



Prevalence and Trends of Obesity among Chinese Korean Nationality Children and Adolescents, 1991–2010

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(Received 22 Sep 2015; accepted 15 Jan 2016)

Abstract

Background: Obesity has become a serious problem for Chinese Han nationality. This research aimed to evaluate the prevalence of and trends in obesity among Chinese Korean nationality children and adolescents (1991–2010).

Methods: We used data from Chinese National Surveys on Students' Constitution and Health (CNSSCH). CNSSCH was utilized to monitor Chinese students' health condition and released its data every 5 yr (1991, 1995, 2000, 2005 and 2010). The standard weight-for-height was the 80th percentile for sex- and age-specific growth charts based on the 1985 CNSSCH data. Obesity was defined as $\geq 120\%$ of standard weight-for-height.

Results: The total age-adjusted prevalence of obesity was 15.9% (95% confidence interval (CI), 14.9-16.9%) among Chinese Korean children and adolescents aged 7 to 18 yr. Children or adolescents who were boys (Rate ratios (RR), 1.35; 95% CI, 1.19–1.53) or aged 10–12 (RR, 1.38; 95% CI, 1.17–1.63) were more likely to be obese. The trend analysis of the 19-yr period implied a serious annual increasing trend during 1991-2000 (RR, 1.05; 95% CI, 1.02–1.07) and during 2000-2010 (RR, 1.12; 95% CI, 1.11–1.13). Chinese Korean children may also be more likely to become obese than Han nationality children during 1991-2010.

Conclusion: A serious and continuous increasing trend was in the prevalence of obesity among Chinese Korean children and adolescents during 1991–2010. Childhood obesity had become a serious problem. This prognosis is worrisome.

Keywords: Childhood obesity, Chinese Korean nationality, Prevalence, Trends

Introduction

Obesity had been recognized a risk factor for coronary heart disease, hypertension, diabetes and many other health disease. It is related to premature death and a heavy economic burden (1). Obesity occurs in all age groups. In China, childhood obesity has become a serious health problem (2, 3). Unfortunately, most of the studies just gave attention to Han nationality children and adolescents. Few trustworthy and representative studies reported the prevalence of and trends in obesity about ethnic minorities. Among the 55 ethnic minorities, Chinese Korean nationality has

the highest income level than other ethnic minorities. This is due to among 1.9238 million Chinese Korean nationalities, 23.5% people went abroad and worked in South Korea by the end of 2011 (4). A good improvement in the economy would lead to a continuous increase in obesity rates (5). The prevalence of childhood obesity would change in these years.

Since many Chinese Korean people worked in South Korea each year. The diet culture and the way of life among Chinese Korean people were always affected by South Korean. The prevalence of

childhood obesity might have the same trend with South Korean children. In South Korea, physical inactivity, an unbalanced diet, and excessive intake, have contributed to creating an obesogenic environment (5). The prevalence of childhood obesity increased significantly and it doubled from 5.4% in 1998 to 10.8% in 2008 (7, 8). However, to Chinese Korean childhood obesity, we lack an accurate study, which would present the prevalence of, and trends in obesity among Chinese Korean children and adolescents. A high prevalence of childhood obesity would have adverse influence on their health. Therefore, it is urgent to have such a study, and this research would give policy-makers sufficient information to make proper policies.

CNSSCH is utilized to monitor national trends in the health of students. Since 1991, CNSSCH data have been utilized to assess the obesity levels among all Chinese children and adolescents. The most recent data were collected in 2010. We use the data from these surveys to estimate the most recent obesity prevalence among Chinese Korean 7-18 yr old children, and to estimate the variation among different demographic and socioeconomic groups in 2010. Then we assessed the trends in childhood obesity prevalence, and changes of physical fitness from 1991 to 2010.

Methods

CNSSCH became a continuous survey from 1985, and it released its data every 5 yr. Our data were acquired from them. In 1985, CNSSCH just measure the Han nationality students. Therefore, our first data was from 1991. Standardized methodology was used in these complex multistage, cross-sectional, nationwide surveys. At different time points, CNSSCH used the same sampling methods. The subjects were 7–18 yr old primary and secondary school students. Chinese Korean children and adolescents were randomly selected from Jilin provinces. In our study, subjects were sorted by region (urban or rural) and gender. Samples of the same size from three socioeconomic classes (lower, middle, upper) were selected in each of the four groups. CNSSCH selected three urban and

three rural residential areas, respectively. A list of primary or secondary schools names and grade 1–12 student's names was provided by a local area's Educational Committee. Primary and secondary schools were firstly and randomly selected. Then according to the size, two or three classes were randomly selected in each grade level (3). This study's data were gathered in 1991, 1995, 2000, 2005, 2010 (N=4762, 4797, 4701, 5750, 5241).

