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# Evaluation of the effect of continuity of care on growth, development, and head control ability in children with brain injury

## A retrospective study

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**Abstract**
Continuity nursing care is a structured intervention designed to improve the developmental outcomes of children with brain injuries. This study aimed to evaluate the effects of continuity nursing care on physical growth, head control, cognitive development, and motor function in children with brain injuries. A retrospective cohort study was conducted, including 95 children with brain injuries treated between January 2022 and December 2023. Participants were divided into a continuity care group (n = 37) and a conventional care group (n = 58). Propensity score matching was used to adjust for baseline differences, resulting in 37 matched pairs. Data were collected on demographics, head control, physical growth (height, weight, head circumference), cognitive development (Bayley Scales of Infant and Toddler Development), motor function (Peabody Developmental Motor Scale), and developmental domains (Gesell Developmental Scale). Statistical analyses included *t* tests, $\chi^2$ tests, repeated measures ANOVA, and Bonferroni corrections. After matching, baseline characteristics between the groups were balanced ($P > .05$). At 3 and 6 months post-intervention, the continuity care group showed significant improvements in head control, cognitive index, and motor function compared with the conventional care group ($P < .001$). For example, at 6 months, the continuity care group exhibited higher scores in gross motor (57.4 ± 5.0 vs 50.8 ± 5.1), fine motor (60.2 ± 5.3 vs 53.5 ± 5.5), and total motor quotient (117.6 ± 7.0 vs 100.3 ± 7.2; $P < .001$). Subgroup analysis revealed that continuity care significantly improved head control in children aged 0 to 3 years ($P < .001$), while no significant difference was observed in children aged 4 to 5 years ($P = .10$). Physical growth indicators (height, weight, head circumference) were also significantly better in the continuity care group at 3 and 6 months ($P < .05$). Continuity nursing care significantly enhances head control, physical growth, cognitive development, and motor function in children with brain injuries, with more pronounced effects in younger children (0–3 years). These findings highlight the importance of continuity care in improving developmental outcomes and suggest its integration into standard pediatric rehabilitation protocols.

**Abbreviations:** BSID = Bayley Scales of Infant and Toddler Development, DQ = developmental quotient, HIE = hypoxic-ischemic encephalopathy, PDMS-2 = Peabody Developmental Motor Scale.

**Keywords:** brain injury, cognitive development, continuity nursing care, motor function, pediatric rehabilitation, physical growth

## 1. Introduction

Brain injury is a common neurological disorder in childhood, with etiologies including hypoxic-ischemic encephalopathy, traumatic brain injury, and others.[1] These injuries can negatively impact the child's cognitive abilities, motor function, and physical development to varying degrees, and may even lead to lifelong disabilities.[2] Despite advancements in modern medical technology, early intervention and rehabilitation have significantly improved the prognosis for children with brain injury. However, the outcomes of rehabilitation still exhibit considerable individual variability, particularly in the absence of continuous care support after discharge, with many children experiencing limited functional improvement.[3]

Nursing interventions play a crucial role in the rehabilitation of children with brain injury. Studies have shown that systematic and structured nursing interventions can enhance rehabilitation compliance and promote recovery of motor function, cognitive abilities, and activities of daily living.[4] However, traditional nursing models mainly focus on in-hospital treatment, and after discharge, children and their families often face numerous challenges due to the lack of

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QT and XH contributed to this article equally.

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The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

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continuous guidance and professional support. For example, family members may struggle to assist children effectively with rehabilitation training due to a lack of knowledge and skills, making it difficult to sustain or further improve rehabilitation outcomes.[5]

Continuity of care is a nursing model designed to provide comprehensive and continuous support and services for patients with chronic conditions and those in the rehabilitation phase.[6] This model extends the role of traditional nursing through multidisciplinary team collaboration and digital health management platforms, covering the entire care continuum, including pre-hospital, in-hospital, and post-hospital phases. Its core concept is to ensure patients receive continuous professional support by offering personalized health education, regular follow-up, optimized rehabilitation plans, and real-time feedback, thereby improving their health outcomes.[7] Currently, continuity of care has achieved good results in areas such as chronic disease management, post-surgical rehabilitation, and high-risk pregnancy care.

The application of continuity of care in children with brain injury has a solid theoretical foundation and practical potential. On one hand, children with brain injuries often require long-term rehabilitation, and continuity of care can provide them with scientifically tailored, dynamically adjusted rehabilitation plans through the establishment of health records and multidisciplinary collaboration mechanisms.[8] On the other hand, the use of digital platforms can enhance family involvement and adherence, effectively addressing the limitations of traditional out-of-hospital care.[9] However, research on the application of continuity of care in children with brain injuries is still limited, particularly in terms of systematic evaluation of its comprehensive effects on head control ability, physical development, cognitive function, and motor function.

Based on the above background, this study aims to evaluate the impact of continuity of care on growth, development, and head control ability in children with brain injury. Through a retrospective cohort study design, this research compares the differences in various developmental indicators between children receiving continuity of care and those receiving conventional care. The study also explores the effects of continuity of care in children of different age groups. The results are expected to provide evidence-based support for the widespread application of continuity of care in children with brain injury and offer practical guidance for optimizing pediatric rehabilitation nursing models.

