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Prevalence and correlates of overweight and obesity among adolescent of northeastern China: a cross-sectional study

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1 Prevalence and correlates of overweight and obesity
2 among adolescent of northeastern China: a
3 cross-sectional study

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22

23 **Abstract**

24 **Objectives:** To estimate the prevalence of overweight/obesity in adolescents and to
25 evaluate the associated factors among this group in Changchun City, Northeastern
26 China.

27 **Methods:** A cross-sectional study of 1955 adolescents aged 11–18 years was
28 conducted in Changchun City, using stratified cluster sampling. Parents and
29 caretakers of children completed the questionnaires as requested without protest,
30 which included demographic characteristics and anthropometric parameters.
31 Univariate and multivariate logistic regression were performed to analyze the
32 relationship between overweight /obesity and related factors.

33 **Results:** In total, the prevalence of overweight was 12.7% (male 17.4%; female
34 10.1%), and the prevalence of obesity was 4.9% (male 8.8%; female 3.1%) in
35 Changchun, Jilin province. The prevalence of overweight and obesity were both
36 higher in men than women ($p < 0.001$). Multivariate logistic regression showed that
37 overweight and obesity were significantly associated with male, age, preterm birth,
38 parental obesity and diet habits (fruit frequency per week, eating picky and eating
39 concentration).

40 **Conclusion:** The prevalence of overweight and obesity among adolescents in
41 Changchun was relatively higher compared with that in Xi'an and Nanjing in recent
42 years. Gender, age, birth history, diet habits, and parental weight were important
43 factors for overweight and obesity in adolescents. Further research should be

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4 44 conducted about the health of adolescents in China and further intervening measures
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7 45 should be done to decrease the prevalence of overweight/obesity.
8

9 46 **Keywords:** overweight; obesity; adolescent; association
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13 47 **Strengths and limitations of this study**

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- 17 48 ● The strength of this study is precise physical measurement, which improved the
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20 49 validity of the results.
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23 50 ● The analysis results might exist some information and confounding bias due to
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26 51 the nature of cross-sectional data.
- 27
28 52 ● The results were from Changchun only and therefore cannot representative of the
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31 53 specific circumstance in Jilin Province.
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35 54 **Introduction**

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39 55 The prevalence of obesity has increased dramatically among children, adolescents and
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42 56 adults during the past decades all over the world[1]. Overall, the global proportion of
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45 57 adolescents with obesity has risen significantly from just 4% in 1975 to just over 18%
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48 58 in 2016[2]. There is compelling evidence implicating that a significantly higher
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51 59 proportion of adolescents who were overweight or obese was found, which reached
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54 60 alarming levels in recent years.

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56 61 In recent years, many scholars have conducted plenty of studies on overweight and
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59 62 obesity. As we all know, overweight and obesity have been predisposing factors for
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4 63 many chronic diseases, such as type 2 diabetes, cardiovascular diseases, respiratory
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7 64 diseases, musculoskeletal disorders, and various types of cancer[3]. Yan Rong et
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10 65 found that the association of adolescent obesity with nonalcoholic fatty liver disease
11
12 66 (NAFLD) and the incidence of NAFLD rose subsequently with body weight's
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15 67 increasing[4]. Quentin Lisan compared patients with obesity and severe obstructive
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18 68 sleep apnea (OSA) with and without prescription of positive airway pressure (PAP)
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21 69 therapy, found that participants with PAP prescriptions had a higher BMI than
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23
24 70 participants not prescribed PAP[5]. It has been estimated that overweight and obesity
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26
27 71 are the fifth leading cause of death worldwide, accounting for nearly 3.4 million
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30 72 deaths annually[6]. In addition, Obesity was considered as a risk factor for the
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33 73 development of chronic kidney disease[7]. In this condition, the American Medical
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36 74 Association classified obesity as a disease to get physicians to pay more attention[8].
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39 75 As the largest developing country, China had nearly one-third of overweight or obese
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42 76 adolescents until 2016; and that the obesity prevalence rate had risen from 0.10% in
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45 77 1976 to 8.50% in 2016. Sun HP found the prevalence of obesity and of overweight
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48 78 and obesity combined was 8.1% and 19.2% among children and adolescents 7–18y in
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51 79 age[9]; Zhang XY reported the prevalence of overweight and obesity among primary
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54 80 school children was 15.2% and 11.7% in Jiangsu Province[10]. Therefore, it is of key
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57 81 importance to make sure the risk factors of overweight and obesity to prevent
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60 82 adolescents from the disease.

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4 83 We investigated the physical condition of adolescents among 11-18 years from six
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7 84 middle schools in Changchun which is the capital of Jilin province. The aim of the
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10 85 current study was to reveal the prevalence of overweight and obesity and to analyze
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12 86 some associated factors among adolescents of overweight and obesity in Changchun,
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15 87 Jilin.

18 19 88 **Methods**

22 23 89 **Subjects**

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27 90 The study sample comprised students from six middle schools (three in urban and
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30 91 three in rural areas) randomly in Changchun City, the capital of Jilin Province in
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32 92 Northeast China, using stratified cluster sampling. Overall, 1955 students aged 11–18
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34
35 93 years were contained in this cross-section survey; subjects with overweight/obesity
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38 94 due to known metabolic and endocrine diseases were excluded. Students were also
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41 95 excluded if they had mental or physical impairments severe enough to cause abnormal
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44 96 behaviors, including congenital disease, intellectual disability, and a psychiatric
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46
47 97 disorder[11]. The study was approved by the ethics committee of the First Hospital of
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49
50 98 Jilin University (Reference Number: 2013-031). The investigation has received
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53 99 informed consent from students and parents. We used the SRQR reporting
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56 100 guidelines[12] in this study.

57 58 101 **Key Variables**

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4 102 Body mass index (BMI) is used here as the necessary indicator for overweight and
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7 103 obesity of adolescent and adult. Weight category was defined using age- and sex-
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10 104 specific cutoff points by the international standard for BMI among adolescents[13].
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12 105 As for adult, the criterion 'BMI \geq 24' was defined as overweight and obesity [14, 15].
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15 106 Parents and caretakers provided adolescents' weight (to the nearest 1 kg) and height
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18 107 (to the nearest 1 cm). Overall children were classified by age as 3 groups (<13,
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20 108 13-15, >15) , region as 2 groups (urban, rural) and gender as 2 groups (male,
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23 109 female). Participants who slept less than 8 h over 3 days a week were classified as
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26 110 'sleep <8 h', and those who slept more than 10 h over 3 days a week were defined as
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29 111 'sleep >10 h'[16]. Participants who were classified as 'picky eater' were defined as
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32 112 adolescents who had eaten something too simple in a week. According to students'
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34 113 eating habits, we categorized these behaviors by whether they were done over twice a
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37 114 week, like eating fresh fruits, dessert, breakfast and fast-food. And students whether
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40 115 eating with concentration or not was a significant classification standard. Based on
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43 116 students' daily exercise frequency, we took students into 3 groups (never, sometimes
44
45 117 and often).

118 **Statistical analysis**

119 Data input was established using Epidata 3.1and statistical analysis was performed
120 using SPSS 24.0. Frequency distributions were used to characterize subjects, and
121 percentage data were used to report prevalence. The relationship between each factor

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4 122 and the adolescents' weight status was reflected by χ^2 tests, univariate and
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7 123 multivariate logistic regression. In univariate analysis, when $p < 0.10$, significant
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10 124 correlation factors were included in a forward stepwise multivariate logistic
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12 125 regression to exclude confounding factors. In all analyses, two-tailed P value < 0.05
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14
15 126 was considered statistically significant.

127 **Data availability**

128 Data referenced in this study are available in the project named "Effect and
129 mechanism of weight loss on upper airway collapsibility in obese patients with
130 OSAS". We selected a portion of the data in the database, including body
131 measurements of adolescent from six middle schools in Changchun City. The data
132 that support the findings of this study are available on request from the corresponding
133 author [HY]. The data are not publicly available due to them containing information
134 that could compromise research participant privacy or consent.

135 **Patient and public involvement**

136 No patient involved.

137 **Results**

138 On the basis of the inclusion and exclusion criteria, we chose 1955 adolescents from
139 Changchun, of which 1825 participants were finally analyzed in this study. The
140 participants with missing information on height or weight or extreme BMI values

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4 141 were excluded from the study. According to the analysis of the frequency distribution,
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7 142 we found that there were 837 boys and 988 girls included; the median age of the
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10 143 students was 15.30 years, ranging from 11 to 18 years; of all these subjects, 42.9%
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12 144 were from rural regions and 57.1% were from urban regions; most of the subjects
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15 145 were Han Chinese, accounted for 98.2%, with only a few minority ethnicities.

16
17 146 According to the BMI classification in the worldwide, the overall prevalence of
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20 147 overweight was 12.7% (male 17.4%; female 10.1%), and the prevalence of obesity
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23 148 was 4.9% (male 8.8%; female 3.1%) in Changchun city, Jilin province (Table 1). The
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25
26 149 overweight and obese rate were both higher in males than in females ($p < 0.001$),
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28
29 150 respectively. A higher prevalence of overweight was found in subjects whose ages
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32 151 ranged from 11-12 years, and the prevalence of obesity was higher in the age groups
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35 152 13-15 ($p = 0.008$). Children from an urban area showed a significantly higher
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38 153 proportion of being overweight. Full-term birth subjects had a higher prevalence rate
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41 154 than others ($p = 0.014$). In addition, Students who had poor diet habits, such as ate
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44 155 fruits less than twice a week ($p = 0.029$), enjoyed fast-food and desserts, ate without
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47 156 concentration ($p = 0.004$) and those picky eaters ($p = 0.028$), were much more likely to
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50 157 be overweight or obese. What's more, a higher prevalence of overweight was found in
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53 158 subjects who never exercised than others. As for genetic factors, we found that
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56 159 parental weight showed significant improvement in compared with childhood weight.

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59 160 **Table 1**

60 161 **Prevalence of overweight and obesity according to demographic characteristics**

Variables	n	Overweight			Obesity		
		PR (%)	χ^2	<i>p</i>	PR (%)	χ^2	<i>p</i>
Gender							
Male	837	17.4	19.81	<0.001	8.8	23.843	<0.001
Female	988	10.1			3.1		
Area							
Urban	1042	14.4	2.178	0.14	5.6	0.03	0.863
Rural	783	12			5.8		
Age							
<13	168	19.3	9.658	0.008	5.1	0.407	0.816
13-15	1157	11.6			5.9		
>15	500	15.5			5.2		
Birth history							
Full-term birth	1621	14.2	8.525	0.014	6	2.513	0.285
Preterm birth	133	5.2			3.2		
Post-term birth	71	10.1			3.1		
Fresh fruits ≤ 2 /week							
Yes	1259	12.2	4.776	0.029	4.8	5.393	0.02
No	566	16.1			7.7		
Dessert ≤ 2 /week							
Yes	887	12.4	1.315	0.252	5.2	0.477	0.49
No	938	14.3			6		
Breakfast ≤ 2 /week							
Yes	1673	13.9	1.758	0.185	5.8	0.475	0.491
No	149	11.1			4.8		
Fast food ≤ 2 /week							
Yes	264	7.6	2.786	0.095	7.6	0.703	0.402
No	1561	13.7			5.5		
Eat with concentration							
Yes	1174	11.6	8.253	0.004	5.4	0.464	0.496
No	651	16.5			6.2		
Picky eater							
Yes	1133	14.8	4.851	0.028	6.7	4.876	0.027
No	692	11.1			4		
Exercise							
Never	451	15.9	3.28	0.194	4.2	2.31	0.315
Sometimes	478	12			6.6		
Often	896	12.8			5.8		
Highest parental degree							
Primary school or low	95	8	4.688	0.196	8	1.322	0.724
Junior high school	799	13			5.1		
Senior high school	468	15.8			6		

University and above	463	12.7			5.7			
Sleep (hours/night)								
<8	884	13.6	0.423	0.809	5.3	2.392	0.302	
≥8	861	13.3			5.6			
>10	80	11			9.7			
Fatherly weight								
Normal	827	15.5	5.575	0.018	7.6	9.426	0.002	
Overweight and obesity	998	11.6			4.1			
Maternal weight								
Normal	1099	15.2	7.504	0.006	5.5	0.06	0.807	
Overweight and obesity	726	10.6			5.8			

162 Note: *PR* (%), Prevalence rate

163 In order to facilitate regression analysis, we divided the participants into two groups:
 164 underweight and normal; overweight and obese. Table 2 shows the univariate analysis
 165 of correlates of overweight and obesity in adolescents. As is impressively
 166 demonstrated in this table, the following factors all had a significant effect: gender,
 167 age, birth history, the frequency of eating fruits, eating habits (eat with concentration,
 168 picky eaters), parental weights ($p < 0.05$). According to the results, we added all these
 169 significant factors to a forward stepwise multivariate logistic regression model.

170 **Table 2**

171 **Univariate analysis of correlates of overweight and obesity in adolescents in Changchun**

Variables	Wald χ^2	<i>p</i>	<i>OR</i>	95% <i>CI</i>
Gender				
Female	35.972	<0.001	1	
Male			2.125	1.661-2.719
Area				
Urban	1.288	0.256	1	
Rural			1.15	0.902-1.473
Age				
<13	5.21	0.07	1	
13-15	4.163	0.041	0.66	0.448-0.984
>15	0.915	0.339	0.81	0.532-1.243

Birth history					
	Full-term birth	9.756	0.008	1	
	Preterm birth	8.418	0.004	0.39	0.21-0.739
	Post-term birth	1.58	0.209	0.63	0.312-1.29
Fresh fruits ≤ 2 /week					
	Yes	8.571	0.003	1	
	No			1.46	1.132-1.87
Dessert ≤ 2 /week					
	Yes	1.663	1.197	1	
	No			1.17	0.921-1.493
Breakfast ≤ 2 /week					
	Yes	2.076	0.15	1.00	
	No			0.79	0.571-1.089
Fast food ≤ 2 /week					
	Yes	1.978	0.16	1	
	No			1.08	0.972-1.19
Eat with concentration					
	Yes	7.303	0.007	1	
	No			0.713	0.558-0.911
Picky eater					
	Yes	8.48	0.004	1	
	No			0.68	0.526-0.882
Exercise					
	Never	0.601	0.74	1	
	Sometimes	0.45	0.502	0.89	0.638-1.246
	Often	0.491	0.484	0.90	0.672-1.207
Highest parental degree					
	Primary school or low	2.878	0.411	1	
	Junior high school	0.284	0.594	1.18	0.648-2.136
	Senior high school	1.444	0.229	1.45	0.79-2.678
	University and above	0.306	0.58	1.19	0.642-2.206
Sleep (hours/night)					
	<8	0.074	0.964	1	
	≥ 8	0.004	0.952	0.99	0.776-1.27
	>10	0.061	0.805	1.08	0.598-1.938
Fatherly weight					
	Normal	11.902	0.001	1	
	Overweight and obesity			0.65	0.513-0.832
Maternal weight					
	Normal	4.582	0.032	1	
	Overweight and obesity			0.76	0.591-0.977

172

173 Table 3 shows the results of logistic regression models comparing the prevalence of
 174 the potential risk factors: gender, age, birth history, the frequency of eating fruits,
 175 eating habits (eat with concentration, picky eaters), parental weights. In this forward
 176 stepwise multivariate logistic regression model, males were more likely to be
 177 overweight and obese than females (OR=2.002, 95%CI: 1.557-2.573). Students aged
 178 from 13-15 (OR=0.642, 95%CI: 0.428-0.962) were less likely to be overweight than
 179 11-12 years old. Compared with full-term birth subjects, those who were preterm birth
 180 (OR=0.442, 95%CI: 0.234-0.835) tended to be normal weight. Participants who ate
 181 fruits less than twice a week (OR=1.335, 95%CI: 1.03-1.73) were 1.335 times more
 182 likely to be overweight and obese. What's more, the prevalence of overweight would
 183 be enhanced if students ate with concentration (OR=1.387, 95%CI: 1.077-1.788).
 184 Picky eaters were much more likely to be overweight than the subjects who ate a
 185 healthy diet (OR=0.682, 95%CI: 0.523-0.889), respectively.

