

Social Emotional Development in the Chinese Children with Cerebral Palsy Aged at 1 to 3 Years and the Associated Risk Factors: A Cross-sectional Study

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Research

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Abstract

Background: With cerebral palsy children's psychological behavior problems loom large, it gradually be taken seriously. This research aimed to analyze the social emotional disorders of the Chinese children with cerebral palsy aged at 1~3 years, and further screen out the independent risk factors that affect their social emotional development.

Methods: A total of 300 Chinese children with cerebral palsy aged 1~3 years-old(192 males, 108 females) and their parents took part in this cross-sectional survey, in which the Chinese Version of Infant Toddler Social-Emotional Assessment (CITSEA), the Bayley Scales of Infant Development (BSID) and the Gross Motor Function Measure (GMFM-88) were for children while the Coping Style Questionnaire, the Hospital Anxiety and Depression Scale (HADS) were for parents. The independent risk factors related to social emotional disorders were screened out using a multivariate logistic or linear regression analysis.

Results: The scores of the externalizing and competency domains for the children with cerebral palsy in different age groups were lower than those for healthy children of the same age and gender ($p<0.05$). For the boys with cerebral palsy, aged at 12~17 and 18~23 months, the scores of the internalizing and dysregulation domains were significantly lower than the norm ($p<0.01$). The effect of perinatal factors on the externalizing and competency domains is more significant than that on other domains, while the coping style of the parents significantly affected the positive detection rate of dysregulation domain ($p=0.001$).

Conclusions: This study found that the parental emotional state, the education level, the parenting style and the perinatal factors are closely related to social emotional problems in the Chinese children with cerebral palsy.

Introduction

Cerebral palsy (CP) describes a group of persistent nonprogressive neurological conditions that affect the foetal and infant brain, mainly characterized by performance for movement disorders and abnormal posture, with an incidence of 1.5‰~4.0‰ in the newborns and children within specific age ranges worldwide [1,2]. In China, 4,000,000 ~ 5,000,000 among the children with cerebral palsy have been diagnosed, and the number of new pediatric patients has increased at a rate of 30,000 ~ 40,000 per year [3]. The disability rate caused by cerebral palsy, 42%~45%, becomes the main cause of severe disability in children and causes huge economic and spiritual burdens on their patients and families as well as the society [4]. Many previous reports on cerebral palsy focused on risk factors, early diagnosis, and rehabilitation of motor functions. In recent years the abnormal psychological and behavioral problems in the children with cerebral palsy have attracted the attention of researchers.

During the human's infancy and childhood, the development of emotion is closely related to the enhanced self-awareness and self-understanding. Previous studies have shown that the emotional distress caused by children's early emotional experiences may become a potential dangerous factor for psychological

problems, behavioral problems, and social adaptation issues in their adulthood [5]. Emotional sociality is the original form of socialization of infant, which will mature as individual psychology develops. Besides the influence by infants' own factors (gender, age, whether they are only children, and personal temperament), the acquired family factors as the harmonious extent of parental marital relationship, the family's financial status, the parental rearing styles, the educational level, and psychological and mental conditions are also play an important role that synergistically affects the development of infants' emotional sociality [6–8].

The children with cerebral palsy have a higher risk of emotional, psychological, and behavioral problems, which can lead to a decrease in the well-being of the children and the compromised quality of life for their family members [9]. For the children with cerebral palsy, the disease itself is a very important factor affecting and limiting the social development of their emotions. Physical activity dysfunction and associated cognitive decline, audio-visual disorders, logopathy, and perceptual disorders could have impeded normal development of their emotional sociality [10]. Unfortunately, most social emotional problems in the children with cerebral palsy during childhood were neglected. Thus they have not accepted timely and appropriate professional guidance, which may cause the children to suffer from emotional and mental disorders while they grow up [11]. Related researches showed that the incidence of social emotional development and various behavioral problems in the children with cerebral palsy under the age of 3 years reaches about 10%, while some reported that the incidence was even higher, reaching 15 ~ 20%. Among the children with cerebral palsy, 86% have mental diseases and 3%~5% have experienced major psychological disorders [12]. Furthermore, the earlier the illness occurs, the heavier condition the children have, which directly affects the clinical treatment efficacy.

There is still, however, the lack of detailed, comprehensive and scientific evidence for the study on emotional disorders in the children with cerebral palsy both in China and overseas. Thus, further research is still needed. In this study, the Chinese children with cerebral palsy aged at 1 ~ 3 years and their parents were selected as the subjects, and the state of social emotional development of the children were assessed using a questionnaire survey. Basing on this, a multivariate Logistic regression analysis was used to screen out the independent risk factors that affect the emotional development of the children with cerebral palsy. The aim of this study was to provide comprehensive theoretical support for the understanding of the current situation and the effecting factors in the children with cerebral palsy aged at 1 ~ 3 years in China. Moreover, this study will provide a new strategy for the establishment of early warning mechanisms for emotional disorders in the children with cerebral palsy as well as the targeted intervention and treatment.

