Post-traumatic stress disorder, anxiety, and care responses among mothers of preterm infants at one month of corrected age after discharge from the neonatal intensive care unit

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Abstract

Background: Preterm birth is a worldwide problem that can cause changes in emotions of mothers. This study aimed to evaluate the effect of maternal anxiety and post-traumatic stress disorder symptoms on maternal care responses to preterm infants, and whether there is a mediation effect of maternal distress between preterm clinical status and maternal care responses.

Methods: This hospital-based longitudinal cohort study included 256 mother-preterm infants who came to the outpatient clinic for a follow-up check after being discharged from the neonatal intensive care unit at one month of corrected age. Mothers completed the Post-traumatic Stress Disorder Questionnaire, the Self-rating Anxiety Scale, and four sub-scales of care responses.

Results: Significant post-traumatic stress disorder and anxiety were observed in 29.7% and 15.6%, respectively, of mothers at one month of corrected age and at about 10.83 weeks postpartum. Path analysis results showed that the final model could be fitted well with sample data(χ^2=33.098, DF =20, P=0.033, CFI=0.992, NFI=0.981, RMSEA=0.051, SRMR= 0.029). Path analysis showed that care responses were directly and indirectly affected by preterm infants' clinical status, maternal post-traumatic stress disorder, and anxiety. Gestational age significantly influenced maternal care responses.

Conclusion: This study identified maternal anxiety and PTSD symptoms may significant effects on maternal care responses to preterm infants at one month of corrected age. To promote the development

of preterm infants after discharge from the neonatal intensive care unit, multiple disciplinary

interventions should be developed to improve maternal care responses.

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Introduction

Preterm birth is a worldwide problem, with a global incidence of 15 million per year [1].

According to a World Health Organization report of 2019, 14.8 million babies were born

prematurely, with a global average preterm birth rate of 10.6%, and China had more than 1.1

million preterm births, with a rate of 6.9% [2]. Preterm births account for approximate one

million neonatal deaths and one million deaths in children under five years old [3]. Preterm

birth is closely related to neonatal complications, cognitive, motor, and language delays,

behavioral disorders, lower academic performance in early childhood, and it may increase

risks of chronic diseases later in life[4-7]. Furthermore, premature newborns are often cared

for in the neonatal intensive care unit (NICU) and have a high risk of physiological problems

including feeding intolerance, respiratory distress, or weight loss, all of which increase

demands on parents[8, 9]. Meanwhile, this also creates an emotional and economic burden for

45 families [10].

46   Many factors may influence the future growth and development of preterm infants,

47 including infants' clinical status, such as gestational age, birth weight, or length of NICU stay

48 (LOS)[11, 12], and maternal characteristics like maternal education [13] and mental health.

49 Maternal post-traumatic stress disorder (PTSD), as a common morbidity of depression, may

50 lead to impaired mother-infant interaction [14] and worse fine motor development in preterm

51 infants [15]. Meanwhile, a study conducted by [16] showed maternal anxiety has negative

52 effects on breastfeeding, mother-infant interaction, sleep, infant temperament, and

53 internalizing behavior in later life. In addition, taking care of the NICU preterm infants could

54 present a great challenge for mothers, despite a family‐centered approach being offered at

55 the NICU [17].

56 **Literature review**

57   Premature birth and hospitalization in the NICU are stressful events and may lead to a

58 series of impacts on the parents, especially mothers. Maternal anxiety and PTSD symptoms

59 are the most significant emotional changes[18]. A recent systematic review and meta-analysis

60 reported the rate of anxiety symptoms to be 42% in pregnant women in China [19] and, the

61 younger the woman, the higher the anxiety on delivery [20]. Another systematic review and

62 meta-analysis of PTSD reported prevalence rates of 3.3% during pregnancy and a further 4%

63 of postpartum PTSD, which mainly relates to traumatic events [21]. In China, the prevalence

64 rates of postpartum PTSD are 6.1% and the risk factors for postpartum PTSD include the

65 presence of postpartum depression, non-Han ethnicity, and low social support, while having

66 one child is a protective factor [22]. Post-traumatic stress disorder is associated with increased

67   impaired mother-infant bonding[23], lower rates of breastfeeding[24], and impairment in

68   maternal ability to detect infant cues[25, 26]. Additionally, some studies have suggested that

69   gestational age, birth weight, LOS, and maternal education level are factors associated with

70   maternal emotional distress and interfere with parental ability to respond to infants in ways

71   that form healthy and nurturing relationships[14, 15].

