Preplanned Studies

Serum Vitamin A Nutritional Status of Children and Adolescents Aged 6−17 Years — China, 2016−2017

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Summary

What is already known on this topic?

Vitamin A deficiency (VAD) in children is still a global public health problem, which needs continuous monitoring and timely intervention.

What is added by this report?

Using surveillance data from China Nutrition and Health Surveillance of Children and Lactating Mothers in 2016–2017, the prevalence of VAD and marginal deficiency was 0.96% and 14.71%, respectively. The vitamin A nutritional status of children and adolescents from urban areas and those aged 12–17 years were better than those from rural areas and aged 6–11 years.

What are the implications for public health practice?

Marginal VAD was a major form of VAD in Chinese children. The monitoring of vitamin A status in key populations should be continuously strengthened, and the public should be encouraged to consume foods rich in vitamin A or vitamin A supplements.

Vitamin A deficiency (VAD) has an important impact on the health of children and adolescents during the time of growth and development. VAD may damage the functioning of visual rod cells, reduce the ability of dark adaptation, and subsequently affect the visual function of children. Eye diseases, secondary to xerophthalmia caused by severe VAD in children, is a major cause of blindness in children worldwide, resulting in irreversible visual impairment in children. Various studies (*1*–*2*) have indicated that VAD, as an independent risk factor for respiratory diseases, may lead to the weakening of immune function in children, as well as recurrent respiratory infections and asthma. Furthermore, VAD may also cause anemia, dysplasia, and other diseases.

It is reported that there are still 190 million preschool children in the world with VAD (*3*). At present, there are about 228 million children with VAD in the world, which causes about 3 million children to die every year, and 10 million children suffer from eye diseases (*4*). Since 2002, serum retinol concentration has been used for the first time to evaluate the vitamin A nutritional status of children aged 3–12 years in China Nutrition and Health Survey. The serum retinol concentration was determined using high performance liquid chromatography (HPLC). In accordance with the National Health Standard (method for VAD screening) from the National Health Commission of the People's Republic of China (*5*): serum retinol concentration <0.2 mg/L (0.70 μmol/L) is VAD, and 0.2 mg/L (0.70 μmol/L)≤ serum retinol concentration <0.3 mg/L (1.05 μmol/L) is marginal VAD.

This study was a cross-sectional study. Data were obtained from the China Nutrition and Health Surveillance of Children and Lactating Mothers in 2016–2017. It was conducted using multistage stratified random sampling method, including 31 provinces, autonomous regions and municipalities in the mainland of China, 150 monitoring sites, and 280 children and adolescents aged 6–17 years from each monitoring site with a sex ratio of 1∶1 (*6*). According to the 2018 China Health Statistics Yearbook, the regions are divided into eastern, central, and western regions. The protocol of this study was evaluated and approved by the ethical committee of China CDC (201614).

The study population was divided into different groups by gender, age, and regions. Data analyses used data from China's Sixth National Census in 2010 with complex weights used in the calculation of rates for sampling. Values were presented as median (25th and 75th percentile) and percentages with their 95% confidence intervals (CIs) for continuous and categorical variables, respectively. Kruskal-Wallis one-way analysis of variance (ANOVA) was used to compare continuous data (such as serum retinol levels) among multiple groups. Rao-Scott chi-square analysis was used to compare categorical data (such as deficiency rates) between different groups. Statistical significance was defined as P<0.05. SAS 9.4 (SAS Institute Inc., Cary, NC, USA) was used to conduct all the analyses.

In total, 63,310 subjects were included for this report, including 31,617 male and 31,693 female with a gender ratio of 1.00. The number of urban and rural subjects were 29,532 and 33,778, respectively. The number of subjects aged 6–11 years and 12–17 years were 35,242 and 28,068, respectively.

Among 63,310 children and adolescents aged 6–17 years, the median of serum vitamin A was 1.35 μmol/L. The median of serum vitamin A in male and female were 1.35 μmol/L and 1.36 μmol/L, respectively. Although the median for female was higher than that of male, the difference was not significant. The median of serum retinol in individuals in urban areas (1.40 μmol/L) was significantly higher than that of those in rural areas (1.31 μmol/L). The median of serum retinol was 1.36 μmol/L, 1.27 μmol/L, and 1.40 μmol/L in the eastern, central, and western regions, respectively. The western region was significantly higher than the other two regions. The 6–11 age group was significantly lower than the 12–17 age group. (Table 1)

The results of VAD and marginal VAD in children and adolescents aged 6–17 years were illustrated in Table 2. The prevalence of VAD in children and adolescents aged 6–17 years was 0.96%, and the marginal VAD was 14.71%. There was no difference in the prevalence of marginal VAD between male and female, but the prevalence of VAD of male was higher than that of female (χ^2=3.895, P=0.048). The prevalence of VAD among rural children and adolescents was higher than that of urban areas (χ^2=20.615, P<0.0001). The prevalence of VAD was the lowest in the western region (χ^2=43.649, P<0.0001). Similar phenomena were also found in the marginal deficiency group. The prevalence of marginal VAD of 6–11 year-old children was significantly higher than that of 12–17 year-old adolescents, which were 21.14% and 8.82%, respectively (χ^2=585.378, P<0.0001). VAD was also higher in the 6–11 age group than in the 12–17 age group.

