Prevalence of depressive symptoms among Chinese university students amid the COVID-19 pandemic: a systematic review and meta-analysis

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Abstract

Aims. Chinese university students are at high risk for depressive symptoms and the ongoing coronavirus disease 2019 (COVID-19) pandemic may have exacerbated the mental health of university students. However, existing studies on depressive symptoms in Chinese university students during the COVID-19 pandemic reported a wide range of prevalence estimates, making mental health planning for this population difficult. The objective of this study was to conduct a systematic review and meta-analysis of surveys that assessed the prevalence of depressive symptoms in Chinese university students amid the COVID-19 pandemic.

Methods. Major Chinese (CNKI, Wanfang, VIP) and English (PubMed, Embase, PsycInfo) databases and preprint platforms were searched to identify cross-sectional studies containing data on the prevalence of depressive symptoms in Chinese university students during the pandemic. Two authors independently retrieved the literature, evaluated the eligibility of potential studies, assessed the risk of bias (RoB) of included studies, and extracted data. RoB was assessed with the Joanna Briggs Institute Critical Appraisal Checklist for Studies Reporting Prevalence Data.

Results. In total, 1177 records were retrieved, and 84 studies involving 1292811 Chinese university students during the pandemic were included. None of the included studies were rated as completely low RoB. Statistically significant heterogeneity in the prevalence estimates of included studies was detected ($I^2 = 99.9\%, p < 0.001$). The pooled prevalence of depressive symptoms was 26.0% (95%CI: 23.3–28.9%), which was significantly higher in female than in male students (30.8% vs. 28.6%, $p < 0.001$), in postgraduates than in undergraduates (29.3% vs. 22.9%, $p < 0.001$), in students living inside than in those living outside the COVID-19 epicentre (27.5% vs. 22.3%, $p < 0.001$), in students from universities at the epicentre than in those from universities outside the epicentre (26.2% vs. 23.1%, $p < 0.001$), in students who had close contact with COVID-19 than in those who did not (46.0% vs. 25.0%, $p < 0.001$), and in students who had acquaintances or relatives infected with COVID-19 (39.7% vs. 24.0%, $p < 0.001$) than in those who did not. Five sources of heterogeneity were identified from the subgroup analysis: survey period, % of males among the survey sample, scale of depressive symptoms, cutoff score of the scale and level of RoB.

Conclusions. Over one-fourth of Chinese university students experienced depressive symptoms during the COVID-19 pandemic. Mental health services for this population should include periodic evaluation of depressive symptoms, expanded social support and psychiatric assessment and treatment when necessary. It is also necessary to design depression prevention programmes that target higher-risk cohorts of university students.

Introduction

Studying in university is an important life stage during which a person moves from family dependence to independence and socialisation. The transition is challenging because of the high level of academic and employment stress and the prevalent interpersonal, romantic and emotional problems in this particular stage for university students (Zhao et al., 2015; Liu et al., 2017; Zhang et al., 2020a). However, due to China’s strict examination-oriented education system, many university students have little training in interpersonal communication, problem solving and teamwork skills before entering university. Therefore, this population has difficulties in adapting to the university environment and is more likely to feel unconfident and confused about the future (Kirkpatrick and Zang, 2011; Hu, 2018). Moreover, university students in China have a high likelihood of experiencing parent–adolescent conflict owing to the popular authoritarian parenting style in the context of Chinese culture, which is characterised by high control and high warmth (Marmorstein and Iacono, 2004; Diao, 2007; Ren and Edwards, 2015). As a result, Chinese university students are at high risk for common

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mental health problems; for example, empirical evidence from a systematic review of 39 studies has shown that as high as 23.8% of Chinese university students suffer from depressive symptoms (Lei et al., 2016).

The ongoing coronavirus disease 2019 (COVID-19) pandemic has caused a global mental health crisis. Lessons learned from the 2003 severe acute respiratory syndrome (SARS) epidemic in China suggest that depressive symptoms are one of the most common mental health problems among university students; for example, during the SARS epidemic, 25.4–29.6% of the Chinese university students had depressive symptoms (Dang et al., 2004; Liu et al., 2004). In China, the pandemic has changed many aspects of university students’ daily lives. Despite an increase in time spent with parents, home-isolated students have an increased chance of conflicting with parents (Luo, 2020). To prevent the spread of the epidemic, students are not allowed to return to campus to resume their studies, potentially delaying their graduation dates. Furthermore, because of social distancing and stay-at-home requirements, social and peer interactions are reduced, likely resulting in an increased level of social disconnectedness and a decreased level of peer support. Because parent–adolescent conflict, social disconnectedness and a lack of peer support have been associated with depressive symptoms in adolescents (Vaughan et al., 2010; Elmer and Stadtfeld, 2020; Rognli et al., 2020), the emotional health of Chinese university students may have been exacerbated by the COVID-19 pandemic.

Mental health services and crisis psychological intervention have been an essential part of the battle against the COVID-19 pandemic (Li et al., 2020a). To facilitate the development of population-specific intervention programmes, it is necessary to understand the epidemiology of depressive symptoms in university students in China amid the COVID-19 pandemic. However, available studies on depressive symptoms among Chinese university students have varied widely in terms of sampling methods, sample sizes and assessments of depressive symptoms, and most importantly, there have been considerable variations in the reported prevalence of depressive symptoms (1.8–79.3%) (Liang et al., 2020a; Ren et al., 2020b), making mental health policymaking and planning difficult. To help clarify this issue, we performed a systematic review and meta-analysis on the prevalence of depressive symptoms among Chinese university students during the COVID-19 pandemic.

Methods

This systematic review and meta-analysis was reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, and the protocol was registered in the International Prospective Register of Systematic Reviews (PROSPERO) with the registration number CRD 42020206666.

Inclusion and exclusion criteria

The inclusion criteria for eligible studies were (a) cross-sectional surveys or baseline surveys of cohort studies with meta-analyzable data (i.e. reporting the prevalence of depressive symptoms); (b) study subjects were Chinese university students, including overseas students and postgraduates; (c) the presence of depressive symptoms was assessed with standardised instruments and (d) the study was conducted during the COVID-19 pandemic (since 1 January 2020). We excluded studies with mixed samples that did not present results separately for university students and studies that assessed depressive symptoms with unstandardised instruments (i.e. a simple self-designed question or a self-designed scale without convincing evidence of reliability and validity).

Literature search

We searched potential studies published between 1 January 2020 and 10 February 2021 in both Chinese and English bibliographic databases: China National Knowledge Infrastructure, Wanfang data, VIP Information, PubMed, Embase and PsycInfo. Key terms used were: (adolescent* OR OR teenage* OR youth* OR student*) OR young adult* OR undergraduate* OR universit* OR college*), (coronavirus disease 2019 or severe acute respiratory syndrome coronavirus 2 or COVID-19 or COVID) and (depress*). To avoid missing relevant studies, reference lists of the retrieved studies and included studies were also hand-searched. Preprint servers were also searched to retrieve grey literature: medRxiv, bioRxiv, PsyArXiv, ChinaXiv and Research Square. The literature search was ended on 12 February 2021. Detailed search strategies are provided in online Supplementary Table 1.

Data extraction

By using a predesigned electronic form, the following variables were extracted from included studies: first author, study site, study period, characteristics of the study sample, sampling method, sample size, survey method, assessment of depressive symptoms and rates of depressive symptoms. According to the State Council Information Office of the People’s Republic of China (The State Council Information Office of the People’s Republic of China, 2020), the study period in China was roughly classified as early stage of the COVID-19 outbreak (20 January–20 February 2020), late stage of the COVID-19 outbreak (21 February–28 April 2020) and post-COVID-19 outbreak (since 29 April 2020).

