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Research paper

Sleep Conditions Associate with Anxiety and Depression Symptoms among Pregnant Women during the Epidemic of COVID-19 in Shenzhen

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ABSTRACT

Background: Pregnant women often encounter psychiatric symptoms and declined sleep quality as pregnancy proceeds. The associations between sleep conditions and anxious and depressive symptoms among pregnant women remained to be investigated, particularly during the epidemic of COVID-19.

Methods: An online cross-sectional survey on pregnant women was conducted at the time period of fast increasing cases of COVID-19 in Shenzhen. The Self-Rating Anxiety Scale (SAS) and the Patient Health Questionnaire (PHQ-9) were applied to detect anxious and depressive symptoms. Multivariable logistic regressions models were established to explore the associations of sleep conditions with psychological symptoms.

Results: In total, 751 pregnant women were enrolled, with a mean age of 30.51 years (Standard deviation: 4.28). Overall, 82.7% of the respondents considered low risk of being infected by COVID-19. The prevalence of anxiety and depression symptoms during the epidemic of COVID-19 among pregnant women were 13.4% and 35.4%, respectively, but most of which were mild. Variables referred to poor sleep conditions were strongly associated with anxious and depressive symptoms, including random or late time of going to bed, difficulty in falling sleep, short sleep duration, and ordinary or poor subjective sleep quality.

Limitations: Non-random sample restricted generalization of our findings to the whole population of pregnant women.

Conclusions: Our research revealed a notable proportion of the pregnant women who exhibited mild anxiety and depression symptoms during the epidemic of COVID-19 in Shenzhen. Targeted interventions in improving sleep conditions might help alleviate gestational anxious and depressive symptoms.

1. Introduction

A novel global health emergency, the appearance of Coronavirus Disease 2019 (COVID-19), has been firstly reported from December, 2019 (Zhu et al., 2020). COVID-19 caused an outbreak of pneumonia in Wuhan, Hubei province, and quickly appeared in the other provinces of China (Li et al., 2020). As of 31 May 2020, data from the World Health Organization (WHO) demonstrated that there were 5,934,936 confirmed cases and 367,166 confirmed deaths occurred globally (available at: https://www.who.int/docs/default-source/coronavirus/situation-reports). COVID-19 is a highly contagious disease caused by the most recently discovered coronavirus, which is similar to the pathogen of the severe acute respiratory symptom (SARS), belonged to a beta-coronavirus family and being spread to humans via some uncertain intermediate hosts (Paules et al., 2020; Velavan and Meyer, 2020). The initial presenting symptoms have been identified to be fever, dry cough, and dyspnea in most observations so far (Jiang et al., 2020). An incubation period of COVID-19 was estimated of 2~14 days and has a mean of around 5 days when integrating public available cases (Linton et al., 2020). Spread via virus-laden respiratory droplets was considered as the
main route of transmission, whereas other potential transmitted routes were also disclosed, e.g. fecal-oral transmission (Zhang et al., 2020). Earlier modeling studies attempted to estimate the reproduction number (R0), which was usually applied to reflect the severity of infectious diseases, suggesting a comparable transmission risk of COVID-19 to H1N1 and SARS (Fang et al., 2020). Moreover, it brought serious concerns and worries to the public due to close human-to-human transmission, in particular of suspected asymptomatic carrier transmission of COVID-19 (Bai et al., 2020).

The Chinese government quickly took efforts to slow down the epidemic of COVID-19, and extended home quarantine to nearly all provinces and cities by the end of January, 2020. People then seldom went outside except for purchasing necessities, and were recommended to stay in a social isolated status at home. Simultaneously, there was urgent shortage of protective supplies across the country, such as protective masks, suits, and medical equipment. Under these circumstances, the ongoing spread of COVID-19 might lead to psychosocial impacts of non-infected persons, similar to the reports during the outbreak of SARS (Cheng and Cheung, 2005; Lee et al., 2006). Recently, a series of psychosocial features was identified in the general public in mainland China immediately after the COVID-19 outbreak, including depression, anxiety, and stress (Wang et al., 2020a), and the severity maintained longitudinally during the peak of COVID-19 epidemic (Wang et al., 2020b). Recent studies found that 7.9% of psychiatric patients (Hao et al., 2020) and 0.4% of general workforce (Tan et al., 2020) suffer from insomnia during the COVID-19 pandemic. However, the majority of studies targeted on the epidemiology, causes, clinical manifestation and diagnosis, treatment, prevention and control of COVID-19, there was still limited known information on the mental health status of specific vulnerable populations varied with the epidemic of COVID-19.

