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## Retrospective Study

# Analysis of influencing factors and the construction of predictive models for postpartum depression in older pregnant women

Lei Chen, Yun Shi

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## Abstract

### BACKGROUND

Changes in China's fertility policy have led to a significant increase in older pregnant women. At present, there is a lack of analysis of influencing factors and research on predictive models for postpartum depression (PPD) in older pregnant women.

### AIM

To analysis the influencing factors and the construction of predictive models for PPD in older pregnant women.

### METHODS

By adopting a cross-sectional survey research design, 239 older pregnant women ( $\geq 35$  years old) who underwent obstetric examinations and gave birth at Suzhou Ninth People's Hospital from February 2022 to July 2023 were selected as the research subjects. When postpartum women of advanced maternal age came to the hospital for follow-up 42 d after birth, the Edinburgh PPD Scale (EPDS) was used to assess the presence of PPD symptoms. The women were divided into a PPD group and a no-PPD group. Two sets of data were collected for analysis, and a prediction model was constructed. The performance of the predictive model was evaluated using receiver operating characteristic (ROC) analysis and the Hosmer-Lemeshow goodness-of-fit test.

### RESULTS

On the 42<sup>nd</sup> day after delivery, 51 of 239 older pregnant women were evaluated with the EPDS scale and found to have depressive symptoms. The incidence rate was 21.34% (51/239). There were statistically significant differences between the PPD group and the no-PPD group in terms of education level ( $P = 0.004$ ), family relationships ( $P = 0.001$ ), pregnancy complications ( $P = 0.019$ ), and mother-infant separation after birth ( $P = 0.002$ ). Multivariate logistic regression analysis showed that a high school education and below, poor family relationships, pregnancy



complications, and the separation of the mother and baby after birth were influencing factors for PPD in older pregnant women ( $P < 0.05$ ). Based on the influencing factors, the following model equation was developed:  $\text{Logit}(P) = 0.729 \times \text{education level} + 0.942 \times \text{family relationship} + 1.137 \times \text{pregnancy complications} + 1.285 \times \text{separation of the mother and infant after birth} - 6.671$ . The area under the ROC curve of this prediction model was 0.873 (95%CI: 0.821-0.924), the sensitivity was 0.871, and the specificity was 0.815. The deviation between the value predicted by the model and the actual value through the Hosmer-Lemeshow goodness-of-fit test was not statistically significant ( $\chi^2 = 2.749$ ,  $P = 0.638$ ), indicating that the model did not show an overfitting phenomenon.

## CONCLUSION

The risk of PPD among older pregnant women is influenced by educational level, family relationships, pregnancy complications, and the separation of the mother and baby after birth. A prediction model based on these factors can effectively predict the risk of PPD in older pregnant women.

**Key Words:** Older pregnant women; Postpartum depression; Influencing factors; Prediction model

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**Core Tip:** Older pregnant women are more likely to develop postpartum depression (PPD) than younger pregnant women. PPD can harm the physical and mental health of pregnant women, offspring development, and family and social harmony. Here, we investigated the PPD status of 239 older pregnant women. Based on whether the older pregnant women experienced depression 42 d postpartum, we divided them into a PPD group and a no-PPD group. By conducting statistical analysis on two sets of data and constructing a prediction model, we examined the issue of how medical personnel can effectively assess the PPD risk of older pregnant women.

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## INTRODUCTION

Postpartum depression (PPD) is a postpartum mental condition characterized by anxiety, irritability, and extreme depression. In severe cases, hallucinations or suicidal tendencies may occur[1]. PPD not only harms the physical and mental health of pregnant women but also has adverse effects on offspring development, families, and society[2]. Related research reports show that the incidence of PPD among younger pregnant women in China is 14.7%. The incidence of PPD in older pregnant women ( $\geq 35$  years old) is as high as 36.9%[3]. There are some recent studies on PPD in pregnant women, but they are all based on analyses of mental illness history, family relationships, and other aspects[4,5]. There is a lack of exploration on pregnancy complications and the separation of mothers and babies after birth. This results in inadequate clinical measures to prevent PPD, and there is a lack of reporting on predictive models. This study combined the overall situation before, during, and after childbirth to understand the influencing factors of PPD in older pregnant women and construct a risk prediction model to provide guidance for obstetricians in predicting the risk of PPD in older pregnant women and developing treatment measures.

