Association between depression and overweight in Chinese adolescents: a cross-sectional study

Zhongyi Zhao, Ning Ding, Shenzhi Song, Yang Liu, Deliang Wen

ABSTRACT

Objective Based on a nationally representative adolescent sample, we examined the association of depression on the prevalence of overweight or obesity and whether this association was moderated by gender.

Methods There were 1081 adolescents from the China Family Panel Studies that participated in our study. Depression in adolescents was assessed using the Center for Epidemiologic Studies Depression Scale (CES-D). Ordered logistic regression model was used to quantify its association with overweight or obesity. Analyses were performed for the total group, and separately for males and females.

Results The prevalence of depression in Chinese adolescents was 23.22%. Depression (CES-D ≥16) was significantly associated with overweight or obesity (OR=1.47, 95% CI: 1.14 to 1.91, p=0.004) after adjustment for personal, household and regional confounders. Among four subdimensions of depression, depressed affect and lack of positive affect were significantly associated with increases in the odds of overweight or obesity. In females, only lack of positive affect was significantly associated with overweight or obesity, whereas the estimated associations of all other measures of depression on overweight or obesity were positive in males.

Conclusions These findings provide evidence that depression is associated with overweight or obesity among adolescents in China, especially among males.

INTRODUCTION

Overweight and obesity in adolescents have become major public health concerns worldwide since their prevalence has increased substantially over recent decades, especially in the developing world. For example, in China, there has been a significant and continuous increase in prevalence of obesity in adolescents, with an approximate 9% annual increase during 1985–2010. In another large developing country, India, the overall prevalence of overweight or obesity in children is as high as 23.9% according to the WHO classification. Considering that overweight or obese adolescents are more likely to remain overweight or obese after maturing and that obesity is associated with many poor health outcomes, including cardiovascular disease and metabolic syndrome, studies identifying risk factors of adolescent obesity will contribute to developing effective and efficient intervention strategies.

In addition to physical inactivity and excessive food intake, many researchers have begun investigating the effects of psychological features such as depression on the development of obesity. Although symptoms of depression might lead to obesity theoretically because they are closely related to several key obesogenic risk factors—such as physical activity, daily screen time and dietary intake—empirical studies have not reached a consensus. For example, whether in clinical or non-clinical adolescent samples, depressed adolescents are at increased risk for development and persistence of obesity, but for Korean and Island Puerto Rican adolescents, overweight or obesity is not related to high levels of depressive symptoms. One possible reason is that depression is multifaceted, including somatic, cognitive and affective dimensions. Dimensions of depression might affect adolescent obesity in different ways, and their effects possibly differ across different populations. Another reason could be the mediation role of cultural factors. The arguments above have not been
confirmed and therefore cannot easily be generalised to China as the existing studies were mostly conducted in western countries.\textsuperscript{11}14,16,17 There have been several studies in China to confirm the role of overweight or obesity in the development of depressive symptoms among young adolescents.\textsuperscript{26,27} However, the association of depression on the prevalence of overweight or obesity and whether this association is moderated by gender remains unclear. Therefore, more investigations using valid and reliable measures of depression based on representative data from Asian countries are needed.

The association between depression and obesity in adolescents is of particular interest in the present study. By using a nationally representative sample of Chinese adolescents and a standardised self-reported scale of depression, we aimed to examine whether (1) depression was associated with overweight or obesity; (2) dimensions of depression differed in their association with overweight or obesity; and (3) there were gender differences in these associations.

