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ORIGINAL RESEARCH

Status of Cardiovascular Health in Chinese Children and Adolescents

A Cross-Sectional Study in China

Yanna Zhu, PhD,[a,*] Pengfei Guo, MBBS,[a,*] Zhiyong Zou, PhD,[b] Xiuhong Li, MD, PhD,[a] Muqing Cao, PhD,[a] Jun Ma, PhD,[b] Jin Jing, MD, PhD[a]

ABSTRACT

BACKGROUND The American Heart Association defined "ideal cardiovascular health (CVH)" in pediatric populations to promote primordial prevention in cardiovascular diseases. Little is known about CVH and associated sociodemographic factors among Chinese children and adolescents.

OBJECTIVES This study aimed to evaluate CVH and the associations with sociodemographic characteristics in Chinese children and adolescents.

METHODS This cross-sectional study analyzed baseline data of 15,583 participants aged 7 to 17 years from a Chinese national intervention program against obesity (2013-2014). CVH status was estimated according to 4 health behaviors (nonsmoking, body mass index, physical activity, and diet) and 3 health factors (total cholesterol, blood pressure, and fasting plasma glucose), using revised American Heart Association criteria. Multinomial logistic regression was used to assess the association between sociodemographic characteristics and the number of ideal CVH metrics.

RESULTS The prevalence of ideal CVH status was 1.7% (males: 1.9%; females: 1.6%) in the study population. The prevalence of ideal CVH behaviors and ideal health factors was 3.1% (males 3.3%; females: 3.0%) and 53.6% (males: 52.4%; females: 54.9%), respectively. Ideal fasting plasma glucose was the most prevalent component (males: 94.4%; females: 97.4%), whereas ideal physical activity (males: 34.6%; females: 23.9%) and diet (males: 28.3%; females: 30.1%) were the least prevalent. Female sex, younger age, undeveloped economy, residence in the southern region, and no family history of cardiovascular diseases were associated with more ideal CVH metrics.

CONCLUSIONS Ideal CVH status in Chinese children and adolescents is alarmingly rare. Physical activity and diet are key to promotion of CVH. Effective interventions are needed to promote CVH and reduce health disparities in early life. (JACC: Asia 2022;2:87–100) © 2022 The Authors. Published by Elsevier on behalf of the American College of Cardiology Foundation. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

Cardiovascular disease (CVD) is acknowledged as a public health burden worldwide (1). In China, CVD has ranked first as a cause of death, accounting for about 42% of all deaths in urban areas and 45% of deaths in rural areas in 2015 (2,3). Despite a remarkable decreasing trend in age-standardized CVD mortality rates from 1990 to 2015 (4-6), maintaining mobility and quality of life into old age remains a major challenge in China.

From the [a]Department of Maternal and Child Health, School of Public Health, Sun Yat-sen University, Guangzhou, China; and the [b]Institute of Child and Adolescent Health, School of Public Health, Peking University, Beijing, China. *Drs Zhu and Guo contributed equally to this work.

The authors attest they are in compliance with human studies committees and animal welfare regulations of the authors' institutions and Food and Drug Administration guidelines, including patient consent where appropriate. For more information, visit the Author Center.

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ABBREVIATIONS AND ACRONYMS

AHA = American Heart Association
BMI = body mass index
BP = blood pressure
CVD = cardiovascular disease
CVH = cardiovascular health
FPG = fasting plasma glucose
TC = total cholesterol

To reverse the rising tide of CVD, the American Heart Association (AHA) 2020 Strategic Impact Goal defined ideal cardiovascular health (CVH) as the coincident presence of 4 health behaviors (nonsmoking, body mass index [BMI], physical activity, and diet) and 3 health factors (total cholesterol [TC], blood pressure [BP], and fasting plasma glucose [FPG]) at ideal levels (7,8). The ideal CVH framework is a practice of primordial prevention (9), promoting health by preventing the development of risk factors (8,10). Although CVD events most commonly occur in elderly persons, and clinical manifestations of CVD may not appear until middle age, the underlying pathophysiological processes originate from a young age (11-14). To achieve primordial prevention, a substantial effort must be launched to improve the ideal CVH status in youths (7,9,15).

Unfortunately, the distribution of CVH status among children and adolescents has not been well examined (16). Data from the general population in the United States revealed a poor status of CVH among both adults and youths (17-19). Several studies indicated that the prevalence of ideal CVH status was extremely low among Chinese adults (20-26). Currently, data are limited among Chinese children and adolescents, mostly from urban areas (27) and major cities (28,29), or are solely of surveyed health behaviors without measurement in biosamples (30).

In addition, determinants of CVH status in youths remain unclear, whereas studies among adults have detected inverse associations between the ideal CVH metrics and the number of cumulative social risk factors (31,32). Previous studies among adults have explored associations between some CVH components and some sociodemographic characteristics, including sex (26,33), education (26,34,35), family disease history (36), and geographic region (37). However, few studies quantified the associations between comprehensive ideal CVH metrics and sociodemographic variables in children and adolescents.

The present cross-sectional study aimed to assess the current status of CVH and to examine associations between sociodemographic factors and ideal CVH metrics in Chinese children and adolescents by using revised AHA criteria.

