Status and trends of diabetes in Chinese children: analysis of data from 14 medical centers

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Original article

Background: **Childhood diabetes has become a growing concern. We conducted a study to evaluate the status and trend of diabetes from 14 medical centers in China. Pre-diabetic status among obese children was also noted.**

Methods: **Hospital medical records were reviewed, and data of diabetes were collected from 1995 through 2010. We took every five years as a calculation unit to analyze the trend of new-onset diabetes. Data on obesity were collected in the recent five years.**

Results: **A total of 4 337 836 patients aged 0-18 years were discharged from the 14 centers. The prevalence (per 100 000 persons) of new-onset type 1 diabetes, type 2 diabetes and other types of diabetes were 96.8, 8.0, and 3.3, respectively. The prevalence of type 1 diabetes increased from 90.9 to 92.9 and 101.4, while type 2 diabetes increased from 4.1 to 7.1 and 10.0 in every five years ($P<0.0001$). The increasing trend was significant from Southwest to East and North China (type 1 diabetes from 59.76 to 80.02 and 120.45, type 2 diabetes from 2.52 to 3.77 and 15.64 (per 100 000 persons) (all $P<0.0001$). Well developed areas in China had a higher prevalence compared to less developed areas [type 1 diabetes: 151.51 *vs.* 32.2 (per 100 000 persons); type 2 diabetes: 15.16 *vs.* 1.64 and others: 7.54 *vs.* 0.42 (per 100 000 persons)]. Of the 3153 obese children, 18.24% had impaired fasting glucose (IFG), 5.99% had impaired gulose tolerance (IGT), and 4% had combined IFG and IGT.**

Conclusions: **The prevalence of childhood diabetes in China has increased dramatically, with type 2 diabetes exceeding type 1 diabetes. The incidence rate of abnormal glucose metabolism in obese children has reached 28.26%.**

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Key words: **diabetes mellitus;**
obesity;
prediabetic status

Introduction

According to the 2000 World Health Organization (WHO) report, the number of Chinese diabetics ranks second in the world, and the increasing onset of diabetes in young children is a matter of great concern. Twenty years ago, childhood diabetes was almost exclusively type 1 diabetes. This situation has changed because of the rapid changes in life style of the people, which exposed the population of children to obesity. There is an increasing trend of type 2 diabetes in both developed and developing countries.[1]

The prevalence of overweight and obesity in Chinese children has increased dramatically, for example, from 5.2% in 1991 to 13.2% in 2006 among children aged 7-17 years.[2] The doubling of the prevalence of overweight and obesity in children poses overwhelming health and economic challenges. Yang et al[3] reported the appearance of diabetes and pre-diabetes in Chinese adults, with the age-standardized prevalence of total diabetes and pre-diabetes at 9.7% and 15.5%, respectively, and revealed that the prevalence

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of diabetes increased with weight increment. However, the data about Chinese children are very limited and only restricted to regional investigations. The incidence (per 100 000 persons) of type 1 diabetes in children from Shanghai was 0.61 in the 1980s and reached 1.7 in 2000. Our recent study found that the new-onset type 1 diabetes and type 2 diabetes cases in the recent 5 years increased by 1.35 and 4.20 times, respectively, comparing with those of the first five-year period in Zhejiang province.[4] Studies in moderate and severe obese children in Zhejiang province showed that the incidences of type 2 diabetes and impaired glucose tolerance (IGT) were 1.44% and 5.7%, respectively.[5]

Obesity and its consequent pre-diabetes are immediate precursors of type 2 diabetes and cardiovascular disease.[6] However, there is no nationwide or large multi-center study on the trend of diabetes and prevalence of pre-diabetes in obese children in China. Therefore, we investigated the status and trend of diabetes in Chinese children, as well as the glucose metabolic status in obese children, based on hospital medical records from 14 principal medical centers with geographical and economic representations in different parts of the country.