186 **Table 3**187 **Multivariate regression analysis of correlates of overweight and obesity in**188 **Changchun**

Variables	Wald χ^2	<i>p</i>	β	SE	OR	95% CI
Gender						
Female					1	
Male	29.35	<0.001	0.694	0.128	2.002	1.557-2.573
Age						
<13					1	
13-15	4.615	0.032	-0.444	0.207	0.642	0.428-0.962
>15	2.468	0.116	-0.351	0.223	0.704	0.454-1.091

Birth history							
Full-term birth						1	
Preterm birth	6.321	0.012	-0.816	0.325	0.442	0.234-0.835	
Post-term birth	1.354	0.245	-0.43	0.369	0.651	0.316-1.342	
Fresh fruits ≤ 2							
Yes						1	
No	4.761	0.029	0.289	0.132	1.335	1.03-1.73	
Eat with concentration							
Yes						1	
No	6.409	0.011	0.327	0.129	1.387	1.077-1.788	
Picky eater							
Yes						1	
No	8.022	0.005	-0.383	0.135	0.682	0.523-0.889	
Fatherly weight							
Normal						1	
Overweight and obesity	11.764	0.001	-0.433	0.126	0.649	0.507-0.831	

189 Discussion

190 To describe the epidemiology of overweight and obesity in Changchun city and
 191 analyze the influence factors in adolescents, we conducted this survey of middle
 192 school students aged 11–18 years from urban and rural areas and found that location,
 193 gender and parental weight have a significant impact on a child's weight.

194 Based on the data, we found the prevalence of overweight was 12.7% (male 17.4%;
 195 female 10.1%), and of obesity was 4.9% (male 8.8%; female 3.1%) among
 196 adolescents in Changchun city, Jilin province. However, in recent studies, the overall
 197 prevalence of obesity in school-aged children in Xi'an was 4.11%, and the rate of
 198 overweight was 6.6% in Nanjing adolescents, which were both lower than data in
 199 Changchun. This difference may be caused by sample size, sex, and age of the studied
 200 population[17, 18]. In addition, demographics distribution and environmental factors

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4 201 are probable cause too[19]. As we all know, the economics in northeast China was
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7 202 less development compared with that in east and south China to some extent[20].
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10 203 Rates of overweight and obesity were also higher in rural areas in the north than in the
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13 204 south[21]. Depending on the season, people in the north might eat high-energy foods
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16 205 to combat the cold, what is said “energy balance related behaviors [22, 23]”. In our
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19 206 data, boys were more often obese than girls, in general, which were in agreement with
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22 207 previous reports[23-26]. On the one hand, in traditional Chinese culture, the
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25 208 preference for boys may be the reason for the differences in diet, and older believe
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28 209 that fat boys are more powerful than thin ones. By contrast, girls with well-groomed
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31 210 and fit are more favored by Chinese society[27-29]. Girls, on the other hand, tend to
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34 211 be more concerned about their weight than boys.
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37 212 We also found that adolescents who ate few fruits in general and were picky about
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40 213 foods were more likely to be overweight and obese in our survey. According to the
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43 214 present cross-sectional observation, children who were picky about foods would
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46 215 prefer more fast food, fried food, sweet food and so on. Nowadays, several studies
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48
49 216 have considered that food intake is a primary factor that determines body
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51
52 217 weight[30-32]. Y. Li et al concluded that overweight Chinese children reported high
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55 218 energy and fat intakes, excessive intake of cooking oil might be one of the risk factors
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58 219 of overweight[33]. Consistent with a previous study in Tianjin[30], overweight
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60 220 students preferred significantly to more sweet foods and take-out food rather than
221 their counterparts with normal weight. The result might be influenced by many

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4 222 elements, such as peer influence, food price, convenience or not, online influence and
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7 223 so on, based on recent report[34]. In order to decrease the fat rate, a series of
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10 224 interventions have been conducted such as controlling the TV time and increasing the
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12 225 sport time.

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15 226 In our research, we found that if fathers were overweight, adolescents were less likely
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17 227 to be overweight, which was opposite to the previous conclusion[35-37]. Studies [25,
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19 228 38]have found that the higher BMI in the father increased the risk of overweight/
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21 229 obesity among males and females. However, the finding is not consistent across
22
23 230 studies. In a previous study, the researchers found that the relationship between
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25 231 parents' and kids' BMI not existed when longitudinal analyses of changes in BMI
26
27 232 over four years were performed[39]. This may explain why a short period of periodic
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29 233 surveys alone does not fully demonstrate a parent-child link to obesity, and we still
30
31 234 need a long-term research if we want to explore the relationship between the two
32
33 235 factors further. What's more, children's growing environment and living habits will
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35 236 also affect their own obesity level, which will have an impact on our results; for
36
37 237 example, in order to adapt to the small groups in school, students always eat
38
39 238 unhealthy food with their peers[34]. Further prospective studies that assess both
40
41 239 energy expenditure and energy intake in children meanwhile are more likely to clarify
42
43 240 this question. In addition, the use of BMI to assess parental weight status may be a
44
45 241 limitation of this study, as BMI did not always reflect a person's body fat percentage,
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47 242 nor did we take into account parental waist circumference in this survey[38].
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4 243 There are several limitations to this study. First, the analysis results were restricted by
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6 244 the less sample size, and we interpolated missing values in the data resulting in
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9 245 random errors eventually. Second, the conclusion might seem a little limited in
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12 246 assessing whether children were obese or not due to BMI, this single index and the
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14
15 247 potential bias. If we could analyze the risk factors of obesity in teenagers from
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18 248 multiple perspectives based on the height-for-age Z-score (HAZ), we might get a
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21 249 more accurate conclusion, which is also a problem we need to improve in the future.
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23 250 Third, the contents of the questionnaire were most recalled by the parents or
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26 251 guardians, and there might be information bias and confounding bias in this survey.
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29 252 Fourth, our data came from six schools in Changchun, which was not representative
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31
32 253 of the specific circumstance in Jilin Province. Further research should be conducted to
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35 254 complete the conclusion.

255 **Conclusions**

256 To sum up, in this cross-section study, we found the prevalence of overweight and
257 obesity among adolescents in Changchun, Jilin Province is relatively high compared
258 with other cities such as Xi'an and Nanjing. Gender, age, birth history, diet habits,
259 and parental weight were important factors for overweight and obesity in adolescents.
260 Therefore, reasonable lifestyle and effective weight control are necessary condition to
261 prevent from overweight or obese for adolescent. There are still several limitations in
262 this study, we need to conduct more information accurately and more specific analysis

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4 263 on it. Further research should be conducted about the health of adolescents in China
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7 264 and further intervening measures should be tailored on decreasing the prevalence of
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10 265 obesity.

11 12 13 266 **Acknowledgements**

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17 267 Thanks to all those who helped with the investigation and the participants.

18 19 20 21 268 **Footnotes**

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27
28 270 study. HY, JJ and XL collected data. RD carried out the measurements, analyzed the
29
30
31 271 data and drafted the manuscript. XY and BZ participated in the coordination of the
32
33
34 272 study and interpreted the data. WB and YL revised the manuscript. All authors have
35
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37 273 approved the final article.

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40
41
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44
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46
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50 278 **Ethical approval:** The investigation was conducted by the First Hospital of Jilin
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53 279 University in April 2016, our data collected from the questionnaire in the survey as
54
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56 280 well. The study was approved by the ethics committee of the First Hospital of Jilin
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59 281 University (Reference Number: 2013-031). The investigation has received informed
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282 consent from students and parents.

283 **Data sharing:** No additional data are available.

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Reporting checklist for qualitative study.

Based on the SRQR guidelines.

Instructions to authors

Complete this checklist by entering the page numbers from your manuscript where readers will find each of the items listed below.

Your article may not currently address all the items on the checklist. Please modify your text to include the missing information. If you are certain that an item does not apply, please write "n/a" and provide a short explanation.

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In your methods section, say that you used the SRQR reporting guidelines, and cite them as:

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	Reporting Item	Page Number
Title		
	#1 Concise description of the nature and topic of the study identifying the study as qualitative or indicating the approach (e.g. ethnography, grounded theory) or data collection methods (e.g. interview, focus group) is recommended	1
Abstract		
	#2 Summary of the key elements of the study using the abstract format of the intended publication; typically includes background, purpose, methods, results and conclusions	2-3
Introduction		
Problem formulation	#3 Description and significance of the problem / phenomenon studied: review of relevant theory and empirical work; problem statement	3-4
Purpose or research question	#4 Purpose of the study and specific objectives or questions	
Methods		
Qualitative approach and research paradigm	#5 Qualitative approach (e.g. ethnography, grounded theory, case study, phenomenology, narrative research) and guiding theory if appropriate; identifying the research paradigm (e.g. postpositivist, constructivist / interpretivist) is also recommended; rationale. The rationale should briefly discuss the justification for choosing that theory, approach, method or technique rather than other options available; the assumptions and limitations implicit in those choices and how those choices influence study conclusions and transferability. As appropriate the rationale for several items might be discussed together.	4-5

1	<i>Researcher characteristics and reflexivity</i>	#6	<i>Researchers' characteristics that may influence the research, including personal attributes, qualifications / experience, relationship with participants, assumptions and / or presuppositions; potential or actual interaction between researchers' characteristics and the research questions, approach, methods, results and / or transferability</i>	5-6
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7	<i>Context</i>	#7	<i>Setting / site and salient contextual factors; rationale</i>	5-6
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9	<i>Sampling strategy</i>	#8	<i>How and why research participants, documents, or events were selected; criteria for deciding when no further sampling was necessary (e.g. sampling saturation); rationale</i>	4-5
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12	<i>Ethical issues pertaining to human subjects</i>	#9	<i>Documentation of approval by an appropriate ethics review board and participant consent, or explanation for lack thereof; other confidentiality and data security issues</i>	5-7
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16	<i>Data collection methods</i>	#10	<i>Types of data collected; details of data collection procedures including (as appropriate) start and stop dates of data collection and analysis, iterative process, triangulation of sources / methods, and modification of procedures in response to evolving study findings; rationale</i>	4-6
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22	<i>Data collection instruments and technologies</i>	#11	<i>Description of instruments (e.g. interview guides, questionnaires) and devices (e.g. audio recorders) used for data collection; if / how the instruments(s) changed over the course of the study</i>	4
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27	<i>Units of study</i>	#12	<i>Number and relevant characteristics of participants, documents, or events included in the study; level of participation (could be reported in results)</i>	4
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30	<i>Data processing</i>	#13	<i>Methods for processing data prior to and during analysis, including transcription, data entry, data management and security, verification of data integrity, data coding, and anonymisation / deidentification of excerpts</i>	6
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35	<i>Data analysis</i>	#14	<i>Process by which inferences, themes, etc. were identified and developed, including the researchers involved in data analysis; usually references a specific paradigm or approach; rationale</i>	6
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40	<i>Techniques to enhance trustworthiness</i>	#15	<i>Techniques to enhance trustworthiness and credibility of data analysis (e.g. member checking, audit trail, triangulation); rationale</i>	6
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43	Results/findings			
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45	<i>Syntheses and interpretation</i>	#16	<i>Main findings (e.g. interpretations, inferences, and themes); might include development of a theory or model, or integration with prior research or theory</i>	7-12
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49	<i>Links to empirical data</i>	#17	<i>Evidence (e.g. quotes, field notes, text excerpts, photographs) to substantiate analytic findings</i>	n/a
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52	Discussion			
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54	<i>Integration with prior work, implications, transferability and contribution(s) to the field</i>	#18	<i>Short summary of main findings; explanation of how findings and conclusions connect to, support, elaborate on, or challenge conclusions of earlier scholarship; discussion of scope of application / generalizability; identification of unique contributions(s) to scholarship in a discipline or field</i>	12-15
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1	<i>Limitations</i>	#19	<i>Trustworthiness and limitations of findings</i>	15
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5	<i>Conflicts of interest</i>	#20	<i>Potential sources of influence of perceived influence on study conduct and conclusions; how these were managed</i>	16
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9	<i>Funding</i>	#21	<i>Sources of funding and other support; role of funders in data collection, interpretation and reporting</i>	16
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12 *None* The SRQR checklist is distributed with permission of Wolters Kluwer © 2014 by the Association of American Medical Colleges. This
13 checklist can be completed online using <https://www.goodreports.org/>, a tool made by the [EQUATOR Network](#) in collaboration with
14 [Penelope.ai](#)
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BMJ Open

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Keywords:	PUBLIC HEALTH, EPIDEMIOLOGY, Risk management < HEALTH SERVICES ADMINISTRATION & MANAGEMENT

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1 Prevalence and correlates of overweight and obesity
2 among adolescents in northeastern China: a
3 cross-sectional study

4 Ruixin Duan^{1, 2}, Changgui Kou¹, Jing Jie², Wei Bai¹, Xiaoxin Lan², Yuanyuan Li¹,
5 Xiao Yu¹, Bo Zhu¹, Haibo Yuan^{2*}

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20 Word count: 3592

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23 Abstract

24 **Objectives:** To estimate the prevalence of overweight/obesity among adolescents and
25 to evaluate the associated factors in this group in Changchun City, northeastern China.

26 **Methods:** A cross-sectional study of 1955 adolescents aged 11–18 years was
27 conducted in Changchun City, using stratified cluster sampling. Parents and
28 caregivers of children completed the questionnaires as requested without objection;
29 the questionnaire included demographic characteristics and anthropometric
30 parameters. Univariate and multivariate logistic regression analyses were performed
31 to analyze the relationship between overweight /obesity and related factors.

32 **Results:** In total, the prevalence of overweight was 12.7% (male 17.4%; female
33 10.1%), and the prevalence of obesity was 4.9% (male 8.8%; female 3.1%) in
34 Changchun, Jilin Province. The prevalence of overweight and obesity was higher in
35 males than that in females ($P < 0.001$). Multivariate logistic regression showed that
36 overweight and obesity were significantly associated with sex (OR=1.912, 95% CI:
37 1.481-2.469), weekly frequency of fruit consumption (OR=1.413, 95% CI:
38 1.085-1.840), picky eating (OR=0.691, 95% CI: 0.528-0.902), slowness in eating
39 (OR=1.373, 95% CI: 1.060-1.778), paternal weight (OR=0.665, 95% CI: 0.516-0.857)
40 and maternal weight (OR=0.723, 95% CI: 0.523-0.999).

41 **Conclusion:** The prevalence of overweight and obesity among adolescents in
42 Changchun was high in recent years. The prevalence of overweight and obesity
43 among males was higher than that among females. Sex, dietary habits (weekly

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4 44 frequency of fruit consumption, picky eating and slowness in eating) and parental
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7 45 weight were important factors for overweight and obesity in adolescents. Further
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10 46 research should be conducted on the health of adolescents in China and further
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12 47 intervention measures should be implemented to reduce the prevalence of
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15 48 overweight/obesity.