RoB assessment of included studies

We used the Joanna Briggs Institute (JBI) Critical Appraisal Checklist for Studies Reporting Prevalence Data (abbreviated as ‘JBI checklist’ hereafter) to assess the RoB of included studies (Munn et al., 2014). This checklist evaluates the RoB in terms of nine methodological domains: sample frame, sampling, sample size, description of subjects and setting, sample coverage of the data analysis, validity of the method for assessing the outcome, standardisation and reliability of the method for assessing outcome, statistical analysis and response rate. Two example items of the JBI checklist used in the current study were ‘Was the sample size adequate?’ and ‘Were valid methods used for assessing depressive symptoms?’. Each item has four choices: yes, no, unclear or not applicable. One point is assigned to a ‘yes’ response, and the RoB score is the sum of the nine items, ranging from zero to nine, with a higher score indicating a lower RoB. In this study, the level of RoB of included studies was operationally categorised into low (RoB score of ‘7–9’), moderate (RoB score of ‘4–6’) and high (RoB score of ‘0–3’). A RoB score of nine represents ‘completely low RoB’.

Literature search, study inclusion, data extraction and RoB assessment were independently performed by the first and second authors of this study. They discussed their differences to arrive at a consensus when disagreement occurred in an assessment.
**Epidemiology and Psychiatric Sciences**

1177 records identified through database searching

PubMed, 385  
CNKI, 130  
EMBASE, 325  
Wanfang, 111  
Psycinfo, 101  
VIP, 125

- 545 duplicates removed
- 632 records screened
- 484 records excluded after review of titles or abstracts
- 72 records excluded after review of full-texts
- 35 not reported prevalence of depressive symptoms
- 19 with mixed samples, no separate results for university students
- 9 used data of the same study
- 8 assessed depressive symptoms with unstandardized instruments
- 1 not collected data during the COVID-19 pandemic

**Fig. 1.** Flowchart of study inclusion.

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**Statistical analysis**

We used meta-analysis to generate pooled estimates and their 95% confidence intervals (95% CIs) for the prevalence of depressive symptoms in the whole sample and in various cohorts of the sample. Forest plots were adopted to display the prevalence rates and pooled estimates. We used the $I^2$ test to evaluate heterogeneity between studies. When there was little evidence of heterogeneity (i.e., $I^2 \leq 50\%$, heterogeneity $P \geq 0.10$), a fixed-effect model was used to generate the pooled estimates; otherwise, the random-effect model was used. The pooled rates of various cohorts were compared by using the $Z$ test. We used subgroup analysis to explore the source of heterogeneity in the prevalence estimate of depressive symptoms. The $Q$-value test was used to test the significance of differences in prevalence rates between subgroups. Publication bias was assessed with funnel plots and Begg’s test, since Begg’s test is fairly powerful for large meta-analyses that include 75 or more original studies (Begg and Mazumdar, 1994). Before pooled analysis, prevalence proportions were transformed by using the Freeman–Tukey variant of the arcsine square root, Arcsine, untransformed, Log or Logit, as appropriate (Barendregt et al., 2013). All analyses were conducted using R (version 4.0.2). A two-sided $P < 0.05$ was considered statistically significant.

**Results**

**Characteristics of included studies**

The process of study inclusion is shown in Fig. 1. Finally, this meta-analysis included 84 studies with a total of 1,292,811 Chinese university students (Cao, 2020; Chang et al., 2020; Chen et al., 2020a, 2020b, 2020c, 2020d; Chi et al., 2020; Cong et al., 2020; Deng et al., 2020; Dong, 2020; Dong et al., 2020; Feng, 2020; Feng et al., 2020; Han et al., 2020; Ji et al., 2020; Jiang et al., 2020; Lei et al., 2020; Li and He, 2020; Li et al., 2020b; Lian et al., 2020; Liang et al., 2020a, 2020b; Lin and Xu, 2020; Lin et al., 2020a, 2020b; Liu, 2020a, 2020b; Liu et al., 2020a, 2020b, 2020c; Ma et al., 2020a, 2020b; Mao et al., 2020; Qian, 2020; Ren et al., 2020a, 2020b, 2020c; Si et al., 2020; Sun et al., 2020, 2021; Tang et al., 2020; Wan and Shao, 2020; Wang and He, 2020; Wang and Li, 2020; Wang et al., 2020a, 2020b, 2020c, 2020d, 2020e, 2020f, 2021; Wei, 2020; Wu et al., 2020, 2021; Xiang et al., 2020; Xiao et al., 2020a, 2020b; Xie et al., 2020; Xin et al., 2020; Xing et al., 2020; Xiong et al., 2020; Xu and Li, 2020; Yan et al., 2020; Yang et al., 2020; Yao et al., 2020; Yi et al., 2020a, 2020b; Yu et al., 2020, 2021; Zhan et al., 2020; Zhang et al., 2020b, 2020c, 2020d, 2020e, 2020f, 2020g, 2020h; Zhao and Hu, 2020; Zhao et al., 2020a, 2020b, 2020c; Zhou et al., 2020; Chen and Zhu, 2021; Ni et al., 2021; Pan et al., 2021). Among the 84 studies, seven were preprint articles (Cong et al., 2020; Liu et al., 2020c; Si et al., 2020; Xiong et al., 2020; Zhang et al., 2020b; Zhao et al., 2020b; Zhou et al., 2020), eight had samples recruited from universities at China’s COVID-19 epicentre (Hubei or Wuhan) (Deng et al., 2020; Liu et al., 2020; Wang et al., 2020a, 2020d, 2020e, 2020f, Xiao et al., 2020b, 2020a; Xu and Li, 2020; Wu et al., 2021) and two recruited samples of overseas Chinese students (Cong et al., 2020; Zhao et al., 2020b). A total of 23 studies adopted probability sampling to recruit subjects, while the remaining studies adopted convenience sampling. The sample sizes of included studies ranged between 84 and 746,217, with a median of 973. A vast majority of the studies collected data via online self-administered questionnaires, while...
seven collected data via paper–pencil self-administered questionnaires (Chen et al., 2020a, 2020c, 2020d; Dong et al., 2020; Liu, 2020b; Liu et al., 2020b; Wu et al., 2020). Among the included studies, the Nine-item Patient Health Questionnaire (PHQ-9) was the most common instrument to assess the presence of depressive symptoms \((n = 37)\), followed by Zung’s Self-rating Depression Scale (SDS) \((n = 22)\), the depression subscale of the Symptom Checklist-90-Revised (SCL-90-R) \((n = 8)\), the depression subscale of the Depression, Anxiety and Stress Scale – 21 Items (DASS-21) \((n = 7)\) and the Center for Epidemiologic Studies – Depression Scale (CES-D) \((n = 7)\). The average and median reported prevalence rates of depressive symptoms were 27.3% and 25.8%, respectively. Other detailed characteristics of the included studies are shown in Table 1.

**RoB of included studies**

In total, 31 studies had a RoB score of ‘0–3’, 42 had a RoB score of ‘4–6’ and 11 had a RoB score of ‘7–8’. No study was scored nine. The two most common methodological issues were inappropriate sample frame \((n = 62)\) and problematic sampling method \((n = 58)\) (online Supplementary Table 2).

**Meta-analysis of prevalence of depressive symptoms**

The pooled prevalence of depressive symptoms among Chinese university students was 26.0% \((% CI: 23.3–28.9\% )\) (Fig. 2). Pooled prevalence rate of severe depressive symptoms was 1.69% \((95\% CI: 0.87–2.77\% )\) (Fig. 3).

The combined prevalence rates of depressive symptoms were significantly higher in female than in male students \((30.8\% v. 28.6\%, p < 0.001)\), in students with siblings than in only child students \((24.2\% v. 20.7\%, p < 0.001)\), in overseas than in domestic students \((44.5\% v. 25.6\%, p < 0.001)\), in postgraduates than in undergraduates \((29.3\% v. 22.9\%, p < 0.001)\), in students living in Hubei than in those living in provinces other than Hubei \((27.5\% v. 22.3\%, p < 0.001)\), in students from universities of Hubei than in those from universities of other provinces \((26.2\% v. 23.1\%, p < 0.001)\), in students who were in close contact with COVID-19 than in those who had no history of COVID-19 contact \((46.0\% v. 25.0\%, p < 0.001)\), and in students who had friends, classmates or relatives infected with COVID-19 than in those who did not \((39.7\% v. 24.0\%, p < 0.001)\) (Table 2).

