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ORIGINAL RESEARCH

Trajectory of Perinatal Depressive Symptoms from the Second Trimester to Three Months Postpartum and Its Association with Sleep Quality

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Purpose: Few studies have explored the association between sleep quality and depressive symptoms in perinatal women from the second trimester to the postpartum period. This study aims to explore this relationship using a longitudinal design.

Patients and Methods: Participants were enrolled at 15 gestational weeks. Demographic information was collected. Perinatal depressive symptoms were measured using the Edinburgh Postnatal Depression Scale (EPDS). Sleep quality was measured employing the Pittsburgh Sleep Quality Index (PSQI) at five timepoints from enrollment to three months postpartum. Overall, 1416 women completed the questionnaires at least thrice. A Latent Growth Curve (LGC) model was performed to identify the relationship between the trajectories of perinatal depressive symptoms and sleep quality.

Results: Of the participants, 23.7% screened positive at least once on the EPDS. The perinatal depressive symptoms trajectory, fitted by the LGC model, decreased at early pregnancy and increased from 15 gestational weeks to three months postpartum. The intercept of sleep trajectory positively affected the intercept of perinatal depressive symptoms' trajectory; the slope of sleep trajectory positively affected both the slope and the quadratic coefficient of perinatal depressive symptoms' trajectory.

Conclusion: The trajectory of perinatal depressive symptoms increased from 15 gestational weeks to three months postpartum following a quadratic trend. Poor sleep quality was associated with depression symptoms beginning at the onset of pregnancy. Moreover, rapidly declining sleep quality could be a significant risk factor for perinatal depression (PND). These findings call for greater attention to perinatal women who report poor and persistently deteriorating sleep quality. Additional sleep-quality evaluations, depression assessments, and referrals to mental health care providers may benefit these women and support PND prevention, screening, and early diagnosis.

Keywords: perinatal depression, sleep quality, trajectory, latent growth curve model

Introduction

Perinatal Depression (PND) includes the depressive symptoms occurring during pregnancy (ie, antenatal depression [AND]) and up to one year postpartum (ie, postpartum depression [PPD]).[1] PND is among the most common obstetric complications and it adversely affects both maternal and child wellbeing.[2] However, it is difficult to recognize because women often do not observe changes in their mood or are reluctant to report them. If left untreated, PND can have devastating effects on women, infants, and families. More specifically, AND is thought to be related to low birth weight, decreased fetal growth, and preterm birth.[3] Whereas, PPD has adverse consequences on the infant's wellbeing and development, and is associated with cognitive, behavioral, and emotional problems in childhood and adolescence.[4] Additionally, PND can lead to suicide which surpasses hemorrhage and hypertensive disorders as a cause of maternal mortality.[5]

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PND's incidence varies across different countries and regions owing to social, economic, and cultural backgrounds; survey timepoints; and survey tools and criteria. During pregnancy, the prevalence of depressive symptoms' ranges from 7% to 20% in high-income countries and exceeds 20% in numerous low- and middle-income countries; furthermore, PPD is estimated to affect 7–30% of women globally and 45% of women in some low-resource settings.[6] In the United States, the prevalence of major and minor depression during pregnancy and the first postpartum year are (reportedly) 8.5–11% and 6.5%–12.9%, respectively; however, some evidence indicates that racial and ethnic differences contribute to PND prevalence rates.[7,8] A recent article suggested that in China, the pooled prevalence of PND, AND, and PPD are 16.3%, 19.7%, and 14.8%, respectively.[9] Moreover, PND's incidence in China was significantly higher than normal during the COVID-19 (Corona Virus Disease 2019) outbreak.[10] However, no published studies have hitherto examined the prevalence of PND in Beijing, the capital of China.

The Trajectory of Depressive Symptoms During the Perinatal Period

In the last decade, instead of employing only a single assessment at non-standardized timepoints as a proxy for the entire perinatal period, the trajectories of depressive symptoms and risk factors from the prenatal period to the years postpartum have attracted the interest of an increasing number of researchers.[11–14] As most of these studies started the assessment in the later stages of pregnancy or a few months postpartum, data on the course of PND symptoms from the first or second trimester through childbirth are still sparse.

Recently, several studies have assessed the progression of depressive symptoms from the first or second trimester for a better understanding of when women are most at risk and what factors are associated with the disorder's onset, severity, and chronicity.[15–19] These studies described trajectories based on severity levels: some trajectories are described as time-stable with a linear trend,[15,17] while other studies reported symptom trajectory trends with variability—a quadratic trend.[16,18–21] Some studies only traced the trajectory during pregnancy,[17] while others merely described rough trajectories, missing the data of either the second trimester[15] or after 36 weeks (right before labor).[16,18,20,21] Meanwhile, most of the samples were from high-income countries, with limited attention paid to relatively low-income populations. Research with a larger sample size, at shorter intervals, and in more diverse settings is still needed in order to inform services and policies regarding how and when to effectively identify women at high risk of PND.

