

A Survey on the Growth and Development of 11026 Children Aged 6-14 in Yangzhou, Jiangsu Province, China

Lin Hang¹, Jie-ping Zhang¹, Yu-ying Chen^{2,*}

¹Thoracic Surgery Department, The First Affiliated Hospital of Zhejiang University School of Medicine, Hangzhou, China

²Nursing Department, Affiliated Hospital of Yangzhou University, Yangzhou, China

Email address:

hlzj9627@163.com (Lin Hang), zjppxwk@zju.edu.cn (Jie-ping Zhang), Chenyuying1965@163.com (Yu-ying Chen)

*Corresponding author

To cite this article:

Lin Hang, Jie-ping Zhang, Yu-ying Chen. A Survey on the Growth and Development of 11026 Children Aged 6-14 in Yangzhou, Jiangsu Province, China. *World Journal of Public Health*. Vol. 8, No. 1, 2023, pp. 37-42. doi: 10.11648/j.wjph.20230801.16

Received: January 24, 2023; Accepted: February 16, 2023; Published: February 21, 2023

Abstract: Objective: To analyze the growth and development of children aged 6-14 in Yangzhou, Jiangsu province, China in 2020, and to provide basis for the healthy development of local children. Methods: A total of 11026 children aged 6-14 from 9 primary schools in Yangzhou were investigated by stratified cluster sampling method. The growth and development indexes were analyzed according to the Chinese children growth standard and growth curve. Results: In Yangzhou, the rate of partial short rate was 4.93%, incidence of short stature was 1.08%, overweight rate was 20.67%, obesity rate was 18.77% and precocious puberty rate was 0.36%. Obesity rates were highest among children at age 7 (20.94%) and the overweight rate was highest at 11 years old (24.01%). The overweight rate and obesity rate of boys from 6 to 14 years old were higher than those of girls (χ^2 values were 6.250, 104.259, $P < 0.01$). The short stature and partial short rate of boys and girls aged 6-14 were similar (χ^2 values were 2.940, 0.136, $P > 0.05$). Conclusion: The obesity problem of children in Yangzhou is increasingly serious, and the obesity rate of boys is higher than that of girls. Parents should check the height, weight and growth of children regularly. The children that has obesity, short stature or precocious puberty problem should see a doctor in time, so that early diagnosis and treatment.

Keywords: Children, Short Stature, Yangzhou City, Precocious Puberty, Obesity

1. Introduction

The growth and development of children is a global health issue [1], which is related to children's physical and mental health. Obesity, short stature and precocious puberty are serious public health problems among children [2, 3]. Obesity is caused by complex interactions among biological, developmental, behavioral, genetic and environmental factors [4], which is a complex problem affecting children of all ages [5-7]. Obesity increases the risk of precocious puberty in children, irregular menstruation in girls, sleep disorders, cardiovascular disease risk and metabolic syndrome [8]. Short stature refers to that the height is significantly lower than 2 standard deviations of the normal population or lower than the third percentile of normal children in the same area, gender and age in the same living environment [9]. The etiology of short stature in children is complicated and influenced by many factors such as environment, heredity, nutrition and

endocrine. The incidence of short stature in Children is about 3.0%, but it is estimated that less than 30,000 patients actually receive reasonable treatment for dwarfism in China every year, and the treatment rate is less than 1% [10]. Precocious puberty refers to the development of secondary sexual characteristics before the age of 8 in girls and 9 in boys [11]. In recent years, with the development of economy and the change of lifestyle, the incidence of precocious puberty in children has been increasing [12]. The total incidence is 1/10 000 ~ 1/5000, and the incidence of precocious puberty in girls is 5 ~ 10 times of that in boys [10]. Precocious puberty not only affects children's ultimate adult height [13], but also may cause children's psychosocial problems [12, 14]. Precocious puberty is associated with rapid bone maturation, reduced adult height, psychological problems and an increased risk of reproductive tract cancers in adulthood [12]. Children's physical development has a direct impact on their physical and mental development, and will also affect their future employment, marriage and other social and economic benefits in adulthood.

