

## Original Article

# Difference in overweight/obesity rates between Chinese and Japanese teenagers

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**Abstract:** Objective: This study aimed to examine the association between being overweight/obese and lifestyle habits in Chinese and Japanese teenagers. Methods: This cross-sectional study was conducted between April and June 2014 among teenagers in Japan (Kyushu Fukuoka, Osaka, Wakayama, and Saitama) and China (Shanghai, Fujian Province, Sichuan Province, and Shanxi Province). Four hundred teenagers in each age group (16 to 18 years old) were selected based on random multistage cluster sampling. Physical measurements and questionnaire surveys were performed. Results: The prevalence of being overweight/obese was 15.5%/6.0% in Chinese teenagers and 9.3%/4.8% in Japanese teenagers. Multivariate analyses showed that Chinese overweight/obese teenagers were more likely to go to school by other means than walking (such as bus, car), have long hours watching TV/using the computer (>3 h/day), do not have days doing sports every week, skip breakfast, and take snacks (≥3 days/week) than normal-weight participants. In Japanese teenagers, the findings were almost the same as that in Chinese teenagers; except we did not find an association between being overweight/obese and spending long hours of watching TV/using the computer (>3 h/day) Japanese teenagers. Conclusions: Both Chinese and Japanese teenagers' overweight/obesity status was generally associated with a sedentary lifestyle, and the present results suggest that we should consider programs that promote an active and healthy lifestyle to prevent teenagers from being overweight/obese in all countries.

**Keywords:** China, Japan, teenagers, lifestyle habits, overweight and obesity

## Introduction

Obesity is a nutrition disturbance disease in which long-term energy intake exceeds energy consumption, leading to excessive energy accumulation in the form of adipose tissue [1, 2]. The thrifty gene hypothesis stipulates that humans, as any other living organism, store excess energy to use these reserves in periods of shortage [3]. However, with the continuous improvement of living standards, many people now live in a state of abundance, leading to continuous energy storage and obesity [1]. Obesity leads to a higher risk of disability, morbidity, and mortality [4]. A study showed that a 5-kg weight gain from early to middle adulthood was associated with an approximate 10% elevated all-cause mortality and a greater than 20% cardiovascular disease-related mortality

in later life among individuals who reached a body mass index (BMI) of 23 or higher in middle adulthood [5].

An increasing concern is the recent epidemics of obesity among children and teenagers caused by overnutrition in developed and developing countries globally [6]. Obesity rates in the world's children and adolescents increased from less than 1% (equivalent to five million girls and six million boys) in 1975 to nearly 6% in girls (50 million) and nearly 8% in boys (74 million) in 2016. An additional 213 million were overweight in 2016 but fell below the threshold for obesity. The rise in childhood and adolescent obesity rates in low- and middle-income countries, especially in Asia, has recently accelerated [7]. As a common nutritional metabolic disease, obesity is a serious problem faced by

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teenagers worldwide [8]. Childhood obesity has a great impact on disability, morbidity, and mortality during adulthood [9, 10].

With the recent and rapid economic development of China and subsequent changes in lifestyle habits [11], being overweight and obese among teenagers is becoming a national concern in China. In 2015, based on the Working Group for Obesity in China (WGOC) criteria, the prevalence of being overweight and obese was 14.0% and 10.5% in boys and 9.7% and 7.1% in girls, respectively [12]. A study showed that the modern Chinese dietary pattern (greatly influenced by Western foods) and the traditional Northern China pattern were associated with a higher risk of childhood obesity [13]. Similar trends have been observed in Japan [14, 15].

Therefore, governments in various countries are paying a lot of attention to the physical health of teenagers. As East Asian countries, China and Japan have shown rapid economic development in recent decades, and both are affected by the epidemics of childhood obesity [12, 14]. This study aimed to examine the association between being overweight/obese and lifestyle habits in Chinese and Japanese teenagers. Identifying these factors will provide a scientific basis for the formulation of relevant preventive policies.

### Materials and methods

#### *Samples*

This cross-sectional study was performed from April to June 2014 including teenagers in Japan (Kyushu Fukuoka, Osaka, Wakayama, and Saitama) and China (Shanghai, Fujian Province, Sichuan Province, and Shanxi Province). Within this period, 12 Chinese schools and 16 Japanese schools participated in this study, and 9530 subjects completed the questionnaire. Equivalent stratified sampling was used to avoid bias. One primary school and one middle school (including junior high school and senior high school) in the provincial capital were selected, and one middle school (including middle school and high school) in the suburbs of each provincial capital was selected. More schools were selected in Japan due to differences in school levels: the Japanese middle school (equivalent to the junior high school in China) is different from the high school (equivalent to the senior high school in China).

In the present study, 2400 teenagers were randomly selected according to age stratification (16, 17, and 18 years old) and country (China and Japan). Each group had 400 teenagers.

