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Original Article

Investigation and influence analysis of motor development in preterm infants

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Abstract: Objective: To study early motor development in preterm infants, analyze related factors causing motor development delay, and provide evidence for early motor intervention. Methods: In this retrospective analysis, the clinical data of 80 preterm infants who were registered in Pingxiang Maternity and Child Care from January 2021 to December 2021 were analyzed. Preterm infants' ages were corrected for month of age and their gross motor development was assessed by the AIMS motor scale. AIMS exercise scale was used to correct the motor development of 1-month-old premature infants. The preterm infants were divided into a normal motor development group (n = 63) and an abnormal motor development group (n = 17) according to their motor development. Sixty-three full-term infants with normal motor development registered in the hospital during the same period were selected as a control group to observe the differences between preterm infants with normal motor development and full-term infants. Logistic regression was used to analyze the factors influencing gross motor retardation in preterm infants. Results: Among the 80 preterm infants, sixty-three (78.75%) had Alberta Infant Motor Scale (AIMS) > P_{25}, indicating normal motor development; seventeen patients (21.25%) had AIMS score ≤ P_{25}, suspected as motor retardation. There were significant differences in birth weight and gestational age between preterm infants and full-term infants after 1 month of correction ($P < 0.05$). Logistic regression analysis showed that height at the corrected age of 1 month, weight at the corrected age of 1 month, head circumference at the corrected age of 1 month, and female sex were protective factors for motor retardation. Multiple pregnancy was a risk factor for motor retardation in preterm infants. Conclusion: The early motor development status of preterm infants is generally good. The height, weight, and head circumeferance at the corrected age of 1 month, and female sex were protective factors for motor development delay in preterm infants. Multiple pregnancy was a risk factor. Attention should be paid to premature boys with slow weight gain, and early detection and intervention for motor retardation in preterm infants should be given.

Keywords: Premature infants, Alberta infant motor scale, influencing factors

Introduction

Preterm infants refer to live babies with gestational age of 28-37 weeks, who are clinically called immature infants. Compared to full-term infants, premature infants have underdeveloped functions of multiple systems and organs, low body weight gain, low immunity, poorer ability to adapt to the environment, and are more likely to be infected with bacteria and viruses that can cause serious complications and even threaten life. According to the World Health Organization (WHO), more than 15 million premature babies are born each year. Every year, about 1.8 million premature babies are born in China, with an incidence reaching 8.1% [1]. With the improvement of perinatal medical technology in recent years, the survival rate of premature infants has been increasing. However, the probability of motor development abnormalities and cerebral palsy in surviving preterm infants has also increased [2]. At the same time, the health risks of premature infants, such as digestive system diseases and learning and cognitive disorders, are also gradually increasing, bringing a great economic and mental burden to the family [3]. Preterm birth is likely to have negative effects on the neurologic development of infants. Studies have shown that preterm infants show worse gross motor devel-

opment in the first year of life compared to full-term infants of the same age [4]. Early intervention for premature infants can significantly reduce the incidence of later motor development abnormalities [5]. Therefore, it is particularly important to conduct early exercise screening and intervention for premature infants. The Alberta Infant Motor Scale (AIMS) was produced in Canada, and the reliability and validity studies on normal children and high-risk children have been carried out in China successively, all of which show that it has acceptable reliability and concurrent validity [6]. AIMS is used to evaluate and detect preterm infants to find gross motor dysplasia and provide for early intervention needs. It is suitable for early monitoring and screening of dyskinesia in high-risk infants [7-11], therefore, in order to improve their gross motor developmental level and survival. In this study, AIMS exercise scale was used to understand the status of gross motor development in premature infants, and relevant factors that may affect gross motor retardation in premature infants were analyzed, to provide evidence for early detection and motor intervention.

Materials and methods

Study subjects

In this retrospective study, 80 preterm infants, including 37 males and 43 females, who were registered in Pingxiang Maternity and Child Care from January 2021 to December 2021 were included. Preterm infants were divided into a normal motor development group (n = 63) and an abnormal motor development group (n = 17). During the analysis, the gestational age of preterm infants was corrected to 40 weeks, and the corrected months = post-birth months - (40-gestational weeks at birth)/4. Inclusion criteria for premature infants: (1) newborns with gestational age of 28-37 weeks; (2) premature infants with corrected age of 1 month. Exclusion criteria: preterm infants with confirmed diagnosis of cerebral palsy; complicated with serious organic diseases of the heart, lung and other important organs; preterm infants premature infants with severe cognitive impairment or visual and hearing impairment who cannot complete the assessment; or preterm infants with obvious abnormal movement posture and movement pattern. 63 full-term infants with normal motor development who were registered in Pingxiang Maternity and Child Care at the same period were selected as a control group. Inclusion criteria for full-term infants: (1) newborns with gestational age ≥ 37 weeks; (2) newborns with normal development indicated by physical examination. This study was approved by the Ethics Committee of Pingxiang Maternity and Child Care.