Therefore, understanding the growth and development of children is conducive to early intervention of relevant measures, so as to improve the growth and development of children. In order to understand and evaluate the growth and development of adolescents in primary and secondary schools in Yangzhou, this study investigated and analyzed the physical indexes (obesity, short stature, precocious puberty and so on.) of children aged 6-14 in 2020 in Yangzhou, so as to provide reference for the formulation of intervention measures to improve childhood obesity, reduce the prevalence of short stature and prevent precocious puberty.

2. Methods

2.1. Participants

In November 2020, a total of 11,579 children from 9 schools in Yangzhou were selected by stratified cluster sampling method (stratified by grade, group sampling by class) for physical examination, and their actual ages were calculated. A total of 11026 children were selected. Average age was (9.41±2.23) years old. There were 5762 boys (52.3%) with an average age of (9.44±1.21) and 5264 girls (47.7%) with an average age of (9.35±2.22). All children were divided into nine groups with 1-year intervals. That is to say, 6~<7 years old is six. 7~<8 years old is seven. The study obtained informed consent from school teachers and parents.

2.2. Evaluation Methods

Children's height and weight were measured in accordance with the requirements of *Chinese children's growth standards and growth curves*. When measuring height and weight, participants were required to take off their shoes and socks, take a standing position, look straight, hold out their chests, drop their arms naturally, and keep heels together. Heel, hip and shoulder blades are three points in the same plane. The height and weight were accurate to 0.1cm and 0.1kg respectively. The recorded personnel was trained. The measurement tools were uniformly configured before each measurement, BMI = weight (kg) /height (m)². Precocious puberty examination was conducted by professional pediatricians.

2.3. Evaluation Criteria

According to the unit value table of standard deviation of height and weight for children aged 0-18 years [15]. Short stature and partial short are screened. If the height value is less than 1 standard deviation, that is partial short. If the height value is less than 2 standard deviation, that is short stature. In this study, the height status is divided into three grades: normal, short stature and partial short. According to *Classification standards of body mass index (BMI) for overweight and obesity screening of children and adolescents in China* [15] screening for overweight and obese children. In this study, the weight status was divided into three grades: normal, overweight and obese. Precocious puberty judgment method: Breast enlargement appeared in girls, and testicular volume was greater than or equal to 4ml in boys, or menstruating in girls before the age of 10 [16].

2.4. Statistical Methods

Excel was used for data entry and collation. All data were analyzed by SPSS 26.0 software. Statistical description of count data was expressed as percentage (%), and comparison between groups was performed by χ^2 test. $P < 0.05$ was considered statistically significant.

3. Result

3.1. The Basic Information and Weight of Children Aged 6-14 in Yangzhou

There were 953 of 6 years old, 1705 of 7 years old, 1765 of 8 years old, 1593 of 9 years old, 1421 of 10 years old, 1324 of 11 years old, 1087 of 12 years old, 769 of 13 years old and 399 of 14 years old. There were 10363 (93.99%) of normal weight, 2279 (20.67%) of overweight, 2070 (18.77%) of obesity, 1243 (21.6%) of male, 1034 (19.6%) of female, 1292 (22.4%) of male and 780 (14.8%) of female. Before age of 11, the overweight rate of children gradually increased with the increase of age. The overweight rate of children at the age of 11 was the highest (24.01%) and gradually decreased after the age of 11. The obesity rate of children at the age of 7 was the highest (20.94%), as shown in Table 1.

Table 1. Distribution of overweight/obesity in children from 6 to 14 years old (n (%)).

