Prevalence and correlates of sleep disturbance and depressive symptoms among Chinese adolescents: a cross-sectional survey study

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ABSTRACT

Study objective: To investigate the prevalence and the correlates of sleep disturbance and depressive symptoms among Chinese adolescents and to examine the association between the two problems.

Design: Cross-sectional survey.

Participants: A total of 3186 school students in grades 7–12 were sampled from the schools in Guangdong. A stratified-cluster random-sampling strategy was used to select the schools.

Main outcome measures: A self-administered questionnaire was used. The Pittsburgh Sleep Quality Index (PSQI) was used to assess the occurrence of sleep disturbance, and the Center for Epidemiology Scale for Depression (CES-D) was used to identify whether individuals had depressive symptoms.

Results: The mean PSQI global score was 8.7 (±2.4) points, and 39.6% of the total sample had sleep disturbance. The mean CES-D score of students was 15.2 (±9.4) points, and 6.4% of the students had depressive symptoms. Additionally, girls and older adolescents were more likely to suffer from sleep disturbance, and the students who had depressive symptoms were 2.47 (95% CI 1.61 to 3.79) times more likely to suffer from sleep disturbance. Factors that were correlated with sleep disturbance and depressive symptoms were having a poor relationship with teachers, feeling lonely, suicide ideation and having run away from home.

Conclusions: Sleep disturbance was determined to be more prevalent among Chinese adolescents with depressive symptoms. Sleep disturbance and depressive symptoms were associated with each other, while school factors, family factors and psychosocial adjustment were comprehensively correlated with both.

INTRODUCTION

Adolescence is often described as occurring between 13 and 18 years of age, which is roughly the period of high school for much of the world. Sleep plays a very important role in the development of adolescents; it impacts physical growth and behaviour, and affects the mental health status. Studies in western countries have estimated that a large proportion (25–40%) of adolescents have sleep disturbance, and a report from China in 2000 revealed that 16.9% of the sample was troubled with sleep disturbance. In total, adolescents’ sleep disturbance has been a major international public health problem, and China is no exception, although the prevalence of Chinese adolescents with sleep disturbance has been a little lower than western countries.

Depressive symptoms are a type of mental disorder, and the link between sleep disturbance and depressive symptoms in adulthood is well established. For instance, women suffering from sleep disturbances have lower self-rated health and more physical and mental health symptoms, such as depressive symptoms. In contrast, a limited number of studies (especially epidemiological studies) have addressed the link between sleep disturbance and depressive symptoms among Chinese adolescents.
disturbance and depressive symptoms among adolescents, and the link is not uniform. One study in the USA has found that adolescents with sleep disturbance are more likely to develop and maintain depressive symptoms than adolescents without sleep disturbance,\textsuperscript{9} but one study found that there did not appear to be a strong association between sleep disturbance and depressive symptoms in adolescents.\textsuperscript{10} Additionally, many researchers in the USA have reported that sleep disturbance can be a sign of depressive symptoms, and depressive symptoms can likewise be a sign of sleep disturbance.\textsuperscript{11} Xu et al.'s\textsuperscript{12} research in China also demonstrated that sleep disturbance and depressive symptoms are closely related, and insufficient sleep may result in depressive symptoms. The recent increase in interest in the link between sleep disturbance and depressive symptoms in adolescents is warranted.

Sleep disturbance and depressive symptoms among adolescents are not only influenced by each other but also by demographics, family, school and social factors.\textsuperscript{13} Several variables have been associated with sleep disturbance and depressive symptoms. Previous studies have differing results about the characteristics of sleep disturbances between the two genders. Boys in Hong Kong were more likely to be troubled by sleep disturbance than girls,\textsuperscript{14} but most of the studies from other countries found that girls were more likely to report sleep disturbances than boys.\textsuperscript{15} \textsuperscript{16} Such inconsistencies may be attributed to differences in the sample and place, which suggested further research with larger samples is warranted. Additionally, Liu et al.'s\textsuperscript{17} study in China indicated that the prevalence of sleep disturbance varies with age and grade level among adolescents, and adolescents from incomplete families were more likely to have sleep disturbance compared with their peers. Furthermore, parents' sleep patterns and psychological functions were associated with adolescents' sleep in Iran.\textsuperscript{18} In addition, school environment is important for sleep quality and mental status of adolescents.\textsuperscript{19} Li's research has demonstrated that poor classmate relation predicted a high level of sleep disturbance and depressive symptoms among Chinese adolescents. One striking difference between Chinese and US adolescents is the salience of school and academic achievements relative to other concerns, and Chinese adolescents care more about academic achievements.\textsuperscript{20} Overall, although we conclude that sleep disturbance and depressive symptoms are a universal phenomenon among adolescents, it is clear that there are cultural variations in their prevalence and the way sleep disturbance or depressive symptoms relate to other factors.\textsuperscript{21} Most previous studies, however, have been carried out in western or developed countries, and only a handful of studies have been conducted in developing countries. There is also a paucity of studies on family status (ie, living arrangement and family economic status), school dynamics (ie, relationships with classmates or teachers) and personal psychosocial adjustment (ie, feeling lonely and attempting suicide) in the Chinese cultural context. Therefore, we conducted this large-scale cross-sectional study in China to estimate the prevalence of sleep disturbance and depressive symptoms; to comprehensively examine the potentially contributing factors to sleep disturbance and depressive symptoms among demographics, school, family and psychosocial health; and to discuss the link between sleep disturbance and depressive symptoms.