**Publication bias among included studies**

As shown in Fig. 4, the funnel plot was generally symmetric. The \(p\) value of the Begg’s test was 0.169. No statistically significant publication bias was detected across the 84 included studies.

**Source of heterogeneity**

Five factors were identified as sources of heterogeneity across included studies (Table 3): survey period, \% of male students among the total sample, scale of depressive symptoms, cutoff score of the scale of depressive symptoms and level of RoB. Specifically, significantly higher pooled prevalence rates of depressive symptoms were observed in studies conducted during the late stage of the COVID-19 outbreak than in those conducted during the early stage \((31.0\% v. 21.8\%, p = 0.015)\), in studies with a percentage of males \(>50\% \) than in those with a percentage of males \(\geq 50\% (27.3\% v. 20.6\%, p = 0.033)\), in studies assessing depressive symptoms with CES-D than in those using SCL-90-R \((40.0\% v. 11.5\%, p = 0.002)\), in studies defining the presence of depressive symptoms as ‘PHQ-9 \(\geq 5\)’ than in those defining it as ‘PHQ-9 \(\geq 10\)’ \((29.2\% v. 15.5\%, p < 0.001)\), and in studies with a high RoB than in those with a low RoB \((28.4\% v. 20.6\%, p = 0.011)\).

**Discussion**

**Main findings**

This systematic review and meta-analysis summarised studies estimating the prevalence of depressive symptoms among Chinese university students amid the COVID-19 pandemic. We found an overall prevalence rate of 26.0\% of depressive symptoms in Chinese university students and significantly higher rates in female students \((v.\) males), in students with siblings \((v.\) only children), in overseas students \((v.\) domestic), in postgraduates \((v.\) undergraduates), in students living within the COVID-19 epicentre \((v.\) those living outside), in students from universities at the epicentre \((v.\) those from universities of provinces other than Hubei), in close contacts of COVID-19-infected persons \((v.\) those without a history of COVID-19 contact) and in students who had COVID-19-infected friends, classmates or relatives \((v.\) those who did not). In addition, 1.69\% of Chinese university students had severe depressive symptoms.

Compared to the 23.8\% prevalence of depressive symptoms among Chinese university students during the non-COVID-19 era (Lei et al., 2016), a higher prevalence of depressive symptoms \((26.0\% )\) was found in Chinese university students amid the COVID-19 pandemic. Nevertheless, the absolute difference between the two rates \((2.2\% )\) is not very large in magnitude. We argue that the result from this direct comparison should be considered with caution because of the significant heterogeneity in the methodologies of included studies. As shown in Table 3, the pooled prevalence of depressive symptoms rose to 29.2\% when included studies were restricted to those defining the presence of depressive symptoms as ‘PHQ-9 \(\geq 5\)’. Previously, empirical studies have reported that the prevalence rates of depressive symptoms in Chinese university students were 19.2\% \((PHQ-9 \geq 5)\), 7.8–12.6\% \((PHQ-9 \geq 10)\) and 26.9\% \((CES-D \geq 16)\) (He et al., 2014; Wu, 2019; Zhao et al., 2019; Gao et al., 2020b; Leung et al., 2020; Li et al., 2021), which are all lower than the corresponding figures in our study \((29.2\%, 15.5\% and 40.0\%, Table 3)\). Moreover, the 1.69\% prevalence of severe depressive symptoms in our study was higher than that reported in two previous studies with samples of Chinese university students \((0.5–0.9\% )\) (Ma et al., 2019; Zhao et al., 2019). These data suggest an elevated risk of depressive symptoms in Chinese university students during the COVID-19 pandemic.

In addition to the abovementioned postponement of graduation, home quarantine and social disconnection due to the COVID-19 pandemic, the cooccurring ‘infodemic’ may also explain the elevated risk of depressive symptoms in university students. This is because smartphone and social media use are very popular among Chinese university students, and students are more likely to be exposed to negative information or even rumours from social media platforms such as short videos of overcrowded hospitals, physically and emotionally exhausted physicians and helpless infected patients. As a supporting case, in this pandemic, Chinese researchers have found the significant