Women at pregnancy were thought to be a susceptible subgroup to unstable emotions, and subsequently emotional or mental problems in this period could result in adverse child outcomes (Glover, 2014). Although at present there was no evidence that pregnant women were at higher risk of being infected by COVID-19 than the general population, nor did they demonstrate intrauterine infection caused by vertical transmission (Chen et al., 2020), pregnant women might have to face with more stressful events because of higher demands for specific healthcare. During the 2003 SARS outbreak, researchers found that pregnant women tended to overestimate the risk of being infected by SARS and adopted behavioral strategies to mitigate their risk (Lee et al., 2006). They also measured the psychological responses of pregnant women and reported a comparable depressive level but a slightly higher level of anxiety when compared to pre-SARS controls (Lee et al., 2006). Similar negative bio-psychosocial impacts on the pregnant women were also demonstrated in Zika virus that caused another infectious disease. The fears of being infected could induce psychosocial adjustment of pregnant women, like negative feelings, changes in behavioral customs, attitudes towards body image, and prevention demands (Figueiras et al., 2017). Nevertheless, potential psychiatric responses to COVID-19 among pregnant women remained to be investigated.

In addition to common mental problems, most pregnant women often encountered declined sleep quality as pregnancy proceeds (Polo-Kantola et al., 2017), which was supposed to be linked with the onset, exacerbation, and relapse of mood disorders (Rumble et al., 2015). The sleep quality of pregnant women were negatively associated with the stress level they received (Li et al., 2016), to some possible extent, generated from an emerging infectious disease outbreak (Chen et al., 2017; Wang et al., 2020a). Hence, priority should be taken place in understanding the sleep conditions of pregnant women during the epidemic of COVID-19 as well. Based on above-mentioned concerns, we attempted to detect the mental manifestations of pregnant women in Shenzhen when suffering the rapid spread of the novel COVID-19, as well as to explore whether sleep conditions impact on their mental health status in the current study, which may provide future directions for the formulation of psychological healthcare interventions during analogous public health emergencies.

2. Methods

2.1. Study setting and subjects

We conducted a cross-sectional survey in Shenzhen city from February 17th to March 16th, 2020, in which the coronavirus infection increased rapidly in mainland China. Shenzhen is an economically developed region with density migrants, located in the central of Guangdong province, Southern China. Thus, it tended out to be one of the cities that were largely affected by the coronavirus infection except Hubei province, reported more than 420 confirmed infections from January to early March, 2020. The targeted population of this study was local pregnant women. Pregnant women who visited obstetric clinics in maternity and child healthcare hospitals of Shenzhen need to receive maternal education courses, and would automatically become members of the Pregnant Woman School (PWS). We successfully distributed a unique two-dimensional code to candidate pregnant women through the WeChat groups that involved in all PWSs, which linked with the electronic questionnaire. We then recruited pregnant women who were willing to participate. Furthermore, a snowball sampling strategy was also applied as we put a recruitment notice through official release by Shenzhen Maternity and Child Healthcare Hospital (SMCHH). Each follower would receive this notice. Here, the majority of the followers are pregnant women, as the official account is linked with the appointment of antenatal examination services. We also encouraged the public that got this notice to pass this survey to pregnant women around. Women without severe physical or mental disorders diagnosed by a clinician before were invited for participation. A full explanation of the study objectives, contents, procedures, associated benefits and risks was provided in front of the questionnaire. During the survey time period, pregnant women, who confirmed their willing to participate in this survey, selected the option of voluntary participation for informed consent, and then got access to finish an online questionnaire. Therefore, a convenient sample of pregnant women in Shenzhen was recruited. The study protocol was approved by the Institutional Review Board of SMCHH.