Methods

Study design and participants

Data collection of hospitalized diabetics

The retrospective study has been approved by the medical ethics committee of each medical center. Data were obtained from hospital medical records on the new-onset diabetes cases in children aged 0-18 years from October 1995 to September 2010 by using unified designed survey protocol. Among the 14 selected centers, 11 are children's hospitals and 3 pediatric departments of general hospitals.

Data analysis was performed according to geographic regions (north, east, southwest China) and economic development status [based on the gross domestic product (GDP) for each province] and different periods of years.

Five years were defined as a calculation unit (October 1995 to September 2000, October 2000 to September 2005, and October 2005 to September 2010). The rate and trend of new-onset diabetes based on the rate of discharge were analyzed, and compared to the geographic and economic impact on the prevalence of type 1 and type 2 diabetes.

Classification of geographic region and economic state

According to China's geographic distribution, Guangzhou, Wuhan, Zhengzhou and Chongqing were resprsentative of southwest China; Shanghai, Zhejiang, Nanjing, Suzhou, Jiangxi east China, and Beijing, Harbin, Tianjin and Shenyang north China.

Based on GDP for each province or city, Shanghai, Beijing, Guangzhou, Zhejiang and Suzhou were defined as well developed areas, while Chongqing, Harbin, Zhengzhou and Jiangxi as less developed regions. Wuhan, Nanjing, Tianjin and Shenyang are between them.

Obesity data collection

To study abnormal glucose metabolic status in obese children (the main group who will develop type 2 diabetes in life), we analyzed oral glucose tolerance test (OGTT) results of the obese children from these centers.

Children meeting the Diagnostic Criteria of Obesity for Chinese Children[7,8] (participants had a BMI that was above the 95th percentile for their age and sex based on the national reference data in 2004) were included. Exclusion criteria were the secondary obesity caused by other diseases such as nephropathy syndrome or connective tissue disease treated with steroids. We collected the data of body weight, height, waist circumference, blood pressure and biochemical indexes of fasting glucose, insulin, lipids [total triglyceride (TG), total cholesterol (TCHO), high-density lipoprotein cholesterol (HDL-C) and low-density lipoprotein cholesterol (LDL-C)], liver function [alanine aminotransferase (ALT), aspartate aminotransferase (AST)] and uric acid. We also recorded the OGTT results of the children.

OGTT and laboratory detections

After at least 8 hours of overnight fasting, venous blood specimens were collected at 0, 30, 60, 90 and 120 minutes after the children were given a standard 1.75 g/kg glucose solution load to measure glucose concentrations.

Plasma glucose was measured with a hexokinase enzymatic method, and serum cholesterol and TG levels were also assessed enzymatically with commercially available reagents at the clinical biochemical laboratories in each province.

Definitions of outcomes

The definition and classification of diabetes types were based on the WHO criteria in 1999 and the American Diabetic Association criteria in 2011.[9] Clinical features (family history, age, obesity, combined diabetic ketoacidosis, acanthosis nigricans, etc), fasting levels of C-peptide, insulin, HbA1c levels and the kind of treatment that the children received were all under consideration. In terms of other types of diabetes, this study was a big collection of other diabetes except for type 1 and type 2, such as drug-induced diabetes, maturity-onset diabetes of the young, mitochondrial diabetes and genetic defects of insulin signaling, etc.

Pre-diabetes was defined as either impaired fasting glucose (IFG) or IGT or combination of both. (a) isolated IFG: fasting glucose level ≥5.6 mmol/L and <7.0 mmol/L, and 2-hour glucose level in the OGTT <7.8 mmol/L; (b) isolated IGT: fasting glucose level <5.6 mmol/L, and 2-hour glucose level >7.8 mmol/L and <11.1 mmol/L; (c) combined IFG and IGT: fasting glucose level ≥5.6 mmol/L and <7.0 mmol/L, and 2-hour glucose level >7.8 mmol/L and <11.1 mmol/L.