## MATERIALS AND METHODS

### Patient characteristics

Adopting a cross-sectional survey research design, 239 older pregnant women ( $\geq 35$  years old) who underwent obstetric examinations and gave birth in our hospital from February 2022 to July 2023 were selected as the research subjects. According to the Edinburgh PPD Scale (EPDS), the presence or absence of PPD symptoms was measured at 42 d postpartum, and the older pregnant women were divided into a PPD group and a no-PPD group. This study was approved by the Medical Ethics Committee of Suzhou Ninth People's Hospital.

### Inclusion and exclusion criteria

The inclusion criteria were as follows: (1) Women with a gestational age  $\geq 37$  wk at delivery, a single birth, and natural conception; (2) women with normal consciousness and intelligence; (3) women without adverse pregnancy outcomes (stillbirth, abortion, deformity); (4) women who were informed of this study and signed an informed consent form; and (5) women who were evaluated with the EPDS at 42 d postpartum. The exclusion criteria were as follows: (1) Women with comorbid malignant tumors; (2) women with trauma or infection before delivery; (3) women diagnosed with

depression during any depression screening during pregnancy (early, middle, late) or the prenatal period (prior to delivery)[6]; and (4) women with past mental illness.

### Survey methods

**General information:** By creating a general data collection form, age, education level, birth history, pregnancy complications (pregnancy-induced hypertension, pregnancy-induced diabetes, *etc.*), delivery mode, separation of the mother and infant after birth (referring to the newborn needing to be admitted to the neonatal department for treatment after birth), neonatal feeding mode and other information of the older pregnant women were collected.

**Family relationships:** The Chinese version of the Family Adaptability Cohesion Environment Scale II-CV[7] was used to evaluate the family relationships of the older pregnant women. This scale mainly evaluates intimacy and adaptability. Intimacy refers to the emotional connection between a mother and her family members. Adaptability refers to the ability of a mother to adapt to the different developmental stages of her family and family situation. This scale consists of 30 items. The total score ranges from 30 to 150 points, and items are scored using a 5-point likert-type (1-5 points) scoring method. The higher the score is, the better the family relationship. In this study, a score of  $\leq 70$  indicates a lack of harmonious family relationships; a score of  $> 70$  indicates a harmonious family relationship.

**PPD diagnosis:** At each pregnant woman's follow-up visit at our obstetric clinic on the 42nd day postpartum, we evaluated whether she had PPD symptoms using the EPDS. The scale consists of 10 items, and the total score is 30 points. When the EPDS score of an older mother is  $\geq 9$  points, it indicates the presence of PPD symptoms[8].

### Statistical procedure

Using SPSS 25.0 software for data analysis, the counting data are expressed in terms of the rate and composition ratio [ $n$  (%)]. The two groups were compared and subjected to the  $\chi^2$  test. The influencing factors of PPD in older pregnant women were analyzed through multiple logistic regression analysis, and predictive model equations were built based on the influencing factors.

The area under the receiver operating characteristic (ROC) area under curve (AUC) was used to evaluate the predictive efficiency of the model, and the Hosmer-Lemeshow goodness-of-fit test was used to evaluate whether the prediction model showed an overfitting phenomenon.  $P < 0.05$  indicated that the difference was statistically significant.

## RESULTS

### The incidence and univariate analysis of PPD in older pregnant women

On the 42<sup>nd</sup> d after delivery, 239 older pregnant women who attended their outpatient follow-up were included, and 51 were found to have depressive symptoms (PPD group) after evaluation with the EPDS. The incidence rate was 21.34% (51/239); 188 women (no-PPD group) had no depressive symptoms. The comparison between the PPD group and the no-PPD group showed statistically significant differences in terms of education level ( $\chi^2 = 8.290$ ,  $P = 0.004$ ), family relationships ( $\chi^2 = 10.672$ ,  $P = 0.001$ ), pregnancy complications ( $\chi^2 = 5.520$ ,  $P = 0.019$ ), and mother-infant separation after birth ( $\chi^2 = 9.681$ ,  $P = 0.002$ ) (Table 1).