**METHODS**

**Data source**

The data used in this study were obtained from the China Family Panel Studies (CFPS), which was a general-purpose, nationally representative, longitudinal social survey conducted by the Institute of Social Science Survey at Peking University in collaboration with the Survey Research Center at the University of Michigan.\textsuperscript{28} Extensive information on economic characteristics and health status was collected.\textsuperscript{29} In the second wave in 2012, the Center for Epidemiologic Studies Depression Scale (CES-D) was introduced into questionnaires for assessing depression among adolescents aged 10–12 years, which was the area of interest of the present study. All relevant variables were extracted from three CFPS databases: variables of age, gender, height, weight, ethnicity, duration of breast feeding, birth weight and region were from the child database; maternal height, weight, and education level were from the adult database; and household income level was from the family database. Then, we matched the three kinds of variables with a unique identification code for each family and 1081 10–12-year-old adolescents with complete information on CES-D and overweight or obesity status formed our sample.

All research data are publicly available (http://www.issp.pku.edu.cn/cfps/index.htm).

**MEASURES**

**Overweight and obesity**

Based on caregiver-reported height and weight, body mass index (BMI, kg/m\textsuperscript{2}) was calculated. Then, according to the criteria of the Working Group on Obesity in China, adolescents were categorised as obese if BMI was greater than or equal to the 95th percentile for age and gender or as overweight if BMI was greater than or equal to the 85th percentile but less than the 95th percentile.\textsuperscript{30}

**Depressive symptoms**

The Chinese version of the CES-D, which was previously validated\textsuperscript{31} and is widely used in studies on Chinese adolescents,\textsuperscript{32} was used to determine if individuals had symptoms of depression. Participants were asked to indicate the frequency of each depressive symptom experienced in the past week. This self-report scale comprises 20 items, which are answered on a four-point Likert scale (0–3 points). Among them, four items (Items 4, 8, 12 and 16) were reversely scored, which means the higher raw score they obtain, the less indicative of depression. The total score ranges from 0 to 60 with higher scores indicating higher levels of depression\textsuperscript{33} and a score of 16 represents the optimal cut-off point for identifying major depressive disorder.\textsuperscript{34} Additionally, the findings of factor analysis implemented by the CFPS group, showed that the four subdimensions of depressive symptoms (depressed affect, lack of positive affect, somatic symptoms and interpersonal problems) can be identified. Therefore, we had three measures of psychological depression: subjects who meet the cut-off point for depression (CES-D ≥16); total CES-D scores; and four subdimensions of CES-D.

**Statistical analysis**

Only adolescents aged 10–12 years with complete information on BMI and CES-D were included in the current study. Further exclusion of those with extreme BMI values (>40 or <10 kg/m\textsuperscript{2}) formed the final sample of 1081 adolescents. The missing values on confounders were imputed by using the multiple imputation technique.\textsuperscript{35} The convergence and dispersion trends for quantitative variables were expressed as mean ± SD deviation and qualitative variables were expressed as frequencies and percentages. The prevalence of depression was calculated and the sociodemographical variables were compared between adolescents with and without depressive symptoms. Continuous variables were compared using the independent-samples t-test. Categorical variables were compared using Pearson’s \(\chi^2\) test or Fisher’s exact test, as appropriate. A comparison of the total CES-D scores and the four subdimensions scores between different weight status groups was performed using one-way analysis of variance.

We ran separate ordered logistic regression models for each measure of depression, where the cut-off for CES-D was used as a binary variable, and the total CES-D scores and the four subdimensions scores were regarded as continuous variables in the model input. In our ordered logistic regression model, the weight status as the dependent variable was grouped by normal BMI, overweight and obesity. We ran separate ordered logistic regression models for each measure of depression. We first ran the regression models without controlling for any confounders (model 1). Model 2 controlled for a series of personal characteristic covariates of adolescents:
gender (reference group: females) and age (in years),
etnicity (reference group: Han ethnic), duration of
breast feeding (reference group: no breast feeding) and
birth weight (reference group: normal birth weight).
In model 3, we further adjusted for three covariates
at the household level: maternal BMI, maternal educa-
tion level (reference group: no schooling) and house-
hold income per capita (in 10^3 RMB Yuan). In model 4,
we additionally introduced the interaction term between
two confounders indicating where the adolescents were
from: rural areas (reference group: urban areas) and
regions (reference group: west). Finally, to determine
the gender difference in any association between depressive
symptoms and weight status, we ran all models after
additional introducing the interaction term between
primary predictor variables and gender. SEs were clus-
tered at the region level. Non-significance of test statis-
tics of the parallel regression assumption for each model
suggested that ordered logistic models might be appro-
priate. Two-sided p<0.05 was considered significant. All
analyses were performed using Stata 13.