## 2. Materials and methods

### *2.1. Study design*

This study was approved by the Ethics Committee of Wuhan Children's Hospital. Since this study is retrospective in nature, the requirement for informed consent was waived by the Ethics Committee. All procedures were conducted in accordance with the principles of the Declaration of Helsinki, and patient data were anonymized to ensure confidentiality. This study is a retrospective cohort study aimed at evaluating the effect of continuity of care on the growth, development (including height, weight, etc), and head control ability (such as the ability to maintain a neutral head position and head movement) in children with brain injury. The goal is to provide evidence for optimizing nursing strategies. A total of 95 children with brain injury who received treatment at our hospital between January 2022 and December 2023 were selected based on inclusion and exclusion criteria. The participants were divided into 2 groups: a continuity of care group (37 children) and a conventional care group (58 children). The continuity of care group had previously received complete continuity of care (as detailed in Section 2.2), while the conventional care group had only received conventional care. To minimize potential confounding factors that could influence the outcomes, we applied propensity score matching. This method matched 37 children from the conventional care group with those in the continuity of care group based on similar baseline characteristics, serving as statistical controls.

*2.1.1. Inclusion criteria.* Children aged 0 to 5 years diagnosed with brain injury. Diagnosed with brain injury through imaging or neurological assessments (e.g., hypoxic-ischemic encephalopathy, traumatic brain injury, etc). Received systematic rehabilitation treatment during hospitalization (e.g., physical therapy, occupational therapy, etc). Complete medical records, including growth and developmental indicators and head control ability assessments. Parental informed consent and willingness to cooperate with follow-up.

*2.1.2. Exclusion criteria.* Children with severe organ dysfunction (e.g., heart failure, kidney failure, etc). Children with other diseases affecting growth and development (e.g., endocrine disorders, genetic metabolic diseases, etc). Incomplete follow-up information (e.g., early loss to follow-up or inability to obtain nursing records). Previous brain injury-related surgical interventions. Children or their guardians who refuse to cooperate with the continuity of care plan.

### *2.2. Nursing process*

*2.2.1. Conventional care group[10].* Before discharge, the responsible nurse provides detailed health education and rehabilitation guidance to the child's family 3 days prior to discharge. The specific content includes:

*2.2.1.1. Health education.* Multimedia videos and illustrated health education pamphlets are used to educate the family. Topics covered include the child's lifestyle habits, diet, medication usage, rehabilitation exercises, proper holding positions, prevention of complications, and follow-up appointment schedules and precautions.

*2.2.1.2. Telephone follow-up.* Every 2 weeks after discharge, a telephone follow-up is conducted to inquire about the child's rehabilitation exercises, functional recovery, nutrition, and medication usage. Targeted guidance is provided, and the follow-up results are recorded.

*2.2.1.3. WeChat official account service.* Families are instructed to follow the hospital's official WeChat account, which regularly pushes health education content related to brain injury. This includes rehabilitation exercises and precautions through text, voice, video, and images.

*2.2.1.4. Offline rehabilitation seminars.* A weekly rehabilitation knowledge seminar is held every Tuesday afternoon, hosted by a rehabilitation specialist nurse. Topics include the causes of brain injury, signs and symptoms in children, rehabilitation exercises, and related precautions. The seminar schedule and content are promoted through the WeChat account in advance, and families can voluntarily participate.

*2.2.2. Continuous care group[11].* Based on the routine care group, the continuous care group introduced the continuous care intervention based on the information platform (Fig. 1). Specific measures are as follows:

*2.2.2.1. Establishment of the continuity of care team.* The continuity of care team consists of: 1 head nurse, 2 rehabilitation specialist nurses, 1 specialist physician, 1 nutritionist, 1 rehabilitation therapist. All team members are senior professionals with more than 5 years of experience in their respective fields. The responsibilities of the team are as follows: head nurse: responsible for quality control and team member training. Rehabilitation specialist nurses: responsible for data