Dyslipidemia was defined according to the consensus on the prevention and treatment of childhood dyslipidemia of the Chinese Society of Pediatrics of the Chinese Medical Association,[10] i.e., (a) hypertriglyceridaemia: serum TG concentration >1.7 mmol/L; (b) hypercholesterol: serum TCHO level ≥5.18 mmol/L; (c) low HDL-C: serum HDL-C ≤1.04 mmol/L; (d) high LDL-C: serum LDL-C >3.37 mmol/L; (e) hypertension: a systolic or a diastolic blood pressure above the 95th percentile for age and sex based on the data of the seventh edition of *Practical Pediatric Textbook* by Fu-Tang Zhu.[11]

Statistical analysis

Age was categorized into two levels (<10 and ≥10 years); data were divided into three time periods as aforementioned; study region was grouped as north, east and southwest China; economical status was defined as well developed and less developed. The prevalence and distribution of type 1 diabetes, type 2 diabetes and other types of diabetes were described by age, gender and periods, respectively. Meanwhile, the prevalence of type 1 diabetes, type 2 diabetes and other types of diabetes was respectively compared by age, gender, study periods, study regions and economic status, using the Chi-square test. Additionally, the *P* trend was tested between different periods. Statistical analyses were performed using SAS 9.2 (SAS Institute, Cary, NC, USA). A *P* value less than 0.05 was considered statistically significant.

Results

Prevalence and trend of type 1 diabetes and type 2 diabetes

In the last 15 years, 4 337 836 children were discharged from the 14 medical centers. There were 4201 children with new-onset type 1 diabetes (accounting for 96.8 per 100 000 persons), 349 children with type 2 diabetes (8.0 per 100 000 persons) and 141 children with other types of diabetes (3.3 per 100 000 persons). Although type 1 diabetes was the most prevalent childhood diabetes mellitus, composing 89.6% (4201/4691) of all diabetes, by using the five-year unit calculation, the prevalence (per 100 000 persons) of type 1 diabetes increased from 90.9 (707/777 383) to 92.9 (1275/1 372 269) and 101.4 (2219/2 188 184) (*P*<0.0001) (Table 1 and Fig. 1).

While the prevalence of type 2 diabetes was only 7.4% (349/4691) of total cases, which has dramatically increased from 4.1 (32/777 383) in the first 5 years to 7.1 (98/1 372 269) in the second 5 years, and to 10.0 per 100 000 persons (219/2 188 184) in the recent 5 years (*P*<0.0001) (Table 1 and Fig. 1). Type 2 diabetes occurred primarily in children aged ≥10 years. The prevalence of type 2 diabetes was 82.2% (287/349) in boys aged ≥10 years old. The prevalence of diabetes in males (57.9%, 202/349) was significantly higher than that in females (42.1%, 147/349) (*P*<0.01). The

Table 1. The distribution of characteristics by types of diabetes

Variables	Subvariables	Type 1 diabetes	Type 2 diabetes	Others*
Total new-onset cases		4201 (96.8)	349 (8.0)	141 (3.3)
Age, y	<10	2501	62	66
	≥10	1700	287	75
Gender	Male	1982	202	73
	Female	2219	147	68
BMI	>95th	55	248	-
	<95th	4146	101	-
Periods Total cases	Oct 1995 to Sep 2000 (777 383)	707 (90.9)	32 (4.1)	4 (0.5)
(4 337 836)	Oct 2000 to Sep 2005 (1 372 269)	1275 (92.9)	98 (7.1)	35 (2.6)
	Oct 2005 to Sep 2010 (2 188 184)	2219 (101.4)	219 (10.0)	102 (4.7)
	Likelihood ratio	9.72	29.37	41.83
	Pearson	9.69	26.79	33.37
	P trend	0.0078	<0.0001	<0.0001

*: The diabetes was not definitively classified in clinic. Data are presented in: *n* (per 100 000 persons).

