Original Article

Association among postpartum posttraumatic stress disorder, family coping, neurodevelopment, and language development in high-risk infants: a retrospective study

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Background: A high-risk infant (HRI) is a child whose fetal, neonatal, and infant development is impacted by adverse factors that may cause cognitive, sensory, behavioral, or language defects. The complex situation in the treatment process is a continuous challenge and stressor for parents. If parents fail to take appropriate coping styles, it will have an adverse impact on the health of parents and the growth and development of children. The purpose of this study was to explore the impact of clinical characteristics, postpartum posttraumatic stress disorder (PTSD), and family coping on the neurodevelopment and language development of HRIs as a reference for targeted intervention.

Methods: This study retrospectively recruited 211 children who were hospitalized in the neonatal intensive care unit (NICU) of Suzhou Kowloon Hospital from January 2018 to December 2021. HRI and their mother were interviewed by telephone with general information questionnaire, Perinatal Post-traumatic Stress Disorder Questionnaire, medical coping modes questionnaire, Bayley Scales of Infant Development the Early Language Milestone Scale to investigate HRI and their mothers; Logistic regression was used to analyze the relationship between HRI mothers' emotions and family coping with neurodevelopment and language development.

Results: The neurodevelopmental scores of HRIs differed according to gestational week of delivery, birth weight, and disease diagnosis. The language development scores of HRIs differed according to gestational week of delivery, birth weight, disease diagnosis, and maternal education. Multiple stepwise regression analysis showed that the neurodevelopmental scores were affected by gestational week of delivery, postpartum PTSD score, and family coping. Logistic regression analysis showed that the language development scores were affected by maternal education and neurodevelopmental level. The correlation analysis showed that the postpartum PTSD scores were negatively correlated with family coping, neurodevelopment, and language development, and that family coping was positively correlated with the neurodevelopment and language development scores ($P<0.05$).

Conclusions: The neurodevelopment and language development of HRIs were affected by the gestational week of delivery, maternal education, the child's birth weight, and disease diagnosis. NICU wards can promote the healthy development of HRIs by providing mothers with targeted health education concerning the child's condition, postpartum PTSD, and family coping strategies.

Keywords: High-risk infant (HRI); postpartum posttraumatic stress disorder (PTSD); family coping; neurodevelopment; language development

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Introduction

High-risk infants (HRIs) are children who experience adverse factors that may harm their development in the fetal, neonatal, and infant periods. In 2008, the American Academy of Pediatrics updated their guidelines for HRIs and divided HRIs into the following 4 categories: (I) premature infants; (II) infants with special health problems or reliance on technology, such as ventilator maintenance and nutritional support; (III) infants at risk due to family conditions, such as low cultural and educational background, lack of social support, unstable marriage, or few prenatal examinations; and (IV) infants with a maternal history of early infant death. In the present study. Statistics show that 8–10% of HRIs have a brain injury and that 50% of HRIs display obvious cognitive, sensory, or behavioral defects (1). In addition, HRIs experience behavioral problems such as ADHD, anxiety, and depression at a rate 4 times higher than their peers (2). HRIs may also experience language delay, which occurs when a child's language development progresses at a slower rate than that of children of the same age (3).

The main caregivers of HRIs after discharge are the parents. The complexities of HRI treatment and care provide a continuous challenge and stressor for parents, and parental care ability is closely related to the prognosis of HRIs and long-term healthy development outcomes. Postpartum posttraumatic stress disorder (PTSD) is a mental disorder that may be caused by early trauma or childhood abuse experiences, pregnancy and childbirth complications, a traumatic childbirth experience, and the delivery of critically ill infants (4). Postpartum PTSD can have adverse consequences for mother–child interaction and the family as a whole (5,6), and these negative effects may last for a year or more (4,7). A failure to adopt appropriate coping strategies can also have an adverse impact on the health of parents and the growth and development of children. Therefore, this study aimed to improve intervention measures for HRIs and promote the healthy growth of infants by analyzing the association among clinical characteristics, postpartum PTSD, family coping, and the neurodevelopment and language development of HRIs. We present the following article in accordance with the SURGE reporting checklist (available at https://tp.amegroups.com/article/view/10.21037/tp-22-128/rc).