General information questionnaire

We used a self-made questionnaire, including gender, gestational age at birth, birth weight, birth height, birth head circumference, weight at corrected age of one month, height at corrected age of one month, and head circumference at corrected age of one month. The parents were also asked general information about the infant and family, including the number of births, breastfeeding, the mother's education level, the average monthly household income, high-risk pregnancies, and early complications after birth. The main complications of premature infants included neonatal respiratory distress syndrome, neonatal sepsis, neonatal anemia, and neonatal retinopathy.

Alberta infant motor scale

This scale mainly assesses gross motor development of infants and young children aged 0-18 months. According to the specific requirements of the assessment, the assessment environment is a warm (26°C-30°C) and quiet room. During the assessment process, we try to keep the infants and young children in an awake and active state, and avoid emotional instability such as hunger, crying, and lethargy. Under the circumstances, the assessor and family can interact with the baby and encourage him to play the best level of exercise. The assessment time was 10-20 min. The assessment process included 4 kinds of postures, including 21 items in prone position, 9 items in supine position, 12 items in sitting position and 16 items in standing position. By observing and evaluating the weight-bearing position, postural characteristics, and anti-gravity movement of infants in each item, the score of each body position was obtained. The AIMS total score was calculated, and the corresponding percentile was found according to the AIMS total score and the age. The judgment criteria were as follows: ≤ P_{10} for motor retardation, P_{11}-P_{25} for suspected motor retardation, and > P_{25} for normal motor development. According to this criterion, AIMS score ≤ P_{25} was classified as the abnormal motor development group, and AIMS score

Table 1. Comparison of general data between preterm infants and full-term infants at one month after correction (n, %)

Factor	Full-term infants with normal development (n = 63)	Preterm infants with normal development (n = 63)	t/χ^2 values	*P* values
Weight at corrected age of 1 month (kg, $\bar{x} \pm s$)	3.98±0.28	3.85±0.44	-1.923	0.057
Height at corrected age of 1 month (cm, $\bar{x} \pm s$)	51.09±1.42	50.63±1.77	-1.590	0.115
Head circumference at corrected age of 1 month (cm, $\bar{x} \pm s$)	36.57±1.41	36.00±2.58	-1.543	0.126
Birth weight (g, $\bar{x} \pm s$)	2973.05±345.93	1987.79±317.13	-16.664	< 0.001
Birth height (cm, $\bar{x} \pm s$)	48.09±1.42	47.13±1.77	-3.332	0.001
Birth head circumference (cm, $\bar{x} \pm s$)	34.57±1.41	31.84±0.79	-13.412	< 0.001
Apgar score	8.67±1.03	8.15±0.99	-2.823	0.006
Gestational age (week, $\bar{x} \pm s$)	38.57±1.15	33.13±2.33	-16.635	< 0.001
Gender				
Male	40	25	7.150	0.007
Female	23	38		
Fetal number				
Singleton	54	56	0.286	0.593
Multiplets	9	7		
Breastfeeding				
Adequate	28	29	0.05	0.975
Bit	19	19		
No	16	15		
Literacy level				
Bachelor's degree or above	29	24	1.028	0.598
Junior college education	21	22		
High school and below	13	17		
Average monthly household income (yuan)				
≥ 10000	35	37	0.13	0.719
< 10000	28	26		
High risk pregnancy				
yes	13	9	0.881	0.348
no	50	54		
Early complications after birth				
Yes	12	8	0.951	0.329
No	51	55		

> P_{25} was classified as the normal motor development group.

Statistical methods

SPSS23.0 statistical software was used for data analysis. Quantitative data were represented as mean ± standard deviation, and comparison between groups was performed by t test. Qualitative data were represented by the number of cases (%), and Chi-square test was used for comparison between groups. Logistic regression analysis was used for multivariate analysis. $P < 0.05$ was considered significant.

Results

Comparison of general data between preterm infants and full-term infants with normal motor development

The preterm infants with normal motor development were compared with full-term infants with normal motor development, and there were significant differences in birth weight, gestational age, birth height, birth head circumference, gender, and Apgar score between the two groups ($P < 0.05$), as shown in **Table 1**.

