

Prevalence and temporal trends of overweight and obesity among children and adolescents in Jilin, Northeast China, 2011-2015

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Objective: In China, the obesity epidemic is truly national and childhood obesity prevalence has rapidly increased and is close to the developed countries. This study aimed to estimate the prevalence and temporal trends of overweight and obesity among children and adolescents in Jilin City, China (2011-2015). **Methods:** The data derived from the census on students' constitution and health in 2011-2015 carried out by the Jilin CDC, Jilin City. 191191 children and adolescents aged 7-18 years were included in the present survey, of which 37549 in 2011 to 41564 in the 2015. The newly developed age- and gender-specific BMI cutoffs by the working group on obesity in China were used to define overweight and obesity in children and adolescents. **Results:** The mean of BMI (body mass index) was significantly increasing from 20.9 kg/m² in 2011 to 21.5 kg/m² in 2015 in all subjects. Overweight and Obesity prevalence of total students aged 7-18 years had a significantly increasing from 2012 to 2015 ($P<0.001$), from 16.0% and 13.1% to 17.1% and 17.1%. The minimum value of BMI and overweight and obesity prevalence in overall age group all presented in 2012. Boys and girls all showed the significant increase in overweight and obesity prevalence in every age group from 2012 to 2015 and boys higher than girls ($P<0.001$). Regardless of girls and boys, the most likely of children and adolescents being overweight and obesity had been observed in the youngest age and lowest school grade category. **Conclusion:** In summary, our results indicate that all the overweight and obesity prevalence among children and adolescents over the past 5 years were higher than the 2010 Chinese National Level and Chinese large coastal cities' level and a significantly increase from 2011-2015. Obesity epidemic is serious, at least not optimistic among children and adolescents in Jilin, Northeast China.

28 observed in the category of the youngest school age. **Conclusion:** Our results indicate that the prevalence of
29 overweight and obesity among children and adolescents over the past 5 years from 2011 to 2015 has been considerably
30 increasing in Jilin City, Northeast China and is higher than that described in the 2010 Chinese National Level and
31 Chinese large coastal cities' level. The secular trend of increasing rates in overweight and obesity among children and
32 adolescents is a major public health concern.

33 **Keywords: children and adolescents; prevalence; trends; overweight; obesity**

34

35 **Introduction**

36 Obesity is a public health threat in the world and Childhood obesity epidemic has become a critical problem in
37 worldwide public health (Williams et al. 2015, Wyatt, Winters and Dubbert 2006, Ng et al. 2014). There are a number
38 of studies on the epidemic of children and adolescent obesity (Lobstein et al. 2015). Childhood obesity increased
39 remarkably worldwide during the past two decades (Ebbeling, Pawlak and Ludwig 2002, Karnik and Kanekar 2015).
40 Childhood overweight and obesity prevalence in worldwide was 6.7% in 2010, and expected to reach 9.1% in 2020(de
41 Onis, Blossner and Borghi 2010). Severe obesity prevalence for Pacific young people increased from 9% in 2007 to
42 14% in 2012 (Utter et al. 2015). In children and adolescents, overweight or obesity are prone to develop obesity in
43 adulthood (Karnik and Kanekar 2015, Melnyk, Small and Moore 2008), that is often associated with various obesity-
44 related health complications (Mullis et al. 2004, Eckel et al. 2004, Munthali et al. 2016, Ahluwalia et al. 2015), such
45 as type 2 diabetes, hypertension, chronic heart diseases and psychosocial disorders. It has been proven that obesity not
46 only markedly reduces life expectancy, but also impairs quality of life and economic wealth of most communities for
47 both developed and developing countries (St Jeor et al. 2004).

48 In China, the obesity epidemic is a truly national issue and incidence of childhood obesity is on the rise, reaching
49 the levels estimated in the developed countries (Chen and Ji 2014, Andegiorgish et al. 2012, Ip et al. 2016). It has
50 been previously reported in the Chinese National Survey on Students' Constitution and Health in 2005 that the
51 prevalence of overweight and obesity had been significantly increasing for Chinese children and adolescents aged 7-
52 18 years from 1985-2005 (Ji and Cheng 2009). In 2010, 9.9% of Chinese children and adolescents were overweight
53 and 5.1% were obesity that is nearly 30.4 million individuals (JI CY 2013). Jilin City is one of the most important

54 tourism as well as chemical industrial cities in Northeast China with a population of 4.41 million. However, despite
55 the fact that many studies on adult obesity and its causes or consequences have been reported in the past decades (JI
56 CY 2013, Ip et al. 2016)), very little research of this issue has been published from Jilin City. The purpose of our
57 present study is therefore to evaluate the prevalence and temporal trends of overweight and obesity among children
58 and adolescents in Jilin City.