The following three hypotheses were formulated. First, following the results of previous studies,\textsuperscript{6} \textsuperscript{9} we hypothesised that sleep disturbance or depressive symptoms are a major public health problem nationwide among Chinese adolescents. Second, consistent with previous findings,\textsuperscript{15} \textsuperscript{18} \textsuperscript{20} we expected that demographics, family, school and psychosocial factors would be related to sleep disturbance or depressive symptoms among Chinese adolescents. Third, in line with prior research linking sleep disturbance and depressive symptoms,\textsuperscript{6} \textsuperscript{12} we expected sleep disturbance to be a risk factor for depressive symptoms among Chinese adolescents, and vice versa.

**METHODS**

**Study design and participants**

This cross-sectional study was based on a province-wide sample to estimate the prevalence of sleep disturbance and depressive symptoms and to examine the relationship between potentially influential factors and their involvement in sleep disturbance and depressive symptoms among Chinese adolescents. The participants were high school students from Guangdong, China. Guangdong is known as an immigrant province, with more than half of the population migrating from other provinces; therefore, the sample from Guangdong has a certain degree of representativeness. First, the schools were divided into three categories: junior high schools (grades 7–9), senior high schools (grades 10–12) and vocational schools (grades 7–12). A stratified-cluster random-sampling method was used to randomly select participants among the three types of schools. Six junior high schools, four senior high schools and two vocational schools were selected. Next, two classes were randomly selected from each grade in these schools. All available students within the grade were surveyed; those not surveyed were absent or refused to participate and consisted of less than 1% of the student population. All the participants were fully informed of the purpose of the survey and were invited to participate voluntarily. Written consent letters were obtained from the school, each participating student and one of the student's parents. A rigorously anonymous method for collection of the self-report questionnaires was guaranteed. The questionnaires were administered by research assistants in the classrooms without the presence of the teachers. It is important to stress that we used a self-designed questionnaire whose questions were based on an instrument proposed by the WHO and adapted to the realities...
of China, and the findings of a number of investigations indicate that such data can be extremely useful.\textsuperscript{1,22}

**Measures**

**Independent variables**

Sociodemographic variables: Age, grade and gender.

Family factors: Living arrangement, family economic status, family relationship and parental caring. Living arrangements were assessed by asking who lived in the student’s primary home. Family economic status was measured by asking the student’s perception of their family’s current economic status (rated from below average to above average). Family relationships were assessed by asking the students, with the responses coded on a 3-point scale ranging from below average to above average. Parental caring was assessed by asking, “Are you satisfied with the love you receive from your father, mother, or both of them, based on a 4-point scale from dissatisfaction to satisfaction?”

School factors: Classmate relations and teacher–classmate relations were also assessed based on the student’s self-rating about their relationships with classmates and teachers, ranging from poor to good. Academic achievements and academic pressure were captured by a single item asking about a personal appraisal of students’ performances or pressure relative to that of their classmates (responses were coded as ‘above average’, ‘average’ and below ‘average’).

Psychosocial adjustment: Feeling lonely was assessed by asking, “During the past 12 months, how often did you feel lonely per week?” Response options ranged from 1 (never) to 4 (over 4 days). Suicidal ideation status was based on whether a participant had endorsed thoughts of suicide over the past year. Suicide-attempt status was based on attempts made over the past year, with one or more attempts indicating endorsement. A student’s attempt to hurt themselves was assessed by asking, “During the past 12 months, did you ever hurt yourself on purpose?” Responses were categorised into four groups: never, considered, planned and attempted. Running away from home was assessed by asking, “During the past 12 months, did you run away from home without your parents’ permission for more than 24 h?” Response options were (1) never, (2) considered, (3) attempted or (4) have run away from home one time or more. Habits of sleeping after lunch were assessed based on the student’s self-rating about their habit, ranging from poor to good.

