



## Research article

# Social support moderates the relationship between sleep quality and mental health: A Chinese Fangcang shelter hospital-based study in asymptomatic COVID-19 carriers

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## ABSTRACT

This study aimed to determine the association between sleep quality and mental health in COVID-19 carriers in China and evaluate the moderating effects of perceived social support. 1283 asymptomatic COVID-19 carriers were enrolled from March 2022 to April 2022 among Ruijin Jiahe Fangcang shelter hospital in Shanghai, China. They were assessed using the Pittsburgh Sleep Quality Index (PSQI), the General Health Questionnaire (GHQ), and the Perceived Social Support Scale (PSSS) respectively. Participants had an average age of 39.64 years and 59.6 % of whom were male. In total, 34.3 % of participants presented with poor sleep quality; 41.1 % showed bad mental health. Sleep quality was positively related to mental health ( $r = 0.321$ ,  $P < 0.001$ , 95 %CI = 0.267, 0.369) and social support was negatively related to mental health ( $r = -0.414$ ,  $P < 0.001$ , 95 %CI =  $-0.457$ ,  $-0.367$ ). Meanwhile, social support played a moderating role between sleep quality and mental health ( $\beta = 0.066$ ,  $P < 0.05$ , 95 %CI = 0.016, 0.117). These findings indicate that mental health resulting from the COVID-19 pandemic are increasingly apparent in China and provide a focus on sleep quality for the early prevention of mental health in asymptomatic carriers. And social support may be beneficial to the improvement of mental health, especially for people in crisis (e.g., COVID-19 pandemic).

## 1. Introduction

The coronavirus disease 2019 (COVID-19) pandemic rapidly occurred in Shanghai, China at the end of February 2022, whose rapidity of spread, wide range of infections, and difficulty in prevention and control posed a huge threat to people's physical and mental health [1]. As a special population, asymptomatic COVID-19 carriers refer to patients with no symptoms at the screening point, which includes pre-symptomatic infections (infected people who have not developed symptoms yet, but go on to develop symptoms

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later), and true asymptomatic or covert infections (those who are infected but never develop any symptoms) [2,3]. A meta-analysis revealed that the combined proportion of asymptomatic infections stands at 32.4 % and indicated that asymptomatic COVID-19 carriers have viral loads comparable to symptomatic individuals, facilitating swift and stealthy spread within populations [4]. However, with temperature checks and symptom monitoring proving less effective at curbing pre-symptomatic transmission, asymptomatic infections emerge as significant potential transmission vectors for COVID-19 [5].

Although Fangcang shelter hospitals have made significant contributions to preventing the spread of pandemics, patients have experienced depression, anxiety, insomnia, and other psychological issues [6]. For example, Gu and colleagues discovered that 50.1 % of patients in Fangcang shelter hospitals exhibited symptoms of anxiety, while 54.4 % experienced depression, 10.2 % suffered from insomnia, and 39.7 % reported perceived stress [7]. A prior systematic review investigating the occurrence of major depressive disorder and anxiety disorder amid the COVID-19 pandemic revealed that the pandemic resulted in a heightened prevalence of anxiety and depression, each surpassing 25 % [8]. Nonetheless, there is a scarcity of research concerning the psychological well-being of asymptomatic COVID-19 carriers in Fangcang shelter hospitals. Sleep disturbances emerge as a primary psychological issue stemming from the COVID-19 pandemic [9], as patients must acclimate to the unfamiliar environment of Fangcang shelter hospitals and grapple with uncertainty regarding the progression of their illness during their admission period. Earlier research has showcased the detrimental impact of COVID-19 on sleep patterns [10], revealing that 56.7 % of patients diagnosed with coronavirus disease experienced disruptions in their sleep quality while hospitalized [11]. Similarly, findings from a meta-analysis indicated that 35.7 % of the general population encountered diverse sleep disturbances during the pandemic, with the prevalence escalating to 74.8 % among individuals afflicted with COVID-19 [12]. Likewise, Zhang and colleagues discovered a significant correlation between the sleep disorders of patients in Fangcang shelter hospitals and their mental health [6]. Hence, it is imperative not to underestimate the potential link between sleep patterns and mental disorders, as poor sleep quality has been shown to elevate the likelihood of encountering mental health issues. The concept that sleep disturbances are intricately intertwined with the susceptibility to future mental health disorders like depression was introduced more than two decades ago [13,14], and has since been consistently corroborated in recent studies encompassing diverse demographics, including university students [15], the elderly [16], and individuals diagnosed with COVID-19 [17].

