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The prevalence and incidence of major depressive disorder in 8079 Chinese university freshmen before and during COVID-19

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ABSTRACT

Background: COVID-19 pandemic may impact the prevalence and incidence of depression in college students. However, there is no longitudinal study focusing on major depressive disorder (MDD) before and during COVID-19 pandemic.

Methods: A cohort study was carried out among 8079 Chinese college freshmen. The baseline survey was conducted in 2018 (T0) and annual follow-ups were in 2019 (T1, before COVID-19) and in 2020 (T2, during COVID-19). CIDI-3.0 was used to diagnose MDD. Random effects logistic models of panel data analysis were used for the risk of MDD incidence. STATA 15.1 was used for all analysis.

Results: The weighted 12-month prevalence of MDD at T2 (2.10%) was significantly lower than that at T1 (2.67%) ($p < 0.001$). However, among students who reported exposure to the COVID-19 events, the annual prevalence of MDD at T2 was higher than that at T1 (4.21% vs. 2.79%, $p < 0.001$). The incidence from T0 to T1, incidence from T1 to T2, and the 2-year incidence was 2.23%, 1.34% and 3.75%, respectively. Only 8.93% of MDD students had chosen to seek professional help during the COVID-19 pandemic period.

Limitations: The computer assisted CIDI may not be as sensitive and specific as the diagnosis made by a psychiatrist and may have caused report bias.

Conclusions: Although the MDD incidence of college students was decreasing over time, the impact of the pandemic on student mental health may depend on exposure to COVID-19 events. Not seeking professional help in the Chinese college students is still an important issue.

1. Introduction

The COVID-19 outbreak started in December 2019 in China and it was declared as a pandemic by World Health Organization on March 11, 2020 (WHO, 2020). Chinese government took swift responses to implement strict measures, including travel restriction and home isolation to constrain the spread of the disease (Horton, 2020). The COVID-19 pandemic and related restriction measures have had a profound

impact on people's lifestyles, living habits, income, social activities, and mental health status, including college students. College students are more vulnerable to suffer from mental disorders, especially depression, compared with their non-college-attending peers (Blanco et al., 2008). It was reported that 5.9% college students in 21 low- or lower-middle-income countries had major depressive disorder (MDD) each year (Auerbach et al., 2016); 6.9% Belgian college freshmen had a new onset of MDD in the first year (Ebert et al., 2019). MDD can have negative

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impacts not only on students' academic performance but also on emotions, interpersonal relationship, and social communications (Dyrbye et al., 2006; Hysenbegasi et al., 2005). However, many college students with MDD would not seek professional help due to stigma which would increase the risk of suicide (Rüsch et al., 2009). Such negative impacts have profound implications for population health and the productivity of future aspiring workforce. As the pandemic has persisted over a year, one important question is how COVID-19 has affected the risk of MDD among college students.

Numerous cross-sectional studies have been conducted during the pandemic to monitor population mental health. The prevalence of depressive symptoms in college students ranged from 7.7% to 62.9% (Chen et al., 2020; Liu et al., 2020). To better understand the impact of COVID-19 on depression, longitudinal studies with a direct comparison to pre-pandemic data are needed. Findings from existing longitudinal studies are inconsistent. A majority of the previous studies showed that the prevalence of depressive symptoms increased during the COVID-19 pandemic (Hawes et al., 2021; Twenge and Joiner, 2020; Veldhuis et al., 2021). Studies in the UK revealed that the prevalence of depressive symptoms decreased during the COVID-19 pandemic compared with that before COVID-19 pandemic (Kwong et al., 2020), and the prevalence of depressive symptoms decreased even during the COVID-19 pandemic period (Fancourt et al., 2021). However, another UK study showed that the prevalence of physician diagnosed depression during COVID-19 decreased until April 2020 and increased afterwards (Carr et al., 2021). It should be noted that many of the existing studies focused on the change in depressive symptoms, not disorder that meets the clinical diagnostic criteria. Furthermore, there is a paucity of longitudinal studies on the changes in MDD during COVID-19 pandemic.

