

Preplanned Studies

Prevalence of Elevated Blood Pressure in Children and Adolescents Aged 7–17 Years Old and Its Association with Dietary Approaches to Stop Hypertension — China, 2021

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Summary

What is already known about this topic?

The prevalence of hypertension in children and adolescents is increasing, which is closely associated with cardiovascular disease risk in adulthood. The Dietary Approaches to Stop Hypertension (DASH) has demonstrated effectiveness in reducing blood pressure in adults. However, limited evidence exists regarding its effects among children in China.

What is added by this report?

This cross-sectional study found that 15.4% of Chinese children and adolescents aged 7 to 17 years had elevated blood pressure. The median DASH score was 24 [interquartile range (IQR) 21–28]. Students with higher DASH scores demonstrated a lower prevalence of elevated blood pressure compared to those with lower scores.

What are the implications for public health practice?

DASH adherence was inversely associated with elevated blood pressure prevalence among students aged 7–17 years in China. Increasing adherence to the DASH dietary pattern could play an effective role in the prevention and management of hypertension among children and adolescents.

Infrastructure. DASH scores were calculated using standardized criteria, and multivariable logistic regression models were employed to evaluate associations between EBP and DASH adherence.

Results: The prevalence of EBP in 7–17-year-olds was 15.4%. The median DASH score was 24 points, with the highest adherence tertile (T3) exhibiting a lower prevalence of EBP (14.9%) compared to T1 (lowest adherence) (16.2%) and T2 (moderate adherence) (15.2%). In the fully adjusted model (Model 2), adolescents aged 13–17 years in the T3 DASH adherence group showed reduced risk of EBP [odds ratio (OR)=0.78, 95% confidence interval (CI)=0.60, 0.98] relative to T1.

Conclusion: Higher DASH adherence is associated with reduced EBP risk in adolescents aged 13–17 years, emphasizing the protective role of DASH-recommended foods in promoting cardiovascular health.

ABSTRACT

Introduction: To investigate the prevalence of elevated blood pressure (EBP) and its association with Dietary Approaches to Stop Hypertension (DASH) adherence among Chinese children and adolescents, providing evidence for dietary interventions targeting pediatric hypertension.

Methods: Data were derived from the “National Survey on Nutrition and Health of Children Aged 0–18 Years,” a key project under China’s 13th Five-Year Plan for National Science and Technology

In recent years, the prevalence of hypertension among children and adolescents has increased globally. Data from the China Nutrition and Health Surveillance (2015–2017) revealed that 19.96% of Chinese children and adolescents had elevated blood pressure (1). Childhood and adolescent hypertension is associated with increased risk of cardiovascular disease in adulthood (2). The Dietary Approaches to Stop Hypertension (DASH) has demonstrated positive effects on reducing hypertension risk in adults (3). However, the association between DASH adherence and hypertension among children and adolescents remains inconsistent across limited studies, with some showing protective effects while others showing no significant association (4–5). Research on this topic is particularly scarce in China. This study aimed to

examine the relationship between DASH adherence and elevated blood pressure (EBP) among Chinese children and adolescents to provide evidence for effective dietary interventions for hypertension prevention in this population.

This study utilized data from the National Nutrition and Health Systematic Survey for children aged 0–18 in China (2019–2021). A multi-stage stratified random cluster sampling method was employed across 28 counties/districts in 14 provincial-level administrative divisions (PLADs) within 7 regions. At each survey site, 30 participants were recruited from each of the 11 age groups spanning 7 to 17 years, yielding a total sample size of 7,933. Detailed methodological information regarding the study design and sampling procedures has been published previously (6).

Diet intake data were collected using a validated food frequency questionnaire (FFQ) covering 72 food items and consumption patterns over the past month. Total daily energy intake (kcal) was calculated according to the Chinese Food Composition Table (Standard Edition, 6th edition). The 72 food items were categorized into 8 groups: fruits, vegetables, nuts and legumes, whole grains, dairy products, salt, red and processed meats, and sugar-sweetened beverages. To account for the influence of energy intake, consumption of each food group was standardized per 1000 kJ and subsequently categorized into quintiles.