This study was approved by the Ethics Committee of the School of Physical Education and Health, East China Normal University (China) (approval number: HR 009-2013). Verbal informed consent was obtained from the participants.

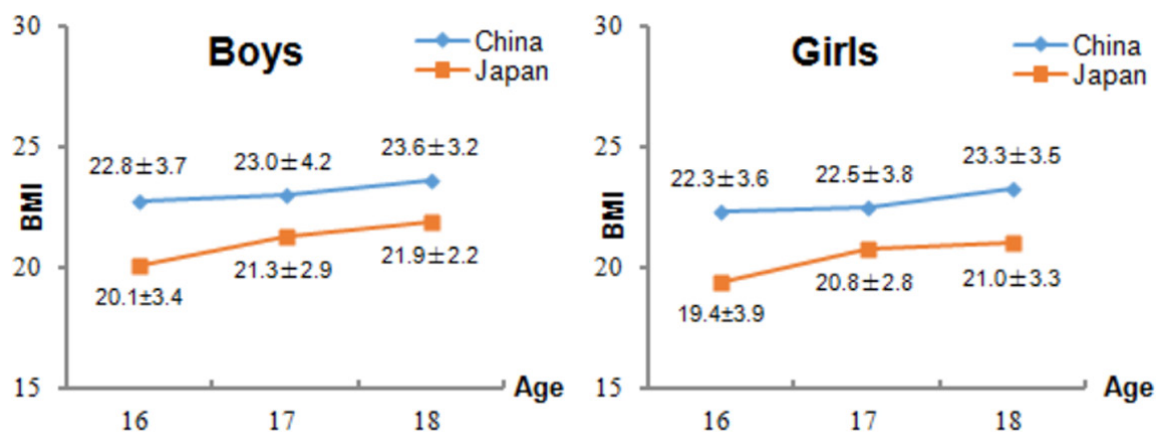
#### *Data collection*

College student volunteers in each city were selected as investigators. After being trained professionally and passing the study examinations, the investigators began the survey. The survey contents involved physical measurements and questionnaires. A pilot study showed that our home-made questionnaire had good reliability and validity. Days with sportive activities refer to days with an exercise time of >30 min at a slight sweating intensity. Often failing to have breakfast refers to no breakfast for at least 3 days a week. Often having snacks refers to eating snacks at least 3 days a week. Often drinking beverages refers to drinking carbonated drinks at least 3 days a week.

Physical measurements included height and weight. Height refers to the vertical distance between the bottom of the foot and the peak point on the head in a standing position. Weight refers to the total body weight measured with light clothing only, without shoes or accessories. Height and weight were measured using an RCS-200 electronic height and weight scale (Suhong Medical Appliance Co., Ltd., Jiangsu, China). Zeroing of the scale was verified prior to any measurements. During measurement, the sight line was parallel to the scale mark. Height was measured at the nearest centimeter. Weight was measured in kilograms at one decimal. BMI was calculated as weight divided by height squared ( $\text{kg}/\text{m}^2$ ). This study adopted the World Health Organization's standards to screen for obesity and being overweight in Chinese and Japanese teenagers [16].

We designed the questionnaire according to the Chinese and Japanese National Nutrition and Health Survey and factors related to obesity among teenagers, such as sports habits [17, 18], dairy diet [19, 20], and screen time length [21]. Many studies show that there is low

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**Figure 1.** BMI of Chinese and Japanese teenagers at different ages (all  $P < 0.05$  for Chinese vs. Japanese for each age group).

prevalence of obesity in Japanese children [22]. On the contrary, a high prevalence has been observed in Chinese teenagers for several decades [23, 24]. Some studies found a low prevalence of obesity in Japanese teenagers, which is correlated with good behavior, habits, and dietary behavior [25]. Therefore, this study attempts to make a comparative analysis of Chinese and Japanese adolescents from the aspects of sports habits, dairy diet, and screen length.

With class as the unit, the questionnaire survey was under the charge of specially assigned persons. The trained investigators explained the purposes and significances of the survey and filling instructions and precautions to the students in detail, to obtain the students' full trust and cooperation and guarantee informed consent from all the respondents. Then a class teacher issued the questionnaires under the supervision of a specially assigned person. The students uniformly filled out the questionnaires strictly according to the requirements. The questionnaires were taken back to the site after filling out and were verified immediately. Any missing information was asked to be filled in. Only complete questionnaires were considered valid for analysis.

### Data management and statistical analysis

EpiData 3.1 (Centers for Disease Control, Atlanta, GA, USA) was used for database management. Differences in average BMI values between Chinese and Japanese teenagers were evaluated by *t*-tests; the Chi-square test

was used to analyze the difference between lifestyle habits and weight status in the two countries. Logistic regression was applied to test the association between children's weight status and lifestyle behavioral factors of each country (China, Japan). SPSS 22.0 (IBM, Armonk, NY, USA) was used for statistical analysis. Two-sided *P* values  $< 0.05$  were considered statistically significant.