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18 49 **Keywords:** overweight; obesity; adolescent; association
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21 50 **Strengths and limitations of this study**

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26 51 ● There have been few studies on obesity among adolescents in North China, so we
27
28 52 studied the risk factors for obesity in adolescents.
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31 53 ● The strength of this study is the precise physical measurement, which improved
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33 54 the validity of the results.
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36 55 ● The analysis results might contain some confounding bias due to the
37
38 56 cross-sectional nature of the data.
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42 57 ● The results were from Changchun, the capital of Jilin Province and therefore
43
44 58 cannot be representative of the specific circumstances in all of China.
- 45
46
47 59 ● The results were mainly discussed in relation to previous Chinese studies,
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49 60 combined with Chinese geographical environment, dietary patterns and
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51 61 adolescent lifestyle.

52 53 54 55 56 57 62 **Introduction**

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4 63 The prevalence of obesity has increased dramatically among children, adolescents and
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7 64 adults worldwide in recent decades [1]. Overall, the global proportion of adolescents
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10 65 with obesity has increased significantly from just 4% in 1975 to just over 18% in
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12 66 2016[2]. There is compelling evidence revealing a significantly higher proportion of
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15 67 overweight or obese adolescents in recent years, which has reached alarming levels.
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18 68 Recently, scholars have conducted many studies on overweight and obesity.
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21 69 Overweight and obesity are predisposing factors for many chronic diseases, such as
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24 70 type 2 diabetes, cardiovascular diseases, respiratory diseases, musculoskeletal
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27 71 disorders, and various types of cancer[3]. Yan R et al. found an association of
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30 72 adolescent obesity with nonalcoholic fatty liver disease (NAFLD) and revealed that
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33 73 the incidence of NAFLD increased with increasing body weight[4]. Lisan Q et al.
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36 74 compared patients with obesity and severe obstructive sleep apnoea (OSA) with and
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39 75 without prescription of positive airway pressure (PAP) therapy and found that
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42 76 participants with PAP prescriptions had a higher BMI (Body mass index) than
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45 77 participants not prescribed PAP [5] . It has been estimated that overweight and obesity
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48 78 are the fifth leading cause of death worldwide, accounting for nearly 3.4 million
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51 79 deaths annually[6]. In addition, obesity is considered a risk factor for the development
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54 80 of chronic kidney disease [7]. In this context, the American Medical Association
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57 81 classified obesity as a disease to get physicians to pay more attention to the condition
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60 82 [8].

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4 83 In China, the largest developing country, nearly one-third of adolescents were
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7 84 overweight or obese in 2016, and the obesity prevalence rate increased from 0.10% in
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10 85 1976 to 8.50% in 2016. Sun HP found that the prevalence of obesity and of
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12 86 overweight and obesity combined was 8.1% and 19.2%, respectively, among children
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15 87 and adolescents at the age of 7–18 [9]. Zhang XY reported that the prevalence rates of
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17 88 overweight and obesity among primary school children were 15.2% and 11.7%,
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20 89 respectively, in Jiangsu Province[10]. Therefore, it is of key importance to understand
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23 90 the risk factors for overweight and obesity to prevent adolescents from developing the
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26 91 disease.

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29 92 We investigated the physical condition of adolescents aged 11-18 years from six
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32 93 middle schools in Changchun which is the capital of Jilin Province. The aim of the
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35 94 current study was to reveal the prevalence of overweight and obesity and to analyze
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38 95 various associated factors among adolescents with overweight and obesity in
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41 96 Changchun, Jilin.

42 43 97 **Methods**

44 45 46 47 98 **Subjects**

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51 99 The study sample comprised middle and high school students from six middle schools
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54 100 (three in urban areas and three in rural areas), selected randomly using stratified
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57 101 cluster sampling, in Changchun City, the capital of Jilin Province in Northeast China.
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60 102 Overall, 1955 students aged 11–18 years were included in this cross-sectional survey;

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4 103 subjects with overweight/obesity due to known metabolic and endocrine diseases
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7 104 were excluded. Students were also excluded if they had mental or physical
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10 105 impairments severe enough to cause abnormal behaviors, including congenital
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12 106 disease, intellectual disability, and a psychiatric disorder [11]. The study was
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14
15 107 approved by the ethics committee of the First Hospital of Jilin University (Reference
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17
18 108 Number: 2013-031). The investigation received informed consent from students and
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20
21 109 parents. We used the STROBE checklist in this study.
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24 110 **Data collection**

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28 111 The study was carried out by the First Hospital of Jilin University in April 2016. The
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31 112 project was named “Effect and mechanism of weight loss on upper airway
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33 113 collapsibility in obese patients with OSAS” and studied the associations of
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36 114 overweight, obesity and related factors with sleep-related breathing disorders and
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39 115 snoring in adolescents. In this database, we focused on the relevant indicators of
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41
42 116 overweight and obesity in adolescents and analyzed the risk factors for obesity in
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45 117 adolescents. The interviewers from the First Hospital of Jilin University helped
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48 118 parents or guardians complete the questionnaire and provided the data. The
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51 119 questionnaire included demographic characteristics (age, sex, area, dietary habits,
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53 120 sleep, exercise, highest parental education, birth history, BMI classification, paternal
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55 121 weight and maternal weight), anthropometric parameters (weight, height) and a
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58 122 paediatric sleep questionnaire- the Sleep-Related Breathing Disorder (PSQ-SRBD).
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4 123 The data about sleep duration and dietary habits (frequency of fresh fruits
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7 124 consumption, frequency of dessert consumption, frequency of breakfast consumption,
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10 125 frequency of fast food consumption, slowness in eating, picky eating) were selected
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12 126 from the PSQ-SRBD scale according to various reports[12-14] about adolescent
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15 127 obesity.

128 **Key variables**

129 Body mass index (BMI) is used here as an indicator of overweight and obesity in
130 adolescents and adults. Weight category was defined using age- and sex- specific
131 BMI cutoff points specifically developed for the Chinese adolescent population [15].
132 We used the 85th and 95th percentiles to define overweight and obesity in adolescents.
133 Therefore, BMI values of 24 and 28 were used as cut-off points
134 for overweight and obesity, both for males and females aged 18 years, which were
135 consistent with Chinese adults. In our study, parental overweight was divided into 2
136 groups: normal (BMI<24) and overweight or obese (BMI≥24) [14, 16]. Parents and
137 caregivers provided information on adolescents' weight (to the nearest 1 kg) and
138 height (to the nearest 1 cm). Overall children were classified by age into 3 groups
139 (<13 years, 13-15 years, >15 years), by region into 2 groups (urban, rural) and by sex
140 into 2 groups (male, female). Participants who slept less than 8 hours 3 days a week
141 were classified as 'sleep <8 h', and those who slept more than 10 hours 3 days a week
142 were defined as 'sleep >10 h'[17]. Birth history was divided into 3 groups: preterm

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4 143 birth (infants born alive before 37 weeks of pregnancy), full-term birth (infants born
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7 144 alive after 37 completed weeks to less than 42 completed weeks) and post-term birth
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10 145 (infants born alive at 42 completed weeks or after) [18]. Parental educational level
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12 146 was divided into 4 groups: primary school or lower (including those who had never
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14 147 attended school and those with elementary schooling only), junior high school, senior
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17 148 high school (including those with 3 years of secondary vocational schooling) and
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20 149 university or above [17]. According to the contents of the questionnaire, we classified
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23 150 the participants' eating habits. According to the Food Guide Pagoda [19], fruit intake
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26 151 should be 200-350 g/d, and sugar intake should be no more than 50 g/d, so we used
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29 152 eating "fresh fruits two or more days per week (350 g/d)", "dessert two or more days
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32 153 per week", "breakfast two or more days per week", and "fast food two or more days
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34 154 per week" as cut-offs. Participants who were classified as "picky eating" were defined
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37 155 as adolescents who had selectivity for a particular kind of food [20]. "Slowness in
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40 156 eating" was defined as adolescents with higher masticatory performance and who ate
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43 157 slowly [21]. Groups were formed according to the number of exercise days (aerobic,
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46 158 strength training or both for at least 30 minutes a day), including never (participate in
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49 159 sports ≤ 1 day per week), sometimes (participate in sports 2-3 days per week) and
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52 160 often (participate in sports ≥ 4 days per week) [22, 23].
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161 **Statistical analysis**

162 Data input was performed using Epidata 3.1, and statistical analysis was performed

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4 163 using SPSS 24.0. Frequency distributions are used to characterize subjects, and
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7 164 percentage data are used to report prevalence. The relationship between each factor
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10 165 and the adolescents' weight status was reflected by χ^2 tests and univariate and
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12 166 multivariate logistic regression. In univariate analysis, when $P < 0.10$, significant
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15 167 correlation factors were included in a forward stepwise multivariate logistic
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18 168 regression to exclude confounding factors. In all analyses, a two-tailed P value < 0.05
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21 169 was considered statistically significant. Since the database was manually collated,
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24 170 some variables in the database had missing values, which resulted in waste and bias of
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27 171 data resources. The missing value was numeric, and the data were approximately
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30 172 normally distributed. The mean interpolation method was adopted in this study.
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32 173 Therefore, we used the "replace missing value" function in SPSS 24.0 and selected
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34 174 the "mean of nearby points" method to interpolate the missing values.
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38 175 **Data availability**

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41 176 Data referenced in this study are available in the project titled "Effect and mechanism
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44 177 of weight loss on upper airway collapsibility in obese patients with OSAS". We
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47 178 selected a portion of the data from the database, including body measurements of
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50 179 adolescents from six middle schools in Changchun City. The data that support the
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53 180 findings of this study are available on request from the corresponding author [HY].
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56 181 The data are not publicly available because they contain information that could
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59 182 compromise research participant privacy or consent.
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183 **Patient and public involvement**

184 The interviewers from the First Hospital of Jilin University helped parents or
185 guardians complete the questionnaire and provided the data. The adolescents were not
186 involved in the design, recruitment or conduction of the study.

187 **Results**

188 On the basis of the inclusion and exclusion criteria, we chose 1955 adolescents from
189 Changchun, and of these adolescents, 1825 were finally analyzed in this study.
190 Participants with missing BMI values were excluded from the study. Since the survey
191 was already completed, we were unable to verify the source of data errors, so we
192 deleted data with missing BMI values. According to the analysis of the frequency
193 distribution, we found that there were 837 boys and 988 girls included; the median
194 age of the students was 15.30 years, ranging from 11 to 18 years; of all these subjects,
195 42.9% were from rural regions and 57.1% were from urban regions; and most of the
196 subjects were Han Chinese, accounting for 98.2%, with only a few participants with
197 minority ethnicities.

198 According to the worldwide BMI classification, the overall prevalence of overweight
199 was 12.7% (male 17.4%; female 10.1%), and the prevalence of obesity was 4.9%
200 (male 8.8%; female 3.1%) in Changchun City, Jilin Province (Table 1). The
201 overweight and obese rates were both higher in males than that in females ($P < 0.001$).
202 A higher prevalence of overweight was found in subjects whose ages ranged from

11-12 years, and the prevalence of obesity was higher in the age group from 13-15 years ($P=0.008$). Children from urban areas showed a significantly higher proportion of overweight. Full-term birth subjects had a higher prevalence of overweight than others ($P=0.014$). In addition, students' dietary habits, such as those who ate fruits less than twice a week ($P=0.029$), ate slowly ($P=0.004$) and those who were picky ($P=0.028$) had significant differences in overweight in the study. Paternal weight ($P=0.018$) and maternal weight ($P=0.006$) also had an effect on the children's weight.

Table 1

Prevalence of overweight and obesity according to demographic characteristics

Variables	n	Overweight		Obesity	
		PR (%)	<i>p</i>	PR (%)	<i>p</i>
Sex					
Male	837	17.4(14.9-20.3)	<0.001	8.8(6.9-11.2)	<0.001
Female	988	10.1 (8.3-12.2)		3.1(2.2-4.5)	
Area					
Urban	1042	14.4(12.4-16.7)	0.14	5.6(4.2-7.3)	0.863
Rural	783	12(9.8-14.5)		5.8(4.3-7.8)	
Age					
<13	168	19.3(13.9-26.1)	0.008	5.1(2.5-10.3)	0.816
13-15	1157	11.6(9.8-13.6)		5.9(4.6-7.5)	
>15	500	15.5(12.5-19.0)		5.2(3.4-7.7)	
Birth history					
Full-term birth	1621	14.2(12.5-16.0)	0.014	6.0(4.9-7.4)	0.285
Preterm birth	133	5.4(2.6-11.0)		3.2(1.2-8.2)	
Post-term birth	71	10.1(4.9-19.8)		3.1(0.8-11.7)	
Fruit ≤2 times/week					
Yes	1259	12.2(10.5-14.2)	0.029	4.8(3.7-6.2)	0.02
No	566	16.1(13.2-19.5)		7.7(5.6-10.4)	
Dessert ≤ 2 times/week					
Yes	887	12.4(10.4-14.8)	0.252	5.2(3.9-7.0)	0.49
No	938	14.3(12.1-16.7)		6.0(4.6-7.9)	
Breakfast ≤ 2					

times/week						
	Yes	1478	13.9(12.2-15.8)	0.185	5.8(4.7-7.3)	0.491
	No	347	11.1(8.2-15.0)		4.8(2.9-7.9)	
Fast food \leq 2						
times/week						
	Yes	264	10.0(6.8-14.3)	0.095	5.4(3.2-9.1)	0.402
	No	1561	13.9(12.3-15.8)		5.7(4.6-7.1)	
Slowness in eating						
	Yes	1174	16.5(13.8-19.7)	0.004	6.2(4.5-8.5)	0.496
	No	651	11.6(9.9-13.6)		5.4(4.1-6.9)	
Picky eating						
	Yes	1133	14.8(12.8-17.1)	0.028	6.7(5.3-8.4)	0.027
	No	692	11.1(8.9-13.7)		4.0(2.7-5.9)	
Exercise						
	Never	451	15.9(12.7-19.6)	0.194	4.2(2.6-6.7)	0.315
	Sometimes	478	12(9.3-15.3)		6.6(4.6-9.4)	
	Often	896	12.8(10.7-15.2)		5.8(4.4-7.7)	
Highest parental education						
	Primary school or lower	95	8.0(3.8-15.8)	0.196	8.0(3.8-15.8)	0.724
	Junior high school	799	13.0(10.8-15.6)		5.1(3.7-7.1)	
	Senior high school	468	15.8(12.7-19.5)		6.0(4.1-8.8)	
	University or above	463	12.7(9.9-16.2)		5.7(3.8-8.4)	
Sleep (hours/night)						
	<8	884	13.6(11.5-16.1)	0.809	5.3(3.9-7.2)	0.302
	\geq 8	861	13.3(11.1-15.8)		5.6(4.2-7.5)	
	>10	80	11.0(5.6-20.4)		9.7(4.7-19.0)	
Paternal weight						
	Normal	827	15.4(13.1-18.1)	0.018	7.6(6.0-9.8)	0.002
	Ow or ob	998	11.6(9.6-13.7)		3.8(2.7-5.4)	
Maternal weight						
	Normal	1099	14.8(13.0-16.8)	0.006	5.6(4.4-7.0)	0.807
	Ow or ob	726	8.5(6.1-11.7)		5.8(3.9-8.7)	

212 Note: *PR* (%), Prevalence rate; Ow or ob, Overweight or obese

213 To facilitate regression analysis, we divided the participants into two groups:

214 underweight and normal and overweight and obese. Table 2 shows the univariate

215 analysis of correlates of overweight and obesity in adolescents. As impressively

216 demonstrated in this table, the following factors all showed significant differences
 217 between two groups: sex, age, birth history, frequency of eating fruits, eating habits
 218 (slowness in eating, picky eating), and parental weights ($P < 0.05$). According to the
 219 results, we added all these significant factors to a forward stepwise multivariate
 220 logistic regression model.

