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# Mental health status and change in living rhythms among college students in China during the COVID-19 pandemic: A large-scale survey

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## 1. Introduction

As a public health emergency of international concern, the 2019 Coronavirus Disease (COVID-19) has gained intense attention globally, posing serious threats to people's lives, as well as to their physical and psychological health [1]. As of 2 April 2020, the number of confirmed cases worldwide has exceeded 1000,000 and the global situation is of the utmost seriousness. The Chinese government has implemented strict self- and forced-quarantine measures across the country. Under the unified deployment of the education department, the return of students to colleges has been postponed in most provinces [2,3]. More than one million college students in Guangdong Province are currently studying online at home.

In any biological disaster, the themes of depression, uncertainty, and fear are common [4,5]. A study included 1210 respondents from 194 cities in China found that 53.8% of respondents rated the psychological impact of the pandemic as moderate or severe; 16.5% reported moderate to severe depressive symptoms; 28.8% reported moderate to severe anxiety symptoms, and 8.1% reported moderate to severe stress levels [6]. Prolonged lockdown had several adverse impacts on mental health. In a survey, respondents aged 12–21.4 years showed a higher psychological impact four weeks later than that on the onset of COVID-19. This age group mainly comprised of students who were undergoing prolonged school suspensions, requiring online education support and uncertainty about examinations and enrollment arrangements [7]. Furthermore, people with preexisting psychiatric illnesses had difficulty accessing mental health services during the lockdown [8]. Strict self-quarantine measures may also affect college students with mental health problems. We need a larger epidemiological survey evaluating the psychological impact of COVID-19 pandemic on college students.

During the pandemic, the regular holiday activities of college students are limited as they have lost the freedom to go out and socialize

face-to-face as they would usually. This kind of loss can be overwhelming, and students who lack an appropriate coping style may experience depression [9]. Furthermore, some college students may experience irregularities in their daily life, such as getting up late, staying up late, spending more time surfing the Internet, and so on. All of these may lead to disruption to their biological rhythms, known to be an important clinical feature and pathophysiological mechanism underlying mental illness [10], closely related to the onset, symptoms and social functions of depression [11,12]. Quarantine for COVID-19 increases the possibility of psychological and mental health problems [13], and depression is more likely to occur and worsen as a result [14]. Simultaneously, the reduction of activity caused by quarantine can lead to a vicious circle in which ways to alleviate negative emotions are reduced [15]. Compared with the SARS pandemic in 2003 and the Wenchuan earthquake in 2008, Internet services are more widely available. Activity on various network platforms among college students is high, and there are many available approaches to obtaining information. A nationwide survey revealed that young people tend to obtain a large amount of information from social media that can easily trigger stress [16]. The length of time spent online to browse information about the COVID-19 pandemic may also affect emotional stability. Therefore, it is particularly important to evaluate the living rhythms and depressive symptoms of college students during the COVID-19 pandemic.

As a result of the pandemic, colleges and universities have been prompted to conduct education online, and autonomous learning at home for college students may raise challenges relating to their self-discipline [17]. Some students report that it is more difficult to persist with study at home than at school, and that students feel higher levels of self-negation and depression. If effective emotional regulation is absent, the risk of depression is likely to be increased. Previous studies have shown that regulatory emotional self-efficacy (RESE) could directly predict mental health, such as depression and anxiety [18,19].

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RESE refers to the degree of confidence with which individuals can effectively regulate their emotional state, which has two components: perceived self-efficacy in managing negative (NEG) and in expressing positive (POS) affect [20]. In a longitudinal study on the relationship between RESE and depressive symptoms in a group of early adolescents, having strong RESE was not only negatively associated with their current levels of depression, but also predicted their depression after 4 years [21]. People with weak RESE were more inclined to choose negative emotional regulation strategies to deal with negative emotions when distressed, leading them to experience worse depression [18]. On the contrary, favorable RESE could help individuals use positive approaches to improve their emotion regulation [22]. A study of graduate students found that RESE would serve as a buffering factor, decreasing the risk of suicide caused by depression [23]. Therefore, it is of great significance to detect the RESE of college students during quarantine at home.