PATIENT AND PUBLIC INVOLVEMENT
Patients were not involved in the development of the
study. The results were intended for publication in a
peer-reviewed journal, but there is no plan to specifically
disseminate the findings to study participants.

RESULTS
The descriptive statistics for the 1081 adolescents aged
10–12 years showed that nearly one-fourth (23.22%) of
adolescents were depressed (table 1). In this special
group, the prevalence of overweight and obesity were
13.15% and 11.95%, respectively, which were significantly
higher than those in the non-depression group (9.88% and
6.75% respectively; χ^2(2)=10.20, p=0.006). The summary
statistics also indicated that those from ethnic
minority groups, rural areas and western China were
more likely to be depressed (table 1). Although maternal
educational level was significantly associated with depres-
sion symptoms, duration of breast feeding, birth weight,
maternal BMI and household income per capita were
irrelevant. Table 2 shows the distribution of the total
CES-D scores and the four subdimensions scores between
different weight status groups (normal weight, overweight
and obesity). We found an increasing trend for the CES-D
scores and the four subdimensions scores between
weight status groups (normal weight, overweight
and obesity). The results of model 1 (table 3) showed that the
presence of depressive symptoms (CES-D ≥16) was signifi-
cantly associated with overweight or obesity (OR=1.70,
95% CI: 1.57 to 1.85, p<0.001). Even after controlling
for personal, household and regional confounders, the
OR of 1.47 (95% CI: 1.14 to 1.91) was still significant at
p<0.01 (model 4). When depression was measured by the
CES-D scores, after introducing the confounders at the
household level, the association between depression
and overweight or obesity became non-significant. Among
the four subdimensions of depression, the estimated effect
of depressed affect was the largest (model 1, OR=1.07,
1.01 to 1.04, p=0.004), which corresponded to each SD increase in CES-D scores (31.45±6.52), resulting in a 13.22% increase in the risk of overweight or obesity. Moreover, the association was gendered—whether depressed, depressed affect, somatic symptoms and interpersonal difficulties were all significantly associated with obesity among male adolescents, but for female adolescents only lack of positive affect was significant.

In the present study, the increased odds of overweight or obesity with depression among Chinese adolescents was consistent with the cross-sectional results of an earlier study of American adolescents indicating that depression and obesity with onsets by early adolescence (by age 14) were concurrently associated. Another cross-sectional study of adults also suggested that depression was a strong risk factor of overweight or obesity among adolescents in China independent of a wide array of confounding variables. Dimensions of depressed affect and lack of positive affect, rather than somatic symptoms or interpersonal difficulties, were significantly associated with overweight or obesity. Moreover, the association was gendered—whether depressed, depressed affect, somatic symptoms and interpersonal difficulties were all significantly associated with obesity among male adolescents, but for female adolescents only lack of positive affect was significant.

### DISCUSSION

Using a nationally representative dataset, we demonstrated that depression (CES-D ≥16) was a significant risk factor of overweight or obesity among adolescents in China independent of a wide array of confounding variables. Dimensions of depressed affect and lack of positive affect, rather than somatic symptoms or interpersonal difficulties, were significantly associated with overweight or obesity. Moreover, the association was gendered—whether depressed, depressed affect, somatic symptoms and interpersonal difficulties were all significantly associated with obesity among male adolescents, but for female adolescents only lack of positive affect was significant.