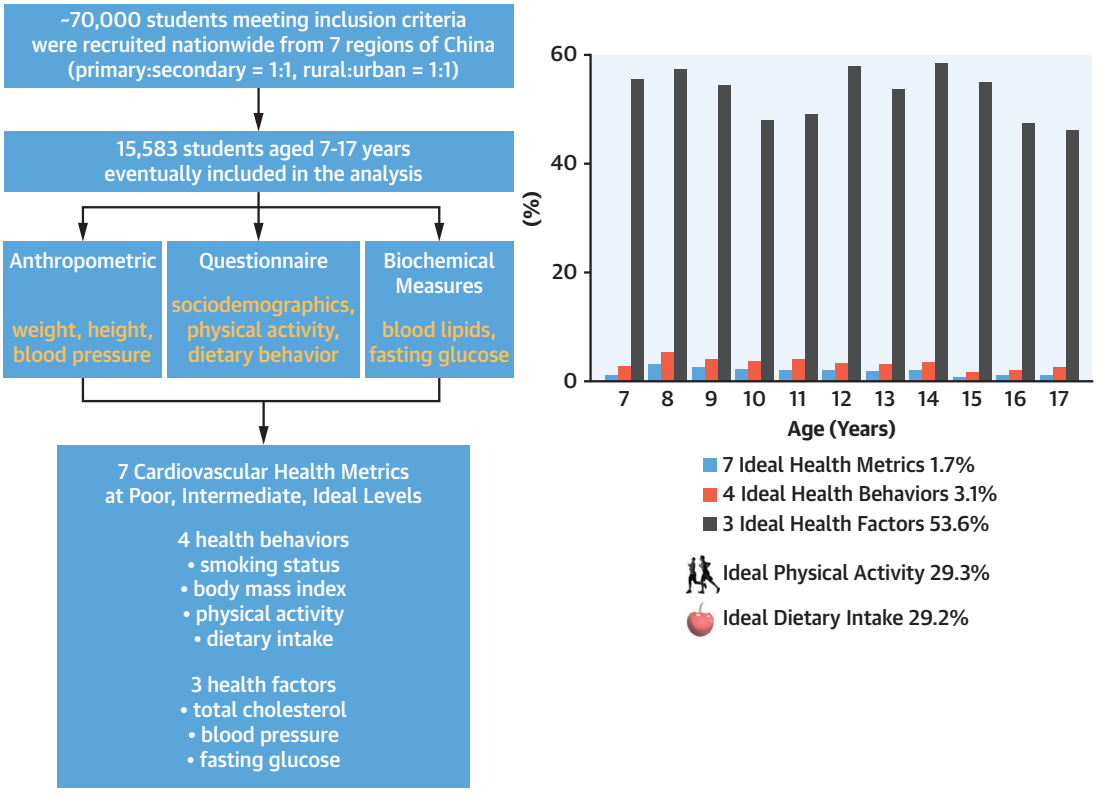
METHODS

STUDY DESIGN AND POPULATION. This cross-sectional study was embedded in the baseline survey of a national school-based project against childhood obesity (38). The study design, recruitment process, and inclusion criteria have been described elsewhere. Briefly, approximately 70,000 children and adolescents were invited from 94 schools in 7 provinces/municipalities (urban: rural = 1:1; primary school: secondary school = 1:1) in September 2013, including Ningxia, Chongqing, Tianjin, Hunan, Guangdong, Liaoning, and Shanghai (**Central Illustration,** Supplemental Table 1). Anthropometric characteristics and questionnaires were collected from all students enrolled, whereas blood samples were only collected from those who signed blood sample collection consents (approximately 25% in each province/municipality). Eventually, 15,583 students aged 7 to 17 years who agreed and completed the questionnaires and blood biochemical measurements were included in the present study. The population characteristics (eg, sex, age, parental education, geographic locations, the prevalence of obesity) were comparable to another study using the same national database (N = 56,401) (39). The Ethical Committee of Peking University approved the study's protocol. All students and parents provided written informed consent and participated in this study voluntarily.

DATA COLLECTION. Details regarding data collection can be found in the study protocol (38). Four types of information were collected and measured: anthropometric characteristics, behavioral outcomes, sociodemographic factors, and blood chemical outcomes. Anthropometric characteristics, including height, weight, and BP, were measured with previously calibrated standard devices by well-trained school doctors/physicians based on a national standardized workbook for procedures in children and adolescents (Supplemental Table 2). Behavioral assessment, including smoking in the past month and prior 7 days, physical activities, and diet (prior 7 days) along with sociodemographic factor information, was performed by using separate self-reported questionnaires for students and parents. For children under Grade 3, both child and parent questionnaires were completed by parents; for children above Grade 3, child questionnaires were answered by the children in class, instructed by teachers. The validity and reliability of the child questionnaire have been tested previously (40), with Cronbach $\alpha = 0.64$. The content validity indices of the subscales ranged from 0.43 to 0.66.

Blood samples were drawn from participants fasted overnight for 12 hours. The analysis of FPG and TC was conducted at a validated biomedical analysis laboratory (38). All data were double entered and corrected for errors with EpiData 3.0 (EpiData Association).

CENTRAL ILLUSTRATION **Status of Cardiovascular Health Metrics in Chinese Children and Adolescents**



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In this nationwide school-based cross-sectional study: 1) ideal cardiovascular health status (having 7 ideal health metrics) was alarmingly rare in Chinese children and adolescents; and 2) ideal physical activity (≥60 minutes of moderate or vigorous activity every day) and ideal dietary intake (having recommended amounts of 4-5 diet components) were the least prevalent metrics.

TABLE 1 **Classification of Cardiovascular Health Metrics for Chinese Children and Adolescents**

	Poor Health	Intermediate Health	Ideal Health
Smoking[a]	Tried prior 30 days	-	Never tried prior 30 days; meanwhile, neither of their parents smoked prior 7 days
Body mass index[b]	>95th percentile	85th-95th percentile	<85th percentile
Physical activity	None	>0 and <60 min of moderate or vigorous activity every day	≥60 min of moderate or vigorous activity every day
Diet[c]	0-1 components	2-3 components	4-5 components
Total cholesterol[d]	≥200 mg/dL	170-199 mg/dL	<170 mg/dL
Blood pressure[d]	>95th percentile	90th-95th percentile or SBP ≥120 or DBP ≥80 mm Hg	<90th percentile
Fasting plasma glucose[d]	≥126 mg/dL	100-125 mg/dL	<100 mg/dL

[a]All other conditions at neither a poor health level nor at an ideal health level were categorized as intermediate health level of smoking. [b]Cutoffs for ideal, intermediate, and poor body mass index and blood pressure were in line with the growth and development characteristics of Chinese children and adolescents according to age- and sex-specific Chinese reference standards recommended for national comparisons. [c]Revised diet components according to The Food Guide Pagoda for Chinese Residents: fruits and vegetables: ≥3 servings (children 6-8 years old) or 4.5 servings (children ≥9 years old) per day; meat: ≤3 servings per day; dairy products: every day; high-energy snacks: ≤1 day per week; and sugared beverages: ≤36 ounces per week. [d]Untreated values.

DBP = diastolic blood pressure; SBP = systolic blood pressure.

TABLE 2 Proportions of CVH Metrics According to Sex, Age, Economic Development, and Geographic Region

		Sex			Age			
	Overall	Male (n = 8,004)	Female (n = 7,579)	*P* Value	7-9 y (n = 5,469)	10-14 y (n = 6,490)	15-17 y (n = 3,624)	*P* Value
Smoking								
Poor health	0.3 ± 0.0	0.5 ± 0.1	0.1 ± 0.0	<0.001[a]	0.5 ± 0.1	0.2 ± 0.1	0.2 ± 0.1	<0.001[a]
Intermediate health	57.1 ± 0.4	57.7 ± 0.6	56.5 ± 0.6		55.0 ± 0.7	58.7 ± 0.6	57.4 ± 0.9	
Ideal health	42.6 ± 0.4	41.8 ± 0.6	43.5 ± 0.6		44.6 ± 0.7	41.1 ± 0.6	42.5 ± 0.9	
Body mass index								
Poor health	10.2 ± 0.2	13.3 ± 0.4	7.0 ± 0.3	<0.001[a]	11.9 ± 0.4	10.8 ± 0.4	6.8 ± 0.4	<0.001[a]
Intermediate health	13.8 ± 0.3	14.9 ± 0.4	12.7 ± 0.4		16.6 ± 0.5	13.6 ± 0.4	10.0 ± 0.5	
Ideal health	75.9 ± 0.3	71.8 ± 0.5	80.3 ± 0.5		71.5 ± 0.6	75.6 ± 0.5	83.2 ± 0.6	
Physical activity								
Poor health	8.8 ± 0.3	7.3 ± 0.3	10.3 ± 0.4	<0.001[a]	10.6 ± 0.5	7.0 ± 0.4	9.3 ± 0.5	<0.001[a]
Intermediate health	61.9 ± 0.4	58.1 ± 0.6	65.8 ± 0.6		60.6 ± 0.8	59.9 ± 0.7	67.0 ± 0.8	
Ideal health	29.3 ± 0.4	34.6 ± 0.6	23.9 ± 0.5		28.8 ± 0.7	33.1 ± 0.7	23.7 ± 0.8	
Dietary intake								
Poor health	2.9 ± 0.1	3.8 ± 0.2	2.1 ± 0.2	<0.001[a]	1.3 ± 0.2	3.5 ± 0.3	4.1 ± 0.4	<0.001[a]
Intermediate health	67.9 ± 0.4	68.0 ± 0.6	67.8 ± 0.6		59.4 ± 0.7	68.7 ± 0.6	78.2 ± 0.7	
Ideal health	29.2 ± 0.4	28.3 ± 0.6	30.1 ± 0.6		39.3 ± 0.7	27.8 ± 0.6	17.7 ± 0.7	
Total cholesterol								
Poor health	5.5 ± 0.2	5.0 ± 0.2	6.0 ± 0.3	<0.001[a]	6.9 ± 0.3	5.0 ± 0.3	4.4 ± 0.3	<0.001[a]
Intermediate health	19.9 ± 0.3	18.4 ± 0.4	21.5 ± 0.5		24.8 ± 0.6	17.4 ± 0.5	17.0 ± 0.6	
Ideal health	74.6 ± 0.3	76.6 ± 0.5	72.4 ± 0.5		68.3 ± 0.6	77.6 ± 0.5	78.6 ± 0.7	
Blood pressure								
Poor health	9.0 ± 0.2	9.6 ± 0.3	8.3 ± 0.3	<0.001[a]	9.5 ± 0.4	10.4 ± 0.4	5.5 ± 0.4	<0.001[a]
Intermediate health	15.4 ± 0.3	17.5 ± 0.4	13.2 ± 0.4		5.9 ± 0.3	16.6 ± 0.5	27.6 ± 0.7	
Ideal health	75.6 ± 0.3	72.9 ± 0.5	78.5 ± 0.5		84.6 ± 0.5	72.9 ± 0.6	66.9 ± 0.8	
Fasting plasma glucose								
Poor health	0.1 ± 0.0	0.2 ± 0.0	0.1 ± 0.0	<0.001[a]	0.1 ± 0.0	0.1 ± 0.0	0.2 ± 0.1	<0.001[a]
Intermediate health	4.0 ± 0.2	5.4 ± 0.3	2.5 ± 0.2		2.7 ± 0.2	4.9 ± 0.3	4.3 ± 0.3	
Ideal health	95.9 ± 0.2	94.4 ± 0.3	97.4 ± 0.2		97.2 ± 0.2	95.0 ± 0.3	95.4 ± 0.3	

