

Physical deviation and precocious puberty among school-aged children in Leshan City: an investigative study

Journal of International Medical Research

48(7) 1–7

© The Author(s) 2020


Article reuse guidelines:

sagepub.com/journals-permissions

DOI: 10.1177/0300060520939672

journals.sagepub.com/home/imr



Qiong Wei, Ming Wu, Yu-Lin Li, Rui Rao,
Song Li, Qin Cen, Hua Wu, Li Lv, Mao Huang,
Yu-Ping Ge, Zhi-Li Lu, Yao-Ping Wen,
Ying Cao, Ting-Ting Liu and Li Wang 

Abstract

Objective: We investigated physical deviation and precocious puberty among school-aged children in Leshan City, to provide a theoretical basis for the management of precocious puberty in children.

Methods: We selected 12 primary schools of Leshan City using a cluster random sampling method and conducted physical examinations among healthy students aged 4–12 years. A total of 11,000 students were recruited (5502 boys and 5498 girls). We measured body mass index (BMI), and participants were tested for precocious puberty according to the Tanner stages and standard maps. Nutritional status was also evaluated.

Results: Obese and overweight children accounted for a high proportion of participants; the prevalence of underweight was the lowest. The prevalence of obesity among boys was higher than that in girls. Precocious puberty was mainly observed in girls, particularly those age 7 years old. The prevalence of precocious puberty among overweight and obese children was higher than that in children with normal weight.

Conclusion: We identified a significant sex difference in precocious puberty among children in Leshan City. Overweight and obesity may be associated with precocious puberty.

Department of Pediatrics, The People's Hospital of
Leshan, Sichuan, China

Corresponding author:

Li Wang, Department of Pediatrics, The People's Hospital
of Leshan, No. 238 Baita Street, Shizhong District, Sichuan
614000, China.

Email: wangli336as@163.com



Creative Commons Non Commercial CC BY-NC: This article is distributed under the terms of the Creative Commons Attribution-NonCommercial 4.0 License (<https://creativecommons.org/licenses/by-nc/4.0/>) which permits non-commercial use, reproduction and distribution of the work without further permission provided the original work is attributed as specified on the SAGE and Open Access pages (<https://us.sagepub.com/en-us/nam/open-access-at-sage>).

Keywords

School-aged children, physical deviation, precocious puberty, children's health care, body mass index, obesity

Date received: 11 July 2019; accepted: 12 June 2020

Introduction

School age is a critical period for the growth and development of children because this is the stage during which children enter puberty. It is important to provide children with adequate health care during this period. With rapid economic development, obesity has become a global public health concern that seriously affects the health of people worldwide. Obesity is correlated with type 2 diabetes mellitus,¹ hypertension,² and many other diseases. Excessive fat in obese children can elevate estrogen levels and promote breast development and the occurrence of precocious puberty.³ Precocious puberty is a phenomenon where the age of sexual development is substantially below to the normal threshold, leading to the early development of sexual organs and the appearance of secondary sexual characteristics. Increased fat or a rapid increase in body mass index (BMI) may be a precursor to precocious puberty.⁴ One study indicated that with improvement of living standards and impacts of environmental factors, the incidence of precocious puberty in China has exhibited an increasing trend.⁵ A report from Denmark indicated that the prevalence of precocious puberty in girls was five times that of boys.⁶ A survey conducted between 2004 and 2010 also revealed that precocious puberty among girls in South Korea showed an upward trend, with a prevalence of 55.9/100,000 in girls and 1.7/100,000 in boys.⁷

Sexual characteristics are reportedly accompanied by accelerated bone growth and early fusion of epiphyses.⁸ It has been

reported that the sexual development of children in China has generally accelerated over the past 20 years, and the incidence of precocious puberty as well as obesity has increased.⁹ In this study, we aimed to investigate the present development of physical and sexual characteristics among children in Leshan City, China and to compare the prevalence of precocious puberty among children with different weights.

Methods

Participants

We selected 12 primary schools in Leshan City using a cluster random sampling method. We then carried out physical examinations among healthy children between 4 and 12 years old in each school. We excluded children with severe organic diseases including heart disease and leukemia, which may affect growth. This study was conducted with the approval of the Ethics Committee of the People's Hospital of Leshan and was conducted in accordance with the Declaration of Helsinki. Written informed consent was given by a parent or guardian of each participant.