### Table 2: Comparisons of the Center for Epidemiologic Studies Depression Scale (CES-D) scores between different weight status groups

<table>
<thead>
<tr>
<th>Variable</th>
<th>Normal weight (n=880)</th>
<th>Overweight (n=115)</th>
<th>Obesity (n=86)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>CES-D scores</td>
<td>31.17±6.52</td>
<td>32.00±6.50</td>
<td>33.57±7.33</td>
<td>0.309</td>
</tr>
<tr>
<td>Depressed affect</td>
<td>9.73±2.76</td>
<td>9.97±2.72</td>
<td>10.72±3.66</td>
<td>0.001</td>
</tr>
<tr>
<td>Positive affect</td>
<td>8.83±2.64</td>
<td>9.32±2.80</td>
<td>9.40±2.67</td>
<td>0.701</td>
</tr>
<tr>
<td>Somatic symptoms</td>
<td>10.05±2.75</td>
<td>10.11±2.51</td>
<td>10.63±2.82</td>
<td>0.408</td>
</tr>
<tr>
<td>Interpersonal difficulties</td>
<td>2.56±0.92</td>
<td>2.60±0.94</td>
<td>2.83±1.12</td>
<td>0.040</td>
</tr>
</tbody>
</table>

95% CI: 1.05 to 1.10, p<0.001; model 4, OR=1.06, 95% CI: 1.02 to 1.11, p=0.009), followed by lack of positive affect (model 1, OR=1.08, 95% CI: 1.05 to 1.11, p<0.001; model 4, OR=1.04, 95% CI: 1.03 to 1.05, p=0.001). However, somatic symptoms and interpersonal difficulties did not affect overweight or obesity significantly in adolescents.

There was a gender difference in the association between depression and weight status (table 4). Only male adolescents with depression, but not females, had a higher risk of overweight or obesity irrespective of whether depression was measured with a binary (CES-D ≥16) or a continuous variable (CES-D scores), and irrespective of which confounders were controlled for. Specifically, compared with non-depressed male adolescents, the overweight or obesity versus normal weight (or obesity versus overweight or normal weight) for the depressed group had OR of 1.48 (95% CI: 1.24 to 1.76, p<0.001). When depression was measured using CES-D scores, a 1-unit increase in score was correlated with a 2% increase in the OR of overweight or obesity (OR=1.02, 95% CI: 1.01 to 1.04, p=0.004), which corresponded to each SD increase in CES-D scores (31.45±6.61), resulting in a 13.22% increase in the risk of overweight or obesity. Additionally, detailed analysis showed that the estimated effect of the depressed affect on obesity was the same for male and female adolescents in magnitude, but only significant for males (OR=1.06, 95% CI: 1.01 to 1.11, p=0.009). Similarly, somatic symptoms and interpersonal difficulties were only associated with male obesity (OR=1.04, 95% CI: 1.01 to 1.07, p=0.013 and OR=1.14, 95% CI: 1.02 to 1.27, p=0.020, respectively), although marginally significant. The fully adjusted model (model 4) showed that the lack of positive affect only had a significant effect on obesity for female adolescents at p<0.01.

