children aged under 5 years in Brazil and found that milk may have hindered the children's absorption of iron from other foods, and children's milk intake may be related to a higher risk of anemia.[49] The current research results on the relationship between milk and anemia in children were inconsistent; further research is necessary to confirm this relationship.

Several limitations should be considered in the results of this study. First, these associations cannot be considered causal because of the observational design of the study. Second, we did not control for the energy intake, physical activity or other potential confounders in this study. Third, recall bias frequently occurs in questionnaire research, and the collected milk data were qualitative but did not contain specific quantifications.

In summary, our results indicated that milk consumption in children aged 8–16 years in poor rural areas of China was extremely low; it was lower than the average milk consumption in Chinese children, and was far behind the recommended standard. Milk consumption and body height and weight among poor rural Chinese pupils had a positive relationship, and a higher frequency of milk consumption was associated with a reduced risk of anemia.

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AUTHOR DISCLOSURE

The authors have no conflicts of interest to declare.

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Table 1. General characteristics of the study population

Sample characteristics	N	%		N	%
Total	22,315	100.0	Provinces		
Area	7960	35.7	Gansu	2382	10.7
Central region			Guangxi	2238	10.0
Western region	14355	64.3	Guizhou	2003	9.0
Gender	11,273	50.5	Hebei	1235	5.5
Boys			Henan	1895	8.5
Girls	11,042	49.5	Heilongjiang	540	2.4
Grade	6440	28.9	Hubei	605	2.7
3~4			Hunan	1654	7.4
5~6	6989	31.3	Jilin	494	2.2
7~9	8886	39.8	Jiangxi	1260	5.7
Ethnicity	15,053	67.5	Inner Mongolia	417	1.9
Han			Ningxia	389	1.7
Minority	7262	32.5	Qinghai	1380	6.2
Age(y)	2183	9.8	Shanxi	277	1.2
8			Shaanxi	967	4.3
9	3089	13.8	Sichuan	972	4.4
10	3350	15.0	Tibet	173	0.8
11	3228	14.5	Yunnan	1887	8.5
12	3228	14.5	Chongqing	1547	6.9
13	2821	12.6	Vegetables†		
14	2670	12.0	Almost no	6703	43.7
15	1366	6.1	1-2/day	8550	55.7
16	380	1.7	3/day	86	0.6
Parents' employment†			Fruits		
Both parents work in town	10,397	46.6	<1/week	2284	10.2
Father works out-of-town	5814	26.1	1-6/week	16360	73.3
Mother works out-of-town	1340	6.0	≥1/day	3671	16.5
Parents work out-of-town	4749	21.3	Snack		
Diarrhea			<1/day	10325	46.3
Almost no	4,584	20.5	1/day	3137	14.0
1-2/year	12,949	58.0	2/day	1715	7.7
≥3/year	4,782	21.5	≥3/day	7138	32.0
Meat			Beverage		
<1/week	2,198	9.9	<3/week	15913	71.3
1-6/week	16,353	73.2	≥3/week	6402	28.7
≥1/day	3,764	16.9	Soy products		
Eggs			<1/week	96	0.4
<1/week	3,062	13.7	1-6/week	22,017	98.7
1-6/week	17,337	77.7	≥1/day	202	0.9
≥1/day	1,916	8.6			

†The sample size of participants with completed parents' employment and vegetable intake frequencies information were 22,300 and 15339 respectively.

Table 2. Weekly frequency of milk consumption†

Features	*N*	< 1/week	1-3/week	4-6/week	≥1/day	Z/χ^2 value	*p* value
Total	22,306	5759 (25.8)	10,214 (45.8)	3969 (17.8)	2364 (10.6)		
Area	7955	2165 (27.2)	3413 (42.9)	1527 (19.2)	850 (10.7)	38.101	<0.001
Central region							
Western region	14351	3535 (24.6)	6710 (46.8)	2522 (17.6)	1584 (11.0)		
Grade							
3~4	6439	1193 (18.5)	3006 (46.7)	1332 (20.7)	908 (14.1)	652.857	<0.001
5~6	6983	1566 (22.4)	3238 (46.4)	1347 (19.3)	832 (11.9)		
7~9	8884	3000 (33.8)	3970 (44.7)	1290 (14.5)	624 (7.0)		
Gender							
Boys	11,266	2887 (25.6)	4982 (44.2)	2132 (18.9)	1265 (11.2)	-4.001	<0.001
Girls	11,040	2872 (26.0)	5232 (47.4)	1837 (16.6)	1099 (10.0)		