For the 5 “healthy” food groups (fruits, vegetables, nuts and legumes, whole grains, and dairy products), participants in the lowest quintile received 1 point, with subsequent quintiles receiving 2, 3, 4, and 5 points respectively. Conversely, for the 3 “unhealthy” food groups (salt, red and processed meats, and sugar-sweetened beverages), a reverse scoring system was applied, with the lowest quintile receiving 5 points and the highest receiving 1 point. The DASH score ranged from 8 to 40 points, according to which participants were classified into tertiles: T1 (bottom tertile as lowest adherence), T2 (2nd tertile as moderate adherence), and T3 (top tertile as highest adherence).

Blood pressure was measured using identical electronic sphygmomanometers across all study sites. EBP was defined according to the “*Reference of Screening For Elevated Blood Pressure Among Students Aged 7–18 Years*” (WS/T 610-2018) (7). Sleep duration was assessed based on the recommended standards in the Dietary Guidelines for School-Aged Children in China (2022 edition). Sufficient physical activity was defined as accumulating 60 minutes or

more of activity daily.

Basic demographic information, including gender, age, parental education, and family income, was collected through a structured questionnaire. Fasting body weight was measured using an electronic scale (accurate to 0.1 kg), while height was determined using a stadiometer (accurate to 0.1 cm). Body mass index (BMI) was calculated as weight (kg) divided by height squared (m^2), according to the national health industry standard “Screening of Child and Adolescent Malnutrition” (WS/T 456-2014), the age-specific height cut-off points for children of different genders were used to judge stunting, and the BMI cut-off points for children of different ages were used to judge wasting. BMI cut-off points for children of different genders and ages were used to determine overweight and obesity in Chinese health industry and participants were classified as undernutrition (including stunting and wasting), normal, overweight, or obese (8–9). For all analyses, participants were stratified into 2 age groups: 7–12 years and 13–17 years.

DASH scores were reported as median and interquartile range (IQR). Categorical variables were presented as n (%). Multivariable logistic regression was used to analyze the association between DASH score tertiles and EBP. All statistical analyses were conducted using SAS (version 9.4, SAS Institute Inc., Cary, USA). A two-sided $P < 0.05$ was considered statistically significant.

Sociodemographic characteristics of the participants, DASH scores by general characteristics, and prevalence of EBP are presented in Table 1. The overall prevalence of EBP was 15.4%. Rural students exhibited a significantly higher prevalence (16.9%) compared to urban students (13.8%; $P < 0.001$). Regarding nutritional status, obese students demonstrated the highest rate of EBP (27.5%), while undernourished students had the lowest rate (8.9%, $P < 0.001$). Bachelor degree or above were associated with lower prevalence of EBP ($P = 0.006$). No significant differences in EBP prevalence were observed across genders, age groups, physical activity status, sleep patterns, maternal education levels, or household income categories. The median DASH score was 24 (IQR 21–28) points.

EBP prevalence showed a progressive decrease across DASH adherence tertiles from T1 (16.2%) to T3 (14.9%), with T2 occupying an intermediate position (15.2%). Table 2 presents the results of multivariable logistic regression analyses examining the association between DASH score tertiles and elevated blood

TABLE 1. Prevalence of elevated blood pressure and DASH diet score in students aged 7–17, China, 2021.