221

222 **Table 2**223 **Univariate analysis of correlates of overweight and obesity in adolescents in Changchun**

Variables	<i>p</i>	<i>OR</i>	95% <i>CI</i>
Sex			
Female	<0.001	1	
Male		2.125	1.661-2.719
Area			
Urban	0.256	1	
Rural		1.150	0.902-1.473
Age			
<13	0.070	1	
13-15	0.041	0.664	0.448-0.984
>15	0.339	0.813	0.532-1.243
Birth history			
Full-term birth	0.008	1	
Preterm birth	0.004	0.394	0.21-0.739
Post-term birth	0.209	0.634	0.312-1.29
Fresh fruits ≤ 2 times/week			
Yes	0.003	1	
No		1.455	1.132-1.87
Dessert ≤ 2 times/week			
Yes	1.197	1	
No		1.172	0.921-1.493
Breakfast ≤ 2 times /week			
Yes	0.15	1	
No		0.789	0.571-1.089
Fast food ≤ 2 times /week			
Yes	0.16	1	

	No		1.080	0.972-1.19
Slowness in eating	Yes	0.007	1	
	No		0.713	0.558-0.911
Picky eating	Yes	0.004	1	
	No		0.691	0.526-0.882
Exercise	Never	0.74	1	
	Sometimes	0.502	0.892	0.638-1.246
	Often	0.484	0.901	0.672-1.207
Highest parental education	Primary school or lower	0.411	1	
	Junior high school	0.594	1.176	0.648-2.136
	Senior high school	0.229	1.454	0.79-2.678
	University or above	0.58	1.190	0.642-2.206
Sleep (hours/night)	<8	0.964	1	
	≥8	0.952	0.992	0.776-1.27
	>10	0.805	1.077	0.598-1.938
Paternal weight	Normal	0.001	1	
	Ow or ob		0.639	0.513-0.832
Maternal weight	Normal	0.011	1	
	Ow or ob		0.666	0.487-0.912

224 Note: Ow or ob, Overweight or obesity

225 Table 3 shows the results of logistic regression models comparing the prevalence of
 226 the potential risk factors: sex, age, birth history, frequency of eating fruits, dietary
 227 habits (slowness in eating, picky eating) and parental weight. In this forward stepwise
 228 multivariate logistic regression model, males were more likely to be overweight and
 229 obese than females (OR=1.912, 95% CI: 1.481-2.496). Students aged 13-15 years
 230 (OR=0.634, 95% CI: 0.420-0.957) were less likely to be overweight than those aged
 231 11-12 years. Compared with full-term birth, preterm birth (OR=0.450, 95% CI:

0.238-0.851) was associated with normal weight. Participants who ate fruit more than twice a week (OR=1.413, 95% CI: 1.085-1.840) were more likely to be overweight or obese. Moreover, the prevalence of overweight was lower in students who ate slowly (OR=1.373, 95% CI: 1.060-1.778). Students who were picky (OR=0.691, 95%CI: 0.528-0.902) were much more likely to be overweight than the subjects who ate a healthy diet.

Table 3

Multivariate regression analysis of correlates of overweight and obesity in

Changchun

Variables	<i>p</i>	β	SE	OR	95% CI
Sex					
Female				1	
Male	<0.001	0.648	0.130	1.912	1.481-2.496
Age					
<13				1	
13-15	0.030	-0.455	0.210	0.634	0.420-0.957
>15	0.121	-0.351	0.226	0.704	0.452-1.097
Birth history					
Full-term birth				1	
Preterm birth	0.014	-0.798	0.325	0.450	0.238-0.851
Post-term birth	0.337	-0.355	0.370	0.701	0.339-1.448
Fresh fruits \leq 2 times/week					
Yes				1	
No	0.010	0.346	0.135	1.413	1.085-1.840
Slowness in eating					
Yes				1	
No	0.016	0.317	0.132	1.373	1.060-1.778
Picky eating					
Yes				1	
No	0.007	-0.370	0.137	0.691	0.528-0.902
Paternal weight					

	Normal				1	
	Ow or ob	0.002	-0.408	0.130	0.665	0.507-0.831
Maternal weight	Normal					
	Ow or ob	0.049	-0.324	0.165	0.723	0.523-0.999

242 Note: Ow or ob, Overweight or obese

243 Discussion

244 To describe the epidemiology of overweight and obesity in Changchun City and
 245 analyze the influencing factors in adolescents, we conducted this survey of middle
 246 school students aged 11–18 years from urban and rural areas. We found that sex,
 247 dietary habits and parental weight had a significant impact on the children's weight.

248 Based on the data, we found that the prevalence of overweight was 12.7% (male
 249 17.4%; female 10.1%) and that the prevalence of obesity was 4.9% (male 8.8%;
 250 female 3.1%) among adolescents in Changchun City, Jilin Province. However, in
 251 recent studies, the overall prevalence of obesity in school-aged children in Xi'an was
 252 4.11%, and the rate of overweight was 6.6% among Nanjing adolescents; these rates
 253 were both lower than the corresponding rates in Changchun. This difference may be
 254 caused by the sample size, sex, and age of the studied population [24, 25]. In addition,
 255 demographic distribution and environmental factors are probable factors [26]. The
 256 economy in northeast China is less developed than that in east and south China to
 257 some extent [27]. Rates of overweight and obesity in rural areas were also higher in
 258 the north than that in the south [28]. Depending on the season, people in the north
 259 might eat high-energy foods to combat the cold, which is referred to “energy balance

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4 260 related behaviors [29, 30]". In our data, boys were more often obese than girls, in
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7 261 general, which was in agreement with previous Chinese reports [30-32]. A Swedish
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10 262 report [33] predicted that there was an alarming increase in the prevalence of
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12 263 overweight and obesity among adolescent boys, which was consistent with our
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15 264 finding. On the one hand, in traditional Chinese culture, the preference for boys may
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18 265 be the reason for the differences in diet, and the elderly believe that fat boys are more
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21 266 powerful than thin boys. On the other hand, well-groomed and fit girls are more
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24 267 favored by Chinese society [34-36]. Girls also tend to be more concerned about their
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27 268 weight than boys.

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29 269 We also found that adolescents who were picky, ate more fruits in general and ate
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32 270 quickly were more likely to be overweight or obese according to our survey. In recent
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35 271 reports [37, 38], a greater fruit intake was a protective factor against overweight,
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38 272 which was opposite of our result. Based on the results of our study, it was reasonable
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41 273 to speculate that the children were already full in addition to the excessive intake of
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44 274 fruits with high sugar content. However, the heavy study demand in China makes the
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47 275 children fail to consume the extra energy through exercise, thus leading to the
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50 276 possibility of being overweight.

51
52 277 According to the present cross-sectional study [39], food preference was an
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55 278 independent risk factor for overweight among children. It is known that children who
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58 279 had selectivity for a particular kind of food would prefer more fast food, snacks, and
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60 280 sugary beverage [40] and fewer fruits and vegetables [41]. However, the frequency of

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4 281 dessert and fast food consumption had no significant effect in our study, perhaps
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6 282 because the data were provided by parents or guardians who provided an inaccurate
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9 283 account of how often their children ate sweets and fast food. Currently, several studies
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12 284 have considered that food intake is a primary factor that determines body weight
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15 285 [42-44]. Y Li et al. concluded that excessive intake of cooking oil might be one of the
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18 286 risk factors for overweight [22]. Consistent with a previous study in Tianjin [42],
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21 287 overweight students preferred significantly more sweet foods and take-out food than
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24 288 their counterparts with normal weight. The result might be influenced by many
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27 289 elements, such as peer influence, food price, convenience, and online influence and so
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30 290 on, based on a recent report[45]. To decrease the prevalence of overweight and
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33 291 obesity, a series of interventions have been implemented, such as controlling TV time
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36 292 and increasing sport time.

37 293 In our research, we found that if fathers and mothers were overweight, adolescents
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40 294 were less likely to be overweight, which was the opposite of the previous conclusions
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43 295 [46-48]. Studies [49, 50] have found that a higher BMI of the father increased the risk
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46 296 of overweight/ obesity among males and females. However, this finding was not
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49 297 consistent across studies. In a previous study, the researchers found that the
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52 298 relationship between parents' and children's BMI did not exist when longitudinal
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55 299 analyses of changes in BMI over four years were performed [51]. This may explain
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58 300 why a short period of periodic surveys alone does not fully demonstrate a parent-child
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60 301 link to obesity, and we still need long-term research to further explore the relationship

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4 302 between the two factors. Moreover, children's growing environment and living habits
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7 303 will also affect their own obesity level, which will have an impact on our results [45].
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10 304 Further prospective studies that assess both energy expenditure and energy intake in
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12 305 children are more likely to clarify this concept. In addition, the use of BMI to assess
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14 306 parental weight status may be a limitation of this study, as BMI does not always
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17 307 reflect a person's body fat percentage, and we did not take into account parental waist
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20 308 circumference in this survey[49].
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23 309 There are several limitations to this study. First, the analysis results were restricted by
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25 310 the small sample size, and we interpolated missing values in the data, potentially
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28 311 resulting in random errors. Second, the conclusion might seem slightly limited in
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31 312 regard to assessing whether children were obese or not based on the value of BMI,
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34 313 which is a single index and may have potential for bias. If we could analyze the risk
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37 314 factors for obesity in teenagers from multiple perspectives based on the height-for-age
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40 315 Z-score (HAZ), we might obtain a more accurate conclusion, which is also a problem
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43 316 we need to address in the future. Third, the contents of the questionnaire were most
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46 317 recalled by the parents or guardians, and there might be information bias and
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49 318 confounding bias in this survey. Fourth, our data came from six schools in
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52 319 Changchun, which was not representative of the specific circumstances in Jilin
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55 320 Province. Further research should be conducted to validate the conclusion.

321 **Conclusions**

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4 322 In summary, in this cross-sectional study, we found that the prevalence of overweight
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6 323 and obesity among adolescents in Changchun, Jilin Province was high. Sex, age, birth
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9 324 history, dietary habits, and parental weight were important factors for overweight and
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12 325 obesity in adolescents. Therefore, reasonable lifestyle and effective weight control are
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15 326 necessary to prevent overweight and obesity in adolescents. There are still several
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18 327 limitations in this study, and we need to obtain more accurate information and
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21 328 perform more specific analysis. Further research should be conducted on the health of
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24 329 adolescents in China and further intervention measures should be implemented to
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27 330 decrease the prevalence of overweight and obesity.

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35 36 37 333 **Footnotes**

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44
45 335 study. HY, JJ and XL collected data. RD carried out the measurements, analyzed the
46
47
48 336 data and drafted the manuscript. XY and BZ participated in the coordination of the
49
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51 337 study and interpreted the data. WB and YL revised the manuscript. All authors have
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54 338 approved the final article.

55
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57
58
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342 **Competing interests:** None declared.

343 **Ethical approval:** The investigation was conducted by the First Hospital of Jilin
344 University in April 2016, our data collected from the questionnaire in the survey as
345 well. The study was approved by the ethics committee of the First Hospital of Jilin
346 University (Reference Number: 2013-031). The investigation has received informed
347 consent from students and parents.

348 **Data sharing:** Data referenced in this study are available in the project titled “Effect
349 and mechanism of weight loss on upper airway collapsibility in obese patients with
350 OSAS”. We selected a portion of the data from the database, including body
351 measurements of adolescents from six middle schools in Changchun City. The data
352 that support the findings of this study are available on request from the corresponding
353 author [HY]. The data are not publicly available because they contain information that
354 could compromise research participant privacy or consent.

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STROBE Statement—Checklist of items that should be included in reports of *cross-sectional studies*

	Item No	Recommendation	Page/line number
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	Page 1
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	Page 2-3, line 23-47
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	Page 3-5, line 61-88
Objectives	3	State specific objectives, including any prespecified hypotheses	Page 5, line 89-92
Methods			
Study design	4	Present key elements of study design early in the paper	Page 5-6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	Page 5-6
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants	Page 5, line 95-102
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	Page 7-8, line 127-158
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	Page 6, line 109-125
Bias	9	Describe any efforts to address potential sources of bias	Page 9, line 167-172
Study size	10	Explain how the study size was arrived at	Page 5, line 95-99
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	Page 7-8, line 127-158
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	Page 8-9, line 160-167
		(b) Describe any methods used to examine subgroups and interactions	Page 8-9, line 160-167
		(c) Explain how missing data were addressed	Page 9, line 167-172
		(d) If applicable, describe analytical methods taking account of sampling strategy	N/A
		(e) Describe any sensitivity analyses	Page 8-9, line 160-167
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	Page 10, line 186-192
		(b) Give reasons for non-participation at each stage	N/A
		(c) Consider use of a flow diagram	N/A
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential	Page 9-10

		confounders	
		(b) Indicate number of participants with missing data for each variable of interest	Page 10, line 186-190
Outcome data	15*	Report numbers of outcome events or summary measures	Page 10, line 186-192
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	Page 11-12
		(b) Report category boundaries when continuous variables were categorized	N/A
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	Page 12-15
Discussion			
Key results	18	Summarise key results with reference to study objectives	Page 16, line 242-245
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	Page 19, line 306-317
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	Page 15-19
Generalisability	21	Discuss the generalisability (external validity) of the study results	Page 19-20, line 319-327
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	Page 20, line 336-338

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ Open

Prevalence and correlates of overweight and obesity among adolescents in northeastern China: a cross-sectional study

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Primary Subject Heading:	Epidemiology
Secondary Subject Heading:	Public health
Keywords:	PUBLIC HEALTH, EPIDEMIOLOGY, Risk management < HEALTH SERVICES ADMINISTRATION & MANAGEMENT

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1 Prevalence and correlates of overweight and obesity
2 among adolescents in northeastern China: a
3 cross-sectional study

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21
22

23 Abstract

24 **Objectives:** To estimate the prevalence of overweight/obesity among adolescents and
25 to evaluate the associated factors in this group in Changchun City, northeastern China.

26 **Methods:** A cross-sectional study of 1955 adolescents aged 11–18 years was
27 conducted in Changchun City, using stratified cluster sampling. Parents and
28 caregivers of children completed the questionnaires as requested without objection;
29 the questionnaire included demographic characteristics and anthropometric
30 parameters. Univariate and multivariate logistic regression analyses were performed
31 to analyze the relationship between overweight /obesity and related factors.

32 **Results:** In total, the prevalence of overweight was 12.7% (male 17.4%; female
33 10.1%), and the prevalence of obesity was 4.9% (male 8.8%; female 3.1%) in
34 Changchun, Jilin Province. The prevalence of overweight and obesity was higher in
35 males than that in females ($P < 0.001$). Multivariate logistic regression showed that
36 overweight and obesity were significantly associated with male (OR=1.91, 95% CI:
37 1.48-2.47), fresh fruits two or more days per week (OR=1.41, 95% CI: 1.09-1.84),
38 eating quickly (OR=1.37, 95% CI: 1.06-1.78). The students who were not picky
39 (OR=0.69, 95% CI: 0.53-0.90) were less likely to be overweight. And adolescents
40 whose father were overweight or obese (OR=0.67, 95% CI: 0.52-0.86) or mother
41 were overweight or obese (OR=0.72, 95% CI: 0.52-0.99) were less likely to be
42 overweight.