In addition to the direct impact of sleep on mental health, perceived social support might be used to understand the mechanism of psychological or mental health problems [18]. Perceived social support concerns the emotional experience and satisfaction of how individuals perceive friends, family, and others as available to provide overall support. Higher ratings of perceived social support are recognized as being associated with lower levels of depression [19]. Ian Grey and colleagues' research demonstrated that amidst the COVID-19 pandemic, individuals who possessed robust social support experienced a 63 % decrease in the likelihood of experiencing depressive symptoms and a 52 % improvement in sleep quality [20]. Moreover, medical staff who posed higher levels of perceived social support also expressed increased sleep quality and reduced anxiety and stress [10]. The Buffer Model of Perceived Social Support states that perceived social support buffers the effects of stressful conditions on an individual's physical and mental health [21]. This potential buffering effect has already received initial validation in previous research. Studies by Yung et al. [22] discovered that social support from peers can effectively buffer the impact of poor sleep on mental issues among mothers. Similarly, research by Lu et al. [23] found a comparable buffering effect among college students. Therefore, we believe that the buffering role of social support in the relationship between sleep and mental health issues, supported by the Buffer Model of Perceived Social Support, is likely to be generalizable. Show concretely: with the interaction of protective factors (perceived social support) and risk factors (sleep problems) reducing the likelihood of adverse outcomes, with low levels of perceived social support leading to a significant decrease in mental health as sleep problems increase, and high levels of perceived social support leading to a decline at a slower rate as sleep problems increase.

Therefore, we conducted a cross-sectional study examining the mental health status, sleep quality, and perceived social support among asymptomatic carriers of COVID-19 during the 2022 Omicron outbreak of SARS-CoV-2 in Shanghai. Despite the highly contagious nature of the Omicron variant, the mortality rate was significantly lower compared to the initial wave of the pandemic in 2020. The study hypothesized that: (1) Sleep quality would demonstrate a significant association with mental health among asymptomatic carriers of COVID-19. (2) Social support would moderate the relationship between sleep quality and mental health.

## 2. Methods

### 2.1. Participants

The inclusion criteria for participants were as follows: (1) Being older than 18 years of age; (2) Being diagnosed with asymptomatic COVID-19 infection, determined by the real-time reverse transcriptase-polymerase chain reaction (RT-PCR) test's Cycle Threshold (Ct) value. A Ct value below 35 in the nasopharyngeal test for SARS-CoV-2 RNA was considered positive; and (3) Having the ability to independently complete the questionnaire using WeChat. Out of 1750 individuals referred to the hospital, 1425 successfully completed the questionnaire, resulting in a response rate of 81.4 %. Following the exclusion of 142 participants who did not meet the inclusion criteria, 1283 participants were included in the study.

### 2.2. Procedures

During the period from March to April 2022, a cross-sectional study was undertaken at the Ruijin Jiahe Fangcang Shelter Hospital in Shanghai. Participants for this study were recruited using non-probability sampling methods. Trained healthcare professionals at the

hospital informed asymptomatic COVID-19 carriers about the research, as well as the potential benefits and risks associated with participation. Field healthcare providers were responsible for inviting asymptomatic patients, with the goal of reaching over 80 % of those admitted. Upon obtaining informed consent, participants were sent the online questionnaire link via WeChat Official Accounts (Tencent, Changsha, Hunan, China; accessible at <https://wx.qq.com/mp/>), and they anonymously completed the electronic questionnaire on their smartphones in adherence to social distancing guidelines. The Chinese-language questionnaires were disseminated via the online survey platform “Questionnaire Star” (Changsha Ranxing Science and Technology, Shanghai, China; available at <https://www.wjx.cn>), a professional survey platform widely utilized by researchers in China.