Group	Sample, N (%)	Elevated blood pressure, n (%)	P	DASH score, median (IQR)	P
Total	7,933	1,219 (15.4)		24 (21, 28)	
Gender			0.725		0.003
Male	3,961 (49.9)	603 (15.2)		24 (21, 28)	
Female	3,972 (50.1)	616 (15.5)		25 (21, 26)	
Age group			0.936		<0.001
7–12 years	4,310 (54.3)	661 (15.3)		25 (21, 28)	
13–17 years	3,623 (45.7)	558 (15.4)		24 (20, 27)	
Area			<0.001		<0.001
Urban	3,981 (50.2)	550 (13.8)		26 (22, 29)	
Rural	3,952 (49.8)	669 (16.9)		23 (20, 27)	
Physical activity situation			0.185		<0.001
Sufficient physical activity	731 (9.2)	100 (13.7)		25 (22, 29)	
Insufficient physical activity	7,202 (90.8)	1,119 (15.5)		24 (21, 28)	
Sleep situation			0.557		<0.001
sufficient sleep	3,536 (44.6)	526 (14.9)		24 (21, 27)	
Insufficient sleep	4,397 (55.4)	693 (15.8)		25 (21, 28)	
Nutritional status			<0.001		<0.001
Undernutrition	481 (6.1)	43 (8.9)		25 (21, 28)	
Normal	5,322 (67.1)	683 (12.8)		24 (21, 28)	
Overweight	1,144 (14.4)	222 (19.4)		25 (21, 28)	
Obesity	986 (12.4)	271 (27.5)		25 (22, 28)	
Paternal education			0.006		<0.001
Junior high school and below	4,147 (52.3)	687 (16.6)		24 (20, 27)	
High school-Junior college	2,471 (31.2)	356 (14.4)		25 (22, 28)	
Bachelor degree or above	1,315 (16.5)	176 (13.4)		25 (21, 28)	
Maternal education			0.443		<0.001
Junior high school and below	4,199 (52.9)	656 (15.6)		20 (17, 24)	
High school-Junior college	2,492 (31.4)	387 (15.5)		22 (18, 25)	
Bachelor degree or above	1,242 (15.7)	176 (14.2)		25 (21, 28)	
Annual household income			0.173		0.445
100,000 yuan or less	5,478 (69.1)	862 (15.7)		24 (21, 28)	
More than 100,000 yuan	2,455 (30.9)	357 (14.5)		24 (21, 28)	

Abbreviation: DASH=Dietary Approaches to Stop Hypertension; IQR=interquartile range.

pressure. In model 1, significant protective associations against EBP were identified in the adolescent subgroup, with both the second tertile [T2: odds ratio (OR)=0.78, 95% confidence interval (CI): 0.63, 0.96] and third tertile (T3: OR=0.74, 95% CI: 0.58, 0.94) of DASH scores showing reduced risk among participants aged 13–17 years.

After adjusting for confounding factors, the protective association remained statistically significant specifically in the adolescent subgroup. In Model 2, the highest DASH adherence group (T3) showed an OR of 0.78 (95% CI: 0.60, 0.98). This consistent pattern

suggests a robust protective effect of higher DASH adherence against elevated blood pressure among adolescents aged 13–17 years. However, no statistically significant associations were detected in either the overall sample or the 7–12-year-old subgroup.

DISCUSSION

This cross-sectional study provides nationally representative data on the prevalence of EBP among Chinese children and adolescents aged 7–17 years (15.4%). After adjusting for confounding variables,

TABLE 2. Association between DASH diet score and blood pressure status among students aged 7–17 years: Logistic regression analysis, China, 2021.

DASH score by age group	Elevated blood pressure, <i>n</i> (%)	Model 1		Model 2	
		OR (95% CI)	<i>P</i>	OR (95% CI)	<i>P</i>
7–17 years					
T1	343 (16.2)	1.00		1.00	
T2	458 (15.2)	1.02 (0.88, 1.18)	0.777	0.98 (0.85, 1.13)	0.798
T3	418 (14.9)	0.93 (0.80, 1.08)	0.484	0.94 (0.80, 1.03)	0.469
7–12 years					
T1	209 (15.5)	1.00		1.00	
T2	226 (14.1)	0.92 (0.75, 1.13)	0.989	0.88 (0.71, 1.09)	0.242
T3	226 (16.6)	1.12 (0.92, 1.37)	0.745	1.12 (0.91, 1.37)	0.290
13–17 years					
T1	134 (17.3)	1.00		1.00	
T2	232 (16.5)	0.78 (0.63, 0.96)	0.019	0.81 (0.66, 1.00)	0.058
T3	192 (13.3)	0.74 (0.58, 0.94)	0.012	0.78 (0.60, 0.98)	0.047

Note: Model 1: unadjusted analysis; Model 2: adjusted for gender, urban-rural area, physical activity status, sleep duration, nutritional status, paternal education, maternal education, and annual household income. T1, T2, and T3 represent tertile groups categorized by ascending DASH scores, with T1 demonstrating the lowest adherence to the DASH diet, T2 exhibiting moderate adherence, and T3 showing the highest level of compliance.