72   Maternal care responses in this study were based on the application of the Family

73   Management Style Framework and the Family Management Measure [27]. The Family

74   Management Style Framework describes key elements of family management related to how

75   family members define their situation, their management behaviors, and the consequences of

76   condition management for family life, which were tested for applicability to Chinese culture

77   [28]. The Family Management Measure is a methodological development of the Family

78   Management Style Framework and comprises six separately scored scales [29]. Considering

79   the vulnerability of preterm infants, almost all families declared that the care of a premature

80   baby required the mother to be always available [30]. Mothers struggled at times with

81   managing the balance between childcare and daily life. Thus, we used four domains of the

82   Family Management Measure and called it maternal care responses: Condition Management

83   Ability (mothers' perception of the overall ability to manage the infant's condition),

84   Condition Management Effort (the time and work required to manage the condition), Family

85   Life Difficulty (mothers' perception of how the condition makes family life difficult), and

86   View of Condition Impact (mothers' perception of the condition's impacts on the future of the

87   child and family). The latter three variables were combined into one latent variable called

88   DIFFICULTY, which represents the hard parts of maternal care responses, while Condition

89   Management Ability is the easy aspect of maternal care responses.

90   Maternal PTSD symptoms and anxiety are associated with maternal care responses to

91   preterm infants[31]. A previous study showed that negative emotions led to poor care in many

92   aspects, such as care management or sensitivity to exceptional situations[32]. A study by[33]

93   found that there was a significant correlation between PTSD symptoms and maternal ability

94   to cope with circumstances following preterm infant birth. A study highlighted by[34] showed

95   that extreme maternal anxiety was related to care behaviors toward preterm infants and the

96   quality of the home environment, which may be related to neurodevelopment in preterm

97   infants.

98   Recent studies reported that the NICU care involvement experience may alter parents'

99   identity and values because of the stressors related to their infants' fragile condition, different

100   parental roles, and the NICU environment [17, 35] quantitative data of late preterm infants

101   showed that maternal care confidence decreased over the first two months, regardless of

102   whether the mother was depressed. Mothers complained that the first month at home with

103   their infants was tough. They were unable to breastfeed, bathe, change nappies, or have

104   proper skin-to-skin contact. As such, supporting parents in the NICU after preterm birth is

105   vital not only for their own mental health, but also due to potential implications for their

106   relationship with their infant and subsequent child development [36].

107   A relationship chain linking gestational age, birth weight, LOS, maternal education,

108   maternal PTSD, anxiety, Conditional Management Ability, Family Life Difficulty, Condition

109   Management Effort, and View of Condition Impact was derived from the literature (Figure 1).

110   Evidence suggested that maternal PTSD and anxiety are related to Conditional Management

111 Ability, Family Life Difficulty, Condition Management Effort, and View of Condition Impact.

112 Moreover, maternal anxiety is interrelated with PTSD[37]. Clinical status of preterm infants

113 is also linked to maternal PTSD, anxiety, Conditional Management Ability, Family Life

114 Difficulty, Condition Management Effort, and View of Condition Impact. Although earlier

115 research has shown that NICU preterm infants increase maternal emotional distress,

116 postpartum PTSD, or anxiety, which has a negative effect on breastfeeding initiation and

117 mother-infant interactions, there are limited studies on how maternal emotional factors and

118 caring responses may be able to mitigate risk and promote positive outcomes in NICU

119 preterm infants. We need to identify the relationships between maternal PTSD, anxiety, and

120 caring responses in mothers of preterm infants discharged from NICU.

121 **Study aim**

122 This study investigated the interrelationships between gestational age, birth weight, LOS,

123 maternal education level, maternal PTSD, anxiety, Conditional Management Ability, Family

124 Life Difficulty, Condition Management Effort, and View of Condition Impact in mothers with

125 preterm infants after discharge from NICU.

126 # Methods

127 **Study design and participants**

128 This longitudinal cohort study was conducted between April 2016 and August 2017 at a

129 Maternity and Infant Hospital in Shanghai, China. This hospital is a center for critically ill

130 newborns and prenatal diagnosis. There are approximately 2,000 preterm infant births

131 annually, with about 600 preterm infants admitted to NICU.