To date, there are few studies on the immediate psychological impact of COVID-19 on college students. Cao et al. examined the prevalence of anxiety among 7143 college students during the pandemic by using the 7-item Generalized Anxiety Disorder Scale (GAD-7), and found that 3.6% of the respondents were experiencing moderate to severe anxiety ( $GAD-7 \geq 10$ ) [24]. The implementation of the depressive symptoms assessment of college students is also an important part of dealing with the pandemic, and to inform the formulation and implementation of relevant mental health intervention policies. Therefore, we focused on the period of occurrence and development of COVID-19 to comprehensively evaluate the immediate psychological influence on college students by considering both negative symptomatology and positive efficacy. We also sought to determine the relationships between depressive symptoms, RESE and living rhythms, and predict the risk factors for mental health difficulties. It was intended that this work would provide a basis for the prevention of mental health difficulties in college students during the COVID-19 pandemic.

## 2. Methods

### 2.1. Study population and design

This was a cross-sectional survey conducted among 85 colleges in Guangdong province in China between 13 and 22 February 2020. A contact person in each college was responsible for the distribution and collection of the questionnaires. College students in Guangdong province were able to access the survey using WeChat and answer the questionnaire anonymously by scanning the two-dimensional barcodes of the questionnaire address or clicking the relevant link. After participants entering the survey homepage, an online consent form would be displayed before the questionnaire. If the participants had no objection to survey objective in the consent form, they could officially start the survey by clicking "Next" button below, or they could have right to cease the survey. Only one response per person to the questionnaire was permitted. Participation was completely voluntary and non-commercial. In our study, the items of name and personal phone number were optional in the questionnaire. In addition, all investigators had signed confidentiality agreements. The senior investigators performed quality control by checking the collected questionnaires daily. The study was approved by the appropriate institutional research and ethics committee.

In total, 361,969 college students completed the questionnaire. Before data processing, we applied a series of strict participant exclusion criteria, namely: (1) If the major could not be identified or was filled in indiscriminately, (2) If the name of the school could not be identified or did not belong to Guangdong Province, (3) If there was an obvious discrepancy between the grade (level) of study and school academic system, (4) If all the living rhythms questions were responded in the same way. According to the above exclusion criteria, 89.4%

(323,489/361,969) questionnaires were considered valid for inclusion in the analysis ultimately.

### 2.2. Measures

Demographic variables included gender (male or female), age, grade, nationality, educational level (junior college or undergraduate college), family residence, and current location. Family residence included the following types: (1) country, (2) town, (3) small and medium-sized city, (4) large city. The current location: (1) Guangdong province, (2) Hubei province, (3) the other provinces of China. (Supplementary Material).

Living rhythms were assessed through four items: (1) time spent on focusing on COVID-19 information, measured by the average time per day spent on browsing information relating to the COVID-19 pandemic over the past two weeks, (2) Sleeping rhythms were assessed by the following two questions: average daily time waking up in the past two weeks, average daily time going to sleep in the past two weeks, (3) Diet habits, in which participants were asked whether they kept the time and quantity of three meals per day as usual and responded with one of with four choices (never, Seldom, sometimes or always), (4) Exercise habits, in which participants reported their average daily time spent on exercise in the past two weeks. (Supplementary Material).

The PHQ-9 Scale was used to measure depressive symptoms. It consists of nine items, each rated on a four-point scale (from 0 = not at all to 3 = almost every day). The score range is 0–27 and higher scores indicate more severe depressive symptomatology. A cutoff of  $\geq 10$  has been recommended for the diagnosis of depressive symptoms, which provides adequate sensitivity and specificity [25]. In our study, a total score of  $PHQ-9 \geq 10$  was used for categorization (that is, with or without depressive symptoms) [26]. The Cronbach's alpha for the PHQ-9 in the current sample was 0.89.

The RESE scale was developed to assess perceived self-efficacy in managing negative (NEG) and in expressing positive (POS) affect [20]. The Chinese version of this scale consists of a total of 17 items and has been validated and extensively utilized in the Chinese population [27]. NEG includes managing the efficacy of anger-irritation (ANG), dependency-distress (DES), and guilt and shame (COM). POS includes the sense of efficacy of expressing happiness (HAP) and pride (GLO). Participants rated their capability to manage their emotional life with responses ranging from 1 = not well at all to 5 = very well. The higher the score, the higher the sense of RESE. In our study, participants with a score less than the median were defined as the low RESE group, and those with a score higher than the median was defined as the high RESE group. The Cronbach's alpha for the RESE scale in the current sample was 0.93.

