Nutritional status of children aged 2-18 years old: a single-center study in China

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Research article

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Abstract

Background:

To assess the nutritional status and associated factors of abnormal nutritional status(malnutrition, overweight and obesity) among children aged 2 to 18 years old in Southwestern China.

Methods:

Children attending routine health checkups at the Children's Hospital of Chongqing Medical University between April 2017 and March 2020 were enrolled in this study. Nutritional status was defined based on BMI cut-off values, and statistically analyzed based on gender, region, and age. Multinomial logistic regression analysis was performed to identify the risk factors for abnormal nutritional status.

Results:

The overall prevalence of malnutrition, overweight and obesity was 5.87% ,9.81% and 10.50%, respectively. The prevalence of obesity and malnutrition in boys was higher than that in girls (P<0.01), while the prevalence of overweight is reversed (P<0.05). The prevalence of overweight among boys in urban regions was higher than in rural regions (P<0.05). Boys had the highest prevalence of obesity (P<0.01), girls had the lowest prevalence of malnutrition (P<0.05) in the 13-18 year-old group.The aOR for obesity and malnutrition in girls was 0.80 (95% CI: 0.73–0.87) and 0.80 (95% CI: 0.71–0.90), respectively. Compared to adolescents in the 13-18 year-old group,the aOR for obesity in children in the 2-6 year-old group, for malnutrition in children in the 7-12 year-old group was 0.55 (95% CI: 0.46–0.67)and 1.70 (95% CI: 1.25–2.33),respectively.

Conclusions:

The nutritional status of children and adolescents in Southwest China is comparable to that at the national level. The prevalence of obesity and malnutrition is shown to be associated with gender, and age.

Background

Nutrition has a profound effect on cognitive and social development in children and adolescents [1]. Being malnourished, overweight or obese during childhood or adolescence is associated with adverse health consequences [2]. Obesity and overweight contribute to a high burden of chronic diseases, such as hyperlipidemia, diabetes, cardiovascular diseases, nephritic diseases, hepatic diseases, and high levels of disability all of which increase the rate of premature mortality [3]. Besides, obesity and overweight cause serious health problems in children and adolescents including growth and developmental problems, psychological disorders and cognitive dysfunction [4–6]. In adolescents, obesity and overweight influence the timing of puberty. Malnutrition can trigger specific health problems in children [7], such as infectious diseases, protein-energy malnutrition, and anemia which can delay physical and brain

development [8, 9]. It is estimated that 45% of deaths among children under the age of five years from low and middle-income countries are linked to malnutrition [1].Malnutrition also affects children's economic, social, educational, and occupational performance. Various forms of nutritional status is a public health issue, whose global burden has increased over the years resulting in adverse effects on the physical and mental health of the affected [10, 11].Currently, there is no study reporting the prevalence and characteristics of the nutritional status of children in Southwestern China based on large sample size. Thus, we conducted this study to assess the nutritional status and explore the related factors of abnormal nutritional status (malnutrition, overweight, and obesity) among children aged 2 to 18 years old in Southwestern China.

Methods

Study population and research methods

A total of 22767 Children aged between 2-18 years old attending routine health checkups were enrolled in this study from April 2017 to March 2020 in the Children's Hospital of Chongqing Medical University in China. We excluded 158 children with various symptoms and chronic diseases (such as fever, diarrhea, congenital heart disease, liver or renal disease, thyroid disorder, and malignancy).

The study received approval from the Medical Ethics Committee of the Children's Hospital of Chongqing Medical University and written informed consent was obtained from legal guardians of all children participants in accordance with the Helsinki Declaration of 1964, and revised in 2000.

In this study, participants were divided into 3 age groups; 2-6, 7-12, and 13–18 years, which is a common age range used in the Chinese educational system for kindergarten, primary school, middle- high school, respectively.

Weight (kg) and Height (cm) were measured using the same type of instruments (DST-500,Co., Ltd. Donghuayuan Medical Equipment, Beijing, China), and by trained personnel. Height was measured with the participants standing straight, barefooted, and the head in the horizontal plane. Weight was measured with the participants wearing lightweight clothing. The weight and height were measured to the nearest 0.1 kg and 0.1 cm, respectively, and the measuring instruments were calibrated before use. BMI (kg/m^2) is a tool used to assess the nutritional status of individuals. It is defined as body weight (kg) divided by height (m) squared (kg/m2). Malnutrition was defined by BMI < 5th percentile, normal weight was defined by 5th ≤ BMI < 85th percentile, overweight was defined by 85th ≤ BMI <95th percentiles, and obesity was defined by BMI ≥ 95th percentile [12-16].