**Dependent variables**

We used the Chinese Pittsburgh Sleep Quality Index (CPSQI) to assess sleep quality and disturbances over a 1-month time interval; the sum of the scores for these seven components yields one global score with a range of 0–21 points in which higher scores indicate worse sleep quality.\textsuperscript{22,23} The CPSQI was translated into Mandarin Chinese to better correspond to the meaning of the original items in PSQI, and it is valid, reliable and commonly used. In China, a PSQI global score of above 7 points indicates poor sleep quality collectively known as sleep disturbance, a higher score indicates a greater reduction in sleep quality.\textsuperscript{22}

The Center for Epidemiology Scale for Depression (CES-D) in Chinese was used to identify whether individuals had depressive symptoms. The respondents were asked to rate the frequency, over the past week, of 20 depressive symptoms by choosing 1 of 4 response options ranging from ‘rarely or none of the time’ to ‘most or all of the time’.\textsuperscript{24} The Chinese version of this scale has been validated,\textsuperscript{25–27} and extensively utilised in Chinese studies.\textsuperscript{28} The score ranges from 0 to 60, and the original recommended cut-off point for having depressive symptoms was 16 points (corresponding to the 80th centiles) by the founder of the CES-D in 1977.\textsuperscript{29} We adopted the 80th centile as the cut-off (a score greater than 28 indicating ‘having depressive symptoms’), and the area under the ROC curve was 0.78. For the Center for Epidemiological Studies Depression Scale (CES-D) survey, those who failed to answer at least 17 of the 20 items were eliminated.

**Statistical analysis**

All data were entered by two investigators independently using EpiData 3.1, and the statistical analyses were conducted using SPSS V.21.0 and SAS V.9.2. Descriptive analyses were used to describe demographic characteristics and the prevalence of sleep disturbances and depressive symptoms among adolescents. Categorical and continuous data were reported in the form of proportions and means (SD). \(\chi^2\) Tests were used to test the difference between the categorical variables referred to above. Multivariate logistic regression models included the significant variables that had been tested by univariate analyses or widely reported in the literature; these were used to screen for the risk factors for sleep disturbance/depressive symptoms according to the ORs and 95% CIs. An OR >1 with \(p<0.05\) was reported as a risk factor. Considering that our study used a multistage sampling, students were grouped into classes; therefore, differences might not segregate independently. Thus, multilevel analyses (the generalised linear mixed effects models adopting the GLMMIX procedure in SAS) in which classes were treated as clusters were adopted in the multivariate logistic regression analyses. All statistical tests were two-sided, with a \(p\) value less than 0.05 considered significant.

**RESULTS**

A total of 3508 students were invited to participate, and 3485 students’ questionnaires were completed and qualified for our survey; the response rate was 95.2%. After excluding students who were not 13–18 years old, we analysed 3186 students’ data.

**Demographic information**

A total of 3186 participants were involved in this analysis. Table 1 provides the basic demographic information for
the sample involved in this study. The proportion of boys was 53.4%, and the male-to-female ratio was approximately 1.2:1. The students ranged in age from 13 to 18 years old, and the mean age of the students was 15.6 (±1.6) years. The students who never slept after lunch accounted for 9.7%. The grade 7–9 group of students represented 52.9% of the sample. Regarding the family factors, a total of 89% of students lived with both biological parents, whereas 4.7% lived in single-parent families. A total of 15.8% of students thought of their family relationships as average, and 77.6% of students were satisfied with both of their parents’ love. A subset of students (30.6%) reported that their current economic status was above average, whereas 8.4% reported that their economic status was below average. Regarding school factors, 28% of students rated their academic achievement as below average, and 42.2% of the students thought their academic pressure was above average. A total of 7.1% of participants reported poor relationships with their teachers and 3.8% had poor relations with their classmates. Regarding the psychosocial factors, 11.9% of students felt lonely more than 4 days per week. A total of 4.1% of students often had suicide ideation, and 1.2% of students had attempted suicide often. In addition, 1.5% of participants often hurt themselves on purpose, and 1.9% of participants had run away from home more than once.

### Univariate analysis for sleep disturbance and depressive symptoms

The mean PSQI global score was 8.7 (±2.4) points (8.6 (±2.5) points among boys, 8.6 (±2.4) points among girls), and 39.6% of the total sample was classified as having sleep disturbances (global score higher than 8 points). In addition, 6.4% of the students had depressive symptoms, according to the CES-D. The mean CES-D score of students was 15.2 (±9.4) points (14.6 (±9.1) points among boys, 15.6 (±8.8) points among girls).

