



## **Secular Trends in Overweight and Obesity among Urban Children in Guangzhou China, 2007-2011**

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### **Abstract**

**Background:** No studies have been reported on children obesity prevalence of Guangzhou, one of the most urbanized areas in China. This study tracks the secular trends of obesity prevalence of children.

**Methods:** The data were derived from the surveys on students' constitution and health carried out by government. Randomly, 3832 students in 2007, 13141 in 2008, 14052 in 2009, 13750 in 2010, and 15225 in 2011, aged 7-12 years, from urban primary school were examined. Anthropometric parameters were measured in all students.

**Results:** The mean of body mass index increased significantly from 16.6 in 2008 to 16.8 in 2011 in the total group of children, and the total prevalence of overweight and obesity increased from 9.4 and 6.2 to 10.5 and 7.5 from 2007 to 2011, respectively. The minimum value of the mean body mass index and the overweight and obesity prevalence in the total age group all appeared in 2008. The prevalence of overweight and obesity in males was significantly higher than that in females in each year among the 5 years.

**Conclusion:** Although the prevalence of children obesity in Guangzhou in 2011 is still lower than the average values of Chinese large coastal cities, a significant increase was found in their prevalence from 2007 to 2011 and the total obesity prevalence of children is even higher than that of adolescent. Furthermore, we found that the minimum value of overweight and obesity prevalence of the total group and almost all gender-specific age groups appeared in 2008.

**Keywords:** Body mass index, Children, Overweight, Obesity, Secular trend

### **Introduction**

Obesity in childhood is associated with a wide range of serious health complications and an increased risk of premature illness and death later in life. Childhood obesity is inversely associated with ideal cardiovascular health index in adulthood (1). Monitoring childhood obesity should be the first step in the health policy for interventions regarding early prevention of chronic diseases. However, the prevalence of childhood overweight and obesity has increased worldwide in recent decades. In

2010, 43 million children (35 million in developing countries) were estimated to be overweight and obese; 92 million were at risk of overweight. The worldwide prevalence of childhood overweight and obesity increased from 4.2 in 1990 to 6.7 in 2010. This trend is expected to reach 9.1 in 2020 (2).

China, used to be known for her slender people, has now joined the world epidemic of obesity (3). Previous reports suggested that the epidemic of

children overweight and obesity in China has spread both in urban and rural areas since the end of 20th century (4).

Guangzhou is one of the largest metropolitan areas in south China, with a population of 17 million, and a leading economic region, a dramatic change in life style might have an impact on the obesity prevalence in children. However, no study to date has investigated the prevalence of children overweight and obesity in Guangzhou. In this study, we therefore aimed to provide data on the prevalence of overweight and obesity among children in five cross-sectional studies in Guangzhou during a 4-year period between the years 2007 and 2011.

## Materials and Methods

### Data sources and sampling

The data were derived from the surveys on students' constitution and health carried out by the government in 2007-2011 in Guangzhou, Guangdong Province. Through a multistage cluster sampling, we first randomly selected four districts from the urban area, and in a second stage, students aged 7–12 yr old from schools in the four districts were invited to participate in this survey. For the purpose of comparison, the prevalence estimated in each database was standardized according to the age distribution of 2007 population. The age and gender specific sample sizes of the respective surveys are given in Table 1.

**Table 1:** Sample size of each survey by age

Age (yr)	2007		2008		2009		2010		2011	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
7	411	336	1329	1103	1263	1007	1235	1064	1372	1141
8	384	316	1190	1075	1505	1226	1325	1107	1414	1199
9	368	300	1254	1065	1333	1158	1488	1162	1424	1155
10	424	320	1273	977	1347	1190	1212	1100	1709	1377
11	396	342	1216	1053	1333	1037	1318	1151	1532	1283
12	133	102	910	696	906	747	927	661	933	686
Total	2116	1716	7172	5969	7687	6365	7505	6245	8384	6841

### Physical measurement

All subjects underwent a thorough medical examination before measurement, to ensure that they were generally free of overt diseases or physical or mental disorders. Stature (centimeter) and weight (kilogram) were measured by the same technicians, and all measurements were taken according to a standardized procedure by means of a uniformly recommended apparatus. The subjects were asked to use the restroom before being measured. Metal column height measuring stands (each 200 cm long with 0.1 cm precision) were used to measure stature. The subjects were required to stand straight on the instruments, barefoot and at ease. Weight was measured with lever scales (each weighing 120 kg with 0.1 kg precision), while the subjects wore only their underwear. Rigid quality control measures were enforced in the field. After completing the daily measurements, 2 of the sub-

jects were measured again, (86.2 of the students agreed to do so). Subjects whose measurements had disparities exceeding the limiting scores (>10) were considered invalid cases. The margin of error was <4 for all the retest measurements.