43 **Conclusion:** The prevalence of overweight and obesity among adolescents in

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4 44 Changchun was high in recent years. The prevalence of overweight and obesity
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7 45 among males was higher than that among females. Sex, dietary habits (weekly
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10 46 frequency of fruit consumption, picky eating and slowness in eating) and parental
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12 47 weight were important factors for overweight and obesity in adolescents. Further
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15 48 research should be conducted on the health of adolescents in China and further
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18 49 intervention measures should be implemented to reduce the prevalence of
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21 50 overweight/obesity.

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23 51 **Keywords:** overweight; obesity; adolescent; association
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27 52 **Strengths and limitations of this study**

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- 31 53 ● In the cross-sectional study, participants were randomly selected from rural and
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34 54 urban areas by stratified cluster sampling.
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37 55 ● Weight category was defined using age- and sex- specific BMI cutoff points
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40 56 specifically developed for the Chinese adolescent population.
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43 57 ● The influence of confounding factors on the results was effectively controlled by
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46 58 the multivariate logistic regression method.
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49 59 ● Missing data from childhood measurements were handled with a mean
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52 60 imputation technique.
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55 61 ● The contents of the questionnaire were most recalled by the parents or guardians
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58 62 and there might be information bias in this survey.

59 63 **Introduction**

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4 64 The prevalence of obesity has increased dramatically among children, adolescents and
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7 65 adults worldwide in recent decades [1]. Overall, the global proportion of adolescents
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10 66 with obesity has increased significantly from just 4% in 1975 to just over 18% in
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13 67 2016 [2]. There is compelling evidence revealing a significantly higher proportion of
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15 68 overweight or obese adolescents in recent years, which has reached alarming levels.
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18 69 Recently, scholars have conducted many studies on overweight and obesity.
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21 70 Overweight and obesity are predisposing factors for many chronic diseases, such as
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24 71 type 2 diabetes, cardiovascular diseases, respiratory diseases, musculoskeletal
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27 72 disorders, and various types of cancer [3]. Yan R et al. found an association of
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30 73 adolescent obesity with nonalcoholic fatty liver disease (NAFLD) and revealed that
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33 74 the incidence of NAFLD increased with increasing body weight [4]. Lisan Q et al.
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36 75 compared patients with obesity and severe obstructive sleep apnoea (OSA) with and
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39 76 without prescription of positive airway pressure (PAP) therapy and found that
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42 77 participants with PAP prescriptions had a higher BMI (Body mass index) than
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45 78 participants not prescribed PAP [5]. It has been estimated that overweight and obesity
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48 79 are the fifth leading cause of death worldwide, accounting for nearly 3.4 million
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51 80 deaths annually [6]. In addition, obesity is considered a risk factor for the
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54 81 development of chronic kidney disease [7]. In this context, the American Medical
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57 82 Association classified obesity as a disease to get physicians to pay more attention to
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60 83 the condition [8].

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4 84 In China, the largest developing country, nearly one-third of adolescents were
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7 85 overweight or obese in 2016, and the obesity prevalence rate increased from 0.10% in
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10 86 1976 to 8.50% in 2016. Sun HP found that the prevalence of obesity and of
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12 87 overweight and obesity combined was 8.1% and 19.2%, respectively, among children
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15 88 and adolescents at the age of 7–18 [9]. Zhang XY reported that the prevalence rates of
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17 89 overweight and obesity among primary school children were 15.2% and 11.7%,
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20 90 respectively, in Jiangsu Province [10]. Therefore, it is of key importance to
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23 91 understand the risk factors for overweight and obesity to prevent adolescents from
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26 92 developing the disease.

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28 93 We investigated the physical condition of adolescents aged 11-18 years from six
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31 94 middle schools in Changchun which is the capital of Jilin Province. The aim of the
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34 95 current study was to reveal the prevalence of overweight and obesity and to analyze
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37 96 various associated factors among adolescents with overweight and obesity in
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40 97 Changchun, Jilin.

41 42 43 98 **Methods**

44 45 46 47 99 **Subjects**

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51 100 A cross-sectional survey was conducted in Changchun City, the capital of Jilin
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54 101 Province in Northeast China. The study sample comprised middle and high school
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57 102 students from six middle schools (three in urban areas and three in rural areas),
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60 103 selected randomly using stratified cluster sampling. Overall, 1955 students aged 11–

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4 104 18 years were included in this cross-sectional survey; subjects with
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7 105 overweight/obesity due to known metabolic and endocrine diseases were excluded.
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9 106 Students were also excluded if they had mental or physical impairments severe
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12 107 enough to cause abnormal behaviors, including congenital disease, intellectual
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15 108 disability, and a psychiatric disorder [11]. We used the STROBE checklist in this
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18 109 study.

110 **Data collection**

111 The study was carried out by the First Hospital of Jilin University in April 2016. The
112 study was approved by the ethics committee of the First Hospital of Jilin University
113 (Reference Number: 2013-031). The investigation received informed consent from
114 students and parents. The project was named “Effect and mechanism of weight loss
115 on upper airway collapsibility in obese patients with OSAS” and studied the
116 associations of overweight, obesity and related factors with sleep-related breathing
117 disorders and snoring in adolescents. In this database, we focused on the relevant
118 indicators of overweight and obesity in adolescents and analyzed the risk factors for
119 obesity in adolescents. The interviewers from the First Hospital of Jilin University
120 helped parents or guardians complete the questionnaire and provided the data. The
121 questionnaire included demographic characteristics (age, sex, area, dietary habits,
122 sleep, exercise, highest parental education, birth history, BMI classification, paternal
123 weight and maternal weight), anthropometric parameters (weight, height) and a

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4 124 paediatric sleep questionnaire- the Sleep-Related Breathing Disorder (PSQ-SRBD).
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7 125 The data about sleep duration and dietary habits (frequency of fresh fruits
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10 126 consumption, frequency of dessert consumption, frequency of breakfast consumption,
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12 127 frequency of fast food consumption, slowness in eating, picky eating) were selected
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15 128 from the PSQ-SRBD scale according to various reports [12-14] about adolescent
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18 129 obesity.

130 **Key variables**

131 Body mass index (BMI) is used here as an indicator of overweight and obesity in
132 adolescents and adults. Weight category was defined using age- and sex- specific
133 BMI cutoff points specifically developed for the Chinese adolescent population [15].
134 We used the 85th and 95th percentiles to define overweight and obesity in adolescents.
135 Therefore, BMI values of 24 and 28 were used as cut-off points
136 for overweight and obesity, both for males and females aged 18 years, which were
137 consistent with Chinese adults. In our study, parental overweight was divided into 2
138 groups: normal (BMI<24) and overweight or obese (BMI≥24) [14, 16]. Parents and
139 caregivers provided information on adolescents' weight (to the nearest 1 kg) and
140 height (to the nearest 1 cm). Overall children were classified by age into 3 groups
141 (<13 years, 13-15 years, >15 years), by region into 2 groups (urban, rural) and by sex
142 into 2 groups (male, female). Participants who slept less than 8 hours 3 days a week
143 were classified as 'sleep <8 h', and those who slept more than 10 hours 3 days a week

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4 144 were defined as 'sleep >10 h' [17]. Birth history was divided into 3 groups: preterm
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7 145 birth (infants born alive before 37 weeks of pregnancy), full-term birth (infants born
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10 146 alive after 37 completed weeks to less than 42 completed weeks) and post-term birth
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12 147 (infants born alive at 42 completed weeks or after) [18]. Parental educational level
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15 148 was divided into 4 groups: primary school or lower (including those who had never
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17 149 attended school and those with elementary schooling only), junior high school, senior
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20 150 high school (including those with 3 years of secondary vocational schooling) and
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23 151 university or above [17]. According to the contents of the questionnaire, we classified
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26 152 the participants' eating habits. According to the Food Guide Pagoda [19], fruit intake
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28 153 should be 200-350 g/d, and sugar intake should be no more than 50 g/d, so we used
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31 154 eating "fresh fruits two or more days per week (350 g/d)", "dessert two or more days
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34 155 per week", "breakfast two or more days per week", and "fast food two or more days
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37 156 per week" as cut-offs. Participants who were classified as "picky eating" were defined
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39 157 as adolescents who had selectivity for a particular kind of food [20]. "Slowness in
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42 158 eating" was defined as adolescents with higher masticatory performance and who ate
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45 159 slowly [21]. Groups were formed according to the number of exercise days (aerobic,
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47 160 strength training or both for at least 30 minutes a day), including never (participate in
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50 161 sports \leq 1 day per week), sometimes (participate in sports 2-3 days per week) and
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53 162 often (participate in sports \geq 4 days per week) [22, 23].

163 **Statistical analysis**

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4 164 Data input was performed using Epidata 3.1, and statistical analysis was performed
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7 165 using SPSS 24.0. Frequency distributions are used to characterize subjects, and
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10 166 percentage data are used to report prevalence. The relationship between each factor
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12 167 and the adolescents' weight status was reflected by χ^2 tests and univariate and
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15 168 multivariate logistic regression. In univariate analysis, when $P < 0.10$, significant
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18 169 correlation factors were included in a forward stepwise multivariate logistic
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21 170 regression to exclude confounding factors. In all analyses, a two-tailed P value < 0.05
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24 171 was considered statistically significant. Since the database was manually collated,
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27 172 some variables in the database had missing values, which resulted in waste and bias of
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30 173 data resources. The missing value was numeric, and the data were approximately
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33 174 normally distributed. The mean interpolation method was adopted in this study.
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36 175 Therefore, we used the "replace missing value" function in SPSS 24.0 and selected
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38
39 176 the "mean of nearby points" method to interpolate the missing values.

177 **Data availability**

178 Data referenced in this study are available in the project titled "Effect and mechanism
179 of weight loss on upper airway collapsibility in obese patients with OSAS". We
180 selected a portion of the data from the database, including body measurements of
181 adolescents from six middle schools in Changchun City. The data that support the
182 findings of this study are available on request from the corresponding author [HY].
183 The data are not publicly available because they contain information that could

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4 184 compromise research participant privacy or consent.
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8 185 **Patient and public involvement**

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11 186 The interviewers from the First Hospital of Jilin University helped parents or
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14 187 guardians complete the questionnaire and provided the data. The adolescents were not
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17 188 involved in the design, recruitment or conduction of the study.
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20 21 189 **Results**

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25 190 On the basis of the inclusion and exclusion criteria, we chose 1955 adolescents from
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28 191 Changchun, and of these adolescents, 1825 were finally analyzed in this study.
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31 192 Participants with missing BMI values were excluded from the study. Since the survey
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34 193 was already completed, we were unable to verify the source of data errors, so we
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37 194 deleted data with missing BMI values. According to the analysis of the frequency
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40 195 distribution, we found that there were 837 boys and 988 girls included; the median
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43 196 age of the students was 15.30 years, ranging from 11 to 18 years; of all these subjects,
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46 197 42.9% were from rural regions and 57.1% were from urban regions; and most of the
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49 198 subjects were Han Chinese, accounting for 98.2%, with only a few participants with
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52 199 minority ethnicities.

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55 200 According to the worldwide BMI classification, the overall prevalence of overweight
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58 201 was 12.7% (male 17.4%; female 10.1%), and the prevalence of obesity was 4.9%
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202 (male 8.8%; female 3.1%) in Changchun City, Jilin Province (Table 1). The

203 overweight and obese rates were both higher in males than that in females ($P < 0.001$).

204 A higher prevalence of overweight was found in subjects whose ages ranged from

205 11-12 years, and the prevalence of obesity was higher in the age group from 13-15

206 years ($P = 0.008$). Children from urban areas showed a significantly higher proportion

207 of overweight. Full-term birth subjects had a higher prevalence of overweight than

208 others ($P = 0.014$). In addition, students' dietary habits, such as those who ate fruits

209 less than twice a week ($P = 0.029$), ate slowly ($P = 0.004$) and those who were picky (P

210 $= 0.028$) had significant differences in overweight in the study. Paternal weight (P

211 $= 0.018$) and maternal weight ($P = 0.006$) also had an effect on the children's weight.

212 **Table 1**

213 **Prevalence of overweight and obesity according to demographic characteristics**

Variables	n	Overweight		Obesity	
		PR (%)	<i>p</i>	PR (%)	<i>p</i>
Sex					
Male	837	17.4(14.9-20.3)	<0.001	8.8(6.9-11.2)	<0.001
Female	988	10.1 (8.3-12.2)		3.1(2.2-4.5)	
Area					
Urban	1042	14.4(12.4-16.7)	0.14	5.6(4.2-7.3)	0.863
Rural	783	12(9.8-14.5)		5.8(4.3-7.8)	
Age					
<13	168	19.3(13.9-26.1)	0.008	5.1(2.5-10.3)	0.816
13-15	1157	11.6(9.8-13.6)		5.9(4.6-7.5)	
>15	500	15.5(12.5-19.0)		5.2(3.4-7.7)	
Birth history					
Full-term birth	1621	14.2(12.5-16.0)	0.014	6.0(4.9-7.4)	0.285
Preterm birth	133	5.4(2.6-11.0)		3.2(1.2-8.2)	
Post-term birth	71	10.1(4.9-19.8)		3.1(0.8-11.7)	
Fruit \leq 2 times/week					
Yes	1259	12.2(10.5-14.2)	0.029	4.8(3.7-6.2)	0.02
No	566	16.1(13.2-19.5)		7.7(5.6-10.4)	
Dessert \leq 2					

times/week						
Yes	887	12.4(10.4-14.8)	0.252	5.2(3.9-7.0)	0.49	
No	938	14.3(12.1-16.7)		6.0(4.6-7.9)		
Breakfast \leq 2						
times/week						
Yes	1478	13.9(12.2-15.8)	0.185	5.8(4.7-7.3)	0.491	
No	347	11.1(8.2-15.0)		4.8(2.9-7.9)		
Fast food \leq 2						
times/week						
Yes	264	10.0(6.8-14.3)	0.095	5.4(3.2-9.1)	0.402	
No	1561	13.9(12.3-15.8)		5.7(4.6-7.1)		
Slowness in eating						
Yes	1174	16.5(13.8-19.7)	0.004	6.2(4.5-8.5)	0.496	
No	651	11.6(9.9-13.6)		5.4(4.1-6.9)		
Picky eating						
Yes	1133	14.8(12.8-17.1)	0.028	6.7(5.3-8.4)	0.027	
No	692	11.1(8.9-13.7)		4.0(2.7-5.9)		
Exercise						
Never	451	15.9(12.7-19.6)	0.194	4.2(2.6-6.7)	0.315	
Sometimes	478	12(9.3-15.3)		6.6(4.6-9.4)		
Often	896	12.8(10.7-15.2)		5.8(4.4-7.7)		
Highest parental education						
Primary school or lower	95	8.0(3.8-15.8)	0.196	8.0(3.8-15.8)	0.724	
Junior high school	799	13.0(10.8-15.6)		5.1(3.7-7.1)		
Senior high school	468	15.8(12.7-19.5)		6.0(4.1-8.8)		
University or above	463	12.7(9.9-16.2)		5.7(3.8-8.4)		
Sleep (hours/night)						
<8	884	13.6(11.5-16.1)	0.809	5.3(3.9-7.2)	0.302	
\geq 8	861	13.3(11.1-15.8)		5.6(4.2-7.5)		
>10	80	11.0(5.6-20.4)		9.7(4.7-19.0)		
Paternal weight						
Normal	827	15.4(13.1-18.1)	0.018	7.6(6.0-9.8)	0.002	
Ow or ob	998	11.6(9.6-13.7)		3.8(2.7-5.4)		
Maternal weight						
Normal	1099	14.8(13.0-16.8)	0.006	5.6(4.4-7.0)	0.807	
Ow or ob	726	8.5(6.1-11.7)		5.8(3.9-8.7)		

214 Note: *PR* (%), Prevalence rate; Ow or ob, Overweight or obese

215 To facilitate regression analysis, we divided the participants into two groups:

216 underweight and normal and overweight and obese. Table 2 shows the univariate
 217 analysis of correlates of overweight and obesity in adolescents. As impressively
 218 demonstrated in this table, the following factors all showed significant differences
 219 between two groups: sex, age, birth history, frequency of eating fruits, eating habits
 220 (slowness in eating, picky eating), and parental weights ($P < 0.05$). According to the
 221 results, we added all these significant factors to a forward stepwise multivariate
 222 logistic regression model.

