

# Prevalence and associated factors of depression and anxiety symptoms among college students: a systematic review and meta-analysis

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**Background:** To evaluate the global prevalence of depression and anxiety symptoms among college students and potential associated factors. **Methods:** PubMed and Web of Science were searched from their inception to March 28, 2021. Random-effects models were used to calculate the pooled prevalence of depression and anxiety. Subgroup analyses were conducted to explore potential heterogeneity. Egger's and Begg's test were used to assess publication bias. **Results:** A total of 64 studies with 100,187 individuals were included in the present meta-analysis. The pooled prevalence of depression and anxiety symptoms among college students was 33.6% (95% confidence interval [CI] 29.3%–37.8%) and 39.0% (95% CI, 34.6%–43.4%), respectively. The highest prevalence of depression symptoms was found in Africa region (40.1%, 95% CI 12.3–67.9%), lower middle-income countries (42.5%, 95% CI 28.6–56.3%), and medical college students (39.4%, 95% CI 29.3–49.6%). For the prevalence of anxiety symptoms, the highest was observed in North America (48.3%, 95% CI 37.4–59.2%), lower middle-income countries (54.2%, 95% CI 35.0–73.4%), medical college students (47.1%, 95% CI 35.1–59.1%) and identified by Beck Anxiety Inventory (BAI) (49.1%, 95% CI 31.0–43.0%). Besides, the prevalence of depression symptoms (35.9%, 95% CI 20.2–51.7%) and anxiety symptoms (40.7%, 95% CI 39.5–42.0%) was higher in studies conducted after the coronavirus disease 2019 (COVID-19) outbreak. **Conclusions:** Our study suggests that a lot of college students experience depression and anxiety symptoms and clarifies factors that are related to these mental disorders. Effective prevention and intervention strategies for mental disorders should be developed among college students. **Keywords:** Depression; anxiety; global prevalence; college students; risk factors.

## Introduction

Mental disorders account for a large proportion of the disease burden in young people globally (Nwachukwu et al., 2021). Most mental disorders begin during adolescence/youth (12–24 years of age), and three-quarters of all lifetime mental disorders emerge before the age of 25 (Tabor, Patalay, & Bann, 2021). The 2019 Annual Report summarizes the data contributed to Center for Collegiate Mental Health with 163 college and university counselling centres during the 2018–2019 academic year, indicating 207,818 unique college students seeking mental health treatment, 4,059 clinicians, and 1,580,951 appointments (Center for Collegiate Mental Health, 2020). And literatures indicated that depression and anxiety symptoms were the most common mental disorders among college students (Liu, Stevens, Wong, Yasui, & Chen, 2019). Meanwhile, the high prevalence of anxiety and depression symptoms are the main causes of years lost due to disability (YLDs) and disability-adjusted life years (DALYs) for young adults (Mokdad et al., 2016), which have several adverse impacts on themselves and their family. Therefore, the mental health of college students should be paid more attention.

At present, an increasing number of studies focus on mental disorder among college students, and the prevalence of depression and anxiety symptoms across studies varied greatly. For instance, it is reported that the prevalence of depression symptoms was 28.90% in China, 7.9% in Australia, and 33.0% in the USA, and the prevalence of anxiety symptoms was 40.0% in the USA, 10.67% in Pakistan among medical students, and 62.93% in Brazil among nursing students. There is no doubt that mental disorders among college students are widespread and common; however, it still lacked a global representative prevalence of depression symptoms as well as anxiety symptoms among college students to help us better understand anxiety and depression conditions among college students. Besides, previous studies revealed that its high prevalence was associated with many factors, such as poor social support, unplanned pregnancy, smoking, alcohol use, academic stress, sleep quality, unemployed status, and financial problems (Ghrouz et al., 2019; Ramón-Arhués et al., 2020; Simić-Vukomanović et al., 2016). To explore, the associated factors could help us to eliminate the anxiety and depression symptoms among college students, as most of these associated factors are modifiable. In addition, associated factors could also be used to better identify college students at higher risk for depression and

Conflict of interest statement: No conflicts declared.

anxiety symptoms even when those factors are not modifiable. However, the results of the association between associated factors and depression/anxiety in different studies are inconsistent, and there are few quantitative reviews to clarify the strength of these associations.