### Table 3: The association between depressive symptoms and weight status

<table>
<thead>
<tr>
<th>Variable</th>
<th>Model 1 OR (95% CI)</th>
<th>Model 2 OR (95% CI)</th>
<th>Model 3 OR (95% CI)</th>
<th>Model 4 OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whether depressed</td>
<td>1.70 (1.57 to 1.85)**</td>
<td>1.63 (1.35 to 1.97)**</td>
<td>1.48 (1.11 to 1.97)**</td>
<td>1.47 (1.14 to 1.91)**</td>
</tr>
<tr>
<td>CES-D scores</td>
<td>1.04 (1.02 to 1.05)**</td>
<td>1.03 (1.01 to 1.05)**</td>
<td>1.02 (0.99 to 1.05)</td>
<td>1.02 (1.00 to 1.05)</td>
</tr>
<tr>
<td>Depressed affect</td>
<td>1.07 (1.05 to 1.10)**</td>
<td>1.07 (1.04 to 1.10)**</td>
<td>1.06 (1.01 to 1.10)*</td>
<td>1.06 (1.02 to 1.10)**</td>
</tr>
<tr>
<td>Lack of positive affect</td>
<td>1.08 (1.05 to 1.10)**</td>
<td>1.06 (1.04 to 1.07)**</td>
<td>1.04 (1.03 to 1.06)**</td>
<td>1.04 (1.03 to 1.05)**</td>
</tr>
<tr>
<td>Somatic symptoms</td>
<td>1.04 (0.99 to 1.10)</td>
<td>1.03 (0.96 to 1.10)</td>
<td>1.02 (0.94 to 1.11)</td>
<td>1.02 (0.95 to 1.10)</td>
</tr>
<tr>
<td>Interpersonal difficulties</td>
<td>1.17 (1.04 to 1.32)**</td>
<td>1.14 (0.98 to 1.33)</td>
<td>1.11 (0.92 to 1.33)</td>
<td>1.11 (0.92 to 1.33)</td>
</tr>
</tbody>
</table>

Model 1: no adjustments; model 2: adjusted for age, gender, ethnic minority, duration of breast feeding and birth weight; model 3: additionally adjusted for maternal body mass index, maternal education and household income per capita on the base of model 2; model 4: additionally adjusted for the interaction between regions and urban areas on the base of model 3.

CES-D, Center for Epidemiologic Studies Depression Scales.

*P<0.05; **P<0.01; ***P<0.001.
Our findings were similar to those reported in studies conducted in some western countries. However, among Asian adolescents, an association between depression and overweight or obesity has not been consistently confirmed, and cultural factors were considered a possible reason. However, the present study suggests little, if any, mediation effect of culture on the association between depression and obesity should comprehensively evaluate the obesity effect of all dimensions of depression.

Our findings were similar to those reported in studies conducted in some western countries. However, among Asian adolescents, an association between depression and overweight or obesity has not been consistently confirmed, and cultural factors were considered a possible reason. However, the present study suggests little, if any, mediation effect of culture on the association between depression and obesity should comprehensively evaluate the obesity effect of all dimensions of depression.