Methods

Research participants

This study retrospectively recruited 211 children who were hospitalized in the neonatal intensive care unit (NICU) of Suzhou Kowloon Hospital from January 2018 to December 2021 and conducted a telephone interview questionnaire survey. The inclusion criteria were as follows: (I) meet the standard definition of HRI as defined by the American Academy of Pediatrics; (II)children with a NICU hospitalization experience; (III) the mother was the main caregiver of the HRI; and (IV) the mother voluntarily participated in the study with informed consent. Patients were excluded according to the following criteria: (I) children with congenital malformations or genetic diseases with severe complications; (II) children who died or were automatically discharged from the NICU during hospitalization; (III) the mother of the child had a serious audio–visual impairment or cognitive impairment; and (IV) premature infants and mothers who had incomplete information and could not be contacted (*Figure 1*).

Questionnaire

General information questionnaire

A general information questionnaire was compiled by the researchers and used to collect the data of HRIs and their mothers. The contents included the basic information of the mothers (age, education, health status during pregnancy, and family income) and the basic information of the HRIs (home address, telephone number, discharge diagnosis, high-risk factors, birth status, and imaging examination).

Perinatal Posttraumatic Stress Disorder Questionnaire (PPQ)

The PPQ was compiled by DeMier *et al.* (8) in 1996 and includes a total of 14 items. It is mainly used to screen postpartum PTSD symptoms of mothers of HRIs under one and a half years old. The scale adopts a three-factor

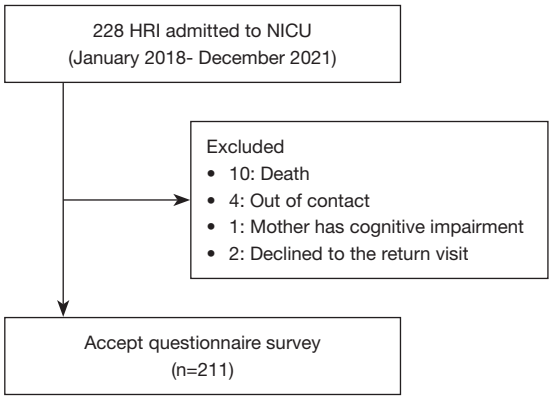

Figure 1 Study flowchart. HRI, high-risk infant; NICU, neonatal intensive care unit.

model including intrusive recall, avoidance symptoms, and excessive vigilance symptoms. When answering the questionnaire, the mother must report postpartum symptoms that last for more than 1 month. The scale has a grade scoring method of 0–4, with a total score of 0–56. When the total score exceeds 19, this indicates that the mother is positive for PTSD after delivery. The Cronbach's αcoefficient is 0.85, and the test–retest reliability of 2–4 weeks is 0.92 (9).

Medical Coping Modes Questionnaire (MCMQ)

The MCMQ, developed by Feifel *et al.* in 1987 (10), investigates a patient's choice of 3 coping strategies (avoidance, acceptance–resignation, and confrontation) in different stages of a disease. The scale includes 20 items. Each item is scored according to 4 grades (1 for "never" and 4 for "almost always"). The higher the score, the more closely aligned the patient's behavior is to that coping strategy. A score of ≥41 points, 30–40 points, or ≤29 points for avoidance, acceptance–resignation, and confrontation, respectively, the Cronbach's αcoefficient is 0.76 (11).

Bayley Scales of Infant and Toddler Development (BSID-III)

The BSID-III is a tool that assesses infants and preschool children aged 0–36 months in 5 developmental domains: cognitive ability, language understanding, language expression, fine motor skills, and gross motor skills. The number of items in each domain that pass is directly added to the score of the domain, and the result is categorized into 3 grades: at risk, emerging and competent (12,13). The total weighted score is 100 points, and the boundary score is 85 points. The higher the score, the higher the level of the child's intellectual and motor development. Children whose score is less than the boundary score are considered to have developmental delay, the Cronbach's αcoefficient is 0.83 (14).