Sleep Quality During the Perinatal Period

Worsening sleep quality and increases in sleep disturbances, which are well-documented complaints from mothers during the perinatal period, have been suggested as important modifiable risk factors for developing PND.[3,22–30] Mothers' subjective sleep quality is disturbed as early as the first trimester of pregnancy[23,28] and deteriorates as pregnancy progresses.[31–34] The proportion of women defined as poor sleepers as per the Pittsburgh Sleep Quality Index (PSQI)—those with scores at or above the cutoff of "5"—has increased significantly.[35] In the postpartum period, sleep problems frequently persist, peaking during the first postpartum months and remaining elevated thereafter.[3,35,36] However, most studies examining sleep quality during pregnancy have only considered one or two timepoints, with most using one time period after 20 weeks' gestation and another in late pregnancy or the post-partum period.[24,25,27,34,37–39] Relative evidence before 20 gestation weeks remains scarce and inconsistent.[31,33,35,40]

Recently, several longitudinal studies have attempted to map out a rough sleep pattern during the perinatal period.[22,23,35,41] While Sivertsen et al found an overall pattern indicating stable or increased sleep problems from late pregnancy to immediately after birth (eight weeks),[41] Gueron-Sela et al assessed only the maternal postpartum sleep pattern.[22] Meanwhile, Tomfohr et al[35] and Solomonova et al[23] tracked the dynamic maternal-sleep trajectory from early pregnancy to the postpartum period employing relatively small sample sizes, but the data of the late pregnancy period was missing. To gain a better understanding of the dynamic change in perinatal sleep quality as a risk factor for PND, first- or second-trimester-to-postpartum period assessments with larger samples are needed.

Association Between Perinatal Sleep Quality and Depressive Symptoms

The association between sleep quality and depressive symptoms has long been discussed. However, the exploration of the relationship between sleep quality and perinatal depressive symptoms has only recently gained increasing attention.[3,28,39,42]

According to a few cross-sectional studies, poor sleep quality is associated with PND across different timepoints.[25,27,30] Longitudinal studies have demonstrated that disturbed sleep is associated with the emergence of perinatal depressive symptoms; specifically, sleep disturbances in the first and/or second trimester predict depressive symptoms during the later pregnancy period.[23,37] Meanwhile, subjective assessments of sleep disturbances in the second and/or third trimester also indicate that sleep disturbances are a predictor of PPD symptoms.[22–24,38,42–48] Other findings have suggested that the effects of poor sleep quality on depressive symptoms persist even after delivery.[26,29,49,50] Most of the existing studies have proven the association between sleep quality and depressive symptoms during the third trimester and postpartum period.[39,42] However, evidence concerning the second trimester or earlier is scarce and inconsistent.[34,37] Only a few studies have shed light on the early stage of pregnancy (before 20 gestation weeks).[20,23,35,51,52]

Moreover, most of the studies have first assessed sleep quality and depressive symptoms at one or two timepoints during the perinatal period, followed by an examination of the sleep quality's immediate and/or prolonged impacts on depressive symptoms (ie, the effects at the same and/or later timepoints).[24,26,29,34,37,38,43–45,47–50] Only a few studies have traced different trajectories of depressive symptoms and then either explored the quality of sleep as a risk factor—how sleep quality at one timepoint influenced each trajectory[20,22] or interpreted the association between perinatal sleep quality and depressive symptoms in process models.[23,53] Longitudinal studies which have drawn associations, by tracking both sleep quality and depressive symptoms changes from the time before 20 gestation weeks to the postpartum period, are lacking.

Both depressive symptoms and sleep quality fluctuate throughout the perinatal period; therefore, identifying the variations in their trajectories and interpreting the relationship between them is crucial. In this study, we aimed to explore: (1) the incidence of PND in Beijing Obstetrics and Gynecology Hospital, (2) the overall depressive symptoms' trajectory from 15 gestation weeks to 3 months postpartum, and (3) how poor sleep quality dynamically impacts depressive symptoms during the perinatal period.

Materials and Methods

This study is part of "The study of risk factors, perinatal outcome, assessment, and management of PND in Beijing Obstetrics and Gynecology Hospital, Capital Medical University" (GRANT NO FCYYGL201902). The protocol was approved by the Ethics Committee of the Beijing Obstetrics and Gynecology Hospital, Capital Medical University (2019-KY-095-02).

Setting and Participants

In this cohort study, participants were enrolled during their first registered clinic visit (15–16 gestational weeks) in the Perinatal Department of Beijing Obstetrics and Gynecology Hospital of China in the period of January 2020 to June 2021. All participants signed the consent form and could understand the questionnaire's meaning.

