FACTORS AFFECTING BODY MASS INDEX IN OVERWEIGHT/OBESE UNIVERSITY STUDENTS, GANSU, CHINA: A CROSS SECTIONAL STUDY

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Abstract. Body mass index (BMI) status especially overweight/obesity remains an important public health concern worldwide. Different statistical methods could produce different conclusions. Two statistical methods, namely, linear regression and ordinal logistic regression were used to explore the relationship among BMI, overweight/obesity and lifestyle of 790 college students, 18-27 years of age, attending Lanzhou University, Gansu, China based on data from a questionnaire. According to the criteria in China, BMI [weight (kg)/height $(m)^2$] status is divided into underweight, normal weight, and overweight/obese, which were used to investigate the association between factors and BMI status and BMI. Compared to females, more males were overweight/obese [odds ratio (OR) =2.67; β coefficient = 1.10], eat breakfast everyday (OR = 0.28) or 1-3 times every week (OR = 0.38; β coefficient = -0.99), spend up to 5 minutes on each meal (OR = 5.09; β coefficient = 2.19), exercised 60-90 minutes per day (OR = 2.59; β coefficient = 1.20), spent 1-3 hours viewing TV/computer daily (OR = 0.51; β coefficient = -0.79). Physical activity every day and sleeping before 10:00 PM was related to BMI status and not BMI (OR = 2.02 and 0.13, respectively). Being a medical student was associated with BMI and not BMI status (β coefficient = -0.48). These findings suggest that gender and lifestyle played important roles in BMI and overweight/obese status, and dichotomous variable overweight/obese status and continuous variable BMI values gave rise to different results when used in detecting associations. Different statistical methods should be combined in analyzing the data.

Keywords: body mass index, lifestyle, overweight/obese, university student, China

INTRODUCTION

Currently, overweight and obesity are major public health issues globally. China is not an exception, with more than 60 million Chinese becoming obese within 1992 to 2002 (Wang *et al*, 2007). Data from the China Health and Nutrition Survey indicted body mass index (BMI; kg/m^2) has increased in those aged >18 years. Prevalence of overweight increased from 9.4% in 1993 to 15.7% in 2009 compared to the increase of 4.0% in 1993 to 10.7% in 2009 (Xi *et al*, 2012). BMI increased by 2.8 kg/m^2 in men and 1.5 kg/m^2 in women during the period 2009 to 1993 (Stern *et al*, 2014).

Overweight and obesity are known risk factors for various chronic diseases, such as chronic kidney disease, type 2

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diabetes, hypertension, cardiovascular disease and cancer (Halpern *et al*, 2010; Huang *et al*, 2015). On the other hand, low BMI could be a sign of chronic energy deficiency. A lack of adequate weight gain during pregnancy can lead to low birth weight babies and adverse health implications, such as secondary amenorrhea and low bone density (Turner *et al*, 2001; Dharmalingam *et al*, 2010).

BMI is the anthropometric measure most commonly used in clinical and population studies (Lu *et al*, 2014). It is not only widely used as a risk factor for the development of several health issues but also in determining public health policies. BMI has been useful in population-based studies because of its wide acceptance in defining specific categories of body mass as a health issue. In addition, BMI can be easily assessed at low cost and is strongly associated with body fat and health risks in adults (James, 2008). Based on the criteria in China an individual is classified as underweight (BMI (<18.5), normal weight (BMI = 18.5-24.0), overweight (BMI >24.0-28.0), and obese (BMI >28.0) (Zhou, 2002).

Obesity in adolescents is associated with poor diet, intake of high-energy food and snacks, insufficient physical activity and other risk lifestyle habits. For example, Munoz-Pareja *et al* (2013) reported obesity-related eating behaviors are associated with higher consumption of food with high energy content, sugar and alcoholic beverages. Greater time spent in light intensive and sedentary activities are associated with higher BMI (Bann *et al*, 2015). These may have implications for behavioral approaches to control elevation in BMI values.