The Early Language Milestone Scale

The Early Language Milestone Scale (15) assesses children's language skills in 3 domains: (I) speech and language expression (A, 26 items), (II) auditory perception and understanding (B, 20 items), and (III) visual understanding and expression (C, 13 items), with a total of 59 items. Each item that passes scores 1 point, and each item that fails scores 0 points. The scores of parts A, B, and C and the total score of the whole scale is calculated, and the corresponding percentile is obtained according to the norm. Compared with children in the same age group, a score less than or equal to the 10th percentile (P10) is considered abnormal, and a score greater than P10 is considered normal, the Cronbach's αcoefficient is 0.79.

Survey methods

The researchers collected basic information about 228 cases of HRI and their mothers from the nursing information system. A return visit was conducted after obtaining informed consent by telephone. A total of 211 questionnaire reports were recovered, and the effective recovery rate was 92.54%. This study adopts the method of multivariate analysis, and the sample size needs to be 5 to 10 times the number of variables. The influencing factors involved in this study plus general demographic data include 15 variables. Therefore, the sample size needed in this study can be between 75 and 150 cases. In order to make the results more reliable, taking the maximum sample size of 150 cases as the standard, considering the phenomenon of no response in the survey process and the 20% loss of follow-up rate, 228 questionnaires are planned to be distributed. Two hundred and eleven samples were actually recovered. The study was approved by the Ethics Committee of Suzhou Kowloon Hospital, Shanghai Jiao Tong University School of Medicine (No. HG-2022-007). Informed consent was obtained from the legal guardians of all patients. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013).

Statistical analysis

The results of each scale was inputted into the computer for

score conversion, and SPSS 22.0 (IBM Corp., Armonk, NY, USA) was used for statistical analysis. The measurement data are expressed as means and standard deviation, and the counting data are expressed as frequency and percentage. *T*-test analysis and analysis of variance were used, and the counting data were analyzed by chi-squared test. Multivariate logistic regression and multiple linear regression were used to correct for confounding factors. Pearson's correlation coefficient was used to analyze the association among postpartum PTSD, family coping, neurodevelopment, and language development. A P value of <0.05 was considered statistically significant.

Results

Baseline data

A total of 211 infants hospitalized in the NICU were included in this study. There were 124 male infants and 87 female infants. The gestational week of delivery was 36.76±3.17 weeks, the birth weight was 2.98±0.98 kg, and the gestational age of the mother was 28.29±4.39 years. The sample included 103 premature infants, 14 infants with neonatal respiratory distress syndrome (NRDS), 54 infants with hyperbilirubinemia, 10 infants with hypoxic ischemic encephalopathy, 23 infants with aspiration pneumonia, and 8 infants with patent ductus arteriosus (PDA). One hundred ninety infants were breastfed, and 21 were not breastfed. During pregnancy, 11 mothers had pregnancy induced hypertension, 4 had gestational diabetes, and 5 had threatened abortion. With respect to maternal education, 29 mothers were educated to a level below junior middle school, 80 were educated to the level of senior high school and technical secondary school, and 102 were educated to a level above junior college. With respect to income, 94 families had an average monthly income of less than 3,000 CNY, 84 families had an average monthly income of 3,000–5,000 CNY, and 33 families had an average monthly income of more than 5,000 CNY (*Table 1*).

The PPQ score of the mothers was 14.47±7.02, and 50 (23.70%) mothers had postpartum PTSD symptoms. The average family coping score was 48.73±11.74, and 56 (26.54%) families had a general and low coping style preference. The neurodevelopmental level of the HRIs was 90.09±6.37, and 34 children had neurodevelopmental abnormalities (16.11%). There were 14 (6.6%) children with dysphasia.

General factors affecting neurodevelopment in HRIs

Taking the HRI neurodevelopmental score as the dependent variable and each variable in the general data questionnaire as the independent variable, the statistical analysis found that there were statistically significant differences in gestational week of delivery, birth weight, and disease diagnosis (P<0.05; *Table 1*).