### Definitions for overweight and obesity

Body mass index (BMI) is calculated by dividing weight in kilograms by stature in meters squared (kg/m<sup>2</sup>). Overweight and obesity were defined by using the Working Group of Obesity in China (WGO) criteria, the cut points of which are 85<sup>th</sup> and 95<sup>th</sup> percentiles of BMI, respectively. (Overweight: 85<sup>th</sup> percentile ≤ BMI < 95<sup>th</sup> percentile; Obesity: 95<sup>th</sup> percentile ≤ BMI) (5). For both males and females aged 18 years, the cut points for overweight and obesity correspond to an adult BMI of 24 (overweight) or 28 (obesity) in China, respectively.

### Statistical analysis

Data input was performed by using Epidata 3.1 software, and calculations were conducted using the SPSS13.0 package. In each of the groups, one-way analysis of variance (ANOVA) was used to compare mean values for continuous variables such as BMI; chi-square tests were used to determine the significance of any difference between two successive years. All the test level is set to 0.05.

### Results

#### Empirical changes in BMI between 2007 and 2011

As illustrated in Table 2, the mean of BMI increased significantly from 2008 to 2011 (from 16.6 to 16.8) in the total group of children. Further analysis showed that, in addition to 7- age group, the differences were statistically significant in other age groups, and the minimum value of the mean BMI all appeared in 2008 of children aged 7-12.

**Table 2:** BMI in six age groups of Guangzhou students aged 7-12 years (Mean  $\pm$  SD)

Age (yr)	2007	2008	2009	2010	2011	P <sup>a</sup>
7	15.3 $\pm$ 2.0	15.4 $\pm$ 2.3	15.5 $\pm$ 2.2	15.4 $\pm$ 2.3	15.4 $\pm$ 2.2	0.38
8	16.2 $\pm$ 2.8	15.8 $\pm$ 2.6	16.1 $\pm$ 2.7	15.8 $\pm$ 2.5	15.9 $\pm$ 2.6	0.01
9	16.5 $\pm$ 2.7	16.2 $\pm$ 2.7	16.6 $\pm$ 3.0	16.5 $\pm$ 3.0	16.4 $\pm$ 2.8	0.01
10	17.4 $\pm$ 3.1	16.9 $\pm$ 3.0	17.2 $\pm$ 3.1	17.1 $\pm$ 3.3	17.3 $\pm$ 3.3	0.01
11	17.7 $\pm$ 3.2	17.5 $\pm$ 3.1	17.8 $\pm$ 3.3	17.9 $\pm$ 3.4	17.9 $\pm$ 3.5	0.01
12	18.0 $\pm$ 3.4	17.9 $\pm$ 3.2	18.2 $\pm$ 3.2	18.3 $\pm$ 3.4	18.3 $\pm$ 3.4	0.01
Total	16.7 $\pm$ 3.0	16.6 $\pm$ 2.9	16.8 $\pm$ 3.1	16.7 $\pm$ 3.1	16.8 $\pm$ 3.1	0.01

a: one-way analysis of variance (ANOVA) was used to compare mean values of BMI between 2007 and 2011.

#### Prevalence of overweight and obesity of children from 2007 to 2011

As shown in Table 3, there was a significant increase of the overweight (from 9.4 to 10.5) and obesity (from 6.2 to 7.5) prevalence for the total group of children (7-12 years) between 2008 and 2011. The obesity prevalence in 10 years old in

2011 was higher than that in 2008 ( $P=0.007$ ). However, the prevalence of obesity in 8 years old decreased significantly from 9.1 in 2007 to 6.8 in 2008 ( $P=0.02$ ). No significant differences on the obesity prevalence in other age groups and the overweight prevalence in 7-to12-year old were observed during the past 5 years.

**Table 3:** The total prevalence of overweight and obesity in six age groups of Guangzhou students aged 7-12 years

	Overweight (%)					Obesity (%)				
	2007	2008	2009	2010	2011	2007	2008	2009	2010	2011
7	7.1	8.2	8.3	8.7	8.9	5.9	7.3	7.7	7.3	7.0
8	8.6	9.0	9.6	9.1	9.8	9.1 <sup>b</sup>	6.8	9.0 <sup>b</sup>	7.2	7.4 <sup>a</sup>
9	9.0	8.9	10.5	10.4	10.5	7.3	6.1	8.1	7.9	6.9
10	13.3	10.5	11.0	10.3	12.0	8.2 <sup>b</sup>	6.0	7.5	8.0 <sup>b</sup>	8.7 <sup>ab</sup>
11	11.2	10.4	10.9	12.2	11.3	5.8	5.9	6.8	7.0	7.7
12	6.3	9.5	10.0	11.4	10.2	5.1	4.5	4.5	6.0	6.3
Total	9.7	9.4	10.1	10.3 <sup>b</sup>	10.5 <sup>ab</sup>	7.1	6.2	7.5 <sup>b</sup>	7.3 <sup>b</sup>	7.5 <sup>ab</sup>

- a.  $P<0.05$ , the difference of overweight and obesity prevalence in six age groups in 2007, 2008, 2009, 2010 and 2011 was analyzed by R\*C chi-square;
- b. Further analysis between 2008 and 2007, 2009, 2010, 2011, respectively, there is a significant difference between them.

