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# Does obesity related eating behaviors only affect chronic diseases? A nationwide study of university students in China

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ABSTRACT

The primary aims of this study are to examine associations between obesity-related eating behaviors (OEB) and chronic and infectious diseases, and mental disorders. A representative nationwide survey was used to collect information among 11,659 medical students from 31 universities in China. Multiple variable logistic regression analysis was conducted to examine the associations between OEB and the diseases. The multiple variable logistic regression model found that OEB was significantly associated with chronic disease (OR (Odds Ratio): 1.74 < 95 % C.I (Confidence Interval): 1.45, 2.65 > ), infectious disease (OR: 3.37 < 95 % C.I: 1.04, 1.81 > ), and mental disorder (OR: 1.87(<95 % C.I: 1.55, 2.25 > ). These findings underscore the importance of addressing OEB in programs and policies to promote health and prevent disease among university students.

## 1. Introduction

It is well known that obesity-related eating behaviors (OEB), including high caloric intake, servings of meat, and overeating habits that result in high caloric intake are the important modifiable behavioral risk factors for obesity (Liebman et al., 2003; Newby et al., 2003; Wang and Beydoun, 2009; Trivedi, et al., 2015). From a physiological perspective, obesity is associated with increased incidence of many chronic diseases, including cardiovascular disease, type 2 diabetes mellitus, dyslipidemia, osteoarthritis, and cancers (Alwan, 2011; Nejat et al., 2010; Pischon et al., 2007). So that it is possible that there are close associations between OEB and various chronic diseases. Although researchers have examined these associations with common chronic diseases (Nishimura et al., 2020; Fostinelli et al., 2020), it may be valuable to explore the association of OEB with other diseases such as infection diseases and mental disorders (Almandoz et al., 2020, Mond et al., 2007).

Psychological theories offer a window into the possible mechanisms that may link OEB with a wider range of illnesses. It is possible OEB may induce mental stress response, that in turn leads to various diseases. In the field of psychosomatic medicine there is support for the influence of psychological factors on the development of various diseases (Krajina, 1989). Researchers have also shown that mental stress may be a key factor in many diseases (Krajina, 1989; Turner et al., 2020). This research is further supported by developments in fields such as psychoneuro-endocrinology and psychoneuroimmunology that have begun to describe mechanisms by which stress affects people (Leigh, 2019). The problem is how to understand association between OEB and mental stress. There are several possibilities to support a positive association between them. People engage in eating behavior as a matter of survival, normally every day. That is, one has to make choices about what to eat, when, and how much (Meule and Claus, 2013). People with OEB may have more cravings for food that leads to overeating, and as a consequence of eating too much may experience mental stress and discomfort. Mental stress may occur as a result of impaired body image, low self-esteem, limited social communication and contacts, and other problems associated with obesity (Hayman et al., 2007; Latha et al., 2006). Some studies found that high rates of OEB are associated with stress and negative mental reactions (Scott et al., 2008; Reynolds et al., 2018; Moazzami et al., 2020).

While researchers have examined associations between OEB and various chronic diseases (Nishimura et al., 2020; Mekary et al., 2012;

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Nitta et al., 2019), few studies have assessed the role of OEB in infectious diseases (Hamer et al., 2019; Almandoz et al., 2020), and mental disorders (Gzt and Zed, 2020; Mond et al., 2007; Fostinelli et al., 2020). Moreover, most of these studies only included small samples from local settings. The results obtained from such studies may be biased. Given that OEB may not only be associated with chronic disease but also associated with infectious disease and mental disorders, it is important to explore these associations. This is important to the understanding of OEB, and to guiding interventions for OEB. Prior studies have not addressed these issues. Our research will address these limitations. The first purpose of the study is to describe OEB and associations with self-reported chronic disease, mental disorders and infectious disease among university students. The second purpose is comparing extents and patterns of OEB and various disease associations.

## 2. Methods

### 2.1. Study design and sampling procedure

This study reports data from the "tobacco control advocacy capacity building" study conducted in medical universities in China. The participants were medical students. The sampling procedure used an observational cross-sectional, multilevel approach with a multi staged cluster sampling design. In Stage 1, 31 universities with medical programs were selected across China and differentiated by regional location. Of these universities, 18 were medical universities offering mainly medical and health programs, and 13 were comprehensive universities offering medical and non– medical programs.

In stage 2, the sampling strategy involved the selection of levels within each university. All levels that had medical/health courses were included. In stage 3, one-third of the courses were randomly selected from each level. On average, two classes were selected to participate in the study at each university. In stage 4, all students in these selected classes were surveyed.