Data source

The participants' basic information, including age, sex, height, weight, ethnicity, BMI, and the region was obtained.

Statistical analysis

Differences in the prevalence of obesity, overweight, and malnutrition among boys vs girls, urban vs rural region, age rang were compared using a χ^2 test. Multinomial logistic regression was performed to examine the association between the three independent variables (gender, living region and age group) and the dependent variable (nutritional status). Adjusted odds ratios (aORs) with 95% confidence interval (CIs) were reported. A P <0.05 was set to determine the statistical significance. All analyses were conducted with SAS (version 9.4; SAS Institute, Cary, NC, USA).

Results

Basic information of participants

The mean age of the participants was 7.74 ± 3.19 years old. The mean weight and height of the participants was 28.10 ±13.40kg, 126.56 ±20.24cm, respectively. All participants were from Southwestern China and of Han ethnicity.

Nutritional status of participants

A total of 22609 children and adolescents were included in the final analysis. Of these, 12860 (56.88%) were boys and 9749 (43.12%) were girls. The overall prevalence of malnutrition, overweight and obesity for the participants was 5.87% ,9.81% and 10.50%, respectively. The prevalence of malnutrition, overweight and obesity in boys and girls was 6.35% vs 5.24%,9.45% vs 10.28%,and 11.39% vs 9.33%, respectively. The prevalence of malnutrition, overweight and obesity in urban and rural region was 5.86% vs 6.29%,9.87% vs 8.15%,and 10.51% vs 10.24%, respectively. The prevalence of malnutrition, overweight and obesity in the 2-6 ,7-12 and 13-18 year old group was 5.26% vs 6.69% vs 4.09%,9.13% vs 10.50% vs 9.84%,and 7.96% vs 12.79% vs 13.56%, respectively(Table 1).

The prevalence of obesity and malnutrition in boys was higher than that in girls (P<0.01),while the prevalence of overweight in boys was lower than that in girls (P<0.05). The prevalence of overweight in boys from the urban region was higher than in those from the rural region (P<0.05). There was no significant difference in the prevalence of obesity and malnutrition between boys or girls in urban and rural regions (P>0.05). Boys in the 13-18 year-old group had the highest prevalence of obesity among the three age groups (P<0.01), while girls in the 13-18 year-old group had the lowest prevalence of malnutrition (P<0.05) (Table 2).

Multinomial logistic regression model predicting obesity, overweight, and malnutrition

The results of multinomial logistic regression are shown in Table 3.

Compared with boys, the aOR for obesity and malnutrition in girls was 0.80 (95% CI: 0.73–0.87) and 0.80 (95% CI: 0.71–0.90), respectively.

The aOR for obesity in children in the 2-6 year-old group was 0.55 (95% CI: 0.46–0.67) compared with adolescents in the 13-18 year-old group. The aOR for malnutrition in children in the 7-12 year-old group was 1.70 (95% CI: 1.25–2.33) compared to adolescents in the 13-18 year-old group.

There was no significant difference in the prevalence of obesity, overweight and malnutritionin children who live in urban and rural region.

Discussion

Economic development has led to a transition from under-nutrition to a dual burden of under- and over-nutrition in children and adolescents. In this study, the overall prevalence of malnutrition, overweight, and obesity for the participants was 5.87%,9.81%, and 10.50%, respectively, which is comparable to the national level prevalence [26]. The prevalence of obesity and malnutrition in boys was higher compared with girls. These findings were consistent with the worldwide nutrition trends based on 2416 population-based measurement studies [2], and also in studies reported in European, American, African, and Asian countries. [17-26]. Although researchers have found gender differences in nutritional status in most countries, it remains unclear how gender affects the nutrition status of an individual. One of the possible explanations for this difference in Southwestern China might be the social and cultural roles played by boys and girls. For instance, parents may be more concerned about the weight and body size of girls than boys. Another possible reason may be that of the son-preference in China, where boys are allocated more resources including food [27,28].

In this study, there was no statistical difference in the prevalence of obesity, overweight, and malnutrition between children in the rural and urban regions, and this was inconsistent with results reported in other studies conducted in China [29-31].This may be attributed to the rapid economic development, reduction in urban-rural disparities over time, and improved standards of living among rural children in Southwestern China [32]. These factors have reduced the disparities in the prevalence of malnutrition, overweight, and obesity between urban-rural regions.