The surveys were conducted in a moving examination center with a standardized physical examination. Ethical approval was obtained from Peking University's Medical Research Ethics Committee. Written informed consent was obtained from each participant and his or her parents before data collection. The surveys were abiding strictly by the same protocols at various times when select the sample and conduct the interviews and examinations (2, 9). Detailed description of these surveys can be found (2, 9).

Well-trained staffs that followed a reference protocol measured the body data (height, weight) and then took notes. When measured the height, the subjects were asked to be barefoot. The height was measured to the nearest 0.10cm with a portable stadiometer. When measured the weight, the subjects were asked to wear lightweight clothes. The weight was measured to the nearest 0.10 kg with a balance-beam scale (3). Childhood weight category was created based on a standardized weight-for-height from the sex- and age-specific 80th percentile weight on the same height population (10). The standards based on the 1985 CNSSCH data (237476 males and 233639 females who were 7–22 yr old). Obesity was defined as $\geq 120\%$ of standard weight-for-height (10).

We used direct method to adjust the age-adjusted prevalence of five times with the 2010 China's Census population using age groups (7–9, 10–12, 13–15, 16–18). The prevalence of childhood obesity was showed by age, sex, and region (urban and rural) subgroups in 2010. The prevalence of childhood obesity which classified by sex-specific area groups was plotted for five survey years (1991, 1995, 2000, 2005, 2010).

In order to test the trends in the prevalence of childhood obesity among Chinese Korean during 1991–2010, generalized linear models (GLM) with a log function based on the binomial distribution was adopted (11). Rate ratio (RR) was used to measure relative risk. The prevalence odds ratio (OR) which estimated by logistic regression is always used to evaluate the age and gender differences and trends of obesity, but the relative risk is often overstated by odds ratio (11). Rate ratio (RR) can estimate an appropriate relative risk. We used GLM to generate rate ratios (RRs) between age group, area, and sex. Moreover, survey period was treated as a continuous variable to assess the linear trends in the prevalence of childhood obesity over the five survey periods with GLM models. We also used GLM to generate the RR for Korean/Han children stratified by sex-specific area. We used the sex-specific GLM to test the differences classified by area and age. These models were also used to test the interaction terms be-

tween sex, age group and area. SAS (Version 9.3; SAS Institute Inc., Cary, NC, USA) statistical software was used to analyze these data.

Results

In 2010, the overall prevalence of obesity was 15.9% (95% CI, 14.9-16.9%, Table 1) among Chinese Korean children and adolescents aged 7 to 18 yr. The prevalence was higher in boys compared with girls (18.2% vs. 13.2%, $P<0.0001$), the RR for boys/girls was 1.35 (95% CI, 1.19-1.53, $P<0.0001$) after controlling for age and area (Table 2). Obesity affected 16.3% study participants in urban areas while it affected 15.5% study participants in rural areas ($P=0.5717$; RR, 1.04; 95% CI, 0.92-1.17). Compared with the other age groups, the 10-12 yr age group had the highest prevalence ($P<0.0001$; RR, 1.38; 95% CI, 1.17-1.63) (Table 1, 2).

Table 1: Prevalence of obesity for children and adolescents of Korean Minority Chinese aged 7–18 yr, 2010