**Table 4** Gendered difference in the association of CES-D scores and weight status

<table>
<thead>
<tr>
<th>Variable</th>
<th>Gender</th>
<th>Model 1 OR (95% CI)</th>
<th>Model 2 OR (95% CI)</th>
<th>Model 3 OR (95% CI)</th>
<th>Model 4 OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whether depressed</td>
<td>Male</td>
<td>1.69 (1.35 to 2.13)**</td>
<td>1.64 (1.36 to 1.97)**</td>
<td>1.49 (1.25 to 1.76)**</td>
<td>1.48 (1.24 to 1.76)**</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>1.81 (1.21 to 2.70)**</td>
<td>1.63 (0.95 to 2.81)</td>
<td>1.47 (0.76 to 2.85)</td>
<td>1.46 (0.76 to 2.80)</td>
</tr>
<tr>
<td>CES-D scores</td>
<td>Male</td>
<td>1.04 (1.03 to 1.06)**</td>
<td>1.03 (1.01 to 1.04)**</td>
<td>1.02 (1.00 to 1.04)**</td>
<td>1.02 (1.01 to 1.04)**</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>1.02 (1.00 to 1.04)**</td>
<td>1.03 (0.99 to 1.08)</td>
<td>1.02 (0.97 to 1.08)</td>
<td>1.02 (0.97 to 1.08)</td>
</tr>
<tr>
<td>Depressed affect</td>
<td>Male</td>
<td>1.10 (1.07 to 1.12)**</td>
<td>1.07 (1.03 to 1.11)**</td>
<td>1.06 (1.01 to 1.10)**</td>
<td>1.06 (1.01 to 1.11)**</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>1.03 (0.98 to 1.01)</td>
<td>1.07 (0.98 to 1.16)</td>
<td>1.06 (0.95 to 1.17)</td>
<td>1.06 (0.96 to 1.16)</td>
</tr>
<tr>
<td>Lack of positive affect</td>
<td>Male</td>
<td>1.10 (1.08 to 1.13)**</td>
<td>1.03 (1.01 to 1.05)**</td>
<td>1.02 (0.98 to 1.06)</td>
<td>1.02 (0.98 to 1.06)</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>1.03 (0.98 to 1.09)</td>
<td>1.09 (1.04 to 1.15)**</td>
<td>1.08 (1.03 to 1.13)**</td>
<td>1.08 (1.03 to 1.13)**</td>
</tr>
<tr>
<td>Somatic symptoms</td>
<td>Male</td>
<td>1.06 (1.01 to 1.12)*</td>
<td>1.04 (1.02 to 1.07)**</td>
<td>1.04 (1.00 to 1.07)</td>
<td>1.04 (1.01 to 1.07)*</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>0.99 (0.94 to 1.05)</td>
<td>1.01 (0.87 to 1.16)</td>
<td>1.00 (0.85 to 1.16)</td>
<td>1.00 (0.86 to 1.16)</td>
</tr>
<tr>
<td>Interpersonal difficulties</td>
<td>Male</td>
<td>1.27 (1.10 to 1.46)**</td>
<td>1.15 (1.06 to 1.26)**</td>
<td>1.13 (1.02 to 1.25)*</td>
<td>1.14 (1.02 to 1.27)*</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>0.99 (0.89 to 1.11)</td>
<td>1.12 (0.83 to 1.51)</td>
<td>1.07 (0.75 to 1.51)</td>
<td>1.05 (0.74 to 1.49)</td>
</tr>
</tbody>
</table>

***P<0.001; **P<0.01; *P<0.05; model 1: no adjustments; model 2: adjusted for age, gender, ethnic minority, duration of breast feeding and birth weight; model 3: additionally adjusted for maternal body mass index, maternal education and household income per capita on the base of model 2; model 4: additionally adjusted for the interaction between regions and urban areas on the base of model 3.

CES-D, Center for Epidemiologic Studies Depression Scales.
acknowledged. First, the cross-sectional nature of the dataset used in the present study did not allow addressing the issue of causality. Second, we focused on the effects of depression on the development of obesity. However, the possible reverse causality might bias our estimation because, as recent longitudinal studies have highlighted, of the bidirectional association between depression and obesity. The clarification of whether psychiatric disorders and psychological problems are a cause or a consequence of childhood obesity among Chinese adolescents requires future longitudinal studies, which could address the reverse causality problem. Third, the measurement of overweight or obesity was calculated based on caregiver-reported height and weight, which might be inaccurate. However, previous studies confirmed that errors in such measurements were limited and did not lead to misclassification with regard to overweight or obesity in adolescent samples. Finally, due to the cross-sectional nature of our research data, we were unable to observe the short-term weight changes (including weight loss and gain) caused by depression, which was mediated by factors such as decreased appetite, sleep disorders and so on. Future studies with longitudinal design were needed to systematically observe the short-term and long-term associations between depressive symptoms and weight changes among Chinese adolescent. Nevertheless, we applied appropriate analytical procedures to collect data comprehensively from a large, nationally representative cohort study and demonstrated that depression, particularly dimensions of depressed affect and lack of positive affect, might be a risk factor of obesity among Chinese adolescents and these influences could be modified by gender.

CONCLUSIONS

If depression is indeed a risk factor for being overweight or obese, then interventions aimed at improving mental health in Chinese adolescents could have major public health implications if they help prevent adolescents becoming overweight or obese. Considering the increasing prevalence of obesity among adolescents worldwide, it is critical to recognise the physiological and psychological characteristics among overweight and obese adolescents and to design corresponding interventions to promote both their physical and mental well-being in the current obesogenic environment.

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Competing interests None declared.

Patient consent Not required.

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