Original Article

Investigation of the catch-up status and termination for corrected age of neurodevelopment in premature infants of different gestational ages

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Background: Corrected age entails determining the age of premature infants by adjusting their gestational age to 40 weeks. Research on corrected age in relation to neurodevelopment is limited, both domestically and internationally, resulting in a lack of consensus and recommendations regarding the appropriate termination of the neurodevelopmental corrected age. This study aimed to assess the neurodevelopmental catch-up status of premature infants with varying gestational ages and to identify appropriate termination criteria for the corrected age of neurodevelopment.

Methods: The study included 1,579 premature infants without high-risk factors and 8,441 full-term infants receiving care at the child health clinics of the Second Affiliated Hospital of Army Medical University, Chongqing Health Center for Women and Children, and Maternal and Child Health Care Hospital of Wanzhou District, Chongqing between January 1, 2018, and March 1, 2023. Infants were grouped based on gestational age into early, middle, and late premature infants, as well as full-term infants. Over a 48-month period, the developmental quotient (DQ) of each functional area on the Gesell Developmental Scale was compared across groups.

Results: There were no statistically significant differences in DQ of all functional areas between late premature infants and full-term infants at 36 months of age (all $P>0.05$). In contrast, some developmental functional areas in middle- and early-premature infants and full-term infants exhibited significant differences at 36 months of age; however, by 48 months of age, these differences were no longer significant (all $P>0.05$). The DQ of all functional areas in the late, middle, and early premature infant groups demonstrated a catch-up trend from 6 to 48 months of chronological age (all $P<0.05$).

Conclusions: The termination age for neurodevelopmental correction in premature infants may continue beyond 36 months of age, with longer correction time required for those born at younger gestational ages.

Keywords: Premature infants; gestational ages; neurodevelopment; catch-up; corrected age

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Introduction

Background

Based on recent data released by the Lancet, it is estimated that approximately 13.4 million premature births occur globally each year, with incidence rates ranging from 6.8% to 16.2% in 103 countries (1). The occurrence of premature birth presents a significant risk for both immediate and prolonged neurodevelopmental challenges in affected children, emphasizing the need for ongoing monitoring of neurodevelopment for their long-term management (2-4). Corrected age entails determining the age of premature infants by adjusting their gestational age to 40 weeks (5). Corrected age is calculated by subtracting the number of weeks born before 40 weeks of gestation from the chronological age (6). This approach has garnered global recognition for the developmental evaluation of premature infants. Nevertheless, improper application of the corrected age can impact clinical decision-making. Inflating the corrected age may obscure developmental deficiencies, whereas deflating it may lead to unnecessary diagnoses (7). Corrections may reduce the apparent gap between premature and full-term infants. In contrast, unadjusted age may result in an underestimation of the developmental level of premature infants. Using chronological age-based developmental assessment scores yielded significantly more infants with developmental delays than using corrected age-based developmental assessment scores. This raises an important clinical question: at what age should the corrected age no longer be used for developmental assessments in premature infants? Answering this question is crucial for objectively assessing the developmental levels of premature infants in clinical settings.

Highlight box

Key findings
- There was a significant distinction in neurodevelopment between late premature infants and full-term infants up to 36 months of age, and between middle- and early-premature infants and full-term infants up to 48 months of age. The rate of catch-up varied across different neurodevelopmental functional areas.

What is known and what is new?
- Corrected age entails determining the age of premature infants by adjusting their gestational age to 40 weeks. The termination criteria for corrected age primarily emphasize the importance of monitoring and correcting physical development in premature infants. Limited research exists on the corrected age for neurodevelopment both domestically and internationally, resulting in a lack of consensus and recommendations regarding the appropriate termination for neurodevelopmental corrected age.
- The neurodevelopmental progress of early- and middle-premature infants cannot fully catch up by the age of 36 months.

What is the implication, and what should change now?
- The termination for corrected age for neurodevelopmental in premature infants may necessitate an extension up beyond 36 months of age to ensure the fairness of conclusions of neurodevelopmental assessment in premature infants.