Procedure

The participants' sociodemographic information was collected at the beginning of their enrollment (15–16 gestational weeks). Thereafter, the Chinese editions of the Postnatal Depression Scale (EPDS) and PSQI were administered at five timepoints; three times during pregnancy as follows: gestational weeks 15–18 (T1), weeks 28–32 (T2), weeks 36–37 (T3); and two after delivery: six-weeks postpartum (T4) and 3–4 months postpartum (T5).

The questionnaires were administered through an online survey platform for mobile phones that was specifically designed for this study. The questionnaires were automatically administered to the participants through the platform during their designated gestation weeks. Subsequently, participants were reminded—by the research group's members and via auto-reminders delivered by the platform—to complete their questionnaires on time.

To ensure the questionnaires' completeness, each participant was required to answer all the questions before submitting the questionnaire. "Lie detector questions", such as "If you have read and answered all the questions truthfully, please select the following answer A (B, C, or D)", were included randomly within each timepoint. The survey results were considered "valid" only if the participants answered all the "lie detector questions" correctly and finished at least three questionnaires from the T1 in sequence (N = 1416).

Measures

Sociodemographic Status

Participants' sociodemographic data included their age, socioeconomic status (SES), marital status, and family's monthly income; SES was weighted by occupation and educational background.[54] The occupation was graded 1–5 points ranging from "Temporary workers or unemployed" to "Senior Professional Manager, Personnel, or Supervisor". Educational background was graded 1–7 points ranging from "No schooling" to "Doctor or above". Table 1 outlines the detailed scoring method. The two scores' sum was recorded as the participants' SES score ranging from 2 to 12.

Depressive Symptoms

Participants' depressive symptoms were assessed using the EPDS' Chinese edition[55] with 10 as the cutoff point.[56] The scores' total sum was used as a continuous variable for statistical analysis to produce a comprehensive measure at both clinical and subclinical levels. The Cronbach's alphas ranged from 0.80 to 0.87, representing satisfactory internal reliability.

Sleep Quality

The PSQI is a self-report scale used to evaluate sleep quality. We evaluated study participants' sleep quality using the PSQI's Chinese edition; a score of 5 was the cutoff point.[57] The total score was used as a continuous variable for further statistical analysis to interpret the association with the EPDS scores. The Cronbach's alphas ranged from 0.80 to 0.84, representing satisfactory internal reliability.

Statistical Analysis

Statistical analyses were performed in three steps. First, SPSS 25.0 software was used to analyze the participants' sociodemographic information, and depressive symptom incidences at each timepoint. Second, the latent growth curve (LGC) model was employed to explore depressive symptoms' overall trajectory from early pregnancy to three months postpartum, using the Mplus 8.3 software. Finally, the LGC model with parallel processes model was utilized to analyze the association between the trajectories of depressive symptoms and sleep quality.

Table 1 Scoring for Socioeconomic Status: Occupation and Educational Background

Occupation	**Score**
Temporary workers, unemployed	1
Labor workers, self-employed workers, skilled workers	2
General manager, professional or technical personnel, clerical staff	3
Middle-class manager, professional or technical personnel, assistant	4
Professional senior manager, personnel, and supervisor	5
Educational Background	Score
No schooling	1
Primary school	2
Junior middle school	3
Senior high school or technical secondary school	4
University (junior college or undergraduate)	5
Masters	6
Doctorate or higher	7

Missing Data

Missing data were treated by the full information maximum likelihood procedure (FIML), which processes estimated parameters iteratively based on complete cases instead of imputing them. The LGC model was fitted by Mplus 8.3 using maximum likelihood estimation with robust standard errors.

Results

Participants' Sociodemographic Characteristics

Figure 1 is a flowchart of the study procedure; it presents the timeline of the study and the number of participant dropouts during each timepoint and the reasons for dropout. The average age of participants was 31.5 ±3.9 years, and the SES score was 8.2 ±1.0. The median monthly income was 20,000 (15,000–32,750) China Yuan (CNY). Of all the participants, 1411 cases (99.6%) were married while only 5 cases (0.4%) were single. No statistically significant difference regarding age (t = 1.283,