Age (years old)	Sample size	Normal (%)	Overweight (%)	Obesity (%)
6	953	639 (67.05)	170 (17.83)	144 (15.11)
7	1705	1050 (61.58)	298 (17.48)	357 (20.94)
8	1765	1102 (62.44)	340 (19.23)	323 (18.30)
9	1593	940 (59.01)	322 (20.21)	331 (20.78)
10	1431	813 (56.81)	335 (23.41)	283 (19.78)
11	1324	754 (56.95)	318 (24.01)	252 (19.03)
12	1087	638 (58.69)	251 (23.09)	198 (18.22)
13	769	472 (61.38)	173 (22.50)	124 (16.12)
14	399	269 (67.12)	72 (18.05)	58 (14.54)
Total	11026	6677 (60.56)	2279 (20.67)	2070 (18.77)

3.2. Height Situation of Children Aged 6-14 in Yangzhou City

There were 6677 (60.56%) of normal height children, 544 (4.93%) of partial short children, 119 (1.08%) of short stature children. There were 307 (2.78%) boys of partial short. There

were 243 (2.20%) girls of short stature. The incidence of short stature in boys was 61 (0.55%). The incidence of short stature in girls was 52 (0.47%). The incidence of short stature was the highest in boys at the age of 13 (7.93%) and was the highest in girls at the age of 8 (1.81%), as shown in Table 2.

Table 2. A survey on the distribution of short stature in children from 6 to 14 years old (n (%)).

Age (years old)	Sample size	Normal (%)	Partial short (%)	Short stature (%)
6	953	931 (97.69)	8 (0.84)	14 (1.47)
7	1705	1611 (94.49)	81 (4.80)	13 (0.76)
8	1765	1637 (92.75)	96 (5.43)	32 (1.81)
9	1593	1449 (90.96)	123 (7.72)	21 (1.32)
10	1431	1340 (93.64)	78 (5.45)	13 (0.91)
11	1324	1249 (94.34)	66 (4.98)	9 (0.68)
12	1087	1007 (92.64)	71 (6.53)	9 (0.83)
13	769	746 (97.01)	16 (7.93)	7 (0.91)
14	399	393 (98.50)	5 (1.25)	1 (0.25)
Total	11026	10363 (93.99)	544 (4.93)	119 (1.08)

3.3. Precocious Puberty in Children Aged 6 to 14 in Yangzhou

There were 40 of precocious puberty (0.36%), all are girls. Precocious puberty mostly occurs in children aged 7 to 10, with the highest incidence of precocious puberty (1.13%). See Table 3.

Table 3. Investigation on distribution of precocious puberty in children from 6 to 14 years old (n (%)).

Age (years old)	Sample size	Normal (%)	Sexual precocity (%)
6	953	953 (100.00)	0 (0)
7	1705	1701 (99.77)	4 (0.23)
8	1765	1745 (98.87)	20 (1.13)
9	1593	1578 (99.06)	15 (0.94)
10	1431	1430 (99.93)	1 (0.07)
11	1324	1324 (100)	0 (0)
12	1087	1087 (100)	0 (0)
13	769	769 (100)	0 (0)
14	399	393 (98.50)	0 (0)
Total	11026	10980 (99.58)	40 (0.36)

3.4. Comparison of Overweight / Obesity / Short / Short Rate Between Boys and Girls Among Children Aged 6 to 14 Years in Yangzhou

Overweight and obesity rates in boys aged 6 to 14 were all higher than in girls ($P < 0.01$). The short stature and partial short were similar aged 6 to 14 between boys and girls ($P > 0.05$). See Table 4, 5.

Table 4. Overweight/obese rate of children aged 6-14 years comparison of male and female students (n (%)).

Gender	Overweight		Obesity	
	Case number	Percentage (%)	Case number	Percentage (%)
Male	1243	21.57	1292	22.42
Female	1034	19.64	780	14.82
χ^2		6.250		104.259
P		<0.05		<0.01
Total	2277	20.58	2072	18.79

Table 5. Overweight/obesity rate of children aged 6-14 years comparison of male and female students (n (%)).