To provide a global prevalence estimate of depression/anxiety symptoms among college students and to clarify the association between associated factors and depression/anxiety symptoms, we performed the systematic review and meta-analysis, and random-effects models were conducted to estimate the prevalence and explore the associated factors. The results could provide references for identifying the level of disease burden and developing measures for managing mental disorders among college students.

## Methods

### Search strategy

We conducted literature searches in PubMed and Web of Science databases from their inception to March 28, 2021 for pertinent studies that reported on depression and anxiety symptoms among college students. In the present study, depression and anxiety included both depressive and anxiety symptoms detected by self-reported screening instruments. We first searched the prevalence of depression and anxiety symptoms, and then factors associated with depression and anxiety symptoms were searched. The search terms were 'depression' or 'depressive disorder' or 'depressive symptom' or 'anxiety' or 'anxiety disorder' or 'mental disorder' or 'mental health' or 'mental illness' or 'mental distress' or 'psychiatry' or 'psychological' or 'dysthymia' or 'dysthymic disorder' or 'affective disorder' and 'college students' or 'university students' or 'undergraduate' or 'young adults'. In addition, the reference list of retrieved articles was also reviewed for identifying additional studies. Only articles published in English were included. The literature search was conducted in accordance with PRISMA.

### Inclusion and exclusion criteria

For the prevalence search, the following criteria were included: (a) the study design was cross-sectional or longitudinal or cohort; (b) the study population was college students; (c) depression/anxiety symptoms was assessed using a validated self-report screening instrument; (d) prevalence of depression/anxiety symptoms was reported or data that could estimate the prevalence of them were provided. Studies were excluded if they: (a) were animal studies, reviews, essays, conference abstracts, letters, and commentaries; (b) lacked information of the prevalence of anxiety symptoms or depression symptoms. For studies with duplicate data from a single database, we selected the study with the most complete information on results or the largest sample size.

For the search of factors associated with depression/anxiety symptoms, we included studies if they: (a) explored associated factors related to depression/anxiety symptoms, such as sociodemographic, study status, and psychiatric variables; (b) reported effect estimates with 95% confidence intervals (CI) of the associations between factors and depression/anxiety symptoms. Studies were excluded if they: (a) lacked any information that prevented the calculation of effect estimates and corresponding 95% CI; (b) were animal studies, reviews, letters, or commentaries.

### Data extraction

Relevant data from eligible studies, including name of first author, year of publication, study design, study location, sample size, gender, measure of depression/anxiety, cut-off points, and prevalence rates. Besides, associated factors and their corresponding effect estimates and 95% CI were extracted for included studies on associated factors of depression/anxiety symptoms. Two investigators (ZYZ and DJC) independently performed the literature search, selected eligible studies, and extracted data; any disagreements were resolved by discussion with the third author (WZL).

### Quality assessment

An 11-point scoring system recommended by the Agency for Healthcare Research and Quality (Rostom et al., 2004) was applied for evaluating cross-sectional studies. The checklist assesses the quality of included studies by evaluating their source of information, ascertainment of subjects, methods for quality assurance, as well as the data reporting and processing. Each item has three choices: 'yes', 'no' and 'unclear'. Study quality was evaluated according to the established scoring system: 1 point if the item was considered in the study and 0 point if the item was not considered or we were unable to determine if it had been considered. The score range of this checklist is 0–11. We assigned scores of 0–3, 4–7, and 8–11 for low, moderate, and high quality of studies, respectively. The quality of cohort/longitudinal studies were evaluated using the Newcastle-Ottawa Scale (NOS) (Wells et al., 2009). The score range of this scale is 0–9 and scores of 0–3, 4–6, and 7–9 were considered for low, moderate, and high quality of studies, respectively. Two reviewers (WZL and ZYZ) independently performed the quality assessment.

### Data analysis

Firstly, we assessed the prevalence of depression and anxiety symptoms among college students. They were calculated in meta-analysis using the random-effects models considering a wide range of characteristics of the included studies. If studies reported results separately by gender or country, these outcomes were considered as independent report in the primary and subgroup analyses. When there was more than one cut-off, the lower one was selected. To identify the factors associated with depression or anxiety symptoms against college students, pooled odds ratios (ORs) for influencing factors were calculated with a random-effects model.