Rationale and knowledge gap

Current guidelines in China, including “Suggestions on the evaluation of children’s physical growth in China”, suggest that corrected age for weight evaluation can be applied until 24 months of age, for length evaluation until 40 months of age, and for head circumference evaluation until 18 months of age. Similarly, the “Feeding recommendation for preterm and low birth weight infants after discharge” recommends corrections of physical assessments for premature infants until the age of 2 years, and up to 3 years for extremely premature infants born before 28 weeks of gestation (8,9). These recommendations emphasize the importance of monitoring and correcting the physical development of premature infants. However, limited research exists on the corrected age for neurodevelopment, both domestically and internationally, resulting in a lack of consensus and recommendations regarding the appropriate termination of the neurodevelopmental corrected age.

Objective

This study aimed to compare the developmental quotient (DQ) of premature infants of varying gestational ages with full-term infants using the Gesell Developmental Scale. We examined the patterns and trends of neurodevelopmental catch-up in premature infants of different gestational ages to determine appropriate criteria for terminating corrected age in neurodevelopmental assessments. The findings will provide a theoretical foundation for long-term care of premature infants. We present this article in accordance with the STROBE reporting checklist (available at https://tp.amegroups.com/article/view/10.21037/tp-24-243/rc).

Methods

Research design and study sample

This study included premature and full-term infants who received follow-up at the Second Affiliated Hospital of Army Medical University, Chongqing Health Center for Women and Children, and Maternal and Child Health Care Hospital of Wanzhou District, Chongqing, between January 1, 2018, and March 1, 2023. All participants were from urban areas and of Han ethnicity, receiving similar medical services. Based on the Chinese "Practice of Neonatology" book, infants were grouped according to their gestational age as follows: early premature infants (~31+6 weeks), middle premature infants (32–33+6 weeks), late premature infants (34–36+6 weeks), and full-term infants (37–41+6 weeks) (10). Inclusion criteria were as follows: (I) premature infants, defined as those born before 37 weeks of gestation; and (II) full-term infants, defined as those born between 37 and 41+6 weeks. Based on previous extensive research which showed that the presence of certain diseases may affect the outcome of childhood neurodevelopment (3,4), exclusion criteria were: (I) congenital genetic metabolic disorders; (II) severe congenital malformations; (III) severe congenital infectious diseases, including toxoplasma, others, rubella virus, cytomegalovirus, herpes virus (TORCH) infections; and (IV) severe neurological diseases, such as moderate or severe hypoxic-ischemic encephalopathy and grade III–IV intracranial hemorrhage).

The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by the ethics committee of the Second Affiliated Hospital of Army Medical University (2023-Research No. 098-02), and informed consent was exempted by the ethics committee due to the retrospective nature of this study. The other hospitals were informed and agreed with this study.

Assessment

We assessed the DQ of the infants using the Gesell Developmental Scale at 6, 12, 18, 24, 36, and 48 months of age across various functional areas. The Chinese version of the Gesell Developmental Scale was used to assess the children's neurodevelopment across five functional areas: gross motor, fine motor, adaptation, language, and personal-social skills (11). Gross motor behaviors included postural responses, head stability, sitting, standing, climbing, and walking. Fine motor behaviors included grasping and manipulating objects with hands and fingers. Adaptation reflected cognitive abilities, such as organizing and perceiving interrelationships, breaking down all stimuli into their components, and reorganizing these components in a meaningful way. Language behavior included imitation and understanding speech. Personal-social behavior evaluated the infant's interaction with their social and cultural environment. Each assessment took about 40–120 minutes, depending on the child's age, test status, and developmental level. Each child was required to complete all five functional areas. The Gesell Developmental Scale is widely recognized as an important tool for assessing the integrity and functional maturity of the nervous system in children. It uses the behavioral patterns of children without disorders as a standard to identify and evaluate observed behavioral patterns, expressing children's developmental level in terms of developmental age and DQ. We calculated DQ by dividing the developmental age by the chronological age and multiplying the result by 100. The developmental levels of the infants were categorized as normal (DQ $\geq$85), abnormal (DQ <75), and borderline (75$\leq$ DQ <85) based on the criteria outlined in the Gesell Developmental Scale. Any functional area with DQ <75 was considered to exhibit abnormal development.