Using the data from a longitudinal study in a sample of first-year university students in China, the objectives of this study were to: (1) estimate the prevalence and incidence of MDD before and during COVID-19; (2) identify the factors associated with the first onset of MDD; (3) examine mental health services use in this population during COVID-19 pandemic period.

2. Methods

2.1. Study design and participants

This cohort study was conducted from April 2018 to October 2020. Participants were first-year students of two medical universities located in three cities (Jining, Weifang, Rizhao) with medium population size and economic development level in Shandong Province, China. Informed consent was obtained before baseline and follow-up data collection. For participants younger than 18 years old, informed consent and parental/guardian consent were obtained. The study protocol was approved by the Medical Ethics Committee of Jining Medical University.

2.2. Data collection

In 2018, there were 9928 first-year students at the two medical universities, who were from 24 different provinces including large and middle urban cities, rural counties, and villages. They were approached and invited to participate in this study. Baseline assessment (T0) occurred between April to October 2018, and 8113 (81.7%) completed the baseline survey. After the quality checking, 34 were excluded because they did not provide any data, despite providing informed consents. Thus, the baseline cohort consisted of 8079 participants. The first annual follow-up survey was conducted from April 2019 to October 2019 (T1), and 7550 participants (93.5%) provided completed data. During T0 and T1 survey, a computer assisted survey system with logical checks and skips was used and installed in 365 computers at the libraries on the campuses. Time slots for participating the survey were uniformly allocated by classes. Six trained quality checkers and lay investigators (4 in Jining, 1 in Rizhao and 1 in Weifang for each time) were responsible

for answering potential questions from participants each time. After the participants completed and submitted all answers, the data was directly uploaded to the central server at Jining Medical University.

Between January 23, 2020 and April 8, 2020, the nation-wide lockdown was implemented in China. As such, all universities and colleges were closed. The campuses were re-opened in September 2020, under strict public health restrictions. The second annual follow-up survey was done between September and October 2020 (T2) via online survey (www.wjx.cn, e.g. "The SurveyStar", Changsha Ranxing Information Science and Technology Co., Changsha, China). The survey process was displayed in Appendix I. 5373 completed the online assessment at T2 which represented 66.5% of the original cohort.

2.3. Baseline measurements

Major depressive disorder (MDD) was measured by Composite International Diagnostic Interview (CIDI 3.0), based on the DSM-5 criteria (Huang et al., 2010; Kessler and Üstün, 2004). The sensitivity and specificity of Chinese version for MDD was 71.1% and 89.0%, respectively, and the test-retest reliability was 0.74 (Huang et al., 2010; Kessler and Üstün, 2004). In this study, lifetime MDD was measured at T0 and MDD in the past 12 months was assessed at T1 and T2. MDD was defined as meeting the diagnostic criteria of major depressive episode without history of a manic or hypomanic episode.

Depressive symptoms were assessed by Patient Health Questionnaire-9 (PHQ-9) at T0 and T2. The PHQ-9 contains nine items, assessing depressive symptoms in the past two weeks. The response to each of the nine items has a 4-point scale: (0) "Not at all", (1) "Several days", (2) "More than half of the days", (3) "Nearly every day". If the participants' PHQ-9 total score were 10 and over, they are generally considered to have moderate or severe depressive symptoms (Liu and Wang, 2015). The Cronbach's α of Chinese version PHQ-9 among college students was 0.85 (Zhang et al., 2013). In this study, the Cronbach's α were 0.83 and 0.90 at T0 and T2, respectively.

Anxiety symptoms were measured by Beck Anxiety Inventory (BAI) at T0. The BAI contains twenty-one items, assessing anxiety symptoms in the past week. The response to each of the twenty-one items has a 4-point scale: (1) "None", (2) "Mild", (3) "Moderate", (4) "Severe". If the participants' BAI total score is 45 and over, they are generally considered to have general anxiety disorders. The Cronbach's α of the Chinese version BAI was 0.95 (Zheng et al., 2002). In this study, the Cronbach's α were 0.93.