Subgroup analyses were conducted by splitting all the participant data into subgroups to explore potential heterogeneity across studies, and the differences among subgroups were tested by meta-regression analysis. Subgroup analyses were performed according to study location, assessment instrument, country income groups (the World Bank Classification), study period and sample size. Publication bias was assessed using funnel plot with the Egger's linear regression test and Begg's rank correlation test, and the non-parametric trim-and-fill method which estimates the number and outcomes of potentially missing studies resulting from publication bias (Egger, Davey Smith, Schneider, & Minder, 1997). We also performed sensitivity analyses to evaluate the effect of each study on the overall estimate by sequentially omitting one study in turn.

Secondly, we explored the associated factors of anxiety and depression symptoms among college students. A variable was considered as an associated factor related to depression or anxiety symptoms if at least two studies provided its OR and 95% CI, and a pooled effect size separately for each factor using random-effects meta-analysis. If the reference group was not consistent, it was transferred using SAS macro RREst by

deriving relative effect and precision estimates for alternative comparisons from a set of estimates presented by exposure level or disease category, or will be excluded. For multi-categorical variables, we calculate the pooled ORs compared with the reference group. Statistical heterogeneity across studies was estimated with the  $I^2$  statistic, which indicates the proportion of total variance attributable to between-study variation. Values of 25%, 50%, and 75% represented cut-off points for low, moderate, and high degrees of heterogeneity, respectively. All statistical analyses were conducted with Stata version 12.0 (College Station, TX, USA). All tests ( $p$  values) were two-tailed, with a significance level of .05.

## Results

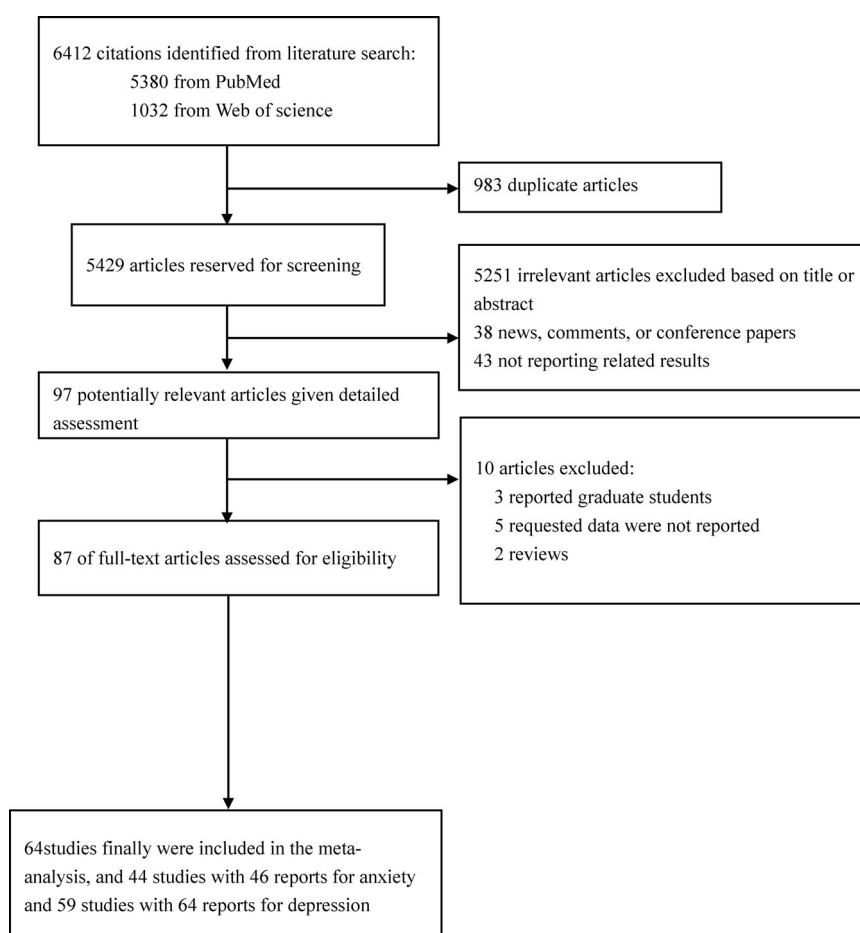
### Basic characteristics

The Figure 1 shows the process of literature identification and initial literature search retrieved 6,412 citations. After removing duplicates and reviewing the titles and abstracts, we identified 97 potentially relevant articles. After reading the full text of articles that may be relevant, 10 were excluded based on the inclusion criteria. Finally, 64 studies were included in the present meta-analysis and 40 of these studies reported both depression and anxiety symptoms, and 16 studies for associated factors of anxiety symptoms and 25 studies for depression symptoms. Quality score was shown in Table S1 and detailed

