

# Burden of nutritional deficiencies among children and adolescents aged 0 to 19 years in China, 1990 to 2015

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*To the Editor:* Nutritional deficiency is one of the major public health concerns in low- and middle-income countries. Children and adolescents are particularly vulnerable to nutritional deficiencies due to their rapid growth and development needs. In 2015, nutritional deficiency was one of the top ten global causes of years lived with disability (YLDs) among children and adolescents in 195 countries and territories.<sup>[1]</sup> Nutritional deficiencies may have irreversible effects on the physical and cognitive development of children and adolescents, which may result in higher morbidity and mortality, and decreased productivity later in life. Nutritional deficiencies are one of the major health concerns among children and adolescents in China. In 2010, the deaths of Chinese children 0 to 14 years of age caused by nutritional deficiencies accounted for about 11.46% of total deaths in Chinese residents due to nutritional deficiencies.<sup>[2]</sup> Understanding the disease burden of nutritional deficiencies among children and adolescents in the whole country is helpful for effective disease control and prevention, which may promote improving the health for all in the future.

Current studies have mainly reported on the prevalence of nutritional deficiencies among children or adolescents in specific age groups or in partial counties or provinces in China. Comprehensive epidemiological data on the distribution of the burden of nutritional deficiencies among children and adolescents aged from 0 to 19 years at the national level remain scarce in China. The Global Burden of Disease, Injuries, and Risk Factors Study 2015 (GBD 2015) provided information on disease burden by age, geography, and time. It is one of the most comprehensive observational epidemiological studies in the world, providing up-to-date health metrics for all major diseases and injuries in 195 countries and regions.<sup>[3]</sup> In this study, we suppose that there would be differences in the distributions of burden of nutritional deficiencies

among Chinese children and adolescents. Based on the GBD 2015, this study aims to assess and analyze the disease burden of nutritional deficiencies among Chinese children and adolescents aged 0 to 19 years, as well as its temporal trend from 1990 to 2015, and to discover the differences in the distribution of nutritional deficiencies burden among children and adolescents.

The nutritional deficiencies in this study included protein-energy malnutrition, iron deficiency anemia (IDA), iodine deficiency, and other nutritional deficiencies. The definition of nutritional deficiencies corresponds to the International Classification of Diseases, ninth revision, (ICD-9) codes of 244.2, 260 to 269.9, 280.1 to 280.8, 281.0 to 281.9, and 716.0 to 716.09. In addition, the ICD-10 codes used for nutritional deficiencies were D50.1 to D50.8, D51 to D52.0, D52.8 to D53.9, D64.3, E00 to E02, E40 to E46.9, E50 to E50.9, E51 to E61.9, E63 to E64.9, and M12.1 to M12.19. In this study, data on children and adolescents were derived from the GBD 2015. The data source of burden of nutritional deficiencies in China and the modeling process have been elaborated upon in previous publications.<sup>[3]</sup> In the GBD 2015, the DisMod-MR 2.1 of a Bayesian meta-regression tool was used to generate internally consistent results for prevalence, incidence, remission, and excess mortality in populations. Using standardized analytical procedures, the prevalence by age, gender, cause, year, and geography were estimated. YLDs in the GBD 2015 were calculated and corresponding GBD disability weights derived from surveys of >60,000 respondents around the world.<sup>[3]</sup> Disability-adjusted life years (DALY) are the sum of YLDs and years of life lost (YLLs).

In this study, indicators such as mortality, prevalence, YLD, YLL, DALY, the YLD rate, the YLL rate, and the DALY rate were used to estimate burden of nutritional deficiencies among Chinese children and adolescents aged

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up to 19 years. Age-standardized results were calculated according to the World Health Organization world population age standard.<sup>[4]</sup> A complete set of age-specific, gender-specific, and geography-specific indicators were computed and analyzed for the years 1990, 1995, 2000, 2005, 2010, and 2015. We also analyzed temporal trends for burden of nutritional deficiencies among children and adolescents over the past decade, from 1990 to 2015. Regional divisions were taken from the National Bureau of Statistics of China, which divides the provinces into three regions: eastern, central, and western. Data analysis was completed in Microsoft Excel 2013 (Microsoft, Redmond, WA, USA).

