Prevalence and risk factors for childhood obesity in Changsha and Shenzhen in China

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Abstract： **Objective**　To determine the prevalence and the risk factors for childhood obesity in Changsha and Shenzhen, China. **Methods**　A case-control study was conducted in 209 obese children (the cases) identified in the investigation on childhood obesity in 6 288 children aged 6 to 9 years in Changsha and Shenzhen in China and 209 children with normal weight (the controls). The cases and controls were matched by gender, age, and school. Adjusted odds ratio (a*OR*) and 95% confidence intervals (CI) for the risk factors were measured. **Results**　The prevalence rate of overweight and obese children was 9.28% and 3.30% in Changsha, and 12.17% and 4.22% in Shenzhen, respectively. The rate of overweight children is significantly higher in Shenzhen than in Changsha. No statistical difference was observed in the rate of obesity between the children in both cities. Paternal obesity (*OR* 1.78, 95% CI 1.01 to 3.16), maternal weight gain during pregnancy ≥15.0 kg (*OR* 5.22, 95% CI 2.78 to 9.80), birth weight ≥4.00 kg (*OR* 2.55, 95% CI 1.24 to 5.26), unhealthy snacks ≥1 per week (*OR* 3.94, 95% CI 1.11 to 13.99), and watching television ≥2 hours per day (*OR* 2.35, 95% CI 1.01 to 5.47) were associated with childhood obesity when potential confounding factors were adjusted by multivariable logistic regression analysis. **Conclusion**　Paternal obesity, gestational weight gain, high birth weight, and unhealthy life-style are important risk factors for obesity in urban children in south China.

Key words： children； obesity； risk factors； case-control study； China

长沙和深圳市儿童肥胖症患病率与危险因素研究

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[摘要]　目的:研究长沙和深圳市儿童肥胖的发生率及其危险因素。方法:以在中国长沙和深圳两市 6 288 名 6～9 岁儿童肥胖调查中发现的 209 名肥胖儿童为病例,按性别、年龄和学校进行配比选择 209 名体质量正常的儿童作对照,进行病例对照研究,计算各危险因素的调整 OR 值和 95% 可信区间。结果:儿童超体质量和肥胖的发生率在长沙为9.28%和3.30%,在深圳为12.17%和4.22%。两地儿童的超体质量发生率差异有统计学意义,而肥胖发生率差异没有统计学意义。中国城市儿童肥胖患病率为3.95%。用多因素 Logistic 回归分析对潜在的混杂因素加以调整后,父亲肥胖(OR:1.78, 95% CI:1.01～3.16),母亲怀孕期体质量增加 15 kg 以上(OR:5.22, 95% CI:2.78～9.80),出生体质量 4 kg 以上(OR:2.55, 95% CI:1.24～5.26),每周不健康快餐 1 次以上(OR:3.94, 95% CI:1.11～13.99),每天看电视 2 h 以上(OR:2.35,95% CI:1.01～5.47)等因素与儿童肥胖有关。结论:父亲肥胖、妊娠期体质量增加、出生体质量和不健康生活方式是中国南方城市儿童肥胖的重要危险因素。

[关键词]　儿童;　肥胖;　危险因素;　病例对照研究;　中国

Obesity has become a serious public health problem worldwide. The World Health Organization (WHO) reported that approximately 1.6 billion adults (aged 15 and above) were overweight, at least 400 million adults were obese, and at least 20 million children under the age of 5 years were overweight globally in 2005, and by 2015, approximately 2.3 billion adults will be overweight and more than 700 million will be obese[1]. Childhood obesity is associated with hypertension, impaired vascular function, and Type 2 diabetes, and the increased risks of cardiovascular diseases and diabetes in the affected children will continue into their adult lives[2]. Data from the International Obesity Task Force (IOTF) indicated that the rate of overweight children aged 6 to 8 years was from 10.5% to 25.6% in some countries[3]. For example, in recent years, a rapid increase in childhood obesity has noticeably occurred within Beijing[4].