Gender	Partial short (%)		Short stature (%)	
	Case number	percentage (%)	Case number	Percentage (%)
Male	307	5.33	61	1.06
Female	243	4.62	52	0.99
χ^2		2.940		0.136
P		0.086		0.712
Total	550	4.99	113	1.02

4. Discussion

4.1. There Are Regional Differences in the Prevalence of Short Stature in Children

This survey found that children aged 6 to 14 years old in Yangzhou had good growth and development, with the incidence of partial stature and short stature of 4.93% and 1.08%, respectively. It was lower than the total prevalence of short stature in Anhui province aged 7 to 12 years of 2.83% investigated by Chen Xianjun [17] et al. Zhang [18, 19] et al reported that the prevalence of short stature was approximately 2.5%, higher than the short stature rate in Yangzhou. This indicates regional differences in the prevalence of short stature. It may be related to the small sample size of this study and most of the subjects in urban areas. It may also be that Yangzhou belongs to the Yangtze River Delta region and the economic level at the top of China. Children have good nutritional status and good height growth status. Short stature is associated with non-genetic factors such as nutrition, chronic systemic disease, affective or psychosocial deprivation as well as innate genetic factors [20]. Short stature caused by congenital factors is inevitable. However, more attention should be paid to changeable circumstances and conditions. The two peaks of height growth are in the first year of life and adolescence, and both periods should pay attention to the child's nutrition. Adolescent parents should encourage their children to participate in outdoor activities, develop good sleep habits and pay attention to dietary structure and nutrition.

4.2. Childhood Rates of Overweight / Obesity Remained High

Childhood obesity is a world public health problem [3]. Childhood obesity will not only affect the physical and mental development of children. If not timely intervention in the early stage, adult obesity, type 2 diabetes, metabolic syndrome, hypertension and other cardiovascular diseases can be induced [21]. This study found that the overweight rate of children aged 6 to 14 years in Yangzhou was 20.7% and obesity rate was 18.8%. One in three children had overweight/obesity. Studies have shown that the prevalence of overweight and obesity among children in China is similar to that in most developing countries with economies in transition, with overall rates on the rise [22]. This is lower to the national average obesity rate for primary school students was 34.9 in Mexico [23]. Also, it is lower than the obesity rate of children aged 7 to 9 years in Shanghai surveyed by Zheng Zhongjie et al [24] (34.14%) and higher than the rate of children aged 7-12 (overweight rate was 29.6% and obesity rate was 21.5%) in Liaoning and Guangdong provinces investigated by Lu Shaomin et al [25]. It indicates that there are regional differences of children obesity worldwide and in China and the problem of child obesity in Yangzhou is serious. Epidemiological survey shows that the prevalence of obesity among children aged 7 to 17 years in China increases at a rate of 0.26% every year [26]. In the past 30 years, the obesity rate

of children aged over 7 years old in China has increased year by year [26]. It is expected that by 2030, the obesity detection rate will increase to 28.0% [26]. This is consistent results Wang et al [27]. The increase in obesity may have much to do with the improvement of people's living standards. Similar findings were found in the [28] study by Joseph George Minja et al. The Joseph George Minja study found that the majority of overweight and obese children came from families with a small number of family members and higher socioeconomic status. Overweight / obesity and precocious puberty influence each other [12, 16, 29]. Therefore, preventing obesity contributes to the prevention of precocious puberty. The prevalence of precocious puberty in this study was 0.36%, lower than that found by Tingting Bo *et al* [30] in 1260 children (0.29% in men and 1.60% in women). Higher than that found in Spain estimates the yearly incidence to be between 0.02 and 1.07 per 100,000 individuals [31]. The mechanisms of precocious puberty are complex, which include the interaction of genetics, nutrition, psychosocial stress and environmental toxins [16]. Some studies suggest that obesity is an important factor in early sexual development, especially for girls [16]. Precocious puberty can lead to short stature, physical structure, uncoordinated proportion and other physiological and psychological problems [32]. To sum up, parents should pay attention to precocious puberty and obesity and take early detection and intervention. Pay attention to the child's nutrition, strengthen exercise, improve the bad life. do early detection, early diagnosis and early treatment.