Quality control

All evaluators were trained and certified in the use of the Chinese Gesell Developmental Scale. The assessments took place in the evaluation rooms of the pediatric outpatient department.

Statistical analysis

The statistical software SPSS 24.0 was utilized for data analysis, with measurement data presented as either mean ± standard deviation (SD) or median (25^{th} percentile, 75^{th} percentile) [M (P25, P75)]. The Kruskal-Wallis *H* test was employed for measurement data exhibiting non-normal distributions or uneven variances between multiple groups. GraphPad Prism 8 was used to generate DQ trend charts depicting the Gesell functional areas of the premature infants in each group at various ages. After Bonferroni correction for multiple comparisons, statistical significance

Table 1 The weight and gestational age the subjects of study

Groups	N (%)	Gestational age (weeks), mean ± SD	Birth weight (kg), mean ± SD
Late preterm	1,119 (11.17)	35.65±0.85	2.52±0.41
Middle preterm	263 (2.62)	33.04±0.58	1.92±0.30
Early preterm	197 (1.97)	30.41±1.05	1.47±0.29
Full-term	8,441 (84.24)	39.36±1.02	3.30±0.40

SD, standard deviation.

was set at P<0.05.

Results

General profile of the study participants

The study included a total of 1,579 premature infants categorized as late premature infants (n=1,119), middle premature infants (n=263), and early premature infants (n=197). Additionally, 8,441 full-term infants were included, comprising 4,494 males and 3,947 females. The average birth weight and gestational age for each group are detailed in *Table 1*.

Neurodevelopmental outcomes in premature infants: comparison of Gesell Developmental Scale quotients across functional domains between premature and full-term infants

Upon comparison of the DQ in various functional areas between premature and full-term infants, it was noted that late premature infants exhibited significantly lower DQ scores in all functional areas up to 24 months compared to full-term infants (all P<0.05). However, at 36 months, there were no statistically significant differences in the DQ scores in any functional area between late premature and full-term infants (all P>0.05). The DQ of most functional areas in the middle premature infant group exhibited a significant decrease compared to the full-term infant group prior to 36 months (all P<0.05). However, no significant difference was observed when compared to the full-term infant group at 48 months (all P>0.05). Before 24 months, the DQ of all functional areas in the early premature infant group was significantly lower than that in the full-term infant group (all P<0.05). However, at 36 months, while there was no statistically significant difference in the DQ of the gross motor, fine motor, language, and personal-social functional areas between early premature and full-term infants, the DQ scores for the remaining functional areas were notably lower in the early premature infant group compared to the full-term infant group. By 48 months, there were no statistically significant differences in the DQ scores for any functional area between the two groups (all P>0.05) (*Table 2*).

Catch-up growth and rate of DQ in functional areas: Gesell Developmental Scale analysis in premature infants across different groups

When examining the DQ of premature infants within each group across various age intervals, a trend of gradual improvement in all functional areas was observed from 6 to 48 months in late, middle, and early premature infants. This trend suggests a catch-up effect in development over time, as indicated by the statistically significant differences (all P<0.05). The slope of the DQ curve of the other four functional areas decreased gradually, except for the language functional areas. This indicates that while there was a rapid catch-up speed in early life, the rate of catch-up gradually slowed over time (*Figure 1A-1E*). Specifically, the DQ scores for gross motor, fine motor, adaptability, and personal-social skills were significantly higher at 12 months compared to 6 months in all three groups of premature infants. The DQ scores for the functional areas of gross motor and fine motor function in both the late and early premature infant groups, as well as the adaptability and personal-social functional area in the early premature infant group, showed a significant increase at 18 months compared to 12 months. However, by 24 months, there were no significant differences in the DQ scores for gross motor, fine motor, adaptability, and personal-social functional areas compared to those at 18 months in any of the premature groups. The DQ of the language functional area displayed an increasing trend from 12 to 24 months in all groups, with the late premature infant group being the only one to exhibit a significant difference in the DQ between 18 and 12 months (*Table 3*).