Table 2. The prevalence of diabetes in different regions and different economic states

Types	Subtypes	Type 1 diabetes	Type 2 diabetes	Others*
		n (per 100 000 persons)		
Different regions	North	1679 (120.45)	218 (15.64)	54 (3.87)
	East	1082 (80.02)	51 (3.77)	58 (4.29)
	Southwest	782 (59.76)	33 (2.52)	12 (0.92)
χ^2 (Pearson)		297.39	192.77	29.35
P		<0.0001	<0.0001	<0.0001
Different economic states	Well developed	1989 (151.51)	199 (15.16)	99 (7.54)
	Less developed	608 (32.20)	31 (1.64)	8 (0.42)
χ^2 (Pearson)		1359.69	196.91	117.36
P		<0.0001	<0.0001	<0.0001

*: The diabetes was not definitively classified in clinic.

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total prevalence of type 2 diabetes in younger children (<10 years) was 17.8 (62/349), much lower than that in elder children (≥10 years) with a prevalence of 82.2% (287/349) (P<0.01). Further analysis found that obese children, either in the younger group (<10 years) or in the elder group (≥10 years) were the main subjects of type 2 diabetes composed of 82.3% (51/62) and 68.6% (197/287), respectively. Among them, obese boys ≥10 years were at the highest risk of type 2 diabetes. Overall, these data showed that a trend of type 2 diabetes was emerging quickly, especially in boys over 10 years old (Table 1).

Geographic analysis showed that there was a clear increasing trend from southwest to east and north China. The prevalence (per 100 000 persons) of type 1 diabetes increased from 59.76 in southwest to 80.02 in east and 120.45 in north China, and type 2 diabetes increased from 2.52 to 3.77 and 15.64 (all P <0.001), other types of diabetes also had a significantly increasing trend (P<0.001) (Table 2 and Fig. 2A). The distribution of 14 medical centers is shown on the map of China (Fig. 3).

Economic analysis showed that well developed areas had a higher prevalence (per 100 000 persons) of type 1, type 2 and other types of diabetes compared with less developed regions, with type 1 diabetes of 151.51 *vs.* 32.2, type 2 diabetes of 15.16 *vs.* 1.64, and other types diabetes of 7.54 *vs.* 0.42 (all P <0.0001) (Table 2, Fig. 2B).

Further analysis of the increase of prevalence (per 100 000 persons) of type 1 diabetes in the age groups showed that there was a steep increase in the group of <6 years, from 15 in the first 5 years to 23.1in the second 5 years and to 32.8 in the recent 5 years (χ^2=6.723, P=0.035). There was no difference in the group aged ≤6-10 years (from 26.8 to 30.9 to 32.6 per 100 000 persons, χ^2=0.591, P=0.744). The prevalence of type 1 diabetes in the group of ≥10 years decreased