Methods

Precocious puberty was diagnosed based on the following criteria for children. 1) Girls presenting with one of the following characteristics before reaching age 8 years: breast enlargement, pubic hair growth, armpit hair growth, >3 cm of areola, and body changes,

or menarche before age 10 years; 2) boys showing one of the following characteristics before reaching age 9 years: testicular enlargement, pomum Adami, and facial or pubic hair.⁵ In assessing the development of sexual characteristics according to Tanner's classification criteria and standard charts, the development of breasts and external genitalia in each participant were staged and evaluated. Children with suspected precocious puberty were then admitted to our hospital and screened using B-mode ultrasound, bone age, bone density, adrenocorticotrophic hormone, sex hormone provocation tests, and magnetic resonance imaging (MRI) of the sella turcica before treatment.

Children's BMI was calculated as weight (kg)/height squared (m²). Body height (cm) was measured using standard height gauges, and body weight (kg) was measured using standard lever scales. The diagnostic criteria for physical deviation were according to the China Growth Reference Standards in Assessing Malnutrition of Children in 2005. The nutritional status of participants was assessed according to the percentile of age- and sex-matched children. BMI < P3 indicated underweight, BMI higher than P85 but lower than P95 indicated overweight, and BMI ≥ P95 indicated obesity. Heights < P3 among age- and sex-matched children indicated short stature.¹⁰

Quality control

All medical staff received standardized training. Each index was measured by one

person, according to a standard measurement method. Instruments were calibrated before each measurement. Quality inspection was carried out at the survey site. The collected data were checked in a timely manner and incorrect data were corrected in a second survey.

Statistical analysis

The data were imported into an Epi Data database, underwent a logic check, and were analyzed using SPSS 16.0 statistical software package (SPSS Inc., Chicago, IL, USA). A paired samples *t*-test was used to analyze significant differences in the prevalence of physical deviation between boys and girls. A *p*-value <0.05 was considered to indicate statistical significance.

Results

A total 11,000 children were enrolled in this study (5502 boys and 5498 girls); data in each age category are shown in Table 1.

Data on the prevalence of physical deviation (Table 2) showed that obese and overweight children accounted for a higher proportion of the total participants; the prevalence of underweight was the lowest. Boys were more likely to be obese than girls (*p*<0.01), and the prevalence of short stature among boys was generally higher than that in girls (*p*<0.01).

Among 6383 children, 29 children (1 boy and 28 girls) were found to have precocious puberty (0.45%). This finding revealed that

Table 1. Age variations in each age category.

	Age (years)	6	7	8	9	10	11	12
Boys	Mean	6.50	7.40	8.39	9.39	10.41	11.41	12.25
	Median	6.5	7.4	8.3	9.4	10.4	11.4	12.2
	Standard deviation	0.32	0.29	0.29	0.28	0.29	0.27	0.22
Girls	Mean	6.52	7.39	8.39	9.39	10.40	11.38	12.26
	Median	6.7	7.4	8.3	9.3	10.4	11.3	12.2
	Standard deviation	0.33	0.29	0.29	0.30	0.30	0.28	0.23

Table 2. Physical deviation in each age category, n (%).

	6		7		8		9		10		11		12	
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
Total number	499	496	1078	1105	1117	1104	1001	984	899	899	668	899	696	239
Normal stature (%)	477 (95.6%)	467 (95.6%)	959 (89.76%)	1020 (92.31%)	977 (87.47%)	1018 (92.21%)	915 (91.41%)	899 (91.36%)	848 (94.33%)	846 (94.11%)	595 (89.07%)	637 (91.52%)	214 (89.54%)	198 (92.96%)
Short stature (%)	22 (4.40%)	29 (5.85%)	119 (10.24%)	85 (7.69%)	140 (12.53%)	86 (7.79%)	86 (8.59%)	85 (8.64%)	51 (5.67%)	53 (5.89%)	73 (10.93%)	59 (8.48%)	25 (10.46%)	15 (7.04%)
Normal weight (%)	394 (78.97%)	394 (79.44%)	868 (80.53%)	888 (80.36%)	887 (79.43%)	873 (79.08%)	797 (79.62%)	853 (86.68%)	688 (76.53%)	674 (74.99%)	514 (76.95%)	503 (72.27%)	157 (65.69%)	152 (71.37%)
Underweight (%)	19 (3.80%)	20 (4.03%)	37 (3.43%)	34 (3.08%)	28 (2.51%)	26 (2.36%)	27 (2.70%)	34 (3.46%)	24 (2.67%)	25 (2.78%)	18 (2.69%)	24 (3.45%)	11 (4.60%)	10 (4.69%)
Overweight (%)	32 (6.41%)	34 (6.85%)	68 (6.30%)	95 (8.60%)	85 (7.61%)	93 (8.42%)	55 (5.49%)	80 (8.13%)	80 (8.90%)	114 (12.67%)	72 (10.78%)	76 (10.92%)	24 (10.04%)	32 (15.02%)
Obese (%)	54 (10.82%)	48 (9.68%)	105 (9.74%)	88 (7.96%)	117 (10.45%)	112 (10.14%)	122 (12.19%)	17 (1.73%)	107 (11.90%)	86 (9.56%)	64 (9.56%)	93 (13.36%)	47 (19.67%)	19 (8.92%)