132 Recruitment was performed when preterm infants were hospitalized in the NICU and

133 came back to hospital for a follow-up check. Eligible mothers and preterm infants were

134 recruited based on the following inclusion criteria: (1) Mothers with an infant who had one of

135 the following situations: gestational age was less than 34 weeks; birth weight was no more

136 than 2,000g; existing serious complications (bronchopulmonary dysplasia,

137 periventricular-intraventricular haemorrhage, sepsis, or neonatal respiratory distress syndrome)

138 after birth; (2) Mothers and infants attended follow-up growth evaluation at one month of

139 corrected age at the hospital outpatient clinic; (3) mothers were Chinese-speaking. Exclusion

140 criteria were as follows: (1) Infants had Ⅲ – Ⅳ grade periventricular-intraventricular

141 haemorrhage; (2) Infants were transferred or died during NICU stay; (3) mothers and infants

142 had no medical records in the hospital database. Finally, 256 mother-preterm infants were

143 included.

144 **Data collection**

145 The data were collected by researchers in our team. Eligible mothers were recruited at

146 the NICU. The researchers explained the purpose of the study to mothers. Participants were

147 also informed that they could withdraw from the research whenever they wanted and all

148 information that they provided would remain confidential. When mothers brought the infants

149 to the neonatal outpatient unit, they were required to fill out the questionnaires after signing

150 the informed consent form. The researchers were available to answer any questions they had

151 and collected the questionnaires.

152 Perinatal characteristics questionnaires were collected from medical records, including

153 maternal characteristics, such as age, education background, gravidity, and parity, as well as

154 neonatal characteristics, such as gestational age, sex, birth weight, delivery mode, five-minute

155 Apgar score, and LOS.

156 Maternal care responses were measured using four scales: the Chinese version of the

157 Condition Management Ability Scale, the Condition Management Difficulty Scale, the

158 Condition Management Effort Scale, and the View of Condition Impact Scale, which has

159 been applied to the preterm infants. The fitting indices of the confirmatory factor analysis are:

160 χ^2= 3214.94, DF=1184, χ^2/DF=2.72, P=0.01, CFI=0.93, NFI=0.89, RMSEA=0.070,

161 SRMR= 0.087 (DF: Degrees of Freedom; P: Probability; CFI: Comparative Fit Index; NFI:

162 Normed Fit Index; RMSEA: Root Mean Square Error of Approximation; SRMR:

163 Standardized Root Mean Square Residual).

164 The Condition Management Ability Scale [38] is a 12-item scale to assess parental

165 perception of ability to manage the preterm infant's condition. It uses five response options

166 ranging from 1 (absolutely disagree) to 5 (absolutely agree). Total scores range from 12 to 60.

167 Higher scores indicate that the condition is viewed as more readily manageable. Cronbach's

168 alpha in this sample was 0.73.

169 The Family Life Difficulty Scale [38] is a 14-item scale for mothers to show perception

170 of the degree that their life is made difficult when caring for a preterm infant. It uses five

171 response options ranging from 1 (absolutely disagree) to 5 (absolutely agree). Total scores

172 range from 14 to 70. Higher scores indicate more difficulty in dealing with the condition.

173 Cronbach's alpha in this sample was 0.81.

174 The Condition Management Effort Scale [38] is a four-item scale to address maternal

175 perception of the time and work required to manage the preterm infant's condition. It uses

176 five response options ranging from 1 (absolutely disagree) to 5 (absolutely agree). Total

177   scores range from four to 20. Higher scores indicate more time and work needed to manage

178   the condition. Cronbach's alpha in this sample was 0.62.

179   The View of Condition Impact Scale [38] is a 10-item scale to address maternal

180   perception of the seriousness of their infant's condition and its implications for the future. It

181   uses five response options ranging from 1 (absolutely disagree) to 5 (absolutely agree). Total

182   scores range from 10 to 40. Higher scores indicate a higher level of concern about the

183   condition. Cronbach's alpha in this sample was 0.61.

184   The level of post-traumatic stress disorder symptoms was assessed using the Chinese

185   version of the Post-traumatic Stress Disorder Questionnaire, which has 14 'yes' or 'no' items,

186   each scoring 1 or 0. Total scores range from 0 to 14. Total scores of more than five are

187   defined as post-traumatic stress disorder. The Cronbach 's alpha was 0.83 [39].

188   Maternal anxiety was assessed using the Chinese version of the Self-Rating Anxiety

189   Scale [40], which contains 20 items. Each item is rated on a four-point scale ranging from 1

190   (never) to 4 (very often). The raw scores are the sum of the item scores. Total scores equal

191   1.25 times the raw scores and ranges from 25 to 100. Total scores more than 49 are defined as

192   maternal postpartum anxiety. Higher scores indicate higher levels of anxiety. Cronbach's

193   alpha in this sample was 0.82.