information of included studies was presented in Tables S2 and S3. The quality assessment scores of all the studies ranged from 3 to 8, with an average score of 4.98. For depression symptoms, studies were conducted in 27 countries spanning six continents, with China contributing the most studies ( $n = 22$ ), followed by United States ( $n = 11$ ), India ( $n = 3$ ), and Pakistan ( $n = 3$ ). Sample size ranged from 141 to 23,863, with a total sample of 100,187, and studies published between 2004 and 2021. For anxiety symptoms, studies were conducted in 19 countries spanning five continents, with China contributing the most studies ( $n = 15$ ), followed by United States ( $n = 10$ ), Pakistan ( $n = 5$ ), and India ( $n = 2$ ). Sample size ranged from 29 to 89,588, with a total sample of 136,402, and studies published between 2004 and 2021.

### The prevalence of anxiety and depression symptoms among college students

In the present meta-analysis, 44 studies with 46 reports showed the prevalence of anxiety symptoms among college students was 39.0% (34.6%–43.4%),  $I^2 = 99.5\%$ ,  $p < .001$  and 59 studies with 64 reports showed that the prevalence of depression symptoms was 33.6% (29.3%–37.8%),  $I^2 = 99.6\%$ ,  $p < .001$ .



**Figure 1** Flow chart for the selection of eligible studies

**Table 1** Subgroup analyses of the prevalence of depression symptoms among college students based on random-effect analysis

	No. of reports	Prevalence (%)	95% CI	$I^2$ (%)	$p$ value for heterogeneity	$p$ value between groups
Study location						
Africa Region	5	40.1	12.3–67.9	99.8	.001	.879
Europe Region	7	24.1	16.5–31.6	98.1	<.001	
North America	14	35.5	27.0–44.1	99.1	<.001	
Australasia	1	7.9	5.8–10.0	–	<.001	
Asia	36	34.8	29.0–40.5	99.7	<.001	
Latin America	1	23.8	21.3–26.3	–	<.001	
Country income group						
High	27	32.3	25.4–39.2	99.4	<.001	.223
Upper to middle	25	30.8	24.2–37.5	99.6	<.001	
Lower to middle	11	42.5	28.6–56.3	99.7	<.001	
Low	1	40.2	35.1–45.3	–	<.001	
Period						
Before Covid-19	59	33.4	28.9–37.9	99.6	<.001	.778
After Covid-19	5	35.9	20.2–51.7	99.8	<.001	
Specialized field						
Medical students	10	39.4	29.3–49.6	98.7	<.001	.295
Non-medical students	54	32.5	28.0–37.0	99.6	<.001	
Assessment instrument						
CES-D	13	38.3	29.7–46.8	99.5	<.001	.774
PHQ-9	10	29.1	18.0–40.1	99.8	<.001	
DASS-21	11	37.9	22.1–53.7	99.6	<.001	
BDI	13	25.0	20.3–29.7	98.7	<.001	
HADS	3	21.9	12.6–31.3	96.5	<.001	
SDS	6	35.8	18.4–53.2	99.7	<.001	
DASS-42	2	48.9	46.6–51.2	4.2	<.001	
Other	6	38.8	16.3–61.3	99.7	.001	
Sample size						
<1,000	38	36.1	28.9–43.3	99.3	<.001	.211
≥1,000	26	30.0	23.9–36.0	99.8	<.001	

CES-D, Centre for Epidemiologic Studies; BDI, Beck Depressive inventory; DASS, Depression Anxiety Stress Scale; HADS, Hospital Anxiety and Depression Scale; PHQ-9: Patient Health Questionnaire; SDS, Self-Rating Depression Scale.