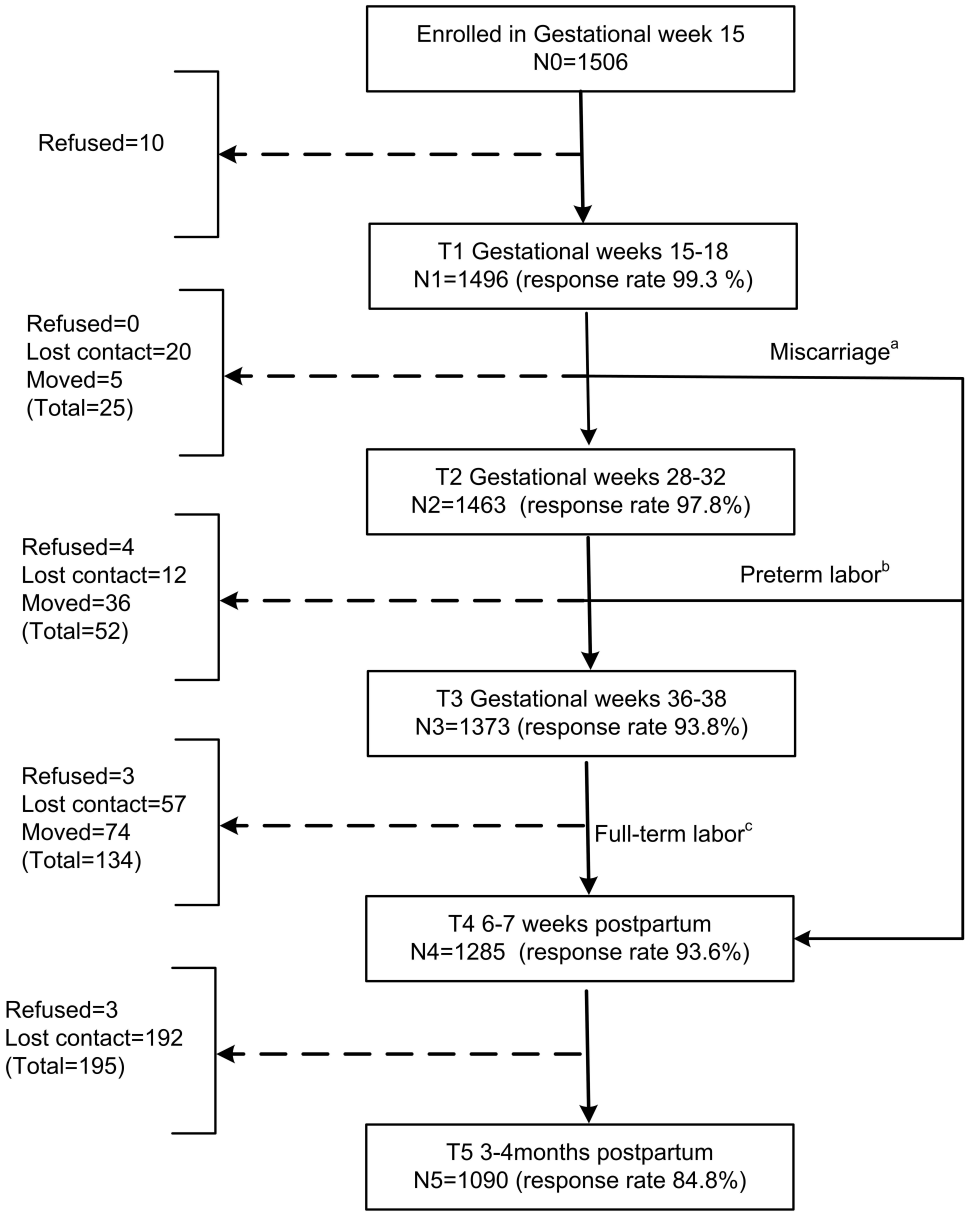

Figure 1 Flowchart of the study procedure. Participants finished at least 3 questionnaires N = 1416 (a + b + c). [a]Miscarriage = 5 (8 finished T1 + T4, 3 lost at T5). [b]Preterm labor = 38 (all finished T1 + T2 + T4). [c]Full-term labor = 1373.

p = 0.95, ns) or SES (t = 2.290, p = 0.46, ns) was noted between the participants who finished at least three measurements (N = 1416) and those who completed two or fewer measurements (n = 90).

The Incidence of PND and Poor Sleep Quality at Different Timepoints

With 10 as the cutoff point of EPDS, the incidence of depressive symptoms was 7.9%, 6.6%, and 6.2% from T1–T3 (during pregnancy), respectively, and 11.4% and 11.5% from T4–T5 (postpartum), respectively. Overall, 336 cases (23.7%) screened positive at least once, while 1080 cases (76.3%) were below the cut-off value at all timepoints.

With 5 as the cutoff point of PSQI, the incidence of poor sleep quality was 35.6%, 37.2%, and 42.8% from T1–T3 (during pregnancy), respectively; thereafter, it went up to 55.1% at T4 (six weeks postpartum) and slightly descended to 47.3% at T5 (three months postpartum).

Trajectory of Perinatal Depressive Symptoms

The EPDS scores indicate that from T1 to T5, the progression of the trajectory of perinatal depressive symptoms follows a quadratic trend. The perinatal depressive symptoms trajectory fitted by the LGC model across the perinatal period followed a presumed U-shape trajectory, as presented in Figure 2. The depression model's parameters were as follows: intercept = 1.687, $p < 0.001$; slope = −0.29, $p < 0.05$; quadratic coefficient = 0.323, $p < 0.001$. No association has been found between maternal age and all parameters (intercept, slope, or quadratic coefficient) of the trajectory when included as a potential confounder in the model ($p > 0.05$).