194   **Statistical analysis**

195   Descriptive statistics and bivariate correlations among variables were examined using

196   SPSS version 24.0. To examine the direct and indirect relationships between gestational age,

197   birth weight, LOS, maternal education, maternal PTSD, anxiety, Conditional Management

198   Ability, Family Life Difficulty, Condition Management Effort, and View of Condition Impact

199   simultaneously, path analysis was performed using Amos 23.0. The testing model was based

200   on the hypothesis model (Figure 1), also depending on the recommended modification indices

201   to improve parsimony. The Chi-square (χ^2), SRMR, RMSEA, CFI, and NFI were used as fit

202   indices. Values for SRMR ranged from 0 to 1, with well-fitted models achieving values <0.05.

203   The CFI and NFI values that were higher than 0.90 and the RMSEA values that were lower

204   than 0.06 indicated excellent fit. Results corresponding to p<0.05 were considered statistically

205   significant. Standardized regression weights were used to estimate direct associations. The

206   significance of indirect effects were determined by examining the bias-corrected bootstrap

207   confidence intervals using 5,000 bootstrap samples [41].

208

209   **Figure 1.** The hypothetical model of interrelationships of variables in mothers of preterm infants

210   *LOS,* length of stay; *PTSD,* post-traumatic stress disorder; *CMA,* Condition Management Ability; *FLD,*

211   Family life difficulty; *CME,* Condition Management Effort; *VCI,* View of Condition Impact; *CMA,*

212   *FLD, CME* and *VCI* may affect each other.

213

214   **Ethical considerations**

215   This study was approved by the Research Ethics Committee of the School of Nursing and

216   Public Health，Shanghai Jiao Tong University (number: 2016027). All mothers of preterm

217   infants were provided informed consent and their anonymity was preserved.

218   **Results**

219   **Sample characteristics**

220   A total of 265 eligible mothers were recruited during the research. One mother did not

complete all the questionnaire and eight preterm infants' gestational age or birth weight records could not be found. Finally, 256 participants (97%) were included, with characteristics of dyads presented in Table 1. The average time after birth was (10.83±2.81) weeks. Additionally, 15.6% of mothers demonstrated clinically significant levels of anxiety, and PTSD symptoms were observed in 29.7% of mothers. The average scores of Conditional Management Ability, Family Life Difficulty, Condition Management Effort, and View of Condition Impact were 41.05±6.96, 36.22±10.26, 12.17±3.10, and 27.10±5.90, respectively, which were all in the moderate level.

Table 1. Description of maternal demographic information and infants' clinical status (N=256)

Correlations among the infants' clinical status, maternal emotional distress, and care responses

As we can see in Table 2, maternal education had no significant correlation with any of the variables we were interested in, while the rest of the variables were all significantly correlated, positively or negatively.

Table 2. Descriptive statistics and correlations for infants' clinical status, maternal emotional distress and care responses (N=256)

Pathways among clinical status, maternal PTSD, anxiety, and care responses at one month of corrected age.

243　　　The final path analysis model with standardized parameter estimates was shown in

244　Figure 2. We only tested paths between variables that were significantly relevant in

245　correlation analysis. The results showed that gestational age had a significant negative impact

246　on maternal PTSD, anxiety, LOS, and DIFFICULTY, but a significant positive impact on

247　birth weight and Conditional Management Ability. Lower birth weight predicted longer LOS

248　and longer LOS predicted higher Conditional Management Ability.

249　Post-traumatic-stress-disorder symptoms were positively associated with maternal anxiety,

250　while being negatively associated with Conditional Management Ability. Higher maternal

251　anxiety was related to lower Condition Management Ability and higher DIFFICULTY.

252

253　**Figure 2.** Final path analysis model (coefficients are standardized parameter estimates)

254　*LOS,* length of stay; *PTSD,* post-traumatic stress disorder; *CMA,* Condition Management Ability; *FLD,*

255　Family life difficulty; *CME,* Condition Management Effort; *VCI,* View of Condition Impact; * p < .05,

256　**p < .01.

257

258　　　To examine whether the mediation effects exist, bootstrapping was conducted. The

259　results of the indirect effects of the overall model were presented with point estimate,

260　standard errors, Sobel Z(Z), percentile 95% confidence interval (CI) and bias-corrected

261　percentile 95% CI of bootstrapping. As we see in Table 3, the model found 23 statistically

262　significant mediation effects.