Values are mean ± SE. [a]$P < 0.05$, assessed by chi-square test for categorical variables. There were 1,604 missing values for smoking status, 519 missing values for body mass index, 3,177 missing values for physical activity, 2,774 missing values for dietary intake, and 41 missing values for blood pressure.

CVH = cardiovascular health.

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SOCIODEMOGRAPHIC FACTORS. The 8 sociodemographic characteristics of interest were sex, age, parental and family history of CVD, paternal and maternal education, economic development of the province/municipality, and geographic region of the province/municipality. Biological sexes were determined by school doctors/physicians on the basis of physical appearance, and birth dates were extracted from the child questionnaire; CVD history of parents and relatives and parental educational levels were collected in the parent questionnaire. Details of these variables are presented in Supplemental Table 3.

CVH METRICS. CVH was evaluated by using revised criteria of the AHA (7,8), including 4 health behaviors (nonsmoking, BMI, physical activity, and diet) and 3 health factors (BP, TC, and FPG). The modified classifications of CVH for Chinese children and adolescents are listed in **Table 1**. Passive smoking (current paternal or maternal smoking) was added to the original AHA criteria on active smoking, given the updated evidence in support of its detrimental effects on cardiovascular status in children (41,42) as well as a remarkable underestimate of tobacco exposure among Chinese children and adolescents if only considering active smoking (43-45). Cutoffs for ideal, intermediate, and poor BMI and untreated BP were from age- and sex-specific Chinese reference standards (46,47). Daily average time of vigorous and moderate physical activities was calculated based on the self-reported number of days participating and hours/minutes for each time in the past 7 days. Five diet components (fruits and vegetables, meat, dairy products, sugared beverages, and high-energy-dense snacks) were modified in accordance with The Food Guide Pagoda for Chinese Residents (48), in which similar modifications have been accepted in studies

TABLE 2 Continued

Economic Development			Geographic Region		
Undeveloped (n = 4,276)	Developed (n = 11,307)	*P* Value	South (n = 8,477	North (n = 7,106)	*P* Value
0.1 ± 0.1	0.3 ± 0.1	<0.001[a]	0.2 ± 0.0	0.4 ± 0.1	<0.001[a]
65.5 ± 0.5	54.7 ± 0.8		54.6 ± 0.6	60.4 ± 0.6	
34.4 ± 0.5	45.0 ± 0.8		45.3 ± 0.6	39.2 ± 0.6	
5.4 ± 0.3	12.0 ± 0.4	<0.001[a]	8.3 ± 0.3	12.5 ± 0.4	<0.001[a]
11.1 ± 0.3	14.9 ± 0.5		13.3 ± 0.4	14.5 ± 0.4	
83.5 ± 0.4	73.1 ± 0.6		78.4 ± 0.5	73.0 ± 0.5	
9.5 ± 0.3	8.6 ± 0.6	0.092	7.0 ± 0.3	11.2 ± 0.4	<0.001[a]
62.7 ± 0.5	61.7 ± 0.9		63.4 ± 0.6	59.8 ± 0.7	
27.8 ± 0.5	29.7 ± 0.9		29.6 ± 0.5	29.0 ± 0.6	
3.6 ± 0.2	2.7 ± 0.3	<0.001[a]	3.1 ± 0.2	2.7 ± 0.2	<0.001[a]
72.6 ± 0.5	66.6 ± 0.8		69.6 ± 0.5	65.6 ± 0.6	
23.8 ± 0.5	30.7 ± 0.8		27.3 ± 0.5	31.7 ± 0.6	
3.2 ± 0.2	6.4 ± 0.3	<0.001[a]	7.3 ± 0.3	3.4 ± 0.2	<0.001[a]
15.7 ± 0.4	21.5 ± 0.6		23.6 ± 0.5	15.5 ± 0.4	
81.1 ± 0.4	72.1 ± 0.6		69.1 ± 0.5	81.1 ± 0.5	
8.0 ± 0.3	11.6 ± 0.5	<0.001[a]	5.7 ± 0.3	12.8 ± 0.4	<0.001[a]
16.1 ± 0.3	13.7 ± 0.5		11.4 ± 0.3	20.2 ± 0.5	
75.9 ± 0.4	74.8 ± 0.7		82.9 ± 0.4	67.0 ± 0.6	
0.1 ± 0.0	0.1 ± 0.0	<0.001[a]	0.1 ± 0.0	0.1 ± 0.0	<0.001[a]
0.8 ± 0.2	5.2 ± 0.1		2.9 ± 0.2	5.3 ± 0.3	
99.2 ± 0.2	94.6 ± 0.1		97.0 ± 0.2	94.6 ± 0.3	

among Chinese populations (22,27). The standards for untreated TC and FPG remained unchanged, as with previous Chinese studies (27).

Each metric was categorized into ideal, intermediate, or poor levels. Ideal CVH status, as well as the ideal health status of behaviors or factors, was defined by all of the included metrics meeting ideal criteria.

STATISTICAL ANALYSIS. Proportions and SEs of each CVH metric in 3 levels were assessed in the total population and according to 8 sociodemographic factors. Meanwhile, proportions and SEs of numbers of ideal CVH metrics, ideal health behaviors, and ideal health factors were calculated. Chi-square tests were used to determine if 2 categorical variables were independent. To identify the association of sociodemographic factors with CVH, multinomial logistic regression was used. The dependent variables were number of ideal CVH metrics (6-7, 4-5, 2-3; reference: 0-1), number of ideal health behaviors (3-4, 2; reference: 0-1), and number of ideal health factors (3, 2; reference: 0-1). The independent variables in the most parsimonious model included sex, age, economic development, geographic region, and family disease history of CVD. Sensitivity analyses entered all 8 sociodemographic factors simultaneously.

Data were analyzed by using SPSS 22.0 (IBM SPSS Statistics, IBM Corporation), with statistical significance at 5% (2-sided). Figures were produced by using the R package *ggplot2* (49,50).

RESULTS

The final sample included 15,583 Chinese children and adolescents aged 7 to 17 years with questionnaires and blood biochemical measurements. Our sample comprised 8,004 male subjects and 7,579 female subjects, with a median age of 12 (P_{25} = 9, P_{75} = 14) years. More people resided in developed provinces/municipalities (72.6%) or lived in the southern region (54.4%).