As illustrated in Figure 2, the presumed vertex (lowest point) of the parabola (coordinates X = 0.45, Y = 1.62) came before the T1 timepoint, and the scores of the EPDS from T1–T5 ascended progressively. The estimated EPDS mean

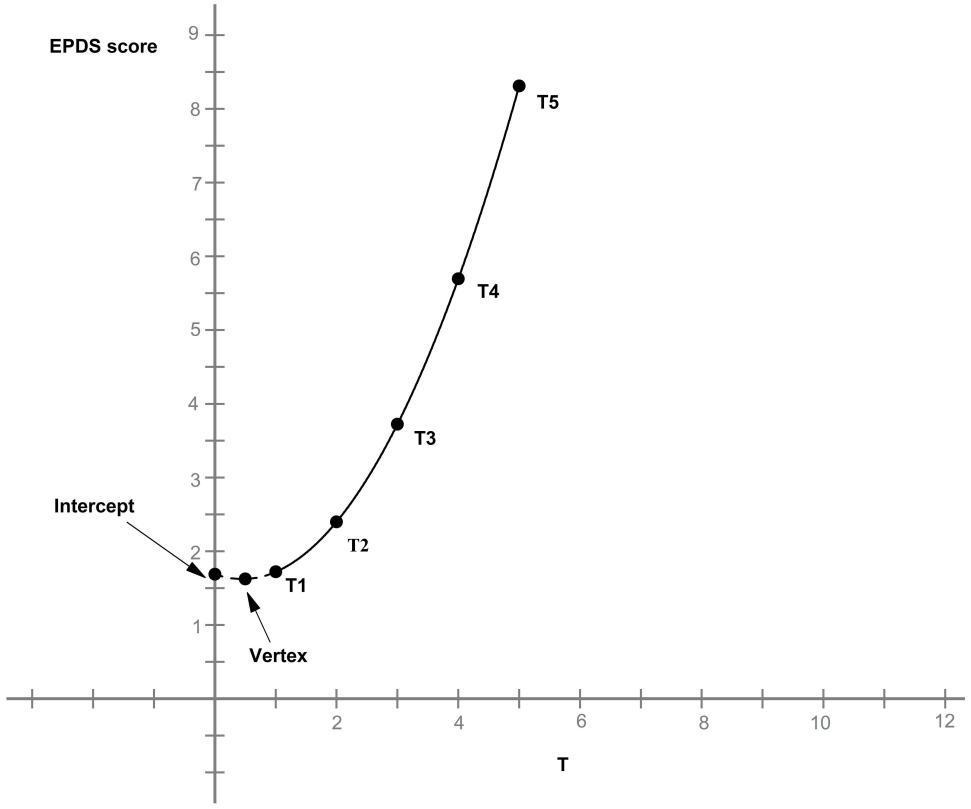

Figure 2 Trajectory of PND. The depression model's parameters: Intercept = 1.687, $p < 0.001$; Slope = −0.29, $p < 0.05$; Quadratic coefficient = 0.323, $p < 0.001$. The presumed vertex (lowest point) of the parabola (coordinates X = 0.45, Y = 1.62) came before the T1.
Notes: This figure was prepared using Mplus 8.3. The measures of the goodness-of-fit are as follows: $\chi^2 = 2614.4$, CFI = 0.987, TLI = 0.978, RMSEA = 0.063 (95% CI: 0.045–0.082).
Abbreviations: EPDS, Edinburgh Postnatal Depression Scale; PND, Perinatal depression; CFI, Comparative Fit Index; TLI, Tucker-Lewis Index; RMSEA, Root Mean Square Error of Approximation.

score was 1.72 at early pregnancy (T1), increasing to 2.39 in the third trimester (T2), and continuing to increase to 3.70 before delivery (T3). After birth, the mean EPDS score was 5.65 at six weeks postpartum (T4), which increased to 8.36 at three months postpartum (T5).

Association Between the Trajectories of PND and Sleep Quality

The parallel processes model depicting the associations between the trajectories of depressive symptoms and sleep quality are presented in Figure 3. The figure depicts impacts of the intercept, slope, and quadratic coefficient of the perinatal depressive symptoms' trajectory on each EPDS score. The effects of the intercept and slope of the sleep quality trajectory on different PSQI scores are also presented. Maternal age, which was included in the model as a possible confounder, only positively affected the intercept of sleep quality.