### 2.2. Data collection

Individual variables were measured via a structured self-administered questionnaire. The survey was carried out under the guidance of the implementation guideline. The questionnaire was administered during regular class meetings and took approximately 30 min to complete. All responses were anonymous. A common research protocol was used across all 31 universities to assure homogeneity of questionnaire administration and data collection techniques. The study also included contextual variables, home location and university type. This was an anonymous survey. The study was approved by the Ethics Committee at the Zhejiang University Medical Center, and verbal consent was obtained from all participants before data collection.

### 2.3. Measurement

#### 2.3.1. Dependent variable

Diseases status. This variable included three aspects. 1. Chronic disease. This was measured by the question: "Do you currently suffer from any chronic diseases(such as, chronic stomach disease, hypertension, diabetes, asthma, etc.)? Also included was the instruction that these chronic diseases refer to those diagnosed by physicians. Response, "Yes' or "No". 2. Infectious disease. This variable was measured by the question: "Have you had colds or diarrhea three or more times in the last six months?" Response, "Yes' or "No". 3. Mental disorders. Mental disorders were defined for the purpose of this study as conditions that cause significant mental distress or impairment of personal functioning (Yang, 2018). Mental health status was measured by the Chinese Health Questionnaire (CHQ) (Yang et al., 2003). This is derived from the General Health Questionnaire (GHQ), which is very widely used by researchers and clinicians who wish to screen individuals for psychiatric disorders (Goldberg and Williams, 1991). This measure has been shown to be acceptable and reliable in the Chinese context (Yang et al., 2003; Ma et al., 2007). The CHQ is a self-administered 12-item instrument designed to screen for potential mental disorders in both the community and among primary care patients. It has a four-point response scale: ''not at all'' and ''same as usual' (both = 0), and ''rather more than usual'' and ''much more than usual'' (both = 1). A total score is obtained by summing up the scores for the individual items to provide a measure of the severity of probable mental disorders. A cut-off score of 3 or more on the CHQ signifies a probable mental disorder (Yang et al., 2003). Currently, the Chinese version of the CHQ can be downloaded and checked online at: https://www.tf-campus.com/redir.php?catalog_id = 19&object_id = 28210.

#### 2.3.2. Explanatory variables

OEB consisted of three different behaviors related to high calorie intake (Yang, 2018) that are common elements of OEB in Chinese culture: eating sweet snacks, overeating habits that result in high caloric intake, and eating fatty foods. They were measured using 3 questions, respectively, "Do you eat sweet snacks?" "Do you eat too many calories?" and "Do you eat fatty foods?". Response categories included: "Almost never" "yes, several days" and "yes, every day". Although the question about eating too many calories did not specify the type of foods consumed, participants included in this study were recruited from the general population in the community where the consumption of traditional Chinese food in everyday life is the norm, despite evidence that nontraditional eating behaviors are emerging (e.g., with introduction of Western foods) (Song & Cho,2017). While traditional Chinese food patterns are influenced by region and socio-economic factors, this diet is typically rich in rice, meat, vegetables, and salted vegetables. The three OEB behaviors measured in this study have a common property, in that they are all high caloric intake behaviors and have been associated with obesity. According to problem behavior theory, health risk behaviors are related to each other and they are dominated by a common factor (Jessor and Jessor,1977). Research on problem behaviors usually refers to adolescents in different phases of development (Jessor,1987). However, researchers have found that this theory holds true among college students as well (Korn et al.,2014; Vazsonyi et al., 2008). Researchers have found these unhealthy dietary behaviors are also clustered (Engelmann, et al., 2021). Similarly, we found that the three OEBs had high loadings on a single factor; factor loadings were: 0.69, 0.74, and 0.45 respectively in eating sweet snacks, eating fatty foods, and overeating calories. Moreover, we found each OEB significantly associated with each type of the disease. For example, the ORs (Odd Ratio) values of associations between eat sweet snacks, eat fatty foods, and eat too many calories, and infectious diseases after controlling all confounding factors are listed in Table 1, and were 1.23 (95 % C.I(Confidence Interval):1.06,1.36), 1.4 (95 % C.I:1.207,1.91)(eat in several days, eat in every day vs almost never eat), 1.24 (95 % C.I:1.00,1.41),1.42, (95 %,C.I:1.21,1.66), and 1.13(95 % C.I:1.04,1.22),1.17(95 % C.I:1.06,1.32), respectively. For the above reasons, and to simplify the analysis, we combined the three behaviors into one variable. OEB was defined as any two of the three behaviors which were chosen as "eat in each day" and one was chosen as "eat in several days". To estimate test consistency, we repeated the measure of OEB two weeks apart in two classes in a university in this study. The test–retest reliability of OBE was 94.8 %. Moreover, we conducted the analysis using each single behavior and the results were very similar with that of the OEB combined measure.