TABLE 3 Proportions of CVH Metrics According to History of Related Diseases and Parental Educational Level

	Parental Disease History			Family Disease History		
	Have Related Diseases (n = 1,894)	No Related Diseases (n = 9,664)	*P* Value	Have Related Diseases (n = 7,320)	No Related Diseases (n = 4,218)	*P* Value
Smoking						
Poor health	0.3 ± 0.1	0.2 ± 0.0	0.450	0.2 ± 0.1	0.3 ± 0.1	<0.001[a]
Intermediate health	53.9 ± 1.2	52.7 ± 0.5		55.1 ± 0.6	49.2 ± 0.8	
Ideal health	45.7 ± 1.2	47.1 ± 0.5		44.7 ± 0.6	50.5 ± 0.8	
Body mass index						
Poor health	15.7 ± 0.9	9.6 ± 0.3	<0.001[a]	11.8 ± 0.4	8.5 ± 0.4	<0.001[a]
Intermediate health	17.3 ± 0.9	13.9 ± 0.4		15.5 ± 0.4	12.6 ± 0.5	
Ideal health	66.9 ± 0.1	76.5 ± 0.4		72.7 ± 0.5	78.9 ± 0.6	
Physical activity						
Poor health	9.0 ± 0.7	8.8 ± 0.3	0.334	8.6 ± 0.3	9.2 ± 0.5	0.006[a]
Intermediate health	60.4 ± 1.2	62.3 ± 0.5		63.1 ± 0.6	59.9 ± 0.8	
Ideal health	30.6 ± 1.1	29.0 ± 0.5		28.3 ± 0.6	30.9 ± 0.8	
Dietary intake						
Poor health	2.7 ± 0.4	2.8 ± 0.2	0.635	2.7 ± 0.2	2.9 ± 0.3	0.010[a]
Intermediate health	68.6 ± 1.1	67.5 ± 0.5		68.7 ± 0.6	65.9 ± 0.8	
Ideal health	28.7 ± 1.1	29.7 ± 0.5		28.5 ± 0.6	31.2 ± 0.8	
Total cholesterol						
Poor health	5.6 ± 0.5	5.5 ± 0.2	0.950	5.8 ± 0.3	5.1 ± 0.3	0.037[a]
Intermediate health	20.5 ± 0.9	20.5 ± 0.4		21.0 ± 0.5	19.6 ± 0.6	
Ideal health	73.8 ± 1.0	74.0 ± 0.4		73.2 ± 0.5	75.3 ± 0.7	
Blood pressure						
Poor health	11.0 ± 0.7	8.6 ± 0.3	<0.001[a]	9.4 ± 0.3	8.0 ± 0.4	0.030[a]
Intermediate health	18.0 ± 0.9	15.6 ± 0.4		16.0 ± 0.4	15.9 ± 0.6	
Ideal health	71.0 ± 1.0	75.9 ± 0.4		74.6 ± 0.5	76.1 ± 0.7	
Fasting plasma glucose						
Poor health	0.1 ± 0.1	0.1 ± 0.0	0.588	0.1 ± 0.0	0.2 ± 0.1	0.086
Intermediate health	4.5 ± 0.5	4.3 ± 0.2		4.3 ± 0.2	4.5 ± 0.3	
Ideal health	95.4 ± 0.5	95.6 ± 0.2		95.6 ± 0.2	95.3 ± 0.3	

Values are mean ± SE. [a]$P < 0.05$, assessed by chi-square test for categorical variables. There were 1,604 missing values for smoking status, 519 missing values for body mass index, 3,177 missing values for physical activity, 2,774 missing values for dietary intake, and 41 missing values for blood pressure.

CVH = cardiovascular health.

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DISTRIBUTION OF 7 CVH METRICS. The distribution of CVH metrics in the overall population and subgroups of sex, age, economic development, geographic region, parental and family CVD history, and parental education is presented in Tables 2 and 3. Ideal FPG was the most prevalent metric (males: 94.4%; females: 97.4%). The ideal levels of BMI, TC, and BP were as high as approximately 75%. Less than 50% of all participants were categorized as ideal smoking status. Comparatively, only about 30% of participants achieved ideal physical activity and ideal diet. Among all diet components, ideal fruit and vegetable intake was as low as 24.4% (3,292 of 13,472), and ideal high-energy snack consumption was 25.8% (3,536 of 13,732). Nearly 10% of participants were at poor levels of physical activity, BMI, and BP.

A significant difference was found in all CVH metrics according to sex, age, and geographic region (Table 2). Females seemed to have better levels in most CVH metrics than males except for physical activity and TC. Younger children tended to have ideal levels in smoking, diet, BP, and FPG, whereas older adolescents exhibited better BMI, physical activity, and TC. More students in southern China had health metrics at better levels, particularly in having lower BP relative to students in northern China, whereas more students in northern China had healthier diet and TC. Also, undeveloped regions observed less favorable diet. Higher proportions of ideal BMI and BP were consistently presented in participants without parental or family history of CVD (Table 3). The distributions of ideal CVH metrics were identical according to parental education.

PROPORTIONS OF NUMBERS OF IDEAL CVH METRICS. The proportions of numbers of ideal CVH metrics in the subgroups of the 8 sociodemographic

TABLE 3 Continued

Paternal Educational Level				Maternal Educational Level			
Primary School or Below (n = 940)	Middle or High School (n = 8,297)	Junior College or Above (n = 3,648)	*P* Value	Primary School or Below (n = 1,245)	Middle or High School (n = 8,142)	Junior College or Above (n = 3,470)	*P* Value
0.5 ± 0.2	0.3 ± 0.1	0.2 ± 0.1	<0.001[a]	0.4 ± 0.2	0.3 ± 0.1	0.1 ± 0.1	<0.001[a]
61.4 ± 1.6	57.4 ± 0.5	42.8 ± 0.8		55.6 ± 1.4	56.5 ± 0.6	45.6 ± 0.9	
38.1 ± 1.6	42.3 ± 0.5	57.1 ± 0.8		44.0 ± 1.4	43.2 ± 0.6	54.2 ± 0.9	
8.0 ± 0.9	11.0 ± 0.3	11.4 ± 0.5	<0.001[a]	8.6 ± 0.8	10.9 ± 0.4	11.6 ± 0.6	<0.001[a]
12.9 ± 1.1	13.9 ± 0.4	16.5 ± 0.6		11.5 ± 0.9	13.7 ± 0.4	17.4 ± 0.7	
79.2 ± 1.3	75.2 ± 0.5	72.1 ± 0.8		79.9 ± 1.2	75.4 ± 0.5	71.0 (0.8	
8.6 ± 1.0	9.2 ± 0.3	8.0 ± 0.5	0.003[a]	8.5 ± 0.9	9.2 ± 0.3	8.0 ± 0.5	<0.001[a]
60.0 ± 1.7	60.9 ± 0.6	64.8 ± 0.8		59.8 ± 1.5	60.9 ± 0.6	65.5 ± 0.9	
31.4 ± 1.6	29.9 ± 0.5	27.2 ± 0.8		31.7 ± 1.4	29.9 ± 0.5	26.5 ± 0.8	
4.2 ± 0.7	3.0 ± 0.2	2.0 ± 0.2	<0.001[a]	3.4 ± 0.5	3.2 ± 0.2	1.7 ± 0.2	<0.001[a]
70.5 ± 1.6	68.8 ± 0.5	64.0 ± 0.8		71.9 ± 1.3	68.3 ± 0.5	64.4 ± 0.9	
25.2 ± 1.5	28.2 ± 0.5	34.0 ± 0.8		24.7 ± 1.3	28.5 ± 0.5	33.9 ± 0.9	
3.2 ± 0.6	5.1 ± 0.2	8.3 ± 0.5	<0.001[a]	3.5 ± 0.5	5.3 ± 0.2	7.9 ± 0.5	<0.001[a]
18.4 ± 1.3	18.9 ± 0.4	25.2 ± 0.7		17.0 ± 1.1	19.6 ± 0.4	24.1 ± 0.7	
78.4 ± 1.3	76.1 ± 0.5	66.6 ± 0.8		79.4 ± 1.1	75.1 ± 0.5	67.9 ± 0.8	
9.7 ± 1.0	9.4 ± 0.3	6.5 ± 0.4	<0.001[a]	8.8 ± 0.8	9.3 ± 0.3	7.0 ± 0.4	<0.001[a]
14.9 ± 1.2	17.2 ± 0.4	12.0 ± 0.5		17.6 ± 1.1	16.6 ± 0.4	12.5 ± 0.6	
75.4 ± 1.4	73.4 ± 0.5	81.5 ± 0.6		73.5 ± 1.3	74.1 ± 0.5	80.5 ± 0.7	
0.2 ± 0.2	0.1 ± 0.0	0.1 ± 0.1	0.488	0.2 ± 0.1	0.1 ± 0.0	0.1 ± 0.1	0.685
3.7 ± 0.6	4.6 ± 0.2	4.0 ± 0.3		4.6 ± 0.6	3.9 ± 0.2	4.4 ± 0.3	
96.1 ± 0.6	95.3 ± 0.2	95.9 ± 0.3		95.3 ± 0.6	95.9 ± 0.2	95.5 ± 0.3	