### Results

#### Univariate analyses of being overweight and obese among Chinese and Japanese teenagers and their lifestyle habits

The prevalence of being overweight/obese was 15.5%/6.0% in Chinese teenagers and 9.3%/4.8% in Japanese teenagers. **Figure 1** presents the BMI comparisons between Chinese and Japanese teenagers at different ages; Chinese teenagers consistently had a larger BMI in all three age groups for both sexes (all  $P < 0.05$  for Chinese vs. Japanese). In both groups, the frequency of being overweight or obese decreased with increasing age (both  $P < 0.05$ ). Obesity was more frequent in Chinese males ( $P = 0.02$ ), but not in Japanese males ( $P = 0.72$ ). Walking and cycling to school, playing sports every week, and duration of sports sessions were associated with a lower frequency of being overweight and obese in both groups (all  $P < 0.001$ ) (**Figure 1**).

Being overweight and obese increased with TV time in both groups (both  $P < 0.05$ ). Failing to eat breakfast very often, eating snacks frequently,

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**Table 1.** Univariate analysis of being overweight/obese among Chinese and Japanese teenagers and their lifestyle habits

Variables	China			P	Japan			P
	Normal weight (N = 942, 78.5%)	Overweight (N = 186, 15.5%)	Obese (N = 72, 6.0%)		Normal weight (N = 1031, 85.9%)	Overweight (N = 112, 9.3%)	Obese (N = 57, 4.8%)	
Age				0.035				0.009
16	303 (75.8%)	67 (16.8%)	30 (7.5%)		332 (83.0%)	44 (11.0%)	24 (6.0%)	
17	307 (76.8%)	67 (16.8%)	26 (6.5%)		335 (83.8%)	42 (10.5%)	23 (5.8%)	
18	332 (83.0%)	52 (13.0%)	16 (4.0%)		364 (91.0%)	26 (6.5%)	10 (2.5%)	
Gender				0.018				0.719
Male	455 (75.8%)	105 (17.5%)	40 (6.7%)		511 (85.2%)	58 (9.7%)	31 (5.2%)	
Female	487 (81.2%)	81 (13.5%)	32 (5.3%)		520 (86.7%)	54 (9.0%)	26 (4.3%)	
Means used in going to school				<0.001				<0.001
Walking	654 (82.6%)	98 (12.4%)	40 (5.1%)		610 (87.8%)	63 (9.1%)	22 (3.2%)	
Bicycling	219 (81.7%)	32 (11.9%)	17 (6.3%)		304 (87.4%)	33 (9.5%)	11 (3.2%)	
Others	69 (49.3%)	56 (40.0%)	15 (10.7%)		117 (74.5%)	16 (10.2%)	24 (15.3%)	
Time spent using the computer/watching TV each day (h)				<0.001				0.013
<1	285 (84.6%)	33 (9.8%)	19 (5.6%)		337 (88.0%)	31 (8.1%)	15 (3.9%)	
1-3	524 (81.1%)	81 (12.5%)	41 (6.3%)		519 (87.4%)	50 (8.4%)	25 (4.2%)	
>3	133 (61.3%)	72 (33.2%)	12 (5.5%)		175 (78.5%)	31 (13.9%)	17 (7.6%)	
<sup>a</sup> Days of playing sports every week				<0.001				<0.001
None	86 (57.7%)	47 (31.5%)	16 (10.7%)		54 (68.4%)	18 (22.8%)	7 (8.9%)	
1-3	625 (81.1%)	100 (13.0%)	46 (6.0%)		683 (82.7%)	93 (11.3%)	50 (6.1%)	
>3	231 (82.5%)	39 (13.9%)	10 (3.6%)		294 (99.7%)	1 (0.3%)	0 (0.0%)	
Number of PE lessons every week				0.837				0.523
1	260 (78.1%)	53 (15.9%)	20 (6.0%)		409 (85.0%)	53 (11.0%)	19 (4.0%)	
2	457 (78.9%)	91 (15.7%)	31 (5.4%)		497 (86.6%)	57 (9.9%)	20 (3.5%)	
>3	225 (78.1%)	42 (14.6%)	21 (7.3%)		125 (86.2%)	2 (1.4%)	18 (12.4%)	
Sports duration for each time (h)				<0.001				<0.001
<0.5	183 (66.8%)	58 (21.2%)	33 (12.0%)		125 (69.1%)	51 (28.2%)	5 (2.8%)	
0.5-1	534 (80.4%)	93 (14.0%)	37 (5.6%)		626 (85.1%)	60 (8.2%)	50 (6.8%)	
>1	225 (85.9%)	35 (13.4%)	2 (0.8%)		280 (98.9%)	1 (0.4%)	2 (0.7%)	
<sup>b</sup> Often fail to have breakfast				<0.001				<0.001
Yes	573 (70.9%)	178 (22.0%)	57 (7.1%)		549 (79.5%)	97 (14.0%)	45 (6.5%)	
No	369 (94.1%)	8 (2.0%)	15 (3.8%)		482 (94.7%)	15 (2.9%)	12 (2.4%)	
<sup>c</sup> Often have snacks				<0.001				<0.001
Yes	671 (75.0%)	161 (18.0%)	63 (7.0%)		615 (80.5%)	102 (13.4%)	47 (6.2%)	
No	271 (88.9%)	25 (8.2%)	9 (3.0%)		416 (95.4%)	10 (2.3%)	10 (2.3%)	
<sup>d</sup> Often drink carbonated beverages				<0.001				<0.001
Yes	422 (72.9%)	116 (20.0%)	41 (7.1%)		415 (74.0%)	101 (18.0%)	45 (8.0%)	
No	520 (83.7%)	70 (11.3%)	31 (5.0%)		616 (96.4%)	11 (1.7%)	12 (1.9%)	