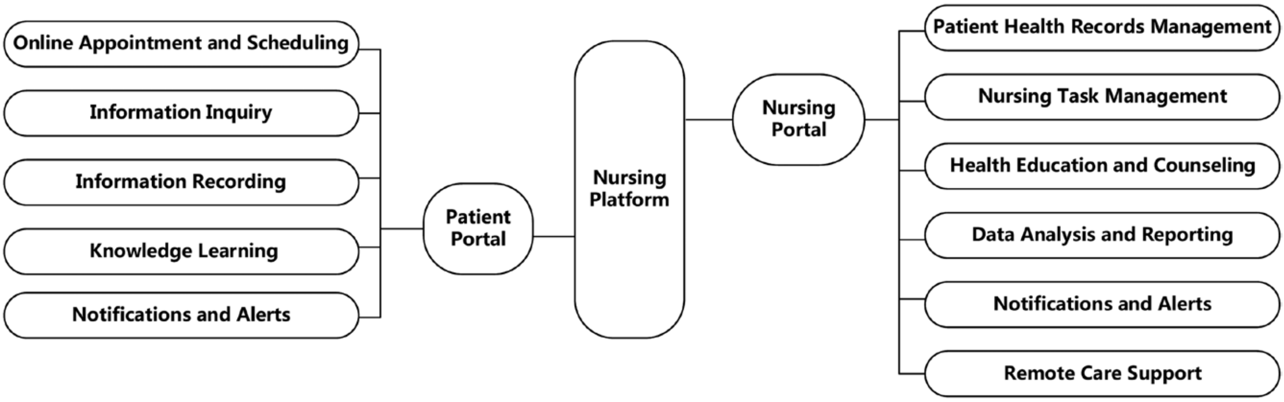

**Figure 1.** Platform structure diagram.

collection, follow-up management, online communication, and feedback. Physician, nutritionist, and rehabilitation therapist: responsible for the formulation and adjustment of treatment and rehabilitation plans.

*2.2.2.2. Application of information platform.*

2.2.2.2.1. Health records. Before discharge, the child's basic information, treatment details, rehabilitation plan, nutrition recommendations, and follow-up schedule are entered into the platform to create a comprehensive health record.

2.2.2.2.2. Real-time interaction. Family members register and enter the platform by scanning a QR code. They log daily attendance and rehabilitation exercises, upload rehabilitation videos and photos. The platform uses intelligent analysis to assess the effectiveness of the rehabilitation and notifies medical staff for timely intervention if needed.

2.2.2.2.3. Warning mechanism. The system has automatic reminder functions, including reminders for missed daily check-ins, incomplete rehabilitation records, and alerts for poor rehabilitation progress. If necessary, offline or online consultations are scheduled via the platform.

2.2.2.2.4. Health education push. Every 3 days, personalized health education content is sent based on the family's learning progress, including early physical training, nutrition guidance, and first aid skills. The system tracks the learning progress, sending reminders if reading or learning is incomplete.

2.2.2.2.5. Follow-up management. Specialist nurses create personalized follow-up plans, including the timing, frequency, and content of follow-ups. The system reminds families 24 hours before the scheduled follow-up to submit feedback as planned. After reviewing the feedback, nurses provide individualized guidance.

2.2.2.2.6. Remote consultation. Regular online consultations are scheduled via the information platform, allowing physicians to adjust rehabilitation treatment plans in real time and answer any questions from the family.

2.2.2.2.7. Follow-up appointment reminders. The platform sends reminders 48 hours before the scheduled follow-up appointment, including the details of the appointment, hospital address, and relevant contact information.

2.2.2.2.8. Rehabilitation plan adjustment. If the platform records indicate that the child's rehabilitation exercises are not showing significant progress (e.g., no noticeable improvement after 4 consecutive weeks), the continuity of care team will collaborate to analyze the reasons and adjust the rehabilitation plan accordingly. Once the family agrees, the new plan will be implemented (Fig. 1).

### *2.3. Data collection*

***2.3.1. Basic information of children.*** The study collected demographic and clinical information of the children, including gender, age, birth weight, mode of delivery (cesarean section or vaginal delivery), and birth history (preterm or full-term). Clinical characteristics such as the type of brain injury (e.g., hypoxic-ischemic encephalopathy, traumatic brain injury), onset (acute or chronic), and severity of the brain injury were recorded. In addition, the presence of comorbidities (e.g., epilepsy or pneumonia) and other relevant medical history were noted. Family background information, including family support score, parental education level, and family economic status, was also gathered to comprehensively assess the impact of family factors on the effectiveness of the nursing care.

***2.3.2. Head control ability.*** Head control ability was assessed using relevant items from the Gross Motor Function Measure-88.[12] Specifically, the following parameters were evaluated: duration of maintaining head in a neutral position (measured in seconds), active head rotation angle (measured in degrees), active head elevation angle (measured in degrees), and head stability score (rated on a 1–5 scale). These measurements were taken at baseline (prior to nursing intervention), 3 months post-intervention, and 6 months post-intervention to dynamically reflect the impact of the nursing care on head control ability improvement.

***2.3.3. Physical development.*** Physical development data of the children were obtained through routine physical examinations, including height (in centimeters), weight (in kilograms), and head circumference (in centimeters). To evaluate the effect of continuity of care on physical development, these indicators were measured and recorded at baseline, 3 months post-intervention, and 6 months post-intervention.

***2.3.4. Developmental domain scores.*** Developmental domains were assessed using the Gesell Developmental Scale,[13] recording the developmental quotient (DQ) for the children in 5 domains: gross motor, fine motor, language, adaptive behavior, and personal-social development. DQ scores were measured at baseline, 3 months post-intervention, and 6 months post-intervention to analyze the effect of continuity of care on promoting overall development in the children.

***2.3.5. Cognitive ability.*** Cognitive ability was assessed using the Bayley Scales of Infant and Toddler Development (BSID),[14] recording the Cognitive Index. The assessments were conducted at baseline, 3 months post-intervention, and 6 months post-intervention to dynamically monitor the improvement in cognitive abilities due to continuity of care.