Table 2 Comparison of DQ in different developmental functional areas of Gesell Developmental Scale between premature infants group and full-term infants group at different ages

Age	Groups	N	Gross motor DQ	Fine motor DQ	Adaptation DQ	Language DQ	Personal-social DQ
6 months	Late	478	70 [62, 78]*	76 [71, 82]*	73 [67, 79]*	76 [71, 82]*	74 [69, 79]*
	Middle	113	62 [56, 69]*	71 [67, 74]*	67 [63, 72]*	72 [68, 77]*	68 [65, 72]*
	Early	69	56 [50, 63]*	64 [59, 67]*	60 [53, 67]*	62 [58, 68]*	63 [57, 65]*
	Full term	2,076	81 [72, 92]	88 [82, 93]	86 [80, 91]	88 [83, 93]	87 [82, 91]
	H		459.541	678.823	700.941	778.787	747.442
	P		<0.001	<0.001	<0.001	<0.001	<0.001
12 months	Late	605	84 [76, 89]*	83 [78, 87]*	83 [78, 87]*	75 [71, 82]*	82 [77, 88]*
	Middle	137	79 [70, 85]*	79 [75, 84]*	79 [75, 83]*	73 [67, 79]*	77 [73, 81]*
	Early	93	70 [61, 78]*	73 [67, 77]*	71 [65, 77]*	67 [62, 72]*	70 [65, 78]*
	Full term	4,351	89 [82, 94]	89 [86, 93]	88 [85, 92]	82 [78, 87]	88 [85, 93]
	H		368.079	813.036	770.298	655.263	703.355
	P		<0.001	<0.001	<0.001	<0.001	<0.001
18 months	Late	285	87 [82, 96]*	86 [81, 92]*	83 [77, 92]*	80 [72, 89]*	83 [80, 87]*
	Middle	78	82 [78, 90]*	82 [79, 88]*	79 [73, 85]*	77 [71, 83]*	80 [77, 83]*
	Early	46	78 [72, 89]*	79 [74, 84]*	76 [70, 82]*	73 [65, 83]*	79 [75, 84]*
	Full term	1,594	90 [86, 95]	90 [86, 94]	86 [81, 91]	87 [81, 91]	87 [85, 90]
	H		99.299	144.884	120.986	161.795	261.456
	P		<0.001	<0.001	<0.001	<0.001	<0.001
24 months	Late	237	89 [86, 95]*	87 [81, 92]*	87 [81, 93]*	81 [73, 88]*	84 [77, 89]*
	Middle	58	85 [80, 90]*	85 [80, 90]*	85 [76, 89]*	78 [69, 87]*	79 [75, 87]*
	Early	51	87 [81, 91]*	80 [75, 86]*	81 [75, 87]*	78 [72, 84]*	79 [74, 86]*
	Full term	1,719	92 [88, 96]	89 [84, 95]	90 [84, 95]	85 [79, 91]	86 [81, 91]
	H		77.610	77.806	83.854	69.257	69.627
	P		<0.001	<0.001	<0.001	<0.001	<0.001
36 months	Late	104	89 [85, 97]	87 [79, 93]	84 [78, 91]	83 [76, 91]	84 [79, 93]
	Middle	28	80 [75, 92]*	80 [78, 84]*	80 [77, 84]	74 [71, 78]*	81 [73, 89]
	Early	25	85 [81, 93]	83 [77, 86]	78 [75, 81]*	79 [70, 86]	82 [76, 85]
	Full term	590	89 [82, 96]	87 [81, 93]	84 [79, 90]	83 [75, 90]	86 [80, 92]
	H		10.348	18.127	16.011	15.008	10.050
	P		0.02	<0.001	0.001	0.002	0.02
48 months	Late	15	85 [77, 90]	84 [73, 86]	85 [71, 86]	85 [71, 90]	85 [79, 91]
	Middle	6	90 [80, 95]	89 [82, 94]	77 [70, 92]	77 [65, 92]	89 [79, 94]
	Early	7	88 [83, 92]	82 [81, 98]	82 [74, 88]	79 [74, 88]	88 [80, 96]
	Full term	134	87 [79, 94]	87 [78, 93]	83 [75, 90]	82 [74, 90]	86 [80, 92]
	H		0.719	2.884	1.258	0.487	1.298
	P		0.87	0.41	0.74	0.93	0.73

Data are presented as M [P25, P75]. *, indicates a statistically significant difference compared with full-term infants of the same age (P<0.05). DQ, developmental quotient; M, median; P25, 25th percentile; P75, 75th percentile.