As it shows in Table 1, the age-standardized prevalence, the age-standardized YLD rate, and the age-standardized DALY rate caused by nutritional deficiencies among Chinese children and adolescents were 20.64%, 852.16 per 100,000, and 884.00 per 100,000, respectively, in 2015. Meanwhile, the age-standardized mortality rate was 0.38 per 100,000, while the age-standardized YLL rate was 31.84 per 100,000 among children and adolescents aged 0 to 19 years. Gender-specific analysis suggested that males had a higher age-standardized prevalence, age-standardized YLD rate, and age-standardized DALY rate than females. From 1990 to 2015, the age-standardized prevalence declined by 7.03%, from 22.20% to 20.64%, while the age-standardized mortality declined by 93.80%, from 6.13 per 100,000 to 0.38 per 100,000. The age-standardized DALY rate among children and adolescents decreased by 38.97%; therein, the reduction rates of the age-standardized DALY rate for females with nutritional deficiencies were higher than males.

For children aged <5 years, the mortality and YLL rates were higher than older children and adolescents. As Supplementary Table 1, <http://links.lww.com/CM9/A752> shows, children aged 5 to 9 years with nutritional deficiencies had a comparatively higher prevalence, YLD

rate, and DALY rate (prevalence: 25.59%; YLD rate: 1272.15 per 100,000; DALY rate: 1278.52 per 100,000) than children and adolescents in other age groups. Girls aged <5 years appeared to have a higher DALY rate of nutritional deficiencies than boys, with a DALY rate of 797.61 per 100,000 against 757.79 per 100,000. Meanwhile, boys aged 5 to 9, 10 to 14, and 15 to 19 years had a higher DALY rate of nutritional deficiencies than girls of the same age.

From 1990 to 2015, the DALY rate of nutritional deficiencies among Chinese children in all age groups presented a continuous downward trend, and differences existed in different age groups. For children aged <5 years who suffered from nutritional deficiencies, the DALY rate per 100,000 decreased from 2716.23 in 1990 to 776.26 in 2015. From 1990 to 2015, the speed of reduction in the DALY rate of nutritional deficiencies in children aged <5 years was higher than that of children and adolescents in the other three age groups. From 1990 to 2015, adolescents aged 15 to 19 years had the lowest DALY rate among children and adolescents, as seen in Supplementary Figure 1, <http://links.lww.com/CM9/A752>.

From 1990 to 2015, the burden of nutritional deficiencies among Chinese children and adolescents aged up to 19 years declined over time in eastern, central, and western regions, while regional difference existed [Supplementary Figure 2, <http://links.lww.com/CM9/A752>]. Age-standardized prevalence declined by 11.60%, from 21.73% to 19.21%, among children and adolescent in the western region, while the age-standardized mortality rate declined by 93.92%. The decline of the age-standardized DALY rate from 1990 to 2015 in the western region was larger than that in the eastern and central regions. By 2015, the age-standardized DALY rate among children and adolescents in the western region was lower than those in the eastern and central regions [Supplementary Table 2, <http://links.lww.com/CM9/A752>].

**Table 1: Age-standardized prevalence, mortality rate, YLD rate, YLL rate, DALY rate, and percentage change of age-standardized rates for nutritional deficiencies among Chinese children and adolescents aged 0 to 19 years, by age and gender, in 1990 and 2015.**

Indicator (age-standardized)	Gender	Year		Percentage change (%)
		1990	2015	
Prevalence (%)	Male	24.78	23.80	-3.95
	Female	19.46	16.99	-12.69
	Total	22.20	20.64	-7.03
Mortality rate (per 100,000)	Male	4.70	0.28	-94.04
	Female	7.70	0.50	-93.51
	Total	6.13	0.38	-93.80
YLD rate (per 100,000)	Male	1064.32	1016.58	-4.49
	Female	779.42	661.42	-15.14
	Total	926.21	852.16	-7.99
YLL rate (per 100,000)	Male	398.91	23.07	-94.22
	Female	656.38	42.00	-93.60
	Total	522.23	31.84	-93.90
DALY rate (per 100,000)	Male	1463.24	1039.64	-28.95
	Female	1435.79	703.42	-51.01
	Total	1448.45	884.00	-38.97

DALY: Disability-adjusted life years; YLD: Years lived with disability; YLL: Years of life lost.