2.2. Measurement

A self-administrated questionnaire contained socio-demographic information and subjective health and behavior evaluation was applied, accompanied by the measure of anxiety and depression symptoms. In order to avoid blank or invalid answers, all items of the questionnaire were set as required questions.

2.2.1. Socio-demographic characteristics

Socio-demographic variables included age, ethnicity, marital status, local household registration, education, employment status, monthly income level, health insurance, parity and gestational weeks for the current pregnancy. Details of the categorical division of nominal or ordinal variables were shown in Table 1.

2.2.2. Subjective health and behavior evaluation

Women were further asked to estimate coronavirus related events and daily behaviors during the epidemic of COVID-19. Firstly, coronavirus related contact histories were asked by two questions: “Have you (or your family members) ever had close contacts related to the coronavirus in recent one month?”, with two options (Yes/No). Here, people who had close contacts were defined as: ever been to the outbreak or epidemic areas, or having close contact with confirmed or suspected cases. Secondly, women were successively asked “whether there were confirmed or suspected coronavirus infections in the community you lived, or among your acquaintances and family members?”, with triple options (Yes/No/ Uncertain). Thirdly, whether women took proper precautions against the
Table 1
Socio-demographic characteristics, subjective health and behavior evaluation of all respondents (N=751).

| Variables                              | Number | Percentage (%) |
|----------------------------------------|--------|----------------|
| **Socio-demographic Characteristics**  |        |                |
| Age (years)                            | 30.51±4.28 |                |
| <30                                    | 325    | 43.3           |
| 30–34                                  | 292    | 38.8           |
| >35                                    | 154    | 17.8           |
| Ethnicity                              |        |                |
| Han ethnicity                          | 700    | 93.2           |
| Other ethnicities                      | 51     | 6.8            |
| Marital status                         |        |                |
| Single/divorced                        | 26     | 3.5            |
| Married                                | 725    | 96.5           |
| Local household registration           |        |                |
| No                                     | 353    | 47.0           |
| Yes                                    | 398    | 53.0           |
| Education                              |        |                |
| Senior high school or below            | 176    | 23.4           |
| College or above                       | 575    | 76.6           |
| Employment status                      |        |                |
| Unemployed                             | 230    | 30.6           |
| Employed                               | 521    | 69.4           |
| Monthly income (RMB)                   |        |                |
| ≤5,000                                 | 245    | 32.6           |
| 5,001–8,000                            | 196    | 26.1           |
| >8,000                                 | 310    | 41.3           |
| Health insurance                       |        |                |
| No                                     | 66     | 8.8            |
| Yes                                    | 685    | 91.2           |
| Parity for current pregnancy           |        |                |
| First                                  | 514    | 68.4           |
| Second                                 | 214    | 28.5           |
| Third or more                          | 23     | 3.1            |
| Gestational weeks for current pregnancy|        |                |
| <14                                    | 74     | 9.9            |
| 14–27                                  | 290    | 38.6           |
| >28                                    | 387    | 51.5           |
| Coronavirus related events             |        |                |
| Close contacts related to the coronavirus of themselves | | |
| No                                     | 718    | 95.6           |
| Yes                                    | 33     | 4.4            |
| Close contacts related to the coronavirus of their family members | | |
| No                                     | 716    | 95.3           |
| Yes                                    | 35     | 4.7            |
| Confirmed or suspected coronavirus infections in the community they lived | | |
| No                                     | 662    | 80.1           |
| Yes                                    | 66     | 8.8            |
| Uncertain                              | 83     | 11.1           |
| Confirmed or suspected coronavirus infections among their acquaintances | | |
| No                                     | 635    | 84.6           |
| Yes                                    | 12     | 1.6            |
| Uncertain                              | 104    | 13.8           |
| Confirmed or suspected coronavirus infections among their family members | | |
| No                                     | 738    | 98.3           |
| Yes                                    | 0      | 0.0            |
| Uncertain                              | 13     | 1.7            |
| Taking precautions against the coronavirus infection | | |
| No                                     | 3      | 0.4            |
| Yes                                    | 748    | 99.6           |
| Subjective risk of being infected by the coronavirus | | |
| Low                                    | 621    | 82.7           |
| Moderate                               | 115    | 15.3           |
| High                                   | 15     | 2.0            |
| Subjective life impact by the coronavirus | | |
| Mild                                   | 54     | 7.2            |
| Moderate                               | 460    | 61.3           |
| Severe                                 | 237    | 31.6           |
| Subjective psychological impact by the coronavirus | | |
| Mild                                   | 170    | 22.6           |
| Moderate                               | 499    | 66.4           |
| Severe                                 | 82     | 10.9           |
| Daily behaviors during the epidemic of COVID-19 | | |
| Time spent in physical exercise per day (minutes) | | |
| None                                   | 158    | 21.0           |
| < 30                                   | 432    | 57.5           |