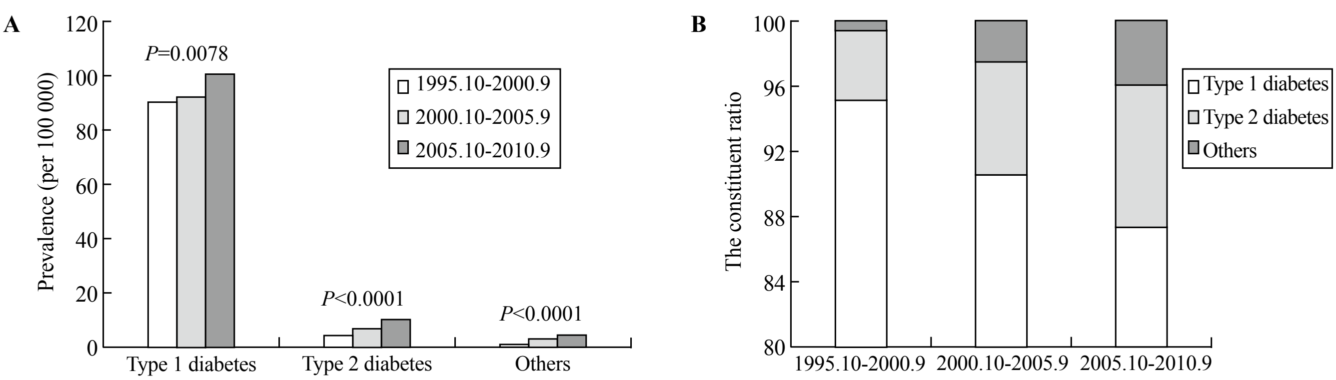

Fig. 1. The prevalence and constituent ratio of diabetes in different periods. **A:** The prevalence (per 100 000 persons) of type 1 diabetes increased from 90.9 to 92.9 and 101.4, the trend was significant (P=0.0078). The prevalence of type 2 diabetes showed a significant progressively increase from 4.5 to 7.1 and 9.1 (P<0.0001); **B**: Type 1 diabetes had the highest percentage of childhood diabetes mellitus, which composed of 95.15% in the first 5 years, 90.55% in the second 5 years and 87.36% in the recent 5 years. The proportion of type 2 diabetes increased rapidly from 4.3% to 6.96% and 8.62% in the same period correspondingly (P<0.01).

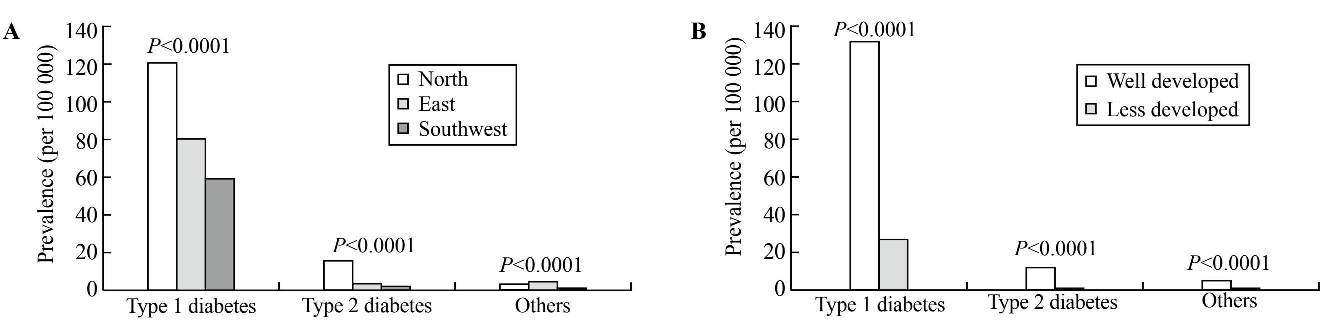

Fig. 2. A: Geographic analysis showed that there was a clear increasing trend from southwest to east and north. The prevalence (per 100 000 persons) of type 1 diabetes increased from 59.76 in southwest to 80.02 in east and 120.45 in north China, and type 2 diabetes increased from 2.52 to 3.77 and 15.64 per 100 000 persons *(P*<0.001), other types of diabetes also had a significantly increasing trend *(P*<0.001). Southwest: Guangzhou, Wuhan, Zhengzhou and Chongqing; east: Shanghai, Zhejiang, Nanjing, Suzhou, Jiangxi; north: Beijing, Harbin, Tianjin and Shenyang. **B**: Economic analysis showed that well developed areas had a higher prevalence (per 100 000 persons) of type 1 diabetes, type 2 diabetes and other types of diabetes comparing with less developed regions, with type 1 diabetes of 151.51 *vs.* 32.2, type 2 diabetes of 15.16 *vs.* 1.64, and other types diabetes of 7.54 *vs.* 0.42 (P<0.0001). Well developed areas: Shanghai, Beijing, Guangzhou, Zhejiang and Suzhou; less developed regions: Chongqing, Harbin, Zhengzhou and Jiangxi.

gradually during the same period (from 49.1 to 38.7 to 36.0 per 100 000 persons, χ^2=2.32, *P*=0.314) (Fig. 4) .