It is estimated that 95% of childhood obesity is simple obesity[5]. Many genetic and environmental factors may have been involved in the complex pathogenesis process leading to the development of childhood obesity. Although several studies have been carried out to examine the risk factors of childhood obesity[4-6], the results have not been consistent. Furthermore, the rapid economic development and the shift from the traditional life-style to a more Western life-style in China, especially among young children, may have a major impact on childhood obesity. The objective of this study was to examine the prevalence and the risk factors of childhood obesity in urban south China using the IOTF standards[7].

1　MATERIALS AND METHODS

1.1　Samples and subjects

This study was carried out between March and June, 2005, in Changsha and Shenzhen in China. We used a multi-stage cluster sampling method to select 15 elementary schools for this study. During the first stage, we selected the Kaifu District in Changsha city in Hunan Province and the Nanshan District in Shenzhen city in Guangdong Province. During the second stage, we randomly selected 10 of 62 elementary schools in Kaifu and 5 of 45 in Nanshan.

1.2　Collection of data

Data on age and gender for all children aged 6 to 9 years in the selected schools was collected and their height and weight were measured. The Cole criteria were used to classify childhood obesity by body mass index (BMI; kg/m^2)[7]. Briefly, a child with BMI equivalent to an adult BMI of 30 and above was diagnosed as obese, and a child with BMI equivalent to an adult BMI between 25 and 30 was diagnosed as overweight (Tab. 1). A case-control study was conducted in 209 obese children and 209 control children of nor-

mal weight. The cases and controls were matched by school (same), age (within 6 months), and gender (same). Self-designed questionnaire was used to collect data on the obese and control children's parental and family information, maternal and perinatal conditions, feeding during the first 6 months of life, and diet and exercises during childhood. We also conducted parental anthropometric measurements.

Tab. 1   Corresponding BMI criteria for overweight and obese male and female children aged 6 to 9 years according to adult criteria

Age	BMI = 25 (adult overweight criteria)		BMI = 30 (adult obesity criteria)	
	Male	Female	Male	Female
6.0	17.55	17.34	19.78	19.65
6.5	17.71	17.53	20.23	20.08
7.0	17.92	17.75	20.63	20.51
7.5	18.16	18.03	21.09	21.01
8.0	18.44	18.35	21.60	21.57
8.5	18.76	18.69	22.17	22.18
9.0	19.10	19.07	22.77	22.81
9.5	19.46	19.45	23.39	23.46

Body weight was measured while wearing single clothes and no shoes with a PGT-160 pointer (the accuracy of measurement went down to 0.1 kg). Standing and sitting height were measured without wearing shoes with a TZG stadiometer (the accuracy of measurement went down to 0.1 cm). Chest circumference, waist circumference, and buttocks circumference were measured with a tape measure (the accuracy of measurement went down to 0.1 cm). Skin thickness was measured on the upper arm and the back of the body by trained technicians. All field workers were trained before the commencement of the study, and an operating manual was provided to them. All the questionnaires were filled out by the parents. All the returned questionnaires were examined by the researchers for consistency and completeness. When a questionnaire was found to be incomplete or inconsistent, a telephone follow-up or home visit by the research team was arranged to obtain the correct information from the parents.

1.3   Statistical analysis

SPSS for Windows (Version 13.0) was used for datum entering, editing, and analysis. We first described the distribution of overweight and obese children by age and gender. We made comparison of the rates of overweight and obese children by chi-square test, and the difference is statistically significant when $P < 0.05$. We then estimated the independent effect of risk factors for childhood obesity by conditional logistic regression analysis. Simple obesity was the outcome of the study. Independent variables included in the regression model were paternal obesity, maternal obesity, maternal weight gain during pregnancy, birth weight, feeding mode before 6 months of age, the time of adding meat to a child's diet, frequency of having Western snacks, duration of a meal, duration of watching TV per day, and duration of playing outside per day.