In this study, logistical analysis results showed that middle and high school students are more likely to be obese than kindergarten students, which differs from the research by Yishan Chen et al [33]. This may be associated with children's high academic pressure and limited exercise after school, poor and irregular diet structure in Southwest China. Therefore, more attention should be paid to the nutritional status of school-going children in higher grades.

This study showed the epidemiologic characteristics of obesity, overweight, and malnutrition in children aged 2 years and above in Southwestern China. The study presents the latest data with a large sample. It is important to understand the nutritional status of children and adopt targeted measures to prevent childhood obesity andmalnutrition. Our study also has several limitations. Firstly, it was a hospital-based study on children attending regular health check-ups, therefore, selection bias exists. Secondly, we did not have data on children’s lifestyle (such as outdoor activity time, dietary habits, etc.), which greatly affect

the nutritional status of children. Therefore, a large multicenter randomized study is required to assess the nutritional status of children in Southwestern China and explore more risk factors.

Conclusion

The nutritional status of children and adolescents in Southwest China is comparable to that at the national level.The prevalence of obesity and malnutrition is shown to be associated with gender, and age.

Declarations

Ethical approval and consent to participate

The study was approved by the Medical Ethics Committee of the Children's Hospital of Chongqing Medical University, and written informed consent was obtained from legal guardians of all children participants in agreement with the Helsinki Declaration of 1964, and revised in 2000.

Consent for publication

Not applicable.

Availability of data and materials

The datasets generated and analysed during the current study are not publicly available due to protect privacy of participants, but are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

Jinwei Tu and Yuan Ding contributed to the study concept and design; Jinwei Tu, Yu Ruan and Zhendan contributed to the acquisition of the data; Jinwei Tu, Yu Ruan and Zhendan He performed the statistical analyses and drafted the manuscript; Jinwei Tu and Yuan Ding critically revised the manuscript and all authors read and approved the final manuscript.

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Tables

Table 1. Basic information of study population

	Malnutrition	Normal	Overweight	Obesity	Total
Gender					
Boys	817	9364	1215	1464	12860
Girls	511	7326	1002	910	9749
Region					
Urban	1274	16043	2147	2286	21750
Rural	54	647	70	88	859
Age(year)					
2-6y	572	8451	993	866	10882
7-12y	712	7458	1118	1362	10650
13-18y	44	781	106	146	1077

Table 2. Prevalence of obesity, overweight, and malnutrition in study population

	Age (Year)			Region		Total
	2-6	7-12	13-18	Rural	Urban	
Boys						
Obesity	$8.6^{**\Delta\Delta}$	$13.6^{**\Delta}$	16.6^{**}	11.0	11.4^{**}	11.4^{**}
Overweight	8.7	10.1	9.9	6.7	$9.6^{\&}$	9.4^{*}
Malnutrition	5.3	$7.6^{**\Delta}$	5.3^{*}	6.7	6.3^{**}	6.4^{**}
Girls						
Obesity	7.1	11.7	9.1	9.1	9.3	9.3
Overweight	9.6	11.0	9.8	10.3	10.3	10.3
Malnutrition	$5.3^{\Delta\Delta}$	5.5^{Δ}	2.3	5.6	5.2	5.2

vs girls $^{*}P<0.05$ $^{**}P < 0.01$; vs rural $^{\&}P < 0.05$ $^{\&\&}P < 0.01$; vs 13-18 age group $^{\Delta}P <0.05$ $^{\Delta\Delta}P <0.01$

Table 3. Multinomial logistic regression model predicting obesity, overweight, and malnutrition

Variables	Obesity	Overweight	Malnutrition
	OR[a] (95%CI)	OR[a] (95%CI)	OR[a] (95%CI)
Age group (year)			
2-6	0.55 (0.46-0.67)	0.86 (0.70-1.07)	1.21 (0.88-1.67)
7-12	0.98 (0.81-1.18)	1.10 (0.89-1.36)	1.70 (1.25-2.33)
13-18 (reference)			
Region			
Urban (reference)			
Rural	0.91 (0.73-1.15)	0.80 (0.62-1.03)	1.03 (0.78-1.37)
Gender			
Boys (reference)			
Girls	0.80 (0.73-0.87)	1.06 (0.97-1.15)	0.80 (0.71-0.90)

[a] Adjustment OR