Obesity in university students is also a public health problem worldwide, but few data are available on this issue. Thus, there is a critical need to identify factors associated with this problem. One approach is by evaluating university students' dietary patterns, physical activity and other lifestyle. In addition, as body shape and lifestyle between China and Western countries are different, China's BMI criteria should be used in investigating associations between different factors and overweight/obese status in Chinese university students. Moreover, several studies have arrived at different conclusions for some factors (Williams, 2007; Al-Hazzaa *et al*, 2012; Bann *et al*, 2015; Al-Agha *et al*, 2016). Hence, we hypothesize that these discrepancies are due to difference in methodology. Some studies have examined the association between factors and BMI (Bann *et al*, 2015; Al-Agha *et al*, 2016), but other studies have examined the association between factors and overweight/obesity (Huang *et al*, 2003; Al-Hazzaa *et al*, 2012; Peltzer *et al*, 2014).

Our primary objective was to analyze the prevalence of overweight/obesity in Lanzhou University students, Gansu, China and factors related to overweight/obesity and BMI. In addition, we explored whether dichotomous variable overweight/obesity status and continuous variable BMI affected assessment of association with possible impacting factors.

MATERIALS AND METHODS

Study design and participants

A cross-sectional study was conducted involving students between the ages of 18 to 27 years attending Lanzhou University, Gansu, China. All data were collected from self-report questionnaires from March to May 2016. The study was approved by the Ethics Review Committee of School of Public Health, Lanzhou University (Ethical Approval Code: 2016-01).

The questionnaire consisted of four parts: In Part 1, basic information was sought on name, telephone number, gender, age, height, weight, and whether a medical student. In Part 2, data on diet were gathered, *viz*. frequency of consumption of breakfast per week (1-3 times, 4-6 times, every day, or never), time spent on each meal (0-5 minutes, 6-10 minutes, 11-20 minutes, or >20 minutes), dietary preferences, frequency of midnight snack (every day, sometimes, hardly, or never), frequency of eating snacks (every day, sometimes, hardly, or never), and eating meal at regular hour and in a fixed quantity. In Part 3, information was obtained on taking exercise, *viz*. duration each time (<30, 30-60, 60-90, or >90 minutes), and frequency per week (1-3, 4-6, every day, or never). In Part 4, data were gathered on pressure status (never, occasionally, often, or always), TV/computer viewing time per day (1-3 hours, 3-5 hours, 5-8 hours, >8 hours), and hours of sleeping.

Categorization of BMI

Height and weight of a number of chosen students were randomly measured to compare the difference between self-reported and measured data. China BMI criteria were: underweight (BMI <18.5), normal weight (BMI = 18.5 - < 24.0), overweight (BMI = 24.0 - <28.0), and obese (BMI ≥ 28.0) (Zhou, 2002). In this study, overweight/obese is defined as BMI ≥ 24.0.

Statistical analysis

EpiData software version 3.1 (EpiData Association, Odense, Denmark) was used for data input. Completeness and inconsistencies in data collected were double-checked. Then all data were analyzed using SPSS 20.0 software (IBM, Armonk, NY) and significance is accepted when *p*-value <0.05. Descriptive statistics were used to analyze age, gender, height, weight, and BMI; continuous variables are presented as mean ± SD; and categorical variables are presented as number or percentage and its 95% confidence interval (CI).

Linear regression and logistic regression analysis were applied to control for various potential confounders and to estimate the magnitude of the effect of any observed differences. In order to determine the predictability of BMI from univariate analysis factors, an adjusted linear regression model was used in which gender, dietary, physical activity, pressure status, and sleeping time were added as independent variables. Unstandardized regression coefficient (β) with 95% CI) was calculated from the linear regression. Similarly, in order to determine the predictability of overweight/obesity from univariate analysis factors, an adjusted logistic regression model was used. Adjusted odds ratio (OR) with 95% CI for overweight/obesity was calculated from logistic regression. OR is considered statistically significant if *p*-value <0.05.

RESULTS

Descriptive characteristics of participants

Eight hundred and sixty-six university students from various years of study were recruited and 790 complete questionnaires were collected (effective response rate of 91.2%). There was no significant difference of height and weight between self-reported and measured data, in line with an earlier study (Dekkers *et al*, 2008). Three hundred and ninety-one (49.5%) males and 399 (50.5%) females were recruited in the study (Table 1). Mean height was 168 ± 9 cm, mean weight 59 ± 11 kg, and mean BMI 21 ± 3 with 17.8% (95% CI: 15.2-20.5) classified as underweight, 71.0% (95% CI: 67.8-74.2) normal weight

Table 1
Basic characters of subjects.