Stressful life events in the past year were assessed by Adolescent Self-Rating Life Events Check List (ASLEC) at T0 with Chinese version (Xin and Yao, 2015). There are 26 items assessing the stressful life events in the past year. Each question may have a "yes" or "no" answer. In this study, the Cronbach's α of the ASLEC was 0.81.

Lifetime severe traumatic events were measured at T0. There are 23 questions about lifetime severe traumatic events. Participants needed to answer yes or no to each question. A complete list of the questions can be found in Appendix II.

Suicidal ideation was measured by the question: "Have you ever had suicidal ideation in the past year?" at T0.

Socioeconomic status: sex, age, rural/urban residence, one child family structure, campus sites, major, religion (yes/no), history of mental disorders or physical diseases were also collected at T0.

Mental health service use during the COVID-19 pandemic was measured by the multiple-choice question as follows: "During the COVID-19 pandemic, who did you usually seek help when you had a mental/psychological need?"

COVID-19 exposure was measured by two questions at T2: "Have you lived in a community with confirmed or suspected cases?" and "Have your relatives or friends been confirmed or suspected cases?" An answer of "yes" was defined as exposure to COVID-19 events.

2.4. Statistical analysis

All analysis was conducted with STATA 15.1 version (STATA, 2015. Stata Corporation (Ed.), 2015). We first examined the differences between follow-up completers and non-completers in baseline demographic and clinical characteristics. To estimate the prevalence and incidence of MDD, we developed weights to account for the effect of attrition, using logistic regression modeling based on sex, age, campus city, one child family structure, bipolar disorder, and lifetime MDD at baseline.

We estimated the lifetime prevalence of MDD at T0, and 12-month prevalence of MDD at T1 and T2. The 12-months prevalence of MDD at T1 and T2 were compared and by exposure to COVID-19 events, using a Chi square test. We estimated the 1-year (T0 – T1, and T1 – T2) and 2-year (T0 – T2) cumulative incidence of MDD in a closed cohort without a lifetime MDD at T0. Additionally, we compared the mean PHQ-9 scores between T0 and T2 with *t*-test. To examine the baseline characteristics associated with the incidence of MDD, we used random effect logistic regression modeling which accounts for the effects of repeated measures and missing outcome values over the follow-up period. Odds ratio (OR) and associated 95% confidence intervals (CI) were displayed. Finally, we estimated the proportions of various types of help the participants had used to deal with emotional and mental health issues during the pandemic.

3. Results

3.1. Characteristics of participants

The descriptive characteristics of participants are displayed in Table 1. There were 8079 participants who provided data at T0. The mean age of participants was 18.36 ± 0.86 years old. There were 3225 (39.92%) male and 4854 (60.08%) female participants. The characteristics of participants at T1 and T2 are provided in Appendix III. The baseline characteristics of the completers and non-completers at T2 are described and compared in Appendix IV.

Table 1
The characteristics of participants at baseline (T0).

Items	Categories	T0 (N = 8079) N (%)
Age	Mean ± SD	18.36 ± 0.86
Sex	Male	3225 (39.92)
	Female	4854 (60.08)
Family residence	Urban	2995 (37.07)
	Rural	5084 (62.93)
One child	Yes	3075 (38.45)
	No	4922 (61.55)
Major	Medicine	5730 (70.92)
	Non-medicine	2349 (29.08)
Religion	Yes	307 (3.80)
	No	7772 (96.20)
Campus sites	Jining	4428 (54.81)
	Rizhao	1066 (13.19)
	Weifang	2585 (32.00)
BAI score (T0)	<45	7807 (97.61)
	≥45	191 (2.39)
PHQ-9 score (T0)	<10	7391 (93.40)
	≥10	522 (6.60)
Suicidal ideation in the past year (T0)	Yes	740 (9.41)
	No	7126 (90.59)
Number of lifetime severe traumatic events (T0)	0	2170 (27.59)
	1	3354 (42.64)
	2	1351 (17.18)
	≥3	991 (12.60)
Number of stressful events in the past year (T0)	0–3	1794 (22.81)
	4–6	2220 (28.22)
	7–9	1944 (24.71)
	≥10	1908 (24.26)