***2.3.6. Motor function.*** Motor function was assessed using the Peabody Developmental Motor Scales (PDMS-2),[15] collecting data on the children's gross motor scores (Gross Motor Standard Score), fine motor scores (Fine Motor Standard Score), and Total Motor Quotient. Data were recorded at baseline, 3 months post-intervention, and 6 months post-intervention to evaluate the impact of continuity of care on promoting motor abilities in the children.

***2.3.7. Data management.*** All data were independently recorded by 2 specially trained rehabilitation nurses, who then handed them over to the research team for verification to ensure the accuracy and completeness of the data. After data entry, all records were stored in an encrypted, secure database and regularly backed up to prevent data loss. Through rigorous data management processes, the reliability and scientific validity of the study results were ensured.

### 2.4. Statistical analysis

Statistical analysis was conducted using SPSS 26.0 software (Armonk). All tests were 2-sided, with a significance level of $P < .05$. Continuous data (such as age, height, weight, etc) were expressed as means ± standard deviations, and independent sample *t* tests were used to compare differences between groups. Categorical variables (such as gender, delivery method, etc) were expressed as frequencies and percentages, with $\chi^2$ tests used to analyze group distribution differences. For non-normally distributed or ordinal variables, the Mann–Whitney *U* test was used for between-group comparisons. To analyze changes in the 2 groups at different time points (baseline, 3 months post-care, and 6 months post-care), paired sample *t* tests were used to compare within-group differences. Repeated measures ANOVA was used to assess trends of changes across multiple time points between groups, with pairwise comparisons performed using the Bonferroni correction.[16] Furthermore, to control for baseline confounding factors, propensity score matching[17] was used. A 1:1 nearest-neighbor matching was performed based on age, gender, clinical characteristics (such as type of brain injury, Gross Motor Function Classification System level), and family support scores. The matching effect was assessed by standardized mean differences, with standardized mean difference < 0.1 indicating good baseline balance.

## 3. Results

### 3.1. Comparison of baseline characteristics between the continuous care group and the conventional care group before and after matching

Before matching, there were significant differences between the continuous care group (n = 37) and the conventional care group (n = 58) in several baseline characteristics, including average age (3.1 ± 1.2 years vs 3.9 ± 1.5 years, $P = .04$), type of brain injury ($P = .02$), Gross Motor Function Classification System level ($P = .03$), family support score ($P = .05$), rehabilitation frequency ($P = .01$), and baseline developmental scores ($P = .05$). After matching, no significant differences were observed between the 2 groups in any baseline characteristics ($P > .05$), such as average age (3.1 ± 1.2 years vs 3.0 ± 1.3 years, $P = .09$), family support score (7.8 ± 2.1 vs 7.61 ± 2.3, $P = .71$), rehabilitation frequency (5.9 ± 1.3 sessions/week vs 6.04 ± 1.4 sessions/week, $P = .68$), and baseline developmental score (75.2 ± 12.4 vs 74.61 ± 12.4, $P = .77$). Matching successfully eliminated bias in baseline data, providing greater comparability between the 2 groups (Table 1).

### 3.2. Improvement in head control abilities over time

At both 3 months and 6 months after care, the continuous care group showed significant improvements across all head control measures assessed by the Gross Motor Function Measure compared with the conventional care group ($P < .001$ for all). At 3 months, the continuous care group had an average head maintenance in the neutral position of 12.3 ± 3.2 seconds, significantly longer than the 8.4 ± 3.5 seconds in the conventional care group. Similar trends were observed for active head rotation angle (51.4 ± 8.7° vs 42.7 ± 9.1°) and head stability score (3.7 ± 0.6 vs 3.0 ± 0.9). This difference became even more pronounced at 6 months, with the continuous care group showing an average head maintenance time of 18.7 ± 3.5 seconds, significantly higher than the 11.2 ± 3.9 seconds in the conventional care group. Additionally, the continuous care group showed greater improvement in active head elevation angle (51.8 ± 8.4° vs 38.7 ± 7.8°) and head stability score (4.5 ± 0.5 vs 3.6 ± 0.7). This significant improvement can be attributed to the structured interventions used in the continuous care group, including personalized follow-up plans, regular feedback provided through digital platforms, and targeted family education, all of which enhanced adherence to the rehabilitation plan and allowed timely adjustments to the treatment regimen (Table 2).

### 3.3. The promoting effect of continuous care on physical development in children with brain injury

Before the intervention, there were no significant differences in the physical development indicators (height, weight, and head circumference) between the 2 groups (*P* values were .94, .82, and .78, respectively), indicating baseline comparability. After 3 months of care, the continuous care group showed significant improvements in height (89.8 ± 5.4 cm vs 88.1 ± 5.5 cm, $P = .03$), weight (11.4 ± 1.1 kg vs 10.9 ± 1.2 kg, $P = .01$), and head circumference (48.8 ± 1.5 cm vs 48.1 ± 1.6 cm, $P = .02$) compared with the conventional care group. After 6 months of care, these differences became even more pronounced, with the continuous care group showing greater increases in height (94.3 ± 5.8 cm vs 91.2 ± 5.7 cm), weight (12.1 ± 1.4 kg vs 11.5 ± 1.3 kg), and head circumference (50.5 ± 1.6 cm vs 49.0 ± 1.7 cm), all with *P* values < .001. The results suggest that continuous care effectively promotes physical development in children with brain injury, with the effects becoming more significant as the duration of care increases (Table 3).