263

264　**Table 3.** indirect effects for overall model from infants' clinical status, maternal emotional distress to

265 care responses

266

267   The fitting indices of the final model were shown as follows: χ^2=33.098, DF =20,

268 P=0.033, CFI=0.992, NFI=0.981, RMSEA=0.051, SRMR= 0.029, indicating that the model

269 fitted well with the data. The final model accounted for 34% and 77% of the total variance of

270 Condition Management Ability and DIFFICULTY, respectively[23], and was used to

271 examine the pathways between clinical status of premature infants hospitalized in the NICU,

272 maternal PTSD, anxiety, and care responses. We found that maternal care responses are

273 directly and indirectly affected by preterm infant clinical status, maternal anxiety, and PTSD.

274 **Disscussion**

275   The aim of this study was to examine the pathways between clinical status of premature

276 infants hospitalized in NICU, maternal PTSD, anxiety and care responses. We found that

277 maternal care responses are directly and indirectly affected by preterm infant clinical status,

278 maternal anxiety and PTSD.

279 **The interrelationship among preterm infants' clinical status and maternal PTSD and**

280 **anxiety**

281   Findings of relationships between gestational age, birth weight, and LOS in this

282 population were consistent with literature that suggested that LOS was inversely proportional

283 to gestational age and birth weight[42]. We found that mothers with PTSD were also more

284 vulnerable to anxiety, which was in agreement with prior studies [43, 44].

285   It must be noted that gestational age, birth weight, and LOS are strongly associated with

286 PTSD symptoms, which were the most important predictors of maternal anxiety in our final

287   model. Several studies have shown that PTSD, anxiety, depression are highly comorbid[45] ,

288   and birth-related PTSD may reflect the continuation of non-specific symptoms, such as

289   hyper-arousal[46] or causing anxiety[47]. These suggest that maternal PTSD may have

290   further adverse effects on mental health of mothers. Besides, The impact of birth weight and

291   LOS on maternal PTSD symptoms and anxiety may be overshadowed. This finding may

292   indicate the importance of minimizing environmental stressors and supporting mothers with

293   an infant born at a lower gestational age, such as having a respected birth plan, performing

294   skin-to-skin contact with the newborn[48].

295   **The interrelationship among preterm infants' clinical status and four aspects of**

296   **maternal care responses**

297   The main result concerning maternal care responses was that Condition Management

298   Ability is an important mediator between gestational age and DIFFICULTY, while LOS plays

299   the major role in the indirect relationship between gestational age and Condition Management

300   Effort if only taking infants' clinical status into account.

301   Caring for a premature infant is a process requiring continuous learning and adaptation.

302   As mothers strengthen their ability by participating in caring practice, they will become more

303   familiar with infants' needs and learn to decode infants' signals, thereby gaining confidence

304   and assuming increased levels of responsibility for the infant [30, 49]. It is evident that an

305   emphasis on strengthening parental empowerment and parent-child interaction should begin

306   as early as possible. A "normal" family can promote the parent-child relationship and can

307   assist with earlier adaptation to the crisis situation that premature birth may create[50, 51].

308   The growth of ability can also improve the cognition of mothers to premature infants. In fact,

309 mothers who treat premature infants as more vulnerable can render these infants to go through

310 more difficulties in development [52-54]. Principles of Family-centred Care (2012) include

311 respect and recognition of each family's unique needs, resources, and skills. This begins with

312 parental involvement. Through participating in the nurse-led intervention programs, the

313 family strengthens the caring ability, accumulates coping experience, clarify needs and values

314 in caring for a preterm infant to help them achieve family well-being[55]. Thus, it may be

315 important for maternal and neonatal healthcare to note the assessments of care responses and

316 develop related interventions, e.g. the Primary Care Triple P Program [56] or

317 mindfulness-based interventions [57, 58] or Cognitive Behavioral Therapy[59] that can

318 potentially improve maternal cognition concerning preterm birth and help modifying thoughts

319 and cognitive distortions , while changing behavioral patterns that maintain distress and

320 recovering sensitive to their infant's condition.