<sup>a</sup>playing sports 30 min/day. <sup>b</sup>failure to have breakfast  $\geq 3$  days/week. <sup>c</sup>have snacks  $\geq 3$  days/week. <sup>d</sup>drink carbonated beverages  $\geq 3$  days/week.

and drinking carbonated beverages frequently were associated with a higher frequency of being overweight and obese in Chinese and Japanese teenagers (all  $P < 0.001$ ) (Table 1).

### *Multivariable analyses of being overweight and obese among Chinese and Japanese teenagers and their lifestyle habits*

To balance the interaction between factors and investigate the influence of various factors on the overweight and obesity status of Chinese and Japanese teenagers, overweight and obe-

sity were used as the dependent variables, and transportation used in going to school, using the computer/watching TV every day, number of days per week playing sports, sports duration each time, often skipping breakfast, having snacks, and drinking carbonated beverages were considered as the independent variables for logistic regression multivariate analysis while controlling for age and gender.

The multivariate analyses showed that Chinese overweight/obese teenagers were more likely to go to school by other than active means

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**Table 2.** Multivariate analysis of being overweight/obese in Chinese teenagers and their lifestyle habits

Variable	Overweight <sup>b</sup>			Obesity <sup>b</sup>		
	OR <sup>a</sup>	95% CI	P-value	OR <sup>a</sup>	95% CI	P-value
Means used in going to school						
Walking	Reference	-	-	Reference	-	-
Bicycling	1.22	0.96-1.52	0.316	1.13	0.91-1.39	0.837
Others <sup>c</sup>	2.57	2.35-2.78	0.014	3.28	3.03-3.52	<0.001
Hours spent using the computer/watching TV per day (h)						
<1	Reference	-	-	Reference	-	-
1-3	1.08	0.84-1.33	2.110	1.66	1.28-1.85	0.049
>3	2.83	2.60-3.05	0.012	3.17	2.90-3.43	<0.001
Days of playing sports every week						
None	3.12	2.69-3.78	0.016	2.67	1.95-3.12	0.029
1-3	1.89	1.01-2.34	0.079	1.45	1.01-1.91	0.038
>3	Reference	-	-	Reference	-	-
Often fail to have breakfast						
Yes	2.34	1.58-2.96	0.020	1.93	1.27-2.76	0.039
No	Reference	-	-	Reference	-	-
Often have snacks						
Yes	3.84	3.18-4.46		2.97	2.38-3.77	<0.001
No	Reference	-		Reference	-	-

<sup>a</sup>OR: odds ratio; 95% CI: 95% confidence interval. Backward LR method. <sup>b</sup>The normal weight group was the reference group, and age and gender were controlled. <sup>c</sup>Others including bus, car, etc.

(such as bus, car) (overweight, odds ratio [OR] = 2.57, 95% confidence interval [CI] = 2.35-2.78; obesity, OR = 3.28, 95% CI = 3.03-3.52), have long hours watching TV/using the computer (>3 h/day) (overweight, OR = 2.83, 95% CI = 2.60-3.05; obesity, OR = 3.17, 95% CI = 2.90-3.43), have no days playing sports/every week (overweight, OR = 3.12, 95% CI = 2.69-3.78; obesity, OR = 2.67, 95% CI = 1.95-3.12), skipping breakfast (overweight, OR = 2.34, 95% CI = 1.58-2.96; obesity, OR = 1.93, 95% CI = 1.27-2.76), and snacking ( $\geq 3$  days/week) (overweight, OR = 3.84, 95% CI = 3.18-4.46; obesity, OR = 2.97, 95% CI = 2.38-3.77) than normal-weight participants (**Table 2**).