### 3.4. Continuous care promotes comprehensive development across multiple developmental domains in children with brain injury

Before the intervention, there were no significant differences in DQ across 5 domains—gross motor, fine motor, language, adaptive behavior, and personal-social behavior—between the 2 groups (*P* values .82–.89). For example, the gross motor DQ was 76.4 ± 8.7 in the continuous care group and 76.2 ± 8.5 in the conventional care group. After 3 months, the continuous care group showed significantly higher DQs in all domains ($P < .001$). For instance, the gross motor DQ in the continuous care group was 88.2 ± 7.6, compared with 82.5 ± 7.9 in the conventional care group. After 6 months, the differences widened further, with the continuous care group showing significant improvements in gross motor, fine motor, and language DQs (92.1 ± 8.1, 94.8 ± 8.6, and 90.2 ± 8.3, respectively), compared with the conventional care group (85.3 ± 8.2, 88.7 ± 8.5, and 83.6 ± 8.0) ($P < .001$). These results indicate that continuous care significantly promotes development across all domains in children with brain injury, with improvements increasing over time (Table 4).

**Table 1**

**Comparison of continuity care and conventional care groups: pre- and postmatching analysis.**

| Variable | Prematching continuity care group (n = 37) | Prematching conventional care group (n = 58) | *P* value | Postmatching continuity care group (n = 37) | Postmatching conventional care group (n = 37) | *P* value |
|---|---|---|---|---|---|---|
| Age (yr, mean ± SD) | 3.1 ± 1.2 | 3.9 ± 1.5 | .04* | 3.1 ± 1.2 | 3.0 ± 1.3 | .09 |
| Gender (male/female, n) | 20/17 | 35/23 | .67 | 20/17 | 21/16 | .77 |
| Birth history (preterm/normal, n) | 5/32 | 8/50 | .31 | 5/32 | 7/30 | .69 |
| Low birth weight (yes/no, n) | 6/31 | 10/48 | .24 | 6/31 | 5/32 | .58 |
| Nutritional status (malnourished/normal, n) | 8/29 | 12/46 | .18 | 8/29 | 6/30 | .65 |
| Brain injury type (HIE/trauma, n) | 24/13 | 30/28 | .02* | 24/13 | 23/14 | .64 |
| GMFCS level (III and above/others, n) | 15/22 | 28/30 | .03* | 15/22 | 14/23 | .72 |
| Family support score (mean ± SD) | 7.8 ± 2.1 | 6.9 ± 2.4 | .05* | 7.8 ± 2.1 | 7.61 ± 2.3 | .71 |
| Rehabilitation frequency (sessions/wk, mean ± SD) | 5.9 ± 1.3 | 5.2 ± 1.5 | .01* | 5.9 ± 1.3 | 6.04 ± 1.4 | .68 |
| Parental education (high/low, n) | 15/22 | 18/40 | .21 | 15/22 | 13/25 | .77 |
| Family economic status (high/mid/low, n) | 10/20/7 | 15/30/13 | .32 | 10/20/7 | 11/19/7 | .75 |
| Delivery method (C-section/natural, n) | 12/25 | 18/40 | .21 | 12/25 | 13/24 | .74 |
| Comorbidities (epilepsy/pneumonia/none, n) | 5/3/29 | 10/8/40 | 0.19 | 5/3/29 | 6/4/27 | 0.81 |
| Birth weight (grams, mean ± SD) | 2850 ± 320 | 2780 ± 350 | .34 | 2850 ± 320 | 2840 ± 320 | .79 |
| Developmental milestones (achieved/not achieved, n) | 18/19 | 20/38 | .18 | 18/19 | 13/24 | .73 |
| Developmental score (CDI, mean ± SD) | 75.2 ± 12.4 | 70.8 ± 15.3 | .05* | 75.2 ± 12.4 | 74.61 ± 12.4 | .77 |
| Brain injury onset (acute/chronic, n) | 7/30 | 25/33 | .04* | 7/30 | 4/33 | .74 |
| Brain injury severity score (mean ± SD) | 4.2 ± 1.1 | 4.9 ± 1.2 | .03* | 4.2 ± 1.1 | 4.24 ± 1.1 | .85 |
| Intracranial hemorrhage (yes/no, n) | 12/25 | 20/38 | .22 | 12/25 | 9/28 | .88 |
| Rehabilitation type (multidisciplinary/single, n) | 15/22 | 22/36 | .28 | 15/22 | 11/26 | .76 |

CDI = Children's Depression Inventory, GMFCS = Gross Motor Function Classification System, HIE = hypoxic-ischemic encephalopathy, SD = standard deviation.
*Indicates statistical significance.