Table 2. Motor development in preterm infants

Factors	Normal motor development group (n = 63)	Abnormal motor development group (n = 17)	t/χ^2 values	*P* values
Gender				
Male	35 (55.56)	9 (52.94)	0.037	0.848
Female	28 (44.44)	8 (47.06)		
Gestational age				
> 34 weeks	18 (28.57)	5 (29.41)	1.169	0.557
32 weeks-34 weeks	26 (41.27)	5 (29.41)		
< 32 weeks	19 (30.16)	7 (41.18)		
Fetal number				
Singletons	56 (88.89)	11 (64.71)	5.753	0.016
Multiplets	7 (11.11)	6 (35.29)		
Breastfeeding				
Adequate	29 (46.03)	10 (58.82)	1.212	0.546
Bit	19 (30.16)	3 (17.65)		
No	15 (23.81)	4 (23.53)		
Literacy level				
Bachelor's degree or above	24 (38.10)	7 (41.18)	0.182	0.913
Junior college education	22 (34.92)	5 (29.41)		
High school and below	17 (26.98)	5 (29.41)		
Average monthly household income (yuan)				
≥ 10000	37 (58.73)	11 (64.71)	0.199	0.655
< 10000	26 (41.27)	6 (35.29)		
High risk pregnancy				
Yes	9 (14.29)	3 (17.65)	0.119	0.731
No	54 (85.71)	14 (82.35)		
Early complications after birth				
Yes	8 (12.70)	1 (5.88)	0.623	0.430
No	55 (87.30)	16 (94.12)		

Motor development of preterm infants

A total of 80 preterm infants were included in this study, including 44 males and 36 females. The gestational age was 30-37 (33.20± 2.38) weeks, the birth weight was 1225-2485 (1980.99±308.40) g, and the AIMS score was more than P_{25} in 63 cases, accounting for 78.75% (63/80), and 17 cases of P_{11}-P_{25}, accounting for 21.25% (17/80). The proportion of premature infants with abnormal motor development in terms of gender and gestational age is shown in **Table 2**.

Univariate analysis of the influencing factors of abnormal motor development in premature infants

Univariate analysis of the influencing factors of abnormal motor development in premature infants showed that the differences in weight, height, and head circumference at corrected age of 1 month, gender, and fetal number were significantly different between the two groups ($P < 0.05$), as shown in **Table 3**.

Multivariate analysis of the influencing factors of abnormal motor development in preterm infants

The normal motor development of premature infants was taken as the dependent variable, and the significant indices in the single factor analysis were taken as independent variables. The variable assignment table is shown in **Table 4**. The results showed that weight, height and head circumference at corrected age of 1 month and female were protective factors for motor development retardation in preterm

Table 3. Univariate analysis of influencing factors for motor development in preterm infants (n, %)

Factor	Normal motor development group (n = 63)	Abnormal motor development group (n = 17)	t/χ^2 values	*P* values
Weight at corrected age of 1 month (kg, $\bar{x}\pm s$)	3.85±0.44	3.55±0.38	2.608	0.011
Height at corrected age of 1 month (cm, $\bar{x}\pm s$)	50.63±1.77	49.02±1.41	3.452	0.001
Head circumference at corrected age of 1 month (cm, $\bar{x}\pm s$)	36.00±2.58	34.41±2.12	2.333	0.022
Birth weight (g, $\bar{x}\pm s$)	1987.79±317.13	1995±281.13	0.378	0.707
Birth height (cm, $\bar{x}\pm s$)	46.39±0.61	46.55±0.72	-0.959	0.341
Birth head circumference (cm, $\bar{x}\pm s$)	31.84±0.79	31.41±0.94	1.915	0.059
Apgar score	8.16±0.99	7.94±1.03	0.799	0.427
Gender				
Male	25	12	5.144	0.023
Female	38	5		
Gestational age				
> 34 weeks	18	5	1.169	0.557
32 weeks-34 weeks	26	5		
< 32 weeks	19	7		
Fetal number				
Singletons	56	11	5.753	0.016
Multiplets	7	6		
Breastfeeding				
Adequate	29	10	1.212	0.546
Bit	19	3		
No	15	4		
Literacy level				
Bachelor's degree or above	24	7	0.182	0.913
Junior college education	22	5		
High school and below	17	5		
Average monthly household income (yuan)				
≥ 10000	37	11	0.199	0.655
< 10000	26	6		
High risk pregnancy				
Yes	9	3	0.119	0.731
No	54	14		
Early complications after birth				
Yes	8	1	0.623	0.430
No	55	16		

Table 4. Assignment table of factors affecting motor development of preterm infants

Influencing factor	Assignment
Whether motor development is normal	no = 0, yes = 1
Weight at corrected age of 1 month	Original value of the input
Height at corrected age of 1 month	Original value of the input
Head circumference at corrected age of 1 month	Original value of the input
Gender	1 = male, 2 = female
Fetal number	singletons = 1, multiplets = 2