Table 1 (continued)

| Variables                              | Number | Percentage (%) |
|----------------------------------------|--------|----------------|
| ≥ 30                                   | 161    | 21.4           |
| Time spent in the internet or social medias per day (hours) | | |
| <1                                     | 165    | 22.0           |
| 1–3                                    | 215    | 28.6           |
| >5                                     | 371    | 49.4           |
| Time spent in news related to the coronavirus per day (hours) | | |
| <1                                     | 382    | 50.9           |
| 1–3                                    | 288    | 38.3           |
| >3                                     | 81     | 10.8           |
| Sleep conditions during the epidemic of COVID-19 | | |
| Time of going to bed                    | | |
| Random time                            | 83     | 11.1           |
| Before 00:00                           | 536    | 71.4           |
| After 00:00                            | 132    | 17.6           |
| Difficulty in falling sleep            |        |                |
| No                                     | 506    | 67.4           |
| Yes                                    | 245    | 32.6           |
| Sleep duration at night                |        |                |
| Short                                  | 87     | 11.6           |
| Moderate                               | 467    | 62.2           |
| Long                                   | 197    | 26.2           |
| Subjective sleep quality               |        |                |
| Good                                   | 362    | 48.2           |
| Ordinary                               | 305    | 40.6           |
| Poor                                   | 84     | 11.2           |
| Mental symptoms during the epidemic of COVID-19 | | |
| SAS standardized score                 | 40.73±7.89 | |
| Anxiety symptom                        |        |                |
| None                                   | 650    | 86.6           |
| Mild                                   | 84     | 11.2           |
| Moderate                               | 16     | 2.1            |
| Severe                                 | 1      | 0.1            |
| PHQ-9 score                            | 3.97±4.09 | |
| Depression symptom                     |        |                |
| None                                   | 485    | 64.6           |
| Mild                                   | 198    | 26.4           |
| Moderate                               | 50     | 6.7            |
| Severe                                 | 16     | 2.1            |
| Extremely severe                       | 2      | 0.3            |

Anxious symptom among pregnant women was detected by the Self-Rating Anxiety Scale (SAS). The SAS has been applied in Chinese populations in numerous studies, performing good validity and acceptable
while 15.3% and 82.7% of the respondents considered moderate or low risk they were at high risk of being infected by the coronavirus, precautions against the coronavirus infection. Only 2.0% of them their acquaintances (1.6%), or even none report among their family less reports on confirmed or suspected coronavirus infections among leaving high proportions of no report or uncertain situations. There were respondents, only a minority reported a close contact related to the trimester of pregnancy (over 28 gestational weeks).

For most of these women (68.4%), the current pregnancy was at over 28 weeks, and more than three quarters (76.6%) of pregnant women were employed, and approximately one third (32.6%) of them had relatively lower monthly income (less than 5,000 RMB), along with a high proportion (91.2%) of owning health insurance. For most of these women (68.4%), the current pregnancy was at the first party, and nearly half of them (51.5%) were in the third trimester of pregnancy (over 28 gestational weeks).