### Table 1: Demographic characteristics of the total sample

| Variable                        | Number (%)       |
|---------------------------------|------------------|
| Total                            | 3186 (100.0)     |
| Gender                           |                  |
| Male                             | 1700 (53.4)      |
| Female                           | 1486 (46.6)      |
| Age (years)                      |                  |
| 13–14                            | 420 (13.2)       |
| 15–16                            | 1687 (53.0)      |
| 17–18                            | 1079 (33.9)      |
| Grade                            |                  |
| 7th–9th                          | 1686 (52.9)      |
| 10th–12th                        | 1500 (47.1)      |
| Living arrangement               |                  |
| Two biological parents           | 2836 (89.0)      |
| Only father or mother            | 149 (4.7)        |
| Others                           | 201 (6.3)        |
| Family economic status           |                  |
| Above average                    | 975 (30.6)       |
| Average                          | 1942 (61.0)      |
| Below average                    | 269 (8.4)        |
| Family relationship              |                  |
| Average                          | 2501 (78.5)      |
| Below average                    | 502 (15.8)       |
| Parental caring                  |                  |
| Satisfied with father or mother  | 545 (17.1)       |
| Satisfied with both of them      | 2471 (77.6)      |
| Dissatisfied with both of them   | 170 (5.3)        |
| Academic achievement             |                  |
| Average                          | 1361 (42.7)      |
| Below average                    | 932 (29.3)       |
| Academic pressure                |                  |
| Average                          | 1344 (42.2)      |
| Below average                    | 1376 (43.2)      |
| Relationship with teachers       |                  |
| Good                             | 1552 (48.7)      |
| Average                          | 1408 (44.2)      |
| Poor                             | 226 (7.1)        |
| Relationship with classmates     |                  |
| Good                             | 2220 (69.7)      |
| Average                          | 846 (26.6)       |
| Poor                             | 120 (3.8)        |
| Feel lonely                      |                  |
| Less than 1 day/week             | 1733 (54.4)      |
| 1 to 4 days/week                 | 1073 (33.7)      |
| More than 4 days/week            | 380 (11.9)       |
| Suicide ideation                 |                  |
| Never                            | 2589 (81.3)      |
| Occasionally (1–2 times/year)    | 391 (12.3)       |
| Sometimes (3–6 times/year)       | 75 (2.4)         |
| Often (over 6 times/year)        | 131 (4.1)        |
| Suicide attempt                  |                  |
| Never                            | 3083 (95.8)      |
| Occasionally (1–2 times/year)    | 81 (2.5)         |
| Sometimes (3–6 times/year)       | 14 (0.4)         |
| Often (over 6 times/year)        | 38 (1.2)         |

### Table 1 Continued

| Variable                        | Number (%)       |
|---------------------------------|------------------|
| Hurt themselves on purpose      |                  |
| Never                            | 2807 (88.1)      |
| Occasionally (1–2 times/year)    | 269 (8.4)        |
| Sometimes (3–6 times/year)       | 61 (1.9)         |
| Often (over 6 times/year)        | 49 (1.5)         |
| Running away from home           |                  |
| Never                            | 2262 (71.0)      |
| Considered                       | 815 (25.6)       |
| Planned                          | 48 (1.5)         |
| Attempted                        | 61 (1.9)         |
| Habit of sleeping after lunch    |                  |
| Never                            | 308 (9.7)        |
| Occasionally (1–4 times/week)    | 1598 (50.2)      |
| Often (over 4 times/week)        | 1280 (40.2)      |

Guo L, et al. BMJ Open 2014;4:e005517. doi:10.1136/bmjopen-2014-005517

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There were no gender differences in the PSQI global scores or the CES-D scores. (p>0.05)

As shown in table 2, without adjustment for other variables, sleep disturbances and depressive groups were correlated with gender, family economic status, family relationships, parental caring, academic pressure, relationships with classmates, feeling lonely, suicide ideation, suicide attempts, hurting themselves on purpose and having run away from home. Only age, grade, relationship with teachers and having depressive symptoms were significantly correlated with having a sleep disturbance, while only living arrangements and having sleep disturbances were significantly correlated with having depressive symptoms.