### Multivariate logistic regression analysis of PPD in older pregnant women

The dependent variable was whether the older pregnant women had symptoms of PPD at 42 d postpartum (0 = no; 1 = yes). Features with statistical significance in univariate analysis (education level, family relationships, pregnancy complications, and the separation of the mother and infant after birth) were included as independent variables, and the assigned values are shown in Table 2. After multiple factor logistic regression analysis, it was found that a high school education and below, poor family relationships, pregnancy complications, and the separation of the mother and baby after birth were the influencing factors for PPD in older pregnant women ( $P < 0.05$ ) (Table 3).

### Construction of a risk prediction model for PPD in older pregnant women

The prediction model was constructed based on the regression coefficients and constant terms shown in Table 2 to obtain the following equation:  $\text{Logit}(P) = 0.729 \times \text{education level (0 = college or higher; 1 = high school and below)} + 0.942 \times \text{family relationships (0 = harmony; 1 = disharmony)} + 1.137 \times \text{pregnancy complications (0 = no; 1 = yes)} + 1.285 \times \text{separation of the mother and infant after birth (0 = no; 1 = yes)} - 6.671$ . Using the predicted probability value of the model as the test variable, the state variable was the presence or absence of PPD in the older mothers. ROC curves were drawn to analyze and predict the performance of the model. The AUC area under the ROC curve of the prediction model was 0.873 (95%CI: 0.821-0.924), the sensitivity was 0.871, and the specificity was 0.815, which indicates that the model has good differentiation ability (Figure 1). The deviation between the predicted value of the model and the actual value through the Hosmer-Lemeshow goodness-of-fit test was not statistically significant ( $\chi^2 = 2.749$ ,  $P = 0.638$ ), indicating that the model showed no overfitting phenomenon.

**Table 1** Single factor analysis of postpartum depression in older pregnant women (*n* = 239)

Characteristics	PPD group ( <i>n</i> = 51)		No-PPD group ( <i>n</i> = 188)		$\chi^2$	<i>P</i> value
	<i>n</i>	Percent	<i>n</i>	Percent		
Age (yr)					2.145	0.143
35-40	40	78.4	163	86.7		
> 40	11	21.6	25	13.3		
Education level					8.290	0.004
High school and below	33	64.7	79	42.0		
College or higher	18	35.3	109	58.0		
Family relationships					10.672	0.001
Harmony	19	37.3	118	62.8		
Disharmony	32	62.7	70	37.2		
Reproductive history					0.920	0.337
Primipara	14	27.5	65	34.6		
Multipara	37	72.5	123	65.4		
Pregnancy complications					5.520	0.019
Yes	20	39.2	43	22.9		
No	31	60.8	145	77.1		
Delivery method					0.045	0.832
Spontaneous labor	22	43.1	78	41.5		
Cesarean section	29	56.9	110	58.5		
Separation of the mother and infant after birth					9.681	0.002
Yes	12	23.5	15	8.0		
No	39	76.5	173	92.0		
Feeding methods of newborns					4.838	0.089
Artificial feeding	11	21.6	19	10.1		
Mixed feeding	18	35.3	79	42.0		
Exclusive breastfeeding	22	43.1	90	47.9		

PPD: Postpartum depression.