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| Study                          | Subjects and setting                          | Dates of the survey                | Sampling method | Sample size | Male students, n (%) | Age (years) | Survey method                        | Assessment of depressive symptoms | Depressed students, n (%) |
|-------------------------------|-----------------------------------------------|------------------------------------|-----------------|-------------|----------------------|-------------|--------------------------------------|----------------------------------|--------------------------|
| Cao (2020)                    | Undergraduates of a junior college in X’an, China | NR                                 | Convenience sampling | 2733        | 1684 (61.6)          | Range: 16–24 | Online self-administered questionnaire | PHQ-9 ≥ 5                        | 575 (21.0)               |
| Chang et al. (2020)           | University students in Guangdong, China        | 31 January–3 February 2020         | Convenience sampling | 3881        | 1434 (36.9)          | Mean: 20.0   | Online self-administered questionnaire | PHQ-9 ≥ 5                        | 821 (21.2)               |
| Chen et al. (2020a)           | Medical postgraduates of a general hospital in Hangzhou, China | February 2020                      | Convenience sampling | 795         | 343 (43.1)           | Mean: 26.6   | Paper-pencil self-administered questionnaire | PHQ-9 ≥ 5                        | 172 (21.6)               |
| Chen et al. (2020b)           | Undergraduates of 85 universities in Hangzhou, China | 13–22 February 2020               | Convenience sampling | 323 489     | 130 516 (40.3)       | <18: 29 510 (9.1) 19–20: 167 932 (61.9) 21–22: 104 800 (32.4) 23–24: 19 710 (6.1) ≥25: 1537 (0.5) | Online self-administered questionnaire | PHQ-9 ≥ 10                | 24 909 (7.7)            |
| Chen et al. (2020c)           | Medical postgraduates of a general hospital in Hangzhou, China | 3–16 February 2020                | Cluster sampling | 286         | NR                   | NR           | Paper-pencil self-administered questionnaire | PHQ-9 ≥ 5                        | 54 (18.9)                |
| Chen et al. (2020d)           | Undergraduates and postgraduates in Beijing, China | ‘post-epidemic of CPVID-19’       | Stratified random sampling | 697         | 183 (26.3)           | Mean: 24.3   | Paper-pencil self-administered questionnaire | Depression subscale of SCL-90-R > 2 | 61 (8.8)                 |
| Chi et al. (2020)             | University students in China                  | 12–17 February 2020               | Convenience sampling | 2038        | 755 (37.0)           | Mean: 20.6   | Online self-administered questionnaire | PHQ-9 ≥ 10                        | 475 (23.3)               |
| Cong et al. (2020)            | Oversea Chinese undergraduates and postgraduates in China | May 18–21, 2020                   | Convenience sampling | 252         | 102 (40.5)           | <18: 2 (0.8) 18–25: 160 (63.5) 26–30: 70 (27.8) >30: 29 (7.9) | Online self-administered questionnaire | PHQ-9 ≥ 5                        | 152 (60.3)               |
| Deng et al. (2020)            | Undergraduates in China                       | 8–11 May 2020                     | Convenience sampling | 1607        | 1041 (64.8)          | <18: 20 (1.2) 18–22: 1573 (97.9) >22: 14 (0.5) | Online self-administered questionnaire | Depression subscale of DASS21 ≥ 10 | 56 (3.5)                 |
| Dong et al. (2020)            | Medical postgraduates of a general hospital in China | 20 January–20 February 2020       | Convenience sampling | 162         | 52 (32.1)            | Mean: 26.4   | Paper-pencil self-administered questionnaire | SDS ≥ 53                         | 63 (38.9)                |
| Dong (2020)                   | Undergraduates of a university in Linfen, China | NR                                 | Cluster sampling  | 4085        | 923 (22.6)           | Mean: 18.9   | Online self-administered questionnaire | Depression subscale of SCL-90-R > 2 | 554 (13.6)               |
| Feng et al. (2020)            | Students of a university in Beijing, China     | 8–28 February 2020                | Simple cluster sampling | 1346        | 364 (27.0)           | Mean: 19.8   | Online self-administered questionnaire | PHQ-9 ≥ 5                        | 429 (31.9)               |
| Feng (2020)                   | Undergraduates of a junior college in Qingyuan, China | 18–22 February 2020              | Random sampling  | 7157        | 2158 (30.2)          | Median: 20.1 | Online self-administered questionnaire | PHQ-9 ≥ 5                        | 1956 (27.3)              |
| Study | Subjects and setting | Dates of the survey | Sampling method | Sample size | Male students, n (%) | Age (years) | Survey method | Assessment of depressive symptoms | Depressed students, n (%) |
|-------|----------------------|---------------------|----------------|-------------|---------------------|------------|---------------|----------------------------------|------------------------|
| Han et al. (2020) | Undergraduates and postgraduates in China | 22–24 February 2020 | Convenience sampling | 405 | 134 (33.1) | NR | Online self-administered questionnaire | Depression subscale of DASS21 ⩾ 10 | 178 (44.0) |
| Ji et al. (2020) | Nursing undergraduates of seven universities in Sichuan, China | 14–19 February 2020 | Cluster sampling | 1013 | 139 (13.7) | Mean: 20.0 | Online self-administered questionnaire | SDS ⩾ 50 | 247 (24.4) |
| Jiang et al. (2020) | Medical undergraduates of a university in China | 27–29 February 2020 | Cluster sampling | 399 | 162 (40.6) | NR | Online self-administered questionnaire | PHQ-9 ⩾ 5 | 104 (26.1) |
| Lei et al. (2020) | Medical undergraduates and postgraduates of a university in Changsha, China | NR | Convenience sampling | 231 | 109 (47.2) | NR | Online self-administered questionnaire | SDS ⩾ 53 | 143 (61.9) |
| Li and He (2020) | Students of a junior college in Jinhua, China | 30 January–15 February 2020 | Convenience sampling | 1144 | 597 (52.2) | NR | Online self-administered questionnaire | PHQ-9 ⩾ 5 | 240 (21.0) |
| Li et al. (2020b) | Undergraduates of a university in Chengdu, China | February–March 2020 | Cluster sampling | 7747 | 3947 (50.9) | Mean: 20.7 | Online self-administered questionnaire | PHQ-9 ⩾ 5 | 1278 (16.5) |
| Lian et al. (2020) | Undergraduates and postgraduates of a university in Changsha, China | NR | Random sampling | 1437 | 789 (54.9) | NR | Online self-administered questionnaire | Depression subscale of SCL-90-R ⩾ 2 | 177 (12.3) |
| Liang et al. (2020a) | Nursing junior college students and nursing undergraduates of three universities in Hebei, China | February 2020 | Convenience sampling | 852 | 80 (9.4) | NR | Online self-administered questionnaire | Depression subscale of SCL-90-R ⩾ 2 | 15 (1.8) |
| Liang et al. (2020b) | Medical postgraduates of a general hospital in Hangzhou, China | NR | Convenience sampling | 793 | 373 (47.0) | NR | Online self-administered questionnaire | Depression subscale of SCL-90-R ⩾ 2 | 40 (5.0) |
| Lin et al. (2020a) | Undergraduates and postgraduates in China | 10–16 March 2020 | Convenience sampling | 625 | 220 (35.2) | Mean: 20.2 | Online self-administered questionnaire | CES-D ⩾ 16 | 217 (34.7) |
| Lin et al. (2020b) | Students of a medical university in Fuzhou, China | 15–20 April 2020 | Random sampling | 320 | 149 (46.6) | NR | Online self-administered questionnaire | PHQ-9 ⩾ 5 | 183 (57.2) |
| Lin and Xu (2020) | Undergraduates of universities in Fuzhou, China | 26–30 March 2020 | Convenience sampling | 1297 | 565 (43.6) | NR | Online self-administered questionnaire | PHQ-9 ⩾ 5 | 320 (24.7) |
| Study Authors | Study Title | Sample Characteristics | Sample Size | Mean Depression Score | Method of Administration | Cut-off Score for Depression | Effect Size |
|---------------|-------------|------------------------|-------------|-----------------------|---------------------------|-----------------------------|------------|
| Liu et al. (2020a) | Undergraduates of a medical university in Wuhan, China | 23 February–2 April 2020 | Convenience sampling | 217 | 90 (41.5) | Mean: 21.7 | Online self-administered questionnaire | PHQ-9 ≥ 5 | 77 (35.5) |
| Liu et al. (2020a) | Undergraduates of a medical university in Beijing, China | NR | Convenience sampling | 611 | 198 (32.4) | Range: 17–23 | Paper–pencil self-administered questionnaire | SDS ≥ 53 | 101 (16.5) |
| Liu et al. (2020c) | Junior college students, undergraduates and postgraduates in China | 1–5 February 2020 | Convenience sampling | 509 | 176 (34.6) | Mean: 21.3 | Online self-administered questionnaire | SDS ≥ 50 | 70 (13.8) |
| Liu (2020a) | Undergraduates of a university in Taiyuan, China | 20–22 February 2020 | Convenience sampling | 191 | NR | NR | Online self-administered questionnaire | Depression subscale of SCL-90-R ≥ 2 | 14 (7.3) |
| Liu (2020b) | Junior college students and undergraduates in Hangzhou, China | NR | Convenience sampling | 90 | 1 (1.1) | Range: 20–23 | Paper–pencil self-administered questionnaire | SDS ≥ 50 | 29 (32.2) |
| Ma et al. (2020a) | Undergraduates of a university in Taiyuan, China | 10–15 February 2020 | Random cluster sampling | 516 | 271 (52.5) | Mean: 20.8 | Online self-administered questionnaire | Depression subscale of SCL-90-R ≥ 2 | 138 (26.7) |
| Ma et al. (2020b) | Undergraduates and postgraduates of 108 universities in Guangdong and Jiangxi, China | 3–10 February 2020 | Convenience sampling | 746 217 | 331 613 (44.4) | <18: 27 640 (3.7) 18–19: 252 616 (33.9) 20–21: 327 639 (43.9) 22–23: 120 142 (16.1) 24–25: 14 925 (2.0) ≥26: 3255 (0.4) | Online self-administered questionnaire | PHQ-9 ≥ 7 | 157 452 (21.1) |
| Mao et al. (2020) | Medical postgraduates of a general hospital in Harbin, China | 31 March–10 May 2020 | Convenience sampling | 240 | 124 (51.7) | Mean: 24.3 | Online self-administered questionnaire | SDS ≥ 50 | 93 (38.8) |
| Qian (2020) | Students of a medical university in Fuzhou, China | 10 March 2020 | Convenience sampling | 535 | 140 (26.2) | Median: 21.0 | Online self-administered questionnaire | SDS ≥ 50 | 137 (25.6) |
| Ren et al. (2020a) | Undergraduates of a university in Zhongshan, China | NR | Convenience sampling | 244 | 85 (34.8) | NR | Online self-administered questionnaire | Depression subscale of DASS21 ≥ 10 | 78 (32.0) |
| Ren et al. (2020b) | Students of two universities in Inner Mongolia, China | 21–28 February 2020 | Convenience sampling | 4560 | 1227 (26.9) | Mean: 21.1 | Online self-administered questionnaire | SDS ≥ 50 | 3614 (79.3) |
| Ren et al. (2020c) | Nursing junior college students and nursing postgraduates of a general hospital in Shandong, China | 5–12 March 2020 | Convenience sampling | 294 | 64 (21.8) | Mean: 21.6 | Online self-administered questionnaire | SDS ≥ 50 | 78 (26.5) |
| Si et al. (2020) | Undergraduates and postgraduates in seven provinces in China | 23 February–5 March 2020 | Convenience sampling | 3606 | 1014 (28.1) | ≤20: 1467 (40.7) 21–22: 1152 (32.0) ≥23: 987 (27.4) | Online self-administered questionnaire | Depression subscale of DASS21 ≥ 10 | 566 (15.7) |