### 2.3. Ethical statement

The authors affirm that all procedures involved in this work adhere to the ethical standards of the relevant national and institutional committees on human experimentation, as well as to the principles outlined in the Helsinki Declaration of 1975, with revisions made in 2008. This study received approval from the Ethics Committee of Shanghai Jiao Tong University School of Medicine affiliated Ruijin Hospital (approval number LL202070). Written informed consent was obtained from all participants.

### 2.4. Measurements

Demographic characteristics, such as gender, age, marital status, education level, and length of time from diagnosis were collected. Following self-report tools were applied.

#### 2.4.1. Pittsburgh Sleep quality index (PSQI)

The PSQI was developed by Chinese researchers to assess individuals' sleep quality [24]. The PSQI is a self-administered questionnaire comprising 19 items, organized into 7 sleep components: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbance, use of sleep medication, and daytime dysfunction. The total score, obtained by summing the component scores, ranges from 0 to 21 points. Elevated scores on the PSQI indicate poorer sleep quality. A cut-off value of 5 points is used to distinguish between good and poor sleepers, with scores exceeding 5 indicating poor sleep quality [25,26]. The PSQI has demonstrated satisfactory reliability (Cronbach's  $\alpha = 0.71$ ) and construct validity and has been extensively used among the Chinese population [27]. In this study, the Cronbach's  $\alpha$  was 0.85 for the total scale.

**Table 1**  
Sociodemographic characteristics and the distribution of mental health.

Variables	Respondents		Mental health			
	n	%	M	SD	t/F	P-value
<b>Sex</b>					1.362	0.243
Male	765	59.6	3.08	2.39		
Female	518	40.4	3.24	2.45		
<b>Age</b>					1.324	0.265
18–29	269	21.0	3.13	2.54		
30–39	394	30.7	3.24	2.42		
40–49	338	26.3	2.93	2.38		
≥50	282	22.0	3.27	2.31		
<b>Marital status</b>					1.000	0.368
Unmarried	285	22.2	3.04	2.49		
Married	948	73.9	3.19	2.40		
Divorced or widowed	50	3.9	2.78	2.16		
<b>Education level</b>					12.462***	< 0.001***
High school or below	906	70.6	3.29	2.34		
College or above	377	29.4	2.77	2.55		
<b>Length of time from diagnosis</b>					0.233	0.873
0–3	77	6.0	2.97	2.22		
4–7	109	8.5	3.17	2.45		
8–13	503	39.2	3.19	2.43		
≥14	594	46.3	3.11	2.42		
<b>Psychological counseling experience</b>					0.406	0.524
Yes	105	8.2	3.29	2.26		
No	1178	91.8	3.13	2.43		
<b>PSQI</b>						
≤5	843	65.7				
>5	440	34.3				
<b>GHQ-12</b>						
≤3	756	58.9				
>3	527	41.1				

Note. \*P < 0.05, \*\*P < 0.01, \*\*\*P < 0.001.

#### 2.4.2. General Health Questionnaire-12 (GHQ-12)

The GHQ-12 was developed by Chinese researchers to evaluate an individual's mental health conditions over the preceding two weeks [28,29]. In the questionnaire, the 0-0-1-1 rating indicates that the first two items selected by participants are scored as 0, while the last two items selected are scored as 1. Total scores range from 0 to 12, with higher scores suggesting more significant impairment in mental health. The cut-off for mental health is set as 3 points, where scores exceeding 3 indicate poor mental health [30,31]. The GHQ-12 has exhibited good construct validity and internal consistency, with a Cronbach's  $\alpha$  of 0.793 [32]. In the present study, the Cronbach's  $\alpha$  was 0.83.

#### 2.4.3. Perceived Social Support Scale (PSSS)

The PSSS was developed by Chinese researchers to evaluate an individual's social support [33]. The PSSS comprises 12 items and is a self-reported assessment tool designed to evaluate perceived social support from three sources: family, friends, and significant others. Respondents were asked to report their agreement with items using a 7-point Likert scale [34]. The PSSS yields total scores ranging from 12 to 84, with higher scores reflecting greater perceived social support. The PSSS demonstrates good psychometric properties and showed satisfactory reliability (Cronbach's  $\alpha = 0.86\text{--}0.89$ ) and validity in Chinese people [33,34]. In the current study, the Cronbach's  $\alpha$  were 0.95, 0.95, 0.93, and 0.98 for the three dimensions and total questionnaire, respectively.