precocious puberty mainly occurred in girls, with a peak appearing at age 7 years (Table 3). In analyzing the prevalence of precocious puberty among children according to BMI, our data showed that the prevalence of precocious puberty was significantly higher among overweight and obese children (1.56%) than those with normal weight (0.24%) (Table 4). In addition, the prevalence of precocious puberty among children with stunting was 0.

Discussion

Precocious puberty is mainly owing to early activation of functioning of the hypothalamus–pituitary gland–gonadal axis. Precocious puberty has become a common childhood disease of the endocrine system.¹¹ Risk factors for precocious puberty in children include the following. (1) Economic development level: the prevalence of precocious puberty is higher in economically developed areas than in less-developed regions. The prevalence of precocious puberty is 0.76% in the Zhengzhou area and 0.68% in Jiujiang City¹² whereas it is 0.45% in Leshan City. Compared with other cities, the detection rate of precocious puberty in Leshan is at a relatively low level; the reason may be owing to improvement in the economy and changes in eating habits among the population in recent years. (2) Sex: the incidence of precocious puberty is much higher among girls than age-matched boys.¹³ In our survey of 6,383 participants, 29 children were found to have precocious puberty and only one of these was a boy; this indicates that precocious puberty is mainly observed in girls. (3) Age: in the present survey, girls age 7 years showed the highest prevalence of precocious puberty in comparison with girls in other age groups. It remains to be determined whether this can be attributed to normal variation in puberty or to pseudo-precocious puberty caused by dietary

Table 3. Prevalence of precocious puberty in children age 6 to 9 years.

Age (years)	Surveyed children			Surveyed children		
	Boys	Precocious puberty	Prevalence (%)	Girls	Precocious puberty	Prevalence (%)
6	499	0	0.00	496	3	0.6
7	1078	0	0	1105	24	2.17
8	1117	1	0.09	1104	1	0.09
9	—	—	—	984	0	0
Total	2694	1	0.04	3689	28	0.76

Table 4. Relationship between the prevalence of precocious puberty and body mass index.

Group	Surveyed children	Precocious puberty	Prevalence (%)
Normal-weight group	5355	13	0.24
Overweight and obese group	1028	16	1.56

habits, climate, or other factors. (4) Obesity: this study revealed that the prevalence of precocious puberty in overweight and obese children was 1.56%, which was significantly higher than that (0.24%) in children with normal weight ($P < 0.05$). Continuous increase in body weight is a risk factor for the early onset of precocious puberty.³ Studies in China and other countries have suggested that mild obesity in girls can cause early breast development and early menstruation.¹⁴ (5) One study reported that extended television watching and computer time may lead to precocious puberty.¹⁵ The main reason is that the strong light emitted from a TV or computer can lead to decreased levels of melatonin, inducing precocious puberty.¹⁶ (6) Studies in various countries have reported that precocious puberty may also be correlated to premature birth.¹⁷

Compared with the results of a national children's growth and development survey, the proportion of obese and overweight children in Leshan City was high and the prevalence of underweight was low,

indicating that a rapid increase in the prevalence of overweight and obesity in children has become a new characteristic in this area. Preventing childhood obesity and promoting balanced physical development are new challenges facing Leshan.