Table 4 and Table 5 depict in details the temporal changes from 2007 to 2011 in overweight and obesity prevalence in 7- to 12-years old for male and female. Males showed a significant increase in the prevalence of obesity in the total and 10- age groups from 2008 to 2011 (from 8.0 to 9.6, 7.5 to 10.9, respectively), no significant differences on the overweight prevalence in all age groups were observed. In females, a significant increase was found in the total prevalence of overweight and

obesity between 2007 and 2011 (from 6.6 to 7.6, 4.1 to 5.4, respectively). However, the prevalence of obesity in 8 years old decreased significantly from 6.9 in 2009 to 4.4 in 2010, the similar trend was also found in 9-age group between 2007 and 2008 (from 6.3 to 3.2,  $P=0.004$ ). When compared the total prevalence of overweight and obesity between males and females, we found that the prevalence in males was higher than that in females in each year.

**Table 4:** Prevalence of overweight and obesity in six age groups of Guangzhou male children aged 7-12 years

	Overweight (%)					Obesity (%)				
	2007	2008	2009	2010	2011	2007	2008	2009	2010	2011
7	7.5	8.4	8.8	9.9	10.3	6.8	9.0	9.7	9.1	8.9
8	11.2	10.8	11.2	10.7	11.6	11.2	8.9	10.8	9.5	9.8
9	9.5	11.3	12.6	12.4	12.3	8.2	8.6	10.0	9.3	9.1
10	16.5	14.4	14.6	13.4	14.8	10.4	7.5	9.5	10.9 <sup>b</sup>	10.7 <sup>ab</sup>
11	16.4	13.7	15.1	16.5	15.1	8.8	7.8	8.3	8.5	10.6
12	9.0	12.0	12.3	15.1	13.2	7.5	5.2	5.4	7.6	7.5
Total	12.1	11.7	12.4	12.9	13.0	9.0	8.0	9.2 <sup>b</sup>	9.2 <sup>b</sup>	9.6 <sup>ab</sup>

a: The comparison of overweight and obesity prevalence for male among the 5 years was via R\*C chi-square, and there is a significant difference among them;

b: Further analysis between 2008 and 2007, 2009, 2010, 2011, respectively, there is a significant difference between them.

**Table 5:** Prevalence of overweight and obesity in six age groups of Guangzhou female children aged 7-12 years

	Overweight (%)					Obesity (%)				
	2007	2008	2009	2010	2011	2007	2008	2009	2010	2011
7	6.5	7.9	7.7	7.2	7.3	4.8	5.3	5.1	5.3	4.8
8	5.4	7.0	7.6	7.2	7.7	6.6	4.5 <sup>b</sup>	6.9	4.4	4.6 <sup>a</sup>
9	8.3	6.0	8.0	7.9	8.2	6.3	3.2 <sup>b</sup>	5.9	6.2	4.2 <sup>a</sup>
10	9.1	5.5	7.0	7.0	8.5	5.3	4.1	5.2	4.9	6.3
11	5.3	6.7	5.5	7.2	6.9	2.3	3.6	4.9	5.2	4.2
12	2.9	6.3	7.2	6.2	6.1	2.0	3.6	3.5	3.9	4.7
Total	6.6	6.6	7.2	7.2	7.6 <sup>ab</sup>	4.8	4.1	5.4 <sup>b</sup>	5.1 <sup>b</sup>	4.8 <sup>a</sup>

a: The comparison of overweight and obesity prevalence for female among the 5 years was via R\*C chi-square, and there is a significant difference among them.

b: Further analysis between 2008 and 2007, 2009, 2010, 2011, respectively, there is a significant difference between them.

## Discussion

Since our surveys on students' constitution and health were carried out by the government and were free of charge, all students of the selected schools were willing to take part. Therefore, the

response rate was almost 100, except that there were very few students staying in hospital or home because of severe disease. Therefore, the selected students can represent the overweight and obesity prevalence of all students in this area (6). The cross-sectional data suggested that the

overall prevalence of overweight and obesity in children had increased during 2007~2011 in Guangzhou area.