321 The study also demonstrated that LOS significantly influenced Family Life Difficulty,

322 View of Condition Impact, and Condition Management Effort negatively, but positively

323 affected Conditional Management Ability. Concerning about the average of length of stay

324 was 25.54 days in this research which indicates most of the preterm infants maybe in a stable

325 situation, the relationships among LOS and Conditional Management Ability, Family Life

326 Difficulty, View of Condition Impact, and Condition Management Effort might be affected

327 by maternal subjective feelings. Some mothers believe that the longer the infant stays in

328 hospital, the better their physical condition will be at discharge, making infant care easier

329 after discharge [60]. Moreover, during hospitalization of infants, mothers can successfully

330 receive support from professionals, which might strengthen their ability to manage an infant's

331 condition[61]. Furthermore, previous research found that LOS influenced the development of

332 essential caregiving relationships and opportunities for parents and infants to develop

333 coregulatory strategies to deal with care tasks [30]. As most preterm infants are hospitalized

334 after birth, postpartum mothers may lack a sense of ownership of their infants and feel they

335 cannot develop a bond with the infant or they are not involved in their care sufficiently. Thus,

336 a longer hospitalization time may lead to less attention from parents when caring for their

337 infants and mothers may have a distorted understanding of their abilities and daily lives.

338 **The mediation effects of anxiety and PTSD between gestational age and maternal care**

339 **responses.**

340 The current study suggested that both maternal PTSD and anxiety are associated with

341 Conditional Management Ability and DIFFICULTY, directly or indirectly. We also found

342 that anxiety and PTSD have mediation effects on the relationships between infants'

343 gestational age and maternal care responses.

344 This requires a shift in neonatal nursing practice, moving the nurses' role away from a

345 mostly caregiving role of the infant to one focussing on the teaching and support of parents.

346 The effect of this has resulted in lower levels of parental stress and anxiety[54].

347 The average gestational age of our preterm infants was 33 weeks; however, mortality

348 and rehospitalization within the first year of life increase with decreasing gestational age,

349 particularly for infants of less than 33 weeks gestational age [62]. Cumulative stressful care

350 tasks may influence maternal ongoing emotion and contribute to concern and perceptions

351 about their child. These findings are consistent with prior studies that demonstrated the

352 importance of maternal mental health on caring for preterm infants[63, 64].

353   The negative relationship between maternal anxiety, PTSD and Condition Management

354   Ability may be attributed to the problem of mother-infant relationship establishment. As early

355   mother-infant interactions are affected by prematurity, as well as maternal mental health,

356   mothers with mental health problems fear or even avoid attachment with preterm infants [63].

357   However, positive attachment was one of the most important sources for mothers in

358   developing knowledge and the ability to manage a child's condition [30]. Negative

359   mother-infant interaction influences the caring ability of mothers with preterm infants.

360   Additionally, evidence has shown that anxious mothers appear to be biased towards emotional

361   expressions in infant faces, rating neutral infant faces as being sad and sad faces as being

362   sadder, while PTSD may also affect mothers' processing of emotion [65, 66]. All these

363   negative mother-infant interactions caused by maternal mood disorders decreased the caring

364   ability of mothers. Therefore, a higher level of maternal anxiety and post-traumatic stress

365   disorder may lead to lower Conditional Management Ability.

366   Moreover, this study showed that higher levels of maternal anxiety and PTSD play an

367   important role in predicting higher DIFFICULTY. The relationships between variables can be

368   explained by two main factors. The anxiety and PTSD of caregivers may affect the

369   relationships within the family, and even lead to family conflicts and disputes. However,

370   Infants involved in this study were all preterm who needed daily constant attention from

371   caregivers, especially mothers, to manage daily feeding, bathing, and to ensure a comfortable

372   environment. Thus a worsening family environment may not only affect infant development

373   [67, 68], but it may also increase parental time commitment and workload in caring for their

374   infants [69]. Besides, higher levels of maternal anxiety are associated with higher View of

375 Condition Impact. Due to the specific needs of premature infants, mothers always think that

376 their infants are fragile and need to receive extra care compared to term infants, as most could

377 easily die if not well cared for[64]. The growth of ability can also improve the cognition of

378 mothers to premature infants. In fact, mothers who treat premature infants as more vulnerable

379 can render these infants to go through more difficulties in development[70].

380 We recognize several limitations in our analysis. First, all participants were recruited from the

381 exclusive NICU setting, which may affect the representation and perhaps does afford an exact

382 assessment of the causality between variables. Second, although we employed the most

383 common used measure of anxiety and PTSD, report bias may arise when relying on

384 self-reported methods. Finally, there may remain some unobserved factor that could affect the

385 results. Considering the above, further studies with a larger and more diverse sample are

386 needed.