The status of pre-diabetes in obese children

The increased incidence of childhood type 2 diabetes paralleled with the outbreak of obesity in China. To assess the glucose metabolic status in obese children, we studied children (male/female=2033/1120) who met the inclusion criteria and found that 575 children (male/female=327/248) had IFG alone, 189 (male/female=109/80) had isolated IGT, and 127 (male/female=77/50) had combined IFG and IGT. These patients accounted for 18.24%, 5.99% and 4% of the total number of children, respectively. The total number of children with abnormal glucose metabolism was 891 (28.26%) (Table 3).

In the obese children, 57.22% (1804/3153) had dislipidemia, 26.51% (836/3153) had hypertriglyceridaemia, 12.60% (397/3153) had hypercholesterol, and 18.11% (571/3153) had low HDL-C. In these obese children, 13% had high systolic blood pressure and 6.85% had high diastolic blood pressure (Table 3). The results indicated a higher risk factor for type 2 diabetes and cardiovascular disease in the future.

The prevalence of multiple disorders in patients with type 2 diabetes

In this study, the overall prevalence of dyslipidemia was 90.8%, in which the prevalence of high TG, high TC and low HDL was 34.4%, 25.2% and 31.2%, respectively. Approximately 50.4% of children with type 2 diabetes had nonalcoholic fatty liver disease (NAFLD) and 29.5% had hypertension.

Discussion

In the past 15 years, the prevalence of childhood diabetes in China has increased dramatically and the growth of type 2 diabetes has exceeded that of type 1 diabetes. Type 1 diabetes has an incidence rate of 89.6% of all diabetes and is still the dominant form of diabetes in children. As the overall annual increase

Table 3. The prediabetes status, dislipidemia and hypertension in 3153 obese children

Age/sex	<10 y		≥10 y		Total, *n* (%)	
	M	F	M	F	M	F
Obese children	688	497	1345	623	2033 (64.5)	1120 (35.5)
Isolated IFG	116	122	211	126	327 (10.4)	248 (7.9)
Isolated IGT	19	25	90	55	109 (3.5)	80 (2.5)
Combined of IFG and IGT	20	20	57	30	77 (2.4)	50 (1.6)
Dislipidemia						
High TG	163	107	367	199	530 (16.8)	306 (9.7)
High TC	72	44	189	92	261 (8.3)	136 (4.3)
Low HDL	94	78	271	128	365 (11.6)	206 (6.5)
Hypertension						
High SBP	55	30	241	84	296 (9.4)	114 (3.6)
High DBP	22	20	114	60	136 (4.3)	80 (2.5)

M: male; F: female; IFG: impaired fasting glucose; IGT: impaired glucose tolerance; TG: triglyceride; TC: total cholesterol; HDL: high-density lipoprotein; SBP: systolic blood pressure; DBP: diastolic blood pressure.

Fig. 3. The 14 medical centers representing north, southwest and east China.

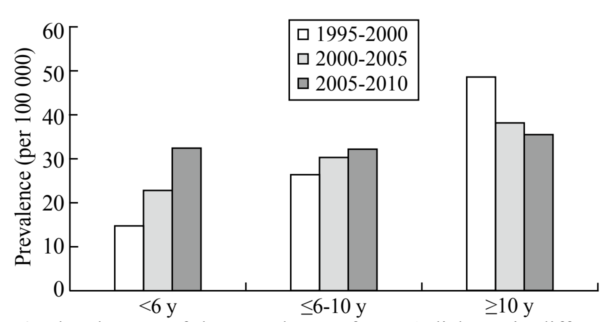

Fig. 4. The changes of the prevalence of type 1 diabetes in different age groups. The steep increase was in the age group of <6 years, from 15 in the first 5 years to 23.1 in the second 5 years and 32.8 per 100 000 persons in the recent 5 years (χ^2=6.723, *P*=0.035). There was no difference among the age group of ≤6-10 years (from 26.8 to 30.9 to 32.6, χ^2=0.591, *P*=0.744). The prevalence (per 100 000 persons) of type 1 diabetes in the age group of ≥10 years decreased gradually during the same period (from 49.1 to 38.7 to 36, χ^2=2.32, *P*=0.314).