Regarding the association between perinatal sleep quality and depressive symptoms, three major results can be seen in Figure 3: 1) The intercept of sleep trajectory positively affects the intercept of depressive symptoms ($\beta = 0.73$, $p < 0.001$); thus, at the onset of the pregnancy, women with poorer sleep quality were more likely to exhibit more severe depressive symptoms. 2) The slope of sleep interacted with the slope of depression ($\beta = 0.33$, $p < 0.05$) such that a higher slope of sleep was followed by a higher the slope of depression. This implies that with progression of time, the rate of reduction of sleep quality increased; the likelihood that the participant would suffer more severe depressive symptoms also increased. 3) The slope of sleep positively affected the quadratic coefficient of depression ($\beta = 0.19$, $p < 0.05$). In other words, the higher the slope of sleep, the more likely that the x coordinate of the depression vertex would shift to the left. Again, our results showed

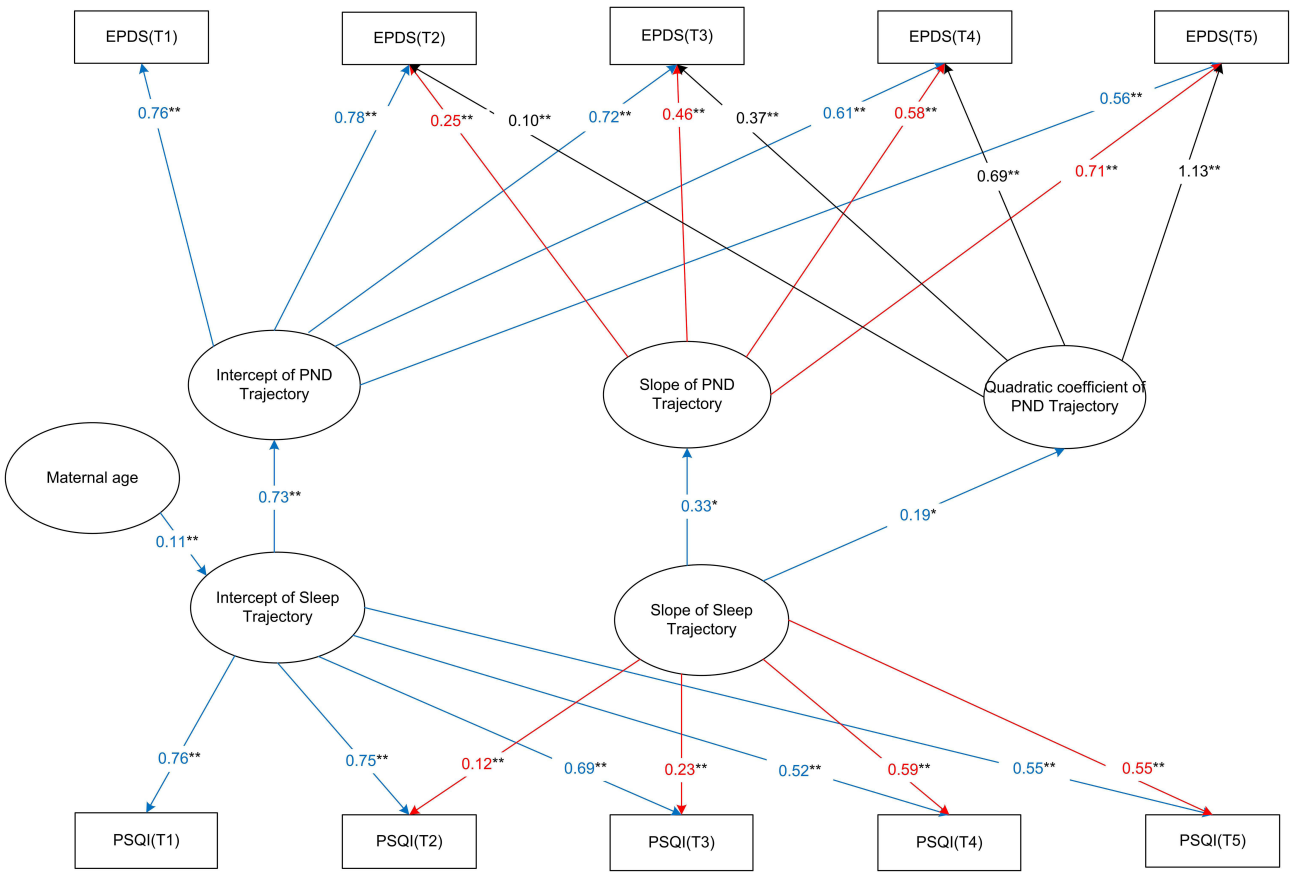

Figure 3 Parallel process model depicting associations between the trajectory of depressive symptoms and sleep quality.
Notes:This Figure was prepared using Mplus 8.3. *p < 0.05; **p < 0.001. The measures of the goodness-of-fit: $\chi^2 = 5857.2$, CFI = 0.950, TLI = 0.931, RMSEA = 0.072 (95% CI: 0.065–0.079).
Abbreviations: EPDS, Edinburgh Postnatal Depression Scale; PND, PND; PSQI, Pittsburgh Sleep Quality Index; CFI, Comparative Fit Index; TLI, Tucker-Lewis Index; RMSEA, Root Mean Square Error of Approximation.

that as time progressed, the more rapidly the reduction of sleep quality became, and the sooner a sudden deterioration of depressive symptom was likely to occur.