387 **Implications and recommendations**

388 The results of this study suggest that neonatal nurses should pay more attention to the

389 changes in parents' emotions to preterm infants during the follow-up appointments. The

390 follow-up period offers a perfect opportunity for midwives, pediatricians, neonatal nurses,

391 and clinical psychologists to work together to contact mothers and detect their emotional

392 distress. Carrying out interventions of parents' emotions as early as possible to enhance

393 maternal care responses in premature infants is of great significance. This research assists the

394 development of an organizational follow-up service for mothers with preterm infants

395 discharged from NICU, and it also highlights the need for mental health training for

396 NICU-related healthcare providers.

Conclusions

Owing to the importance of maternal care behaviors and perceptions on the development of preterm infants, the factors influencing care responses, as well as their relationships and pathways, should be a public health priority. Our findings add to the existing literature, showing that maternal anxiety and PTSD symptoms may have significant effects on maternal care responses to preterm infants at one month of corrected age discharged from NICU, and present a new finding that there may be a significant mediation effect of maternal distress between preterm clinical status and maternal care responses.

Abbreviations

NICU:the Neonatal Intensive Care Unit;LOS:Length Of NICU Stay;PTSD:Post-Traumatic Stress Disorder;DF:Degrees of Freedom;P:Probability;CFI:Comparative Fit Index; NFI:Normed Fit Index; RMSEA:Root Mean Square Error of Approximation; SRMR:Standardized Root Mean Square Residual;CMA:Condition Management Ability;FLD:Family Life Difficulty;CME:Condition Management Effort;View of Condition Impact:VCI;GA:Gestational Age.

Authors' contributions

Study design: Wenwen Ding, Ying Zhang

Data collection: Wenwen Ding, Wenying Gao

Data analysis: Qihui Wang, Wenying Gao, Ying Zhang

419   Manuscript writing: Qihui Wang, Wenying Gao, Ying Zhang

420   **Funding**

425   **Availability of data and materials**

426   The datasets used and analyzed during the current study are in Chinese language and are not

427   publicly available due to confidentiality of the participates, but are available from the

428   corresponding authors upon official request.

429   **Declarations**

430   **Ethics approval and consent to participate**

431   This study was approved by the Research Ethics Committee of the School of Nursing and

432   Public Health, Shanghai Jiao Tong University (number: 2016027), and all methods were

433   performed in accordance with the relevant guidelines and regulations. All mothers of preterm

434   infants were provided informed consent and their anonymity was preserved.

435   **Consent for publication**

436   Consent for publication is not applicable for this paper of review.

437   **Competing interests**

438   The authors declare that they have no competing interest.

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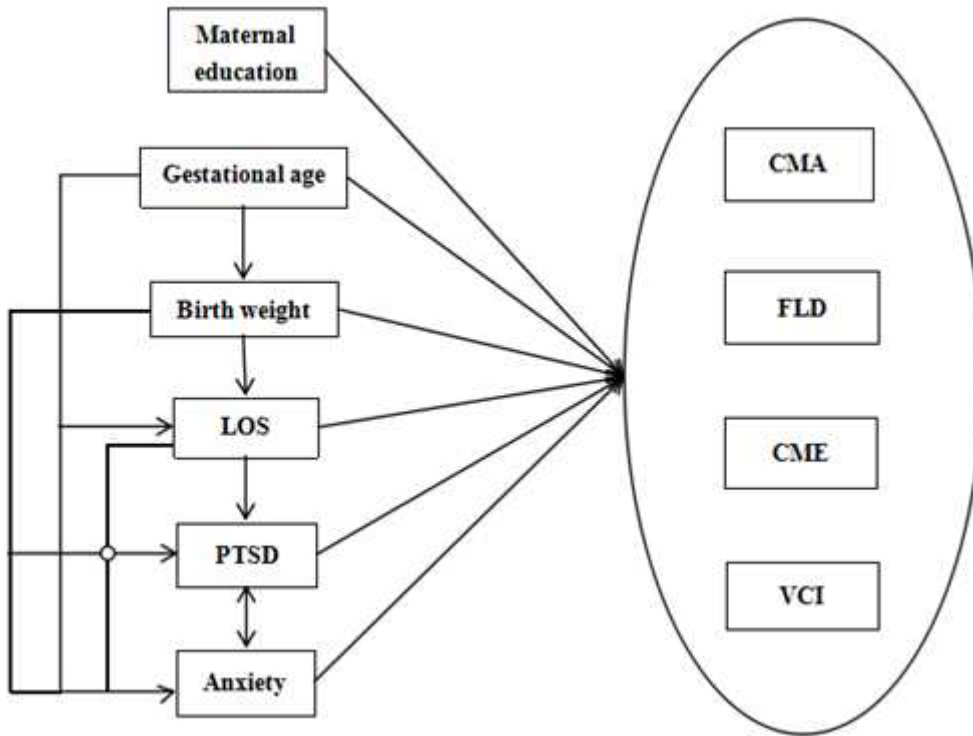
Figures