Multilevel logistic regression analysis: sleep disturbance
The final logistic regression model for sleep disturbance is presented in table 3. Ten of the original variables remained in the final model: gender, age, habit of sleeping after lunch, family relationships, academic pressure, relationships with teachers, feeling lonely, suicide ideation, running away from home and depressive symptoms. The results revealed that girls, the 15–16 and the 17–18-year age group were all more likely to suffer from sleep disturbance. Taking occasional naps after lunch was a risk factor for sleep disturbance compared with the group that never napped after lunch (adjusted OR=1.68, 95% CI 1.27 to 2.22). Adolescents with below-average family relationships (AOR=1.54, 95% CI 1.06 to 2.26) had a slightly higher probability of sleep disturbance. Likewise, students with poor relationships with teachers (AOR=1.26, 95% CI 1.19 to 1.77) were more troubled with sleep disturbances. In addition, students feeling lonely 1–4 days a week (AOR=1.64, 95% CI 1.39 to 1.94) or over 4 days a week (AOR=2.22, 95% CI 1.70 to 2.89) had a higher probability of sleep disturbances compared with those never feeling lonely. Having suicide ideations occasionally or sometimes was a risk factor for sleep disturbance, and students who considered running away from home (AOR=1.76, 95% CI 1.46 to 2.13) or attempted running away from home (OR=2.59, 95% CI 1.38 to 4.88) were also more likely to have a sleep disturbance compared with students who had never considered running away from home. Finally, students who had depressive symptoms were 2.47 (95% CI 1.61 to 3.79) times more likely to suffer from sleep disturbance than those who did not. Notably, students with average academic pressure (AOR=0.80, 95% CI 0.65 to 0.99) or below-average academic pressure (AOR=0.41, 95% CI 0.33 to 0.51) compared with the above-average academic pressure group were less likely to be troubled by sleep disturbance.

Multilevel logistic regression analysis: depressive symptoms
The final model for depressive symptoms in table 4 showed many correlations. Adolescents with a below-average family relationship (AOR=1.97, 95% CI 1.24 to 3.15) were more likely to have depressive symptoms. Having average relationships with classmates (AOR=2.82, 95% CI 1.62 to 4.90) or poor relationships with classmates (AOR=1.60, 95% CI 1.14 to 2.25) was a risk factor for having depressive symptoms. Students who felt lonely 1–4 days a week (AOR=2.67, 95% CI 1.75 to 4.07) or over 4 days a week (AOR=4.24, 95% CI 2.65 to 6.80) also had a higher probability of having depressive symptoms. Likewise, students occasionally, sometimes or often having suicide ideation had a higher probability of having depressive symptoms. Considering running away from home (AOR=1.71, 95% CI 1.20 to 2.44) was also a risk factor for depressive symptoms compared with students who never considered running away from home. Students with sleep disturbance were also more likely to have depressive symptoms (AOR=2.52, 95% CI 1.64 to 3.86).

DISCUSSION
In this study, we found that sleep disturbance was not rare among Chinese adolescents, with a prevalence of 39.6%. Similar studies have reported that the prevalence of sleep disturbance in children and adolescents ranges from 66% to 90%. A report from China in 2000 revealed that 16.9% of the sample was troubled with sleep disturbance, while a report from China in 1987 reported a prevalence of 14.9%. This study also agrees with the results from a western report in which 43% of children experienced sleep disturbance. The considerable variation in the prevalence of sleep disturbances may be due to the different time periods, different target populations and different methodological definitions of sleep disturbances. Adolescent sleep disturbance has been recognised as a major international public health problem, and China is no exception, although the prevalence of Chinese adolescents with sleep disturbance was a little lower than western countries.

In addition, our results indicate that girls were more likely to suffer from sleep disturbance, which agrees with the previous study from Anhui province and Hong Kong in China. Additionally, multivariate logistic regression analyses performed to control for confounding factors and to determine the main correlates of sleep disturbance showed that poor family relationships, poor relationships with teachers, feeling lonely, suicide ideation, running away from home and depressive symptoms were correlated with sleep disturbance. These findings are in accordance with the results of many previous studies. For example, a study from Shandong province of China in 2000 also reported that poor marital relations of parents, poor family economic status, poor child-parent and peer relations, poor school achievement and social
Table 2  Univariate $\chi^2$ analysis for sleep disturbance and depressive symptoms, n (%)  