Discussion

Incidence and Trajectory of Perinatal Depressive Symptoms

To the best of our knowledge, this is the first study conducted in China to explore the association between sleep and perinatal depressive symptoms. In this study, participants were recruited from relatively developed regions of the country with higher SES. Compared with previous literature, the incidence of depressive symptoms at each timepoint in this study was lower than the incidence in developing countries and close to that in developed countries; nevertheless, the overall incidence of the entire perinatal period is in accordance with previous studies[6–8] and is slightly higher than that of other reports in China.[9] This indicates that nearly one in every five women might experience depression at least once during their perinatal period, which is a concern that should not be ignored.

Although the incidence of depressive symptoms descends slightly from T2–T3 and ascends after delivery, perinatal depressive symptoms' trajectory—based on the EPDS scores—increases progressively with a quadratic trend from 15 gestation weeks to three months postpartum. The presumed vertex (lowest point) of the parabola exists before T1, which implies that the depressive symptoms might presumably be relieved in early pregnancy. Even though maternal age is often considered a relative risk factor for developing depressive symptoms, no relationship has been found between maternal age and the depression trajectory in this study. This reason for this could be due to all participants being in childbearing age (31.5 ±3.9 years old), meaning that there were not big age differences in the sample to allow us to observe the effect of maternal age on depression.

The trajectory described in this study is partly consistent with most previous literature, which included at least one continuously increasing trajectory from the second trimester to a few months postpartum.[16,20,21,58] However, the trajectory in our study is not consistent with Figueiredo and Conde, who stated that depressive symptoms showed a significant decrease from the first to second trimesters, but the changes afterward were not significant.[18] The differences might have occurred due to the different sample size, the cultural background of the participants, and the timepoints of the assessment (our study included the timepoint of 36–37 gestation weeks and 8 weeks postpartum, whereas Figueiredo and Conde set one different timepoint, which was at childbirth).

The Dynamic Relationship Between Sleep Quality and Depressive Symptoms

The sleep trajectory's intercept affects the sleep quality from T1–T5, which indicates that entering pregnancy with elevated PSQI scores is associated with significantly worse sleep quality throughout the perinatal period. These results partly confirm the findings of prior studies.[35] To our knowledge, this is one of the few studies interpreting the dynamic relationship between depressive symptoms and sleep quality with multi-point questionnaires from the second trimester to the postpartum period. Our findings contribute to the evidence in the literature regarding the association between poor sleep quality and PND.

According to the results of this study, poor sleep quality was associated with depressive symptoms from as early as the beginning of pregnancy. This is consistent with the results of previous studies.[23,35,52] Our results are similar to those of Solomonova et al[23] and Gueron-Sela et al.[22] Solomonova et al reported that sleep disturbances in early pregnancy directly predict depressive symptoms in late pregnancy, and Gueron-Sela et al established that poor sleep quality in late pregnancy is associated with more depressive symptoms from 3 to 18 months postpartum. However, in this study, we prove—with a relatively larger sample size compared to previous studies—that sleep quality positively affects depressive symptoms from the beginning of a pregnancy to the postpartum period. Moreover, to our knowledge, this study is the first to interpret how the slope of the sleep quality trajectory affects the changes in depressive symptoms during the perinatal period. Our results indicate that as time progresses and sleep quality rapidly deteriorates, perinatal women are likely to experience more severe depressive symptoms, and their condition may deteriorate suddenly and rapidly. This means that a minor change in sleep quality might be a normal side effect of pregnancy; however, major decreases in sleep quality may be a significant risk factor of PND. This was partly in agreement with Tomfohr et al, who investigated sleep

trajectories and their relationship with PND, and further predicted a potential threshold of change in sleep quality, indicating new-onset depression.[35]

PND's etiology remains poorly understood but is assumed to be the result of a complex interaction involving genetics, epigenetics, the neuroendocrine hypothalamic-pituitary-adrenal (HPA) axis, and environmental and social factors.[59,60] Research on other biological factors precipitating PND include the following: systemic inflammation, immune system dysregulation, alterations in cortisol and amylase, intrauterine artery resistance, thyroid dysregulation, alterations in oxytocin, and prolactin.[47,61]

Although the mechanisms linking sleep disturbances and depressive symptoms remain unclear, several mechanisms can underlie these processes. First, there is evidence that both sleep disturbances and depressive symptoms during pregnancy have been associated with the augmentation of inflammatory responses and changes in immune function.[22] Okun et al have found that poor sleep quality is associated with higher circulating and stimulated levels of interleukin-6 (IL-6) and tumor necrosis factor-α (TNF-α). Such elevated levels of inflammatory markers have also been found in patients with depression;[62,63] furthermore, insufficient sleep during pregnancy may disrupt the typical course of inflammatory "switch off", leading to unfavorable maternal outcomes,[64] including PND. Another likely contributing factor is the dramatic change in hormone levels.[4,42] Reproductive hormones, especially estrogen and progesterone, are considered responsible for maintaining sleep quality in menopausal women.[65,66] Relevant evidence obtained during the perinatal period is still sparse and disputed. However, the available evidence suggests that the interaction between poor sleep/insomnia and a dramatic decrease in hormones following childbirth may augment the risk of PND.[4] Additionally, the impact of sleep disturbance on emotion regulation is another potential mediator. Disruptions in circadian/ultradian rhythms have been linked to alterations in emotional reactivity and the increased likelihood of perceiving ambiguous information as threatening, which may eventually lead to the emergence of a depressed mood.[67] Finally, physiological hyperarousal, a known biomarker for sleep disorders, is also associated with depression and anxiety disorders.[22]