### 2.3. Data analysis

First, descriptive analyses were conducted to describe demographic characteristics, living rhythms, depressive symptoms, and RESE status of students during the COVID-19 pandemic. Second, the data for depressive symptoms and RESE were checked using the Kolmogorov–Smirnov test. Results showed that they were non-normal continuous variables. The prevalence of depressive symptoms and RESE stratified by demographic characteristics and living rhythms characteristics were reported, and Mann–Whitney *U* tests or Kruskal–Wallis tests were used to compare the differences between groups as appropriate. Third, binary logistic regression analysis was performed to explore the potential influencing factors for depressive symptoms and RESE. Odds ratios (ORs) and 95% confidence intervals (95% CIs) were obtained from the logistic regression models. All data were analyzed using the Statistical Package for Social Sciences (SPSS) version 22.0. *P*-values of less than 0.05 were considered statistically significant (two-sided tests).

**Table 1**  
Distribution of depressive symptoms and RESE among participants by demographic characteristics.

Variables	Number (%)	Depressive symptoms ( <i>M</i> ± <i>SD</i> )	RESE ( <i>M</i> ± <i>SD</i> )
Gender			
Male	130,516 (40.3%)	3.22 ± 4.21	64.66 ± 10.59
Female	192,973 (59.7%)	3.63 ± 4.05	63.46 ± 9.34
		$Z = -46.91, p < 0.001, df = 1$	$Z = -32.87, p < 0.001, df = 1$
Educational level <sup>a</sup>			
Junior college	188,001 (58.1%)	3.35 ± 4.13	63.79 ± 10.07
Undergraduate college	134,781 (41.7%)	3.64 ± 4.10	64.29 ± 9.60
		$Z = -29.29, p < 0.001, df = 1$	$Z = -18.44, p < 0.001, df = 1$
Province			
Guangdong province	304,167 (94.0%)	3.46 ± 4.11	63.94 ± 9.87
Hubei province	1221 (0.4%)	3.45 ± 4.18	63.66 ± 9.60
Other provinces	18,101 (5.6%)	3.62 ± 4.27	64.02 ± 9.98
		$\chi^2 = 15.60, p < 0.001, df = 2$	$\chi^2 = 2.33, p = .31, df = 2$
Grade			
Freshman year	130,700 (40.4%)	3.46 ± 4.12	63.72 ± 9.93
Sophomore year	102,460 (31.7%)	3.40 ± 4.09	63.95 ± 9.90
Junior year	66,397 (20.5%)	3.45 ± 4.10	64.18 ± 9.83
Senior year	23,668 (7.3%)	3.86 ± 4.28	64.50 ± 9.57
Fifth year	264 (0.1%)	3.91 ± 4.32	63.74 ± 10.47
		$\chi^2 = 305.41, p < 0.001, df = 4$	$\chi^2 = 255.91, p < 0.001, df = 4$
Age			
18 and below	29,510 (9.1%)	3.60 ± 4.26	63.33 ± 10.04
19–20	167,932 (51.9%)	3.45 ± 4.10	63.85 ± 9.87
21–22	104,800 (32.4%)	3.46 ± 4.11	64.12 ± 9.82
23–24	19,710 (6.1%)	3.49 ± 4.17	64.63 ± 9.81
25 and above	1537 (0.5%)	3.39 ± 4.19	65.42 ± 10.15
		$\chi^2 = 24.58, p < 0.001, df = 4$	$\chi^2 = 392.97, p < 0.001, df = 4$
Nationality			
The Han nationality	319,017 (98.6%)	3.47 ± 4.12	63.95 ± 9.88
Minority nationality	4472 (1.4%)	3.74 ± 4.41	63.60 ± 9.89
		$Z = -3.47, p = .001, df = 1$	$Z = -2.32, p = .02, df = 1$
Family residence			
County	131,013 (40.5%)	3.23 ± 3.95	63.85 ± 9.70
Town	97,929 (30.3%)	3.59 ± 4.14	63.81 ± 9.79
Small and medium-sized city	57,153 (17.7%)	3.64 ± 4.26	64.14 ± 10.05
Large city	37,394 (11.6%)	3.72 ± 4.40	64.35 ± 10.43
		$\chi^2 = 692.58, p < 0.001, df = 3$	$\chi^2 = 104.22, p < 0.001, df = 3$

Abbreviations: *M*, mean; *SD*, Standard deviation; RESE, regulatory emotional self-efficacy.