#### 2.5. Data analysis

All the data was analyzed by SPSS 28.0 software. As all questions within the survey system were pre-set as mandatory, participants were only able to submit the questionnaire upon completion of every item, thereby ensuring no missing data. Initial analyses involved examining group variances in demographic characteristics, mental health, and sleep quality through t-tests and chi-square tests (Table 1). Spearman correlation analysis was used to test the associations between sleep quality, mental health and social support. After adjusting for covariates (sex, age, marital status, educational level, and length of time from diagnosis). Moderation analysis was conducted using version 4.1 of the PROCESS macro (Model 1) [35] to examine the indirect effect of social support. A significant indirect effect ( $a \times b$  path) is indicated when the 95 % confidence interval does not include zero [36]. Interaction terms were deemed statistically significant if they had a two-tailed  $P$ -value  $< 0.05$ , indicating moderating effects in the moderation model.

### 3. Results

#### 3.1. Descriptive statistics

Table 1 presents the demographic characteristics and the prevalence of mental health and sleep quality among 1283 asymptomatic COVID-19 carriers in Shanghai. A total of 51.7 % of participants were under the age of 40, and 765 (59.6 %) were male. The majority of participants were married (948 [73.9 %]) and had attained a high school education or below (906 [70.6 %]). Additionally, over 80 % of participants (1097) had been diagnosed as asymptomatic carriers for a duration of eight days or more. Psychological counseling was reported by 105 (8.2 %) participants. 34.3 % of patients exhibited poor sleep quality (PSQI  $> 5$ ), while 41.1 % showed poor mental health (GHQ  $> 3$ ). Through independent  $t$ -test and ANOVA analyses, it was discovered that participants with a high school education or below ( $M = 3.29$ ,  $SD = 2.34$ ) exhibited poorer mental health compared to those with a college education or higher ( $M = 2.77$ ,  $SD = 2.55$ ),  $t(3, 1281) = 3.53$ ,  $P < 0.001$ , Cohen's  $d = 0.21$ .

#### 3.2. Correlation analysis

Given the notable impact of education level on mental health observed in the  $t$ -test, the covariates were incorporated into the subsequent analysis. Table 2 provides the variables' means,  $SD$ , and correlations. After controlling education level, sleep quality was positively related to mental health ( $r = 0.321$ ,  $P < 0.001$ , 95 %CI = 0.267, 0.369) and social support was negatively related to mental health ( $r = -0.415$ ,  $P < 0.001$ , 95 %CI =  $-0.457$ ,  $-0.367$ ).

#### 3.3. Moderation analysis

According to Fang et al. [37], we can obtain standardized estimates of moderating effects by processing the missing values at first, ensuring that the data for all variables is complete, and then standardizing all variables in the condition of moderation effects of observed variables. Meanwhile, "Model 1" in the PROCESS macro version 4.1 was adopted to analyze the moderation effects, sleep

**Table 2**  
Correlations among variables in the measurement model.

Variables	$M$	$SD$	1	2	3
1.Sleep quality	4.80	3.47	1		
2.Mental health	3.14	2.41	0.321***	1	
3.Social support	57.51	19.32	0.048	$-0.415^{***}$	1

Note. \* $P < 0.05$ , \*\* $P < 0.01$ , \*\*\* $P < 0.001$ .

quality was set as the independent variable, mental health was the dependent variable, and the moderator was perceived social support. All variables were standardized, and educational level was controlled. In the moderation model, as shown in Table 3, poor sleep quality was significantly associated with lower mental health status ( $\beta = 0.348$ ,  $P < 0.001$ , 95 % CI = 0.301, 0.394). Additionally, social support negatively moderated the relationship between sleep quality and mental health ( $\beta = 0.065$ ,  $P < 0.05$ , 95 % CI = 0.015, 0.116). Fig. 1 depicts the association identified in the moderation effect analysis. Individuals with low social support exhibited a more significant impact of poor sleep quality on mental health ( $\beta = -0.402$ ,  $P < 0.001$ ) compared to those with high social support ( $\beta = -0.276$ ,  $P < 0.001$ ). Sensitivity analyses were conducted in the subgroup of participants who did not receive psychological counseling ( $N = 1178$ ). The sensitivity analysis revealed consistent findings in the fully-adjusted model, indicating that social support negatively moderated the relationship between sleep quality and mental health ( $\beta = 0.071$ ,  $P < 0.01$ , 95 %CI = 0.018, 0.124) (Table 3).