223 **Table 2**

224 **Univariate analysis of correlates of overweight and obesity in adolescents in Changchun**

Variables	<i>p</i>	<i>OR</i>	95% <i>CI</i>
Sex			
Female	<0.001	1	
Male		2.13	1.66-2.72
Area			
Urban	0.256	1	
Rural		1.15	0.90-1.47
Age			
<13	0.070	1	
13-15	0.041	0.67	0.45-0.98
>15	0.339	0.81	0.53-1.24
Birth history			
Full-term birth	0.008	1	
Preterm birth	0.004	0.40	0.21-0.74
Post-term birth	0.209	0.63	0.31-1.29
Fresh fruits ≤ 2 times/week			
Yes	0.003	1	
No		1.46	1.13-1.87
Dessert ≤ 2 times/week			
Yes	1.197	1	
No		1.17	0.92-1.49
Breakfast ≤ 2 times /week			
Yes	0.15	1	
No		0.79	0.57-1.09

Fast food \leq 2 times /week				
	Yes	0.135	1	
	No		1.32	0.92-1.91
Slowness in eating				
	Yes	0.007	1	
	No		0.71	0.56-0.91
Picky eating				
	Yes	0.004	1	
	No		0.69	0.53-0.88
Exercise				
	Never	0.74	1	
	Sometimes	0.502	0.89	0.64-1.25
	Often	0.484	0.90	0.67-1.21
Highest parental education				
	Primary school or lower	0.411	1	
	Junior high school	0.594	1.18	0.65-2.14
	Senior high school	0.229	1.45	0.79-2.68
	University or above	0.58	1.19	0.64-2.21
Sleep (hours/night)				
	<8	0.964	1	
	\geq 8	0.952	0.99	0.78-1.27
	>10	0.805	1.08	0.60-1.94
Paternal weight				
	Normal	0.001	1	
	Ow or ob		0.64	0.51-0.83
Maternal weight				
	Normal	0.011	1	
	Ow or ob		0.67	0.49-0.91

225 Note: Ow or ob, Overweight or obesity

226 Table 3 shows the results of logistic regression models comparing the prevalence of
 227 the potential risk factors: sex, age, birth history, frequency of eating fruits, dietary
 228 habits (slowness in eating, picky eating) and parental weight. In this forward stepwise
 229 multivariate logistic regression model, males were more likely to be overweight and
 230 obese than females (OR=1.91, 95% CI: 1.48-2.50). Students aged 13-15 years
 231 (OR=0.63, 95% CI: 0.42-0.96) were less likely to be overweight than those aged

11-12 years. Compared with full-term birth, preterm birth (OR=0.45, 95% CI: 0.24-0.85) was associated with normal weight. Participants who ate fruit more than twice a week (OR=1.41, 95% CI: 1.09-1.84) were more likely to be overweight or obese. Moreover, the prevalence of overweight was higher in students who ate quickly (OR=1.37, 95% CI: 1.06-1.78) than those who ate slowly. Students who were not picky (OR=0.69, 95%CI: 0.53-0.90) were less likely to be overweight than the subjects who ate a healthy diet.

Table 3

Multivariate regression analysis of correlates of overweight and obesity in

Changchun

Variables	<i>p</i>	β	SE	OR	95% CI
Sex					
Female				1	
Male	<0.001	0.65	0.13	1.91	1.48-2.50
Age					
<13				1	
13-15	0.030	-0.46	0.21	0.63	0.42-0.96
>15	0.121	-0.35	0.23	0.70	0.45-1.10
Birth history					
Full-term birth				1	
Preterm birth	0.014	-0.80	0.33	0.45	0.24-0.85
Post-term birth	0.337	-0.36	0.37	0.70	0.34-1.45
Fresh fruits \leq 2 times/week					
Yes				1	
No	0.010	0.35	0.14	1.41	1.09-1.84
Slowness in eating					
Yes				1	
No	0.016	0.32	0.13	1.37	1.06-1.78
Picky eating					
Yes				1	
No	0.007	-0.37	0.14	0.69	0.53-0.90
Paternal weight					

	Normal				1	
	Ow or ob	0.002	-0.41	0.13	0.67	0.51-0.83
Maternal weight	Normal					
	Ow or ob	0.049	-0.32	0.17	0.72	0.53-0.99

242 Note: Ow or ob, Overweight or obese

243 Discussion

244 To describe the epidemiology of overweight and obesity in Changchun City and
 245 analyze the influencing factors in adolescents, we conducted this survey of middle
 246 school students aged 11–18 years from urban and rural areas. We found that sex,
 247 dietary habits and parental weight had a significant impact on the children's weight.

248 Based on the data, we found that the prevalence of overweight was 12.7% (male
 249 17.4%; female 10.1%) and that the prevalence of obesity was 4.9% (male 8.8%;
 250 female 3.1%) among adolescents in Changchun City, Jilin Province. However, in
 251 recent studies, the overall prevalence of obesity in school-aged children in Xi'an was
 252 4.11%, and the rate of overweight was 6.6% among Nanjing adolescents; these rates
 253 were both lower than the corresponding rates in Changchun. This difference may be
 254 caused by the sample size, sex, and age of the studied population [24, 25]. In addition,
 255 demographic distribution and environmental factors are probable factors [26]. The
 256 economy in northeast China is less developed than that in east and south China to
 257 some extent [27]. Rates of overweight and obesity in rural areas were also higher in
 258 the north than that in the south [28]. Depending on the season, people in the north
 259 might eat high-energy foods to combat the cold, which is referred to “energy balance

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4 260 related behaviors [29, 30]". In our data, boys were more often obese than girls, in
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7 261 general, which was in agreement with previous Chinese reports [30-32]. A Swedish
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10 262 report [33] predicted that there was an alarming increase in the prevalence of
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12 263 overweight and obesity among adolescent boys, which was consistent with our
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15 264 finding. On the one hand, in traditional Chinese culture, the preference for boys may
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18 265 be the reason for the differences in diet, and the elderly believe that fat boys are more
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21 266 powerful than thin boys. On the other hand, well-groomed and fit girls are more
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24 267 favored by Chinese society [34-36]. Girls also tend to be more concerned about their
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27 268 weight than boys.

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29 269 We also found that adolescents who were picky, ate more fruits in general and ate
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32 270 quickly were more likely to be overweight or obese according to our survey. In recent
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35 271 reports [37, 38], a greater fruit intake was a protective factor against overweight,
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38 272 which was opposite of our result. Fructose, which is ubiquitous found in fruit and
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41 273 sugar-sweetened beverages, is one of the factors contributing to rising obesity rates
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44 274 [39, 40]. High intakes of fructose may decrease the abundance of the bacterial species
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47 275 *Eubacterium eligens*, reduce metabolism of monosaccharide and lose the ability to
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50 276 consume large amounts of fat [41]. The fructose intake threshold of adolescents is
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53 277 currently average 75g/d. If teenagers get too much fructose without consuming
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56 278 glycogen in time, fructose will be converted into fat at a higher rate [42, 43]. Based on
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59 279 the results of our study, it was reasonable to speculate that the children were already
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280 full in addition to the excessive intake of fruits with high sugar content. However, the

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4 281 heavy study demand in China makes the children fail to consume the extra energy
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6 282 through exercise, thus leading to the possibility of being overweight. Further research
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9 283 should be conducted to validate the conclusion.
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12 284 According to the present cross-sectional study [44], food preference was an
13
14 285 independent risk factor for overweight among children. It is known that children who
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17 286 had selectivity for a particular kind of food would prefer more fast food, snacks, and
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20 287 sugary beverage [45] and fewer fruits and vegetables [46]. However, the frequency of
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23 288 dessert and fast food consumption had no significant effect in our study, perhaps
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26 289 because the data were provided by parents or guardians who provided an inaccurate
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29 290 account of how often their children ate sweets and fast food. Currently, several studies
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32 291 have considered that food intake is a primary factor that determines body weight
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34 292 [47-49]. Y Li et al. concluded that excessive intake of cooking oil might be one of the
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37 293 risk factors for overweight [22]. Consistent with a previous study in Tianjin [47],
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40 294 overweight students preferred significantly more sweet foods and take-out food than
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43 295 their counterparts with normal weight. The result might be influenced by many
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46 296 elements, such as peer influence, food price, convenience, and online influence and so
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48
49 297 on, based on a recent report [50]. To decrease the prevalence of overweight and
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52 298 obesity, a series of interventions have been implemented, such as controlling TV time
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55 299 and increasing sport time.

56 300 In our research, we found that if fathers and mothers were overweight, adolescents
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58 301 were less likely to be overweight, which was inconsistent with the previous
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4 302 conclusions [51-53]. Studies [54, 55] have found that a higher BMI of the father
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7 303 increased the risk of overweight/ obesity among males and females. However, this
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10 304 finding was not consistent across studies. In a previous study, the researchers found
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12 305 that the relationship between parents' and children's BMI did not exist when
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15 306 longitudinal analyses of changes in BMI over four years were performed [56]. This
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17 307 may explain why a short period of periodic surveys alone does not fully demonstrate a
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20 308 parent-child link to obesity, and we still need long-term research to further explore the
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23 309 relationship between the two factors. Berge JM et al. found that overweight or obese
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26 310 parents were more likely to adopt a strict dietary restriction to prevent adolescent
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28 311 obesity [57]. Moreover, children's growing environment and living habits will also
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31 312 affect their own obesity level, which will have an impact on our results [50]. Further
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34 313 prospective studies that assess both energy expenditure and energy intake in children
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37 314 are more likely to clarify this concept.

38
39 315 However, some potential limitations exist in this cross-sectional study. The contents
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42 316 of the questionnaire were most recalled by the parents or guardians and there might be
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45 317 information bias in this survey. In addition, we set the classification standard of eating
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47 318 fruit frequency as "eating fruit 2 days a week" combined with the questionnaire data
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50 319 recalled by the parents or guardians, which may not be appropriate, so different
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53 320 results could have been obtained. Further research should be conducted to validate the
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56 321 conclusion.

322 **Conclusions**

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4 323 In summary, in this cross-sectional study, we found that the prevalence of overweight
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6 324 and obesity among adolescents in Changchun, Jilin Province was high. Sex, age, birth
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9 325 history, dietary habits, and parental weight were important factors for overweight and
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12 326 obesity in adolescents. Therefore, reasonable lifestyle and effective weight control are
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15 327 necessary to prevent overweight and obesity in adolescents. There are still several
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18 328 limitations in this study, and we need to obtain more accurate information and
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21 329 perform more specific analysis. Further research should be conducted on the health of
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24 330 adolescents in China and further intervention measures should be implemented to
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27 331 decrease the prevalence of overweight and obesity.

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334 **Footnotes**

335 **Contributors:** RD, CK and HY conceived the study, participated in the design of the
336 study. HY, JJ and XL collected data. RD carried out the measurements, analyzed the
337 data and drafted the manuscript. XY and BZ participated in the coordination of the
338 study and interpreted the data. WB and YL revised the manuscript. All authors have
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343 **Competing interests:** None declared.

344 **Ethical approval:** The investigation was conducted by the First Hospital of Jilin
345 University in April 2016, our data collected from the questionnaire in the survey as
346 well. The study was approved by the ethics committee of the First Hospital of Jilin
347 University (Reference Number: 2013-031). The investigation has received informed
348 consent from students and parents.

349 **Data sharing:** Data referenced in this study are available in the project titled “Effect
350 and mechanism of weight loss on upper airway collapsibility in obese patients with
351 OSAS”. We selected a portion of the data from the database, including body
352 measurements of adolescents from six middle schools in Changchun City. The data
353 that support the findings of this study are available on request from the corresponding
354 author [HY]. The data are not publicly available because they contain information that
355 could compromise research participant privacy or consent.

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60STROBE Statement—Checklist of items that should be included in reports of *cross-sectional studies*

	Item No	Recommendation	Page/line number
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	Page 1
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	Page 2-3, line 23-48
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	Page 3-5, line 61-90
Objectives	3	State specific objectives, including any prespecified hypotheses	Page 5, line 91-94
Methods			
Study design	4	Present key elements of study design early in the paper	Page 5-6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	Page 5-6
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants	Page 5-6, line 97-104
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	Page 7-8, line 127-158
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	Page 6, line 107-125
Bias	9	Describe any efforts to address potential sources of bias	Page 9, line 167-172
Study size	10	Explain how the study size was arrived at	Page 5, line 97-101
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	Page 7-8, line 127-158
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	Page 8-9, line 160-172
		(b) Describe any methods used to examine subgroups and interactions	Page 8-9, line 160-172
		(c) Explain how missing data were addressed	Page 9, line 167-172
		(d) If applicable, describe analytical methods taking account of sampling strategy	N/A
		(e) Describe any sensitivity analyses	Page 8-9, line 160-172
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	Page 10, line 186-192
		(b) Give reasons for non-participation at each stage	N/A
		(c) Consider use of a flow diagram	N/A
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential	Page 9-10

		confounders	
		(b) Indicate number of participants with missing data for each variable of interest	Page 10, line 186-190
Outcome data	15*	Report numbers of outcome events or summary measures	Page10, line 186-192
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	Page 11-12
		(b) Report category boundaries when continuous variables were categorized	N/A
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	Page 12-15
Discussion			
Key results	18	Summarise key results with reference to study objectives	Page 16, line 240-243
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	Page 19, line 310-316
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	Page 15-19
Generalisability	21	Discuss the generalisability (external validity) of the study results	Page 19-20, line 318-326
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	Page 20, line 335-337

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at www.strobe-statement.org.

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1 Prevalence and correlates of overweight and obesity
2 among adolescents in northeastern China: a
3 cross-sectional study

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22

23 Abstract

24 **Objectives:** To estimate the prevalence of overweight/obesity among adolescents and
25 to evaluate the associated factors in this group in Changchun City, northeastern China.

26 **Methods:** A cross-sectional study of 1955 adolescents aged 11–18 years was
27 conducted in Changchun City, using stratified cluster sampling. Parents and
28 caregivers of children completed the questionnaires as requested without objection;
29 the questionnaire included demographic characteristics and anthropometric
30 parameters. Univariate and multivariate logistic regression analyses were performed
31 to analyze the relationship between overweight /obesity and related factors.