Further analysis showed that the prevalence of overweight and obesity both in male and female is lower than the average values of large coastal cities (overweight: male: 20.7, female: 11.1; Obesity: male: 17.8, female: 9.8), but close to the whole Chinese national level in 2010 (overweight: male: 14.2, female: 7.7; Obesity: male: 9.4, female: 5.4)(7). JI attributed this regional disparity in both overweight and obesity prevalence to the complex interaction of genetic and many geographic-climate factors in China's long history (8). People living in the South in a warm and humid environment will have different appetites, food selection, and other dietary habits from those who live in the north drier and colder areas. Children in Guangzhou usually drink soup before eating, which will account for part of the stomach capacity, and then children will not eat too much and have a lower risk of gain in weight. However, we also found that more than 7.5 of 7- to 12-years olds children were obese compared with 4.2 of 12- to 18-years olds in 2011 ( $P<0.001$ ), and the obesity prevalence in total age group of male and female children both increased significantly, a similar trend was reported in a meta-analysis research in China (9).

Another important finding of the present study is that the minimum value of overweight and obesity prevalence of the total group appeared in 2008, and the similar phenomenon was found in almost all gender-specific age groups. Theoretical models suggest that interventions targeting behaviors, attitudes, knowledge, and skills at multiple levels, and environment levels such as neighborhood and school, environment types such as policy and culture, are most likely to be successful at slowing unhealthy weight gain (10). In 2007, Chinese government issued opinions on improving the youth physical activity level and enhancing their physical fitness, rigorous interventions for the Ministry of education to ensure that students spend at least one hour in daily exercise at school (10). Furthermore, many sports infrastructures had been built before Olympics, these low-cost or no-cost facili-

ties, public spaces provide additional physical activity opportunities for children, the spirit of the Olympic Games athletes, and the health education during Olympics can inspire children to take more exercise to keep a health weight. The study of social effects of the 2012 Olympics held in London showed similar results (11-12).

The present study also showed that the increasing trends of children overweight and obesity prevalence differ among sex groups. The overweight and obesity prevalence were higher in male than in female, which is in accordance with studies conducted in the other metropolitan cities, Hong Kong, Beijing, and Shanghai, in China (13-14), whereas in some countries there are more girls diagnosed as overweight and obese (15-16). The socio-cultural, behavioral, and genetic factors may play some important roles in the gender disparity in overweight and obesity (17-19). Obesity in Chinese boys is not recognized as detrimental or unbearable in China. On the other hand, Chinese girls prefer a slender shape, especially during puberty, and they are more likely to control their weight compared with their male counter-parts (20). Lifestyle changes may have also contributed to the gender disparity in the prevalence of overweight and obesity (21) The 2005 Chinese National Youth Risk Behavior Surveillance(NYRBS) reported that 4.3 of boys and 2.7 of girls had soft-drinks frequently, 23.6 of girls and 9.1 of boys tried to lose weight by restricting diet, and 29.1 of Chinese boys spent  $\geq 2$  h per day playing computer games, which were 2.0 times higher than girls(21). The 2010 Chinese National Surveillance on Students' Constitution and Health (CNSSCH) also found that unhealthy dietary habits, less physical activity, and more sedentary behavior were closely related to overweight and obesity between Chinese primary and middle school (22). Gender differences might also exist in various obesity-related genes in Chinese children, i.e., rs6548238 (TMEM18) in boys and rs9939609 (FTO) in girls. Research have showed that rs6548238 (TMEM18) was significantly associated with obesity related indices in Chinese boys, but not in girls. In contrast, rs9939609 (FTO) showed a strong associa-



tion with obesity indices only in Chinese girls (23-24).

Our study is not a prospective cohort study, as each cross-sectional CNSSCH was conducted on different subjects. Unintentional errors might occur when estimating the prevalence of overweight and obesity in Guangzhou and comparing their trends. However, our study collected three city representative data of large sample size, and the prevalence estimated in each database was standardized according to the age distribution of 2007 population for the purpose of comparison. In addition, because of the data absence on family income, parents' BMI, and number of siblings in our present surveys, we could not adjust for these factors associated with childhood overweight and obesity (25-27). Finally, we did not collect data regarding children's physical activity and diet in the present large-scaled study, thus it could not be confirmed why the minimum value of children's obesity and overweight appeared in 2008 (28).

## Conclusion

Using the data from five sets of large, consecutive cross-sectional and representative cohorts, we found that although the children overweight and obesity prevalence in Guangzhou in 2011 is still lower than the average values of Chinese large coastal cities, a significant increase was still found in their prevalence from 2007 to 2011 and the total obesity prevalence of the 7- to 12- years old children is even higher than that of 12- to 18- years old. Furthermore, we also found that the minimum value of overweight and obesity prevalence of the total group and almost all gender-specific age groups appeared in 2008.

## Ethical considerations

Ethical issues (Including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

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