## 4. Discussion

### 4.1. Main findings

To our knowledge, this study represents the inaugural attempt to elucidate the moderating mechanism underlying the relationship between sleep quality and mental health among asymptomatic COVID-19 carriers in China. Our survey uncovered the detrimental impact of poor sleep quality on the mental health of asymptomatic COVID-19 carriers. Moreover, perceived social support was identified as a moderator in the relationship between sleep quality and mental health. These findings enhance comprehension of the interplay among sleep quality, perceived social support, and mental health, thereby facilitating the development of effective interventions to mitigate mental health issues.

The findings from this cross-sectional study indicate that approximately 41.1 % of the asymptomatic COVID-19 carriers sampled exhibited signs of poor mental health, a proportion slightly lower than the prevalence of psychological issues reported in other studies conducted several months or even a year after the onset of the COVID-19 pandemic [38]. For instance, in an observational, cross-sectional study conducted among 129 patients with mild to moderate illness at Jiangxia Fangcang hospitals in Wuhan, China, it was observed that 49.6 % of participants exhibited depressive or anxiety disorders [39]. A systematic review and meta-analysis, covering studies from November 1, 2019, to May 25, 2020, investigated the psychological impact of COVID-19 on healthcare workers, the general population, and particularly vulnerable patients. The review revealed that individuals with pre-existing conditions and those infected with COVID-19 experienced heightened levels of anxiety and depression, with anxiety rates reaching 56 % (ranging from 39 % to 73 %) and depression rates at 55 % (ranging from 48 % to 62 %) [40]. Discrepancies in findings may stem from variations in the measurement scales used to assess psychological problems. Furthermore, asymptomatic COVID-19 carriers typically lack relevant clinical symptoms such as fever, cough, sore throat, and others, which may mitigate their mental stress. Nevertheless, the prevalence of affective disorders among patients treated in Fangcang shelter hospitals remained higher than that of the general population, even after the virulence of the Omicron variant significantly weakened. A previous study investigated 1014 patients from two major Fangcang shelter hospitals in Shanghai between April 22 and May 8, 2022. The study revealed that the rates of positive screening for anxiety and depression were 55.3 % and 27 %, respectively [41]. Even one year post-infection, anxiety and depression persisted in a relatively high proportion of COVID-19 survivors (15.7 % and 20.9 %, respectively) [42]. These findings underscore the importance of addressing mental health issues among patients in Fangcang shelter hospitals.

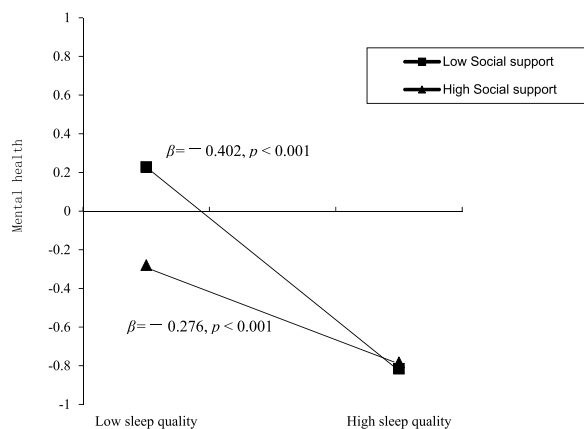
In our study, the pooled prevalence of sleep problems was 34.3 %, indicating that a proportion of participants experienced poor sleep quality significantly higher than a previous meta-analysis reporting the prevalence of sleep problems in adult general population in China 15 % before the COVID-19 pandemic [43]. A systematic review encompassing 10 studies with 13,025 individuals indicated

**Table 3**

Results of regression analyses of moderating effect of social support between sleep quality and mental health.