All	Age group (yr) Sample size (7–18)	All N=5241	Male N=2652	Female N=2589
	7–18	15.9 (14.9-16.9)	18.2 (16.7-19.7)	13.2 (11.9-14.5)
	7–9	15.3 (13.4-17.2)	17.4 (14.6-20.3)	12.6 (10.0-15.2)
	10–12	20.9 (18.7-23.2)	22.9 (19.6-26.2)	18.5 (15.5-21.6)
	13–15	16.3 (14.3-18.3)	18.0 (15.1-21.0)	14.2 (11.6-16.9)
	16–18	12.4 (10.7-14.2)	15.4 (12.7-18.2)	9.3 (7.1-11.5)
Urban	Sample size (7–18)	N=2552	N=1289	N=1263
	7–18	16.3 (14.8-17.7)	19.2 (17.0-21.3)	12.9 (11.1-14.8)
	7–9	14.6 (11.8-17.3)	15.3 (11.3-19.3)	13.7 (9.9-17.5)
	10–12	22.0 (18.8-25.3)	25.4 (20.6-30.1)	17.9 (13.5-22.2)
	13–15	16.4 (13.5-19.3)	19.1 (14.8-23.4)	13.1 (9.3-16.8)
	16–18	13.2 (10.6-15.8)	17.2 (13.0-21.3)	9.0 (5.9-12.2)
Rural	Sample size (7–18)	N=2689	N=1363	N=1326
	7–18	15.5 (14.2-16.9)	17.3 (15.3-19.3)	13.4 (11.6-15.3)
	7–9	16.0 (13.2-18.7)	19.3 (15.2-23.3)	11.4 (7.9-14.9)
	10–12	19.8 (16.7-23.0)	20.4 (15.9-24.8)	19.2 (14.8-23.6)
	13–15	16.2 (13.4-18.9)	17.0 (13.0-21)	15.3 (11.5-19)
	16–18	11.7 (9.3-14.1)	13.8 (10.1-17.5)	9.5 (6.4-12.6)

Table 2: Rate ratios for obesity prevalence of Korean Minority Chinese in 2010, RR (95% CI)

Parameter	All	Male group	Female group
Male/female	1.35 (1.19-1.53)		
Urban/ rural	1.04 (0.92-1.17)	1.09 (0.93-1.28)	0.96 (0.79-1.17)
Age group (yr)			
10–12/7–9	1.38 (1.17-1.63)	1.32 (1.06-1.64)	1.48 (1.14-1.93)
13–15/7–9	1.08 (0.91-1.29)	1.03 (0.82-1.30)	1.15 (0.87-1.51)
16–18/7–9	0.83 (0.69-1.01)	0.89 (0.70-1.13)	0.75 (0.55-1.03)

The overall prevalence of obesity significantly increased over time from 1991 to 2010. From 1991 to 2000, the increasing trend in prevalence was mild. However, from 2000 to 2010, the prevalence

of childhood obesity was significantly increasing for the overall population and for the area, and sex subpopulations (Fig. 1).

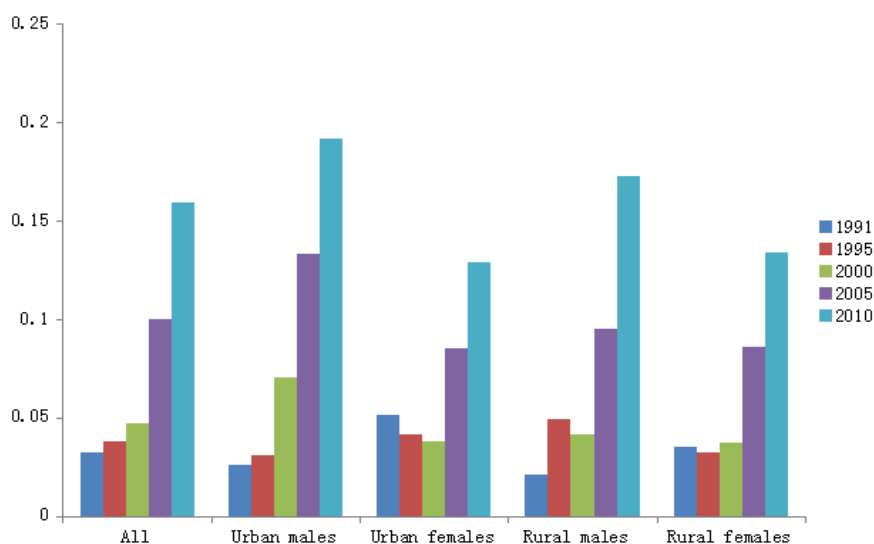


Fig.1: The changes in the prevalence of obesity for children and adolescents of Korean Minority Chinese, 1991-2010

Trend analyses for the 19-yr period showed a significant trend in childhood obesity prevalence. The annual increase in the rate ratios of obesity prevalence was 1.10 (95% CI, 1.07-1.14) for boys from 1991 to 2010. However, for girls, the prevalence of obesity kept stable. From 2000 to 2010, the annual increase in the rate ratios was both

high (boys: RR, 1.12 95% CI, 1.10-1.14; girls: RR, 1.12; 95% CI, 1.10-1.14). The overall annual increase in the rate ratios of obesity was significantly higher during 2000-2010 period (RR, 1.12; 95% CI, 1.11-1.13) than 1991-2000 period (RR, 1.05; 95% CI, 1.02-1.07) (Table 3).