In Japanese teenagers, compared with teenagers who were of normal weight, overweight/obese ones were more likely to go to school by other than active means (such as bus, car) (overweight, OR = 3.71, 95% CI = 3.42-3.97; obesity, OR = 3.97, 95% CI = 3.72-4.19), have no days playing sports/every week (overweight, OR = 3.67, 95% CI = 3.21-4.12; obesity, OR = 2.72, 95% CI = 2.32-3.12), skipping breakfast (overweight, OR = 2.35, 95% CI = 1.89-2.98; obesity, OR = 1.56, 95% CI = 1.24-1.95), and

snacking ( $\geq 3$  days/week) (overweight, OR = 3.02, 95% CI = 2.54-3.71; obesity, OR = 2.36, 95% CI = 1.89-2.91), while we failed to find that association between being overweight/obese and long hours watching TV/using the computer (>3 h/day) (**Table 3**).

### Discussion

In this study, we found that Chinese teenagers' prevalence to being overweight and obese was higher than that of Japanese teenagers; however, overweight-/obesity-related lifestyle habits in Chinese teenagers were almost the same as those in Japanese teenagers. Those who go to school by other than active means (such as bus, car), have long hours watching TV/using the computer (>3 h/day) (no Japanese), have no days playing sports/every week, skip breakfast, and have snacks ( $\geq 3$  days/week) suffered from a higher risk of being overweight/obese than others.

In the present study, the prevalence of being overweight/obese was 15.5%/6.0% in Chinese teenagers and 9.3%/4.8% in Japanese teenagers, which is roughly similar to the national



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**Table 3.** Multivariate analysis of being overweight/obese status in Japanese teenagers and their lifestyle habits

Variable	Overweight			Obesity		
	OR	95% CI	P-value	OR	95% CI	P-value
Means used in going to school						
Walking	Reference	-	-	Reference	-	-
Bicycling	1.36	0.95-1.60	0.132	1.26	0.96-1.56	0.234
Others	3.71	3.42-3.97	<0.001	3.97	3.72-4.19	<0.001
Days playing sports every week						
None	3.67	3.21-4.12	<0.001	2.72	2.32-3.12	0.023
1-3	0.82	0.56-1.08	0.181	0.87	0.62-1.12	0.599
>3	Reference	-	-	Reference	-	-
Often fail to have breakfast						
Yes	2.35	1.89-2.98	<0.001	1.56	1.24-1.95	<0.001
No	Reference	-	-	Reference	-	-
Often have snacks						
Yes	3.02	2.54-3.71	0.008	2.36	1.89-2.91	0.017
No	Reference	-	-	Reference	-	-

OR, odds ratio; 95% CI, 95% confidence interval. Backward LR method. The normal-weight group was the reference group, and age and gender were controlled.

prevalence of these two countries [12, 14, 26]. Obesity was more prevalent in Chinese males, as previously reported [12], but not in Japanese males, as observed in other non-Chinese countries [27-29]. This could be due to a number of factors including a fish-based diet in Japan [30]. Nevertheless, this prevalence was lower than that observed in other countries [27, 31-33].

This study has shown that both Chinese and Japanese teenagers who go to school by other than active means (such as bus, car) were more likely to be overweight/obese than those who go to school walking/bicycling. This finding is consistent with a previous study [34]. The common use of mechanical means of transportation to go to school is associated with a lower level of energy expenditure, contributing to increased weight in teenagers.

Previous studies have shown that skipping breakfast is an important risk factor for obesity [26], which is in line with our finding that being overweight/obese is associated with skipping breakfast and snacks. Breakfast is often associated with a higher intake of carbohydrates, fibers, and micronutrients and a lower intake of fat [35, 36], which could contribute to a more healthy energy balance among the different macronutrients. A large-sample Swedish study

showed that skipping breakfast was associated with a higher risk of obesity than alcohol or physical inactivity [37]. Eating snacks between meals increases the energy input. In addition, these snacks are often rich in refined sugar and fats and poor in dietary fibers. Eating snacks has been shown to increase the likelihood of developing cardiovascular risk factors (including obesity) in adults [38] and children [39, 40].

In the present study, we found that overweight/obese teenagers in both China and Japan were more likely to have no days playing sports/ every week compared to the normal-weight teenagers. We also found that only Chinese overweight/obese teenagers who spend long hours watching TV/using the computer (>3 h/day) were more likely to be overweight/obese. The relationship between physical inactivity and overweight/obesity (lack of exercise and long hours watching TV/using the computer) is controversial and seems to vary among populations. The time spent watching TV/using the computer is frequently used as an indicator of inactivity in epidemiologic and intervention studies [41]. This parameter correlates strongly with obesity in children and teenagers [42]. Indeed, Guo et al. [26] did not associate watching TV with obesity among teenagers. This is consistent with our finding where we did not find an association between being overweight/

obese and long hours spent watching TV/using the computer (>3 h/day) in Japanese teenagers. Yi et al. [43] showed no association between obesity and physical inactivity among children 5-18 years old in Northern China, which was also observed in Saudi Arabia [27]. Reilly et al. [44] showed that physical activity did not reduce the weight status of young children. A Swedish study showed that watching TV>2 h/day was associated with obesity [45], similar to the results of other studies [42, 46, 47], thus supporting the present study. Indeed, the present study showed that physical inactivity was associated with being overweight and obese in Chinese and Japanese teenagers.