Gender	No.	Height(cm) (mean±SD)	Weight(kg) (mean±SD)	BMI(kg/m^2) (mean±SD)	BMI status (95% Confidence interval) BMI<18.5 Lean	18.5≤BMI<24.0 Normal	BMI≥24.0 Overweight/obese
Men	391	175±6	66±10	22±3	11.0% (7.9, 14.1)	70.6% (66.1, 75.1)	18.4% (14.6, 22.3)
Women	399	162±6	53±7	20±2	24.6% (20.3, 28.8)	71.4% (67.0, 75.9)	4.0% (2.1, 5.9)
Total	790	168±9	59±11	21±3	17.8% (15.2, 20.5)	71.0% (67.8, 74.2)	11.1% (8.9, 13.3)

and 11.1% (95% CI: 8.9-13.3) overweight/obese. For males, mean BMI was 22 ± 3, underweight, normal weight and overweight/obese accounting for 11.0% (95% CI: 7.9-14.1), 70.6% (95% CI: 66.1-75.1) and 18.4% (95% CI: 14.6-22.3), respectively; and for women, mean BMI was 20 ± 2 and underweight, normal weight and overweight/obesity accounting for 24.6% (95% CI: 20.3-28.8), 71.4% (95% CI: 67.0-75.9) and 4.0% (95% CI: 2.1-5.9), respectively.

Relationship between BMI status and various factors

Regarding overweight/obesity among the students, based on ordinal logistic regression analysis and after adjusting for multiple factors, males were more likely than females (OR = 2.67); having breakfast 1-3 times, 4-6 times or every day less likely than those never having breakfast (OR = 0.38, 0.46 and 0.28, respectively); and spending 0-5 minutes or 6-10 minutes each meal a higher risk than spending >20 minutes (OR = 5.09 and 1.90, respectively) (Table 2). Students who exercise or take physical activity <90 minutes every day had higher BMI status than those exercising or taking physical activity >90 minutes every day (OR = 2.59 and 2.02, respectively); spend 1-3 h or 5-8 h in front of the TV/computer daily had lower BMI status than those who spend over 8 h (OR = 0.51 and 0.57, respectively); and go to bed before 10:00 PM had lower BMI than those going to bed after 12:00 PM (OR = 0.58).

Relationship between BMI and various factors

From linear regression analysis and after adjusting for multiple factors, men had a higher BMI compared with women (β coefficient = 1.10); medical students had lower BMI than non-medical students (β coefficient = -0.48); and students having

Table 2
The relationship between BMI status and factors among university students in Lanzhou.

	BMI status (Ordinal logistic regression)		
	OR	95%CI	*p*-value[a]
Gender			
Women (reference)			
Men	2.67	(1.84, 3.87)	<0.001
Breakfast intake per week			
Never (reference)			
1-3	0.38	(0.18, 0.81)	0.012
4-6	0.46	(0.22, 0.98)	0.044
Everyday	0.28	(0.13, 0.61)	0.001
Time spend on meal (minutes)			
≥20 (reference)			
0-5	5.09	(1.88, 13.83)	0.001
6-10	1.90	(1.11, 3.22)	0.019
11-20	1.53	(0.92, 2.53)	0.099
Physical activity per week/day			
Never (reference)			
Everyday	2.02	(1.07, 3.81)	0.031
1-3	1.59	(1.01, 2.52)	0.045
4-6	2.09	(1.16, 3.67)	0.014
Exercise duration each time/minute			
≥90 (reference)			
<30	1.73	(0.80, 3.73)	0.162
30-60	1.85	(0.85, 4.02)	0.122
60-90	2.59	(1.10, 6.10)	0.029
Daily TV/computer viewing time/hour			
≥8 (reference)			
1-3	0.51	(0.29, 0.87)	0.014
3-5	0.75	(0.47, 1.19)	0.220
5-8	0.57	(0.36, 0.92)	0.022
Go to bed			
≥12:00 PM (reference)			
<10:00 PM	0.13	(0.02, 0.83)	0.031
10:00-11:00 PM	0.99	(0.55, 1.78)	0.973
11:00-12:00 PM	1.05	(0.72, 1.53)	0.797

OR-Odds ratio; CI-Confidence interval; [a]*p*-values are based on the Wald statistic for ordinal logistic regression.

breakfast 1-3 times a week had significantly lower BMI than those who never had breakfast (β coefficient = -0.99) (Table 3). A positive relationship was observed between time spent on meal and BMI. Students spending 0-5 minutes or 6-10 minutes each meal had higher BMI than those who spent >20 minutes each meal (β coefficient =2.19 and 1.09, respectively); exercising <90 minutes had a higher BMI

Table 3
The relationship between BMI and factors in university students in Lanzhou.