Table 3: Estimated annual increase in the rate ratios of obesity prevalence during 1991–2000 and 2000–2010, in different subpopulations, RR (95% CI)

	1991-2000	2000-2010
Males	1.10 (1.07-1.14)	1.12 (1.10-1.14)
Males, urban	1.14 (1.09-1.19)	1.09 (1.07-1.12)
Males, rural	1.06 (1.01-1.11)	1.15 (1.12-1.18)
Females	0.99 (0.96-1.03)	1.12 (1.10-1.14)
Females, urban	0.97 (0.93-1.02)	1.12 (1.09-1.15)
Females, rural	1.02 (0.97-1.07)	1.12 (1.09-1.15)
All	1.05 (1.02-1.07)	1.12 (1.11-1.13)

The RR for the Korean/Han children showed the risk of being obese between the two nations. The RR was 1.85 (95% CI, 1.58-2.17) in 1991, 1.27 (95% CI, 1.10-1.47) in 1995, 0.97 (95% CI, 0.85-1.10) in 2000, 1.52 (95% CI, 1.41-1.64) in 2005, 1.94 (95% CI, 1.82-2.07) in 2010. In general, Chinese Korean children may be more likely to occur obese than Han nationality children from 1991 to 2010.

Discussion

The result of data analysis has presented us the prevalence of and trends in obesity among Chinese Korean children and adolescents over the past 19 yr. In 2010, the prevalence of childhood obesity was higher than the previous four time points. Obesity had become a serious problem among Chinese Korean children and adolescents. All nations were directly comparable because the CNSSCH used the same measure in all ethnic minorities. The RR for the Korean/Han children indicated that Chinese Korean children might be more likely to become obesity than Han nationality children from 1991 to 2010. Previous studies showed that the proportion of Korean residents with high salt and high carbohydrate diet was significantly higher than the local Han Chinese. Owing to their different diets, the sodium intake and the serum sodium level were always higher in Korean residents. What's more, the local Korean preferred high-calorie and high-fat food such as beef and dogs (12, 13). These differences may lead to Chinese Korean children have more risk of being obese. Then, when we compared the prevalence

of obesity between different nations in 2010, we concluded that the Han nationality and the Mongol nationality had similar high prevalence of childhood obesity. Other nations were lower than they were. Chinese Korean children had the highest prevalence of obesity than any other nations, which need us to pay more attention to (14).

The swift increase of the childhood obesity epidemic in such a brief period may be the result from the change of caloric intake, energy expenditure and lifestyle changes (15, 16). First, with the increase of Chinese economic, great improvements had happened in diet, a significant shift from undernutrition towards overnutrition (17). Overnutrition has played an important role in Chinese Korean childhood obesity (18). Second, because of the decrease in body movement and energy expenditure during transportation, people can get more leisure time, which is always spent as inactive spare time. This causes another large component of obesity (19, 20). In China, 30 percent of boys and 15 percent of girls spent more than 2 h per day playing computer games (21). Sitting in front of computers for hours makes reduce our energy expenditure. Third, in several researches, environmental factors including psychological stress were found to have a great influence on the development of obesity (22). In South Korea, schoolwork and an excessive competition for entrance exam have become the 'stress' factor which becomes the cause of children obesity (23). In China, the college entrance examination not just became the 'stress' factor in Chinese Korean

children. It also reduced outdoor activities in order to be engaged in better schools.

The data analysis revealed that rural children and urban children had the similar risk of becoming obesity in 2010. However, the prevalence of obesity reached epidemic proportions just in urban Chinese Korean children (13). The large disparity in the prevalence of obesity between rural children and urban children in different periods may be due to the change in the regional socioeconomic status. China's economic development was profited by urban residents firstly. Urban residents experience better living conditions and participate in less physical activity than rural residents (24). So the prevalence obesity was always higher in urban in the past. However, children in rural also benefited a lot from economic development. In the recent several years, rural children also experienced similar changes with urban children, which could help to explain why childhood obesity has also become a serious problem in rural areas.