#### 2.3.3. Individual confounding variables

Age, gender, and ethnicity were included as routine confounding variables. Many studies have found that low socioeconomic status has been associated with high mental stress and health problems (World Health Organization, 2001). Since university students' economic resources mainly come from their families, their economic status is determined by their family's financial level. However, some students

may be unaware of their family income. Hence, we used an indirect measure of family economic resources by asking about monthly expenses (in CNY/Yuan), because the two variables are related. The correlation coefficient (r) between family income and monthly student expenses was 0.2995($p < 0.0001$) (Yang et al., 2018). Student monthly expense was measured by the question, "How much do you spend each month?" A number of studies have shown that academic achievement is also related to mental health (Yang et al., 2018). This variable was measured by the question; "Where are your grades in relation to other students in your class?" Response categories included: "upper third," "middle third" and "lower third". In this study smoking and alcohol use were also included. We employed standard methods for computing these measures (World Health Organization,1998; Yang, 2018). They were measured using the question: "Do you smoke currently?" Response categories included: "yes, every day" "yes, several days" and "no". "Do you drink currently?" Response categories included: "yes, every day" "yes, several days" and "no". The first and second responses were categorized as smoke or drink, the third response was categorized as no smoke or drink.

#### 2.3.4. Contextual home and university environment confounding variables

We also included a measure of home location since this can reflect the social and economic position of the family and because social and economic development varies greatly between rural and urban areas (Yang et al., 2018). Family location was defined as whether students came from the countryside, township, county town, or city. The influence of university-level differences on the impact of health status (Yang et al., 2018) was assessed using a university control variable university type, selected based on evidence that different universities have different social resources and academic competition, which may influence health and disease status (Yang et al., 2018). University type was determined using the China university ranking system (low, middle and high level) as established by the National Ministry of Education (2015a).

### 2.4. Data analysis

All data were entered into a database using Microsoft Excel. Data entry errors were minimized by conducting double data entry and by resolving discrepancies. The dataset was imported into SAS (9.4 version) for the statistical analyses. Descriptive statistics were calculated for the prevalence of various diseases including 95 % confidence intervals across OBE and confounding variables. Both unadjusted and adjusted methods were considered in analyses to assess the association between OBE and the diseases. SAS survey logistic procedures were applied in the analysis, using the university as the clustering unit, in order to account for a within-clustering correlation, attributable to the complex sample for analysis. Associations were confirmed through the application of a multivariate logistic regression model using the SAS (Wang et al., 2008). This analysis we built multivariate models of each disease with two and multiple OBE categories models. The parameters were estimated using the maximum likelihood method. (Wang et al., 2008).

All analyses were weighted. Weights included: (1) sampling weights, as the inverse of the probability of selection, calculated at the university level, and (2) post-stratification weights, calculated in relation to sex, based on estimated distributions of this characteristic from a national survey (National Ministry of Education, 2015b). The final overall weights were computed as the product of the above two weights. We did not consider using a non-response weight because non-response rates were low (range: 0.6–2.0 % at per university) in this study.

## 3. Results

A total of 11,802 individuals were identified as potential subjects for this study. The participating students are 11,783 in 31 universities. After excluding incomplete and logically wrong responses, we had a final sample of 11,659. It should be mentioned that this survey was conducted in the classroom when students were attending classes. The response rate is very high because the absenteeism rate is very low among students.

Of the study sample, 20.2 % were younger than 18 years old, 61.7 % were from 18 to 21 years old, and 18.1 % % were 21 years and more or more. 20.2 % were<18 years. 68.8 % were female and 86.0 % were Han Chinese, see Table 1.

The total chronic disease prevalence, infection disease prevalence, and mental disorder prevalence in this sample was 24.9 % (95 % CI: 22.7 %, 27.1), 31.3 % (95 % CI: 29.7 %, 32.6 %), and 22.4 % (95 % CI: 19.8 %, 24.7 %). Table 2 shows that prevalence for each of these diseases among female students was higher than for male students. The prevalence of chronic disease and mental disorders was also higher among students from minority groups than among Han Chinese students. The prevalence of infectious disease was higher among students whose families were located in townships and cities than in countryside locations. Students' reported monthly expense was positively associated with with chronic disease and infectious disease. Academic major was also associated with these diseases. Students reporting lower academic achievement had higher mental disorder prevalence. Smoking and alcohol use were positively associated with self-reported chronic disease and mental disorder. Students enrolled in high level universities had higher infection disease prevalence. The prevalence of all diseases is higher in the OBE group than reference group, and the disease prevalence increased with higher OBE scores, see Table 1.