DISCUSSION

The current results showed that the nutritional status of vitamin A in children and adolescents aged 6 to 17 years in China has been improving significantly. The results of the China Nutrition and Health Surveillance (2010–2012) showed that the serum VAD rate and marginal deficiency rate of children and adolescents aged 6 to 17 in China were 6.4% and 18.7% (*7*), respectively. The VAD rate and marginal VAD rate of children and adolescents aged 6 to 17 years in China were 0.96% and 14.71%, respectively, from 2016 to 2017.

The results of our study suggest that the level of vitamin A increases with age from 2016 to 2017 in Chinese children, while the rate of VAD and marginal VAD decreases with age, which align with previous studies (*7*–*10*). Compared with children and adolescents aged 12 to 17 years, children and adolescents aged 6 to 11 years are more likely to suffer from VAD, which may be related to differences in eating habits and absorption. For example, children in the lower age group generally have bad eating habits such as picky eating and snacking, while children in high age groups have a more diversified dietary structure (*11*). This may also be due to other reasons such as use of one single cut-off point for all age groups and not considering potentially physiologically lower vitamin A levels in younger children (*12*–*13*).

Our study also discovered that the nutritional status of vitamin A in urban children aged 6 to 17 years in China was better than that in rural areas. This may be connected with the popularization of nutrition knowledge and the level of regional economic development. A previous study (*14*) had shown that the incidence of VAD was lower in urban areas with relatively high economic levels. In addition, our study found no significant difference in vitamin A level between male and female, suggesting that the correlation between vitamin A level and gender was not strong, which was consistent with the results of previous studies (*12*).

Although the nutritional status of vitamin A has been significantly improved in children and adolescents aged 6 to 17 years in China, the proportion of marginal VAD was still more than 20% in children aged 6 to 11 years. Moreover, although the overall level of vitamin A of children and adolescents aged 6 to 17 years in rural areas had improved in recent years, it was still significantly lower than that of children and adolescents aged 6 to 17 years in urban areas. Therefore, children and adolescents aged 6 to 11 years in rural areas will still be the target areas and groups for vitamin A prevention and control in China in the future.

This study was subject to some limitations. First, the current study was that the dietary intake, dietary supplement intake, and other information of the respondents were not included. Second, the vitamin A grouping variables included in this study are still very

TABLE 1. Analysis of serum vitamin A levels in children and adolescents aged 6–17 years in China from 2016 to 2017.

Variable	N (%)	Serum vitamin A (μmol/L)		χ^2	*P*
		P_{50}	P_{25}–P_{75}		
Gender				0.758	0.384
Male	31,617 (49.94)	1.35	1.12–1.61		
Female	31,693 (50.06)	1.36	1.14–1.61		
Area type				536.950	<0.0001
Urban	29,532 (46.65)	1.40	1.17–1.65		
Rural	33,778 (53.35)	1.31	1.10–1.58		
Region				976.740	<0.0001
East	20,963 (33.11)	1.36	1.14–1.60		
Middle	19,971 (31.55)	1.27	1.08–1.54		
West	22,376 (35.34)	1.40	1.19–1.68		
Age group (years)				3,312.530	<0.0001
6–11	35,242 (55.67)	1.26	1.09–1.50		
12–17	28,068 (44.33)	1.47	1.23–1.72		
Total	63,310 (100.00)	1.35	1.12–1.61		

TABLE 2. Nutritional status of vitamin A in children and adolescents aged 6–17 years in China from 2016 to 2017.

Variable	Marginal deficiency		χ^2	*P*	Deficiency		χ^2	*P*
	N	Rate (%, 95%CI)			N	Rate (%, 95%CI)		
Gender			0.432	0.510			3.895	0.048
Male	4,890	14.87 (14.16, 15.57)			358	1.07 (0.89, 1.27)		
Female	4,603	14.53 (13.83, 15.23)			285	0.82 (0.65, 0.99)		
Area type			201.260	<0.0001			20.615	<0.0001
Urban	3,525	10.91 (10.28, 11.54)			240	0.64 (0.49, 0.80)		
Rural	5,968	18.14 (17.38, 18.89)			403	1.24 (1.04, 1.44)		
Region			124.935	<0.0001			43.649	<0.0001
East	3,068	13.95 (13.05, 14.84)			259	1.27 (1.00, 1.53)		
Middle	4,020	19.14 (18.28, 20.00)			285	1.17 (0.95, 1.39)		
West	2,405	12.02 (11.25, 12.80)			99	0.40 (0.06, 0.52)		
Age group (years)			585.378	<0.0001			72.702	<0.0001
6–11	6,956	21.14 (20.32, 21.97)			491	1.51 (1.26, 1.74)		
12–17	2,537	8.82 (8.26, 9.38)			152	0.46 (0.35, 0.57)		
Total	9,493	14.71 (14.21, 15.21)			643	0.96 (0.83, 1.09)		

limited, which is not conducive to the clear analysis of the correlation between vitamin A nutritional status and potential influencing. Therefore, in future studies, the relevant information affecting the nutritional status of vitamin A in children and adolescents should be added.

In conclusion, the results of our study indicated that the overall nutrition status of vitamin A had been significantly improved in Chinese children aged 6 to 17 years, however, marginal VAD still remains an issue. Future interventions for VAD in children and adolescents should focus on younger age groups and children and adolescents with marginal VAD in rural areas.

Acknowledgment: Local CDCs.

Conflicts of interest: No conflicts of interest were declared.

Funding: Ntional Health Commission of the People's Republic of China Medical Reform Major Program: Chinese Adults Chronic Diseases and Nutrition Surveillance (2015).

doi: 10.46234/ccdcw2021.057

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Submitted: January 19, 2021; Accepted: February 20, 2021

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