Boys had more risk of being obesity than girls in our study. This trend was same as the trend of childhood in China (boys was higher than girls were) (3). Maybe they have the same cause related to China's traditional idea; sons were more preferred than girls especially in rural areas. Boys are more likely to be better raised than girls are. Therefore, they could attain much more food and get less work. In addition, obesity is not deemed as harmful or unbearable among boys in Chinese cultural value (26). However, parents and grandparents hope girls to be thinner and slimmer. For this reason, boys are allowed to eat more food than girls do. Moreover, Chinese adolescent girls have more aspirations for body image (preference for thinness). This also contributed to the difference in obesity trends (25, 27). In lifestyle, Chinese boys drank more soft drinks than girls, but fewer attempted to lose weight by restricting diet. At the same time boys spent more time playing computer games than girls (28). Different lifestyle between boys and girls may also contribute to the gender disparity in the prevalence of obesity.

In our result, the RR for Korean/Han children was not statistically significant in 2000. The reason may be that the annual increase in the obesity rate was significantly fast during the 2000-2010 periods. During 1991-2000, it increased slowly in Chinese Korean children. The annual increase in obesity rate of Han nationality children was in a different situation. During the 1991-2000 period, the speed was very fast, but it slowed down after 2000 (3). Different situations in the same period lead the RR in 2000 to be not statistically significant.

Two limitations existed in our study. First, childhood obesity defined based on weight-for-height, that is not a perfect method to reveal body fat. It is highly related to body fat. Regardless of the measure used, the change in prevalence of obesity was obvious. The second limitation was that the data from five cross-sectional surveys, and each survey was conducted on different subjects. When we estimated the prevalence of and trends in obesity, unintentional errors might occur. Besides, in our study the prevalence estimated in each CNSSCH was standardized according to the age distribution of the 2010 population for the purpose of comparison. In spite of having limitations, our results had made a significant contribution to know about the condition of obesity among Chinese Korean children and adolescents.

Conclusion

Obesity is highly prevalent in Chinese Korean children. This result is terrible and a significant and steady increase was happening among all sex-specific area groups. These trends present lots of critical public health challenges. Policymakers should have the awareness of stopping and reversing the trend from physically active to sedentary pastimes. Investments enhancing children health are extremely important to Chinese Korean children now. Many public health policies should be taken to solve these issues.

Ethical considerations

Ethical issues (Including plagiarism, informed consent, misconduct, data fabrication and/or fal-

sification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

Acknowledgements

This study was funded by National Natural Science Foundation of China (81402761), the Foundation Research Project of Jiangsu Province (The Natural Science Fund NO. BK20140361), Priority Academic Program Development of Jiangsu Higher Education Institutions (PAPD) and Jiangsu Key Laboratory of Preventive and Translational Medicine for Geriatric Diseases (KJS1513). The authors thank the CNSSCH for providing the data for the analysis. The authors declare that there is no conflict of interests.

References

1. Wang YC, McPherson K, Marsh T, Gortmaker SL, Brown M (2011). Health and economic burden of the projected obesity trends in the USA and the UK. *Lancet*, 378(9793): 815-25.
2. Ji CY, Chen TJ, Working Group on Obesity in China (2013). Empirical changes in the prevalence of overweight and obesity among Chinese students from 1985 to 2010 and corresponding preventive strategies. *Biomed Environ Sci*, 26(1): 1-12.
3. Sun H, Ma Y, Han D, Pan CW, Xu Y (2014). Prevalence and trends in obesity among China's children and adolescents, 1985-2010. *PLoS One*, 9(8): e105469.
4. Xu Tao (2012). Chinese Korean migrants in Korea more than 450000. China: HUNAN DAILY. Available from: <http://cj.voc.com.cn/article/201208/201208280827534286.html>
5. Meng L, Xu H, Liu A, van Raaij J, Bemelmans W, et al. (2013). The costs and cost-effectiveness of a school-based comprehensive intervention study on childhood obesity in China. *PLoS One*, 8(10): e77971.
6. Byun W, Dowda M, Pate RR (2012). Associations between screen-based sedentary behavior and cardiovascular disease risk factors in Korean youth. *J Korean Med Sci*, 27(4): 388-94.
7. Korean Centers for Disease Control and Prevention (2010): *National health statistics in 2008 based on the Fourth Korea National Health and Nutrition Examination Survey (KNHANES IV)*, 2008. In. Seoul: Korean Centers for Disease Control and Prevention, South Korea.
8. Kim HM, Park J, Kim HS, Kim DH, Park SH (2006). Obesity and cardiovascular risk factors in Korean children and adolescents aged 10-18 years from the Korean National Health and Nutrition Examination Survey, 1998 and 2001. *Am J Epidemiol*, 164(8): 787-93.
9. Ji CY, Cooperative Study on Childhood Obesity: Working Group on Obesity in China (2008). The prevalence of childhood overweight/obesity and the epidemic changes in 1985-2000 for Chinese school-age children and adolescents. *Obes Rev*, 9 Suppl 1: 78-81.
10. Working Group on Physical Health of Chinese school students (1987). *Report on the physical fitness and health surveillance of Chinese school students*. Beijing: People's Education Press, China, pp.25-26.
11. McNutt LA, Wu C, Xue X, Hafner JP (2003). Estimating the relative risk in cohort studies and clinical trials of common outcomes. *Am J Epidemiol*, 157(10): 940-3.
12. Sun N, Zhou W, Xiong Y H, Fang J N (2007). Comparative study on different types of obesity among the Chinese Korean and Han nationality in countryside community of Yanbian area. *Journal of Medical Science Yanbian University*, 30(3): 183-5. (In Chinese)
13. Xiong N, University P (2006). Epidemiological status of overweight and obesity