4.3. Male Gender and Age Differences Exist in Childhood Obesity

This study found that there are differences in men and women obesity, boys' overweight rate and obesity rate are higher than girls, this is consistent with Wen *et al* [33] research report, in other studies [34] have similar reports. It may be related to the Chinese traditional concept of "big fat boy", which think that boys fat is good [35]. Some parents even think boys fat appear strong and wouldn't be bullied by students at school [35]. Otherwise, boys have a weak awareness of "beauty" and body shape control, eat more high-calorie foods such as high fat and high sugar in life, and the popularization of electronic products, smoking and drinking occasionally occur [36]. High-calorie diet, computer games, tobacco and alcohol are the important influencing factors for boys' obesity [36]. And the traditional concepts of China think that girls "thin for beauty". So girls deliberately control the diet and their parents also play a positive guiding role to avoid girls become fat [33], which may be the reason why the obesity rate of boys is higher than girls. This study found the highest childhood obesity rate at age 7 (20.94%) and childhood overweight at age 11 (24.01%), and was similarly reported in other studies [37]. Previous studies have shown that BMI in adolescence increases due to puberty initiation [38]. In addition, it has been shown that stress and other factors can lead to weight gain in children. The fifth grade is the period of children's academic pressure, decreased exercise time and increased sitting time lead to an increase in obesity.

Some studies have shown that school age is prone to obesity, adolescence tends to be stable, so primary school is the critical period for obesity intervention [37, 39]. Therefore, obesity should be intervened in time to prevent long-term harm to children's physical and mental health.

5. Conclusion

Obesity, short stature and precocious puberty are public health problems in today's society, and obesity and precocious puberty are closely related. So the prevention of obesity contributes to the prevention of precocious puberty. In this research, most of the research samples come from the urban area of Yangzhou. Therefore, there are certain biases and limitations, so it is necessary to further expand the scope of research to provide a more reliable theoretical basis for future research.

6. Recommendation

The prevention and treatment of obesity, short stature and precocious puberty requires the participation of family, school, society so as to establish good eating habits, strengthen physical training, actively explore intervention programs, and reduce or avoid the occurrence of related diseases. For parents of children, children's height, weight and growth should be monitored regularly. Children with obesity and short stature or precocious puberty should see a doctor in time for early diagnosis and treatment to improve children's lifelong growth and development.