3.2. Prevalence of depressive symptoms at T0 and T2

The mean score of PHQ-9 at T0 (4.64 ± 3.39) was significantly higher than that at T2 (3.33 ± 3.90) (*p* < 0.001). The prevalence of moderate or severe depressive symptoms at T0 (6.60%, 95% CI: 6.07%–7.17%) was also significantly higher than that at T2 (6.33%, 95% CI: 5.70%–7.03%) ($\chi^2 = 192.73, p < 0.001$).

3.3. Prevalence and incidence of MDD at T0, T1, T2

The lifetime prevalence of MDD at T0 was 5.52% (95% CI: 5.04%–6.05%). The weighted 12-month prevalence of MDD at T1 (2.67%, 95% CI: 2.33%–3.05%) was significantly higher than that at T2 (2.10%, 95% CI: 1.74%–2.52%) ($\chi^2 = 159.75, p < 0.001$). The weighted 1-year incidence from T0 to T1, 1-year incidence from T1 to T2, and the 2-year incidence from T0 to T2 was 2.23% (95% CI: 1.91%–2.60%), 1.34% (95% CI: 1.04%–1.71%) and 3.75% (95% CI: 3.24%–4.34%), respectively (Table 2).

3.4. The 12-month prevalence of MDD by exposure to COVID-19 events

In 5373 participants who were followed-up at T2, 248 reported the exposure to COVID-19 events. The weighted prevalence of MDD in COVID-19 exposure group (4.21%, 95% CI: 2.25%–7.73%) were significantly higher than those without exposure to COVID-19 events (2.00%, 95% CI: 1.64%–2.42%) ($\chi^2 = 5.69, p = 0.021$). In the COVID-19 exposure group (*n* = 248), the weighted prevalence of MDD at T2 (4.21%, 95% CI: 2.25%–7.73%) was higher than that at T1 (2.79%, 95% CI: 1.32%–5.78%) ($\chi^2 = 26.91, p < 0.001$). However, in the COVID-19 non-exposure group (*n* = 5125), the weighted prevalence of MDD at T2 (2.00%, 95% CI: 1.64%–2.42%) was lower than that at T1 (2.70%, 95% CI: 2.28%–3.18%) ($\chi^2 = 122.52, p < 0.001$).

3.5. Factors associated with the incidence of MDD

The 1-year and 2-year incidence of MDD by baseline demographic and clinical characteristics are presented in Table 3. The incidence of MDD differed significantly by baseline levels of PHQ-9 and BAI scores, suicidal ideation in the past year, lifetime severe traumatic events and stressful events in the past year (*p* < 0.05) (Table 3). The results of multivariate random effect logistic analysis indicated that PHQ-9 score at T0 (≥10), suicidal ideation in the past year, stressful life events in the past year (≥10) and lifetime severe traumatic events (≥3) were significantly associated with the new onset of MDD over the 2-year follow-up

Table 2
The prevalence (T0, T1, T2) and incidence of MDD (T1, T2, T1 + T2) among 8079 freshmen, respectively.