*Z* values derived from Mann–Whitney *U* tests.

$\chi^2$  values derived from Kruskal–Wallis tests.

<sup>a</sup> Missing value: 707(0.2%) students did not fill in school name.

### 3. Results

#### 3.1. Demographic characteristics

The majority of participants (84.3%) were in the 19 to 22 years of age range. Females accounted for 59.7% of the total respondents. A significant gender difference was observed, with females reporting lower levels of depressive symptoms and higher levels of RESE than males ( $Z = -46.91, df = 1, p < .001$  and  $Z = -32.87, df = 1, p < .001$ ; respectively). Most respondents (94.0%) were located in Guangdong province, while 0.4% were located in Hubei Province and 5.6% were located in other provinces. Significant differences in the level of depressive symptoms were found according to location: students in the other provinces had higher scores of depressive symptoms than those in Guangdong or Hubei ( $\chi^2 = 15.60, df = 2, p < .001$ ). However, there was no statistically significant difference in RESE according to province ( $\chi^2 = 2.33, df = 2, p = .31$ ). Grade of study, age, nationality, educational level, and family residence all showed significant differences according to the students' depressive symptoms and RESE scores. Table 1 presents the socio-demographic characteristics of the sample.

#### 3.2. Prevalence of depressive symptoms and RESE during the COVID-19 pandemic

The average score for depressive symptoms overall was

3.47 ± 4.12. According to the cutoff of PHQ-9 ≥ 10, which has been recommended for the diagnosis of depressive symptoms, depressive symptoms was detected in 7.7% of participants. We summarized the mean scores for each of the PHQ-9 items as responded to by the college students with depressive symptoms, as shown in Table 2. We found that “lack of energy”, “lack of pleasure” and “sleep disorder” were the main

**Table 2**

Descriptive statistics for the PHQ-9 items among the college students with depressive symptoms.<sup>a</sup>

PHQ-9 items	( <i>M</i> ± <i>SD</i> )
Little interest or pleasure in doing things	2.91 ± 0.84
Feeling tired or having little energy	2.91 ± 0.79
Trouble falling or staying asleep, or sleeping too much	2.83 ± 0.89
Poor appetite or overeating	2.58 ± 0.88
Feeling down, depressed, or hopeless	2.55 ± 0.79
Trouble concentrating on things	2.48 ± 0.89
Feeling bad about yourself or that you are a failure	2.51 ± 0.88
Moving or speaking so slowly that other people could have noticed	2.17 ± 0.89
Thoughts that you would be better off dead or of hurting yourself	1.61 ± 0.82
Total score	13.56 ± 3.78

Abbreviations: PHQ-9, Patient Health Questionnaire; *M*, mean; *SD*, Standard deviation.

<sup>a</sup> Students with depressive symptoms were those scoring PHQ-9 ≥ 10.

