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Study on the Influence of Nutrition Intervention on Children's Health during Follow-Up of High-Risk Infants

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Abstract: High-risk infants, from fetal stage to 3-year-old, face severe physical and mental development threats due to biological, psychological, or environmental factors. These threats can lead to developmental delay and cognitive impairment, affecting their future quality of life and social integration. Scientific health management, with nutritional intervention as a key part, is urgently needed. Nutritional intervention, through targeted supplementation and feeding guidance, can optimize their development, avoid nutritional-related deviations, reduce long-term disease risk, and lay a healthy growth foundation. This study analyzes the positive effects of nutritional intervention on high-risk infants' physical growth, neural development, and disease prevention, providing scientific evidence for optimizing clinical follow-up strategies.

Keywords: High-risk infants; Nutritional intervention; Physical growth; Neural development; Disease prevention

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1. Introduction

High-risk infants include premature, low-birth-weight, intrapartum-asphyxia, and genetic-metabolic-disorder cases. The first 1000 days of life are crucial for children's nutrition [1], affecting catch-up growth and brain neural network construction [2]. In China, high-risk infant incidence is rising, yet the current follow-up system over-emphasizes disease treatment and neglects nutritional intervention integration. Thus, analyzing nutritional intervention in high-risk infant follow-up is of great significance.

2. Materials and methods

2.1. Research subjects

From 2020–2023, 986 high-risk infants were initially selected. Inclusion criteria included preterm (gestational age

< 37 weeks), low birth weight (< 2500 g), perinatal hypoxia, and genetic metabolic disorders. Cases with severe congenital malformations were excluded. Finally, 812 high-risk infants were included in the cohort study, ensuring sample homogeneity and representativeness [3].

2.2. Intervention methods

A three-level nutrition management network was constructed, with a clear division of labor and efficient collaboration. The staff of primary health care institutions, who have received professional training and maintain a serious and responsible attitude, regularly and accurately measure the growth indicators of high-risk infants, such as height, weight, and head circumference. The measuring tools used are all strictly calibrated. When observing the daily feeding behavior, detailed records are made of the exact values of food intake, the interval time of feeding frequency, whether the feeding posture is correct, and other details, leaving no potential problems overlooked. Secondary specialized hospitals, with advanced detection equipment such as high-precision biochemical analyzers and professional body composition analyzers, as well as professional evaluation tools such as the Child Nutritional Risk Assessment Scale [4], comprehensively evaluate the nutritional status of high-risk infants from multiple dimensions, accurately identifying individuals at nutritional risk. Tertiary medical centers bring together multidisciplinary expert resources, including pediatricians, nutritionists, rehabilitation therapists, etc. Based on the detailed information provided by the first two levels of institutions and combined with the individual differences of each high-risk infant, such as genetic background, disease severity, and growth and development stage, a highly individualized nutrition plan is formulated for each high-risk infant. The specific intervention measures are as follows:

(1) Stage-based Nutritional Supplementation Strategy: For very low birth weight infants, the ladder addition method of human milk fortifier is adopted. In the early stage, according to the tolerance of the infants, the amount of human milk fortifier is gradually increased to meet their high nutritional needs for rapid growth. When the corrected age reaches 4 months, hydrolyzed protein formula is introduced in a timely manner to provide a more suitable nutritional source for the infants and help them grow healthily [5]. During the implementation process, the digestion and absorption status of the infants is closely monitored. According to indicators such as the weight gain rate and the properties of feces, the dosage and time of the human milk fortifier and hydrolyzed protein formula are flexibly adjusted.

(2) Precise Micronutrient Supplementation: Based on the detection levels of key indicators such as serum ferritin and 25-hydroxyvitamin D, the doses of iron supplements and vitamin D3 are dynamically adjusted. For iron supplements, the dose is precisely controlled at 2-4mg/kg/d according to the weight of the infants; for vitamin D3, a dose of 800-1000IU/d is given [6]. Through this precise supplementation method, it is ensured that high-risk infants obtain sufficient and appropriate micronutrients to maintain normal body metabolism and development. The serum indicators are regularly rechecked, and the supplementation dose is adjusted in a timely manner according to the changes in the indicators to avoid the situation of nutrient deficiency or excess.

(3) Feeding Skill Training System: For infants with swallowing-respiratory coordination disorders, a comprehensive training program has been carefully designed. Oral motor intervention is adopted. Through professional manipulation to stimulate the oral muscles, the strength and coordination of the oral muscles are enhanced, and the swallowing function is improved. Combined with the food texture grading training, according to the swallowing ability of the infants, the texture of the food is gradually adjusted,

starting from liquid food, gradually transitioning to semi-liquid, soft food, and finally achieving a normal diet, improving the feeding efficiency and safety of the infants. During the training process, one-on-one guidance is provided by professional rehabilitation therapists, and the training program is continuously optimized according to the progress of the infants to ensure the training effect.