Results of subgroup analyses are summarized in Tables 1 and 2. The prevalence of depression and anxiety symptoms among college students differed significantly according to study location, country income groups, specialized field, sample size, and the assessment instrument. In terms of study location, the prevalence of depression symptoms was the highest in Africa Region (40.1%, 95% CI 12.3–67.9%), lower middle-income countries (42.5%, 95% CI 28.6–56.3%), and among medical college students (39.4%, 95% CI 29.3–49.6%). Of the different self-report instruments, the prevalence identified by DASS-42 was the highest (48.9%, 95% CI 46.6–51.2%). For the prevalence of anxiety symptoms, the highest was observed in North America (48.3%, 95% CI 37.4–59.2%), lower middle-income countries (54.2%, 95% CI 35.0–73.4%), medical college students (47.1%, 95% CI 35.1–59.1%), and identified by Beck Anxiety Inventory (BAI) (49.1%, 95% CI 31.0–43.0%). Besides, the prevalence of depression symptoms (35.9%, 95% CI 20.2–51.7%) and anxiety symptoms (40.7%, 95% CI 39.5–42.0%) was higher in studies conducted after COVID-19 outbreak.

The results of sensitivity analysis showed that no study could probably affect the summary of risk estimates in this study (Figure S1). The pooled

estimated prevalence of depression and anxiety symptoms did not significantly substantive change after deletion of a single study. Regarding publication bias, visual inspection of the funnel plot showed some asymmetry (Figure S2), and Begg's and the Egger's test suggested evidence of publication bias (Begg,  $p = .014$ , Egger,  $p = .007$  for depression; Begg,  $p = .012$ , Egger,  $p = .646$  for anxiety). The corrected OR using the trim-and-fill method was 36.9% (95% CI 32.3–41.5%; random-effects model,  $p < .001$ ) for anxiety and 21.6% (95% CI 17.0–26.1%; random-effects model,  $p < .001$ ) (Figure S3).

### Factors associated with anxiety and depression symptoms among college students

Factors associated with depression and anxiety symptoms were presented in Tables 3 and 4, and included studies for each factor were summarized in Tables S4 and S5. Female college students were more likely to have depression symptoms (pooled OR: 1.47, 95%CI: 1.29–1.67) and anxiety symptoms (pooled OR: 1.50, 95%CI: 1.13–1.98). Academic stress (pooled OR: 2.33, 95%CI: 1.99–2.71), smoking (pooled OR: 1.87, 95%CI: 1.44–2.44), traumatic experiences (pooled OR: 4.59, 95%CI: 3.01–7.30),

**Table 2** Subgroup analyses of the prevalence of anxiety symptoms among college students based on random-effect analysis

	No. of reports	Prevalence (%)	95% CI	$I^2$ (%)	$p$ value for heterogeneity	$p$ value between groups
Study location						
Africa Region	2	30.0	11.6–48.5	97.7	.001	.665
Europe Region	5	35.9	26.0–45.8	98.3	<.001	
North America	12	48.3	37.4–59.2	99.0	<.001	
Australasia	1	17.5	14.5–20.5	–	<.001	
Asia	26	37.0	30.9–43.1	99.7	<.001	
Country income group						
High	20	42.1	33.4–44.4	98.9	<.001	.672
Upper to middle	18	29.8	23.3–36.3	99.7	<.001	
Lower to middle	7	54.2	35.0–73.4	99.4	<.001	
Low	1	39.6	34.5–44.7	–	<.001	
Period						
Before Covid-19	41	38.9	33.0–43.8	99.4	<.001	.867
After Covid-19	5	40.7	39.5–42.0	45.3	<.001	
Specialized field						
Medical students	10	47.1	35.1–59.1	99.0	<.001	.163
Non-medical students	36	36.8	31.8–41.8	99.6	<.001	
Assessment instrument						
BAI	3	49.1	31.0–43.0	98.0	<.001	.895
GAD-7	11	33.5	26.3–40.7	99.2	<.001	
DASS-21	12	47.7	34.4–61.0	99.4	<.001	
HADS	3	42.4	23.1–61.7	98.9	<.001	
SAS	10	23.3	18.2–28.4	99.2	<.001	
Other	7	49.0	35.0–63.0	99.0	<.001	
Sample size						
<1,000	26	45.9	36.0–55.9	99.2	<.001	.009
≥1,000	20	30.4	24.6–36.1	99.7	<.001	

BAI, Beck Anxiety Inventory; DASS, Depression Anxiety Stress Scale; GAD, General Anxiety Disorder Scale; SAS, Self-Rating Anxiety Scale.