Coronavirus related events were also displayed in Table 1. Of all respondents, only a minority reported a close contact related to the coronavirus for themselves (4.4%) or their family members (4.7%). Less than one tenth of them (8.8%) reported that there were confirmed or suspected coronavirus infections in the community where they lived, leaving high proportions of no report or uncertain situations. There were reports on confirmed or suspected coronavirus infections among their acquaintances (1.6%), or even none report among their family members (0.0%). Nearly all women (99.6%) reported having taken precautions against the coronavirus infection. Only 2.0% of them thought they were at high risk of being infected by the coronavirus, while 15.3% and 82.7% of the respondents considered moderate or low risk, respectively. More than thirty percent (31.6%) and ten percent (10.9%) of pregnant women reported severe life and psychological impacts by this novel virus, respectively.

During the epidemic of COVID-19, one fifth of pregnant women did not have physical exercise, 57.5% of them took exercise for less than 30 minutes, and the remaining one fifth spent over 30 minutes in exercise. About half of the participants (49.4%) spent over five hours per day in the internet or social media, whereas 10.8% of pregnant women followed news related to the coronavirus for more than three hours per day. Sleep conditions of pregnant women during the epidemic of COVID-19 were also surveyed (Table 1). Most of participants (71.4%) went to bed before 00:00, the rest of them slept after 00:00 (17.6%) or with a random time (11.1%). Sixty-two percent of pregnant women had a moderate sleep duration (7~9 hours), while 11.6% and 26.2% of them reported a shorter or longer duration. Almost one third (32.6%) of the women had difficulty in falling sleep. Less than half of the women (48.2%) reported a good subjective sleep quality, 40.6% of them replied an ordinary level, and 11.2% of them complained a bad sleep quality.

Of all participant, the mean standardized score of SAS scale was 40.73 (standard deviation: 7.89). The prevalence of anxiety symptom among pregnant women was 13.4% (11.2% for mild, 2.1% for moderate, and 0.1% for severe symptom, respectively). The mean score of PHQ-9 scale was 3.97 (standard deviation: 4.09). Totally 35.4% of women showed depression symptom during the epidemic of COVID-19. The proportions of mild, moderate, severe, and extremely severe symptom were 26.4%, 6.7%, 2.1%, and 0.3%, respectively (Table 1).

The anxious and depressive symptoms of pregnant women distributed differently across distinct sleep conditions (all P values were less than 0.05, Table 2 and 3). The associations of sleep conditions with anxiety and depression during the epidemic of COVID-19 also remained robust even after adjusting for various potential confounders in different models. Sleep variables found to be associated with anxiety symptom were: random (OR=2.67, 95%CI: 1.36~5.22) time of going to bed, difficulty in falling sleep (OR=4.02, 95%CI: 2.45~6.58), odds ratio (OR=3.43, 95%CI: 2.16~6.87) and poor subjective sleep quality (OR=27.34, 95%CI: 12.37~60.44) (Table 2). Similar associations of sleep conditions with depression symptom were also observed: random (OR=4.38, 95%CI: 2.55~7.50) or late (OR=2.78, 95%CI: 1.79~4.31) time of going to bed, difficulty in falling sleep (OR=6.04, 95%CI: 4.19~8.72), short sleep duration (OR=2.08, 95%CI: 1.24~3.50), ordinal (OR=4.70, 95%CI: 3.19~6.93) and poor subjective sleep quality (OR=17.55, 95%CI: 9.09~33.88) (Table 3).

To our knowledge, this study was the first investigation to examine sleep conditions and psychological symptoms of pregnant women in response to the epidemic of COVID-19, and helpfully to guide the direction of maintaining mental health among emotionally sensitive groups when undergoing public health emergency of international or nationwide concerns. We observed that even though few pregnant women had COVID-19 related close contacts (direct or indirect), nor considered a high risk of being infected, a substantial proportion (one fifth) of them still complained moderate or severe psychological impacts by this novel virus, respectively.
using the same assessment tool, the overall prevalence of antenatal anxiety in our study (13.4%) was close to that in Shanghai (11.4%) (Ma et al., 2019), but lower than those in Changchun (20.6%) (Kang et al., 2018), Zhejiang province (Li et al., 2019) when using a cut-off point (moderate to extremely severe levels), the prevalence was changed to be 35.4%, much higher than the rate (12.0%) among postmenopausal women in Zhejiang province (Li et al., 2019). The reasons for varied prevalence possibly lied in diverse cultural, social, economic, and religious backgrounds in different countries and regions (Zhang et al., 2018). Besides, different measurement instruments, cut-off scores, and samples from distinct trimesters of pregnancy across multiple studies could also contribute to these inconsistencies. Since most of measurement instruments were self-administered and subjective rating, the prevalence of mental disorders might be over or under estimated to some extent. Therefore, restrictive standard diagnosis tools could be required in further investigations, such as using the Diagnostic and Statistical Manual of Mental Disorders (DSM) (Park and Kim, 2020).