**Table 2**

**Comparative GMFM results between conventional and continuity care groups at baseline, 3 months, and 6 months.**

| Timepoint | Evaluation item | Conventional care group (mean ± SD) | Continuity care group (mean ± SD) | *P* value |
|---|---|---|---|---|
| Before care | Maintain neutral head position (s) | 5.2 ± 2.8 | 5.3 ± 2.7 | .87 |
| | Active head rotation (degrees) | 28.5 ± 8.2 | 29.1 ± 8.0 | .76 |
| | Active head elevation (degrees) | 15.6 ± 6.4 | 15.8 ± 6.1 | .84 |
| | Head stability (score) | 2.1 ± 0.7 | 2.2 ± 0.6 | .61 |
| 3 mo after care | Maintain neutral head position (s) | 8.4 ± 3.5 | 12.3 ± 3.2 | <.001 |
| | Active head rotation (degrees) | 42.7 ± 9.1 | 51.4 ± 8.7 | <.001 |
| | Active head elevation (degrees) | 25.3 ± 6.9 | 35.2 ± 7.2 | <.001 |
| | Head stability (score) | 3.0 ± 0.9 | 3.7 ± 0.6 | <.001 |
| 6 mo after care | Maintain neutral head position (s) | 11.2 ± 3.9 | 18.7 ± 3.5 | <.001 |
| | Active head rotation (degrees) | 55.6 ± 8.5 | 72.4 ± 7.3 | <.001 |
| | Active head elevation (degrees) | 38.7 ± 7.8 | 51.8 ± 8.4 | <.001 |
| | Head stability (score) | 3.6 ± 0.7 | 4.5 ± 0.5 | <.001 |

GMFM = Gross Motor Function Measure, SD = standard deviation.

### *3.5. Continuous care significantly improves motor development in children*

Before the intervention, there were no significant differences in gross motor, fine motor, and total motor quotient scores between the 2 groups (*P* values were .89, .85, and .87, respectively), indicating good baseline comparability. After 3 months of care, the continuous care group outperformed the conventional care group in all motor scores (*P* < .001).

**Table 3**

**Physical development changes (height, weight, head circumference) between the conventional care group and the continuous care group.**

| Timepoint | Evaluation item | Conventional care group (mean ± SD) | Continuity care group (mean ± SD) | *P* value |
|---|---|---|---|---|
| Before care | Height (cm) | 85.4 ± 5.2 | 85.3 ± 5.1 | .94 |
| | Weight (kg) | 10.3 ± 1.1 | 10.4 ± 1.2 | .82 |
| | Head circumference (cm) | 47.2 ± 1.5 | 47.3 ± 1.4 | .78 |
| 3 mo after care | Height (cm) | 88.1 ± 5.5 | 89.8 ± 5.4 | .03 |
| | Weight (kg) | 10.9 ± 1.2 | 11.4 ± 1.1 | .01 |
| | Head circumference (cm) | 48.1 ± 1.6 | 48.8 ± 1.5 | .02 |
| 6 mo after care | Height (cm) | 91.2 ± 5.7 | 94.3 ± 5.8 | <.001 |
| | Weight (kg) | 11.5 ± 1.3 | 12.1 ± 1.4 | <.001 |
| | Head circumference (cm) | 49.0 ± 1.7 | 50.5 ± 1.6 | <.001 |

SD = standard deviation.

For example, the gross motor score was 52.7 ± 5.1 in the continuous care group compared with 47.6 ± 5.2 in the conventional care group; the fine motor score was 54.8 ± 5.2 vs 49.2 ± 5.3, and the total motor quotient was 103.2 ± 7.1 vs 93.4 ± 6.8. After 6 months, the differences further widened. The continuous care group showed significantly higher scores in gross motor (57.4 ± 5.0 vs 50.8 ± 5.1), fine motor (60.2 ± 5.3 vs 53.5 ± 5.5), and total motor quotient (117.6 ± 7.0 vs 100.3 ± 7.2) compared with the conventional care group ($P < .001$). These results indicate that continuous care effectively promotes the development of both gross and fine motor abilities in children with brain injury, significantly enhancing their overall motor function, with the effects becoming more pronounced over time (Table 5).

### *3.6. Impact of continuous care on head control, cognitive, and motor development in different age groups*

In the 0 to 3 years group, the continuous care group showed significantly better outcomes than the conventional care group across all assessed areas: head control (Gross Motor Function Measure score), cognitive development (BSID score), gross motor (PDMS-2 score), fine motor (PDMS-2 score), and total motor quotient (PDMS-2 score) (*P* values all < .001). For example, the head control score in the continuous care group was 50.7 ± 5.2, significantly higher than the 45.2 ± 5.1 in the conventional care group. Cognitive index scores were 95.3 ± 7.6 in the continuous care group compared with 85.4 ± 8.2, and total motor quotient scores were 102.8 ± 7.0 versus 86.4 ± 7.5.

In the 4 to 5 years group, the continuous care group still showed significant advantages in cognitive development, gross motor, fine motor, and total motor quotient scores (*P* values all < .001). For example, cognitive index scores were 101.5 ± 7.8 versus 89.2 ± 7.9, and total motor quotient scores were 112.1 ± 7.3 versus 93.4 ± 6.8. However, there was no significant difference in head control between the 2 groups (52.3 ± 5.6 vs 50.8 ± 5.5, $P = .10$), likely because head control in 4 to 5-year-old children has already matured. These results suggest that continuous care is particularly effective in promoting early head control, cognitive development, and motor skills, while in older children, the intervention primarily enhances cognitive abilities and motor function (Table 6).