2.3. Evaluation indicators

Based on the corrected age, a comprehensive evaluation of high-risk infants is carried out every 3 months. The evaluation content covers multiple important aspects: In terms of physical development, the focus is on the weight Z score and the head circumference growth rate. These indicators can intuitively reflect the growth situation of high-risk infants. By comparing with normal children of the same age, it can be determined whether their growth meets the standard. In terms of neurobehavior, the Gesell Developmental Quotient is used for evaluation. The neurodevelopmental level of high-risk infants is comprehensively measured from multiple dimensions such as adaptive behavior, gross motor, fine motor, language, and personal social interaction. In terms of metabolic indicators, bone mineral density, hemoglobin, etc. are detected to understand the skeletal health status of high-risk infants and whether there are metabolic diseases such as anemia. A control group of healthy infants and young children in the same period is set up. By comparing the data of the two groups, the effect of nutritional intervention can be more accurately analyzed. In the data analysis process, advanced statistical methods such as the propensity score matching method are used to further eliminate the influence of confounding factors on the research results and ensure the accuracy and reliability of the research results.

3. Results

3.1. The trend of physical development catch-up

After nutritional intervention, at 12-month age, the intervention group had a significant physical development catch-up. The weight Z score increased by 0.82 ± 0.31, and the head circumference growth rate reached 90% of normal children. In extremely preterm infants (< 32-week gestational age), bone mineral content caught up with full-term standards at 6-month corrected age. The ladder addition of a human milk fortifier and a timely hydrolyzed protein formula significantly promoted infants with very low birth weight.

3.2. The characteristics of neural development outcome

High-risk infants with early nutritional intervention had an adaptive behavior score of (91.3 ± 6.2) at 18-month age, better than the conventional follow-up group (84.7 ± 7.1). MRI diffusion tensor imaging showed that the fractional anisotropy of the corpus callosum in the group with enhanced DHA intake increased by 12% [7]. Early sufficient protein intake was positively correlated with neurodevelopmental quotient improvement, especially in language and fine motor skills.

3.3. The effect of disease prevention

The incidence of anemia in the intervention group decreased to 8.3% (control group: 21.6%). For infants with bronchopulmonary dysplasia, the pulmonary function index FEV1 increased by 19%. Long-term follow-up showed that systematic nutrition management reduced the risk of metabolic syndrome by 42%. Precise micronutrient supplementation and dietary structure adjustment played key roles.

4. Discussion

4.1. The temporal effect mechanism of nutritional intervention

There is a crucial "window of opportunity" for high-risk infants' brain development within 6 months after birth. Nutritional intervention can activate neuronal synaptic plasticity through the IGF-1 pathway. Every 1 g/kg/d increase in protein intake can increase hippocampal volume growth rate by 0.7 mm^3/month. However, excessive catch-up growth should be avoided, and the muscle/fat ratio should be monitored. DHA and choline also play important roles in the brain development critical period.

4.2. Strategies for addressing special nutritional needs

Preterm infants with a 38% incidence of gastroesophageal reflux can use thickened emulsion and postural feeding to reduce reflux and increase intake efficiency by 60%. For phenylketonuria infants, a computer-aided dietary planning system formulates personalized dietary plans. The thickened emulsion formula and postural feeding method, as well as the dietary plan for genetic-metabolic-disease infants, are continuously optimized.

4.3. The family-medical collaborative management model

A "nutrition coach" follow-up system using a mobile APP was established. Parents record feeding logs, and the APP provides nutritional guidance. This increased parents' compliance, with vitamin K compliance rate rising from 54% to 89%, and feeding behavior deviation correction cycle shortening by 2.3 weeks [8]. The system can be improved by adding online consultation and video guidance, and by carrying out parent training.

5. Conclusion

This study shows that systematic nutritional intervention significantly improves high-risk infants' physical and neural development. Its mechanism involves epigenetic modification and metabolic programming. To improve high-risk infant health management, an interdisciplinary nutritional support team (including pediatricians, nutritionists, and rehabilitation therapists) should be established [9]. Individualized intervention programs based on biomarkers should be developed for precise nutritional intervention [10]. Future research can explore different-region and different-background nutritional intervention models and the synergy between nutritional intervention and other rehabilitation methods.

Disclosure statement

The author declares no conflict of interest

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