General factors affecting language development in HRI

Taking the HRI language development score as the dependent variable and each variable in the general data questionnaire as the independent variable, the statistical analysis found that there were statistically significant differences in gestational week of delivery, maternal education, children's birth weight, disease, and HRI language level (P<0.05; *Table 2*).

Correlation analysis of neurodevelopment and its influencing factors

Multiple stepwise regression analysis was performed with the HRI neurodevelopmental score as the dependent variable and each explanatory variable of the univariate analysis as the independent variable. The results showed that the neurodevelopmental score was affected by gestational week of delivery, postpartum PTSD score, and family coping (P<0.05; *Table 3*).

Correlation analysis of language development and its influencing factors

Logistic regression analysis was carried out using the HRI language development score as the dependent variable and each explanatory variable of the univariate analysis as the independent variable. The results showed that the language development score was affected by maternal education and neurodevelopmental level (P<0.05; *Table 4*).

Correlation analysis of postpartum PTSD, family coping, neurodevelopment, and language development

The results of the correlation analysis showed that the postpartum PTSD score was negatively correlated with family coping, neurodevelopment, and language development (P<0.05), and that family coping was

Table 1 Comparison of neurodevelopmental levels of HRIs with different characteristics

Factor	Group	n	Neurodevelopmental score	Neurodevelopmental delay	t	P
Gender	Male	124	90.30±6.21	17 (13.7%)	1.286	0.257
	Female	87	89.79±6.63	17 (19.5%)		
Gestational week of delivery	28–32	18	80.78±6.75	14 (77.8%)	5.760	0.000
	33–36	85	88.19±3.79	10 (11.8%)		
	≥37	108	93.14±5.86	10 (11.8%)		
Birth weight, Kg	<1.5	11	81.64±8.51	8 (72.7%)	5.587	0.000
	1.5–2.5	57	87.14±4.82	13 (22.8%)		
	>2.5	143	91.92±5.78	13 (9.1%)		
Disease diagnosis	Premature delivery	103	86.89±5.24	24 (23.3%)	14.099	0.015
	NRDS	14	90.50±7.32	4 (28.6%)		
	Hyperbilirubinemia	53	93.94±5.29	2 (3.8%)		
	Neonatal hypoxic ischemic encephalopathy	10	91.40±7.81	2 (20%)		
	Aspiration pneumonia	23	92.70±5.60	2 (8.7%)		
	PDA	8	95.88±2.90	0 (0%)		
Feeding mode	Breastfeeding	190	90.26±6.44	32 (16.8%)	0.749	0.387
	Non-breastfeeding	21	88.57±5.60	2 (9.5%)		
Maternal gestational age, weeks	≤24	40	91.50±6.21	5 (12.5%)	0.663	0.508
	25–30	113	90.58±6.48	17 (15.0%)		
	31–35	44	87.23±5.72	11 (25.0%)		
	≥36	14	91.14±5.79	1 (7.1%)		
Abortion history	No	196	90.26±6.30	29 (14.8%)	2.304	0.129
	Yes	15	87.87±7.06	5 (33.3%)		
Prenatal examination	Yes	198	89.98±6.40	31 (15.7%)	0.100	0.752
	No	13	91.77±5.86	3 (23.1%)		
Diseases of perinatal mothers	Normal	191	90.13±6.54	32 (16.8%)	1.339	0.247
	PIH	11	89.82±5.15	2 (18.2%)		
	Gestational diabetes mellitus	4	87.25±2.63	0 (0%)		
	History of threatened abortion	5	91.40±4.16	0 (0%)		
Maternal education	Below junior school	29	89.79±5.55	4 (13.8%)	0.245	0.884
	High school and technical secondary school	80	89.91±6.87	14 (17.5%)		
	College degree or above	102	90.31±6.23	16 (15.7%)		
Average monthly household income, CNY	<3,000	94	89.60±6.50	16 (17.0%)	0.105	0.949
	3,000–5,000	84	90.06±6.13	13 (15.5%)		
	≥5,000	33	91.58±6.56	5 (15.2%)		

HRI, high-risk infant; NRDS, neonatal respiratory distress syndrome; PDA, patent ductus arteriosus; PIH, pregnancy-induced hypertension syndrome.