In line with the general population of which 84.7% spent 20–24 hours per day at home due to home quarantine (Wang et al., 2020a), most women tended to take no or less physical exercise (less than 30 minutes per day) when staying at home in the current study. On the contrast, they spent much time (more than 5 hours per day) in the internet or social media, since the internet was thought to be the primary health information channel (Wang et al., 2020a). These daily customs probably did affect the sleep conditions of pregnant women. We found that women might experience less insufficient (11.6%) and more excessive (26.2%) sleep duration in our study when compared to the

Table 2

| Sleep conditions | With anxiety symptom n(%) | Without anxiety symptom n(%) | P value | Model 1 OR (95%CI) | Model 2 OR (95%CI) | Model 3 OR (95%CI) |
|------------------|---------------------------|-----------------------------|--------|--------------------|--------------------|--------------------|
| Time of going to bed |                           |                             |        |                    |                    |                    |
| Random time     | 19 (22.9)                 | 64 (77.1)                   | <0.001 | 2.50 (1.38, 4.54)  | 2.72 (1.47, 5.01)  | 2.67 (1.36, 5.22)  |
| Before 00:00    | 51 (9.5)                  | 485 (90.5)                  |        | 1.00 (reference)   | 1.00 (reference)   | 1.00 (reference)   |
| After 00:00     | 31 (23.5)                 | 101765.5                    |        | 2.82 (1.71, 4.65)  | 2.87 (1.72, 4.80)  | 2.19 (1.23, 3.91)  |
| Difficulty in falling sleep | No | 33 (6.5)                  | 473 (93.5)                  | <0.001 | 1.00 (reference)   | 1.00 (reference)   | 1.00 (reference)   |
|                  | Yes                      | 68 (27.8)                  |        | 5.53 (3.51, 8.72)  | 5.71 (3.60, 9.07)  | 4.02 (2.45, 6.58)  |
| Sleep duration at night (hours) | Short | 19 (21.8) | 68 (78.2) | 0.029 | 1.93 (1.07, 3.46)  | 1.99 (1.10, 3.62)  | 1.63 (0.84, 3.14)  |
|                  | Moderate                 | 62 (13.3)                  | 405 (86.7) | 1.00 (reference)   | 1.00 (reference)   | 1.00 (reference)   |
|                  | Long                     | 20 (10.2)                  | 177 (89.8) | 0.68 (0.40, 1.17)  | 0.70 (0.40, 1.21)  | 0.58 (0.32, 0.96)  |
| Subjective sleep quality | Good | 12 (3.3)                  | 350 (96.7) | <0.001 | 1.00 (reference)   | 1.00 (reference)   | 1.00 (reference)   |
|                  | Ordinary                 | 43 (14.1)                  | 262 (85.9) | 4.90 (2.52, 9.52)  | 5.10 (2.60, 10.01) | 4.33 (2.16, 8.67)  |
|                  | Poor                     | 46 (54.8)                  | 38 (45.2) | 36.49 (17.59, 75.70) | 42.27(20.25, 92.47) | 27.34 (12.37, 60.44) |

Model 1: Adjusted for age (continues)
Model 2: Adjusted for age (continues), ethnicity, local household registration, marital status, education, monthly income, employment, health insurance, parity and gestational week for current pregnancy
Model 3: Adjusted for age (continues), ethnicity, local household registration, marital status, education, monthly income, employment, health insurance, parity and gestational week for current pregnancy, subjective life impact and risk of being infected by the coronavirus, time spent in physical exercise and using the internet or social medias per day.