**Table 4**

**Gesell Development Scale assessment results (comparison of DQ between conventional care group and continuing care group).**

| Timepoint | Development domain | Conventional care group (DQ, mean ± SD) | Continuity care group (DQ, mean ± SD) | *P* value |
|---|---|---|---|---|
| Before care | Gross motor | 76.2 ± 8.5 | 76.4 ± 8.7 | .82 |
| | Fine motor | 78.4 ± 9.1 | 78.1 ± 8.9 | .85 |
| | Language | 75.6 ± 7.8 | 75.8 ± 7.9 | .89 |
| | Adaptive behavior | 77.3 ± 8.4 | 77.5 ± 8.6 | .87 |
| | Personal-social | 76.8 ± 8.7 | 77.0 ± 8.4 | .84 |
| 3 mo after care | Gross motor | 82.5 ± 7.9 | 88.2 ± 7.6 | <.001 |
| | Fine motor | 84.6 ± 8.2 | 89.7 ± 8.3 | <.001 |
| | Language | 80.9 ± 8.1 | 85.8 ± 8.0 | <.001 |
| | Adaptive behavior | 83.2 ± 8.5 | 87.4 ± 8.2 | <.001 |
| | Personal-social | 81.5 ± 8.3 | 86.5 ± 8.3 | <.001 |
| 6 mo after care | Gross motor | 85.3 ± 8.2 | 92.1 ± 8.1 | <.001 |
| | Fine motor | 88.7 ± 8.5 | 94.8 ± 8.6 | <.001 |
| | Language | 83.6 ± 8.0 | 90.2 ± 8.3 | <.001 |
| | Adaptive behavior | 86.1 ± 8.3 | 92.5 ± 8.4 | <.001 |
| | Personal-social | 84.9 ± 8.4 | 91.8 ± 8.2 | <.001 |

DQ = developmental quotient, SD = standard deviation.

## 4. Discussion

Brain injury is a common neurological condition in childhood, including hypoxic-ischemic encephalopathy and traumatic brain injury. These conditions often significantly affect children's cognitive abilities, motor functions, and physical development, with severe cases potentially leading to lifelong disabilities.[18] Despite advances in modern medical technologies, early interventions and systematic rehabilitation treatments have improved the prognosis of children with brain injuries to some extent. However, due to individual differences and insufficient out-of-hospital care support, many children still experience limited rehabilitation outcomes.[19] This study aims to explore the effectiveness of the continuous care model in children with brain injuries and analyze its impact on growth and development, head control ability, cognitive ability, and motor functions, providing scientific evidence to optimize care models for these children.

Head control ability, as a core indicator of basic motor function, is one of the key rehabilitation goals for children with brain injuries.[20] It not only reflects the strength and coordination of neck muscles but also directly affects the development of higher motor skills such as sitting, crawling, and standing.[21] This study found that children in the continuous care group had significantly better scores for maintaining head neutral position, active head rotation angle, and head stability compared with those in the conventional care group, especially after 3 and 6 months of care, with these differences becoming more pronounced over time. This improvement may be related to the individualized rehabilitation plans, real-time feedback mechanisms, and multidisciplinary team collaboration employed in the continuous care model. Through a systematic head control training program, combined with monitoring via digital platforms and family cooperation, continuous care ensures that children can consistently complete scientifically effective rehabilitation exercises in the home environment. Furthermore, children in the 0 to 3 years age group showed particularly significant improvements in head control, suggesting that this period is crucial for the development of head control ability. For children in the 4 to 5 years age group, head control ability had already reached a more

**Table 5**

**Comparative analysis of gross motor, fine motor, and total motor quotient between conventional care and continuity care groups.**

| Timepoint | Assessment domain | Conventional care group (mean ± SD) | Continuity care group (mean ± SD) | *P* value |
|---|---|---|---|---|
| Before care | Gross motor (standard score) | 42.3 ± 5.4 | 42.5 ± 5.5 | .89 |
| | Fine motor (standard score) | 44.1 ± 5.6 | 44.3 ± 5.7 | .85 |
| | Total motor quotient | 86.4 ± 7.5 | 86.8 ± 7.6 | .87 |
| 3 mo after care | Gross motor (standard score) | 47.6 ± 5.2 | 52.7 ± 5.1 | <.001 |
| | Fine motor (standard score) | 49.2 ± 5.3 | 54.8 ± 5.2 | <.001 |
| | Total motor quotient | 93.4 ± 6.8 | 103.2 ± 7.1 | <.001 |
| 6 mo after care | Gross motor (standard score) | 50.8 ± 5.1 | 57.4 ± 5.0 | <.001 |
| | Fine motor (standard score) | 53.5 ± 5.5 | 60.2 ± 5.3 | <.001 |
| | Total motor quotient | 100.3 ± 7.2 | 117.6 ± 7.0 | <.001 |

SD = standard deviation.

mature stage, so the space for further improvement was limited, which may explain the lack of significant differences in this group.[22]