Variable	Mental health			
	$\beta$	<i>t</i>	95 % CI	<i>P</i> -value
<b>Model 1</b>				
Educational level	-0.126	-2.36	[-0.231, -0.021]	0.019*
Sleep quality	0.348	14.61	[0.301, 0.394]	<0.001***
Social support	-0.419	-16.39	[-0.469, -0.369]	<0.001***
Sleep quality × social support	0.065	2.53	[0.015, 0.116]	0.011*
R <sup>2</sup>	0.299			
<i>P</i>				<0.001***
<b>Model 2</b>				
Educational level	-0.136	-2.46	[-0.244, -0.027]	0.014*
Sleep quality	0.357	14.41	[0.308, 0.406]	<0.001***
Social support	-0.422	-15.78	[-0.475, -0.370]	<0.001***
Sleep quality × social support	0.071	2.61	[0.018, 0.124]	0.009**
R <sup>2</sup>	0.308			
<i>P</i>				<0.001***

Note. \* $P < 0.05$ , \*\* $P < 0.01$ , \*\*\* $P < 0.001$ . Model 1 was adjusted for educational level; Model 2 was additionally adjusted by excluding ever taking psychological counseling last week.



**Fig. 1.** Moderation effects of social support on the association between sleep quality and mental health in asymptomatic COVID-19 carriers (“Model 1” in the PROCESS macro version 4.1).

that the sleep quality of all populations during the COVID-19 epidemic was poor [44]. Comparable results to those of the present study were noted in Jahrami’s work [12]. Their systematic reviews, comprising 44 papers, uncovered a significant prevalence of insomnia or sleep problems among the general population during the COVID-19 pandemic (35.7 %). Similarly, another systematic review, incorporating 66 studies, identified a heightened prevalence of sleep disturbances (37.9 %) among various populations during the COVID-19 pandemic [45]. These differences can be partially attributed to the reliance of meta-analyses on proportions, which are influenced by factors such as the frequency of events, the total population, and the number of studies included [46]. Another contributing factor could be that many of the studies incorporated in previous systematic reviews were conducted within the first six months of the COVID-19 pandemic outbreak. This period was characterized by heightened anxiety and uncertainty as individuals grappled with adapting to the emergency circumstances [47]. Nonetheless, even when compared with previous investigations into the mental health of patients in Fangcang shelter hospitals, our data were gathered two years after the onset of the pandemic, during a period when patients had acquired more knowledge about COVID-19. Despite this increased awareness, the prevalence of sleep disorders in our study remains notably high, aligning with findings from a survey conducted by Peng et al. among patients treated in Fangcang shelter hospitals in Shanghai in 2022. Peng et al. similarly reported a high prevalence of insomnia among patients (47.8 %) [41]. A recent longitudinal study has highlighted a pooled prevalence of 23.86 % for insomnia as a long-term consequence of COVID-19, observed after a 24-month follow-up period. Consequently, sleep disturbances ought to be regarded as a significant intervening factor, given their recognized status as persistent and prevalent neuropsychiatric sequelae affecting the mental health of COVID-19 [48].

Extensive research indicates that stressful life events and outbreaks of infectious diseases, such as COVID-19, can significantly impact sleep quality [49–51]. Additionally, previous studies have documented the effects of sleep quality on mental health across various populations, highlighting its universal importance. For instance, a study by Olagunju et al. [52] found that the proportions of psychological distress and sleep disturbances reported by healthcare workers, who are on the front lines of the COVID-19 response, were significantly higher than those documented in similar situations before the pandemic. The high levels of poor sleep were significantly associated with their mental health problems. Similar findings were also reported by a study targeting frontline nurses [53]. Besides, for COVID-19 survivors, research by Cai et al. [54] found that although they successfully recovered physically from the disease, they commonly face ongoing poor sleep and psychological problems, with a close relationship with each other. These findings align with our observations among asymptomatic COVID-19 carriers, suggesting that poor sleep quality is a pervasive risk factor for mental health issues across different demographics affected by the pandemic. The results we obtained can be interpreted as being due to the fact that poor sleep quality, for example, difficulty falling asleep and short sleep duration, may exacerbate emotional states and heighten feelings of anxiety with daytime tiredness. This, in turn, may contribute to an increase in mental health problems. Moreover, the link between poor sleep quality and depressive and anxious symptoms may be attributed to an increased activation of REM sleep mechanisms [55].