Multivariate logistic regression model showed OBE was associated significantly with chronic disease (OR: 1.74 < 95 % C.I: 1.45, 2.65 > ), infection disease (OR: 3.37 < 95 % C.I: 1.04, 1.81 > ), and mental disorder (OR: 1.87(<95 % C.I: 1.55, 2.25 > ). The ORs increased with OBE score increasing. Age and ethnicity, academic major, smoking, and alcohol entered the final equation in OBE and mental disorder mode; sex, home location, and monthly expense entered the final equation in OBE and infection disease model; sex academic major, smoking and alcohol entered final equation in OBE and chronic disease model, see Table 2.

## 4. Discussion

The first aim of the study addressed the question of quantifying the prevalence of OEB and determining associations with the presence of chronic disease, and together with mental and infectious disease among university students. The results indicate that the prevalence of eating sweet snacks, overeating calories and eating fatty foods to be 50.1 % (95 % CI: 50.1 %, 53.7), 37.6 % (95 % CI: 34.5 %, 40.7), and 53.9 % (95 % CI: 51.6 %, 56.2). This is consistent with other studies, where unhealthy eating behavior is a common problem among university students (Weiwei et al., 2011; Lazarevich et al., 2013; Wadhera and Wilkie, 2018).

The study also found that self-reported chronic disease prevalence, infection disease prevalence, and mental disorder prevalence in this sample was 24.9 % (95 % CI: 22.7 %, 27.1), 31.3 % (95 % CI: 29.7 %, 32.6 %), and 22.4 % (95 % CI: 19.8 %, 24.7 %). It should be noted that the infectious diseases in this study are represented by colds and diarrhea, which are common problems in people's daily lives. In any case, since more than one-fifth of respondents reported any one of these diseases, these problems must be given more attention.

The second purpose was to compare extents and patterns of OEB and various disease associations. The results showed OEB was not only associated with self-reported chronic disease, but associated also with mental and infectious diseases among university students. It is worth noting that the prevalence of disease increased with higher OEB scores, which strengthened the reliability of associations between OEB and the diseases under study. This study shows that the ORs association of OEB and chronic disease, infection disease, and mental disorder were 1.74 (95 % CI: 1.45, 2.65), 3.37(95 % CI: 1.04, 1.8), 1.87(95 % CI: 1.55, 2.25), respectively. ORs of these associations showed no significant