References

- [1] [HTTPS:// U L A T I C M U W W B G J C M E M, WWW.UNICEF.ORG/MEDIA/60626/FILE/JOINT-MALNUTRITION-ESTIMATES-2019.PDF](https://ulatlamicmuwwbgjcmem.org/WWW.UNICEF.ORG/MEDIA/60626/FILE/JOINT-MALNUTRITION-ESTIMATES-2019.PDF).
- [2] LIU Y, YU T, LI X, et al. Prevalence of precocious puberty among Chinese children: a school population-based study [J]. *Endocrine*, 2021.
- [3] (ACCESSED ON 6 FEBRUARY 2021). WHO COE COFA FOC OA OH W W I E-C-O F E.
- [4] QASIM A, TURCOTTE M, DE SOUZA R J, et al. On the origin of obesity: identifying the biological, environmental and cultural drivers of genetic risk among human populations [J]. *Obes Rev*, 2018, 19 (2): 121-149.
- [5] GURNANI M, BIRKEN C, HAMILTON J. Childhood Obesity: Causes, Consequences, and Management [J]. *Pediatr Clin North Am*, 2015, 62 (4): 821-840.
- [6] SAHOO K, SAHOO B, CHOUDHURY A K, et al. Childhood obesity: causes and consequences [J]. *J Family Med Prim Care*, 2015, 4 (2): 187-192.
- [7] BROWN C L, HALVORSON E E, COHEN G M, et al. Addressing Childhood Obesity: Opportunities for Prevention [J]. *Pediatr Clin North Am*, 2015, 62 (5): 1241-1261.
- [8] KANSRA A R, LAKKUNARAJAH S, JAY M S. Childhood and Adolescent Obesity: A Review [J]. *Front Pediatr*, 2020, 8: 581461.
- [9] WANG Y, GE J, MA J, et al. Short stature with precocious puberty caused by aggrecan gene mutation: A case report [J]. *Medicine (Baltimore)*, 2020, 99 (34): e21635.
- [10] WANG L, JIANG Q, WANG M, et al. The effect of triptorelin and leuprolide on the level of sex hormones in girls with central precocious puberty and its clinical efficacy analysis [J]. *Transl Pediatr*, 2021, 10 (9): 2307-2312.
- [11] JIANG L Q, ZHOU Y Q, YUAN K, et al. Rare mutation in MKRN3 in two twin sisters with central precocious puberty: Two case reports [J]. *World J Clin Cases*, 2021, 9 (32): 10018-10023.
- [12] LIU G, GUO J, ZHANG X, et al. Obesity is a risk factor for central precocious puberty: a case-control study [J]. *BMC Pediatr*, 2021, 21 (1): 509.
- [13] PARK J, HWANG T H, KIM Y D, et al. Longitudinal follow-up to near final height of auxological changes in girls with idiopathic central precocious puberty treated with gonadotropin-releasing hormone analog and grouped by pretreatment body mass index level [J]. *Ann Pediatr Endocrinol Metab*, 2018, 23 (1): 14-20.
- [14] CHOI M S, KIM E Y. Body image and depression in girls with idiopathic precocious puberty treated with gonadotropin-releasing hormone analogue [J]. *Ann Pediatr Endocrinol Metab*, 2016, 21 (3): 155-160.
- [15] HUI LI C L, XINNAN ZONG ET AL. STANDARDIZED GROWTH CURVES OF HEIGHT AND WEIGHT OF CHILDREN AGED 0-18 YEARS IN CHINA [J]. *CHINESE JOURNAL OF PEDIATRICS*, 2009, 47 (7): 487-492 (IN CHINESE).
- [16] XIE L, TANG Q, YAO D, et al. Effect of Decaffeinated Green Tea Polyphenols on Body Fat and Precocious Puberty in Obese Girls: A Randomized Controlled Trial [J]. *Front Endocrinol (Lausanne)*, 2021, 12: 736724.
- [17] XIANJUN CHEN L Y, ET AL. DEYUN LIU. PREVALENCE OF SHORT STATURE AMONG CHILDREN IN THREE CITIES OF ANHUI PROVINCE, CHINESE JOURNAL OF CHILD HEALTH CARE, 2017, 25 (04): 401-405.(IN CHINESE).
- [18] YUAN QIN L Y P A E A O S S I C I W C J M A C H C I C, 2017, 32 (14): 3306-3310. (IN CHINESE).
- [19] ZHANG Z, WANG Y, GAO Y, et al. Morphological changes in the central sulcus of children with isolated growth hormone deficiency versus idiopathic short stature [J]. *Dev Neurobiol*, 2021, 81 (1): 36-46.
- [20] CHEN W W, LIU H X, LIU J, et al. [Etiology and genetic diagnosis of short stature in children] [J]. *Zhongguo Dang Dai Er Ke Za Zhi*, 2019, 21 (4): 381-386.
- [21] CORRECTION TO: HEART DISEASE AND STROKE STATISTICS-2017 UPDATE: A REPORT FROM THE AMERICAN HEART ASSOCIATION [J]. *CIRCULATION*, 136 (10): E196.
- [22] CHEN J, HU C, ZENG G, et al. Trends and Prevalence of Overweight and Obesity among Children Aged 2-7 Years from 2011 to 2017 in Xiamen, China [J]. *Obes Facts*, 2019, 12 (4): 476-488.