Furthermore, the current study revealed that individuals who reported lower levels of social support were more susceptible to mental health issues. This corroborates previous research emphasizing the crucial role of social support in coping with prolonged stressors that cannot be easily resolved on an individual basis [56]. Social support functions as a buffer for poor sleep quality and bad mental health. Higher perceived social support could serve as a foundation for sustaining a stable psychological state. Those who experience greater degrees of social support possess more psychological resources, enabling them to more efficiently harness these resources to mitigate the detrimental impacts of stress or challenging circumstances on their psychological health. Study by Yung et al. [22] proposed that social support would buffer the effects of poor sleep on mental health among mothers. For young individuals in this demographic facing difficulties, friends are often the most accessible source of support. Through effective support from friends, they can receive ample emotional support. This emotional support helps reduce daily stress, reducing the possibility of bad emotions worsening into mental problems [57]. In the present study, perceived social support was found to protect those with poor sleep quality following COVID-19 from mental health problems, otherwise, individuals with lower perceived social support may fail in recuperation

and rejuvenation of the brain, which then leads to increased anxiety and depressive mood. Firstly, families should give more emotional care to asymptomatic COVID-19 carriers, more importantly, it is the support in terms of speech and mental encouragement. Secondly, Fangcang shelter hospital needs to provide scientific knowledge about COVID-19, organize as many appropriate activities as possible to promote communication and establish new social support relationships among patients. In addition, when giving social support to asymptomatic COVID-19 carriers, we should pay attention not only to the psychological social support given, but also to the actual social support given as much as possible, such as a quiet environment to rest, enough masks, and nutritious diets. That is, pay more attention to the asymptomatic COVID-19 carriers' emotions and improve their ability to perceive social support to improve their psychological health.

#### 4.2. Strengths and limitations

One notable limitation of this study is its cross-sectional design, which precludes the establishment of a causal relationship between sleep quality and mental health. Cross-sectional studies might be helpful in understanding different scenarios of public health, but this design is far to be the best design investigating mechanisms. Another limitation of this study is the utilization of self-reported questionnaires, which introduces the potential for response bias. Participants may have underreported or overreported their sleep quality and mental health status due to social desirability bias or inaccuracies in recall. Future research could mitigate this limitation by incorporating objective measurements of sleep quality, such as actigraphy, and clinical assessments of mental health to provide a more accurate evaluation. Third, we could not adjust for other factors that could affect sleep quality and mental health in this study, such as socioeconomic status, comorbidities, and medicine usage, which we recommend taking into account in the following research to control these possible confounding biases. Despite these limitations, we believe that our results are valuable, given the substantial sample size of asymptomatic COVID-19 carriers admitted to this study. Additionally, our results contribute meaningful insights that can inform future public health interventions regarding the importance of sleep quality in mitigating and addressing mental health issues.

#### 5. Conclusions

The research highlighted the considerable influence of sleep quality on the mental health of asymptomatic COVID-19 carriers hospitalized in Fangcang shelter hospitals. Additionally, perceived social support emerged as a protective factor against mental health challenges. These results offer targeted guidance for hospitals and healthcare facilities to integrate psychosocial support and interventions for asymptomatic COVID-19 patients. Implementing psychological counseling and support services can enhance coping mechanisms aimed at addressing feelings of anxiety and fear related to COVID-19, thereby potentially averting long-term mental health consequences in individuals experiencing poor sleep quality [58]. Furthermore, early identification and relief of asymptomatic COVID-19 carriers may effectively block the effects of sleep quality problems on psychological distress. Particularly, physicians should be alert about delayed-onset and persistent courses of poor sleep conditions and bad mental health among asymptomatic COVID-19 carriers, which might lead to chronic post-traumatic stress disorder [59]. Further studies of asymptomatic COVID-19 carriers are needed to monitor the long-term association between sleep quality and psychological condition to avoid further chronic impact of the epidemic.

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#### Data availability statement

Data will be made available on request.

#### CRediT authorship contribution statement

**Lulu Xu:** Writing – original draft, Methodology, Formal analysis, Conceptualization. **Ying Gao:** Writing – original draft, Formal analysis. **Dake Shi:** Resources, Investigation. **Ying Wang:** Supervision. **Rui Li:** Writing – review & editing, Validation. **Yong Cai:** Writing – review & editing, Funding acquisition.

#### Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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