59

60 **Methods**

61 **Data sources and sampling**

62 Our data derived from a census on students' constitution and health that was carried out by the Jilin CDC, Jilin City,
63 in 2011-2015. The census has run through a five-year period for all public schools in Jilin City, including 9 primary
64 schools and 15 junior high schools and 19 high schools. Students aged 7-18 years old participated in the study. Written
65 informed consent forms were obtained from children and adolescents, and their parents. Ethical approval was obtained
66 from Beihua University School of Public Health.

67 **Physical measurements and definitions for overweight and obesity**

68 All participants had a thorough medical examination to evaluate students' constitution and health. Subjects with
69 any unrelated physical or mental disorders or diseases were exclude from the current study. Physical measurements
70 including height and weight, were conducted by a team of professionals following the same reference/protocol at each
71 survey site (Sun et al. 2014). Body mass index (BMI) was calculated by dividing the weight (kg) by height squared
72 (m^2). The newly developed age- and gender-specific BMI cutoffs by the Working Group on Obesity in China (JI CY)
73 were used to define overweight and obesity in children and adolescents, 85th percentile \leq BMI<95th percentile as
74 overweight, 95th percentile \leq BMI as obesity. For the group of age 18, the cutoffs for overweight and obesity were the
75 same for both boys and girls and consistent for adults in China (Andegiorgish et al. 2012).

76 **Statistical analysis**

77 All data analysis was performed using SPSS 22.0 (SPSS Inc., Chicago, Illinois, USA). BMI values of different
78 categories were expressed as mean \pm standard deviation (sd). One-way analysis of variance (ANOVA) was performed
79 to compare mean values for continuous variables and χ^2 test was performed to compare the prevalence differences
80 between genders and among five surveys. Trends of variables category between 2011 and 2015 were performed by
81 the logistic regression with enter method with the 2011 survey as the reference. Logistic regression models with enter

82 method were used to estimate the association of overweight and obesity with age, sex and grade factors. Statistical
83 tests were set with a significance level of 0.05.

84

85 **Results**

86 191,191 children and adolescents aged 7-18 years were recruited in the present census (2011-2015), the range of
87 which was 37,549~41564 between 2011 and 2015, and 3280 to 10493 in every school grade- and age-specific
88 subgroups over a five-year period (Supplementary and raw data). The subjects consisted of 96131(50.3%) boys and
89 95060 (49.7%) girls, 18.7%, 33.6% and 47.7% of them were from Primary school, Junior high school and High school
90 respectively. The mean of BMI in all students was significantly increased from 2011 to 2015 (from 20.9 kg/m² to 21.5
91 kg/m²) and boys showed higher than girls ($P<0.001$). Statistic difference was also observed in gender-, age- and school
92 grade-specific subgroups. Moreover, it appeared that the minimum mean values of BMI presented in 7-years-olg group
93 and Primary school group ($P<0.001$)).

94 Table 1 presented that the prevalence of overweight and obesity of all students aged 7-18 years had a significant
95 increase from 2012 to 2015 ($P<0.001$), from 16.0% to 17.1% of overweight and from 13.1% to 17.1% of obesity; and
96 the minimum prevalence of overweight and obesity in the overall age group all presented in 2012. There were
97 significantly increasing on the prevalence of overweight and obesity in most age groups by further analysis between
98 2012 and 2011, 2013, 2014, 2015, especially on obesity ($P<0.001$).

99 Table 2 and Table 3 showed the details of changes in prevalence of overweight and obesity from 2011 to 2015
100 in children and adolescents aged 7-18 years old for boys and girls. Both boys and girls showed significant increases
101 in overweight and obesity prevalence in total age group from 2012 to 2015 (Boys-Overweight: 18.5% to 19.1%,
102 Obesity: 17.6% to 22.0%, $P<0.001$; Girls-Overweight: 13.5% to 15.1%; Obesity: 8.5% to 12.0%; $P<0.001$). Trends
103 of the overweight and obesity prevalence were consistent between the years 2011 and 2015 for boys and girls, reached
104 their peak of the overweight and obesity prevalence in 2014 and stand by in next survey period (Table 2, Table 3,
105 Table 4). There were some different evidences in different years by gender, boys reached their peak at aged 12-year
106 and girls at aged 10 to 13-year, that all followed by a slight decline.