characteristics are displayed in Tables 4 and 5. The majority of Chinese children and adolescents had 3 to 5 ideal metrics. Although 53.6% had all 3 ideal health factors (males: 52.4%; females: 54.9%), only 1.7% had all 7 ideal CVH metrics (males: 1.9%; females: 1.6%); only 3.1% had all 4 ideal health behaviors (males: 3.3%; females: 3.0%). Moreover, the distributions in numbers of ideal health behaviors were significantly different according to all examined sociodemographic factors. Among those also with significant different distributions in numbers of ideal health factors, younger ages and southern region remained favorable characteristics. The proportions of the ideal health status of CVH, behaviors, and factors according to age and sex are shown in Figure 1.

ASSOCIATIONS BETWEEN SOCIODEMOGRAPHIC FACTORS AND NUMBERS OF IDEAL CVH METRICS. The relationship between sociodemographic characteristics and numbers of ideal CVH metrics is shown in Table 6. Female sex, younger age, undeveloped economy, southern region, and no family history of CVD were associated with greater numbers of ideal CVH metrics. Younger age was associated with 4 times higher odds of 6 to 7 ideal metrics than older age, compared with 0 to 1 ideal metrics (7-9 years vs 15-17 years; odds ratio: 4.14; 95% confidence interval: 2.49-6.90). Females (vs males), undeveloped economy (vs developed economy), southern region (vs northern region), and no family history of CVD (vs yes) were all associated with approximately twofold odds of 6 to 7 ideal metrics, compared with 0 to 1 ideal metrics. There were no significant associations of parental disease history of CVD and parental education levels with numbers of ideal CVH metrics.

The associations of sex, age, geographic regions, and family disease history with numbers of ideal health behaviors and ideal health factors remained consistent compared with those with total number of ideal metrics. An undeveloped economy was positively associated with ideal health factors, but inverse associations were noted in ideal health behaviors. Paternal education seemed to be associated with only

TABLE 4 Number of Ideal CVH Metrics According to Sex, Age, Economic Development, and Geographic Region

			Sex			Age	
	n	Overall	Male (n = 8,004)	Female (n = 7,579)	*P* Value	7-9 y (n = 5,469)	10-14 y (n = 6,490)
No. of ideal CVH metrics							
0	11	0.1 ± 0.0	0.1 ± 0.0	0.1 ± 0.0	<0.001[a]	0.0 ± 0.0	0.1 ± 0.0
1	120	1.1 ± 0.1	1.4 ± 0.2	0.8 ± 0.1		0.8 ± 0.2	1.0 ± 0.1
2	702	6.3 ± 0.2	7.0 ± 0.3	5.6 ± 0.3		5.2 ± 0.4	6.4 ± 0.4
3	2,023	18.1 ± 0.4	18.8 ± 0.5	17.3 ± 0.5		17.0 ± 0.6	18.0 ± 0.6
4	3,639	32.5 ± 0.4	31.4 ± 0.6	33.6 ± 0.6		30.6 ± 0.8	31.8 ± 0.7
5	3,227	28.8 ± 0.4	27.9 ± 0.6	29.7 ± 0.6		30.2 ± 0.8	28.8 ± 0.7
6	1,285	11.5 ± 0.3	11.6 ± 0.4	11.4 ± 0.4		13.8 ± 0.6	12.1 ± 0.5
7	192	1.7 ± 0.1	1.9 ± 0.2	1.6 ± 0.2		2.2 ± 0.2	1.9 ± 0.2
No. of ideal health behaviors							
0	767	6.8 ± 0.2	7.7 ± 0.4	6.0 ± 0.3	0.002[a]	7.2 ± 0.4	6.9 ± 0.4
1	3,710	33.1 ± 0.4	33.3 ± 0.6	32.8 ± 0.6		29.6 ± 0.8	33.0 ± 0.7
2	4,396	39.2 ± 0.5	37.8 ± 0.6	40.5 ± 0.7		38.6 ± 0.8	38.5 ± 0.7
3	2,002	17.8 ± 0.4	18.0 ± 0.5	17.7 ± 0.5		20.7 ± 0.7	18.3 ± 0.6
4	350	3.1 ± 0.2	3.3 ± 0.2	3.0 ± 0.2		3.9 ± 0.3	3.3 ± 0.3
No. of ideal health factors							
0	73	0.5 ± 0.1	0.6 ± 0.1	0.4 ± 0.1	<0.001[a]	0.3 ± 0.1	0.4 ± 0.1
1	1,023	6.6 ± 0.2	7.3 ± 0.3	5.8 ± 0.3		5.1 ± 0.3	7.1 ± 0.3
2	6,113	39.3 ± 0.4	39.7 ± 0.5	38.9 ± 0.6		38.8 ± 0.7	39.0 ± 0.6
3	8,333	53.6 ± 0.4	52.4 ± 0.6	54.9 ± 0.6		55.8 ± 0.7	53.5 ± 0.6

Values are mean ± SE. [a]$P < 0.05$, assessed by chi-square test for categorical variables. There were 4,384 missing values for number of ideal cardiovascular health (CVH) metrics, 4,358 missing values for number of ideal health behaviors, and 41 missing values for number of ideal health factors.

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ideal health behaviors. Additional analyses adjusting for all 8 sociodemographic factors did not materially change the findings.

DISCUSSION

To our knowledge, this is the first nationwide study to investigate ideal CVH status and the associated sociodemographic factors among Chinese children and adolescents using revised AHA criteria. Overall, we found that the prevalence of meeting all 7 ideal metrics or all 4 ideal health behaviors was alarmingly low. We also observed important sociodemographic disparities associated with CVH in the distribution of sex, age, economic development, geographic region, and family disease history. The findings among youths would be important for developing CVH promotion strategies.

INDIVIDUAL CVH METRICS AND SOCIODEMOGRAPHIC DISPARITIES. In terms of individual CVH metrics, our study found a great discrepancy in ideal smoking status when further newly accounting for passive smoking based on the active smoking criteria (**Table 1**). The prevalence of ideal smoking considering only active smoking in Chinese children and adolescents (98.7%) was much higher relative to the United States (17) and Europe (21). However, after adding current parental smoking, the percentage of ideal smoking was reduced by more than one-half. China has endeavored to ban smoking in public to reduce this established risk factor for noncommunicable diseases. We further suggest control of household smoking to promote long-term CVH of every family member.