Table 2 Comparison of language proficiency of HRIs with different characteristics

Factor	Group	Language development delay	χ^2	P
Gender	Male	11 (8.9%)	2.427	0.119
	Female	3 (3.4%)		
Gestational week of delivery	28–32	5 (27.8%)	8.987	0.011
	33–36	4 (4.7%)		
	≥37	5 (4.6%)		
Birth weight, Kg	<1.5	3 (27.3%)	5.093	0.024
	1.5–2.5	4 (7.0%)		
	>2.5	7 (4.9%)		
Disease diagnosis	Premature delivery	9 (8.7%)	7.14	0.069
	NRDS	1 (7.1%)		
	Hyperbilirubinemia	0 (0%)		
	Neonatal hypoxic ischemic encephalopathy	2 (20.0%)		
	Aspiration pneumonia	2 (8.7%)		
	PDA	0 (0%)		
Feeding mode	Breastfeeding	13 (6.8%)	0.132	0.716
	Non-breastfeeding	1 (4.8%)		
Maternal gestational age, weeks	≤24	2 (5.0%)	5.173	0.160
	25–30	6 (5.3%)		
	31–35	6 (13.6%)		
	≥36	0 (0%)		
Abortion history	No	12 (6.1%)	0.295	0.587
	Yes	2 (13.3%)		
Prenatal examination	Yes	13 (6.6%)	0.025	0.874
	No	1 (7.7%)		
Diseases of perinatal mothers	Normal	12 (6.3%)	2.931	0.402
	PIH	2 (18.2%)		
	Gestational diabetes mellitus	0 (0%)		
	History of threatened abortion	0 (0%)		
Maternal education	Below junior school	8 (27.6%)	17.396	0.000
	High school and technical secondary school	4 (5.0%)		
	College degree or above	2 (2.0%)		
Average monthly household income, CNY	<3,000	9 (9.6%)	2.545	0.280
	3,000–5,000	4 (4.8%)		
	≥5,000	1 (3.0%)		

HRI, high-risk infant; NRDS, neonatal respiratory distress syndrome; PDA, patent ductus arteriosus; PIH, pregnancy-induced hypertension syndrome.

Table 3 Multiple linear regression analysis of neurodevelopment in HRIs

Related factor	β	SE	β'	t	P
Gestational week of delivery	1.737	0.228	0.864	7.629	0.000
Birth weight	–0.078	1.040	–0.012	–0.075	0.940
Disease diagnosis	–0.253	0.289	–0.062	–0.874	0.383
PTSD	1.660	0.128	0.066	5.969	0.039
Family coping	–1.442	0.365	–0.078	–4.657	0.042

HRI, high-risk infant; PTSD, posttraumatic stress disorder; SE, standard error.

Table 4 Logistic regression analysis of language development in HRIs

Related factor	β	SE	P	OR	95% CI
Gestational week of delivery	0.048	0.007	0.931	0.954	0.126–2.031
Birth weight	5.389	1.481	0.224	10.893	3.289–14.067
Maternal education	8.064	4.315	0.038	17.523	0.963–33.165
Neurodevelopment	1.757	4.269	0.039	3.173	0.090–5.423
PTSD	–0.168	0.311	0.577	–1.183	–2.759 to –0.423
Family coping	0.169	1.289	0.256	0.854	0.123–1.46

HRI, high-risk infant; PTSD, posttraumatic stress disorder; SE, standard error; OR, odds ratio.