2   RESULTS

A total of 6 288 children aged 6 to 9 years (3 306 boys and 2 982 girls) in the 15 participating elementary schools were examined (response rate 100%). Among them, 641 (10.19%) were overweight and 226 (3.59%) were obese. The rates for overweight and obese children were significantly higher in boys than girls (Tab. 2). A U-shaped association between birth weight and BMI at childhood was observed (Fig. 1).

Tab. 2   Comparison of the rates of overweight and obese male and female children in Changsha and Shenzhen, China

Groups		Screened Number	Overweight		Obesity	
			Number	Prevalence/%	Number	Prevalence/%
Gender	Male	3 306	418	12.64 * *	178	5.38 * *
	Female	2 982	223	7.48	48	1.61
City	Changsha	4 299	399	9.28##	142	3.30
	Shenzhen	1 989	242	12.17	84	4.22
	Total	6 288	641	10.19	226	3.59

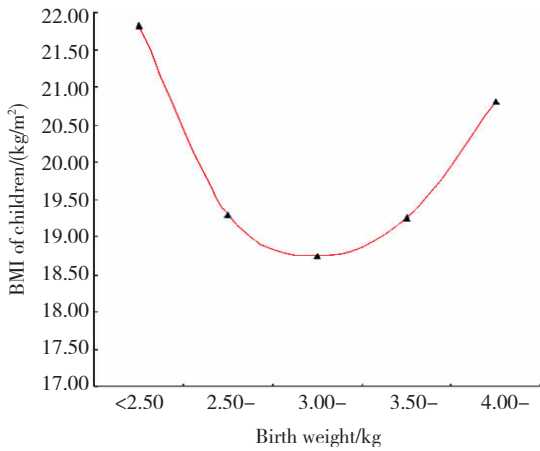Compared with female, * * $P < 0.001$; Compared with Shenzhen, ## $P < 0.001$.

Fig. 1   Relationship between birth weight and BMI.

Two hundred and nine (92.5%) obese children and 209 control children with normal weight were included in the case-control study. The results showed that paternal obesity, maternal weight gain during pregnancy ≥15.0 kg, birth weight ≥4.00 kg, unhealthy snacks ≥1 per week, and watching television ≥2 h per day were independently related to childhood obesity (Tab. 3).

Tab. 3   Risk factors for simple obesity in children aged 6 to 9 years in China in a case-control study

Risk factors	Exposed/Non exposed	b	c	Crude		Adjusted	
				OR	OR 95% CI	OR	OR 95% CI
Paternal obesity	BMI≥25.0 / <25.0	38	62	1.63	1.09 − 2.43	1.78	1.01 − 3.16
Maternal obesity	BMI≥25.0 / <25.0	8	24	3.00	1.40 − 6.42	1.79	0.64 − 5.00
Maternal weight gain during pregnancy	≥15.0 kg / <15 kg	17	105	6.18	3.95 − 9.67	5.22	2.78 − 9.80
Birth weight	≥4.00 kg / ≥2.50 kg and <4.00 kg	21	48	2.29	1.39 − 3.77	2.55	1.24 − 5.26
Feeding mode before 6 months old	Artificial / Breast	47	80	1.70	1.19 − 2.43	1.74	0.95 − 3.20
Time of adding meat to a child's diet	Before 6 months / after 6 months	59	92	1.64	1.12 − 2.17	1.87	0.76 − 4.59
Frequency of having Western snacks per week	≥1 / <1	28	49	1.75	1.11 − 2.77	3.94	1.11 − 13.99
Duration of a meal	≤15 min / >15 min	51	80	1.57	1.11 − 2.23	1.51	0.78 − 2.94
Duration of watching TV per day	≥2 h/ <2 h	20	38	1.90	1.12 − 3.23	2.35	1.01 − 5.47
Duration of playing outside per day	≤2 h / >2 h	53	83	1.57	1.11 − 2.21	1.44	0.72 − 2.85

b: Case is unexposed but control is exposed; c: Case is exposed but control is unexposed.