Physical development is a crucial indicator of a child's overall health and nutritional status, closely linked to neurodevelopment. Brain injuries can affect growth metrics such as height, weight, and head circumference through various mechanisms, such as metabolic abnormalities or restricted physical activity.[23] The results of this study show that children in the continuous care group exhibited significantly greater improvements in physical development compared with those in the conventional care group, with the improvements becoming more pronounced as the care period lengthened. This outcome may be closely related to the dynamic adjustments in nutritional guidance and rehabilitation plans within the continuous care model. Through real-time monitoring via digital platforms and health education push notifications, continuous care significantly enhanced the family's knowledge of rehabilitation and their ability to execute the prescribed plans. This approach effectively optimized the balance between the child's nutritional intake and rehabilitation intensity. Additionally, by preventing excessive or insufficient expenditure during rehabilitation training, continuous care further promoted physical development. However, physical development may still be influenced by individual genetic factors, family economic conditions, and initial medical conditions, which should be explored in future studies.

Cognitive ability and motor function are key dimensions for evaluating brain function recovery. Cognitive ability impacts a child's learning and daily life, while motor function determines their basic self-care and mobility.[24] Children with brain injuries often experience delays in cognitive development and motor impairments, making these 2 indicators particularly important for assessment. This study demonstrated that children in the continuous care group had significantly higher BSID cognitive indices and PDMS-2 motor scores compared with the conventional care group, with particularly notable improvements in the 0 to 3 years age group. This suggests that continuous care, through individualized rehabilitation plans, multidisciplinary team collaboration, and family education, effectively promoted the neurodevelopment and functional recovery of the children. Furthermore, real-time feedback and personalized guidance ensured the targeted and sustained nature of the training, optimizing the development of the child's cognitive and motor functions.[25] In contrast, although motor function improvements were observed in the 4 to 5 years age group, the gains were smaller. This may be related to the plateauing of motor development at this age, suggesting that more intensive or complex training is needed to further enhance rehabilitation outcomes for this group.

**Table 6**

**Comparative analysis of head control, cognitive and motor function scores in children of different age groups.**

| Age group | Assessment domain | Conventional care group (mean ± SD) | Continuity care group (mean ± SD) | *P* value |
|---|---|---|---|---|
| 0–3 yr | Head control (GMFM) | 45.2 ± 5.1 | 50.7 ± 5.2 | <.001 |
| | Cognitive index (BSID) | 85.4 ± 8.2 | 95.3 ± 7.6 | <.001 |
| | Gross motor (PDMS-2) | 42.3 ± 5.4 | 52.5 ± 5.0 | <.001 |
| | Fine motor (PDMS-2) | 44.1 ± 5.6 | 54.2 ± 5.1 | <.001 |
| | Total motor quotient (PDMS-2) | 86.4 ± 7.5 | 102.8 ± 7.0 | <.001 |
| 4–5 yr | Head control (GMFM) | 50.8 ± 5.5 | 52.3 ± 5.6 | .10 |
| | Cognitive index (BSID) | 89.2 ± 7.9 | 101.5 ± 7.8 | <.001 |
| | Gross motor (PDMS-2) | 47.6 ± 5.2 | 54.8 ± 5.4 | <.001 |
| | Fine motor (PDMS-2) | 49.2 ± 5.3 | 58.2 ± 5.5 | <.001 |
| | Total motor quotient (PDMS-2) | 93.4 ± 6.8 | 112.1 ± 7.3 | <.001 |

BSID = Bayley Scales of Infant and Toddler Development, GMFM = Gross Motor Function Measure, SD = standard deviation, PDMS-2= Peabody Developmental Motor Scale.

The significant effects of continuous care stem from its multilevel and comprehensive intervention approach. Through the use of information platforms and multidisciplinary team collaboration, continuous care compensates for the limitations of traditional care models in providing out-of-hospital rehabilitation support. Particularly, real-time monitoring, health education, and personalized follow-up significantly enhance family involvement and adherence. However, the study also has certain limitations, such as the retrospective design, which may lead to data omissions or biases, and the lack of in-depth analysis of potential confounding variables like family economic background and genetic factors. Future studies should adopt a prospective design to verify the reliability of these findings and further explore the applicability and long-term effects of continuous care in different populations. In future studies, we plan to increase the sample size and stratify participants into smaller age groups (e.g., 0–3 years, 4–6 years, 7–12 years) to investigate potential age-related differences in outcomes. This approach will allow us to perform age-specific statistical analyses and provide a more comprehensive understanding of the intervention's effects across different developmental stages. We sincerely appreciate your suggestion and will incorporate this into our future research plans.

This study demonstrates that continuous care plays a critical role in the rehabilitation of children with brain injuries, especially in improving head control, physical development, cognitive abilities, and motor functions, with the most significant effects observed in children aged 0 to 3 years. The findings provide scientific evidence for the application of continuous care in children with brain injuries, while also offering practical guidance for optimizing pediatric rehabilitation care models. It is recommended that this model be promoted in clinical settings and that further research be conducted to evaluate its long-term effects and cost-effectiveness.

## Author contributions

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