Table 5 Correlation analysis of postpartum PTSD, family coping, neurodevelopment, and language development

Related factor	PTSD	Family coping	Neurodevelopment	Language development
PTSD	1.000	–	–	–
Family coping	–0.887**	1.000	–	–
Neurodevelopment	–0.519**	0.502**	1.000	–
Language development	–0.172*	0.143*	0.435**	1.000

*, P<0.05, **, P<0.01. PTSD, posttraumatic stress disorder.

positively correlated with neurodevelopment and language development (P<0.05; *Table 5*).

Discussion

Approximately 1.5 million HRIs are born in China every year, accounting for 10% of newborns (16). In the United States and Japan, the incidence of low birth weight or premature birth is as high as 8–10% (17). As neonatal intensive care technology has developed, the survival rate of HRIs has improved. The survival rate of preterm infants born at less than 28 weeks in Australia is reported to be 73%, while the survival rate of very low birth weight infants in Korea is reported to be 85.5% (18,19). In China, the survival rate of premature infants is reported to be 60.3% (20). However, short-term nursing during hospitalization can only help HRIs through the life-threatening period. In the long term, HRIs still face adverse outcome such as nervous system dysplasia, growth disorders, and auditory and visual dysfunction, which seriously affects an individual's development and quality of life and poses a heavy burden to the family and society. In this study, 16.11% of the HRIs had neurodevelopmental abnormalities (*Tables 1*,*2*). The level of neurodevelopment and language development of preterm infants was lower than that of term infants, and the rate of neurodevelopmental delay of preterm infants was higher than that of term infants (21).

Therefore, improving the neurodevelopment and language development of HRIs in the early stages is still an urgent problem to be solved.

The family is one of the key controllable factors affecting the neurodevelopment and language development of HRIs (22). Mothers of HRIs experience more pressure after childbirth than normal mothers, and their needs are more urgent. When a baby is born and enters the NICU for treatment, the mother is separated from the child, although they may wish to be close to the child and to know the child's condition in real time. However, due to mother–infant separation and the insufficient attention of medical and nursing personnel, the needs of mothers are not met, and this exacerbates negative emotions such as anxiety and fear (23). Gestational week of delivery, birth weight, and diagnosis of major diseases were the main factors affecting the needs of mothers. In real clinical situations, when children are hospitalized, these influencing factors do not exist alone but may appear at the same time. In addition, mothers of HRIs and their families must come to terms with the fact that the average length of hospital stay is longer than that of term infants, the rehospitalization rate is higher than that of term infants, and it is difficult to take care of and feed HRIs after discharge (24). Family coping strategies are influenced by the mother's understanding of her child's condition and the family situation. Mothers with severe postpartum PTSD symptoms have low sensitivity and effectiveness in their interactions with HRIs, but high control (25). This is consistent with our result, that PTSD was negatively correlated with neurodevelopment and language development, and family coping was positively correlated with neurodevelopment and language development.

This study had some limitations. First, the subjects were all from 1 city, so there may be some regional bias. Second, the study was limited to 1 hospital and was therefore not representative. Further multicenter experimental research should be carried out on this topic. Third, due to the limitations of manpower, time, and funds, we only conducted 1 survey of each household, and we were unable to conduct a sustained long-term effects survey.

Conclusions

The results of this study suggested that NICU wards can promote the early growth and development of HRIs by providing more support to mothers. This might involve understanding the mother's needs in real time according to her characteristics during the pregnancy, providing targeted health education, improving the mother's understanding of her pregnancy status and the condition of her children, alleviating the occurrence of adverse emotions such as postpartum anxiety and depression, and improving family coping strategies.

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Footnote

Reporting Checklist: The authors have completed the SURGE reporting checklist. Available at https://tp.amegroups.com/article/view/10.21037/tp-22-128/rc

Data Sharing Statement: Available at https://tp.amegroups.com/article/view/10.21037/tp-22-128/dss

Conflicts of Interest: Both authors have completed the ICMJE uniform disclosure form (available at https://tp.amegroups.com/article/view/10.21037/tp-22-128/coif). Both authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by the Ethics Committee of Suzhou Kowloon Hospital, Shanghai Jiao Tong University School of Medicine (No. HG-2022-007). Informed consent was obtained from the legal guardians of all patients.

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