Ideal diet and physical activity were the least common among all ideal CVH metrics, which is consistent with most previous studies (7,16,18,27,28,30). The diet status was even worse in the United States, with <1% meeting 4 to 5 components of the criteria (18). Diet and physical activity should be the most urgent CVH metrics to improve globally. The major focus of diet improvement might lie in reducing consumption of high-energy snacks and increasing intake of fruits and vegetables. We also found that the diet status of children and adolescents in the undeveloped regions or southern China was more worrying, which should motivate mapping and eliminating "food deserts" (51) in China. A 23-year longitudinal study among Chinese adults found that the convenience food pattern in the southern region was positively associated with hypertriglyceridemia and low-density lipoprotein cholesterol levels (52). The substantial regional differences in access to healthy food, surplus energy levels (53), food cultures, and dietary habits might

TABLE 4 Continued

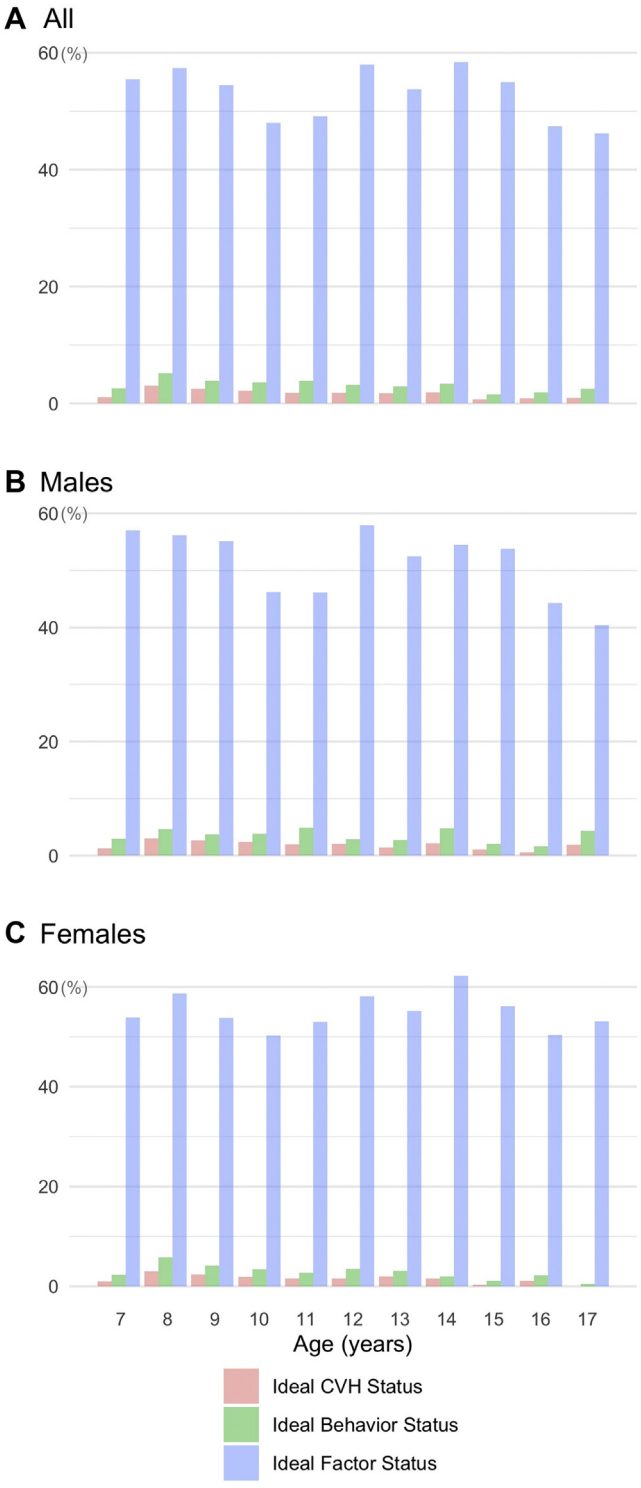
Age			Economic Development			Geographic Region		
15-17 y (n = 3,624)		*P* Value	Undeveloped (n = 4,276)	Developed (n = 11,307)	*P* Value	South (n = 8,477)	North (n = 7,106)	*P* Value
No. of ideal CVH metrics								
0.2 ± 0.1		<0.001[a]	0.0 ± 0.0	0.1 ± 0.0	<0.001[a]	0.1 ± 0.0	0.1 ± 0.1	<0.001[a]
1.4 ± 0.2			0.5 ± 0.4	1.2 ± 0.1		0.8 ± 0.1	1.4 ± 0.2	
7.3 ± 0.5			4.0 ± 0.2	6.8 ± 0.3		5.4 ± 0.3	7.5 ± 0.4	
19.5 ± 0.7			18.2 ± 0.8	18.0 ± 0.4		16.9 ± 0.5	19.6 ± 0.6	
35.9 ± 0.9			37.5 ± 1.0	31.2 ± 0.5		33.0 ± 0.6	31.9 ± 0.7	
27.1 ± 0.8			27.5 ± 0.9	29.2 ± 0.5		30.0 ± 0.6	27.2 ± 0.7	
7.6 ± 0.5			10.6 ± 0.6	11.7 ± 0.3		12.1 ± 0.4	10.6 ± 0.4	
0.8 ± 0.2			1.7 ± 0.3	1.7 ± 0.1		1.7 ± 0.2	1.7 ± 0.2	
No. of ideal health behaviors								
6.3 ± 0.5		<0.001[a]	5.5 ± 0.5	7.2 ± 0.3	<0.001[a]	5.6 ± 0.3	8.5 ± 0.4	<0.001[a]
37.4 ± 0.9			38.1 ± 1.0	31.8 ± 0.5		33.0 ± 0.6	33.2 ± 0.7	
41.0 ± 0.9			39.6 ± 1.0	39.1 ± 0.5		39.9 ± 0.6	38.2 ± 0.7	
13.5 ± 0.6			14.4 ± 0.7	18.7 ± 0.4		18.4 ± 0.5	17.0 ± 0.5	
1.8 ± 0.2			2.5 ± 0.3	3.3 ± 0.2		3.1 ± 0.2	3.2 ± 0.3	
No. of ideal health factors								
0.9 ± 0.2		<0.001[a]	0.0 ± 0.0	0.6 ± 0.1	<0.001[a]	0.4 ± 0.1	0.6 ± 0.1	<0.001[a]
7.8 ± 0.4			4.7 ± 0.3	7.3 ± 0.2		5.6 ± 0.3	7.7 ± 0.3	
40.7 ± 0.8			35.5 ± 0.7	40.8 ± 0.5		38.6 ± 0.5	40.1 ± 0.6	
50.6 ± 0.8			59.8 ± 0.8	51.3 ± 0.5		55.4 ± 0.5	51.5 ± 0.6	

TABLE 5 Number of Ideal CVH Metrics According to History of Related Diseases and Parental Educational Level