**Table 2** Variable assignment description

Variable	Description of valuation
Education level	0 = college or higher; 1 = high school and below
Family relationships	0 = harmonious; 1 = disharmony
Pregnancy complications	0= no; 1= yes
Separation of the mother and infant after birth	0= no; 1= yes

## DISCUSSION

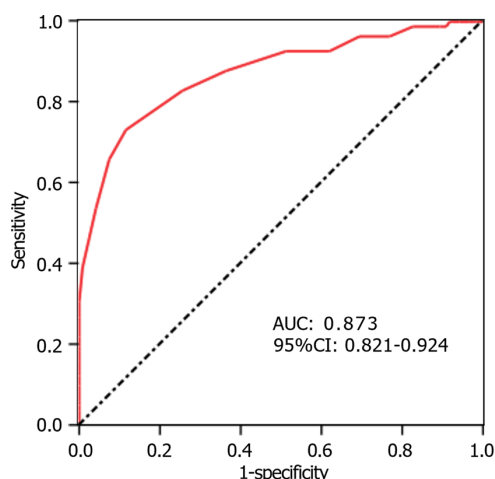
China's fertility policy is open, which has resulted in a significant increase in the number of older pregnant women[9]. The incidence of PPD among older pregnant women is relatively high. Some influencing factors for the occurrence of PPD in older pregnant women were identified, and a model was constructed to predict the PPD risk of older pregnant women early, help to take early preventive measures, and reduce the incidence of PPD in older pregnant women.



**Table 3 Multivariate logistic regression analysis results of postpartum depression in older pregnant women**

Variable	$\beta$	SE	Wald $\chi^2$	P value	OR (95%CI)
High school and below	0.729	0.279	6.827	0.009	2.073 (1.199-3.582)
Incompatible family relationships	0.942	0.349	7.285	0.007	2.565 (1.294-5.083)
Pregnancy complications	1.137	0.414	7.543	0.006	3.117 (1.385-7.015)
Separation of the mother and infant after birth	1.285	0.416	9.541	0.002	3.615 (1.599-8.166)
Constant	-6.671	1.884	12.538	< 0.001	

SE: Standard error; OR: Odds ratio.



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**Figure 1 Receiver operating characteristic curve evaluation of the postpartum depression risk prediction model for older pregnant women.** AUC: Area under curve.

An analysis of the Chinese PPD population showed that the incidence of PPD was highest within 6 wk after delivery (the postpartum period)[10]. This study found that the incidence of PPD in older pregnant women at 42 d postpartum was 21.34%, which is within the scope of literature reports[11,12]. PPD symptoms in older pregnant women may be caused by various factors. This study further found that a high school education and below, poor family relationships, pregnancy complications, and the separation of the mother and baby after birth were all factors affecting PPD in older pregnant women. Some possible reasons are as follows: (1) Studies have shown that pregnant women with low education levels are prone to fear of childbirth[13]. When a mother has the psychological characteristics of fear, poor cognitive integration, a lack of proactive ways to seek help, and is extremely prone to negative emotions, if she cannot find a positive way to alleviate her fear, she may have a low self-evaluation of postpartum care for her newborn, have an increased psychological burden, and develop PPD. Additionally, a low education level and a poor living environment and family economic situation may also affect PPD risk to some extent[14]. The pressure of raising young children is high [15], quality of life is affected[16], and it is easy to generate negative emotions, which triggers PPD symptoms; (2) family relationships play an important role in the family[17]. A woman usually needs care and attention from her mother-in-law after childbirth[18]; differences in cognition between the two generations may result in differences of opinion regarding the care of the newborn and even conflicts. This invisibly causes psychological pressure and burdens for the new mother [19]. As a result, the family environment is not harmonious, which often increases the mental burden on mothers[20]. Severe cases may result in the mother not receiving sufficient family support, thus increasing her risk of PPD occurrence; (3) older pregnant women tend to have diabetes and hypertension during pregnancy[21]. Research shows that, women diagnosed with pregnancy induced hypertension were more likely to have depressive symptoms than their normotensive counterparts[22]. These pregnancy complications not only increase the risk of PPD[23] but also increase the risk of complications such as postpartum infections and bleeding[24]. Studies have shown that puerperal infection events are significantly correlated with PPD[25]. Which increases the risk of PPD and affects the physical recovery of the mother. Therefore, pregnancy complications are an important factor in increasing PPD; and (4) the health status of newborns is a key concern for mothers and their families. Previous studies have shown that infant health is a contributing factor to PPD in postpartum women[26]. This may be due to the combination of other diseases at birth and the need for a newborn to be transferred to a neonatal department for relevant monitoring and treatment[27], increase maternal concerns about the health status of their children, causing psychological storage of certain negative information, aggravate psychological stress, making it easy for mothers to be emotionally affected by these negative information, increase the risk of

postpartum PPD. At the same time, when the newborn is complicated with diseases, the family has to bear a large amount of medical expenses and increase the family burden[28], which significantly increases the probability of PPD in the maternal.