The present study has some limitations. First, with regard to physical measurement, even if the investigators were trained, results could still suffer from some bias due to errors of instruments, responsibilities of investigators, and other uncertain factors. Second, with regard to the questionnaire survey, the children could fail to answer the questionnaires truthfully due to complicated mentalities such as self-abasement and vanity. The questionnaires were completed by the children independently, and a recall bias may exist. Finally, some factors were not assessed in the present study, such as socioeconomic factors. Additional studies are still necessary to comprehensively understand the risk factors of being overweight and obese among teenagers.

### Conclusions

In conclusion, this study reported the prevalence of being overweight/obese in Chinese and Japanese teenagers, analyzing the association between being overweight/obese and lifestyle habits' factors. Whether overweight or obese, a higher prevalence is observed in Chinese teenagers than that in Japanese teenagers. It was found that overweight/obese teenagers were more likely to go to school by other than active means (such as bus, car), have long hours watching TV/using the computer (>3 h/day), have no days playing sports/ every week, skip breakfast, and have snacks ( $\geq 3$  days/week) more than normal-weight participants in China. In Japan, the findings were almost similar to those of Chinese teenagers; we merely failed to find an association between being overweight/obese and long hours spent watching TV/using the computer (>3 h/day).

Our findings illustrated that being overweight/obese is related to a sedentary lifestyle in Chinese and Japanese teenagers; therefore, we should consider programs that push an active and healthy lifestyle to prevent being overweight/obese in teenagers in both countries.

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### Disclosure of conflict of interest

None.

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### References

- [1] Kushner RF and Ryan DH. Assessment and lifestyle management of patients with obesity: clinical recommendations from systematic reviews. *JAMA* 2014; 312: 943-952.
- [2] Jensen MD, Ryan DH, Apovian CM, Ard JD, Comuzzie AG, Donato KA, Hu FB, Hubbard VS, Jakicic JM, Kushner RF, Loria CM, Millen BE, Nonas CA, Pi-Sunyer FX, Stevens J, Stevens VJ, Wadden TA, Wolfe BM, Yanovski SZ, Jordan HS, Kendall KA, Lux LJ, Mentor-Marcel R, Morgan LC, Trisolini MG, Wnek J, Anderson JL, Halperin JL, Albert NM, Bozkurt B, Brindis RG, Curtis LH, DeMets D, Hochman JS, Kovacs RJ, Ohman EM, Pressler SJ, Sellke FW, Shen W, Smith Jr SC and Tomaselli GF. 2013 AHA/ACC/TOS guideline for the management of overweight and obesity in adults: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines and The Obesity Society. *Obesity* 2014; 63: 2985-3023.
- [3] Hay T. Commentary: the invention of aboriginal diabetes: the role of the thrifty gene hypothesis in Canadian Health Care Provision. *Ethn Dis* 2018; 28 Suppl 1: 247-252.