**Table 3**  
Distribution of depressive symptoms and RESE among participants by living rhythms.

Variable	Number (%)	Depressive symptoms ( $M \pm SD$ )	RESE ( $M \pm SD$ )
Time on browsing COVID-19 information			
< 1 h	167,532 (51.8%)	3.53 $\pm$ 4.19	62.90 $\pm$ 9.89
1–2 h	122,311 (37.8%)	3.33 $\pm$ 3.91	65.09 $\pm$ 9.47
3–5 h	177,37 (5.5%)	3.67 $\pm$ 4.26	65.17 $\pm$ 9.96
> 5 h	15,909 (4.9%)	3.72 $\pm$ 4.77	64.78 $\pm$ 11.42
		$\chi^2 = 99.02, p < 0.001, df = 3$	$\chi^2 = 4162.59, p < 0.001, df = 1$
Exercise time			
Never	68,947 (21.3%)	4.51 $\pm$ 4.93	60.47 $\pm$ 10.31
< 30 min	180,381 (55.8%)	3.38 $\pm$ 3.87	64.11 $\pm$ 9.29
30–60 min	62,526 (19.3%)	2.71 $\pm$ 3.59	66.71 $\pm$ 9.57
> 60 min	11,635 (3.6%)	2.73 $\pm$ 4.08	67.10 $\pm$ 11.35
		$\chi^2 = 6151.94, p < 0.001, df = 3$	$\chi^2 = 15,035.48, p < 0.001, df = 3$
Wake time			
Before 6:00	1580 (0.5%)	4.47 $\pm$ 5.64	62.44 $\pm$ 14.31
6:00–8:00	32,134 (9.9%)	2.75 $\pm$ 3.67	65.73 $\pm$ 10.11
8:00–10:00	138,537 (42.8%)	2.94 $\pm$ 3.59	65.13 $\pm$ 9.41
After 10:00	107,041 (33.1%)	3.87 $\pm$ 4.28	63.04 $\pm$ 9.77
Irregular	44,197 (13.7%)	4.65 $\pm$ 5.05	61.20 $\pm$ 10.39
		$\chi^2 = 6420.66, p < 0.001, df = 4$	$\chi^2 = 8093.02, p < 0.001, df = 4$
Sleep time			
Before 22:00	11,058 (3.4%)	2.55 $\pm$ 3.87	66.20 $\pm$ 11.43
22:00–24:00	133,280 (41.2%)	2.66 $\pm$ 3.37	65.80 $\pm$ 9.31
After 24:00	111,871 (34.6%)	3.98 $\pm$ 4.29	62.97 $\pm$ 9.68
Irregular	67,280 (20.8%)	4.37 $\pm$ 4.82	61.53 $\pm$ 10.25
		$\chi^2 = 9968.42, p < 0.001, df = 3$	$\chi^2 = 11,459.62, p < 0.001, df = 3$
Diet habits (regular frequency and quantity)			
Never	9019 (2.8%)	6.41 $\pm$ 6.32	58.20 $\pm$ 12.00
Seldom	25,479 (7.9%)	5.97 $\pm$ 5.21	59.64 $\pm$ 9.93
Sometimes	80,199 (24.8%)	4.62 $\pm$ 4.30	62.00 $\pm$ 9.17
Always	208,792 (64.5%)	2.59 $\pm$ 3.42	65.47 $\pm$ 9.65
		$\chi^2 = 27,835.34, p < 0.001, df = 3$	$\chi^2 = 15,858.61, p < 0.001, df = 3$

Abbreviations: *M*, mean; *SD*, Standard deviation; RESE, regulatory emotional self-efficacy, COVID-19, 2019 Coronavirus Disease.  $\chi^2$  values derived from Kruskal-Wallis tests.

symptoms with the highest average scores. During the past two weeks, the incidence of suicidal ideation was 7.2%: 0.4% (1143) of the students had suicidal thoughts almost every day, 0.9% (2804) had suicidal thoughts for more than a week, and 5.9% (18,986) had suicidal thoughts over a few days. The average score for the RESE was  $63.95 \pm 9.88$ . The score for POS ( $4.12 \pm 0.60$ ) was higher than for NEG ( $3.56 \pm 0.70$ ), especially for ANG ( $3.53 \pm 0.77$ ) which was the lowest score overall. We found significant differences in the RESE scores between students with and without depressive symptoms: students with depressive symptoms had lower levels of RESE ( $55.5 \pm 10.1$ ) than those without depressive symptoms ( $64.7 \pm 9.5$ ) ( $Z = -134.58, p < .001$ ).

### 3.3. Living rhythms of students during the COVID-19 pandemic

The living rhythms of students during the COVID-19 pandemic are summarized in Table 3. Browsing information relating to COVID-19 was undertaken by 51.8% of the students for less than 1 h, by 37.8% for 1–2 h, 5.5% for 3–5 h and 4.9% for more than 5 h per day. Depressive symptoms of the students differed according to the average time spent on pandemic information per day ( $\chi^2 = 99.02, df = 3, p < .001$ ), and those focusing on it for more than 5 h per day had the highest scores of depressive symptoms. In terms of physical exercise, students who had not undertaken exercise in the past two weeks accounted for 21.3% of the total participants whereas 55.8% exercised for 30 min, and only 3.6% of the students exercised for more than 1 h. Non-parametric tests showed that students who exercised for more than 30 min had lower depressive symptoms and higher RESE scores compared to the other students ( $\chi^2 = 6151.94, df = 3, p < .001$  and  $\chi^2 = 15,035.48, df = 3, p < .001$ ; respectively). As for sleeping rhythms, most students would wake up from 6:00–8:00 and go to bed from 22:00–24:00. Many students got up after 10:00 or irregularly, accounting for 33.1% and

13.7% of the participants, respectively. More than half of the students went to bed later than 24:00 or irregularly, accounting for 55.4% in total. There were statistically significant differences in depressive symptoms and RESE scores according to the sleeping rhythms of college students (as shown in Table 3). In terms of diet, 10.7% of students “Seldom” or “never” kept to the usual habit of three meals per day and their depressive symptoms were significantly higher and RESE scores were significantly lower than the other students ( $\chi^2 = 27,835.34, df = 3, p < .001$  and  $\chi^2 = 15,858.61, df = 3, p < .001$ ; respectively).