Index	Number of MDD diagnosed (N)	Number of new onset of MDD	Weighted index and 95% CI (%)
Prevalence at T0 (lifetime)	437 (7913)	–	5.52 (5.04–6.05) ^a
Prevalence at T1 (in last year) ^a	203 (7547)	–	2.67 (2.33–3.05)
Prevalence at T2 (in last year) ^a	112 (5373)	–	2.10 (1.74–2.52)
First annual incidence (T0–T1)	–	158	2.23 (1.91–2.60)
Second annual incidence (T1–T2)	–	62	1.34 (1.04–1.71)
2-year incidence (T1 + T2)	–	179	3.75 (3.24–4.34)

^a There were statistically significant between the prevalence of T1 and T2 ($\chi^2 = 159.75, p < 0.001$).

^a Unweighted.

Table 3
The annual incidence and cumulative incidence of MDD by baseline demographics and health related factors.

Variables	Categories	Weighted first annual incidence (95% CI) (%)	Weighted second annual incidence (95% CI) (%)	Weighted 2-year incidence (95% CI) (%)
Sex	Female	2.39 (1.98–2.90)	1.31 (0.95–1.79)	3.77 (2.97–4.78)
	Male	1.97 (1.52–2.56)	1.38 (0.93–2.06)	3.74 (3.12–4.49)
Family residence	Urban	2.29 (1.78–2.95)	1.35 (0.90–2.03)	3.91 (3.08–4.94)
	Rural	2.19 (1.80–2.66)	1.33 (0.97–1.81)	3.66 (3.05–4.40)
One child	Yes	2.25 (1.75–2.88)	1.34 (0.89–2.02)	3.92 (3.10–4.94)
	No	2.25 (1.84–2.74)	1.32 (0.96–1.82)	3.68 (3.05–4.43)
Major	Medicine	2.23 (1.86–2.67)	1.38 (1.03–1.84)	3.88 (3.28–4.60)
	Non-medicine	2.22 (1.65–2.99)	1.22 (0.74–1.98)	3.41 (2.57–4.52)
Religion	Yes	2.22 (1.00–4.89)	1.27 (0.31–5.01)	4.70 (2.21–9.74)
	No	2.23 (1.90–2.61)	1.34 (1.04–1.72)	3.72 (3.21–4.31)
Campus sites	Jining	2.08 (1.68–2.58)	1.28 (0.90–1.82)	3.71 (3.03–4.55)
	Rizhao	1.20 (0.62–2.29)	1.21 (0.54–2.69)	2.36 (1.34–4.12)
	Weifang	2.89 (2.28–3.65)	1.46 (1.00–2.16)	4.30 (3.45–5.36)
BAI score (T0)	<45	2.16 (1.84–2.53)	1.33 (1.03–1.71)	3.66 (3.15–4.24)
	≥45	4.73 (2.25–9.68)	2.37 (0.57–9.24)	8.08 (3.83–16.27)
PHQ-9 score (T0)	<10	1.80 (1.51–2.15)	1.18 (0.90–1.55)	3.02 (2.56–3.57)
	≥10	9.26 (6.76–12.55)	4.08 (2.20–7.47)	15.29 (11.45–20.13)
Suicidal ideation in the past year (T0)	Yes	6.48 (4.74–8.80)	4.78 (2.94–7.69)	12.20 (9.17–16.05)
	No	1.83 (1.53–2.19)	1.07 (0.80–1.43)	3.05 (2.58–3.61)
Number of lifetime severe traumatic events (T0)	0	1.97 (1.44–2.69)	0.90 (0.51–1.59)	2.81 (2.05–3.84)
	1	1.44 (1.07–1.93)	1.13 (0.75–1.70)	2.67 (2.05–3.47)
	2	2.73 (1.95–3.83)	1.67 (0.97–2.85)	4.73 (3.44–6.46)
	≥3	5.00 (3.70–6.73)	2.88 (1.71–4.82)	8.91 (6.73–11.70)
Number of stressful life events in the past year (T0)	0–3	1.14 (0.72–1.78)	1.05 (0.58–1.90)	2.17 (1.44–3.25)
	4–6	1.51 (1.06–2.14)	1.24 (0.77–1.99)	2.67 (1.95–3.65)
	7–9	1.92 (1.36–2.69)	1.12 (0.65–1.92)	3.23 (2.33–4.45)
	≥10	4.55 (3.63–5.68)	2.03 (1.32–3.10)	7.25 (5.85–8.95)

period (Table 4).