Figure 1

The hypothetical model of interrelationships of variables in mothers of preterm infants

LOS, length of stay; *PTSD,* post-traumatic stress disorder; *CMA,* Condition Management Ability; *FLD,* Family life difficulty; *CME,* Condition Management Effort; *VCI,* View of Condition Impact; *CMA, FLD, CME* and *VCI* may affect each other.
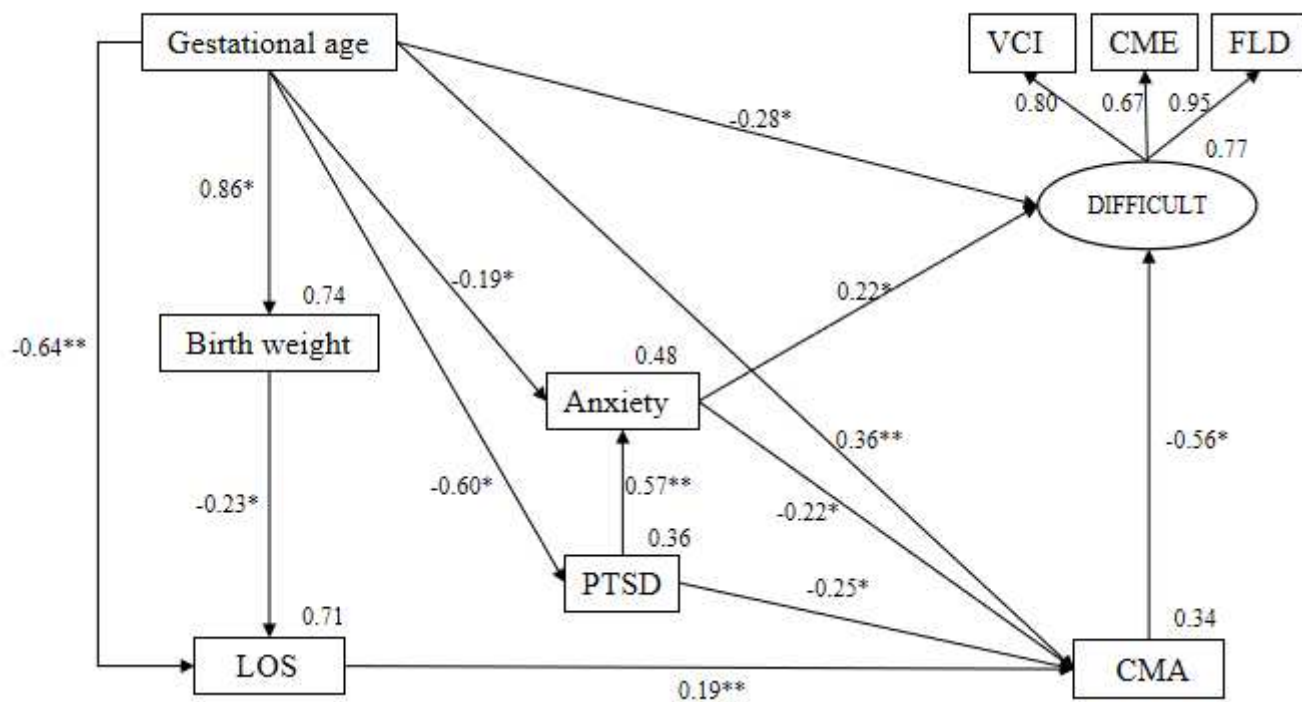
Figure 2

Final path analysis model (coefficients are standardized parameter estimates)

LOS, length of stay; *PTSD,* post-traumatic stress disorder; *CMA,* Condition Management Ability; *FLD,* Family life difficulty; *CME,* Condition Management Effort; *VCI,* View of Condition Impact; * p < .05, **p < .01.