### 3.4. Associations between living rhythms, depressive symptoms and RESE

In the binary logistic regression models, time on browsing COVID-19 information, exercise, wake time, sleep time, and regular frequency of three meals were all significantly associated with depressive symptoms and RESE (Table 4). Time on browsing COVID-19 information for 3–5 h or > 5 h were risk factors for depressive symptoms (OR = 1.30, 95% CI: 1.23–1.38,  $p < .001$  and OR = 1.33, 95% CI: 1.26–1.41,  $p < .001$ ; respectively), and sleeping times later than 24:00 or irregular bedtimes were also harmful factors relating to depressive symptoms (OR = 1.53, 95% CI: 1.39–1.68,  $p < .001$  and OR = 1.58, 95% CI: 1.43–1.73,  $p < .001$ , respectively). Three protective factors for depressive symptoms were also identified (all  $p < .001$ ): doing some exercise, keeping a regular diet, and a waking time later than 6:00. Even less than 30 min of exercise was found to be protective for RESE (OR = 0.63, 95% CI: 0.61–0.64,  $p < .001$ ) and keeping regular three meals “sometimes” (OR = 0.77, 95% CI: 0.74–0.81,  $p < .001$ ) or “always” (OR = 0.47, 95% CI: 0.45–0.49,  $p < .001$ ) helped increase RESE referring to “never”. Students who focused on the COVID-19 pandemic for 3 h or more per day were not likely to develop lower RESE than those spending less than 1 h (OR = 0.75, 95% CI: 0.72–0.77,



**Table 4**  
Binary logistic regression analyses for depressive symptoms and RESE by living rhythms.

Variable	Participants with and without depressive symptoms <sup>a</sup>		Participants with high and low RESE <sup>b</sup>	
	OR (95% CI)	<i>p</i>	OR (95% CI)	<i>p</i>
Time on browsing COVID-19 information		< 0.001		< 0.001
< 1 h	1.00		1.00	
1–2 h	0.99 (0.96–1.02)	0.43	0.77 (0.76–0.78)	< 0.001
3–5 h	1.30 (1.23–1.38)	< 0.001	0.75 (0.72–0.77)	< 0.001
> 5 h	1.33 (1.26–1.41)	< 0.001	0.78 (0.75–0.80)	< 0.001
Exercise time		< 0.001		< 0.001
Never	1.00		1.00	
< 30 min	0.61 (0.59–0.63)	< 0.001	0.63 (0.61–0.64)	< 0.001
30–60 min	0.50 (0.48–0.52)	< 0.001	0.43 (0.42–0.44)	< 0.001
> 60 min	0.63 (0.58–0.69)	< 0.001	0.42 (0.40–0.44)	< 0.001
Wake time		< 0.001		< 0.001
Before 6:00	1.00		1.00	
6:00–8:00	0.47 (0.40–0.54)	< 0.001	0.72 (0.65–0.80)	0.001
8:00–10:00	0.37 (0.31–0.42)	< 0.001	0.69 (0.62–0.76)	< 0.001
After 10:00	0.38 (0.33–0.44)	< 0.001	0.70 (0.63–0.78)	< 0.001
Irregular	0.48 (0.41–0.56)	< 0.001	0.79 (0.71–0.88)	< 0.001
Sleep time		< 0.001		< 0.001
Before 22:00	1.00		1.00	
22:00–24:00	0.82 (0.75–0.90)	< 0.001	1.07 (1.03–1.12)	< 0.001
After 24:00	1.53 (1.39–1.68)	< 0.001	1.44 (1.38–1.51)	< 0.001
Irregular	1.58 (1.43–1.73)	< 0.001	1.68 (1.60–1.75)	< 0.001
Diet habits (regular frequency and quantity)		< 0.001		< 0.001
Never	1.00		1.00	
Seldom	0.82 (0.77–0.86)	< 0.001	1.00 (0.95–1.06)	0.98
Sometimes	0.47 (0.44–0.49)	< 0.001	0.77 (0.74–0.81)	< 0.001
Always	0.19 (0.18–0.20)	< 0.001	0.47 (0.45–0.49)	< 0.001
Constant	0.72	< 0.001	3.38	< 0.001

Abbreviations: RESE, regulatory emotional self-efficacy; OR, odds ratio; 95% CI, 95% confidence interval; COVID-19, 2019 Coronavirus Disease.