3   DISCUSSION

Our study of 6 288 school children aged 6 to 9 years in Changsha and Shenzhen in China showed that the rates of overweight and obese children were 10.19% and 3.59%. These rates are consistent with the IOTF reports[3], which suggests that childhood obesity has already become an important public health problem in China, especially in urban China. We also found that the rate of obesity in boys was higher than that in girls. This finding is consistent with the data from other studies of the Chinese population[8], but is different from the results from non-Chinese populations[9]. Chinese culture favors boys. Reasons for the boy preference in China are not clearly understood. Due to lack of a social security system in China, parents rely on their sons' eco-

nomic support when they get old. Daughters usually live with their husbands' families after marriage and cannot provide the same level of support to their own parents as sons do. Moreover, family names are considered an important symbol of the family and children are usually named after the husband's family name. Another interpretation of the difference in obesity between boys and girls is that parents tend to overfeed boys because physical strength is considered the most important health issue for them while for girls staying slimmer is a sign of beauty[10].

It is interesting that in our data, a U-shaped association between birth weight and BMI at childhood was observed. This observation is similar to the association of birth weight and Type 2 diabetes, with both low birth weight and macrosomia associated with an increased risk of diabetes[11-12]. Increased BMI or obesity during childhood is a risk factor of Type 2

diabetes[13]. The slow growth- and accelerated growth-related Type 2 diabetes may represent different disease mechanisms, and both may be modified by growth during infancy and childhood[14-16]. Infants with high birth weights tend to have a large mass of lipocytes, which once formed, are difficult to be removed or reduced, and thereby provide a foundation for the development of obesity[17]. Low birth weight is also considered to be a risk factor for childhood obesity[18-20]. However, the effect of low birth weight on childhood obesity was not statistically significant in our study. This may be caused by the small number of children with low birth weight. Further studies are needed to explore the real reasons why low birth weight was not statistically significant after adjustment for confounding factors.

In the case-control study, we found that parental obesity was related to childhood obesity. This finding is consistent with results from several previous studies[8-10], which suggests that a genetic factor is an important determinant of childhood obesity. The study of Liu et al.[21] offered a potential mechanism. Excessive weight gain during pregnancy increased the risk of childhood obesity, which is similar to the finding of Szostak-Wegierek, et al.[22]. Weight gain during pregnancy measures, at least in part, the amount of energy intake of the mother, and the amount of maternal energy intake will affect fetal growth. Because the fetus is sensitive to maternal energy intake and there is a rapid increase in the volume of lipocytes during 24 to 37 weeks gestation[5], maintaining a normal but not excessive weight gain, especially during 24 to 37 weeks gestation, may be an important issue in the prevention of childhood obesity.

The risk of developing childhood obesity substantially increased in children who were not breast fed during the first 6 months after birth. Adding meat to the diet of a child before 6 months of age also increased the risk of childhood obesity. These findings are consistent with those of Ong, et al.[23-24]. However, the association between these two risk factors in childhood obesity disappeared when potential confounding factors were adjusted. Feeding for children younger than 6 months old is

usually based on the parents' judgment. This may explain why the effect of feeding practice in infancy on childhood obesity disappeared when the risk factor of parental characteristics was adjusted.

As it is consistent with previous studies[25-27], we found that diet and exercise during childhood were important risk factors for the development of childhood obesity in urban Chinese school age children. These findings emphasize that actions need to be taken to change the behaviors of school children and to launch major educational campaigns in China before the situation becomes uncontrollable.

In summary, the present study shows that childhood obesity has become a major public health problem in south China, especially for boys with one or more of the following: a higher birth weight, one or both obese parents, a mother who gained too much weight during pregnancy, or an unhealthy lifestyle. A U-shaped association between birth weight and BMI at childhood was observed.

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