32 **Results:** In total, the prevalence of overweight was 12.7% (male 17.4%; female
33 10.1%), and the prevalence of obesity was 4.9% (male 8.8%; female 3.1%) in
34 Changchun, Jilin Province. The prevalence of overweight and obesity was higher in
35 males than that in females ($P < 0.001$). Multivariate logistic regression showed that
36 overweight and obesity were significantly associated with male sex (OR=1.91, 95%
37 CI: 1.48-2.47), eating fresh fruits more than two days per week (OR=1.41, 95% CI:
38 1.09-1.84), eating quickly (OR=1.37, 95% CI: 1.06-1.78). The students who were not
39 picky (OR=0.69, 95% CI: 0.53-0.90) were less likely to be overweight. And
40 adolescents whose father were overweight or obese (OR=0.67, 95% CI: 0.52-0.86) or
41 mother were overweight or obese (OR=0.72, 95% CI: 0.52-0.99) were less likely to
42 be overweight.

43 **Conclusion:** The prevalence of overweight and obesity among adolescents in

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4 44 Changchun was high in recent years. The prevalence of overweight and obesity
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7 45 among males was higher than that among females. Sex, dietary habits (weekly
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10 46 frequency of fruit consumption, picky eating and slowness in eating) and parental
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12 47 weight were important factors for overweight and obesity in adolescents. Further
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15 48 research should be conducted on the health of adolescents in China and further
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18 49 intervention measures should be implemented to reduce the prevalence of
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21 50 overweight/obesity.

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23 51 **Keywords:** overweight; obesity; adolescent; association
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27 52 **Strengths and limitations of this study**

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- 31 53 ● In the cross-sectional study, participants were randomly selected from rural and
32
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34 54 urban areas by stratified cluster sampling.
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37 55 ● Weight category was defined using age- and sex- specific BMI cutoff points
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40 56 specifically developed for the Chinese adolescent population.
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43 57 ● The influence of confounding factors on the results was effectively controlled by
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45
46 58 the multivariate logistic regression method.
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49 59 ● Missing data from childhood measurements were handled with a mean
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52 60 imputation technique.
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55 61 ● The contents of the questionnaire were most recalled by the parents or guardians
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58 62 and there might be information bias in this survey.

59 63 **Introduction**

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4 64 The prevalence of obesity has increased dramatically among children, adolescents and
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7 65 adults worldwide in recent decades [1]. Overall, the global proportion of adolescents
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10 66 with obesity has increased significantly from just 4% in 1975 to just over 18% in
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13 67 2016 [2]. There is compelling evidence revealing a significantly higher proportion of
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15 68 overweight or obese adolescents in recent years, which has reached alarming levels.
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17 69 Recently, scholars have conducted many studies on overweight and obesity.
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20 70 Overweight and obesity are predisposing factors for many chronic diseases, such as
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23 71 type 2 diabetes, cardiovascular diseases, respiratory diseases, musculoskeletal
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26 72 disorders, and various types of cancer [3]. Yan R et al. found an association of
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29 73 adolescent obesity with nonalcoholic fatty liver disease (NAFLD) and revealed that
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31
32 74 the incidence of NAFLD increased with increasing body weight [4]. Lisan Q et al.
33
34
35 75 compared patients with obesity and severe obstructive sleep apnoea (OSA) with and
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37
38 76 without prescription of positive airway pressure (PAP) therapy and found that
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41 77 participants with PAP prescriptions had a higher BMI (Body mass index) than
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43
44 78 participants not prescribed PAP [5]. It has been estimated that overweight and obesity
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46
47 79 are the fifth leading cause of death worldwide, accounting for nearly 3.4 million
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50 80 deaths annually [6]. In addition, obesity is considered a risk factor for the
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53 81 development of chronic kidney disease [7]. In this context, the American Medical
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56 82 Association classified obesity as a disease to get physicians to pay more attention to
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58
59 83 the condition [8].
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4 84 In China, the largest developing country, nearly one-third of adolescents were
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7 85 overweight or obese in 2016, and the obesity prevalence rate increased from 0.10% in
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10 86 1976 to 8.50% in 2016. Sun HP found that the prevalence of obesity and of
11
12 87 overweight and obesity combined was 8.1% and 19.2%, respectively, among children
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15 88 and adolescents at the age of 7–18 [9]. Zhang XY reported that the prevalence rates of
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17 89 overweight and obesity among primary school children were 15.2% and 11.7%,
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20 90 respectively, in Jiangsu Province [10]. Therefore, it is of key importance to
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23 91 understand the risk factors for overweight and obesity to prevent adolescents from
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26 92 developing the disease.

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28 93 We investigated the physical condition of adolescents aged 11-18 years from six
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31 94 middle schools in Changchun which is the capital of Jilin Province. The aim of the
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34 95 current study was to reveal the prevalence of overweight and obesity and to analyze
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37 96 various associated factors among adolescents with overweight and obesity in
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40 97 Changchun, Jilin.

41 42 43 98 **Methods**

44 45 46 47 99 **Subjects**

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51 100 A cross-sectional survey was conducted in Changchun City, the capital of Jilin
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54 101 Province in Northeast China. The study sample comprised middle and high school
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57 102 students from six middle schools (three in urban areas and three in rural areas),
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60 103 selected randomly using stratified cluster sampling. Overall, 1955 students aged 11–

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4 104 18 years were included in this cross-sectional survey; subjects with
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7 105 overweight/obesity due to known metabolic and endocrine diseases were excluded.
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9 106 Students were also excluded if they had mental or physical impairments severe
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12 107 enough to cause abnormal behaviors, including congenital disease, intellectual
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15 108 disability, and a psychiatric disorder [11]. We used the STROBE checklist in this
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18 109 study.

110 **Data collection**

111 The study was carried out by the First Hospital of Jilin University in April 2016. The
112 study was approved by the ethics committee of the First Hospital of Jilin University
113 (Reference Number: 2013-031). The investigation received informed consent from
114 students and parents. The project was named “Effect and mechanism of weight loss
115 on upper airway collapsibility in obese patients with OSAS” and studied the
116 associations of overweight, obesity and related factors with sleep-related breathing
117 disorders and snoring in adolescents. In this database, we focused on the relevant
118 indicators of overweight and obesity in adolescents and analyzed the risk factors for
119 obesity in adolescents. The interviewers from the First Hospital of Jilin University
120 helped parents or guardians complete the questionnaire and provided the data. The
121 questionnaire included demographic characteristics (age, sex, area, dietary habits,
122 sleep, exercise, highest parental education, birth history, BMI classification, paternal
123 weight and maternal weight), anthropometric parameters (weight, height) and a

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4 124 paediatric sleep questionnaire- the Sleep-Related Breathing Disorder (PSQ-SRBD).
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7 125 The data about sleep duration and dietary habits (frequency of fresh fruits
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10 126 consumption, frequency of dessert consumption, frequency of breakfast consumption,
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12 127 frequency of fast food consumption, slowness in eating, picky eating) were selected
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14
15 128 from the PSQ-SRBD scale according to various reports [12-14] about adolescent
16
17
18 129 obesity.

130 **Key variables**

131 Body mass index (BMI) is used here as an indicator of overweight and obesity in
132 adolescents and adults. Weight category was defined using age- and sex- specific
133 BMI cutoff points specifically developed for the Chinese adolescent population [15].
134 We used the 85th and 95th percentiles to define overweight and obesity in adolescents.
135 Therefore, BMI values of 24 and 28 were used as cut-off points
136 for overweight and obesity, both for males and females aged 18 years, which were
137 consistent with Chinese adults. In our study, parental overweight was divided into 2
138 groups: normal (BMI<24) and overweight or obese (BMI≥24) [14, 16]. Parents and
139 caregivers provided information on adolescents' weight (to the nearest 1 kg) and
140 height (to the nearest 1 cm). Overall children were classified by age into 3 groups
141 (<13 years, 13-15 years, >15 years), by region into 2 groups (urban, rural) and by sex
142 into 2 groups (male, female). Participants who slept less than 8 hours over 3 days a
143 week were classified as 'sleep <8 h', and those who slept more than 10 hours over 3

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4 144 days a week were defined as 'sleep >10 h' [17]. Birth history was divided into 3
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7 145 groups: preterm birth (infants born alive before 37 weeks of pregnancy), full-term
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10 146 birth (infants born alive after 37 completed weeks to less than 42 completed weeks)
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12 147 and post-term birth (infants born alive at 42 completed weeks or after) [18]. Parental
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15 148 educational level was divided into 4 groups: primary school or lower (including those
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18 149 who had never attended school and those with elementary schooling only), junior high
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21 150 school, senior high school (including those with 3 years of secondary vocational
22
23 151 schooling) and university or above [17]. According to the contents of the
24
25
26 152 questionnaire, we classified the participants' eating habits. According to the Food
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29 153 Guide Pagoda [19], fruit intake should be 200-350 g/d, and sugar intake should be no
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31 154 more than 50 g/d, so we used eating "fresh fruits more than two days per week (350
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34 155 g/d)", "dessert more than two days per week", "breakfast more than two days per
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37 156 week", and "fast food more than two days per week" as cut-offs. Participants who
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40 157 were classified as "picky eating" were defined as adolescents who had selectivity for
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43 158 a particular kind of food [20]. "Slowness in eating" was defined as adolescents with
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46 159 higher masticatory performance and who ate slowly [21]. Groups were formed
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49 160 according to the number of exercise days (aerobic, strength training or both for at
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52 161 least 30 minutes a day), including never (participate in sports \leq 1 day per week),
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55 162 sometimes (participate in sports 2-3 days per week) and often (participate in sports \geq
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58 163 4 days per week) [22, 23].

164 **Statistical analysis**

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4 165 Data input was performed using Epidata 3.1, and statistical analysis was performed
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6
7 166 using SPSS 24.0. Frequency distributions are used to characterize subjects, and
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10 167 percentage data are used to report prevalence. The relationship between each factor
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12 168 and the adolescents' weight status was reflected by χ^2 tests and univariate and
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15 169 multivariate logistic regression. In univariate analysis, when $P < 0.10$, significant
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18 170 correlation factors were included in a forward stepwise multivariate logistic
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21 171 regression to exclude confounding factors. In all analyses, a two-tailed P value < 0.05
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23
24 172 was considered statistically significant. Since the database was manually collated,
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27 173 some variables in the database had missing values, which resulted in waste and bias of
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30 174 data resources. The missing value was numeric, and the data were approximately
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33 175 normally distributed. The mean interpolation method was adopted in this study.
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36 176 Therefore, we used the "replace missing value" function in SPSS 24.0 and selected
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38
39 177 the "mean of nearby points" method to interpolate the missing values.

178 **Data availability**

179 Data referenced in this study are available in the project titled "Effect and mechanism
180 of weight loss on upper airway collapsibility in obese patients with OSAS". We
181 selected a portion of the data from the database, including body measurements of
182 adolescents from six middle schools in Changchun City. The data that support the
183 findings of this study are available on request from the corresponding author [HY].
184 The data are not publicly available because they contain information that could

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4 185 compromise research participant privacy or consent.
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8 186 **Patient and public involvement**

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10
11 187 The interviewers from the First Hospital of Jilin University helped parents or
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13 188 guardians complete the questionnaire and provided the data. The adolescents were not
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17 189 involved in the design, recruitment or conduction of the study.
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20 190 **Results**

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25 191 On the basis of the inclusion and exclusion criteria, we chose 1955 adolescents from
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27 192 Changchun, and of these adolescents, 1825 were finally analyzed in this study.

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30 193 Participants with missing BMI values were excluded from the study. Since the survey
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33 194 was already completed, we were unable to verify the source of data errors, so we
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36 195 deleted data with missing BMI values. According to the analysis of the frequency
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39 196 distribution, we found that there were 837 boys and 988 girls included; the median
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42 197 age of the students was 15.30 years, ranging from 11 to 18 years; of all these subjects,
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44 198 42.9% were from rural regions and 57.1% were from urban regions; and most of the
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47 199 subjects were Han Chinese, accounting for 98.2%, with only a few participants with
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50 200 minority ethnicities.

51
52 201 According to the worldwide BMI classification, the overall prevalence of overweight
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55 202 was 12.7% (male 17.4%; female 10.1%), and the prevalence of obesity was 4.9%
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58 203 (male 8.8%; female 3.1%) in Changchun City, Jilin Province (Table 1). The
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60

204 overweight and obese rates were both higher in males than that in females ($P < 0.001$).

205 A higher prevalence of overweight was found in subjects whose ages ranged from

206 11-12 years, and the prevalence of obesity was higher in the age group from 13-15

207 years ($P = 0.008$). Children from urban areas showed a significantly higher proportion

208 of overweight. Full-term birth subjects had a higher prevalence of overweight than

209 others ($P = 0.014$). In addition, students who ate fruits more than twice a week (P

210 $= 0.029$), ate slowly ($P = 0.004$), and were picky ($P = 0.028$) had a lower higher

211 prevalence of overweight in the study. Paternal weight ($P = 0.018$) and maternal

212 weight ($P = 0.006$) also had an effect on the children's weight.

213 **Table 1**

214 **Prevalence of overweight and obesity according to demographic characteristics**

Variables	n	Overweight		Obesity	
		PR (%)	<i>p</i>	PR (%)	<i>p</i>
Sex					
Male	837	17.4(14.9-20.3)	<0.001	8.8(6.9-11.2)	<0.001
Female	988	10.1 (8.3-12.2)		3.1(2.2-4.5)	
Area					
Urban	1042	14.4(12.4-16.7)	0.14	5.6(4.2-7.3)	0.863
Rural	783	12(9.8-14.5)		5.8(4.3-7.8)	
Age					
<13	168	19.3(13.9-26.1)	0.008	5.1(2.5-10.3)	0.816
13-15	1157	11.6(9.8-13.6)		5.9(4.6-7.5)	
>15	500	15.5(12.5-19.0)		5.2(3.4-7.7)	
Birth history					
Full-term birth	1621	14.2(12.5-16.0)	0.014	6.0(4.9-7.4)	0.285
Preterm birth	133	5.4(2.6-11.0)		3.2(1.2-8.2)	
Post-term birth	71	10.1(4.9-19.8)		3.1(0.8-11.7)	
Fruit \leq 2 times/week					
Yes	1259	12.2(10.5-14.2)	0.029	4.8(3.7-6.2)	0.02
No	566	16.1(13.2-19.5)		7.7(5.6-10.4)	
Dessert \leq 2					

times/week						
Yes	887	12.4(10.4-14.8)	0.252	5.2(3.9-7.0)	0.49	
No	938	14.3(12.1-16.7)		6.0(4.6-7.9)		
Breakfast \leq 2						
times/week						
Yes	1478	13.9(12.2-15.8)	0.185	5.8(4.7-7.3)	0.491	
No	347	11.1(8.2-15.0)		4.8(2.9-7.9)		
Fast food \leq 2						
times/week						
Yes	264	10.0(6.8-14.3)	0.095	5.4(3.2-9.1)	0.402	
No	1561	13.9(12.3-15.8)		5.7(4.6-7.1)		
Slowness in eating						
Yes	1174	16.5(13.8-19.7)	0.004	6.2(4.5-8.5)	0.496	
No	651	11.6(9.9-13.6)		5.4(4.1-6.9)		
Picky eating						
Yes	1133	14.8(12.8-17.1)	0.028	6.7(5.3-8.4)	0.027	
No	692	11.1(8.9-13.7)		4.0(2.7-5.9)		
Exercise						
Never	451	15.9(12.7-19.6)	0.194	4.2(2.6-6.7)	0.315	
Sometimes	478	12(9.3-15.3)		6.6(4.6-9.4)		
Often	896	12.8(10.7-15.2)		5.8(4.4-7.7)		
Highest parental education						
Primary school or lower	95	8.0(3.8-15.8)	0.196	8.0(3.8-15.8)	0.724	
Junior high school	799	13.0(10.8-15.6)		5.1(3.7-7.1)		
Senior high school	468	15.8(12.7-19.5)		6.0(4.1-8.8)		
University or above	463	12.7(9.9-16.2)		5.7(3.8-8.4)		
Sleep (hours/night)						
<8	884	13.6(11.5-16.1)	0.809	5.3(3.9-7.2)	0.302	
8-10	861	13.3(11.1-15.8)		5.6(4.2-7.5)		
>10	80	11.0(5.6-20.4)		9.7(4.7-19.0)		
Paternal weight						
Normal	827	15.4(13.1-18.1)	0.018	7.6(6.0-9.8)	0.002	
Ow or ob	998	11.6(9.6-13.7)		3.8(2.7-5.4)		
Maternal weight						
Normal	1099	14.8(13.0-16.8)	0.006	5.6(4.4-7.0)	0.807	
Ow or ob	726	8.5(6.1-11.7)		5.8(3.9-8.7)		

215 Note: *PR* (%), Prevalence rate; Ow or ob, Overweight or obese

216 To facilitate regression analysis, we divided the participants into two groups:

217 underweight/normal weight and overweight/obese. Table 2 shows the univariate
 218 analysis of correlates of overweight and obesity in adolescents. As impressively
 219 demonstrated in this table, the following factors all showed significant differences
 220 between two groups: sex, age, birth history, frequency of eating fruits, eating habits
 221 (slowness in eating, picky eating), and parental weights ($P < 0.05$). According to the
 222 results, we added all these significant factors to a forward stepwise multivariate
 223 logistic regression model.