<sup>a</sup> With depressive symptoms included individuals with PHQ-9  $\geq$  10, without depressive symptoms was defined as individuals with PHQ-9 < 10.

<sup>b</sup> High RESE included individuals with RESE scores higher than the median, low RESE was defined as RESE scores lower than the median.

$p < .001$  and OR = 0.78, 95% CI: 0.75–0.80,  $p < .001$ ; respectively).

#### 4. Discussion

In response to the COVID-19 pandemic, the National Health Commission of China released the notification of basic principles for emergency psychological crisis interventions on 26 January 2020 [28]. The Chinese Ministry of Education has issued official documents to support colleges and universities in providing psychological assistance hotlines on 28 January 2020 [29]. To date, there remains few epidemiological data on the mental health problems and psychiatric morbidity of college students. A recent study on the prevalence of anxiety in Chinese college students suggested that the COVID-19-related stressors (included effects on daily-life, and academic delays) were positively associated with the level of anxiety symptoms, indicating that the mental health of college students could be affected by public health emergencies [24]. In this study, we supplemented the effect of COVID-19 pandemic on the prevalence of depressive symptoms in Chinese college students and explored potential influencing factors.

Evidence indicated that major mental health burdens of the public during the COVID-19 outbreak included anxiety symptoms, depressive symptoms and sleep disorder [16]. A study surveyed immediate psychological responses among Chinese general population by using the 21-item Depression Anxiety Stress Scale (DASS-21), showing that 4.3% respondents were considered to suffer from severe and extremely severe depressive symptoms (DASS-21  $\geq$  21) in the initial outbreak of the pandemic (from January 31 to February 2, 2020) [6]. There was no significant longitudinal reduction in depressive level in the pandemic's peak four weeks later (from February 28 to March 1, 2020) [7]. Besides, student status was associated with a greater psychological impact of the outbreak, higher levels of stress, and depression [6]. Similarly, our study demonstrated that 7.7% of students reported depressive symptoms, relatively higher than the detection rates of depressive symptoms

among general population during the pandemic. The incidence of suicidal ideation in our study was 7.2%. According to a survey conducted on Chinese college students in 2014, 9.1% ( $n = 479$ ) of the 5245 students reported they have at some point thought about committing suicide [30]. One meta-analysis has shown that the overall pooled prevalence of suicidal ideation among Chinese college students is 10.72% [31]. Furthermore, the low prevalence of suicidal ideation in our study corresponds to the findings of recent epidemiological studies during the COVID-19 pandemic. An online survey of 673 healthy adults by Tan W et al. found that the prevalence of suicidal ideation was less than 2% [8]. Another study of people with and without psychiatric illnesses during the pandemic demonstrated that only 0.9% of healthy control reported suicidal ideation [32]. To some extent, while the current pandemic takes away health and life, college students are reminded to think about the theme of death. Although COVID-19 has created considerable stress and worry along with having significant impacts on daily life, healthcare professionals are on the front lines, battling diseases and caring for sick and dying patients, even while knowingly putting themselves at risk [33]. The determination of healthcare professionals to save lives as reported in the news is one form of positive life education. This may account for the high prevalence of depressive symptoms but relatively low suicidal ideation among college students during the pandemic as reported here.

In terms of demographic factors, female respondents showed significantly higher depressive symptoms than their male counterparts. This finding corresponds to previous study which found that women were at higher risk of depression [34]. Another recent study also reported that female had a greater psychological impact as well as higher levels of depression during the outbreak of COVID-19 [6]. Several studies have found that senior students have higher depressive symptoms compared with freshmen [35,36], similar to our findings. This may be because the higher grade students face more stressful events, such as graduation and employment [35].