| Variable                        | Total          | With sleep disturbance | With depressive symptoms |
|---------------------------------|----------------|------------------------|--------------------------|
| Total                            | 3186 (100.0)   | 1261 (100.0)           | 205 (100.0)              |
| Gender*                         |                |                        |                          |
| Male                            | 1700 (53.4)    | 729 (57.8)             | 92 (44.9)                |
| Female                          | 1486 (46.6)    | 532 (42.2)             | 113 (55.1)               |
| Age (years)†                    |                |                        |                          |
| 13–14                           | 420 (13.2)     | 240 (19.0)             | 22 (10.7)                |
| 15–16                           | 1687 (53.0)    | 667 (52.9)             | 111 (54.1)               |
| 17–18                           | 1079 (33.9)    | 354 (28.1)             | 72 (35.1)                |
| Grade†                          |                |                        |                          |
| 7th–9th                         | 1686 (52.9)    | 740 (58.7)             | 108 (52.7)               |
| 10th–12th                       | 1500 (47.1)    | 521 (41.3)             | 97 (47.3)                |
| Living arrangement‡             |                |                        |                          |
| Two biological parents          | 2836 (89.0)    | 1125 (89.2)            | 169 (82.4)               |
| Only father or mother           | 149 (4.7)      | 51 (4.0)               | 16 (7.8)                 |
| Others                          | 201 (6.3)      | 85 (6.7)               | 20 (9.8)                 |
| Family economic status*         |                |                        |                          |
| Above average                   | 975 (30.6)     | 437 (34.7)             | 45 (22.0)                |
| Average                         | 1942 (61.0)    | 738 (58.5)             | 127 (62.0)               |
| Below average                   | 269 (8.4)      | 86 (6.8)               | 33 (16.1)                |
| Family relationship*            |                |                        |                          |
| Above average                   | 2501 (78.5)    | 1063 (84.3)            | 115 (56.1)               |
| Average                         | 502 (15.8)     | 155 (12.3)             | 46 (22.4)                |
| Below average                   | 183 (5.7)      | 43 (3.4)               | 44 (21.5)                |
| Parental caring*                |                |                        |                          |
| Satisfied with father or mother | 545 (17.1)     | 184 (14.6)             | 58 (28.3)                |
| Satisfied with both of them     | 2471 (77.6)    | 1029 (81.6)            | 118 (57.6)               |
| Dissatisfied with both of them  | 170 (5.3)      | 48 (3.8)               | 29 (14.1)                |
| Academic achievement            |                |                        |                          |
| Above average                   | 1361 (42.7)    | 558 (44.3)             | 84 (41.0)                |
| Average                         | 932 (29.3)     | 362 (28.7)             | 59 (28.8)                |
| Below average                   | 893 (28.0)     | 341 (27.0)             | 62 (30.2)                |
| Academic pressure*              |                |                        |                          |
| Above average                   | 1344 (42.2)    | 399 (31.6)             | 137 (66.8)               |
| Average                         | 1376 (43.2)    | 625 (49.6)             | 49 (23.9)                |
| Below average                   | 466 (14.4)     | 237 (18.8)             | 19 (9.3)                 |
| Relationship with teachers†     |                |                        |                          |
| Good                            | 1552 (48.7)    | 694 (55.0)             | 69 (33.7)                |
| Average                         | 1408 (44.2)    | 493 (39.1)             | 95 (46.3)                |
| Poor                            | 226 (7.1)      | 74 (5.9)               | 41 (20.0)                |
| Relationship with classmates*   |                |                        |                          |
| Good                            | 2220 (69.7)    | 928 (73.6)             | 94 (45.9)                |
| Average                         | 846 (26.6)     | 289 (22.9)             | 79 (38.5)                |
| Poor                            | 120 (3.8)      | 44 (3.5)               | 32 (15.6)                |
| Feel lonely*                    |                |                        |                          |
| Less than 1 day/week            | 1733 (54.4)    | 830 (65.8)             | 34 (16.6)                |
| 1 to 4 days/week                | 1073 (33.7)    | 335 (26.6)             | 98 (47.8)                |
| More than 4 days/week           | 380 (11.9)     | 96 (7.6)               | 73 (35.6)                |
| Suicide ideation*               |                |                        |                          |
| Never                           | 2589 (81.3)    | 1108 (87.9)            | 88 (42.9)                |
| Occasionally (1–2 times/year)   | 391 (12.3)     | 88 (7.0)               | 68 (33.2)                |
| Sometimes (3–6 times/year)      | 75 (2.4)       | 12 (1.0)               | 18 (8.8)                 |
| Often (over 6 times/year)       | 131 (4.1)      | 53 (4.2)               | 31 (15.1)                |
| Suicide attempt*                |                |                        |                          |
| Never                           | 3083 (95.8)    | 1223 (97.0)            | 169 (82.4)               |
| Occasionally (1–2 times/year)   | 81 (2.5)       | 17 (1.3)               | 20 (9.8)                 |
| Sometimes (3–6 times/year)      | 14 (0.4)       | 4 (0.3)                | 3 (1.5)                  |
| Often (over 6 times/year)       | 38 (1.2)       | 17 (1.3)               | 13 (6.3)                 |

Continued
competence were risk factors for sleep problems,6 and a study in Switzerland also documented the relationship between sleep disturbance in adolescents and family functioning and demonstrated that the mother’s and adolescent children’s sleep and well-being are particularly strongly correlated with each other.33 Furthermore, prior studies also demonstrated that suicide completers had higher rates of overall sleep disturbance among adolescents,34 and running away from home was as common as suicide completion among adolescents with depressive symptoms.35 Notably, our results also indicate that students with average or below-average academic pressure compared with above-average academic pressure were less likely to be troubled by sleep disturbance. This indicates that academic pressure is an important type of stress that affects sleep, and other studies have provided evidence that stress is associated with sleep disturbance.36

Consistent with our expectation, adolescents who had depressive symptoms were at a higher risk for sleep disturbance. Xu et al12 has detected an association between sleep disturbance and depressive symptoms among Chinese adolescents. We found that sleep disturbance was common among adolescents in China, and an adolescent’s family, school and psychosocial factors have influences on sleep disturbance. Thus, educational campaigns directed at families and schools are needed to improve awareness of the adverse consequence of sleep disturbance.