Materials And Methods

Participants

This study was performed in the Neurology and Rehabilitation Department of The Children's Hospital of Xi'an Jiaotong University from June 2015 to December 2017 using a convenience sampling method. The

children aged at 1 ~ 3 years, who were diagnosed with cerebral palsy in the department, and their parents were enrolled in this study. The diagnosis of cerebral palsy disease was based on the diagnostic criteria discussed and adopted in the National Pediatric Cerebral Palsy Rehabilitation Conference in 2014 and the criteria illustrated in the China Cerebral Palsy Rehabilitation Guidelines (2015): Part I. The inclusion and exclusion criteria were specified as shown in Additional file 1. All the children with cerebral palsy were selected according to the inclusion and exclusion criteria, and their parents were invited to participate in the investigation.

Measures

The measurement tools used in this study including: i) the General Information Survey for the Children with Cerebral Palsy and Their Parents, designed by our investigators according to the purpose and content of this study, which is mainly used to collect the data of demographic characteristics and clinical medical characteristics for surveyed subjects; ii) the Gross Motor Function Measure (GMFM-88), which is widely used to assess the changes of the gross motor status in the children with cerebral palsy over time or intervention methods, and blindly performed by the rehabilitators who had undergone standardized training in the hospital; iii) the Bayley Scales of Infant Development (BSID), which is a measure for evaluating the effect of cerebral palsy treatment, consisting of the Mental, Motor and Behavior scales; iv) the standardized Chinese Version of Infant Toddler Social-Emotional Assessment (CITSEA), which is introduced from Yale University and standardized for Chinese children to evaluate their sociality and emotional conditions[13].

The GMFM-88 consisting of a total of 88 test items is divided into five function regions: A for horizontal position and turning (17 items), B for sitting position (20 items), C for climbing (14 items), D for standing (13 items), and E for walking and running jump (24 items). Each item is divided into 4 levels scored 0 ~ 3. The score 0 means that the motor event cannot be completed at all, and 1 indicates the event being less than 10% completed, 2 being 10%~99% completed and 3 being 100% completed. The total score 100 indicates that the children with cerebral palsy can complete all the test items independently. The higher test score indicates the stronger gross motor ability of the children, and vice versa. In this study, the raw scores and the total scores of the five function regions of GMFM-88 were recorded.

In the BSID designed as a measure of intellectual development assessment for children and toddlers, the Mental scale contains 163 items in correlation with adaptive behavior, language, and exploration activities, and the Motor scale contains 81 items related to gross motor (head-up, sitting, climbing, standing, walking, etc.) and fine motor (grasping, gripping, etc.) functions. Mental development index (MDI) is presented as the test score of the Mental scale, while psychomotor development index (PDI) is for the Motor scale. The average score and the standard deviation of the MDI is 100 and 16, respectively, as well as the PDI. The subjects with the score 130 or more both in MDI and PDI will be assessed as “very excellent” and those with a score less than 69 as “developmental delay”. “Developmental quotient” is one of the core indicators used to measure the level of mental development in infants and young children. It is mainly measured according to the function regions including motor, language, adaptive and personal-social behavior of the

test subjects. In our study, the developmental quotient scores of the children with cerebral palsy were measured using the BSID-III.

We used the CITSEA to estimate the children's sociality and emotional conditions. It is divided into 4 domains and loaded with 19 dimensions as following: 1) Externalizing behavior domain: a. activity/impulsivity, b. aggressiveness/ resistance, c. offensiveness against peers; 2) Internalizing behavior domain: a. frustration/recession, b. anxiety, c. segregation anxiety, d. resistance to new things; 3) Dysregulation domain: a. sleep, b. negative emotions, c. diet, d. sensory sensitivities; 4) Competency domain: a. compliance, b. attention, c. imitation/gaming, d. motivation, e. empathy, f. prosocial companionships. A three-level scoring method is used in the scale to firstly calculate the initial total score of each dimension and then convert the average raw score of each domain into a norm standard T-score, where the mean is 50 and the standard deviation is 10. The problem domains include the externalizing behavior, internalizing behavior and dysregulation domains. The positive result of problem domain is presented by a calculated T-score more than 63, where the higher T-score indicates the worse problem. On the contrary, the T-score less than 37 for the competency domains considered positive, where the lower score indicates the worse problem.