**Table 1**
Characteristics of sample, OEB and the diseases prevalence.

| Group | N<br>N | % of sample<br>% of sample | Chronic disease<br>Prevalence(%) 24.9(22.7,27.1) | <br>Unadjusted OR (95 % C.I) | Infection disease<br>Prevalence(%) 31.1(29.7,32.6) | <br>Unadjusted OR (95 % C.I) | Mental disorder No/yes<br>Prevalence(%) 22.4(19.8,24.7) | <br>Unadjusted OR (95 % C.I) |
|---|---|---|---|---|---|---|---|---|
| ***Age(year)*** | | | | | | | | |
| <18 | 1873 | 20.2 | 26.5 | 1.00 | 32.5 | 1.00 | 20.2 | 1.00 |
| 19- | 2523 | 20.3 | 24.2 | 0.86(0.72,1.09) | 31.8 | 0.97(0.85,1.11) | 20.7 | 1.04(0.98,1.25) |
| 20- | 2993 | 22.5 | 25.3 | 0.94(0.81,1.10) | 30.7 | 0.92(0.81,1.05) | 21.8 | 1.11(0.98,1.25) |
| 21- | 2370 | 18.8 | 23.6 | 0.86(0.73,1.01) | 30.8 | 0.93(0.74,1.16) | 23.7 | 1.23(1.05,1.43)** |
| 22 & over | 1990 | 18.1 | 24.8 | 0.92(0.66,1.28) | 29.8 | 0.88(0.15,1.10) | 25.9 | 1.38(1.16,1.65)** |
| ***Sex*** | | | | | | | | |
| Male | 3722 | 33.2 | 20.6 | 1.00 | 27.9 | 1.00 | 21.8 | 1.00 |
| Female | 7937 | 66.8 | 27.0 | 1.43(1.30,1.54)** | 32.7 | 1.26(1.08,1.46)** | 22.6 | 1.05(0.94,1.17) |
| Ethnicity | | | | | | | | |
| Han | 10,713 | 86.0 | 24.3 | 1.00 | 31.1 | 1.00 | 21.4 | 1.00 |
| ***Minority*** | 946 | 14.0 | 28.4 | 1.24(1.02,1.53)* | 31.4 | 1.01(0.86,1.19) | 27.9 | 1.42(1.10,1.82)** |
| Home location | | | | | | | | |
| Countryside | 5709 | 51.3 | 24.3 | 1.00 | 29.0 | 1.00 | 23.0 | 1.00 |
| Township | 1370 | 11.5 | 25.4 | 1.06(0.84,0.33) | 34.3 | 1.28(1.11,1.47)** | 22.8 | 0.99(0.80,1.23) |
| County town | 2002 | 15.8 | 25.6 | 1.07(0.92,1.25) | 31.2 | 1.11(0.93,1.33) | 20.9 | 0.88(0.71,1.10) |
| City | 2578 | 21.4 | 25.7 | 1.00(0.88,1.15) | 34.5 | 1.16(1.02,1.31)* | 21.5 | 1.04(0.89.1.22) |
| ***Monthly expenses (CNY/Yuan)*** | | | | | | | | |
| <1000 Yuan | 3998 | 33.7 | 23.5 | 1.00 | 27.6 | 1.00 | 21.5 | 1.00 |
| 1000–1499 Yuan | 5364 | 48.6 | 24.7 | 1.07(0.94,1,22) | 30.9 | 1.17(1.09,1.25)** | 22.7 | 1.05(0.98,1.12) |
| 1500 and over Yuan | 2297 | 24.9 | 27.4 | 1.23(1.04,1.46)* | 35.6 | 1.45(1.25,1.69)** | 23.1 | 1.03(0.91,1.16) |
| ***Academic Major*** | | | | | | | | |
| Public health | 2589 | 24.6 | 24.2 | 1.00 | 33.1 | 1.00 | 25.4 | 1.00 |