(Continued)
| Study                   | Subjects and setting                                                                 | Dates of the survey         | Sampling method               | Sample size | Male students, n (%) | Age (years) | Survey method                                      | Assessment of depressive symptoms          | Depressed students, n (%) |
|------------------------|--------------------------------------------------------------------------------------|----------------------------|-------------------------------|-------------|----------------------|-------------|--------------------------------------------------|---------------------------------------------|----------------------------|
| Sun et al. (2020)      | Undergraduates in a university in Hong Kong, China                                   | 6 June 6–14 July 2020      | Convenience sampling          | 255         | 33 (12.9)            | Mean: 21.0  | Online self-administered questionnaire           | CES-D-10 ≥ 10                             | 145 (56.9)                 |
| Tang et al. (2020)     | Undergraduates of six universities in Chengdu and Chongqing, China                   | 20–27 February 2020        | Convenience sampling          | 2485        | 960 (38.6)           | Mean: 19.8  | Online self-administered questionnaire           | PHQ-9 ≥ 10                               | 223 (9.0)                  |
| Wan and Shao (2020)    | Students of three junior colleges in Heilongjiang, China                              | NR                         | Convenience sampling          | 2358        | 1183 (50.2)          | NR          | Online self-administered questionnaire           | PHQ-9 ≥ 5                                | 464 (19.7)                 |
| Wang and He (2020)     | University students in Sichuan, Guizhou and Chongqing, China                         | Late February to middle March, 2020 | Convenience sampling | 1775       | NR (<50)             | NR          | Online self-administered questionnaire           | 'One SD above the mean' on depression subscale of PQUEPH | 308 (17.4)                 |
| Wang and Li (2020)     | Junior college students, undergraduates and postgraduates in Sichuan, Yunnan and Chongqing, China | February 2020              | Convenience sampling          | 3178        | 878 (27.6)           | NR          | Online self-administered questionnaire           | SDS ≥ 50                                 | 888 (27.9)                 |
| Wang et al. (2020b)    | Students of a medical university in Xi’an, China                                     | 13–16 February 2020        | Stratified equal proportion sampling | 430         | 139 (32.3)           | Range: 18–25 | Online self-administered questionnaire           | SDS ≥ 53                                 | 39 (9.1)                   |
| Wang et al. (2020c)    | Postgraduates in China                                                              | 24 February–7 March 2020   | Convenience sampling          | 109         | 38 (34.9)            | 20–25: 69.9 | Online self-administered questionnaire           | SDS ≥ 53                                 | 22 (20.2)                  |
| Wang et al. (2020d)    | Students of a university in Hubei, China                                             | 9–14 March 2020            | Convenience sampling          | 2168        | 952 (43.9)           | Mean: 20.8  | Online self-administered questionnaire           | CES-D ≥ 16                               | 752 (34.7)                 |
| Wang et al. (2020e)    | Junior college students, undergraduates and postgraduates of universities in Wuhan, China | 28 May–3 June 2020         | Convenience sampling          | 3179        | 942 (29.6)           | NR          | Online self-administered questionnaire           | PHQ-9 ≥ 5                                | 1123 (35.3)                |
| Wang et al. (2020f)    | Undergraduates and postgraduates of four universities in Guangzhou, China           | 31 January–5 February 2020 | Cluster sampling              | 44 447      | 20 271 (45.6)        | Mean: 21.0  | Online self-administered questionnaire           | CES-D ≥ 28                               | 5404 (12.2)                |
| Wei (2020)             | Students of a junior college in Guangzhou, China                                     | 13–18 February 2020        | Convenience sampling          | 6289        | NR                   | NR          | Online self-administered questionnaire           | PHQ-9 ≥ 5                                | 1310 (20.8)                |
| Wu et al. (2020)       | Undergraduates of a university in Shanghai, China                                    | March 2020                 | Random sampling               | 807         | 413 (51.2)           | NR          | Paper–pencil self-administered questionnaire     | Depression subscale of SCL-90-R ≥ 2       | 216 (26.8)                 |
| Study                          | Population Description                                      | Sampling Method    | Sample Size | Mean Age | Depression Measure | Questionnaire Description | Notes | % with Depression |
|-------------------------------|---------------------------------------------------------------|--------------------|-------------|----------|-------------------|---------------------------|-------|------------------|
| Xiang et al. (2020)           | Undergraduates and postgraduates in China                    | Convenience sampling | 1396        | 20.7     | SDS > 50          | Online self-administered questionnaire |       | 583 (41.8)       |
| Xiao et al. (2020)            | Undergraduates and postgraduates of two medical universities in Beijing and Wuhan, China | 4-12 February 2020 | 933 (Beijing: 558; Wuhan: 375) | 279 (29.9) | 17-24: 755 (80.9) >25: 178 (19.1) | Online self-administered questionnaire |       | 236 (25.3) Beijing: 131 (23.5) Wuhan: 105 (28.0) |
| Xiao et al. (2020a)           | Undergraduates and postgraduates of two universities in Wuhan, China | 5-9 February 2020 | 3966        | 20.6     | NR               | PHQ-9 > 5                 |       | 1075 (27.1)      |
| Xiao et al. (2020b)           | Undergraduates of provinces other than Hubei in China        | Convenience sampling | 933 (Beijing: 558; Wuhan: 375) | 2705 | 608 (22.5) | NR | PHQ-9 > 5 | 493 (18.2) |
| Xin et al. (2020)             | Undergraduates and postgraduates in China                    | Stratified cluster sampling | 24 378 | 17-24: 755 (80.9) >25: 178 (19.1) | 5361 (14.8) | PHQ-9 > 5 | 279 (29.9) |
| Xie et al. (2020)             | Medical undergraduates of two universities in Hangzhou, China | Convenience sampling | 595         | 29.2     | NR               | PHQ-9 > 5                 |       | 114 (19.2)       |
| Xing et al. (2020)            | Undergraduates and postgraduates of a university in Guangzhou, China | Convenience sampling | 563         | 30.6     | Mean: 21.5 | Online self-administered questionnaire |       | 69 (12.3)        |
| Xiong et al. (2020)           | Undergraduates of a university in Hubei, China               | Cluster sampling   | 6891        | 30.7     | NR               | SDS ≥ 53                  |       | 1874 (27.2)      |
| Xu and Li (2020)              | Medical undergraduates in Putian, China                       | Cluster sampling   | 634         | 14.0     | Mean: 19.3 | Online self-administered questionnaire |       | 146 (23.0)       |
| Yan et al. (2020)             | Undergraduates and postgraduates of Universities in Shaanxi, China | Convenience sampling | 1667        | 48.2     | Mean: 20.6 | Online self-administered questionnaire |       | 257 (15.4)       |
| Yang et al. (2020)            | Students of a military university in China                    | Convenience sampling | 84          | 61.9     | Mean: 19.9 | Online self-administered questionnaire |       | 21 (25.0)        |
| Yao et al. (2020)             | Undergraduates and postgraduates of a university in Zhanjiang, China | Convenience sampling | 393         | 30.8     | Mean: 21.7 | Online self-administered questionnaire |       | 104 (26.5)       |
| Yi et al. (2020)              | Undergraduates of a medical college in Xinxiang, China       | Convenience sampling | 1234        | 37.4     | NR               | PHQ-9 > 5                 |       | 276 (22.4)       |
| Yi et al. (2020a)             | Undergraduates of a university in Guangdong, China           | Convenience sampling | 427         | 23.0     | NR               | Online self-administered questionnaire |       | 129 (30.2)       |
| Study | Subjects and setting | Dates of the survey | Sampling method | Sample size | Male students, n (%) | Age (years) | Survey method | Assessment of depressive symptoms | Depressed students, n (%) |
|-------|----------------------|---------------------|-----------------|-------------|----------------------|------------|---------------|-------------------------------|------------------------|
| Zhan et al. (2020) | Junior college students, undergraduates and postgraduates of four medical universities in Hunan and Fujian, China | 17–19 March 2020 | Convenience sampling | 266 | 76 (28.6) | <18: 16 (6.0) 18–25: 188 (70.7) 26–35: 58 (21.8) >35: 4 (1.5) | Online self-administered questionnaire | Depression subscale of DASS21 ⩾ 10 | 54 (20.3) |
| Zhang et al. (2020b) | Undergraduates of four universities in Guangdong, China | 31 January–4 February 2020 | Convenience sampling | 312 | 67 (21.5) | Mean: 19.6 | Online self-administered questionnaire | PHQ-9 ⩾ 5 | 92 (29.5) |
| Zhang et al. (2020c) | University students in China | 4–7 February 2020 | Convenience sampling | 7833 | 2081 (26.6) | Mean: 19.8 | Online self-administered questionnaire | PHQ-9 ⩾ 5 | 3053 (39.0) |
| Yang et al. (2020), Zhang et al. (2020d) | Medical undergraduates in China | 11–19 February 2020 | Convenience sampling | 6226 | 2484 (39.9) | Range: 18–27 | Online self-administered questionnaire | PHQ-9 ⩾ 5 | 2206 (35.4) |
| Zhang et al. (2020e) | Medical undergraduates of a university in Chenzhou, China | 27–29 February 2020 | Cluster sampling | 932 | 505 (54.2) | NR | Online self-administered questionnaire | PHQ-9 ⩾ 5 | 270 (29.0) |
| Zhang et al. (2020f) | Medical students of two universities in Inner Mongolia, China | February 2020 | Random sampling | 1486 | 453 (30.5) | Mean: 21.7 | Online self-administered questionnaire | PHQ-9 ⩾ 5 | 528 (35.5) |
| Zhang et al. (2020g) | Undergraduates and postgraduates in China | February–April, 2020 | Convenience sampling | 1409 | 733 (52.0) | NR | Online self-administered questionnaire | SDS ⩾ 53 | 160 (11.4) |
| Zhang et al. (2020h) | Students of 57 universities in China | 21–24 February 2020 | Convenience sampling | 2270 | 877 (38.6) | ⩽19: 660 (29.1) 20–30: 1458 (64.2) ⩾30: 152 (6.7) | Online self-administered questionnaire | SDS ⩾ 53 | 237 (10.4) |
| Zhao et al. (2020a) | Undergraduates and postgraduates in China | 23 March–20 April 2020 | Convenience sampling | 281 | 83 (29.5) | Mean: 23.6 | Online self-administered questionnaire | PHQ-9 ⩾ 5 | 170 (60.5) |
| Zhao et al. (2020b) | Chinese undergraduates and postgraduates in South Korea | 23 March–8 April 2020 | Convenience sampling | 171 | 57 (33.3) | Mean: 24.1 | Online self-administered questionnaire | PHQ-9 ⩾ 10 | 49 (28.7) |
| Zhao et al. (2020c) | University students in China | NR | Convenience sampling | 364 | NR | NR | Online self-administered questionnaire | Depression subscale of DASS21 ⩾ 10 | 118 (32.4) |
| Zhao and Hu (2020) | Undergraduates of a medical college in Ganzhou, China | March–April 2020 | Convenience sampling | 456 | 240 (52.6) | Mean: 22.1 | Online self-administered questionnaire | SDS ⩾ 53 | 50 (11.0) |
| Study | Population | Sampling Period | Sampling Method | Sample Size | N | Median | Online | Self-Administered Questionnaire | PHQ-9 ≥ 5 | N |
|-------|-------------|-----------------|----------------|-------------|---|--------|--------|--------------------------------|----------|---|
| Zhou et al. (2020) | Undergraduates and postgraduates in China | 1–15 March 2020 | Convenience sampling | 11,133 | 4,195 (37.7) | Median: 21.0 | Online self-administered questionnaire | 4,119 (37.0) |
| Chen and Zhu (2021) | Undergraduates and postgraduates of a university in Shanghai, China | 12–15 March 2020 | Convenience sampling | 3,353 | 1,651 (49.2) | Mean: 21.8 | Online self-administered questionnaire | 1,693 (50.5) |
| Ni et al. (2021) | Medical postgraduates of a general hospital in Nanjing, China | 4 March 2020 | Convenience sampling | 157 | NR | NR | Online self-administered questionnaire | 76 (48.4) |
| Pan et al. (2021) | Undergraduates and postgraduates in China | 4–9 March 2020 | Convenience sampling | 3,975 | 1,611 (40.5) | Range: 16–30 | Online self-administered questionnaire | 1,568 (39.4) |
| Sun et al. (2021) | Undergraduates and postgraduates in China | 20 March–April 2020 | Convenience sampling | 1,912 | 578 (30.2) | Mean: 20.3 | Online self-administered questionnaire | 890 (46.5) |
| Wang et al. (2021) | Junior college students, undergraduates and postgraduates in Anhui, China | 18–20 February 2020 | Convenience sampling | 840 | 276 (32.9) | Mean: 20.2 | Online self-administered questionnaire | 233 (27.7) |
| Wu et al. (2021) | Undergraduates in 16 provinces and cities in China | 4–12 February 2020 | Random sampling | 11,787 | 5,056 (42.9) | Mean: 20.5 | Online self-administered questionnaire | 3,053 (25.9) |
| Yu et al. (2021) | Undergraduates in China | 3–15 March 2020 | Convenience sampling | 1,681 | 592 (35.2) | NR | Online self-administered questionnaire | 955 (56.8) |