The coping style questionnaire used for the parents in this study is a self-reported behavioral assessment scale revised by the domestic scholars, based on the existing theory and scale of foreign countries and combined with the cultural and social background and the actual situation in China[14]. The coping style questionnaire includes 6 factors: i) Problem solving; ii) Self-blame; iii) Seeking help; iv) Fantasy; v) Retreat; vi) Rationalization. According to the score of each factor, the coping style is divided into three types: mature (Problem solving – Seeking help), immature (Self-blame – Fantasy - Retreat) and mixed (Rationalization).

In addition, the measurement of anxiety and depression in the parents of the children with cerebral palsy was performed in this study using the Hospital Anxiety and Depression Scale (HADS), which is a tool proposed by Zigmond and Snaith in 1983 for rapid screening of emotional disorders as anxiety and depression in those with the symptoms of physical illness [15]. The scale is divided into an anxiety subscale (HADS-A) and a depression subscale (HADS-D), each of which contains 7 sub-items and a total of 14 items. The score 0 ~ 7 is considered asymptomatic, and 8 ~ 10 indicates suspicious symptoms and 11 ~ 21 confirmed symptoms.

Data collection and statistical analysis

The procedures of our study were strictly under quality control as shown in Additional file 2. Epidata 3.0 software was used for data entry and management. A couple of researchers and an investigator were responsible for inputting all the questionnaire data. Statistical analysis was performed using SPSS19.0 software. The continuous variables with normal distribution were expressed as *mean ± standard deviation* (SD), and the abnormal distributed variables as median and interquartile range. The categorical variables were expressed with frequency and percentage. The differences between two groups were compared using an *unpaired t-test*. The comparisons among multiple groups were conducted using a *one-way analysis of*

variance, followed by a *LSD t-test* for pairwise comparisons. The measurement data were analyzed using a chi-square test or Fisher exact test. The difference between the sample and the average was compared using a one-sample *t-test*. The *p*-values less than 0.05 were considered statistically significant.

Multivariate Logistic Regression Analysis of the Influencing Factors of Social Emotional Development in the Children with Cerebral Palsy

Each domain of the social emotional development score was classified as negative and positive according to the critical value of standardized score (T-score). For the problem domain (externalizing behavior, internalizing behavior and dysregulation domains), $T > 63$ is determined as positive, while $T < 37$ for competency domain is as positive. And this result was used as a binary categorical outcome variable. The univariate analysis indicators with significant differences in the results of the previous analysis were included as the independent variables in the Logistic multiple regression model, and the risk factors associated with the positive results of each domain were screened out using a backward conditional regression analysis. The independent variables related to each domain could be found in Supplementary Table S5-S8. At each step of the selection, the variables with $p < 0.05$ were included in the equation and the ones with $p > 0.10$ were excluded until all the included variables conformed to the demand for model establishment. Then the model was evaluated for goodness of fit.

Results

Participants and Demographic Characteristics

According to the inclusion and exclusion criteria, a total of 322 children with cerebral palsy were investigated in this study, and 22 invalid questionnaires was excluded. The final study included 300 children aged at 1 ~ 3 years, among whom 192 were male (64.0%) and 108 female (36.0%). Among the children, 148 (49.3%) aged at 12 ~ 17 months, 68 (22.7%) at 18 ~ 23 months, 64(21.3%) at 24 ~ 29 months and the remaining 20 (6.7%) at 30 ~ 36 months. The birth weight of the children ranged from 1.10 kg to 5.30 kg with a mean of (3.15 ± 0.66) kg. There were 68 premature infants (22.7%) and 28 infants born with asphyxia (48.8%). Spastic tetraplegia is the main type of clinical classification, with a proportion of 45.3%. 196 (65.3%) among the children had some complications, of whom 168 (56.0%) had dysfluency. There were 36 cases (12.0%) presented with EEG abnormalities. In addition, about 10.7% of the children had visual and auditory evoked potential abnormalities. The demographic characteristics of the subjects recruited in this study were shown in Table 1.