| Clinic | 6402 | 59.6 | 24.6 | 1.03(0.92,1.15) | 31.2 | 0.91(0.78,1.07) | 22.0 | 0.83(0.63,0.99)* |
| Nurse | 1067 | 6.5 | 25.7 | 1.08(0.83,1.42) | 27.5 | 0.77(0.59,0.99)* | 18.5 | 0.67(049,0.91)* |
| Others | 1601 | 9.2 | 28.2 | 1.23(1.04,1.47)* | 28.2 | 0.79(0.60,1.05) | 19.0 | 0.69(0.54,0.88)** |
| **Academic achievement** | | | | | | | | |
| Upper third | 3902 | 30.9 | 24.9 | 1.00 | 31.2 | 1.00 | 22.1 | 1.00 |
| Middle third | 5426 | 48.6 | 24.4 | 0.97(0.84,1.11) | 30.7 | 0.98(0.89,1.07) | 21.3 | 0.95(0.79,1.15) |
| Low third | 2331 | 20.0 | 26.1 | 1.06(0.91,1.24) | 32.2 | 1.05(0.89,1.23) | 25.0 | 1.17(1.06,1.30)** |
| ***Smoke*** | | | | | | | | |
| No | 10,847 | 92.2 | 24.2 | 1.00 | 31.1 | 1.00 | 21.5 | 1.00 |
| Yes | 812 | 7.8 | 33.1 | 1.55(1.36,1.77)** | 31.6 | 1.03(0.80,1.31) | 32.8 | 1.78(1.36,2.34)** |
| ***Alcohol use*** | | | | | | | | |
| No | 8322 | 69.7 | 23.9 | 1.00 | 30.6 | 1.00 | 20.2 | 1.00 |
| Yes(?) | 3337 | 39.3 | 27.9 | 1.18(1.09,1.29)** | 32.3 | 1.08(0.89,1.31) | 27.3 | 1.27(1.73)** |
| **University type** | | | | | | | | |
| Lower level | 3276 | 17.0 | 24.6 | 1.00 | 27.9 | 1.00 | 23.0 | 1.00 |
| Middle level | 7481 | 68.1 | 25.6 | 1.05(0.83,1.34) | 31.3 | 1.18(0.97,1.43) | 22.0 | 0.94(0.73,1.23) |
| High level | 902 | 14.8 | 22.1 | 0.87(0.69,1.09) | 34.9 | 1.34(1.01,1.78)* | 23.0 | 1.00(0.69,1.45) |
| ***OEB*** | 5.7 (4.8,6.5) | | | | | | | |
| No | 11,175 | 94.7 | 24.2 | 1.00 | 30.7 | 1.00 | 21.6 | 1.00 |
| Yes | 484 | 5.3 | 37.3 | 2.26(2.73,3.89)** | 38.7 | 3.56(2.61,4.84)** | 36.3 | 2.55(2.09,3.10)** |
| ***OEB Score*** | | | | | | | | |
| 0- | 891 | 7.1 | 20.0 | 1.00 | 26.2 | 1.00 | 19.3 | 1.00 |
| 1- | 2020 | 16.8 | 21.6 | 1.10(0.69,1.77) | 25.2 | 0.95(0.81,1.12) | 18.0 | 0.92(0.67,1.26) |
| 2- | 3758 | 31.0 | 23.0 | 1.19(0.72,1.90) | 30.3 | 1.23(1,10,1,36)** | 21.6 | 1.15(0.85,1.54) |
| 3- | 3111 | 27.0 | 25.4 | 1.36(0.89,2.08) | 33.4 | 1.42(1.17,1.71)** | 21.5 | 1.16(0.89,1.48) |
| 4- | 1395 | 13.5 | 29.9 | 1.70(1.08,2.68)* | 35.2 | 1.53(1.32,1.78)** | 27.1 | 1.56(1.20,2.02)** |
| 5- | 360 | 4.0 | 37.2 | 2.36(1.86,3.00)** | 38.8 | 1.64(1.20,2.25)** | 35.1 | 2.26(1.51,3.80)** |
| 6- | 124 | 1.3 | 37.4 | 2.39(1.75,3.27)** | 44.5 | 2.26(1.25,4.09)** | 40.2 | 2.81(1.72,4.54)** |