**Table 3** Meta-analyses of factors associated with depression symptoms based on random-effect analysis

Factors	No. of studies	Min OR	Max OR	Pooled OR with 95%CI	$I^2$ (%)	$p$ value for heterogeneity
Regular exercise (no vs. yes)	2	1.74	12.14	4.43 (0.66–29.70)	92.5	<.001
Gender (female vs. male)	9	0.86	2.21	1.47 (1.29–1.67)	51.5	.036
Academic stress (yes vs. no/less)	7	0.41	2.98	2.33 (1.99–2.71)	0.0	.484
Current smoking (yes vs. no)	5	1.40	3.67	1.87 (1.44–2.44)	72.0	.006
Parent relationships (disharmony vs. harmony)	2	1.41	10.31	3.02 (0.45–20.06)	76.3	.040
Social support (yes vs. no/weak)	3	0.18	0.94	0.83 (0.67–1.03)	76.2	.006
Traumatic experiences (yes vs. no)	4	1.67	10.31	4.59 (3.01–7.30)	80.9	<.001
Frequent alcohol use (yes vs. no)	4	1.58	3.86	2.53 (1.99–3.20)	0.0	.525
Year of study (reference = year 1)	5	0.35	2.90	0.94 (0.79–1.12)	52.5	.003
Physical activity (reference = low)	3	0.16	0.74	0.38 (0.20–0.75)	93.3	<.001
Sleep quality (PSQI/reference = good)	6	1.39	13.02	2.52 (1.82–3.50)	88.9	<.001
Family economic situation (poor vs. good)	3	1.34	2.09	1.60 (1.20–2.14)	54.3	.110
Self-confidence (reference = yes)	3	3.84	26.30	9.43 (3.28–27.15)	77.4	.004

frequent alcohol use (pooled OR: 2.53, 95%CI: 1.99–3.20), poor sleep quality (pooled OR: 2.52, 95%CI: 1.82–3.50), poor family economic situation (pooled OR: 1.60, 95%CI: 1.20–2.14) and no self-confidence (pooled OR: 9.43, 95%CI: 3.28–27.15) were related with depression. Additionally, poor sleep quality (pooled OR: 1.76, 95%CI: 1.41–2.19), irregular eating habits (pooled OR: 1.77, 95%CI: 1.01–3.14), internet addiction (pooled OR: 2.77, 95%CI: 2.42–

3.17), drinking (pooled OR: 2.37, 95%CI: 1.88–2.98), low self-esteem (pooled OR: 2.25, 95%CI: 1.53–3.30) and academic difficulty (pooled OR: 1.94, 95%CI: 1.06–3.53) were associated with anxiety.

## Discussion

The present meta-analysis showed that the prevalence of depression and anxiety symptoms among



**Table 4** Meta-analyses of factors associated with anxiety symptoms based on random-effect analysis

Factors	No. of studies	Min OR	Max OR	Pooled OR with 95%CI	I <sup>2</sup> (%)	p value for heterogeneity
Gender (reference = male)	5	1.01	2.49	1.50 (1.13–1.98)	92.7	<.001
Physical activity level (reference = low)	3	0.16	0.76	0.42 (0.15–1.21)	94.9	<.001
Sleep quality (PSQI/reference = good)	4	1.39	2.15	1.76 (1.41–2.19)	85.6	<.001
Interpersonal relationship (reference = Harmonious)	2	1.14	2.57	1.53 (0.71–3.30)	72.4	.057
Eating habits (reference = Regular)	2	1.38	2.49	1.77 (1.01–3.14)	77.9	.034
Internet addiction (no)	2	2.71	2.86	2.77 (2.42–3.17)	0.0	.706
Drinking (reference = No/occasional)	2	2.26	2.59	2.37 (1.88–2.98)	0.0	.585
Smoking (reference = no)	2	0.52	2.15	1.07 (0.27–43.29)	94.6	<.001
Self-esteem/Self-efficacy (reference = Normal/high)	2	2.04	2.6	2.25 (1.53–3.30)	0.0	.544
Year of study (reference = year 1)	4	0.22	1.61	1.04 (0.95–1.14)	80.5	<.001
Academic difficulty	2	1.49	2.77	1.94 (1.06–3.53)	674	.080

college students was 33.6% and 39.0%, respectively. As we all know, depression and anxiety syndrome are often under detected or neglected, and college students could not help to avoid severe mental illness, which may lead to undesirable even serious consequences (Gorczyca, Filip, & Walczak, 2013). Therefore, mental disorder among college students should be paid more attention. In addition, our study verified that eight factors were associated with depression symptoms, including female, academic stress, current smoking, traumatic experience, frequent alcohol use, poor sleep quality, poor family economic situation, and no self-confidence; and seven factors were associated with anxiety symptoms, including female, poor sleep quality, irregular eating habit, internet addiction, drinking, low self-esteem/self-efficacy, and academic difficulty. These above-mentioned associated factors should be considered for the government and college when developing strategies to prevent and intervene in depression and anxiety symptoms among college students.