† The sample size of participants with complete information on frequency of milk consumption was 22,306

Table 3. Characteristics of height and weight

Age(y)	Height (cm)				Weight (kg)			
	Boy		Girl		Boy		Girl	
	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD
8	128.7	6.1	128.1	6.2	26.5	4.5	25.7	4.4
9	132.6	6.4	132.3	7.0	29.2	5.7	28.1	5.4
10	137.0	6.8	138.1	7.6	32.0	6.6	31.6	6.5
11	142.6	7.6	144.2	7.7	35.6	7.9	36.1	7.5
12	148.4	8.7	149.5	7.4	39.6	8.5	40.1	7.6
13	155.1	9.0	152.8	6.8	44.3	9.4	43.7	7.4
14	160.3	8.7	155.0	6.2	48.3	9.0	46.8	7.2
15	163.1	7.9	155.2	6.3	50.7	8.2	48.4	6.7
16	163.4	8.5	154.8	5.9	51.3	8.7	48.2	6.8

Table 4. Characteristics of anemia, malnutrition, and overweight and obesity

Features	Anemia *N (%)*	χ^2	*p*	Malnutrition *N (%)*	Overweight/obesity *N (%)*	χ^2	*p*
Total	1447 (6.5)			2484 (11.0)	2244 (10.0)		
Area							
Central region	366 (4.6)	72.616	<0.001	723 (9.1)	1068 (13.4)	196.891	<0.001
Western region	1081 (7.5)			1730 (12.1)	1147 (8.0)		
Grade							
3~4	347 (5.4)	61.177	<0.001	738 (11.4)	705 (11.0)	43.914	<0.001
5~6	383 (5.5)			783 (11.2)	760 (10.9)		
7~9	717 (8.1)			932 (10.5)	750 (8.4)		
Gender							
Boys	666 (5.9)	12.486	<0.001	1528 (13.6)	1289 (11.4)	235.967	<0.001
Girls	781 (7.1)			925 (8.4)	926 (8.4)		

Table 5. Multivariate multiple linear regression analysis for height and weight (n = 22,315)[†]

Milk consumption	Height				Weight			
	B value	*sx*	*t* value	*p* value	*B* value	*sx*	*t* value	*p* value
<1/week(ref)	-	-	-	-	-	-	-	-
1-3/week	0.857	0.002	3.55	<0.001	0.842	0.193	4.35	<0.001
4-6/week	0.961	0.003	3.35	<0.001	0.608	0.230	2.64	0.008
≥1/day	1.349	0.004	3.84	<0.001	1.039	0.283	3.68	<0.001

[†]In this model, area, gender, age, ethnicity, parental employment, frequency of meat, eggs, soy products, vegetables, fruits, snacks and beverage consumption were adjusted for as confounding factors.

Table 6. Multivariate logistic regression analysis for malnutrition, overweight/obesity, and anemia (OR [95% CI], n = 22,315) †

Milk consumption	Height				Weight			
	B value	*sx*	*t* value	*p* value	*B* value	*sx*	*t* value	*p* value
<1/week(ref)	-	-	-	-	-	-	-	-
1-3/week	0.857	0.002	3.55	<0.001	0.842	0.193	4.35	<0.001
4-6/week	0.961	0.003	3.35	<0.001	0.608	0.230	2.64	0.008
≥1/day	1.349	0.004	3.84	<0.001	1.039	0.283	3.68	<0.001

[†] In this model of malnutrition and overweight/obesity, area, gender, grade, ethnicity, parental employment frequency of meat, eggs, soy products, vegetables, fruits, snacks and beverage consumption were adjusted for as confounding factors. As for anemia, in addition to the above confounding factors, the frequency of diarrhea has also been adjusted.