In this study, we found that the age-standardized DALY rates of IDA and other nutritional deficiencies among Chinese children and adolescents were higher than that of the average global level in 2015.<sup>[3]</sup> The age-standardized DALY rate for IDA among Chinese children and adolescents in 2015 (787.21 per 100,000) was the highest. As a comparison of the reduction of health burdens caused by different nutritional deficiencies among children and adolescents in 1990 and 2015, the reduction of the age-standardized DALY rate of protein-energy malnutrition was higher than other common nutritional deficiencies [Supplementary Table 3, <http://links.lww.com/CM9/A752>]. Chinese children and adolescents endured a higher burden of health caused by IDA and protein energy malnutrition (PEM) than those in Japan, Singapore, and the Republic of Korea in Asia.<sup>[1]</sup> The percentage change in the age-standardized YLD rate of nutritional deficiencies among children and adolescents was <8.0 between 1990 and 2015, with no obvious decline. Meanwhile, some studies presented a declining trend in micronutrient consumption by children and adolescents, starting in 1991.<sup>[5]</sup> Nutritional deficiencies still affected the health of Chinese children and adolescents, needing continuous interventions.

Children aged <5 years experienced the largest decline in the age-standardized DALY rate (71.42%) from 1990 to 2015, while the least progress was observed in the adolescent group. Age-specific differences in distribution of DALY rates of nutritional deficiencies existed. The differences could be explained by the relatively large decline in the burden of PEM, which is a common disease in children aged <5 years. Meanwhile, we found that a higher proportion of males aged 0 to 19 years suffered from nutritional deficiencies than females. Gender differences were recognized in some conditions, such as IDA, which had higher age-standardized DALY rates in males, while others were higher in females. The difference in inherent physiological characteristics and lifestyles were regarded as common factors contributing to the difference between males' and females' susceptibility. Compared to females, the higher prevalence in males could be explained by the higher demand for iron during their rapid growth stage (age of 10–19 years), less awareness of iron nutrition facts among male students, and the higher prevalence among boys aged 6 to 11 years than girls. More data and concerns are needed in further studies.

By 2015, the age-standardized DALY rate among children and adolescents in the western region was lower than that in the eastern and central regions. This improvement may be a result of a series of projects and interventions implemented in poverty-stricken areas, which are mainly located in the western region, to improve the nutritional status of children and adolescents.<sup>[6]</sup>

There are several strong points in this study. First, this study systematically described the burden of nutritional deficiencies among Chinese children and adolescents aged 0 to 19 years, revealing the trends in nutritional deficiencies by age groups, gender, and regions within 25 years. Second, DALY, which links the burden of disease in populations with the degree of illness, disability, and long-term survival, was used to assess the disease burden of

nutritional deficiencies. Finally, data from GBD 2015 was continuously updated, making the results more reliable.

However, this analysis also has several limitations. First, the disability burden was mainly derived from the Western population, and differences in culture and economic levels between China and Western countries might limit the comparability of results.<sup>[3]</sup> Second, the conclusions may partially be influenced by the limitation of the inherent data quality of GBD 2015, including unpublished data that may not be included in the disease burden estimation, and lacks data on adolescents, which is a worldwide problem.<sup>[1]</sup>

In summary, over the past 25 years, we have made great achievements in the prevention and control of nutritional deficiencies among children and adolescents in China. However, nutritional deficiencies are still affecting the health of Chinese children and adolescents. More in-depth research is needed to provide a more comprehensive picture of this issue.

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### Conflicts of interest

None.

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