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- [4] Global BMI Mortality Collaboration, Angelantonio ED, Bhupathiraju S, Wormser D, Gao P, Kaptoge S, Gonzalez AB, Cairns B, Huxley R, Jackson C, Joshy G, Lewington S, Manson J, Murphy N, Patel A, Samet J, Woodward M, Zheng W, Zhou M, Bansal N, Barricarte A, Carter B, Cerhan J, Smith G, Fang X, Franco O, Green J, Halsey J, Hildebrand J, Jung K, Korda R, McLerran D, Moore S, O’Keeffe L, Paige E, Ramond A, Reeves G, Rolland B, Sacerdote C, Sattar N, Sofianopoulou E, Stevens J, Thun M, Ueshima H, Yang L, Yun Y, Willeit P, Banks E, Beral V, Chen Z, Gapstur S, Gunter M, Hartge P, Jee S, Lam T, Peto R, Potter J, Willett W, Thompson S, Danesh J and Hu F. Body-mass index and all-cause mortality: individual-participant-data meta-analysis of 239 prospective studies in four continents. *Lancet* 2016; 388: 776-786.
- [5] Jia G, Shu X, Liu Y, Li H, Cai H, Gao J, Gao Y, Wen W, Xiang Y and Zheng W. Association of adult weight gain with major health outcomes among middle-aged Chinese persons with low body weight in early adulthood. *JAMA Network Open* 2019; 2: e1917371.
- [6] Sharma T and Mitra S. Functional capacity and quality of life in overweight and obese children aged 13-18 years. *IJHSR* 2016; 6: 146-151.
- [7] World Health Organization: 2017. Tenfold increase in childhood and adolescent obesity in four decades: new study by Imperial College London and WHO.
- [8] Keller A, Rohde JF, Raymond K and Heitmann BL. Association between periodontal disease and overweight and obesity: a systematic review. *J Periodontol* 2015; 86: 766-76.
- [9] Twig G, Yaniv G, Levine H, Leiba A, Goldberger N, Derazne F, Shor DB, Tzur D, Afek A, Shamiss A, Haklai Z and Kark JD. Body-mass index in 2.3 million adolescents and cardiovascular death in adulthood. *N Engl J Med* 2016; 374: 2440.
- [10] Kim SJ, Ahn J, Kim HK and Kim JH. Obese children experience more extremity fractures than nonobese children and are significantly more likely to die from traumatic injuries. *Acta Paediatr* 2016; 105: 1152-1157.
- [11] Popkin BM. Synthesis and implications: China’s nutrition transition in the context of changes across other low- and middle-income countries. *Obes Rev* 2014; 15: 60-67.
- [12] Zhang J, Wang H, Wang Z, Du W, Su C, Zhang J, Jiang H, Jia X, Huang F, Ouyang Y, Wang Y and Zhang B. Prevalence and stabilizing trends in overweight and obesity among children and adolescents in China, 2011-2015. *BMC Public Health* 2018; 18: 571.
- [13] Zhang J, Wang H, Wang Y, Xue H, Wang Z, Du W, Su C, Zhang J, Jiang H, Zhai F and Zhang B. Dietary patterns and their associations with childhood obesity in China. *Br J Nutr* 2015; 113: 1978-1984.
- [14] Goto K, Ominami C, Song C, Murayama N and Wolff C. Globalization, localization and food culture: perceived roles of social and cultural capitals in healthy child feeding practices in Japan. *Glob Health Promot* 2014; 21: 50-58.
- [15] Sakai R. Relationship between prevalence of childhood obesity in 17-year-olds and socio-economic and environmental factors: prefecture-level analysis in Japan. *Asia Pac J Public Health* 2013; 25: 159-169.
- [16] World Health Organization: 2009. WHO child growth standards and the identification of severe acute malnutrition in infants and children - a joint statement.
- [17] Zhou N and Cheah CS. Ecological risk model of childhood obesity in Chinese immigrant children. *Appetite* 2015; 90: 99-107.
- [18] Ashdown-Franks G, Vancampfort D, Firth J, Veronese N, Jackson SE, Smith L, Stubbs B and Koyanagi A. Leisure-time sedentary behavior and obesity among 116762 adolescents aged 12-15 years from 41 low-and middle-income countries. *Obesity* 2019; 5: 830-836.
- [19] Luger M, Lafontan M, Bes-Rastrollo M, Winzer E, Yumuk V and Farpour-Lambert N. Sugar-sweetened beverages and weight gain in children and adults: a systematic review from 2013 to 2015 and a comparison with previous studies. *Obes Facts* 2017; 10: 674-693.
- [20] Hardy LL, Bell J, Bauman A and Mihrshahi S. Association between adolescents’ consumption of total and different types of sugar-sweetened beverages with oral health impacts and weight status. *Aust N Z J Public Health* 2018; 42: 22-26.
- [21] Minematsu K, Kawabuchi R, Okazaki H, Tomita H, Tobina T, Tanigawa T and Tsunawake N. Physical activity cutoffs and risk factors for preventing child obesity in Japan. *Pediatr Int* 2015; 57: 131-136.
- [22] United Nations International Children’s Emergency Fund: 2019. The State of the World’s Children 2019-children, food and nutrition: growing well in a changing world.
- [23] School of Public Health of Peking University & United Nations International Children’s Emergency Fund: 2019. Report on childhood obesity in China.
- [24] Jia P, Xue H, Zhang J and Wang Y. Time trend and demographic and geographic disparities in childhood obesity prevalence in China-evidence from twenty years of longitudinal data. *Int J Environ Res Public Health* 2017; 14: 369.
- [25] Fumio K, Yasuo K and Terue K. Relationship of dietary habits and obesity to oxidative stress in Palauan people: compared with Japanese and