Table 3

| Sleep conditions | With depression symptom n(%) | Without depression symptom n(%) | P value | Model 1 OR (95%CI) | Model 2 OR (95%CI) | Model 3 OR (95%CI) |
|------------------|-----------------------------|-----------------------------|--------|--------------------|--------------------|--------------------|
| Time of going to bed |                           |                             |        |                    |                    |                    |
| Random time     | 49 (59.0)                  | 34 (41.0)                   | <0.001 | 3.62 (2.24, 5.85)  | 4.42 (2.64, 7.40)  | 4.38 (2.55, 7.50)  |
| Before 00:00    | 145 (27.1)                 | 391 (72.9)                  |        | 1.00 (reference)   | 1.00 (reference)   | 1.00 (reference)   |
| After 00:00     | 72 (54.5)                  | 60 (45.5)                   |        | 3.17 (2.14, 4.70)  | 3.35 (2.22, 5.04)  | 2.78 (1.79, 4.31)  |
| Difficulty in falling sleep | No | 107 (21.1) | 399 (78.9) | <0.001 | 1.00 (reference)   | 1.00 (reference)   | 1.00 (reference)   |
|                  | Yes                      | 159 (64.9)                 |        | 6.99 (4.97, 9.85)  | 7.25 (5.09, 10.32) | 6.04 (4.19, 8.72)  |
| Sleep duration at night (hours) | Short | 44 (50.6) | 43 949.4 | 0.007 | 2.09 (1.31, 3.34)  | 2.24 (1.38, 3.64)  | 2.08 (1.24, 3.50)  |
|                  | Moderate                 | 158 (33.8)                 | 309 (66.2) | 1.00 (reference)   | 1.00 (reference)   | 1.00 (reference)   |
|                  | Long                     | 64 (32.5)                  | 133 (67.5) | 0.90 (0.63, 1.29)  | 0.95 (0.66, 1.38)  | 0.88 (0.59, 1.29)  |
| Subjective sleep quality | Good | 57 (15.7) | 305 (84.3) | <0.001 | 1.00 (reference)   | 1.00 (reference)   | 1.00 (reference)   |
|                  | Ordinary                 | 142 (46.6)                 | 163 (53.4) | 4.77 (3.31, 6.87)  | 5.11 (3.50, 7.46)  | 4.70 (3.19, 6.93)  |
|                  | Poor                     | 67 (79.8)                  | 17 (20.2) | 21.22 (11.56, 38.96) | 23.38 (12.43, 45.98) | 17.55 (9.09, 33.88) |

Model 1: Adjusted for age (continues)
Model 2: Adjusted for age (continues), ethnicity, local household registration, marital status, education, monthly income, employment, health insurance, parity and gestational week for current pregnancy
Model 3: Adjusted for age (continues), ethnicity, local household registration, marital status, education, monthly income, employment, health insurance, parity and gestational week for current pregnancy, subjective life impact and risk of being infected by the coronavirus, time spent in physical exercise and using the internet or social medias per day.
rates of pregnant women (23.9% and 20.9%, respectively) (Xu et al., 2017), and general women (24.2% and 16.0%, respectively) (Chen et al., 2018) in previous multi-center surveys. Moreover, the subjective sleep quality of them might also be improved, as we noticed a lower proportion of poor quality in our study (11.2%) than the earlier counterparts (15.3%) (Xu et al., 2017). It has been verified that both insufficient and excessive sleep were associated with a variety of changes in well-being, physical and psychological parameters (Pines, 2017). Hence, despite the potential promotion of longer sleep among pregnant women during the epidemic of COVID-19, monitoring sleep quality of the public dynamically should be listed as a routine matter of primary healthcare.