Abbreviation: DASH=Dietary Approaches to Stop Hypertension.

participants in the highest DASH adherence group demonstrated a significant inverse association with EBP in those aged 13–17 years, suggesting that DASH may serve as a protective factor against high blood pressure in this population. No association was found between DASH and blood pressure in Chinese children aged 7–12 years. These findings indicate that DASH demonstrates potential utility as a preventive nutritional strategy against hypertension among Chinese adolescents.

The United States national survey data (1999–2020) reported a hypertension prevalence of 9.81% among 6,095 children aged 8–17 years (10). Japanese longitudinal research (2000–2019) identified a hypertension prevalence rate of 10.6% among male adolescents aged 12–18 years during the 2015–2019 observation period (11). This discrepancy may be attributable to divergent diagnostic criteria, wherein U.S. and Japanese studies reported hypertension prevalence rates, whereas the present study documented EBP detection rates. A nationally representative survey (2016–2017) in China showed that 19.96% of children and adolescents aged 7–17 years exhibited EBP (1). Another national study reported a 15.3% prevalence of EBP among Chinese children and adolescents aged 7–17 years in 2019 (12). The prevalence of EBP in this survey is lower than that observed in 2016–2017, with results closely aligning with 2019 findings. This study found that the

prevalence of EBP among urban pediatric populations was lower compared to their rural counterparts, which aligns with prior research observations (12). These differences may be attributed to variations in dietary structure between urban and rural areas, the direct impact of economic level on dietary diversity, and differences in salt intake. Notably, the prevalence of EBP was 19.4% in overweight individuals and increased to 27.5% among those who are obese. These rates are appreciably higher than in children with normal nutritional status. Both overweight and obesity have been firmly established as critical risk factors for the onset of hypertension (13). Additionally, deviations from a healthy weight range during childhood augment the risk of developing hypertension in later life (14). These findings underscore the critical need for comprehensive public health interventions aimed at promoting healthy BP management in childhood.

The DASH diet emphasizes high consumption of fruits, vegetables, legumes, and low-fat dairy while restricting sodium, added sugars, and processed meats (15), aligning closely with recommendations in the Chinese Dietary Guidelines for School-age Children (2022). The dynamic physiological and behavioral changes of adolescence might complicate the outcomes of dietary interventions. The National Nutrition Survey (2003–2012) of 9,793 children revealed an inverse association between DASH score and systolic blood pressure ($\beta=-0.46$; 95% CI: $-0.83, -0.09$),

though no significant relationship was observed for diastolic measures (4). A school-based study conducted in Brazil demonstrated no association between DASH compliance and blood pressure parameters (5). However, a United States clinical trial demonstrated systolic improvement (Z score = -0.3, $P=0.03$) among 159 hypertensive adolescents following DASH protocols (16). Additionally, children and adolescents from different countries and regions have different dietary patterns and varying adherence to the DASH model, which may contribute to inconsistent results across studies.

This study has several limitations. First, the use of FFQ to calculate DASH scores may introduce recall bias. However, the FFQ employed in this survey demonstrated validated reliability and validity through rigorous testing, and all investigators received standardized training to ensure consistency in data collection, which likely minimized recall bias in self-reported dietary data. Second, the cross-sectional design precludes establishing causal relationships between DASH adherence and blood pressure in children and adolescents; longitudinal studies are needed to verify these associations.

In conclusion, the prevalence of EBP among Chinese children and adolescents is high, particularly in those with obesity and overweight. Priority should be given to blood pressure monitoring for this population. Health professionals should implement nutritional education programs for children and their caregivers that emphasize adherence to the DASH dietary pattern for managing blood pressure. Collaborative multicenter trials involving CDC institutions and hospitals are needed to further evaluate the efficacy of DASH in pediatric blood pressure management.

Conflicts of interest: No conflicts of interest.

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