in the incidence of type 1 diabetes in children was estimated to be 3%,[12] the prevalence of type 1 diabetes in our study was relatively stable from 1995 to 2005, but increased obviously in the recent 5 years according to the hospital records. We found that there was a steep increase in children of less than 6 years old, which was consistent with other studies showing the highest increase in type 1 diabetes incidence in the youngest individuals (age <5 years).[13] Why this increase takes place in young children is unknown. Possibly, these younger children have a higher proportion of human leukocyte antigen (HLA) susceptibility genes, but there is an increased tendency in this age-group because of negative environmental changes.

Diabetes is varied with regional differences around the world.[14] Childhood diabetes in China is characterized by different geographical distributions. The tendency of diabetes development from southwest to east and north China has shown strong regional differences. Differences in climate, diet habits and lifestyles may partially explain the results. Colder climate, high-sugar diet, more fat composition, and less fiber dietary may contribute to the high incidence of diabetes in north China. But whether a different genetic susceptibility included a low frequency of high-risk HLA alleles could explain the lower prevalence of islet-specific autoantibodies and the low incidence of type 1 diabetes, or different genetic and environmental interactions or early childhood diet, obesity might be involved in the etiology of type 1 diabetes.[15] Therefore, population-based epidemiological studies are required to identify risk determinants that may be useful for primary prevention of diabetes.

The prevalence of diabetes is higher in economically developed regions than that in less developed regions in China. Economic development may be associated with changes in lifestyle that often lead to physical inactivity, unhealthy diet, and obesity, which are contributing factors for the development of diabetes. However, a study from Brazil showed a decline in obesity among the higher-income groups who are aware of the benefits of diet and physical activity and could afford healthier food.[16,17] This finding indicated that economic growth is not a decisive factor for obesity and that the knowledge of healthy lifestyle is more important.

In this study, the prevalence of childhood type 2 diabetes in China has doubled in the recent 5 years. Though the prevalence rate is lower than that of the United States (8%-46%),[18] the consequences are serious as China has the largest population in the world. It was predicted that one third of Americans will be overweight by the year of 2025, and there will be a global explosion of type 2 diabetes, which will hit the United States, India and China. Obese children with type 2 diabetes often have multiple disorders, including dyslipidemia, NAFLD and hypertension.[19] Moreover, type 2 diabetes appears in younger children, and its complications occur more earlier, which means a significant burden on the family and society. We firstly reported a 12-year-old boy with type 2 diabetes associated with ischemic stroke confirmed by cerebrovascular magnetic resonance angiography.[20] We also found that intima-media thickness in the obese and MS groups by B-ultrasound was significantly greater than that in the control group.[21] The presence of these cardio-vascular risk factors in childhood and adolescence is predictive of coronary artery disease later in adult life.