3.6. Mental health service use during the COVID-19 pandemic

When the participants had mental health problems or felt stressed

Table 4
The factors associated with the incidence of MDD among 4752 freshmen by random effects model of panel data analysis.

Factors	OR (95% CI)	
	Univariate random effects model	Multivariate random effects model
Female	1.10 (0.82–1.46)	1.13 (0.83–1.53)
Age	0.71 (0.46–1.09)	0.97 (0.82–1.14)
Rural	0.96 (0.72–1.27)	1.03 (0.74–1.44)
One child	1.01 (0.76–1.35)	0.98 (0.70–1.38)
Medicine student	1.05 (0.77–1.44)	1.34 (0.97–1.86)
Religion	1.12 (0.55–2.27)	0.96 (0.47–1.96)
BAI score at T0(≥45)	2.12 (0.99–4.55)	0.95 (0.43–2.10)
PHQ-9 score at T0(≥10)	5.37 (3.63–7.95)	3.01 (1.98–4.58)
Suicidal ideation in the past year at T0	4.29 (3.01–6.12)	2.33 (1.59–3.40)
Number of lifetime severe traumatic events at T0		
1	0.87 (0.59–1.27)	0.80 (0.54–1.18)
2	1.55 (1.01–2.37)	1.16 (0.75–1.81)
≥3	3.32 (2.20–5.01)	1.82 (1.17–2.83)
Number of stressful life events in the past year at T0		
4–6	1.28 (0.79–2.06)	1.15 (0.71–1.86)
7–9	1.70 (1.06–2.72)	1.27 (0.78–2.10)
≥10	3.70 (2.39–5.91)	2.16 (1.35–3.44)

during the COVID-19 pandemic, the participants reported that their choices of seeking help were friends (59.59%), parents (50.03%), classmates (36.03%), solving by themselves (29.87%), talking to nobody (15.24%), teachers (11.09%), seeking help online (9.51%), relatives (7.84%), health professionals (5.75%), and telephone hotline (1.19%) (Fig. 1). Among those with an MDD, the top five choices of seeking help during the COVID-19 pandemic were friends (48.21%), solving by themselves (44.64%), talking to nobody (38.39%), classmates (36.15%) and parents (27.68%) (Fig. 1). Among the 112 participants diagnosed with an MDD, only 8.93% of them chose to seek professional help from psychiatrists or psychologists during the COVID-19 pandemic period.

4. Discussions

This study estimated the prevalence and incidence of MDD in a representative sample of college freshmen before and during the COVID-19 pandemic. The annual prevalence and incidence of MDD in the whole cohort during the pandemic decreased compared to the year before the pandemic. However, in participants who reported COVID-19 exposure, the annual prevalence of MDD during the pandemic was significantly higher than that before the pandemic. Baseline depressive symptoms, previous suicidal ideation, stressful life events and severe traumatic events experience were significantly associated with the new onset of MDD in the participants. Half of the participants reported friends as their first option for psychological supports when they had mental health problems during the COVID-19 pandemic. Over 40% of participants who were suffering from MDD did not seek any help. Only 8.93% of participants with MDD and 5.68% of participants without MDD sought help from health professionals during the COVID-19 pandemic.

In this study, the lifetime prevalence of MDD in college freshmen was 5.52% which was higher than that in the Chinese general population (3.90%) (Huang et al., 2019). The 12-month prevalence of MDD in 2020 was 2.10% which was significantly lower than that in 2019 (2.67%) before the COVID-19 outbreak. The prevalence of moderate and severe depressive symptoms in 2020 (6.33%) was lower than that in 2018 (6.60%). Although the differences were statistically significantly, caution should be taken when interpreting the statistical significance because of the small absolute differences and the large sample size of our study.