NR, not reported; S.D., standard deviation; PHQ-9, 9-item Patient Health Questionnaire; DASS-21, Depression, Anxiety and Stress Scale – 21 Items; PQEEPH, Psychological Questionnaires for Emergent Events of Public Health; SCL-90-R, Symptom Checklist-90-Revised; CES-D, Center for Epidemiologic Studies Depression Scale; SDS, Zung’s Self-Depression Rating Scale; HADS, Hospital Anxiety and Depression Scale.
Fig. 2. Forest plot of prevalence of depressive symptoms among Chinese university students amid the COVID-19 pandemic.
association between frequent social media exposure and depressive symptoms in the general population (Gao et al., 2020).

Cohort-specific prevalence of depressive symptoms
The higher risk of depressive symptoms in female than in male students during the COVID-19 pandemic is in line with the findings of previous studies with samples of general university students (Li et al., 2018; Gao et al., 2020; Ismail et al., 2020). This phenomenon could be ascribed to the personality traits of females, such as higher levels of neuroticism/negative emotionality and conscientiousness, in comparison to males (Klein et al., 2011; Weisberg et al., 2011). A meta-analysis of studies comparing the psychopathology between only children and children with siblings in China revealed the small mental health advantage experienced by only child university students in comparison to their peers with siblings, i.e. fewer psychiatric symptoms, including depressive symptoms (Falbo and Hooper, 2015). It seems that this phenomenon also exists in university students affected by the COVID-19 pandemic, i.e. significantly lower rate of depressive symptoms in only child students than in students with siblings, with a small magnitude of difference between the two groups (Cohen’s $d = 0.17$) (Table 2). One possible explanation for the higher risk of depressive symptoms in overseas than in domestic students is the status of ethnic minority groups in foreign countries (Li et al., 2014). As migrants, overseas students per se have inadequate social support, and this situation worsens owing to the social distancing requirements during the COVID-19 pandemic, potentially increasing the risk of depressive symptoms (Zhong et al., 2015). Due to the higher levels of academic stress in postgraduates than in undergraduates, it is generally believed that postgraduates are at higher risk for depressive symptoms than undergraduates in China (Wang et al., 2019). Similarly, a significantly higher prevalence