Some previous studies have assessed the mental health for college students. However, Wang et al. assessed the prevalence of anxiety and depression symptoms among college students only during the COVID-19 pandemic (Wang et al., 2021), Rotenstein et al. (2016) explored the prevalence of depression symptoms just among medical students, and Akhtar et al. evaluated the prevalence of anxiety and depression symptoms only in low and middle-income countries between January 1, 2009 and December 31, 2018 (Akhtar et al., 2020). Our study conducted the prevalence of anxiety and depression symptoms among college students globally until March 28, 2021. Meanwhile, we also conducted subgroup analysis for the prevalence and explored associated factors of anxiety and depression symptoms among college students, which was not assessed among those studies. Thus, our study represents a significant advance from previous studies and could provide more information. In the

subgroup analysis, our study showed that both the prevalence of depression and anxiety symptoms varied greatly in different socio-economic levels of countries, and the highest was observed in lower to middle-income countries, which may be due to the fact that college students in lower middle-income countries need to face not only the study pressure but also the economic pressure. Besides, the low quality and insufficient medical resources have less access to screening tests, interventions and treatments at the earliest (Azad, Shahid, Abbas, Shaheen, & Munir, 2017). Additionally, it should be noted that studies conducted in low-income countries are rare, and more researches should be warranted to evaluate the mental health and its associated factors. The overall prevalence of depression and anxiety symptoms were higher among medical students, which may result from higher academic pressure, more courses, and occupational pressure. In addition, the epidemic of the coronavirus disease 2019 (COVID-19) may affect college students' mental health, and our results indicated that the prevalence of depression and anxiety symptoms were higher after the outbreak of COVID-19. Long-term isolation, all kinds of negative news and increased class workload due to online classes given the lack of in-person support from instructors or teaching assistants may be an important reason (Vindegard & Benros, 2020). The present meta-analysis showed that all studies assessed depression and anxiety symptoms using self-reported instruments rather than structured clinical interviews, therefore, the results only suggested depressive or anxiety symptoms among college students, not for mental illness or disease. Nevertheless, it still has high clinical utility with convenient to perform and sensitive to depressive or anxiety symptoms. The results indicated that there were big differences on the prevalence of depression and anxiety symptoms assessed by different self-reported instruments, further studies are required to explore which one or which kind of scale is more

suitable to evaluate depressive and/or anxiety symptoms among college students.

In the present study, eight factors were confirmed to be associated with depression symptoms and seven with anxiety symptoms. Female students were more prone to have depression and anxiety symptoms, which may be due to biological and psychosocial factors, such as social roles and physiological state accompanied with more often exposed to stressful situations and emotional problems and more often faced with negative conditions and feelings (Bangasser et al., 2010; Kvrđic et al., 2013). Academic stress/difficulty was positive associated with mental health, and teachers and college administrators should attach great importance to students, and arrange teaching tasks reasonably, as well as give prompt guidance and help when students have psychological problems. Healthy lifestyle is of great importance to mental health (Boardman & Alexander, 2011; Groth & Morrison-Beedy, 2011), and our study further confirmed smoking and drinking was related with depression and anxiety symptoms. It was estimated that 23.6% of young adults aged 18–24 years are smoking daily (Centers for Disease Control and Prevention, 2004) and the prevalence of tobacco use among college-aged population is approximately 30%. Previous study indicated that alcohol and smoking are often paired activities in young adults (McKee, Hinson, Rounsaville, & Petrelli, 2004), daily smoking is associated with the development of alcohol use disorders (Harrison & McKee, 2011). The majority of college students experience great change of living environment and are more likely to develop a bad lifestyle such as playing games for a long time, irregular eating habit, and research showed that living arrangements of college students are strong predictors of drinking behaviour and should be more concerned (Wechsler, Dowdall, Davenport, & Castillo, 1995). In addition, our results presented that poor sleep quality was a risk factor of both depression and anxiety symptoms. Sleep quality is well known as being a crucial element of psychological health and a disturbed sleep has been related to psychopathology (Hertenstein et al., 2019), and thus, it should attach importance to develop good sleep habits by scheduling regular work and rest time, regular physical activity and health education (Ghrouz et al., 2019). Furthermore, self-confidence or self-esteem and harmonious interpersonal/parent relationships were also associated with mental health, helping college students to build self-confidence, and harmonious interpersonal relationships are contributed to improve their mental health (Chen et al., 2013; Farrer, Gulliver, Bennett, Fassnacht, & Griffiths, 2016), which should be concerned by family, colleges, and themselves.