In this study, the prevalence of students with depressive symptoms was 6.4%, slightly lower than the 8% reported in an Australian study.25 Depressive symptoms are a prevalent and disabling condition among adolescents that result in emotional suffering and sleep disturbance; therefore, it is important for us to focus on this problem.37 Our study reports that the prevalence of depressive symptoms among girls was not much higher than among boys, but a previous study reported prevalence rates of emotional problems to be higher in boys than in girls.38 These differences may due to emotional problems, including depressive symptoms and others. Additionally, our multivariate logistic regression showed that below-average family relationship, average or below-average relationships with classmates, emotional problems (including feeling lonely more than 1 day per week, having suicide ideations, considering running away from home) and having sleep disturbance was a risk factor for having depressive symptoms. Given that depressive symptoms are a type of emotional problem,39 it is not surprising that our results indicate a link between sleep disturbance and emotional problems. Consistent with the third hypothesis, our results clearly showed a link between sleep disturbance and depressive symptoms. However, the direction of the link was difficult to determine due to the nature of this cross-sectional study; they might mutually reinforce each other, thereby formulating a vicious circle.

Given adolescents’ vulnerability to sleep disturbance and depressive symptoms, we conducted this large-scale study aimed to investigate the prevalence and correlates of both problems in Chinese adolescents. To date, no research has expressly considered comprehensively the correlates of sleep disturbance and depressive symptoms among demographics, school, family and psychosocial domains in this population. Additionally, it must be stressed that there are several limitations to the current large-scale study. First, the data are cross-sectional, so no causal inference can be made regarding the observed relationships between sleep disturbance and depressive symptoms, and the common-method

| Variable                        | Total      | With sleep disturbance | With depressive symptoms |
|---------------------------------|------------|------------------------|--------------------------|
| Hurt themselves on purpose*     |            |                        |                          |
| Never                           | 2807 (88.1)| 1147 (91.0)            | 140 (68.3)               |
| Occasionally (1–2 times/year)   | 269 (8.4)  | 78 (6.2)               | 43 (21.0)                |
| Sometimes (3–6 times/year)      | 61 (1.9)   | 20 (1.6)               | 7 (3.4)                  |
| Often (over 6 times/year)       | 49 (1.5)   | 16 (1.3)               | 15 (7.3)                 |
| Running away from home*         |            |                        |                          |
| Never                           | 2262 (71.0)| 1006 (79.8)            | 79 (38.5)                |
| Considered                      | 815 (25.6) | 226 (17.9)             | 103 (50.2)               |
| Planned                         | 48 (1.5)   | 14 (1.1)               | 6 (2.9)                  |
| Attempted                       | 61 (1.9)   | 15 (1.2)               | 7 (3.8)                  |
| Depressive symptoms†            |            |                        |                          |
| Yes                             | 205 (6.4)  | 29 (2.3)               | –                        |
| No                              | 2981 (93.6)| 1232 (97.7)            | –                        |
| Sleep disturbance‡              |            |                        |                          |
| Yes                             | 1261 (39.6)| –                     | 29 (14.1)                |
| No                              | 1925 (60.4)| –                     | 176 (85.9)               |

*According to the χ² test, without adjusting for other variables, p<0.05 in the sleep disturbance group and the depressive symptoms group. †p<0.05, only in the sleep disturbance group. ‡p<0.05, only in the depressive symptoms group.
Table 3  Adjusted OR (95% CI) for sleep disturbance by multilevel logistic regression