Numerous studies have reported worsening mental health of the populations in different regions over the course of the pandemic (Daly

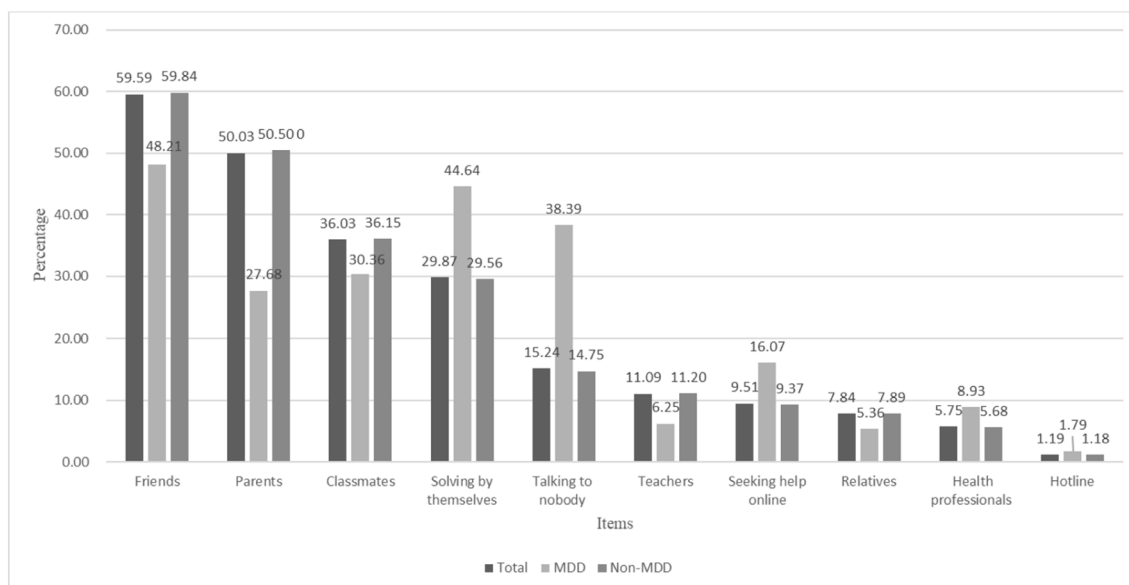


Fig. 1. The choices of help-seeking among 5373 freshmen during COVID-19 pandemic at T2 in 2020 (No. of MDD = 112; No. of Non-MDD = 5261).

et al., 2020; Hawes et al., 2021; Twenge and Joiner, 2020; Veldhuis et al., 2021). The data from this study suggested that the impact of the pandemic on student mental health may be complicated, and it may depend on the exposure to COVID-19 events. The decrease in the overall prevalence of MDD in this study, in comparison to pre-pandemic estimate, was unexpected, but was consistent with the UK study (Kwong et al., 2020). There are several possible explanations. First, due to the COVID-19 pandemic, college students had to be quarantined at home and take online courses for a whole semester in 2020. Learning from home and high passing rate for the online examinations may have considerably reduced college students' academic pressure, the impacts of negative interpersonal relationships and the negative events in school context, especially among those who were not exposed to any COVID-19 events. Although the direct exposure to COVID-19 might have increased the MDD prevalence in college students, the relatively stable and small number of COVID-19 cases in China in 2020 may have contributed to the decreased prevalence of MDD in the whole student population. Second, the T2 survey was conducted when students returned to campus and reunited with classmates after a prolonged home confinement. As indicated by the data, friends and classmates were the primary sources for help if participants needed mental health services during the pandemic. The re-union with friends and classmates may have alleviated the stress or improved their mental health and wellbeing, which partly contributed to the low prevalence of MDD. Finally, it is possible that the prevalence and incidence of MDD in university students is in the V shape in relation to time (Carr et al., 2021). T2 survey was conducted at the time when the baseline cohort entered their 3rd year study in the university. The participants' mental health may improve because of the adaptation of university culture and environment in the following years. The prevalence and incidence may increase at the final year of university, mainly due to the pressure of employment, meet family expectations and relocation. Therefore, although the prevalence and incidence of MDD in college students during the COVID-19 pandemic decreased, we should be mindful to possible increase after the COVID-19 pandemic. Longitudinal studies monitoring the mental health status and trajectories over the course of university study are needed. The findings of this study highlighted the importance of assessing the detailed exposure to COVID-19 in order to examine the impact of the pandemic on population mental health. However, due to the small number of students who exposed to COVID-19 events in our cohort ($n = 248$), studies with larger samples are needed to replicate the results.