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- Mongolian people. *Curr Aging Sci* 2009; 2: 214-222.
- [26] Guo X, Zheng L, Li Y, Zhang X, Yu S, Yang H, Zhang X, Sun Z and Sun Y. Prevalence and risk factors of being overweight or obese among children and adolescents in northeast China. *Pediatr Res* 2013; 74: 443-449.
- [27] Mahfouz AA, Shatoor AS, Khan MY, Daffalla AA, Mostafa OA and Hassanein MA. Nutrition, physical activity, and gender risks for adolescent obesity in Southwestern Saudi Arabia. *Saudi J Gastroenterol* 2011; 17: 318-322.
- [28] Ene-Obong H, Ibeanu V, Onuoha N and Ejekwu A. Prevalence of overweight, obesity, and thinness among urban school-aged children and adolescents in southern Nigeria. *Food Nutr Bull* 2012; 33: 242-250.
- [29] Tuan NT, Butte NF and Wang Y. Demographic and socioeconomic correlates of adiposity assessed with dual-energy X-ray absorptiometry in US children and adolescents. *Am J Clin Nutr* 2012; 96: 1104-1112.
- [30] Yamori Y. Worldwide epidemic of obesity: hope for Japanese diets. *Clin Exp Pharmacol Physiol* 2004; 31: S2-S4.
- [31] Dereń K, Nyankovskyy S, Nyankovska O, Łuszczki E, Wyszyńska J, Sobolewski M and Mazur A. The prevalence of underweight, overweight and obesity in children and adolescents from Ukraine. *Sci Rep* 2018; 8: 3625.
- [32] Ferreira RJ and Marques-Vidal PM. Prevalence and determinants of obesity in children in public schools of Sintra, Portugal. *Obesity (Silver Spring)* 2008; 16: 497-500.
- [33] Cassimos D, Sidiropoulos H, Batzios S, Balodima V and Christoforidis A. Sociodemographic and dietary risk factors for excess weight in a greek pediatric population living in Kavala, Northern Greece. *Nutr Clin Pract* 2011; 26: 186-191.
- [34] Vasques C, Mota M, Correia T and Lopes V. Prevalence of overweight/obesity and its association with sedentary behavior in children. *Rev Port Cardiol* 2012; 31: 783-788.
- [35] de la Hunty A, Gibson Sand Ashwell M. Does regular breakfast cereal consumption help children and adolescents stay slimmer? A systematic review and meta-analysis. *Obes Facts* 2013; 6: 70-85.
- [36] Ardeshirlarijani E, Namazi N, Jabbari M, Zeinali M, Gerami H, Jalili RB, Larijani B and Azadbakht L. The link between breakfast skipping and overweight/obesity in children and adolescents: a meta-analysis of observational studies. *J Diabetes Metab Disord* 2019; 18: 657-664.
- [37] Croezen S, Visscher TL, Ter Bogt NC, Veling ML and Haveman-Nies A. Skipping breakfast, alcohol consumption and physical inactivity as risk factors for overweight and obesity in adolescents: results of the E-MOVO project. *Eur J Clin Nutr* 2009; 63: 405-412.
- [38] Njike VY, Smith TM, Shuval O, Shuval K, Edshiteyn I, Kalantari V and Yaroch AL. Snack food, satiety, and weight. *Adv Nutr* 2016; 7: 866-878.
- [39] Xu R, Zhou Y, Li Y, Zhang X, Chen Z, Wan Y and Gao X. Snack cost and percentage of body fat in Chinese children and adolescents: a longitudinal study. *Eur J Nutr* 2019; 58: 2079-2086.
- [40] Li M, Xue H, Jia P, Zhao Y, Wang Z, Xu F and Wang Y. Pocket money, eating behaviors, and weight status among Chinese children: the childhood obesity study in China mega-cities. *Prev Med* 2017; 100: 208-215.
- [41] van Ekris E, Altenburg TM, Singh AS, Proper KI, Heymans MW and Chinapaw MJ. An evidence-update on the prospective relationship between childhood sedentary behaviour and biomedical health indicators: a systematic review and meta-analysis. *Obes Rev* 2016; 17: 833-49.
- [42] Katzmarzyk PT, Barreira TV, Broyles ST, Champagne CM, Chaput J, Fogelholm M, Hu G, Johnson WD, Kuriyan R, Kurpad A, Lambert EV, Maher C, Maia J, Matsudo V, Olds T, Onywera V, Sarmiento OL, Standage M, Tremblay MS, Tudor-Locke C, Zhao P and Church TS; ISCOLE Research Group. Relationship between lifestyle behaviors and obesity in children ages 9-11: results from a 12-country study. *Obesity (Silver Spring)* 2015; 23: 1696-1702.
- [43] Yi X, Yin C, Chang M and Xiao Y. Prevalence and risk factors of obesity among school-aged children in Xi'an, China. *Eur J Pediatr* 2012; 171: 389-394.
- [44] Reilly JJ, Kelly L, Montgomery C, Williamson A, Fisher A, McColl JH, Conte RL, Paton JY and Grant S. Physical activity to prevent obesity in young children: cluster randomised controlled trial. *BMJ* 2006; 333: 1171-1172.
- [45] Garmy P, Clausson EK, Nyberg P and Jakobsson U. Overweight and television and computer habits in Swedish school-age children and adolescents: a cross-sectional study. *Nurs Health Sci* 2014; 16: 143-148.
- [46] Garmy P, Clausson EK, Nyberg P and Jakobsson U. Insufficient sleep is associated with obesity and excessive screen time amongst ten-year-old children in Sweden. *J Pediatr Nurs* 2018; 39: e1-e5.
- [47] Zhang G, Wu L, Zhou L, Lu W and Mao C. Television watching and risk of childhood obesity: a meta-analysis. *Eur J Public Health* 2016; 26: 13-18.