Further analysis of the characteristics of type 2 diabetes in this cohort found that obese children either in the younger group or in the elder group are predominant. This finding is consistent with the result of other population-based studies on type 2 diabetes, that children and adolescents with a clinical diagnosis of type 2 diabetes are almost overweight or obese.[22,23] In our study, obese boys of 10 years old or older were at an increased risk of type 2 diabetes, which is different from other reports such as Pima Indian adolescents with a female/male ratio of 1.67 and Taiwanese adolescents with a female/male ratio of 1.89.[24,25] High epidemics of obesity in Chinese boys may explain the situation. A study covering nine provinces in China conducted from 1991 to 2006[2] showed the greatest increase of incidence of type 2 diabetes in boys and adolescents in whom body overweight tripled from 4.8% in 1991 to 15.4% in 2006, compared with 5.4% and 11.0% in girls in the same period. The epidemiologic survey of metabolic syndrome in 2010 revealed that in 21 858 children aged 7-16 years (male/female=11 460/10 398) there was also a higher prevalence rate of male obesity (male/female=937/455).[26] Why obesity is predominant in boys is still unknown. Traditionally, Chinese families preferring boys to girls and thoughts of keeping fit during puberty in girls may partially explain the fact. Whether sex hormones are involved in this situation needs further investigation.

This study also showed that obese children are potential pools of type 2 diabetes. In 3153 obese children, 891 (28.26%) suffered from pre-diabetes: 18.24% had isolated IFG, 5.99% had isolated IGT, and 4.0% had both. The detection rate of type 2 diabetes was slightly lower than that in the United States (IFG=18%, IGT=25%),[27] but higher than that in Italy (IFG=7.66%, IGT=3.18%).[28] Fasting glucose and postprandial glucose in many obese individuals are independent and inconsistent, indicating that both can be detected while screening pre-diabetes. These pre-diabetic children are needed to be investigated whether

IFG and IGT are stable and how long they take to develop type 2 diabetes.

The limitation of this study is that the data were collected from medical records during hospitalization. Some children who are managed originally in community hospitals and not admitted to principal medical centers might have been missed. However, hospital admissions can be underestimated rather than overestimated as the total number of children affected.

In summary, the prevalence of childhood diabetes in China has increased dramatically, and the incidence of type 2 diabetes has exceeded that of type 1 diabetes in the past 15 years. The incidence of childhood diabetes in China is affected by geographical and economic conditions. The incidence of abnormal glucose metabolism in obese children has reached 28.26%. Obese children are at a particular risk for type 2 diabetes, and they should be closely monitored, especially in the period of puberty.

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Ethical approval: This study was approved by the ethical committees of the 14 medical centers.

Competing interest: All authors disclosed no conflict of interest.

Contributors: Fu JF designed the study as well as the data collection instruments and coordinated and supervised data collection in Hangzhou, drafted the initial manuscript, reviewed and revised the manuscript, and approved the final manuscript. Liang L conceptualized and designed the study, and approved the final manuscript as submitted. Gong CX coordinated and supervised data collection in Peking, critically reviewed the manuscript, and approved the final manuscript. Xiong F coordinated and supervised data collection in Chongqing, critically reviewed the manuscript, and approved the final manuscript as submitted. Liu GL coordinated and supervised data collection in Tianjin, critically reviewed the manuscript, and approved the final manuscript as submitted. Luo FH coordinated and supervised data collection in Shanghai, critically reviewed the manuscript, and approved the final manuscript as submitted. Li P also coordinated and supervised data collection in Shanghai, critically reviewed the manuscript, and approved the final manuscript as submitted. Liu L coordinated and supervised data collection in Guangzhou, critically reviewed the manuscript, and approved the final manuscript. Xin Y coordinated and supervised data collection in Shenyang, critically reviewed the manuscript, and approved the final manuscript. Yao H coordinated and supervised data collection in Wuhan, critically reviewed the manuscript, and approved the final manuscript. Cui LW coordinated and supervised data collection in Harbin, critically reviewed the manuscript, and approved the final manuscript. Shi X coordinated and supervised data collection in Nanjing, critically reviewed the manuscript, and approved the final manuscript. Yang Y coordinated and supervised data collection in Jiangxi, critically reviewed the manuscript, and approved the final manuscript. Chen LQ coordinated and supervised data collection in Suzhou, critically reviewed the manuscript, and approved the final manuscript. Wei HY coordinated and supervised data collection in Zhengzhou, critically reviewed the manuscript, and approved the final manuscript. All authors contributed eaqually to this study.

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