107

108 There was a significant increase in the overweight and obesity prevalence both boys and girls in all categories by
109 comparing 2015 to 2011. The possibility and risky of becoming overweight and obesity in children and adolescents
110 increases by year, and girls had more risk than boys (Boys: OR, 1.16; 95%CI, 1.11-1.21; Girl: OR, 1.28; 95%CI, 1.22-
111 1.34). Regardless of girls and boys, the most likelihood of children and adolescents being overweight and obesity had
112 been observed in the youngest age and lowest school grade category (Boys-7~9: OR, 1.31; 95%CI, 1.15-1.48; Primary
113 school: OR, 1.31; 95%CI, 1.19-1.43; Girls-7~9: OR, 1.34; 95%CI, 1.16-1.54; Primary school: OR, 1.31; 95%CI, 1.17-
114 1.45) (Table 4).

115
116 During the 2011-2015 period, the risk of being overweight and obesity was higher in 2013, 2014, 2015 compared
117 with 2011, after adjusted for age, gender and school grade (Table 5). Children and adolescents of girls and aged 13~15,
118 16~18 years had a lower risk of overweight and obesity compared with boys and aged 7~9 years (Girls: overweight
119 and obesity: OR, 0.51; 95%CI, 0.50-0.52; 13~15 years: OR, 0.89; 95%CI, 0.84-0.94; 16~18 years: OR, 0.80; 95%CI,
120 0.75-0.86), after adjust for year of data, gender and school grade. However, Children and adolescents aged 10~12
121 years had a significantly higher risk of being overweight and obesity than aged 7~9 years (Overweight and Obesity:
122 OR, 1.13; 95%CI, 1.08-1.13). Junior High school students had a significantly higher risk of being overweight and
123 obesity than primary school students (Overweight and Obesity: OR, 1.19; 95%CI, 1.13-1.24). Likewise, the results
124 suggest that boys, aged 10~12 years and junior high school among children and adolescents in 2012-2015 are more
125 likely to be overweight or/and obesity.

126

127 **Discussion**

128 Although there are numerous reports on adult obesity and its causes and/or consequences, little information is
129 available for the prevalence of childhood obesity in the past decades in Jilin, Northeast China. This is the first large
130 student-based study investigating the trends of overweight and obesity prevalence among Chinese children and
131 adolescents aged 7 to 18 years in Jilin city. Remarkably, for the 2011-2015 period, temporal trends in the prevalence
132 of overweight and obesity showed an increase in all students and subgroups. We found that the rates of overweight
133 and obesity among children and adolescents over the past 5 years were higher than that reported in the 2010 Chinese
134 National Level (Song et al. 2015, JI CY 2013) and the average values of large coastal cities in China (Zhang et al.
135 2016). The causes of overweight and obesity are multi-factorial, due to a complex interplay of genetic, nutritional,
136 physiological, psychological, environmental, and social factors. Yet, the most important factor underlying the body
137 weight gain is the excessive caloric intake coupled with limited energy expenditure (Wu al. 2010, Barness L A
138 2007). With rapid economic growth in China , social-environmental and living conditions have improved and
139 benefited Chinese people with no doubt (Ip et al. 2016). However, as a consequence of societal shifts, there is more

140 consumption of fatty, western style fast foods and adoption of a more sedentary lifestyle with the shift from rural to
141 urban living (Braithwaite et al. 2014, Yang et al. 2016, Shang et al. 2012, Suk et al. 2016). In the early 2010s,
142 electronic devices (Smart phones, tablets etc.) roared onto the Chinese market and its impact on Chinese life style,
143 and especially on children, has been the subject of great interest and debate. It has raised concerns that because of
144 the widespread popularity, electronic devices are quickly embraced by younger generations and incorporated more
145 seamlessly into their daily routines, therefore, leads to decline in physical activity (Nair et al. 2015). Previous studies
146 have shown that inactive leisure time activities are related to childhood obesity (Chan and Woo 2010, Lifshitz and
147 Lifshitz 2014). Besides, Chinese students generally spend much more time in homework from school, compared to
148 those from western counties, which even worsens the situation and unbalances the dietary intake with energy
149 expenditure from physical activity (Li et al. 2007). We found that the obesity prevalence is increasing in all
150 subgroups, but it seems to reach a plateau or started to slow in recent two years. This is possibly affected by a general
151 increased awareness of health and adverse effects of childhood obesity in recent years (JI CY 2013).