Fig. 3. Forest plot of prevalence of severe depressive symptoms among Chinese university students amid the COVID-19 pandemic.
### Table 2. Results of meta-analyses of prevalence of depressive symptoms among Chinese university students

| Subpopulation by variable | Number of studies | Sample size | Number of depressed students | Heterogeneity, I² (%), (P) | Pooled prevalence (95% CI), % | Proportion transformation approach | Z | P | Cohen’s d* |
|---------------------------|-------------------|-------------|-----------------------------|-----------------------------|-------------------------------|----------------------------------|----|----|------------|
| Overall                   |                   |             |                             |                             |                               |                                  |    |    |            |
| Depressive symptoms       | 84                | 1,292,811   | 235,330                     | 99.9 (<0.001)               | 26.0 (23.3, 28.9)             | Freeman–Tukey double arcsine     |    |    |            |
| Severe depressive symptoms| 47                | 140,423     | 7831                        | 99.4 (<0.001)               | 1.69 (0.87, 2.77)             | Freeman–Tukey double arcsine     |    |    |            |
| Gender                    |                   |             |                             |                             |                               |                                  |    |    |            |
| Male                      | 27                | 352,972     | 70,616                      | 99.8 (<0.001)               | 28.6 (21.4, 38.3)             | Log                              |    |    |            |
| Female                    | 28                | 449,308     | 106,677                     | 99.9 (<0.001)               | 30.8 (24.3, 39.2)             | Log                              | 119.34 | <0.001 | 0.270     |
| Ethnic group              |                   |             |                             |                             |                               |                                  |    |    |            |
| Han                       | 2                 | 3079        | 565                         | 99.4 (<0.001)               | 21.0 (0.64, 41.3)             | Untransformed                    |    |    |            |
| Minorities                | 2                 | 537         | 101                         | 97.9 (<0.001)               | 21.7 (0.00, 46.4)             | Untransformed                    |    |    |            |
| Residence place           |                   |             |                             |                             |                               |                                  |    |    |            |
| Urban                     | 11                | 37,382      | 9796                        | 99.9 (<0.001)               | 27.4 (18.0, 41.8)             | Log                              |    |    |            |
| Rural                     | 11                | 47,872      | 10,487                      | 99.9 (<0.001)               | 26.8 (16.3, 44.2)             | Log                              | 6.41 | <0.001 | 0.044     |
| The only-child in the family |             |             |                             |                             |                               |                                  |    |    |            |
| Yes                       | 4                 | 1931        | 309                         | 98.3 (<0.001)               | 20.7 (9.81, 43.6)             | Log                              |    |    |            |
| No                        | 4                 | 2194        | 419                         | 99.2 (<0.001)               | 24.2 (10.4, 56.5)             | Log                              | 5.53 | <0.001 | 0.171     |
| Subject category          |                   |             |                             |                             |                               |                                  |    |    |            |
| Medical                   | 34                | 33,263      | 10,717                      | 99.5 (<0.001)               | 27.5 (21.0, 34.6)             | Arcsine                          |    |    |            |
| Non-medical               | 20                | 32,329      | 9181                        | 99.7 (<0.001)               | 27.5 (20.6, 36.7)             | Log                              | <0.001 | 0.399 | <0.001     |
| Type of students          |                   |             |                             |                             |                               |                                  |    |    |            |
| Oversea students          | 2                 | 423         | 201                         | 97.9 (<0.001)               | 44.5 (13.5, 75.6)             | Untransformed                    |    |    |            |
| Domestic students         | 82                | 1,292,388   | 235,129                     | 99.9 (<0.001)               | 25.6 (22.9, 28.3)             | Freeman–Tukey double arcsine     | 12.32 | <0.001 | 0.844     |
| Grade                     |                   |             |                             |                             |                               |                                  |    |    |            |
| Undergraduates            | 42                | 1,183,315   | 206,398                     | 99.9 (<0.001)               | 22.9 (19.6, 26.3)             | Freeman–Tukey double arcsine     |    |    |            |
| Postgraduates             | 14                | 20,303      | 4192                        | 99.1 (<0.001)               | 29.3 (21.6, 37.7)             | Arcsine                          | 112.14 | <0.001 | 1.028     |
| Geographic location of current residence |             |             |                             |                             |                               |                                  |    |    |            |
| Hubei                     | 9                 | 14,849      | 3977                        | 95.0 (<0.001)               | 27.5 (22.8, 32.2)             | Untransformed                    |    |    |            |
| Non-Hubei                 | 22                | 768,375     | 162,354                     | 99.5 (<0.001)               | 22.3 (17.6, 27.9)             | Logit                            | 130.35 | <0.001 | 1.033     |
| Location of the university |                   |             |                             |                             |                               |                                  |    |    |            |
| Hubei                     | 8                 | 23,290      | 6455                        | 99.3 (<0.001)               | 26.2 (19.5, 33.6)             | Freeman–Tukey double arcsine     | 66.74 | <0.001 | 0.543     |
| Non-Hubei                 | 59                | 1,190,866   | 207,920                     | 99.9 (<0.001)               | 23.1 (19.4, 27.2)             | Logit                            |    |    |            |
of depressive symptoms in postgraduates than in undergraduates was observed in our study. According to our experiences with some university students from the crisis hotline services during the outbreak period, the negative impact of the COVID-19 pandemic on academic achievement is greater in postgraduates than in undergraduates since undergraduates are able to continue their studies through online courses, but many postgraduates rely on university campus labs to continue their research. Because of the closure of campuses, postgraduates are more likely to be depressed.

Due to Hubei residents’ higher risk of infection and province-wide stringent mass quarantine measures, an elevated risk of depressive symptoms in students living in the epicentre relative to that in students living outside the epicentre is expected. Despite having left Hubei before the Spring Festival, students from universities in Hubei had been compulsorily isolated for medical observation in their hometowns and experienced a high level of discrimination and social exclusion due to their potential to spread the COVID-19 virus at the initial stage of the outbreak (He et al., 2020). Therefore, it is reasonable to find significantly higher rates of depressive symptoms in students from universities at the epicentre than in those from universities of provinces other than Hubei in our study.

Studies have reported the significant association of depressive symptoms with having relatives or acquaintances infected with COVID-19 in general populations of both China and Italy during the COVID-19 pandemic (Mazza et al., 2020; Zhong et al., 2020). Consistent with these findings, the rate of depressive symptoms was significantly higher in university students with COVID-19-infected acquaintances or relatives, which may be attributed to these students’ high levels of concern about the health of the infected persons. Previous studies have found a greater level of fear of COVID-19 infection in persons who were suspected of having COVID-19, which was in turn associated with a higher risk of depressive symptoms (Koçak et al., 2021; Tsang et al., 2021). For a similar reason, university students with a history of COVID-19 contact exhibited a significantly higher prevalence of depressive symptoms.

Findings from subgroup analysis

Subgroup analysis revealed a higher prevalence of depressive symptoms in studies with samples with fewer men, which is consistent with the female predominance phenomenon of depression (Albert, 2015). However, what is counterintuitive is the higher risk of depressive symptoms in studies conducted late in the COVID-19 outbreak than that in studies conducted early in the COVID-19 outbreak in the subgroup analysis because the daily number of newly confirmed COVID-19 cases in China peaked during the early stage, and the outbreak was under control during the late stage. Similarly, a two-wave longitudinal study in China found increased severity of depressive symptoms in a cohort of the general population four weeks after the epidemic’s peak relative to the initial COVID-19 outbreak (Wang et al., 2020a). We speculate that during the early stage, people may have been shocked by the sudden outbreak, and they focused on safety and physical health. After the outbreak, the negative impacts of the pandemic, including economic loss and unemployment, gradually increased with time, leading people to feel depressed. Because of the problematic methodology of poorly designed studies, i.e. mental health surveys adopting convenience sampling are likely to recruit students having potential needs for mental health.
services, a statistically higher prevalence of depressive symptoms in studies with a high level of RoB was found in this study.