	BMI (Linear regression)		
	β[a]	95%CI[b]	*p*-value[c]
Gender			
Women (reference)			
Men	1.10	(0.73, 1.47)	<0.001
Medical students			
No (reference)			
Yes	-0.48	(-0.84, -0.13)	0.008
Breakfast intake per week			
Never (reference)			
1-3	-0.99	(-1.18, -0.16)	0.019
4-6	-0.61	(-1.41, 0.20)	0.140
Everyday	-0.79	(-1.59, 0.02)	0.055
Time spend on meal (minutes)			
>20 (reference)			
0-5	2.19	(1.06, 3.32)	<0.001
6-10	1.09	(0.51, 1.68)	<0.001
11-20	0.51	(-0.05, 1.07)	0.073
Exercise duration each time/min			
>90 (reference)			
<30	0.51	(-0.31, 1.32)	0.222
30-60	0.70	(-0.15, 1.56)	0.105
60-90	1.20	(0.28, 2.12)	0.011
Daily TV/computer viewing time/h			
>8 (reference)			
1-3	-0.79	(-1.37, -0.21)	0.008
3-5	-0.16	(-0.67, 0.35)	0.538
5-8	-0.48	(-0.99, 0.03)	0.067

[a]β is the unstandardized regression coefficient. [b]CI, Confidence interval. [c]*p*-values are based on the *t* statistic for linear regression.

than those who exercised >90 minutes (β coefficient = 1.20); and spending 1-3 hours daily in front of a TV/computer had a lower BMI than those who spent >8 hours (β coefficient = -0.79).

DISCUSSION

We conducted a survey among university students to determine factors impacting BMI and overweight/obesity. We determined whether different statistical methods could result in different conclusions. The associations among BMI, percent body fat and health risks are different between European and Chinese populations. For example, compared to a European population, Chinese people have lower BMI but with a high risk of type 2 diabetes and cardiovascular disease (WHO, 2004). Thus, we employed the classification of BMI status based on

China BMI criteria. However, because of different values of cut-off points used in different ethnic groups, this issue should be taken into consideration in further research on comparisons of BMI status.

The majority of our participants were in the normal weight range and females were more likely to be underweight than males, in line with previous study (Sakamaki *et al*, 2005). The prevalence of overweight/obesity among males was higher than females, which also agreed well with previous studies on college students (Huang *et al*, 2003; Yahia *et al*, 2008; Peltzer *et al*, 2014). Hence, more attention of prevention of obesity should be paid to men in universities. The reason for the higher prevalence of underweight in female students might be that women tended to consider a thinner body shape as ideal, overestimated their own body weight and be more concerned with weight control than men (Kuan *et al*, 2011). In addition, the differences in body composition including fat mass and lean body mass may be another reason for men having a higher BMI than women. However, the effect of gender is still unclear. For example, the association between BMI or obesity and lifestyle could be stratified according to gender (Vera-Villarroel *et al*, 2014) or analyzed using a logistic model (Al-Hazzaa *et al*, 2012; Aryeetey *et al*, 2017; Thurber *et al*, 2018), similar to our study. When choosing an optimal model and statistical method to dissect the role of gender, the following questions should be considered: 1) whether gender is associated with BMI or obesity, 2) whether gender is related to the factor under consideration, and 3) whether gender is the intermediate variable between the factor of interested and BMI.