| Covariate                        | Adjusted OR (95% CI)   | p Value |
|----------------------------------|------------------------|---------|
| Age (years)                      |                         |         |
| 13–14                            | 1.00 (reference)        |         |
| 15–16                            | 2.40 (1.87 to 3.08)     | <0.001  |
| 17–18                            | 1.36 (1.15 to 1.62)     | <0.001  |
| Gender                           |                         |         |
| Male                             | 1.00 (reference)        |         |
| Female                           | 1.27 (1.08 to 1.48)     | 0.003   |
| Habit of sleeping after lunch    |                         |         |
| Never                            | 1.00 (reference)        |         |
| Occasionally (1–4 times/week)    | 1.68 (1.27 to 2.22)     | <0.001  |
| Often (over 4 times/week)        | 1.05 (0.89 to 1.23)     | 0.590   |
| Family relationship              |                         |         |
| Above average                    | 1.00 (reference)        |         |
| Average                          | 1.08 (0.71 to 1.64)     | 0.723   |
| Below average                    | 1.54 (1.06 to 2.26)     | 0.025   |
| Academic pressure                |                         |         |
| Above average                    | 1.00 (reference)        |         |
| Average                          | 0.80 (0.65 to 0.99)     | <0.001  |
| Below average                    | 0.41 (0.33 to 0.51)     | <0.001  |
| Relationship with teachers       |                         |         |
| Good                             | 1.00 (reference)        |         |
| Average                          | 0.79 (0.57 to 1.11)     | 0.174   |
| Poor                             | 1.26 (1.19 to 1.77)     | <0.001  |
| Feel lonely                      |                         |         |
| Less than 1 day/week             | 1.00 (reference)        |         |
| 1 to 4 days/week                 | 1.64 (1.39 to 1.94)     | <0.001  |
| More than 4 days/week            | 2.22 (1.70 to 2.89)     | <0.001  |
| Suicide ideation                 |                         |         |
| Never                            | 1.00 (reference)        |         |
| Occasionally (1–2 times/year)    | 1.78 (1.36 to 2.34)     | <0.001  |
| Sometimes (3–6 times/year)       | 2.37 (1.25 to 4.54)     | 0.009   |
| Often (over 6 times/year)        | 0.80 (0.54 to 1.20)     | 0.280   |
| Running away from home           |                         |         |
| Never                            | 1.00 (reference)        |         |
| Considered                       | 1.76 (1.46 to 2.13)     | <0.001  |
| Planned                          | 1.42 (0.74 to 2.73)     | 0.298   |
| Attempted                        | 2.59 (1.38 to 4.88)     | 0.003   |
| Depressive symptoms              |                         |         |
| No                               | 1.00 (reference)        |         |
| Yes                              | 2.47 (1.61 to 3.79)     | <0.001  |

Adjusted OR means OR adjusted by multivariate analysis for screening risk factors for adolescents showing depressive symptoms.

Table 4  Adjusted OR (95% CI) for depressive symptoms by multilevel logistic regression

| Covariate                        | Adjusted OR (95% CI)   | p Value |
|----------------------------------|------------------------|---------|
| Family relationship              |                         |         |
| Above average                    | 1.00 (reference)        |         |
| Average                          | 1.22 (0.82 to 1.81)     | 0.329   |
| Below average                    | 1.97 (1.24 to 3.15)     | 0.004   |
| Relationship with classmates     |                         |         |
| Good                             | 1.00 (reference)        |         |
| Average                          | 2.82 (1.62 to 4.90)     | <0.001  |
| Poor                             | 1.60 (1.14 to 2.25)     | 0.007   |
| Feel lonely                      |                         |         |
| Less than 1 day/week             | 1.00 (reference)        |         |
| 1 to 4 days/week                 | 2.67 (1.75 to 4.07)     | <0.001  |
| More than 4 days/week            | 4.24 (2.65 to 6.80)     | <0.001  |
| Suicide ideation                 |                         |         |
| Never                            | 1.00 (reference)        |         |
| Occasionally (1–2 times/year)    | 2.72 (1.85 to 3.98)     | <0.001  |
| Sometimes (3–6 times/year)       | 2.77 (1.46 to 5.26)     | 0.002   |
| Often (over 6 times/year)        | 3.38 (1.89 to 6.04)     | <0.001  |
| Running away from home           |                         |         |
| Never                            | 1.00 (reference)        |         |
| Considered                       | 1.71 (1.20 to 2.44)     | 0.003   |
| Planned                          | 1.08 (0.40 to 2.90)     | 0.885   |
| Attempted                        | 1.42 (0.65 to 3.10)     | 0.386   |
| Sleep disturbance                |                         |         |
| No                               | 1.00 (reference)        |         |
| Yes                              | 2.52 (1.64 to 3.86)     | <0.001  |

Adjusted OR means OR adjusted by multivariate analysis for screening risk factors for adolescents showing depressive symptoms.

In conclusion, the prevalence and correlates of sleep disturbances and depressive symptoms among adolescents in China are high, and further research into the causes, effects and remedies is warranted. The prevalence of sleep disturbance observed in this study suggests the importance of research on preventive interventions targeting sleep quality among Chinese students. Effective preventive measures require full consideration of the social and environmental factors. We should focus on the high-risk population whose family factors, school factors and psychosocial adjustments are negative.

Acknowledgements The authors gratefully acknowledge the contribution of the Guangdong Education Bureau and its participating schools. The authors also thank the local health professionals, principals and teachers of participating schools. We express great thanks to all participants of our study.

Contributors LG and CYL searched the literature, conceived the study, designed the study, analysed the data, interpreted the results, and drafted the...
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