The development of a good prediction model lies in screening effective indicators. This study analyzed the influencing factors of PPD in older pregnant women through multiple logistic regression analysis and built a prediction model based on influencing factors. After analysis, it was found that the area under the ROC curve of the prediction model was 0.873, which indicated that the model has high predictive performance. Some reasons for this are as follows: The model was tested with independent samples in this article, irrelevant indicators were filtered out, related indicators were included, information complementarity was realized, and the predictive performance of the model was enhanced. The difference between the value predicted by the model and the actual value through the goodness-of-fit test was not statistically significant, indicating that there was no overfitting in the model, which is suitable for clinical promotion and application. Therefore, building a model based on the various influencing factors of PPD in older pregnant women can effectively predict PPD risk, providing a new approach for medical personnel to assess high-risk populations early to develop personalized management measures. For example, strengthening psychological counseling and health education for high-risk populations, advising family members to provide material and spiritual support to new mothers, helping mothers relieve stress, guiding mothers and their families in the care of newborns, enhancing maternal feeding confidence, and reducing the incidence of depressive symptoms are some possible management measures.

However, our study still has some limitations: (1) This was a single-center study with a single source of patients, and the representativeness is relatively limited; and (2) the sample size was small, which may lead to biased results. More participants need to be included to validate the conclusion.

## CONCLUSION

The risk of PPD among older pregnant women is closely related to their educational level, family relationships, pregnancy complications, and the admission of newborns to the neonatal department after birth. A PPD risk prediction model for older postpartum women with good discrimination should be constructed.

## ARTICLE HIGHLIGHTS

### Research background

Postpartum depression (PPD) is a mental illness that can be caused by multiple factors, including the process of physical recovery in the postpartum period, newborn health, psychological stress, *etc.* The physiological functions of older pregnant women are far inferior to those of younger women. The process of physical recovery in the postpartum period is slow, and the decrease in a mother's own physiological stress ability makes them more prone to mental and psychological disorders.

### Research motivation

Exploring the influencing factors of PPD in older pregnant women and constructing predictive models will provide guidance for the clinical evaluation of PPD risk in older pregnant women and the development of relevant measures.

### Research objectives

This study aimed to identify the influencing factors of PPD in older pregnant women and construct a prediction model based on the influencing factors of PPD in older pregnant women.

### Research methods

This study used a cross-sectional survey to investigate the PPD status of older pregnant women in our hospital and collected their data for analysis.

### Research results

The incidence of PPD in older pregnant women at 42 d postpartum was 21.34%. Among these older pregnant women, a high school education and below, poor family relationships, pregnancy complications, and the separation of the mother and baby after birth were all influencing factors for PPD. A prediction model built based on these factors had high prediction efficiency.

### Research conclusions

The risk of PPD among older pregnant women is closely related to their educational level, family relationships, pregnancy complications, and the admission of newborns to the neonatal department after birth. Constructing a PPD risk prediction model for older postpartum women based on the above factors can enable medical staff to perform early assessment of PPD risk for older pregnant women.

## Research perspectives

The influencing factors of PPD in older pregnant women were identified, and a predictive model was constructed based on these influencing factors to determine the risk of PPD in older pregnant women in the future.

## FOOTNOTES

**Author contributions:** Chen L and Shi Y conceived and designed the study; Shi Y guided the study; Chen L collected the clinical data; Chen L and Shi Y analyzed the data; all authors drafted and revised the manuscript.

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