224 **Table 2**

225 **Univariate analysis of correlates of overweight and obesity in adolescents in Changchun**

Variables	<i>p</i>	<i>OR</i>	95% <i>CI</i>
Sex			
Female	<0.001	1	
Male		2.13	1.66-2.72
Area			
Urban	0.256	1	
Rural		1.15	0.90-1.47
Age			
<13	0.070	1	
13-15	0.041	0.67	0.45-0.98
>15	0.339	0.81	0.53-1.24
Birth history			
Full-term birth	0.008	1	
Preterm birth	0.004	0.40	0.21-0.74
Post-term birth	0.209	0.63	0.31-1.29
Fresh fruits ≤ 2 times/week			
Yes	0.003	1	
No		1.46	1.13-1.87
Dessert ≤ 2 times/week			
Yes	1.197	1	
No		1.17	0.92-1.49
Breakfast ≤ 2 times /week			
Yes	0.15	1	
No		0.79	0.57-1.09

Fast food \leq 2 times /week				
	Yes	0.135	1	
	No		1.32	0.92-1.91
Slowness in eating				
	Yes	0.007	1	
	No		0.71	0.56-0.91
Picky eating				
	Yes	0.004	1	
	No		0.69	0.53-0.88
Exercise				
	Never	0.74	1	
	Sometimes	0.502	0.89	0.64-1.25
	Often	0.484	0.90	0.67-1.21
Highest parental education				
	Primary school or lower	0.411	1	
	Junior high school	0.594	1.18	0.65-2.14
	Senior high school	0.229	1.45	0.79-2.68
	University or above	0.58	1.19	0.64-2.21
Sleep (hours/night)				
	<8	0.964	1	
	8-10	0.952	0.99	0.78-1.27
	>10	0.805	1.08	0.60-1.94
Paternal weight				
	Normal	0.001	1	
	Ow or ob		0.64	0.51-0.83
Maternal weight				
	Normal	0.011	1	
	Ow or ob		0.67	0.49-0.91

226 Note: Ow or ob, Overweight or obesity

227 Table 3 shows the results of logistic regression models comparing the prevalence of
 228 the potential risk factors: sex, age, birth history, frequency of eating fruits, dietary
 229 habits (slowness in eating, picky eating) and parental weight. In this forward stepwise
 230 multivariate logistic regression model, males were more likely to be overweight and
 231 obese than females (OR=1.91, 95% CI: 1.48-2.50). Students aged 13-15 years
 232 (OR=0.63, 95% CI: 0.42-0.96) were less likely to be overweight than those aged

11-12 years. Compared with full-term birth, preterm birth (OR=0.45, 95% CI: 0.24-0.85) was associated with normal weight. Participants who ate fruit more than twice a week (OR=1.41, 95% CI: 1.09-1.84) were more likely to be overweight or obese. Moreover, the prevalence of overweight was higher in students who ate quickly (OR=1.37, 95% CI: 1.06-1.78) than those who ate slowly. Compared with picky eaters, students who were not picky (OR=0.69, 95%CI: 0.53-0.90) were less likely to be overweight.

Table 3

Multivariate regression analysis of correlates of overweight and obesity in

Changchun

Variables	<i>p</i>	β	SE	OR	95% CI
Sex				1	
Female				1	
Male	<0.001	0.65	0.13	1.91	1.48-2.50
Age				1	
<13				1	
13-15	0.030	-0.46	0.21	0.63	0.42-0.96
>15	0.121	-0.35	0.23	0.70	0.45-1.10
Birth history				1	
Full-term birth				1	
Preterm birth	0.014	-0.80	0.33	0.45	0.24-0.85
Post-term birth	0.337	-0.36	0.37	0.70	0.34-1.45
Fresh fruits \leq 2 times/week				1	
Yes				1	
No	0.010	0.35	0.14	1.41	1.09-1.84
Slowness in eating				1	
Yes				1	
No	0.016	0.32	0.13	1.37	1.06-1.78
Picky eating				1	
Yes				1	
No	0.007	-0.37	0.14	0.69	0.53-0.90
Paternal weight					

	Normal				1	
	Ow or ob	0.002	-0.41	0.13	0.67	0.51-0.83
Maternal weight	Normal					
	Ow or ob	0.049	-0.32	0.17	0.72	0.53-0.99

243 Note: Ow or ob, Overweight or obese

244 Discussion

245 To describe the epidemiology of overweight and obesity in Changchun City and
 246 analyze the influencing factors in adolescents, we conducted this survey of middle
 247 school students aged 11–18 years from urban and rural areas. We found that sex,
 248 dietary habits and parental weight had a significant impact on the children's weight.

249 Based on the data, we found that the prevalence of overweight was 12.7% (male
 250 17.4%; female 10.1%) and that the prevalence of obesity was 4.9% (male 8.8%;
 251 female 3.1%) among adolescents in Changchun City, Jilin Province. However, in
 252 recent studies, the overall prevalence of obesity in school-aged children in Xi'an was
 253 4.11%, and the rate of overweight was 6.6% among Nanjing adolescents; these rates
 254 were both lower than the corresponding rates in Changchun. This difference may be
 255 caused by the sample size, sex, and age of the studied population [24, 25]. In addition,
 256 demographic distribution and environmental factors are probable factors [26]. The
 257 economy in northeast China is less developed than that in east and south China to
 258 some extent [27]. Rates of overweight and obesity in rural areas were also higher in
 259 the north than that in the south [28]. Depending on the season, people in the north
 260 might eat high-energy foods to combat the cold, which is referred to “energy balance

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4 261 related behaviors [29, 30]". In our data, boys were more often obese than girls, in
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7 262 general, which was in agreement with previous Chinese reports [30-32]. A Swedish
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10 263 report [33] predicted that there was an alarming increase in the prevalence of
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13 264 overweight and obesity among adolescent boys, which was consistent with our
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16 265 finding. On the one hand, in traditional Chinese culture, the preference for boys may
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19 266 be the reason for the differences in diet, and the elderly believe that fat boys are more
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22 267 powerful than thin boys. On the other hand, well-groomed and fit girls are more
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25 268 favored by Chinese society [34-36]. Girls also tend to be more concerned about their
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28 269 weight than boys.

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31 270 We also found that adolescents who were picky, ate more fruits in general and ate
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34 271 quickly were more likely to be overweight or obese according to our survey. In recent
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37 272 reports [37, 38], a greater fruit intake was a protective factor against overweight,
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40 273 which was opposite of our result. Fructose, which is ubiquitous found in fruit and
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43 274 sugar-sweetened beverages, is one of the factors contributing to rising obesity rates
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46 275 [39, 40]. High intakes of fructose may decrease the abundance of the bacterial species
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49 276 *Eubacterium eligens*, reduce metabolism of monosaccharide and lose the ability to
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52 277 consume large amounts of fat [41]. The fructose intake threshold of adolescents is
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55 278 currently average 75g/d. If teenagers get too much fructose without consuming
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58 279 glycogen in time, fructose will be converted into fat at a higher rate [42, 43]. Based on
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60 280 the results of our study, it was reasonable to speculate that the children were already
281 full in addition to the excessive intake of fruits with high sugar content. Moreover, the

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4 282 heavy study demand in China makes the children fail to consume the extra energy
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7 283 through exercise, thus leading to the possibility of being overweight. For obese
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10 284 children, their parents believe they can control their weight by increasing their fruit
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12 285 intake. This may also have contributed to the fact that the children in our
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15 286 cross-sectional study who ate more fruit were more likely to be overweight. However,
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18 287 given our inconsistent results with previous finding [37, 38], whether the reason is
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20 288 due to different classification needs further research.

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23 289 According to a recent study [44], food preference was an independent risk factor for
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26 290 overweight among children. It is known that children who had selectivity for a
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29 291 particular kind of food would prefer more fast food, snacks, and sugary beverage [45]
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32 292 and fewer fruits and vegetables [46]. However, the frequency of dessert and fast food
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35 293 consumption had no significant effect in our study, perhaps because the data were
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38 294 provided by parents or guardians who provided an inaccurate account of how often
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41 295 their children ate sweets and fast food. Currently, several studies have considered that
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44 296 food intake is a primary factor that determines body weight [47-49]. Y Li et al.
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47 297 concluded that excessive intake of cooking oil might be one of the risk factors for
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50 298 overweight [22]. According to a previous study in Tianjin [47], overweight students
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53 299 preferred significantly more sweet foods and take-out food than their counterparts
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56 300 with normal weight. The result might be influenced by many elements, such as peer
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59 301 influence, food price, convenience, and online influence and so on, based on a recent
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302 report [50]. To decrease the prevalence of overweight and obesity, a series of

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4 303 interventions have been implemented, such as controlling TV time and increasing
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9 305 In our research, we found that if fathers and mothers were overweight, adolescents
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12 306 were less likely to be overweight, which was inconsistent with the previous
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15 307 conclusions [51-53]. Studies [54, 55] have found that a higher BMI of the father
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18 308 increased the risk of overweight/ obesity among males and females. However, this
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21 309 finding was not consistent across studies. In a previous study, the researchers found
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24 310 that the relationship between parents' and children's BMI did not exist when
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27 311 longitudinal analyses of changes in BMI over four years were performed [56]. This
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30 312 may explain why a short period of periodic surveys alone does not fully demonstrate a
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33 313 parent-child link to obesity, and we still need long-term research to further explore the
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36 314 relationship between the two factors. Berge JM et al. found that overweight or obese
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39 315 parents were more likely to adopt a strict dietary restriction to prevent adolescent
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42 316 obesity [57]. Moreover, children's growing environment and living habits will also
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45 317 affect their own obesity level, which will have an impact on our results [50]. Further
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48 318 prospective studies that assess both energy expenditure and energy intake in children
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51 319 are more likely to clarify this concept.

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53 320 However, some potential limitations exist in this cross-sectional study. The contents
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56 321 of the questionnaire were most recalled by the parents or guardians and there might be
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59 322 information bias in this survey. In addition, we set the classification standard of eating
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323 fruit frequency as "eating fruit 2 days a week" combined with the questionnaire data

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4 324 recalled by the parents or guardians, which may not be appropriate. Further studies
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7 325 considering different classification and a quantitative measurement are required.
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10 326 **Conclusions**

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15 327 In summary, in this cross-sectional study, we found that the prevalence of overweight
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17 328 and obesity among adolescents in Changchun, Jilin Province was high. Sex, age, birth
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20 329 history, dietary habits, and parental weight were important factors for overweight and
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23 330 obesity in adolescents. Therefore, reasonable lifestyle and effective weight control are
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26 331 necessary to prevent overweight and obesity in adolescents. There are still several
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29 332 limitations in this study, and we need to obtain more accurate information and
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32 333 perform more specific analysis. Further research should be conducted on the health of
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35 334 adolescents in China and further intervention measures should be implemented to
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37 335 decrease the prevalence of overweight and obesity.
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52
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56 340 study. HY, JJ and XL collected data. RD carried out the measurements, analyzed the
57
58
59 341 data and drafted the manuscript. XY and BZ participated in the coordination of the
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7 343 approved the final article.
8

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19
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21
22
23 349 University in April 2016, our data collected from the questionnaire in the survey as
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25
26 350 well. The study was approved by the ethics committee of the First Hospital of Jilin
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29 351 University (Reference Number: 2013-031). The investigation has received informed
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32 352 consent from students and parents.
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34 353 **Data sharing:** Extra data can be accessed via the Dryad data repository at
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37 354 <http://datadryad.org/> with the doi:10.5061/dryad.gljwstqnw
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STROBE Statement—Checklist of items that should be included in reports of *cross-sectional studies*

	Item No	Recommendation	Page/line number
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	Page 1
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	Page 2-3, line 23-48
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	Page 3-5, line 61-90
Objectives	3	State specific objectives, including any prespecified hypotheses	Page 5, line 91-94
Methods			
Study design	4	Present key elements of study design early in the paper	Page 5-6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	Page 5-6
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants	Page 5-6, line 97-104
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	Page 7-8, line 127-158
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	Page 6, line 107-125
Bias	9	Describe any efforts to address potential sources of bias	Page 9, line 167-172
Study size	10	Explain how the study size was arrived at	Page 5, line 97-101
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	Page 7-8, line 127-158
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	Page 8-9, line 160-172
		(b) Describe any methods used to examine subgroups and interactions	Page 8-9, line 160-172
		(c) Explain how missing data were addressed	Page 9, line 167-172
		(d) If applicable, describe analytical methods taking account of sampling strategy	N/A
		(e) Describe any sensitivity analyses	Page 8-9, line 160-172
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	Page 10, line 186-192
		(b) Give reasons for non-participation at each stage	N/A
		(c) Consider use of a flow diagram	N/A
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential	Page 9-10

		confounders	
		(b) Indicate number of participants with missing data for each variable of interest	Page 10, line 186-190
Outcome data	15*	Report numbers of outcome events or summary measures	Page 10, line 186-192
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	Page 11-12
		(b) Report category boundaries when continuous variables were categorized	N/A
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	Page 12-15
Discussion			
Key results	18	Summarise key results with reference to study objectives	Page 16, line 240-243
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	Page 19, line 310-316
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	Page 15-19
Generalisability	21	Discuss the generalisability (external validity) of the study results	Page 19-20, line 318-326
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	Page 20, line 335-337

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at www.strobe-statement.org.