152 Interestingly, we found that the minimum value of BMI and the prevalence of overweight and obesity in all
153 students declined in 2012. Presumably, the Olympics spirits and health education brought by 2012 London Olympics,
154 influenced young people to take more physical activities for self-health control, that was confirmed by other studies
155 (Mahtani et al. 2013, Ma et al. 2014). Moreover, it is attributed to improvements in country's infrastructure before
156 Olympics and changes in government policies that allow school-based intervention on physical activities.

157 We also found that the overweight and obesity prevalence were increasing in gender-specific subgroups over time
158 and showed boys were higher than girls, that was consistent with previous studies in Chinese population (Liu et al.
159 2016), but not with those from other Asian or Western countries (Shirasawa et al. 2015, Peltzer and Pengpid 2016,
160 Zhang et al. 2014). This is most likely due to traditional Chinese culture, overweight or obesity is generally accepted
161 as good health, especially in boys. Unrecognizing obese status of their sons, parents would not take steps to change
162 situations. On the other hand, from a society point of view, Chinese girls are more likely to shape their body and
163 control weight for beauty compared with their male counterparts (Zhang et al. 2016, Yang et al. 2016, Zhang et al.
164 2014). Moreover, changes in lifestyle may contribute to this gender disparity in obesity and overweight as well. A
165 recent study shows that the prevalence of screen time ≥ 2 hours/day is higher in urban boys aged 13–18 years (44%),

166 compared to that in urban girls at the same group (34.7%)(Cui et al. 2011). Researchers also found that additive effects
167 of multiple obesity predisposing genes across the whole genome affects childhood body weight in Chinese children
168 (Wang J 2012), that could account for this gender difference. Previous studies suggested that overweight and obesity
169 have its vulnerable periods in childhood and it is difficult to reverse. Furthermore, there is strong evidence supporting
170 that childhood obesity is prone to develop adult obesity and closely associated with comorbidities (So et al. 2008,
171 Utter et al. 2015). Not surprisingly, it appeared in our study that overweight and obesity occur at the youngest school
172 age group.

173 Having a healthy diet and being physically active help children maintain a healthy body weight throughout
174 childhood. Well balancing calories consumed from foods with the energy burned through physical activity plays a
175 critical role in preventing excess weight gain (Kwon et al. 2015). More importantly, to reverse the obesity epidemic,
176 community should make efforts to support healthy diet and active living in a variety of settings, for example, schools
177 or families can encourage children to drink water in place of sugar-sweetened beverage, ensure that children eat
178 healthy food that meets dietary recommendations in reference to Dietary Guidelines for Chinese Residents (2016),
179 increase the amount of time that students are physically active during school day and create a Local School Wellness
180 Policy to promote student health and reduce childhood obesity. (Crawford et al. 2007, Brown and Summerbell 2009).

181 There are several limitations in the study. First, our study is a cross-sectional, but not a prospective study. Second,
182 the definition of overweight and obesity among children and adolescents is based on BMI that is an imperfect method
183 to evaluate obesity. To compensate these limitations, we attempted to collect a large number of data from all primary-,
184 junior high- and high school students across Jilin area, which can be representatives and kept using the same protocol
185 for all techniques and equipments throughout measuring height and weight. To minimize bias, the data was adjusted
186 for demographic covariates in multivariable trend analysis; but some unmeasured confounders, just like family status,
187 number of siblings, physical activity and diet in the large-size study, may have affected the results. Knowing
188 limitations, the present study -has significant implications for our understanding the trends of overweight and obesity
189 prevalence among children and adolescents in Jilin, Northeast China.

190 **Conclusion**

191 In summary, our results provide an insight of the most recent trend in Childhood obesity in Jilin City, Northeast

192 China. It indicates that the prevalence of overweight and obesity among children and adolescents over the past 5 years
193 were higher than that in the 2010 Chinese National Level and the average values of Chinese large coastal cities. This
194 rising prevalence of childhood obesity poses a major public health challenge in Jilin City, Northeast China. A further
195 comprehensive intervention program with a behavioral modification is urgently required to control childhood obesity.

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201 Li, ZJ Li, Q Sun, GY Wu and YL Qi participated in revising the manuscript. All authors approved the final
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205 **Competing Interests:** None declared.

206 **Ethics approval:** Ethical approval was obtained from Beihua University School of Public Health, and written
207 informed consent was obtained from all subjects.

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