	Parental Disease History			Family Disease History			Paternal Educational Level				Maternal Educational Level			
	Have Related Diseases (n = 1,894)	No Related Diseases (n = 9,664)	*P* Value	Have Related Diseases (n = 7,320)	No Related Diseases (n = 4,218)	*P* Value	Primary School or Below (n = 940)	Middle or High School (n = 8,297)	Junior College or Above (n = 3,648)	*P* Value	Primary School or Below (n = 1,245)	Middle or High School (n = 8,142)	Junior College or Above (n = 3,470)	*P* Value
No. of ideal CVH metrics														
0	0.2 ± 0.1	0.1 ± 0.0	<0.001[a]	0.1 ± 0.0	0.0 ± 0.0	<0.001[a]	0.3 ± 0.2	0.1 ± 0.0	0.0 ± 0.0	<0.001[a]	0.1 ± 0.1	0.1 ± 0.0	0.0 ± 0.0	0.346
1	1.5 ± 0.3	1.1 ± 0.1		1.3 ± 0.1	0.9 ± 0.2		1.0 ± 0.4	1.1 ± 0.1	1.1 ± 0.2		1.2 ± 0.3	1.0 ± 0.1	1.2 ± 0.2	
2	6.9 ± 0.6	6.1 ± 0.3		6.7 ± 0.3	5.5 ± 0.4		4.0 ± 0.7	7.1 ± 0.3	4.7 ± 0.4		5.4 ± 0.7	6.5 ± 0.3	5.9 ± 0.4	
3	20.9 ± 1.0	16.8 ± 0.4		19.0 ± 0.5	14.9 ± 0.6		18.5 ± 1.5	17.9 ± 0.5	16.6 ± 0.7		16.2 ± 1.2	18.1 ± 0.5	16.6 ± 0.7	
4	31.2 ± 1.2	31.6 ± 0.5		32.2 ± 0.6	30.3 ± 0.8		33.5 ± 1.8	31.8 ± 0.6	31.7 ± 0.9		33.1 ± 1.5	31.9 ± 0.6	31.4 ± 0.9	
5	27.5 ± 1.1	29.7 ± 0.5		28.1 ± 0.6	31.6 ± 0.8		31.1 ± 1.7	28.7 ± 0.6	30.2 ± 0.9		30.6 ± 1.5	28.9 ± 0.6	30.0 ± 0.9	
6	10.0 ± 0.8	12.7 ± 0.4		11.1 ± 0.4	14.4 ± 0.6		10.6 ± 1.1	11.4 ± 0.4	13.5 ± 0.6		11.2 ± 1.0	11.8 ± 0.4	12.6 ± 0.6	
7	1.8 ± 0.3	1.9 ± 0.2		1.5 ± 0.2	2.5 ± 0.3		1.0 ± 0.4	1.8 ± 0.2	2.2 ± 0.3		2.1 ± 0.5	1.7 ± 0.2	2.2 ± 0.3	
No. of ideal health behaviors														
0	8.3 ± 0.7	6.2 ± 0.3	<0.001[a]	7.5 ± 0.3	5.1 ± 0.4	<0.001[a]	6.4 ± 0.9	7.5 ± 0.3	5.3 ± 0.4	<0.001[a]	5.4 ± 0.7	7.1 ± 0.3	6.5 ± 0.5	0.010[a]
1	33.5 ± 1.2	30.9 ± 0.5		33.4 ± 0.6	27.9 ± 0.8		34.3 ± 1.8	32.8 ± 0.6	27.5 ± 0.8		32.1 ± 1.5	32.1 ± 0.6	29.3 ± 0.9	
2	39.3 ± 1.2	39.7 ± 0.6		39.1 ± 0.6	40.6 ± 0.9		38.2 ± 1.8	39.0 ± 0.6	42.0 ± 0.9		40.8 ± 1.6	39.4 ± 0.6	40.2 ± 0.9	
3	15.7 ± 0.9	19.7 ± 0.5		17.1 ± 0.5	22.3 ± 0.7		19.1 ± 1.5	17.6 ± 0.5	21.0 ± 0.8		18.2 ± 1.3	18.4 ± 0.5	19.8 ± 0.8	
4	3.2 ± 0.4	3.4 ± 0.2		3.0 ± 0.2	4.1 ± 0.3		2.1 ± 0.5	3.2 ± 0.2	4.2 ± 0.4		3.5 ± 0.6	3.0 ± 0.2	4.2 ± 0.4	
No. of ideal health factors														
0	0.9 ± 0.2	0.5 ± 0.1	0.004[a]	0.6 ± 0.1	0.5 ± 0.1	0.064	0.6 ± 0.3	0.5 ± 0.1	0.5 ± 0.1	0.068	0.6 ± 0.2	0.4 ± 0.1	0.6 ± 0.1	0.257
1	8.1 ± 0.6	6.8 ± 0.3		7.3 ± 0.3	6.5 ± 0.4		5.5 ± 0.7	7.2 ± 0.3	6.6 ± 0.4		6.3 ± 0.7	7.0 ± 0.3	6.7 ± 0.4	
2	40.8 ± 1.1	39.6 ± 0.5		40.3 ± 0.6	38.9 ± 0.8		37.2 ± 1.6	39.6 ± 0.5	41.2 ± 0.8		37.2 ± 1.4	40.1 ± 0.5	40.5 ± 0.8	
3	50.2 ± 1.2	53.2 ± 0.5		51.9 ± 0.6	54.2 ± 0.8		56.7 ± 1.6	52.8 ± 0.5	51.6 ± 0.8		55.8 ± 1.4	52.4 ± 0.6	52.3 ± 0.8	

Values are mean ± SE. [a]$P < 0.05$, assessed by chi-square test for categorical variables. There were 4,384 missing values for number of ideal cardiovascular health metrics (CVH), 4,358 missing values for number of ideal health behaviors, and 41 missing values for number of ideal health factors.

FIGURE 1 **Ideal CVH Behaviors and Factors According to Age and Sex**



Proportions of participants with ideal cardiovascular health (CVH) status (7 ideal health metrics), ideal health behavior status (4 ideal health behavior metrics), and ideal health factor status (3 ideal health factor metrics) according to age in the total population **(A)**, male subjects **(B)**, and female subjects **(C)**.

TABLE 6 Odds Ratio (95% CI) of Number of Ideal CVH Metrics Associated With Sociodemographic Characteristics

	No. of Ideal CVH Metrics			No. of Ideal Health Behaviors		No. of Ideal Health Factors	
	6-7 vs 0-1	4-5 vs 0-1	2-3 vs 0-1	3-4 vs 0-1	2 vs 0-1	3 vs 0-1	2 vs 0-1
Female	1.87 (1.26-2.78)[a]	2.02 (1.37-2.97)[b]	1.66 (1.12-2.45)[c]	1.05 (0.94-1.18)[c]	1.13 (1.03-1.24)[c]	1.41 (1.22-1.63)[b]	1.30 (1.12-1.51)[b]
Age, y							
7-9	4.14 (2.49-6.90)[b]	2.15 (1.32-3.51)[a]	1.86 (1.13-3.05)[c]	1.72 (1.48-2.00)[b]	1.04 (0.92-1.18)	2.25 (1.85-2.73)[b]	1.83 (1.51-2.23)[b]
10-14	2.76 (1.75-4.36)[b]	1.55 (1.00-2.39)[c]	1.44 (0.93-2.23)	1.59 (1.37-1.84)[b]	1.04 (0.92-1.17)	1.44 (1.21-1.72)[b]	1.24 (1.04-1.48)[c]
15-17	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Undeveloped economy	2.09 (1.10-3.98)[c]	2.38 (1.26-4.47)[a]	1.79 (0.94-3.38)	0.77 (0.67-0.89)[a]	1.03 (0.92-1.16)	1.98 (1.61-2.42)[b]	1.49 (1.21-1.83)[b]
Southern region	1.94 (1.32-2.86)[a]	1.86 (1.28-2.71)[a]	1.42 (0.97-2.07)	1.15 (1.03-1.29)[c]	1.13 (1.02-1.24)[c]	1.55 (1.34-1.80)[b]	1.30 (1.12-1.50)[b]
No parental disease history	1.24 (0.76-2.03)	1.22 (0.76-1.95)	1.06 (0.66-1.71)	1.10 (0.94-1.29)	1.02 (0.90-1.16)	1.19 (0.98,1.45)	1.15 (0.94-1.40)
No family disease history	2.27 (1.47-3.49)[b]	1.75 (1.15-2.67)[a]	1.33 (0.87-2.04)	1.62 (1.45-1.81)[b]	1.29 (1.17-1.42)[b]	1.21 (1.04-1.40)[c]	1.11 (0.95-1.29)
Paternal educational level							
Primary school or below	0.62 (0.28-1.37)	0.88 (0.41-1.89)	0.92 (0.42-1.99)	0.68 (0.54-0.86)[a]	0.74 (0.61-0.90)[a]	1.21 (0.88-1.66)	0.97 (0.70-1.33)
Middle or high school	0.80 (0.51-1.26)	0.94 (0.61-1.46)	1.12 (0.72-1.75)	0.68 (0.60-0.77)[b]	0.76 (0.68-0.85)[b]	0.99 (0.83-1.17)	0.91 (0.77-1.08)
Junior college or above	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Maternal educational level							
Primary school or below	0.81 (0.40-1.65)	0.94 (0.48-1.86)	0.90 (0.45-1.80)	0.87 (0.70-1.08)	0.98 (0.82-1.18)	1.05 (0.80-1.38)	0.87 (0.66-1.16)
Middle or high school	1.10 (0.70-1.73)	1.20 (0.78-1.86)	1.34 (0.86-2.09)	0.83 (0.73-0.95)[a]	0.93 (0.93-1.04)	0.99 (0.83-1.18)	0.98 (0.82-1.16)
Junior college or above	1.00	1.00	1.00	1.00	1.00	1.00	1.00