Table 1
Basic information on children with cerebral palsy (n = 300)

Baseline characteristics	Classifications	Number of Participants(n)	Proportion(%)
Gender	Male	192	64.0
	Female	108	36.0
Age(months)	12 ~ 17	148	49.3
	18 ~ 23	68	22.7
	24 ~ 29	64	21.3
	30 ~ 36	20	6.7
The only child	Yes	156	52.0
	No	144	48.0
Gestational age	Full-term	204	68.0
	Premature	68	22.7
	Late-term	28	9.3
Delivery mode	Normal childbirth	216	72.0
	Caesarean section	84	28.0
Postpartum asphyxia	Yes	252	84.0
	No	48	16.0
Type of cerebral palsy	Spastic tetraplegia	136	45.3
	Spastic diplegia	8	2.7
	Spastic Hemiplegia	32	10.7
	Dyskinetic	60	20.0
	Ataxia	4	1.3
	Mixed	60	20.0
Complication	None	104	34.7
	Epilepsy	4	1.3
	Logopathy	168	56.0
	Visual disorder	20	6.7
	Audio disorder	4	1.3
Electroencephalogram	Normal	264	88.0

Baseline characteristics	Classifications	Number of Participants(n)	Proportion(%)
	Abnormal	36	12.0
Auditory evoked potential	Normal	268	89.3
	Abnormal	32	10.7
Visual evoked potential	Normal	268	89.3
	Abnormal	32	10.7

Scores of Developmental Quotient, Gross Motor Function and Social Emotional Development

The average score of developmental quotients was 71.93 ± 7.35 and that of gross motor was 47.79 ± 12.80 (Additional file 3). Meanwhile, the developmental quotient scores of the participants were graded. The results showed that 124 children (41.3%) had a developmental quotient score less than 69, which indicated developmental delay. 132 patients (44.0%) got the score 70 ~ 79 in a critical level of normal development, and only 44 (14.7%) among the children had the score 80 ~ 89, indicating that the children have a medium level of development (Additional file 4).

In this study, the positive detection rate in the dimension of externalizing behavior domain was 16.0%, while that of internalizing behavioral domain and dysregulation domain was 8.0% and 10.7%, respectively. On the other hand, the detection rate in the dimension of competency domain with a standard score less than 37 was 13.3% (Additional file 5).

Comparison of the Scores of Social Emotional Development in the Children with Cerebral Palsy with the National Norm

The results showed that the scores of the externalizing behavior and competency domains for the boys and girls with cerebral palsy in different age groups were lower than those for healthy children of the same age and gender, where the difference was statistically significant. For the scores of internalizing and dysregulation domains, there was no significant difference in the girls with cerebral palsy in all age groups, according to the national norm. Furthermore, the scores of the boys with cerebral palsy aged at 12 and 23 months were significantly lower than the norm, which was not found in those aged at 24 ~ 36 months (Table 2).

Table 2

Comparison the scores of social emotional development in children with cerebral palsy and national norm

Scoring dimensions	Boy		Girl	
	Cerebral palsy	National norm	Cerebral palsy	National norm
Externalizing domain				
12 ~ 17moths	0.389 ± 0.214**	0.586 ± 0.301	0.338 ± 0.227**	0.552 ± 0.292
18 ~ 23 moths	0.444 ± 0.313*	0.600 ± 0.327	0.402 ± 0.216**	0.567 ± 0.314
24 ~ 29 moths	0.406 ± 0.188**	0.607 ± 0.330	0.402 ± 0.250**	0.546 ± 0.307
30 ~ 36 moths	0.418 ± 0.439**	0.607 ± 0.320	0.342 ± 0.189**	0.525 ± 0.299
Internalizing domain				
12 ~ 17moths	0.379 ± 0.171**	0.449 ± 0.229	0.529 ± 0.315	0.471 ± 0.238
8 ~ 23 moths	0.383 ± 0.346**	0.511 ± 0.251	0.606 ± 0.260	0.533 ± 0.246
24 ~ 29 moths	0.541 ± 0.268	0.525 ± 0.255	0.514 ± 0.147	0.544 ± 0.245
30 ~ 36 moths	0.546 ± 0.224	0.533 ± 0.248	0.555 ± 0.243	0.541 ± 0.247
Dysregulation domain				
12 ~ 17moths	0.509 ± 0.230**	0.608 ± 0.271	0.557 ± 0.306	0.618 ± 0.286
18 ~ 23 moths	0.463 ± 0.278**	0.634 ± 0.285	0.708 ± 0.322	0.633 ± 0.299
24 ~ 29 moths	0.583 ± 0.211	0.640 ± 0.279	0.552 ± 0.215	0.625 ± 0.279
30 ~ 36 moths	0.739 ± 0.298	0.633 ± 0.282	0.555 ± 0.305	0.638 ± 0.277
Competency domain				
12 ~ 17moths	0.621 ± 0.352**	1.096 ± 0.299	0.774 ± 0.377**	1.136 ± 0.280
18 ~ 23 moths	0.876 ± 0.342**	1.214 ± 0.286	0.582 ± 0.223**	1.241 ± 0.309
24 ~ 29 moths	1.055 ± 0.286**	1.261 ± 0.282	1.050 ± 0.200**	1.317 ± 0.305
30 ~ 36 moths	1.075 ± 0.286**	1.305 ± 0.260	1.052 ± 0.470**	1.326 ± 0.307

Notes: * $p < 0.05$, ** $p < 0.01$. The scores in each domain of CITSEA in the participants were recorded for comparison, based on the national norm, in different age groups and gender using a one-sample *t*-test.