(*continued on next page*)

**Table 1** (*continued*)

| Group | N | % of sample | Chronic disease | | Infection disease | | Mental disorder No/yes | |
|---|---|---|---|---|---|---|---|---|
| | N | % of sample | Prevalence(%) 24.9(22.7,27.1) | Unadjusted OR (95 % C.I) | Prevalence(%) 31.1(29.7,32.6) | Unadjusted OR (95 % C.I) | Prevalence(%) 22.4(19.8,24.7) | Unadjusted OR (95 % C.I) |

P-values were generated by logistic regression: *P < 0.05; **P < 0.01.
OEB: obesity-related eating behaviors
CNY/Yuan:Currency of China

**Table 2**
Result of multivariate logistic regression analysis.

| Group | Chronic disease OEB modelOR (95 % C.I) | OEB Score modelOR (95 % C.I) | Infection disease OEB modelOR (95 % C.I) | OEB Score modelOR (95 % C.I) | Mental disorder OEB modelOR (95 % C.I) | OEB Score modelOR (95 % C.I) |
|---|---|---|---|---|---|---|
| ***Age(year)*** | | | | | | |
| <18 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 19- | 0.87(0.75,1.01) | 0.87(0.75,1.01) | 0.99(0.86,1.16) | 1.00(0.86,1.46) | 0.99(0.91,1.08) | 0.99(0.91,1.08) |
| 20- | 0.93(0.82,1.05) | 0.94(0.72,1.03) | 0.93(0.80,1.07) | 0.94(0.82,1.08) | 1.01(0.89,1.12) | 1.01(0.90,1.14) |
| 21- | 0.84(0.68,1.05) | 0.85(0.86,1.29) | 0.92(0.73,1.08) | 0.92(0.74,1.15) | 1.04(0.85,1.28) | 1.05(0.86,1.29) |
| 22 & over | 0.91(0.72,1.22) | 0.93(0.69,1.24) | 0.86(0.68,1.08) | 0.87(0.69,1.10) | 1.13(0.93,1.37) | 1.14(0.94,1.38) |
| ***Sex*** | | | | | | |
| Male | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Female | 1.75(1.56,1.95)** | 1.71(1.52,1.94)** | 1.39(1.19,1.63)** | 1.36(1.15,1.60)** | 1.73(1.17,1.53)** | 1.31(1.13,1.52)** |
| ***Ethnicity*** | | | | | | |
| Han | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Minority | 1.30(0.96,1.33) | 1.09(0.95,1.26) | 1.02(0.86,1.20) | 0.98(0.83,1.17) | 1.32(1.09,1.61)** | 1.31(1.09,1.53)** |
| ***Home location*** | | | | | | |
| Countryside | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Township | 1.06(0.84,1.34) | 1.05(0.83,1.31) | 1.26(1.09,1.46)** | 1.24(1.08,1.42)** | 0.99(0.83,1.20) | 0.98(0.81,1.19) |
| County town | 1.07(0.96,1.19) | 1.06(0.96,1.18) | 1.09(0.91,1.30) | 1.08(0.90,1.28) | 0.86(0.71,1.04) | 0.85(0.71,1.03) |
| City | 1.01(0.88,1.14) | 1.01(0.88,1.40) | 1.16(1.03,1.31)* | 1.16(1.03,1.31)* | 1.50(0.92,1.21) | 1.04(0.92,1.19) |
| ***Monthly expenses (CNY/Yuan)*** | | | | | | |
| <1000 Yuan | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 1000–1499 Yuan | 1.11(0.88,1.41) | 1.11(0.87,1.40) | 1.08(0.93,1.26) | 1.07(0.92,1.25) | 0.79(0.63,1.02) | 0.75(0.66,0.98)* |
| 1500 and over Yuan | 1.45(0.93,1.41) | 1.14(0.93,1.41) | 1.10(0.96,1.27) | 1.09(0.95,1.26) | 0.84(0.71,1.06) | 1.44(1.13,1.84) |
| 1500 and over Yuan | 1.20(0.98,1.48) | 1.19(0.97,1.47) | 1.18(1.02,1.48)* | 1.16(0.98,1.36) | | |
| ***Academic Major*** | | | | | | |
| Public health | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Clinic | 1.05(0.94,1.17) | 1.05(0.94,1.18) | 0.91(0.76,1.07) | 0.90(0.77,1.06) | 0.85(0.71,1.03) | 0.85(0.71,1.02) |
| Nurse | 1.05(0.81,1.37) | 1.05(0.81,1.36) | 1.09(0.91,1.30) | 0.78(0.61,1.03) | 0.68(0.54,0.87)** | 0.68(0.54,0.86) |
| Others | 1.24(1.08,1.43)** | 1.25(1.09,1.43)** | 1.16(1.03,1.31)* | 0.77(0.59,1.02) | 0.78(0.63,0.98)* | 0.78(0.62,0.98)* |
| Academic achievement | | | | | | |
| Upper third | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Middle third | 0.97(0.92,1.36) | 0.96(0.85,1.09) | 0.99(0.91,1.09) | 0.98(0.89,1.09) | 0.94(0.82,1.08) | 0.93(0.81,1.17) |
| Low third | 1.12(0.92,1.36) | 1.10(0.92,1.32) | 1.11(0.97,1.27) | 1.08(0.95,1.25) | 1.08(0.97,1.18) | 1.08(0.99,1.19) |
| ***Smoke*** | | | | | | |
| No | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Yes | 1.37(1.27,1.49)** | 1.37(1.26,1.49)** | 1.05(0.94,1.13) | 1.02(0.93,1.12) | 1.36(1.14,1.69)** | 1.26(1.05,1.57)** |
| ***Alcohol use*** | | | | | | |
| No | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Yes | 1.28(1.18,1.38)** | 1.26(1.16,1.49)** | 1.21(0.99,1.46) | 1.18(0.98,1.44) | 1.48(1.32,1.67)** | 1.47(1.30,1.67)** |
| ***OEB*** | | | | | | |
| No | 1.00 | | 1.00 | 1.00 | 1.00 | |
| Yes | 1.71(1.14,2.58)* | | 1.37(1.04,1.82)* | 1.37(1.04,1.82)* | 1.86(1.59,2.23)** | |
| ***OEB* Score** | | | | | | |
| 0- | | 1.00 | | 1.00 | | 1.00 |
| 1- | | 1.09(0.69,1.74) | | 0.94(0.81,1.08) | | 0.96(0.70,1.29) |
| 2- | | 1.05(0.89,1.23) | | 1.16(1.04,1.26)** | | 1.06(0.96,1.17) |
| 3- | | 1.28(0.85,1.93) | | 1.35(1.12,1.64)** | | 1.16(0.89,1.50) |
| 4- | | 1.57(1.02,2.46)* | | 1.45(1.27,1.66)** | | 1.51(1.26,2.03)** |
| 5- | | 2.17(1.70,2.78)** | | 1.56(1.11,2.19)* | | 2.17(1.47,3.21)** |
| 6- | | 1.96(1.33,2.89)** | | 2.08(1.15,3.76)* | | 3.38(1.37,4.14)** |