[a]$P < 0.01$. [b]$P < 0.001$. [c]$P < 0.05$, assessed by multinomial logistic regression adjusted for sex, age, economic development, geographic region, and family disease history of cardiovascular diseases.
CI = confidence interval; CVH = cardiovascular health.

explain the diet-related disparities, which should be considered for delivering effective nutrition education. As for physical activity, only about 30% met the ideal standard, a medium level among existing studies (16). Unfortunately, nearly one-tenth did not do any moderate to vigorous activity (poor level), and we found no significant difference in physical inactivity according to regional economic development as in earlier studies (54). Similar with our study, female subjects had poorer levels of physical activity than male subjects in China (28,54), Europe (55), and the United States (17,19). Effective physical activity monitoring and promotion are needed in both urban and rural areas, particularly in female subjects.

Diet and physical activity might be the key to overall CVH, as both have direct implications on multiple CVH behaviors and factors (16). Poor diet and poor activity could directly result in subsequent poor BMI and even poor TC, BP, and FPG (16,19,56). Thus, although more youths in undeveloped economies reached ideal levels of BMI than those in developed regions (57), as well as TC, BP, and FPG, this advantage would be challenging to maintain with an ongoing suboptimal diet or activity. Also, children with greater BMI may be more likely to have onset of high BP during adolescence (58,59). A critical prevention window in the transition from overweight to poor BP may exist (56,58). Those with parental or family history of CVD (36,60), or prehypertensive status (56), may need to be prioritized in interventions. Among health factors, ideal FPG was the most prevalent metric as in the Young Finns study (61), with a higher percentage than other studies (16). The percentage of ideal BP in this study was lower than the average level of the existing studies, while the percentage of ideal TC was higher than average (16).

IDEAL CVH: DIVERGENT SINCE YOUNG AGE, VARIED AMONG GROUPS. The majority of children are born with ideal CVH (62); however, in the present study, the majority of Chinese children and adolescents had 3 to 5 ideal metrics, which was similar to previous studies in Chinese adults (22) and youths (27,28). The extremely low proportion of ideal CVH status was slightly higher than in Chinese adults (22) and better than zero ideal CVH among 5,547 participants aged 12 to 19 years in the United States (19). Children and adolescents in Beijing, although with ideal CVH status over our national level, had exhibited a sharp decline in ideal CVH status from 19.5% to 9.8% in 2004 to 2014 (28). The most recent study among urban Chinese children and adolescents reported only 0.5% of ideal CVH, along with a particularly low prevalence for ideal diet and physical activity (27).

Similar to previous studies (20,22,26,28,55), female sex and younger ages were found to be strongly associated with ideal CVH status. Importantly, the Lancet Commission reported that adult women are more likely than men to be subject to health

disparities in CVD (63). Given the stagnation in reducing CVD burden in women in the last decade, the favorable CVH status in female subjects implies that the maintenance of ideal CVH from childhood and adolescence might be key to reducing sex-related disparities in later CVD. Previous studies did not suggest a starting age for monitoring CVH (16). Future interventions may consider primordial prevention; that is, interventions in childhood or even early life (9,15).

Interestingly, the undeveloped region was associated with better CVH, which was similar among Chinese adults (6-7 vs 0-1 metrics; odds ratio: 3.57; 95% confidence interval: 2.98-4.28) (22). However, we found opposite associations in further break-downs for ideal health behaviors, which should be examined in future studies. Overall, the southern region was associated with ideal CVH compared with the northern region. These regional differences may need to be incorporated with urban/rural comparisons within provinces to guide the intervention strategies. Family history of CVD was associated with fewer ideal CVH metrics, which supported a high-risk population strategy (36). Parental education did not show significant associations with ideal CVH in our study, but our data revealed some suggestive relationships between higher parental education and an increase in CVH behaviors (28). Future studies are needed to develop effective targeted interventions that reduce health disparities in terms of sociodemographic characteristics.

STUDY LIMITATIONS. First, the associations in this cross-sectional study do not necessarily indicate causality. Second, inaccuracy in self-reports from young children, especially in diet and physical activity, could lead to misclassification (8); however, the reported reliability and validity of the child questionnaire were acceptable, with a slightly low Cronbach α (0.6-0.7), and were less likely to result in a systematic overestimation or underestimation (40). If the children tended to underreport intake of unhealthy food or overreport time spent on physical activity, the percentage of ideal CVH status could only be more concerning. Third, diet is an extremely diverse and complex constellation in China, and no single biomarker exists specifically for heart-healthy dietary habits (16); therefore, additional investigation regarding advanced diet evaluation methods is needed. Furthermore, current diet components only focused on nutrient composition. Finally, economic development was estimated at an aggregated population level. Individual-level income could be added in future analysis.

CONCLUSIONS

The largest national cross-sectional study conducted to date indicates that the prevalence of ideal CVH status among Chinese children and adolescents is alarmingly low. Diet and physical activity are the key metrics for CVH improvement. Female sex, younger age, undeveloped economy, southern region, and no family history of CVD are associated with more ideal CVH metrics, which might suggest health disparities in young populations. Longitudinal studies could further explore sociodemographic determinants of changes in CVH for effective interventions.

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ADDRESS FOR CORRESPONDENCE: Dr Jun Ma, No. 38, Xueyuan Road, Haidian District, Beijing 100191, China. E-mail: majunt@bjmu.edu.cn. OR Dr Jin Jing, No. 74, Zhongshan 2nd Road, Guangzhou 510085, China. E-mail: jingjin@mail.sysu.edu.cn. Twitter: @Pengfei20182431.

PERSPECTIVES

COMPETENCY IN MEDICAL KNOWLEDGE: A large proportion of parental smoking, the remarkable occurrence of obesity and poor BP, and the low prevalence of sufficient physical activity and ideal healthy diet could threaten maintenance of CVH into adulthood and older age in China. Health disparities in cardiovascular outcomes have begun to emerge in young populations.

TRANSLATIONAL OUTLOOK: To alleviate CVD burden and health inequality, targeted interventions in childhood and adolescence toward ideal CVH are critical. Longitudinal studies should further explore determinants of CVH across the life span, providing actionable insights to reshape population CVH.

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APPENDIX For supplemental tables, please see the online version of this paper.