- [23] COSTA-URRUTIA P, COLISTRO V, FRANCO-TRECU V, et al. Dyslipidemia, Obesity, and Ethnicity in Mexican Children [J]. *Int J Environ Res Public Health*, 2021, 18 (23).
- [24] KANGJIE ZHENG L S, XIAOLIN WU, ET AL. PREVALENCE TREND OF OVERWEIGHT AND OBESITY AMONG PRIMARY AND SECONDARY SCHOOL STUDENTS IN BAOSHAN DISTRICT, SHANGHAI FROM 2009 TO 2014 [J]. *MATERNAL AND CHILD HEALTH CARE IN CHINA*, 2018, 33 (2): 414-416. (IN CHINESE).
- [25] SHAOMIN LU D P, JINDONG LIU, ET AL. COMPARISON OF OBESITY STATUS AMONG CHILDREN AGED 7-12 IN LIAONING AND GUANGDONG [J]. *CHINESE JOURNAL OF SCHOOL HEALTH*, 2017, 38 (02): 173-176. (IN CHINESE).
- [26] ZHAI L, DONG Y, BAI Y, et al. Trends in obesity, overweight, and malnutrition among children and adolescents in Shenyang, China in 2010 and 2014: a multiple cross-sectional study [J]. *BMC Public Health*, 2017, 17 (1): 151.
- [27] WANG H, XUE H, DU S, et al. Time trends and factors in body mass index and obesity among children in China: 1997-2011 [J]. *Int J Obes (Lond)*, 2017, 41 (6): 964-970.
- [28] MINJA J G. Prevalence of childhood obesity and its related factors in Tanzania [D]. Fujian Medical University, 2017. (In Chinese).
- [29] BO T, WEN J, GAO W, et al. Influence of HFD-induced precocious puberty on neurodevelopment in mice [J]. *Nutr Metab (Lond)*, 2021, 18 (1): 86.
- [30] Tingting Bao, Cui Yang, Yan Wang, et al. Epidemiological investigation of precocious puberty among 1260 primary school students in Binhai New Area of Tianjin and analysis of related factors [J]. *Maternal and Child Health care in China*, 2020, 35 (09): 1715-1718. (In Chinese).
- [31] SORIANO-GUILLÉN L, CORRIPIO R, LABARTA J I, et al. Central precocious puberty in children living in Spain: incidence, prevalence, and influence of adoption and immigration [J]. *J Clin Endocrinol Metab*, 2010, 95 (9): 4305-4313.
- [32] VALSAMAKIS G, ARAPAKI A, BALAFOUTAS D, et al. Diet-Induced Hypothalamic Inflammation, Phoenixin, and Subsequent Precocious Puberty [J]. *Nutrients*, 2021, 13 (10).
- [33] LI W, LIU Q, DENG X, et al. Association between Obesity and Puberty Timing: A Systematic Review and Meta-Analysis [J]. *Int J Environ Res Public Health*, 2017, 14 (10).
- [34] REINEHR T, ROTH C L. Is there a causal relationship between obesity and puberty? [J]. *Lancet Child Adolesc Health*, 2019, 3 (1): 44-54.
- [35] CHUNMING CHEN. THE PREVENTION AND TREATMENT OF CHILDHOOD OBESITY SHOULD NOT BE MISSED [J]. *CHINESE JOURNAL OF EPIDEMIOLOGY*, 25 (2): 95-96 (IN CHINESE).
- [36] OGDEN C L, CARROLL M D, KIT B K, et al. Prevalence of childhood and adult obesity in the United States, 2011-2012 [J]. *Jama*, 2014, 311 (8): 806-814.
- [37] HUGHES A R, SHERRIFF A, LAWLOR D A, et al. Incidence of obesity during childhood and adolescence in a large contemporary cohort [J]. *Prev Med*, 2011, 52 (5): 300-304.
- [38] SHOKRI E, HEIDARIANPOUR A, RAZAVI Z. Positive effect of combined exercise on adipokines levels and pubertal signs in overweight and obese girls with central precocious puberty [J]. *Lipids Health Dis*, 2021, 20 (1): 152.
- [39] CAO Z J, WANG S M, CHEN Y. A randomized trial of multiple interventions for childhood obesity in China [J]. *Am J Prev Med*, 2015, 48 (5): 552-560.