Analysis of Clinical Features Affecting the Social Emotional Development of the Children with Cerebral Palsy

The *t*-test or the *one-way analysis of variance* showed that the gender difference in the children with cerebral palsy affected the scores of internalizing and dysregulation domains, i.e. the scores for the girls

were higher than those for the boys, where the difference was statistically significant ($p < 0.01$ and $p < 0.05$, respectively). In addition, the older they are, the higher scores they have. The clinical classification and the birth gestational age significantly affected the four dimensions of social emotional development in the children with cerebral palsy. The preterm infants with cerebral palsy had the higher scores in the problem domain and the lower scores in the competency domain, compared with the full-term and late-term infants. The children with cerebral palsy, who suffered from postpartum asphyxia, had the decreased scores in the externalizing and competency domains. Among the children with cerebral palsy, those with abnormal electroencephalograms had the higher scores of dysregulation domain, compared with those with normal electroencephalograms, where the difference was statistically significant ($t = -5.14$, $p = 0.000$) (Additional file 6).

The effect of the family-social demographic characteristics on social emotional development of the children with cerebral palsy

The parents' ages could affect the positive detection rate of dysregulation domain for the social emotional development of the children with cerebral palsy. In the meanwhile, the paternal age is related to the competency domain and the maternal age is related to the externalizing domain. The parental education level could affect the positive detection rate of the children's externalizing, internalizing and competency domains, where the difference is statistically significant in different age groups. The parental rearing style and frequency for the children participating in social entertainment activities were mainly reflected in the positive detection rate of competency domain, where the difference was statistically significant. Different caregivers had a significant effect on the positive detection rate of externalizing domain (Table 3).

Table 3

The effect of family-social demographic characteristics on the positive detection rate of each dimension

Characteristics	Number of participants(n)	Externalizing domain(%)	Internalizing domain(%)	Dysregulation domain(%)	Competency domain(%)
Paternal age(years)					
20–29	75	20 (26.7)	8(10.7)	12 (16.0)**	12 (16.0)*
30–39	153	8 (5.3)	8 (5.3)	8 (5.3)	24 (15.7)
≥ 40	72	20 (27.8)	8 (11.1)	12 (16.7)	4 (5.6)
Maternal age(years)					
20–29	120	20 (16.7)**	12 (10.0)	12 (10.0)**	20 (16.7)
30–39	174	20 (11.5)	12 (6.9)	12 (6.9)	20 (11.5)
≥ 40	6	0 (0.0)	0 (0.0)	8 (100.0)	0 (0.0)
Paternal education level					
Junior high school	60	8 (13.3)*	0 (0.0)**	8 (13.3)	8 (13.3)**
Senior high school/ technical secondary school	60	16 (26.7)	4 (6.7)	4 (6.7)	4 (6.7)
Junior college	88	16 (18.2)	4 (4.5)	8 (9.1)	24 (27.3)
Undergraduate	76	4 (5.3)	12 (15.8)	8 (10.5)	4 (5.3)
Postgraduate	16	4 (25.0)	4 (25.0)	4 (25.0)	0 (0.0)
Maternal education level					
Junior high school	88	20 (22.7)**	0 (0.0)**	8 (9.1)	20 (22.7)**
Senior high school/ technical secondary school	44	4 (9.1)	8 (18.2)	4 (9.1)	0 (0.0)
Junior college	80	12 (15.0)	0 (0.0)	8 (10.0)	12 (15.0)
Undergraduate	80	8 (10.0)	16 (20.0)	12 (15.0)	8 (10.0)
Postgraduate	8	4 (50.0)	0 (0.0)	0 (0.0)	0 (0.0)
Parenting style					

Notes: * $p < 0.05$, ** $p < 0.01$. Comparison between each group in different family-social demographic characteristics.