Table 5. Logistic regression analysis of influencing factors for motor development in preterm infants

Influencing factor	B	S.E.	Wald χ^2	*P* values	OR (95 % CI) values
Gender	14.945	4.81	9.655	0.002	180.513 (3.925-8301.649)
Weight at corrected age of 1 month	-5.756	2.659	4.686	0.030	0.003 (0.000-0.58)
Height at corrected age of 1 month	-1.502	0.694	4.682	0.030	0.223 (0.057-0.868)
Head circumference at corrected age of 1 month	-1.524	0.598	6.505	0.011	0.218 (0.068-0.703)
Fetal number	3.635	1.707	4.535	0.033	37.901 (1.336-1075.282)

infants, and fetal number was a risk factor, as shown in **Table 5**.

Discussion

In recent years, with continuous improvement inneonatal perinatal technology, the survival rate of preterm infants has been on the rise [12]. Subsequently, there have been more problems related to motor development, and the risk of motor retardation in preterm infants has also gradually increased [13, 14], especially in infants with low birth weight. AIMS Infant Motor Scale is a gross movement observation of infants aged 0-18 months to evaluate whether the motor development of infants is offset. It has the advantages of simple operation and short time consumption [15]. Gross motor function is the most variable part of the early development of infants and young children, and human development involves the integration of language, intelligence, fine motor, gross motor development, and coordinated development; therefore, an assessment of gross motor development of infants and young children can reflect the overall developmental state.

The results of this study showed that the height, weight and head circumference at corrected age of 1 month were protective factors for motor retardation in preterm infants. Similar to a prior report [16], the physical development of preterm infants is rapid, and a rapid growth in height and weight is conducive to later neuromotor systemdevelopment. Head circumference is an important indicator reflecting brain development and brain volume of infants. Poor growth in height, weight, and head circumference can lead to poor gross motor development. Good nutritional status of preterm infants is the basis of neural development. A study [17] has shown that early intervention for the nutritional status of preterm infants can reduce the adverse effects of neuromotor development. Therefore, in the process of management, medical staff and their families should pay attention to the growth and development of height, weight, and head circumference of preterm infants. They should correct malnutrition, so as to meet infants' neuromotor development needs. Being female is a protective factor for motor development retardation in preterm infants, and the risk of female motor development retardation is lower than that of male infants. At the corrected age of 1 month, the motor development of male infants is worse than that of female infants. Wu [18] showed that the gross motor development of girls was relatively better than that of boys. A study [19] has shown that the difference between different gender development levels may be because males have only one X chromosome, which determines language, emotional regulation, and social interaction. Therefore, medical staff and their families should establish standardized exercise training programs for premature boys in time. This analysis, which included singleton and multiple pregnancies, showed that multiple births were an important risk factor for preterm birth. A study [20] showed that the preterm birth rate of multiple pregnancies was 38.39%. Multiple preterm infants are born with a small gestational age and low body weight, so it is necessary to prepare for neonatal resuscitation and monitoring treatment of preterm infants. Some studies [21, 22] have analyzed and compared the motor skill trajectories of preterm infants and full-term infants in the first year of life, and found that targeted parenting and care for preterm infants in the early stage can promote their motor development and behavioral performance, and achieve control of demanding postures. Exercise is an important part of children's early development, and can promote the development of children's physical, psychological, and social abilities [23, 24]. Caregivers integrate sports into the daily nursing process of infants and young children, which can develop children's motor ability and

cultivate children's exercise habits and is helpful to promote early development of infants and young children.

Advantages and limitations

Based on the AIMS, this study analyzed the current situation of motor development and its influencing factors in preterm infants and evaluated the motor nerve development of preterm infants to detect motor development retardation early and give timely intervention. However, due to the limited conditions, there are some deficiencies in this study, such as too small of a sample size and lack of the early basic diseases of premature infants. Future research can be improved in the above aspects to further explore the motor development of premature infants.

Conclusions

In this study, 21.25% of preterm infants did not reach the normal standard of motor development at the corrected age of 1 month. Among them, height, weight, and head circumference at corrected age of 1 month and female were protective factors for motor development retardation of preterm infants, and multiple pregnancy was a risk factor. Therefore, medical staff and their caring families should pay attention to the growth and development of the height, weight, and head circumference, especially for boys with low weight. Infant motor development is not only the basis of cognitive and social ability development, but also an important screening index for early identification of developmental disorders and neurological diseases [25]. Therefore, early intervention in sports, language, and other aspects of premature infants can promote physical growth and reduce the risk of motor retardation through nutrition improvement and environmental improvement.

Disclosure of conflict of interest

None.

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