- among Chinese Korean students and its comparison with Chinese Han students. *Chin J Publ Heal*, 8(22): 901–2. (In Chinese)
14. Working Group on Physical Health of Chinese school students (2010). *Reports on the physical fitness and health research of Chinese school students*. Beijing: People's Education Press, China, pp.711-46.
 15. Lee HJ, Lee SY, Park EC (2015). Do family meals affect childhood overweight or obesity?: nationwide survey 2008–2012. *Pediatr Obes*, 11(3): 161-5.
 16. Ji CY, Cheng TO (2009). Epidemic increase in overweight and obesity in Chinese children from 1985 to 2005. *Int J Cardiol*, 132(1), 1-10.
 17. Popkin BM, Gordon-Larsen P (2004). The nutrition transition: worldwide obesity dynamics and their determinants. *Int J Obes Relat Metab Disord*, 28 Suppl3: S2–9.
 18. Fang J N, Quan Z Y, Cui L H, Han X Z, Jin C J (2000). Comparative study on development of growth and obesity in students of Korean-Chinese and Han nationality. *Journal of Medical Science Yanbian University*, 23(4): 267-70. (In Chinese)
 19. Rosiek A, Maciejewska NF, Leksowski K, Rosiek-Kryszewska A, Leksowski Ł (2015). Effect of Television on Obesity and Excess of Weight and Consequences of Health. *Int J Environ Res Public Health*, 12(8): 9408-26.
 20. Saris WH, Blair SN, van Baak MA, Eaton SB, Davies PS, et al. (2003). How much physical activity is enough to prevent unhealthy weight gain? Outcome of the IASO 1st Stock Conference and consensus statement. *Obes Rev*, 4(2): 101-14.
 21. Song Y, Wang HJ, Ma J, Wang Z (2013). Secular trends of obesity prevalence in urban Chinese children from 1985 to 2010: gender disparity. *PLoS One*, 8(1): e53069.
 22. Horsch A, Wobmann M, Kriemler S, Munsch S, Borloz S, et al. (2015). Impact of physical activity on energy balance, food intake and choice in normal weight and obese children in the setting of acute social stress: a randomized controlled trial. *BMC Pediatr*, 15:12.
 23. Kim DM, Ahn CW, Nam SY (2005). Prevalence of obesity in Korea. *Obes Rev*, 6(2): 117-21.
 24. Harpham T (2009). Urban health in developing countries: what do we know and where do we go? *Health Place*, 15(1): 107-16.
 25. Wang Y, Monteiro C, Popkin BM (2002). Trends of obesity and underweight in older children and adolescents in the United States, Brazil, China, and Russia. *Am J Clin Nutr*, 5(6): 971-7.
 26. Marsh HW, Hau KT, Sung RY, Yu CW (2007). Childhood obesity, gender, actual-ideal body image discrepancies, and physical self-concept in Hong Kong children: cultural differences in the value of moderation. *Dev Psychol*, 43(3): 647-62.
 27. Garner DM, Garfinkel PE, Schwartz D, Thompson M (1980). Cultural expectations of thinness in women. *Psychol Rep*, 47(2): 483–91.
 28. Ji C (2007). *Report on the 2005 Chinese National Survey on Youth's Health Risk Behavior*. Beijing: Peking University Medical Science Press, China.