Characteristics	Number of participants(n)	Externalizing domain(%)	Internalizing domain(%)	Dysregulation domain(%)	Competency domain(%)
Authoritative	272	40 (14.7)	24 (8.8)	28 (10.3)	32 (11.8)*
Authoritarian	12	4 (33.3)	0 (0.0)	0 (0.0)	4 (33.3)
Permissive	16	4 (25.0)	0 (0.0)	4 (25.0)	4 (25.0)
Recreational activities					
Frequently	76	12 (15.8)	8 (10.5)	4 (5.3)*	4 (5.3)**
Occasionally	132	24 (18.2)	12 (9.1)	12 (9.1)	16 (12.1)
Never	92	12 (13.0)	4 (4.3)	16 (17.4)	20 (21.7)
Primary caregiver					
Parents	220	28 (12.7)*	24 (10.9)	24 (10.9)	32 (14.5)
Grandparents	76	20 (26.3)	0 (0.0)	8 (10.5)	8 (10.5)
Babysitter or relatives	4	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Notes: * $p < 0.05$, ** $p < 0.01$. Comparison between each group in different family-social demographic characteristics.					

Correlation analysis between the scores of parental coping style and the four dimensions of social emotional development in the children with cerebral palsy

In this study, the coping styles were mature in 76 parents, immature in 168 and mixed in 56. Among the children with positive scores in each domain of social emotional development, the ones whose parents showed the immature coping styles had a higher positive rate, compared with 18.45% in the externalizing domain. In addition, data analysis showed that parental coping style significantly affected the positive detection rate of dysregulation domain ($p = 0.001$), while the effect on the rates of other domains was not statistically significant (Table 4).

Table 4
Relationship between parental coping styles and positive detection rate

Coping styles	Mature	Immature	Mixed	p-value
Dimensions				
Dysregulation domain				0.001
Negative	73 (96.05%)	152 (90.48%)	43 (76.79%)	
Positive	3 (3.95%)	16 (9.52%)	13 (23.21%)	
Competency domain				0.455
Negative	63 (82.89%)	149 (88.69%)	48 (85.71%)	
Positive	13 (17.11%)	19 (11.31%)	8 (14.29%)	
Internalizing domain				0.158
Negative	71 (93.42%)	157 (93.45%)	48 (85.71%)	
Positive	5 (6.58%)	11 (6.55%)	8 (14.29%)	
Externalizing domain				0.129
Negative	63 (82.89%)	137 (81.55%)	52 (92.86%)	
Positive	13 (17.11%)	31 (18.45%)	4 (7.14%)	
Note: Mature (Problem solving - Seeking help), Immature (Self-blame - Fantasy - Retreat) ; Mixed (Rationalization).				

The effect of parental anxiety and depression on the scores and the positive detection rate of social emotional development in the children with cerebral palsy

For 48 among the children with cerebral palsy in the externalizing domain that was detected positive, all of their parents showed positive symptoms of anxiety and depression. Meanwhile, compared with paternal psychological state, when the mothers had anxiety and depression, their children showed a higher proportion of positive results in the internalizing, dysregulation and competency domains. Moreover, we observed that the proportion of positive results in each domain for the children whose parents had depression, compared with anxiety, was further increased (Table 5).

Table 5
The effect of parental anxiety and depression on the positive detection rate

Parents	Positive symptoms	Positive externalizing domain	Positive internalizing domain	Positive dysregulation domain	Positive competency domain
Father	Anxiety	48(100%)	8(33%)	16 (50%)	20 (50%)
	depression	48(100%)	16(66%)	22 (69%)	20 (50%)
Mother	Anxiety	48(100%)	8(33%)	8 (25%)	20 (50%)
	depression	48(100%)	12(50%)	16 (50%)	20 (50%)

Multivariate Logistic Regression Analysis of the Influencing Factors of Social Emotional Development

Among the independent variables, the risk of externalizing behavior positive in the children with caesarean section was 2.5 times higher than that in those with spontaneous delivery (OR = 0.501, 95% CI: 1.225 ~ 5.107). As for the influence of caregivers, the children who were looked after by their grandparents, babysitters or relatives showed the doubled risk of positive externalizing behavior, compared with others (OR = 1.893, 95% CI: 0.977 ~ 3.667). Beyond that, the birth weight, gestational age, and maternal education level were the protective factors for the occurrence of externalizing behavior (Additional file 7).

Then, for the positive internalizing domain, the OR for time of final diagnosis is less than 1 if other variables were maintained under control. The earlier the diagnosis is, the lower the positive rate is. The maternal education level is also an independent risk factor affecting the children's internalizing emotions. The children whose mother had a high-school education level or less, compared with those with college degree or above, have a one-fold increase in the prevalence of positive internalizing domain (OR = 2.083, 95% CI: 1.315 ~ 3.301). Paternal depression is another independent variable related to the positive internalizing domain, which is responsible for a 1.37-fold higher risk, compared with the children whose father had no depression (Additional file 8).