Despite the strong association between poor sleep and PND, routine sleep quality evaluation has not been included in prenatal visits and postpartum follow-ups. To date, most obstetric health providers still consider poor sleep quality during the perinatal period as attributable to normal pregnancy and postpartum changes; thus, its role as a PND risk factor is often overlooked. Interventions to improve perinatal sleep quality are not readily available and have rarely been studied. This study provides evidence that obstetric care providers, including obstetricians, midwives, pediatricians, psychiatrists, and general practitioners, should be more attentive to poor sleep quality in patients from early pregnancy through the postpartum period. Patient care standards should include an additional sleep quality evaluation for perinatal women with persistent complaints of poor sleep quality. Moreover, maternal care for those with rapidly deteriorating sleep quality should include depression assessments and referrals to mental health care providers, as these patients may benefit from prevention, screening, and early diagnosis of PND. Tailored interventions for poor sleep quality may relieve perinatal women from more severe sleep problems and depressive symptoms later during the perinatal period.

Limitations and Future Directions

This study had several limitations. Firstly, this was a single-centered study, in which most participants came from Chaoyang District, Beijing and has a similar SES; therefore, this should be considered when generalizing these results to other samples. Secondly, a score of "5" was used as the cut-off in the PSQI, which is in accordance with previous studies; however, that cutoff might not be valid for pregnant participants due to changes during pregnancy. Thirdly, the participants were first enrolled near the beginning of their second trimester (15–18 weeks) at their first routine visit, and evaluations ended at 3-months postpartum. Therefore, the data from the first trimester and from 3 to 12 months postpartum were not included in our analysis.

Regarding future research, we look forward to conducting multi-centered studies with larger sample sizes. To understand the fluctuation of depressive symptoms more specifically and thoroughly, we suggest a multi-centered study conducted with a larger sample, using repeated assessments at shorter intervals (especially starting at the beginning of/before pregnancy and ending at 1 year postpartum). Such a study may yield a more nuanced understanding of the trajectory. A topic to discuss in future articles are studies aiming to interpret the latent trajectory groups such as time-stable, linear trajectory or draw.

Conclusion

The trajectory of depressive symptoms, from 15 gestation weeks to three months postpartum, increases progressively with a quadratic trend. Poor sleep quality might be associated with depressive symptoms as early as the beginning of the pregnancy. Rapid reduction of sleep quality could be a significant risk factor of PND. As time progresses and sleep quality rapidly deteriorates, perinatal women are likely to experience more severe depressive symptoms, and their condition may deteriorate suddenly and rapidly. This evidence should serve to alert all obstetric care providers, including obstetricians and midwives, as well as pediatricians, psychiatrists, and general practitioners to the importance of poor sleep quality among women from early pregnancy through the postpartum period. Additionally, further evaluation of sleep quality should be advised for all perinatal women with persistent complaints of poor sleep quality. Those with rapidly deteriorating sleep quality may benefit from an assessment of depression and referral to mental healthcare providers for the prevention, screening, and early diagnosis of PND. Moreover, tailored interventions for poor sleep quality in perinatal women can prevent the development of more severe sleep problems and depressive symptoms later in the perinatal period.

Abbreviations

PND, Perinatal depression; AND, Antenatal Depression; PPD, postpartum depression; COVID-19, Corona Virus Disease 2019; EPDS, Edinburgh Postnatal Depression Scale; PSQI, Pittsburgh Sleep Quality Index; SES, socioeconomic status; LGC, latent class growth curve; FIML, full information maximum likelihood procedure; CNY, China Yuan; HPA, hypothalamic-pituitary-adrenal; IL-6, interleukin-6; TNF-α, tumor necrosis factor-α; CFI, Comparative Fit Index; TLI, Tucker-Lewis Index; RMSEA, Root Mean Square Error Of Approximation.

Data Sharing Statement

The datasets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Ethics Approval and Consent to Participate

The authors assert that all procedures contributing to this work comply with the ethical standards of the relevant national and institutional committees on human experimentation as well as with the Helsinki Declaration of 1975, as revised in 2008. This study was approved by the ethical institutional review board of Beijing Obstetrics and Gynecology Hospital (2019-KY-095-02).

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Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis, and interpretation, or in all these areas; took part in drafting, revising, or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

The authors report no conflicts of interest in this work.

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