In this study, we demonstrated that frequency of having breakfast and time spent on each meal were associated with overweight/obesity and BMI. Ortega *et al* (1996) reported poor breakfast habit may contribute to obesity, and Thompson-McCormick *et al* (2010) found among Fijian adolescent girls more frequent skipping of breakfast is associated with greater odds of overweight and obesity, which suggests breakfast skipping is a risk factor of overweight and obesity. The reason might be that breakfast consumption increases satiety and thus decreases energy intake later in the day (Timlin and Pereira 2007). Regarding time spent on each meal and overweight/obesity, Zandian *et al* (2012) noted that if insufficient time is given for school lunch, children would eat at high speed and lose control of food intake and become obese. A previous study also reported when women are forced to eat quickly, they over-eat, and conversely, when forced to eat slowly, they under-eat (Zandian *et al*, 2009). As suggested by some authors, if the speed of eating could be controlled through a computerized feedback system, this could be employed in the fight against obesity epidemic (Mesas *et al*, 2012). Therefore, conditions at school meals should be adapted to allow students to eat a normal amount of food over an appropriate period of time.

We found that daily exercise duration and TV/computer viewing time was associated with BMI and overweight/obesity, respectively. A school-based study conducted in 2010 by the Centers for Disease Control and Prevention, USA, identified significant differences in the prevalence of daily physical activity, muscle-strengthening activity, viewing TV based on BMI status (Lowry *et al*, 2013). One study revealed that the longer the time spent in light intensity and lower sedentary activities were associated with lower BMI (Bann *et al*, 2015). A previous

study using representative longitudinal data suggested leisure-time physical activity exerts a negative effect on BMI and the effects are greater for women (Sarma *et al*, 2014). Physical exercise has an impact on BMI status probably because metabolism is accelerated. University students are unwilling to participate in exercise and spend more sedentary time because of a lack of exercise facilities, enormous academic pressure and popularization of computer in school. Al-Agha *et al* (2016) revealed children who spent ≥2 hours daily on electronic devices have higher BMI values, which agree well with our results. Steffen *et al* (2009) also considered longer TV, computer, video game and other media exposure time are associated with adverse health outcomes, such as becoming overweight. In addition, a previous study revealed overweight/obese people are more sedentary and spend more time watching TV screen than normal weight people (Herman *et al*, 2014). Lengthy TV/computer viewing time is a cause of promoting BMI status by three mechanisms: 1) displacement of physical activity, 2) increase in calorie consumption due to the habit of eating snacks while watching, and 3) reduction in resting metabolism (Robinson, 2001).

However, our study revealed being a medical student was associated with BMI not overweight/obesity. We suggest that university students in medicine were better trained than other students in four-year college and comprehensive university in healthy lifestyle, because medical curricula make medical students pay more attention to adopting healthy lifestyles (Wang *et al*, 2013). Physical activity per week and the time going to bed were associated with overweight/obese not BMI. This result can be explained by studies concluding that an association is different if dichotomous variable overweight/obese than if continuous variable BMI is used (Dialektakou and Vranas, 2008; Liu *et al*, 2013).

Some studies have examined the association between factors and BMI (Bann *et al*, 2015; Al-Agha *et al*, 2016), but other studies have examined the association between factors and overweight/obesity (Huang *et al*, 2003; Al-Hazzaa *et al*, 2012; Peltzer *et al*, 2014). This study examined both the relationship between factors and BMI and overweight/obesity. Although our results were in line with those of previous reports, several limitations of the study should be taken into consideration. Firstly, data including height, weight and lifestyle were self-reported and bias cannot be ruled out, although a study suggested that self-reported BMI is sufficiently accurate to assess the prevalence of overweight/obesity (Dekkers *et al*, 2008). Secondly, BMI cannot provide sufficient information on the distribution of body fat, thus other indicators such as waist circumference and body fat mass should be combined with BMI to evaluate underweight, normal weight, overweight/obesity in future investigations. Thirdly, the role of gender should be evaluated at greater depth. And fourthly, quantitative variables to evaluate lifestyle and study's size should be adopted as much as possible.

In conclusion, among students in an institution of higher education in China BMI or overweight/obesity was associated with gender, being a medical student, frequency of having breakfast daily, time spent on each meal, daily exercise, time of going to bed, and TV/computer viewing time. In addition, dichotomous variable overweight/obese and continuous variable BMI affected detection of associations. Future deep longitudinal and ex-

perimental studies are required to confirm these findings and identify intervention measures to reduce BMI or overweight/obesity prevalence in university students in China.

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CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

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