With an increase in the children's age, the risk of detection in the dysregulation domain was reduced (OR = 0.406, 95% CI: 0.214 ~ 0.772) ($p = 0.006$). Compared with the children with spastic quadriplegia, the prevalence of positive dysregulation domain in the children with other types of cerebral palsy was relatively lower (OR = 0.447, 95% CI: 0.297 ~ 0.673). Interestingly, we found that the maternal age was positively correlated with the risk of detection, while an increase in the paternal age led to the relatively reduced risk. In addition, paternal anxiety and depression can lead to a 0.04-fold and 2.7-fold increase in the positive rate of dysregulation domain in the children, respectively (Additional file 9).

Lastly, as shown in Additional file 10, the children with cerebral palsy who experienced postnatal asphyxia had 2.6 times of the risk of disability, compared with those with no asphyxia. Compared with the children who regularly participate in social recreational activities, those with occasional or non-involved

recreational activities presented a higher risk of positive competency domain (OR = 2.418, 95% CI: 1.253 ~ 4.665). Moreover, maternal depression will increase the children's disability.

Discussion

In this study, we investigated the clinical features and the related influencing factors for social-emotional behavior in the children with cerebral palsy. The results showed that the scores of externalizing behaviors and competency domains in the children with cerebral palsy were significantly lower, compared with healthy children of the same age and gender, which suggests that the children with cerebral palsy have low activity, weak impulse and aggressiveness. Meanwhile, the clinical classification of cerebral palsy and the gestational age of the children significantly affected the scores in the four dimensions of social emotional development.

We found, however, that the boys with cerebral palsy at the age of 12 ~ 17 months and 18 ~ 23 months had lower scores in the internalizing and dysregulation domains, compared with healthy children, which seems to contradict our theoretical expectations. Firstly, the brain is a high-level center for the regulation and implementation of human mind and behavior, even if there are subtle abnormalities in its organizational structure that may cause emotional expression and regulation disorders. Previous imaging studies showed abnormal brain imaging findings in 83% of the children with cerebral palsy [16]. The children have suffered from brain damage or hypoplasia, mostly presented with the structural changes of neurons in the brainstem nucleus, cortex and gray matter masses, as well as the pathological damage in myelin sheaths and in nerve fibers of the white matter. This may result in their low-intensity externalizing behavior and thus affect the detection limit of problem behaviors [17, 18]. Secondly, brain structure and active connections of regional network are the structural basis for brain-specific emotional regulation. The damage of cerebral cortex in the children with cerebral palsy could result in the disorders of these regulatory networks, so that they cannot appropriately perceive and integrate these emotional information [19]. This limits their ability of socializing and affects the learning and expression of their emotions. What's more, the disruption in the balance and homeostasis of neurotransmitter in the children with cerebral palsy may result in an imbalance between postsynaptic inhibition and excitation, leading to various behavioral abnormalities [20]. In this study, the sample composition may be another important factor affecting the experimental results. The subjects enrolled in this study were 1–3 years old, among whom those aged at 12 ~ 17 months accounted for about 50% of the entire sample population. The emotional response of the children was not perfect, and their performance may not be fully revealed due to the caregiver intervention or other treatment interventions. As a result, the occurrence and performance of these positive behaviors are inevitably underestimated by our researchers. There are many factors influencing the ability defects in the children with cerebral palsy. Therefore, it is not difficult to understand the influence of pathological changes in brain injury on the competency attributes and emotional shaping in the children.

The social emotional development is the basis for young children to form their healthy personality characteristics and good social adaptability. The occurrence of the children's psychological behavior

problems is related to such factors as home environment, parental education level, parental mental disorders, and mental status during pregnancy. The results from this study showed that the gestational age significantly affected the four dimensions of social emotional development in the children with cerebral palsy. The preterm infants had higher scores in the problem domains (including the externalizing, internalizing and dysregulation domains) and lower scores in the ability domain, compared with healthy and post-term children. Spittle *et al.* [21] reported that the scores of the internalizing and dysregulation domains in the preterm infants were significantly lower than those in healthy children, but there was no significant difference in the externalizing domain. Similarly, Cheong *et al.* [22] found that the social ability scores of the preterm children were significantly lower than those of healthy children. The above phenomenon may be related to the low birth weight of the preterm infants. A previous multicenter study revealed that the risk of cerebral palsy is ten times higher in the low birth-weight infant or fetal macrosomia, compared with the children with normal birth-weight [23]. Compared with healthy newborns, the preterm infants are vulnerable to impaired white matter and gray matter in the brain [24], periventricular leukomalacia, overactivated microglial cells and opened astrocyte channels, resulting in the release of ATPs and the activation of purinergic receptors as well as the proliferation of pro-inflammatory microglial cells in early damage [25]. Moreover, a significant difference was showed in the scores of externalizing, internalizing, and competency domains in different types of cerebral palsy, while there is no significant difference in the dysregulation domain. The children with left-sided brain injury showed significant delays in speech and language functions, while the children with right-sided brain injury developed poorly in the visual and spatial skills as well as somatesthesia functions [26].