The present study is the first study investigating the global prevalence of depression and anxiety symptoms and potential associated factors among

college students. Subgroup analysis showed important findings that the prevalence of depression and anxiety symptoms were much higher in lower middle-income countries, and among medical college students. Factors associated with depression and anxiety symptoms provide references for screening, management, improving prevention and intervention strategies of mental health for college students. However, some limitations should also be acknowledged. First, the symptoms of anxiety and depression were relied entirely on self-reported scales. Second, the associated factor analysis is likely influenced by substantial reporting bias in studies. For instance, only reported associations of risk factors and anxiety/depression symptoms was used may lead to a reporting bias, as significant associations are more likely to be reported in studies. Third, high heterogeneity was observed in this meta-analysis, which may due to differences in the study design, samples, culture backgrounds, and assessment scale. Fourth, there were multiple thresholds among different studies when using the same assessment scale, which may under- or over-estimated the prevalence. Finally, statistical analysis suggested publication bias for the main analyses, which should be cautious. Further study is warranted to clarify and explore more efficient and accurate assessment scale.

## Conclusions

The present study indicates that the global prevalence of depression and anxiety symptoms among college students are high and academic stress/difficulty, smoking, drinking, sleep quality, family economic situation, self-confidence/esteem, eating habits and traumatic experiences are significantly associated with depression and/or anxiety symptoms. More and more attention should be paid to the mental health of college students, especially for medical students, female students, and those from low- and lower to middle-income countries. Further studies are required to explore which scale is more suitable to assess depressive or anxiety symptoms, as well as to develop efficient measures to screen, prevent, and treat depression and anxiety symptoms according to their associated factors.

## Supporting information

Additional supporting information may be found online in the Supporting Information section at the end of the article:

**Figure S1.** Sensitivity analyses for prevalence of depression (A) and anxiety (B) symptoms.

**Figure S2.** Funnel plot for studies on prevalence of depression (A) and anxiety (B) symptoms.

**Figure S3.** Filled funnel plot for studies on prevalence of depression (A) and anxiety (B) symptoms.

**Table S1.** (A) Quality assessment of including cross-sectional studies. (B) Quality assessment of including longitudinal studies.

**Table S2.** Characteristics of studies included in the meta-analysis of prevalence of depression symptoms among college students.

**Table S3.** Characteristics of studies included in the meta-analysis of prevalence of anxiety symptoms among college students.

**Table S4.** Included studies of associated factors of anxiety symptoms.

**Table S5.** Included studies of associated factors of depression symptoms.

## Acknowledgements

The study was supported by the Fundamental Research Funds for the Central Universities (2019kfyXJJS032). The funder did not play any role in study design; in the collection, analysis, and interpretation of data; in the writing of the report; nor in the preparation, review, or

approval of the manuscript. The authors have declared that they have no competing or potential conflicts of interest.

## Author contributions

W.Z.L. designed the research; W.Z.L. and Z.Y.Z. conducted the research; W.Z.L. and D.J.C. performed statistical analysis; W.Z.L. wrote the paper; Z.Y.Z., D.J.C., Y.P. and Z.X.L. revised the paper; W.Z.L. had primary responsibility for final content. All authors have read and approved the final manuscript.

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## Key points

- This systematic review provides the first overview that synthesizes the global prevalence of depression and anxiety symptoms and potential associated factors among college students.
- It is shown that the prevalence of depression and anxiety symptoms among college students was 33.6% and 39.0%, respectively.
- Our study shows that both the prevalence of depression and anxiety symptoms varied greatly in different socio-economic levels of countries, and the highest was observed in lower to middle-income countries.
- Findings of this review highlight the need for interventions to focus on the mental health of college students.

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Accepted for publication: 23 February 2022