There are few longitudinal studies on the incidence of MDD in university students. The annual incidence of MDD in Chinese freshmen (2.23%) was much lower than the weighted annual incidence in Ebert et al.'s report (6.90%) which was conducted with 2519 Belgian college freshmen (Ebert et al., 2019). Cross-national cohort studies are required to verify the differences especially in low-income countries. Half of MDD participants have experienced severe traumatic events such as childhood abuse or maltreatment which are hard to mitigate after grow-up (Tracy et al., 2019). MDD prediction research should be explored in college students to identify high-risk individuals in a timely manner and improve the mental health status of college students.

While suffering from mental problems, most college students did not seek professional help, and this has been a global problem. Besides the lack of education for mental health, Chinese college students with mental problems are unwilling to disclose their issues and refuse to receive professional treatment and medication, primarily due to stigma. College students who seek professional psychological help during the COVID-19 pandemic have significantly better mental health than those who do not seek professional help (Liang et al., 2020). Due to the current COVID-19 pandemic, people are in home isolation which reduces the possibility of contact with mental health professionals. In this context, network interventions such as internet-based or telephone-based cognitive-behavioral therapy (CBT) including psychoeducation, stress management, and problem-solving therapy may be more meaningful for college students (Webb et al., 2017). Due to the possible V shape trajectory of depression in college students, we suggest focusing psychological interventions on freshmen and last year students.

5. Limitations

There are several limitations in this study. First, the response rate of at the second annual follow-up was 66.5%. Although the estimates of prevalence of MDD were weighted, selection bias is still possible. The prevalence and incidence may have been either over or underestimated. Second, the computer assisted CIDI may not be as sensitive and specific as the diagnosis made by a psychiatrist. Therefore, there is a possibility of misclassification bias associated with the MDD. The Semi-structured Clinical Interview for DSM-IV (SCID) would be more appropriate but more costly. Finally, data collection relied on self-report. Reporting and recall biases may affect the results of this study.

6. Conclusions

This is the first cohort study measuring the prevalence and incidence of MDD in college freshmen before and during COVID-19 pandemic. The data indicated that the impact of the pandemic on student mental health may depend on detailed exposure to COVID-19 events. We should be vigilant about trend of MDD in college students after the COVID-19 pandemic. Not seeking professional help for mental disorders in college students had been a global problem. Reducing stigma through mental health education and promotion is critical to address the lack of mental health service utilization. It is crucial to build a mental health prevention system in Chinese universities to provide timely treatment and intervention to college students with mental disorders.

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CRedit authorship contribution statement

D Liu and N Liu did the literature search. F Hao, Z Su, Y Tang, JL Wang and Y Liu did the study design. D Liu, N Liu, Y Tang, J Zhu and Y Liu did the data collection and epidemiological screening. B Li, F Hao, Z Su, and B Wang did the patients diagnosis. D Liu, JL Wang and Y Liu did the data analysis. JL Wang and Y Liu did the data interpretation, accessed, and verified the data. D Liu, B Li, F Hao and N Liu wrote the first draft of the manuscript. All authors approved the final version of the manuscript.

Declaration of competing interest

The authors declare no conflicts of interests.

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Appendix A. Supplementary data

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