We further screened out the risk factors associated with the positive domains for the social emotional development scale using a multivariate logistic regression method, which showed that parental emotional state and education level are closely related to problems arise in multiple dimensions of the children's social emotion. The effect of perinatal factors on the externalizing and competency domains in the children is more significant than that on other domains. And parental emotion and coping styles have more significant effects on the internalizing and dysregulation domains. As the primary guardians of the children, their parents impart their own experiences, knowledge and feelings to the children consciously or unconsciously in the interactive process of communication [27]. A family raising a child with cerebral palsy is always faced with heavy mental burdens and huge economic pressures, and thus the family relationships are very fragile. If the parents can't effectively release and dredge the long-term psychological stress resulting from a huge gap between the reality and ideals, they are very likely to struggle with anxiety and depression [28]. Some previous studies found that maternal anxiety and depression during pregnancy had a negative impact on the children's intelligence and personality development. The children grown up with their families with parental psychological abnormalities have a higher risk of social emotional behavior problems, even if parental psychological problems are within the subclinical range [6, 29, 30]. Meanwhile, parental education level, related to a variety of social family factors as parenting style, family atmosphere and economic condition, may have a greater impact on the children's emotional disorders. In this point, we advocate an overall parenting model that helps create a good family environment and atmosphere for the children. Additionally, it is important to pay more attention to the children, and give appropriate language and information stimulation as well as necessary

guidance and assistance, which will be very beneficial to the children's emotional management and social development.

The externalizing and competency domains reflect the ability for individuals to regulate and control emotions. In this study, we found that the effect of perinatal factors on the children's positive problems of the externalizing and competency domains was more prominent than that on other domains. The biological basis of the children's emotional regulation is the development level of brain nerve, in which the excitatory and inhibition of parasympathetic nerve plays an important role in the perception and control of emotion. The low-level vagus nerve inhibition is a risk factor for emotional health and poor mood regulation, while the high-level vagal inhibition is generally beneficial [31]. Brain damage in the children with cerebral palsy caused by perinatal risk factors makes it difficult for them to regulate the emotions through biological process. This leads to many problems in their emotional management, making them susceptible to stimulation and impulsivity [32]. In addition, parental emotional state and coping style have more significant effects on the internalizing and dysregulate domains. Stress management for parenthood can be challenging, especially for the parents whose children have cerebral palsy. Previous studies found that the long-term development of the children's psychology and sociality is closely related to the participation of paternal parenting activities and the secretion of hormones as prolactin and oxytocin, which was correlated with maternal care [33]. For the cerebral palsy family, the father's family and social roles are particularly important. Paternal anxiety and depression directly affect his family and social participation as well as the family atmosphere, thus having some influences on the children's emotion, mentality and behavior [34, 35]. Therefore, in the parenting activities for the children with cerebral palsy, special attention should be paid to the adjustment and intervention of paternal psychological state to help them cope with the difficulties in the children's growth. And the treatment of limb function recovery should be coordinate with counseling psychology for the children and their parents [36, 37].

Conclusion

To our knowledge, this is the first study to investigate the clinical features and screen out the risk factors associated with the positive domains for social emotional development in the children with cerebral palsy in China. The findings suggest that parental emotional state, education level, parenting style and perinatal factors are closely related to social emotional problems in the children with cerebral palsy. This study is, however, a single-center study with a relatively small sample size. Therefore, further studies with a multi-center large sample size are needed to validate the results in the future.

Declarations

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Authors' contributions

Yanxia Huang, Yanni Chen and You Wu, made substantial contribution to the conception and design of the work. You Wu and Jianyong Tang analyzed and interpretation the patient data. You Wu, Jianyong Tang and Yanxia Huang, was a major contributor in writing the manuscript. The authors read and approved the final manuscript.

Authors' information

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Availability of data and materials

All data generated or analyzed during this study are included in this published article and its supplementary information files.

Ethics approval and consent to participate

Both the study design and proposal implementation were approved by the Medical Ethics Committee of the Children's Hospital of Xi'an Jiaotong University (approval number: 201503). Before the questionnaire survey, the parents were fully informed about the purpose and significance of this study, and their informed consent was obtained.

Consent for publication

All authors have given consent for publication.

Competing interests

We wish to confirm that the authors report no declarations of interest.

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