P-values were generated by logistic regression: *P < 0.05; **P < 0.01.
OEB: obesity-related eating behaviors.
CNY/Yuan:Currency of China.

differences. Although it is generally thought that OEB has an important influence on a range of chronic diseases, in fact OEB may consistently produce an adverse effect on all types of diseases. The findings provide support for the universality of health hazards related to OEB. Although age, gender and ethnicity are important demographic variables that have been recognized as influencing factors on almost all diseases (World Health Organization, 2013; Yang et al., 2018), only gender and ethnicity were associated with self-reported mental disorders. Home location and monthly expenditure are important determinants of socioeconomic status, dietary patterns and nutritional status, which in turn, can influence immune status, which in turn, affects infectious disease occurrence (World Health Organization, 2013; Yang, 2018). Smoking and alcohol were associated with chronic disease and mental disorder in OEB associated models, a finding that is supported by other

studies (World Health Organization, 2013; Yang et al., 2018).

Currently, in China, unhealthy lifestyles have already become a severe public health problem associated with a rapidly developing economy. Both government and local health authorities need to develop programs to support healthy behaviors, and to reduce the high prevalence of OEB now evident in China. A multifaceted approach to prevention and treatment should be incorporated into community healthcare programs. While the government has increased its investment, some institutional changes are necessary, such as ensuring student access to healthy food and sugar-free beverages, and increasing opportunities for physical activity. A health education curriculum should be provided in all schools and universities to help young people recognize the health risk of unhealthy behaviors, and to teach them skills to that support healthy lifestyles.

## 5. Strengths and limitations

The study has strengths and limitations. First, the cross-sectional study design is an important limitation in this study, causal links between OEB and various diseases. Given this study aimed to describe a possible causal linkage between OEB and the diseases included in this study, we still cannot rule out the possibility that health problems may lead to OEB. While we hypothesized that OEBs precede mental stress there is also plenty of literature suggesting that OEBs occur in response to stress (Konttinen et al., 2019; Pool et al., 2015). Moreover, there is accumulating evidence that both negative emotional affect and unwanted weight gain are independent products of consuming ultra-processed food (Lane et al., 2022; Neri et al.,2022); their correlation, in other words, may reflect the influence of a common third order variable. There is clearly room for a more in-depth and comprehensive exploration of the issues involved in OEB and its influence on various diseases. Second, our participants were medical university students. Thus, our results cannot be generalized to other populations or the wider Chinese population. Third, the question “do you eat too many calories” did not capture the type of food consumed. A study found that excess consumption of raw plant foods, for example, is associated with a risk of being underweight and is not a risk factor for obesity-related disease (Koebnick et al., 1999). However, it should be noted that although the participants in this study were medical students they were from the general population where eating traditional Chinese food is the norm and typically includes lightly steamed or stir-fried plant-based foods, accompanied by starches, fish, and meat in bite-size portions to flavor the meal. Nevertheless, the question related to overeating is worth clarifying in future surveys to examine dietary patterns, including the emergence of non-traditional food (e.g. western fast foods, processed foods) consumption in China. In addition, a more precise measure of self-reported chronic disease in future research may yield more replicable findings.

Fourth, although our research was based on classical scientific theories to establish hypotheses, there are new developments in the field that support this work. For example, obesity-related elevated low-grade inflammation has recently been observed to exacerbate the risk of serious COVID-19 infection (Muscogiuri et al., 2022) and in contributing to the risk of depression (Chae et al., 2022). Elevated systemic inflammation was also established as a common contributor to increased risk for all of the diseases addressed in this study (Ellulu et al., 2017).

## 6. Conclusion

Healthy lifestyles that include health eating behaviors are increasingly important in China and elsewhere to promote health and wellness. This study provides new information about the association of OEB with both chronic and infectious diseases and mental disorders, and offers further support for a possible causal linkage. These findings underscore the importance of addressing OEB in programs and policies to support disease prevention and health promotion among university students.

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## CRediT authorship contribution statement

**Sihui Peng:** Resources, Investigation, Data curation, Validation. **Dan Wu:** Resources, Investigation, Data curation, Validation. **Tingzhong Yang:** Conceptualization, Funding acquisition, Supervision, Formal analysis, Writing – original draft. **Joan L Bottorff:** Conceptualization, Methodology, Writing – review & editing.

## Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## Data availability

Data will be made available on request.

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## Further reading

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