Limitations
This study has some limitations. First, none of the included studies were rated as completely low RoB. Subgroup analysis according to RoB level found a significantly higher prevalence of depressive symptoms in studies with a high level of RoB, so it is possible that the reported overall pooled estimate overestimates the true prevalence. Second, because several included studies used strict criteria to define the presence of depressive symptoms (i.e. PHQ-9 ≥ 10), we may have underestimated the prevalence of depressive symptoms. Given the above two limitations, it is difficult to assess the magnitude and direction of bias in the prevalence estimate. Cautions are needed when generalising our findings. Third, even after stratifying the studies, high levels of heterogeneity were still kept within each strata of study in the subgroup analysis, so there remained other factors associated with the risk of depressive symptoms that were not identified. The heterogeneity of the results suggests that further rigorously designed studies using widely accepted assessments of depressive symptoms and representative samples of Chinese university students amid the COVID-19 pandemic are warranted to arrive at accurate estimates. Fourth, because of the small number of studies during the postoutbreak period, longitudinal data are needed to examine the trajectory of depressive symptoms in Chinese university students in the postpandemic era. Fifth, since the sample size of overseas students was relatively small (n = 423), the sample representativeness of overseas students may be limited in our study. Finally, patterns of utilisation of mental health services among depressed students are very important for mental health planning and policy-making in the context of the COVID-19 pandemic, but the included studies provided little information on service use.

Implications and conclusions
In this study, over one out of every four Chinese university students had depressive symptoms, which suggests a high level of mental healthcare need in this population amid the COVID-19 pandemic. Depression takes a high toll on individuals, families and societies, and, in particular, it is a major risk factor for attempted and completed suicide. Given the high prevalence of depressive symptoms, mental health services for this population amid the pandemic should include periodic evaluation of depressive symptoms to ensure early identification of students with severe depressive symptoms or high risk of suicide and psychiatric assessment and treatment when necessary. The higher prevalence rates of depressive symptoms revealed in several cohorts of Chinese university students (i.e. postgraduates, students living in the epicentre and COVID-19 contacts) indicate that cohort-specific prevention programmes, which are probably cost-effective, need to be designed.

China is a mental health services resource-poor country, so university managers and staff, including campus psychological counselors, should have a critical role in depression prevention; for example, they could provide expanded social support to students at risk, engage in follow-up care, mental health education and periodic screening of depressed students and promote social services.
connectedness between students. Although the pandemic increases physical distances between staff and students, support services can be easily provided to students via smartphones.

In addition, the 28.9% prevalence of depressive symptoms during the postoutbreak era in this study (Table 3) and some small new COVID-19 outbreaks in recent months in China suggest the necessity of continuous mental health monitoring and services for Chinese university students during the postoutbreak era. Further rigorous research is also needed to understand the longitudinal changes in depressive symptoms of Chinese university students during the postoutbreak era.

**Supplementary material.** The supplementary material for this article can be found at https://doi.org/10.1017/S2045796021000202

**Data.** All the data involved have been included in Tables and Figures of this paper, including supplementary files.

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### Table 3. Subgroup analysis of the source of heterogeneity of included studies

| Study characteristics | Number of studies | Sample size | Number of depressed students | Heterogeneity, I² (%) (P) | Pooled prevalence (95% CI), % | Q (P) |
|-----------------------|-------------------|-------------|------------------------------|--------------------------|--------------------------------|-------|
| **Survey period**     |                   |             |                              |                          |                                |       |
| Early stage of COVID-19 outbreak | 32 | 1 214 858 | 211 065 | 99.9 (<0.001) | 21.8 (18.3, 25.5) | Reference |
| Late stage of COVID-19 outbreak | 34 | 50 290 | 18 286 | 99.6 (<0.001) | 31.0 (24.5, 38.0) | 5.93 0.015 |
| Post-COVID-19 era     | 6     | 12 881 | 341  | 99.6 (<0.001) | 28.9 (15.7, 44.2) | 0.95 0.329 |
| Not reported          | 12    | 14 782 | 2568  | 98.2 (<0.001) | 22.3 (17.2, 27.8) | 0.03 0.869 |
| **Percentage of males among the survey sample** |                   |             |                              |                          |                                |       |
| >50%                  | 14    | 22 866 | 4321  | 98.8 (<0.001) | 20.6 (15.7, 26.0) | Reference |
| <50%                  | 65    | 1 262 658 | 229 437 | 99.9 (<0.001) | 27.3 (24.2, 30.5) | 4.53 0.033 |
| Not reported          | 5     | 7287 | 1572  | 96.3 (<0.001) | 24.1 (15.5, 34.0) | 0.45 0.500 |
| **Mean/median age (years)** |                   |             |                              |                          |                                |       |
| >20.8                 | 19    | 70 547 | 16 696 | 99.9 (<0.001) | 31.4 (20.2, 43.8) | Reference |
| ≤20.8                 | 21    | 83 904 | 19 037 | 99.5 (<0.001) | 25.7 (21.4, 30.2) | 0.81 0.367 |
| Not reported          | 44    | 1 138 360 | 199 597 | 99.9 (<0.001) | 23.9 (20.5, 27.5) | 1.49 0.222 |
| **Survey method**     |                   |             |                              |                          |                                |       |
| Online self-administered | 77  | 1 289 363 | 234 634 | 99.9 (<0.001) | 26.3 (23.5, 29.1) | Reference |
| Paper–pencil self-administered | 7  | 3448 | 696  | 95.6 (<0.001) | 22.3 (15.7, 29.5) | 1.05 0.306 |
| **Sampling method**   |                   |             |                              |                          |                                |       |
| Convenience sampling  | 61    | 1 170 724 | 213 585 | 99.9 (<0.001) | 27.1 (23.7, 30.7) | Reference |
| Probability sampling  | 23    | 122 087 | 21 745 | 99.4 (<0.001) | 23.0 (19.7, 26.4) | 2.87 0.090 |
| **Assessment**        |                   |             |                              |                          |                                |       |
| Depression subscale of SCL-90-R | 8  | 9378 | 1215  | 98.4 (<0.001) | 11.5 (6.6, 17.5) | Reference |
| PHQ-9                 | 37    | 1 189 597 | 212 581 | 99.9 (<0.001) | 27.3 (23.5, 31.2) | 17.39 <0.001 |
| CES-D                 | 7     | 56 504 | 10 734 | 99.9 (<0.001) | 40.0 (22.4, 58.9) | 10.07 0.002 |
| Depression subscale of PQEEPH | 2  | 3442 | 565  | 57.3 (0.130) | 16.4 (14.5, 18.3) | 2.42 0.120 |
| Depression subscale of DASS-21 | 7  | 7055 | 1119  | 98.9 (<0.001) | 21.1 (11.7, 32.5) | 2.81 0.094 |
| SDS                   | 22    | 26 201 | 8970  | 99.7 (<0.001) | 28.4 (19.0, 38.9) | 9.25 0.002 |
| Depression subscale of HADS | 1  | 634  | 146   | Not applicable | 23.0 (19.8, 26.4) | 10.45 0.001 |
| **Cut-off score of PHQ-9** |           |             |                              |                          |                                |       |
| >10                   | 5     | 352 561 | 29 275 | 99.4 (<0.001) | 15.5 (10.3, 21.5) | Reference |
| ≥5                    | 32    | 837 036 | 183 306 | 99.8 (<0.001) | 29.2 (26.4, 32.1) | 15.33 <0.001 |
| **RoB score**         |                   |             |                              |                          |                                |       |
| 7–8 (low)             | 11    | 95 842 | 15 507 | 99.5 (<0.001) | 20.6 (16.4, 25.0) | Reference |
| 4–6 (moderate)        | 42    | 1 156 633 | 208 692 | 99.9 (<0.001) | 25.7 (21.7, 29.9) | 2.88 0.090 |
| 0–3 (high)            | 31    | 40 336 | 11 131 | 98.8 (<0.001) | 28.4 (24.3, 32.7) | 6.49 0.011 |

**PHQ-9, 9-item Patient Health Questionnaire; DASS-21, Depression, Anxiety and Stress Scale – 21 Items; PQEEPH, Psychological Questionnaires for Emergent Events of Public Health; SCL-90-R, Symptom Checklist-90-Revised; CES-D, Center for Epidemiologic Studies Depression Scale; SDS, Zung’s Self-Depression Rating Scale; HADS, Hospital Anxiety and Depression Scale.**
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