There are several limitations in this study. First, the diagnosis of precocious puberty was made solely based on the results of physical examination. A detailed clinical history, hormone testing, and imaging studies of the central nervous system are needed for a more accurate diagnosis. Second, this was a cross-sectional study and our findings are observational. Longitudinal or experimental studies are needed to investigate causal relationships between the variables of interest.

In conclusion, precocious puberty was mainly observed in girls, particularly those age 7 years. The prevalence of precocious puberty among overweight and obese children was higher than that in normal-weight children. Our findings indicate that overweight/obesity is associated with precocious puberty in Leshan City. Current lifestyle

factors such as decreased physical activity and increased sedentary behavior may be responsible for the development of both overweight/obesity and precocious puberty. Whether there is a causal association between increased body fatness and the development of precocious puberty requires further investigation in longitudinal studies.

Acknowledgement

We are particularly grateful to all the people who have given us help with our article.


Declaration of conflicting interest

The authors declare that there is no conflict of interest.

Funding

This study was supported by the Leshan Science and Technology Plan Project (grant no. 14SZD110).

ORCID iD

Li Wang  <https://orcid.org/0000-0001-5506-435X>

References

- Pulgaron ER and Delamater AM. Obesity and type 2 diabetes in children: epidemiology and treatment. *Curr Diab Rep* 2014; 14: 508.
- Juonala M, Magnussen CG, Berenson GS, et al. Childhood adiposity, adult adiposity, and cardiovascular risk factors. *N Engl J Med* 2011; 365: 1876–1885.
- Burt Solorzano CM and McCartney CR. Obesity and the pubertal transition in girls and boys. *Reproduction* 2010; 140: 399–410.
- Lee JM, Kaciroti N, Appugliese D, et al. Body mass index and timing of pubertal initiation in boys. *Arch Pediatr Adolesc Med* 2010; 164: 139–144.
- Group of Endocrinology, genetics and metabolism, youth development research group, Chinese medical association pediatric branch. Secondary sexual characteristics and menarche age of female children in nine cities of China. *Chin J Endocrinol Metab* 2010; 26: 669–675.
- Teilmann G, Pedersen CB, Jensen TK, et al. Prevalence and incidence of precocious pubertal development in Denmark: an epidemiologic study based on national registries. *Pediatrics* 2005; 116: 1323–1328.
- Kim SH, Huh K, Won S, et al. A Significant Increase in the Incidence of Central Precocious Puberty among Korean Girls from 2004 to 2010. *PLoS One* 2015; 10: e0141844.
- Shim KS. Pubertal growth and epiphyseal fusion. *Ann Pediatr Endocrinol Metab* 2015; 20: 8–12.
- Zhai L, Liu J, Zhao J, et al. Association of Obesity with Onset of Puberty and Sex Hormones in Chinese Girls: a 4-Year Longitudinal Study. *PLoS One* 2015; 10: e0134656.
- Li H, Ji CY, Zong XN, et al. Body mass index growth curves for Chinese children and adolescents aged 0–18 years. *Chin J Pediatr* 2009; 47: 493–498.
- Styne DM and Grumbach MM. Puberty: ontogeny, neuroendocrinology, physiology, and disorders. In: Melmed S, Polonsky KS, Larsen PR and Kronenberg HM (eds). *Williams Textbook of Endocrinology*. 12th ed. Philadelphia, PA: Saunders, 2011, pp.1054–1201.
- Wei HY, Chen YX and Li CZ. Epidemiological investigation of precocious puberty in children aged 3~12 years in Zhengzhou. *J Appl Clin Pediatr* 2010; 25: 1568–1570.
- Carel JC and Leger J. Clinical practice. Precocious puberty. *N Engl J Med* 2008; 358: 2366–2377.
- Atay Z, Turan S, Guran T, et al. The prevalence and risk factors of premature thelarche and pubarche in 4-to 8-year-old girls. *Acta Paediatr* 2012; 101: e71–e75.
- Ke JW and Duan R. Research progress on risk factors of sexual precocity and precocious puberty. *Lab Lab Med* 2012; 30: 243–249.

-
16. Wei HY, Wang HZ and Liu XJ. Levels of sex hormones and leptin levels in girls with precocious puberty and its influencing factors. *J Clin Pediatr* 2011; 29: 1133–1135.
 17. Neville KA and Walker JL. Precocious pubarche is associated with SGA, prematurity, weight gain, and obesity. *Arch Dis Child* 2005; 90: 258–261.