A recent study demonstrated that majority of Chinese people stayed at home for 20–24 h per day during the COVID-19 pandemic (84.7%) [6]. It is necessary to learn about the relationship between the living rhythms and the mental health when they were quarantined at home. Our study noted that college students who went to bed early (before 24:00), rose early (6:00–8:00), undertook physical exercise and kept a regular diet had fewer depressive symptoms. Disruptions to circadian rhythms can lead to affective changes and may elicit or exacerbate symptoms in individuals with a predisposition for mental health disorders [37,38]. The associations between physical exercise, depression, and stress have already been widely discussed. Physical exercise was significantly and meaningfully associated with self-reported mental health burden, and might also mitigate the social isolation stress on immune system [39,40]. Furthermore, our research shows that during the COVID-19 pandemic, students who browse the pandemic information for less than 2 h a day have the lowest levels of depressive symptoms, and those who browse events for more than 5 h have the highest levels of depressive symptoms. This is consistent with the results by Yeen Huang and colleagues that young people who spend too much time browsing information of the COVID-19 pandemic are at high risk for mental illness [16]. From the perspective of stress theory, excessive attention on information of the current pandemic may lead to alternative trauma [41]. Although college students quarantined at home have no personal experience of infection and treatment, they show empathy through visceral experience when browsing the information about the death of patients and health care workers. And some college students might study in healthcare subjects and they are empathetic about the high stress levels experienced by healthcare workers [42,43]. Excessive empathy can also cause psychological pain and trauma [44].

We also found that favorable living rhythms are conducive to maintaining good levels of RESE, which refers to the degree of confidence with which individuals can effectively regulate their emotional state. This self-confidence can help individuals to use positive emotional regulation methods to adjust their emotions effectively [22]. In our study, the factor score for POS was higher than for NEG, and the score for ANG was the lowest. These results remind us of the need to pay attention to strengthening college students' skills in regulating negative emotions, in particular in regulating anger. Studies have shown that low levels of RESE can affect mental health, especially depressive symptoms [21]. RESE is a positive psychological quality that can help individuals fight depressive symptoms, anxiety and other negative emotions [19]. People with good RESE are less likely to have depressive symptoms [45], that is, different RESE levels have different probabilities for depressive symptoms. Therefore, RESE is also a protective factor against depressive symptoms in difficult circumstances such as the current pandemic.

The findings of this study lead to several recommendations for future interventions. First, we recommend that methods of emotion regulation should be publicized to college students during the pandemic, particularly relating to the relationship between living rhythms and emotion, and skills for improving negative emotion regulation efficacy. This could be achieved through online means. Second, we suggest that the home-school alliance should promote the need for students to create positive living rhythms, such as going to bed early, rising on time, and consuming regular meals. Third, clear communication with regular and accurate updates about the COVID-19 pandemic should be provided, and due in course, information about the return to school arrangements and academic tasks should be provided to address students' sense of uncertainty and improve their sense of control over life. Fourth, we suggest that college students try to limit their time spent on the current pandemic to no more than 2 h a day, only pay attention to the necessary information (such as clear facts and data) [46]. Fifth, colleges and universities should take the following personal and organizational prevention measures before the school reopen, such as keeping hand hygiene and wearing face masks, as well as good ventilation.

Improvement of school hygiene and increased concerns on students' physical health status could be helpful for reducing psychiatric problems [32].

This study has several limitations. First, the data and relevant analyses presented here were derived from a cross-sectional design, so it is difficult to make causal inferences. Second, the study adopts a network survey method because of quarantine. The sampling in our study was voluntary and conducted online but the possibility of bias should be nonetheless be considered. Third, based on the convenience sampling method, the participants in this study were college students in Guangdong Province. As a result, it cannot be applied to other provinces in China or other countries. In future research, stratified sampling needs to be carried out across the Chinese provinces in order to obtain a more comprehensive understanding of the situation of Chinese college students.

In conclusion, this observational cross-sectional clinical study aimed to determine the living rhythms and mental health of college students during quarantine at home during the COVID-19 pandemic. Through conducting a large-scale survey, we found that staying up late or irregular bedtimes were prominent problems experienced by college students when quarantined at home, which is worth paying attention to. Favorable living rhythms and moderate attention towards the pandemic may be protective factors for depressive symptoms and RESE. Our findings can be used to formulate psychological interventions aiming to prevent psychological problems in college students during the COVID-19 pandemic.

#### Declaration of Competing Interest

The authors have no competing interests to report.

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