Sleep disturbance was believed to engage in mental disorders, as researchers thought sleep related variables might play a key role in psychiatric comorbidity processes (Baglioni et al., 2016). In our study, we detected strong associations of short sleep duration, and ordinary or poor subjective sleep quality with anxiety and depression symptoms. Our findings were roughly consistent with previous researches with slight differences. Similarity existed that short or poor sleep significantly increased odds of experiencing anxiety and depression disorders during pregnancy (Beijing et al., 2015; Yu et al., 2017; Zhai et al., 2015; Zhong et al., 2015), implying certain impacts of sleep on maternal mental health whether under emergency situations or not. Discrepancies were mainly owing to different evaluation methods or classification criteria of sleep variables and mental symptoms, with heterogeneity between studies (Gonzalez-Mesa et al., 2019). Besides, these associations might vary in different stages of pregnancy (Polo-Kantola et al., 2017). Our study also identified random or late time of going to bed to play risky roles in mental symptoms during the epidemic of COVID-19, and random time of going to bed had higher odds than a late but regular time, particularly for depression symptom (OR:4.38 vs. 2.78). Studies on shift-workers have shown that sleep and circadian rhythm disruption (SCRD) could result not only in cognitive impairment, but also psychiatric illness including depression (Jagannath et al., 2017). As a manifestation of SCRD, it could be inferred that irregular time of going to bed might act in a greater harmful way than simple staying up late. Likewise, we observed that difficulty in falling sleep, a typical symptom of insomnia, could exacerbate both anxious and depressive symptoms. Biological mechanisms of associations between insomnia and psychological symptoms possibly lied as follows: cognitive and affective alterations (Jackson et al., 2014), impaired emotional regulation and stability (Yoo et al., 2007), persistent arousal and chronic activation of hyperactivity in the hypothalamic–pituitary–adrenal (HPA) axis (Balbo et al., 2010).

There were several limitations in our study. Firstly, due to a voluntary participation option of online surveys, the current study sample was not a random group of pregnant women in Shenzhen, reaching a restricted generalization of our findings to the whole population of pregnant women. According to distinct epidemic levels of COVID-19 in different regions, our results could be used as a contemporaneous reference for other cities with similar epidemic status. In addition, it was ideally to collect historical information of the study subjects using the same measurements prior to this novel infectious disease, in order to provide direct comparison of “before and after COVID-19” and detect possible variations (Wang et al., 2020b). Secondly, we could not conclude causal relations because of cross-sectional study design, thus, the associations identified in our study should be verified in further prospective studies. Thirdly, as a common shortage of similar studies, most of the variables were derived from a self-reported questionnaire rather than assessment by psychiatric professionals, which might be more susceptible to information bias. We followed the implementation procedures of other observational studies and applied widely-used assessment tools to ensure the comparability between studies. Furthermore, due to a length limit of online questionnaire, we failed to put the Pittsburgh Sleep Quality Index (PSQI) into our questionnaire when we have to compromise the application of PHQ-9 and SAS. However, four key questions referred to sleep conditions were all originated from the PSQI questionnaire, including time of going to bed, difficulty in falling sleep, sleep duration at night, and subjective sleep quality. As other researchers did (Xu et al., 2017), it might not restrict the exploration of potential associations. Fourth, this study did not record the occupation of participants which could be a confounding factor. Some participants could be healthcare workers and they are more vulnerable to anxiety and depression during COVID-19 pandemic (Tan et al., 2020; Chew et al., 2020). Fifth, this study did not measure specific psychiatric symptom such as panic buying of necessities (Ho et al., 2020) that could affect sleep.

5. Conclusion

Anxiety and depression were common psychological symptoms among pregnant women. We found few pregnant women had COVID-19 related close contacts, nor considered a high risk of being infected in Shenzhen during the epidemic of COVID-19. The prevalence of maternal anxious and depressive symptoms were acceptable, most of which were in mild levels. The sleep conditions of pregnant women strongly linked with their anxiety and depression symptoms. These findings might help alleviate the mental illness through targeted intervention in improving maternal sleep conditions when encountering public health emergencies.

Authorship contribution statement

All authors have made substantial contributions to this study in the various sections described below. YW, WL, BW, and SH originated the study, conceptualization, design, supervised implementation. BC, GL, SL, KL, CZ and WH acquired the data. WL, YW, and SY interpreted the data and performed statistical analysis. WL wrote the draft of the manuscript. All authors contributed to the critical revision of the manuscript and gave their final approval for the manuscript to be published.

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Declaration of Competing Interest

The authors declare that they have no conflict of interest.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.jad.2020.11.114.

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