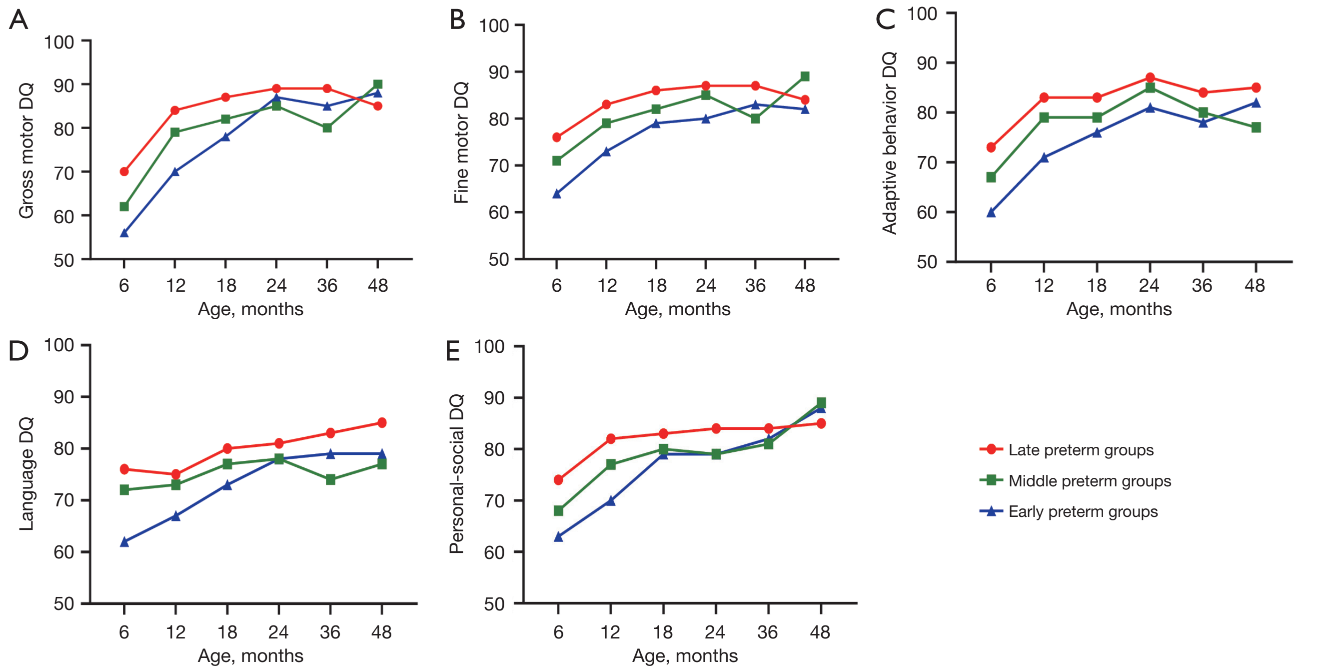

Figure 1 Trends in DQ across developmental functional areas of the Gesell Developmental Scale among premature infants at different ages. (A) DQ for gross motor functional areas changes with age. (B) DQ for fine motor functional areas changes with age. (C) DQ for adaptability functional areas changes with age. (D) DQ for language functional areas changes with age. (E) DQ for personal-social functional areas changes with age. DQ, developmental quotient.

Discussion

Monitoring neurodevelopment in premature infants following discharge from the neonatal intensive care unit is a crucial aspect of pediatric care. The judicious application of corrected age during infancy and early childhood allows healthcare providers and parents to gain a scientific understanding of growth and development, facilitating timely identification and intervention of potential issues to prevent underdiagnosis or overdiagnosis (12). Current correction methods and standards outlined in China's "Premature infant health care standards" primarily focus on physical development, with limited evidence supporting their use for neurodevelopmental assessment (13). While research suggests a connection between improved physical development, particularly head circumference, and enhanced neurological development in areas such as cognitive and motor functions, the correlation is not entirely linear (14-17). Hence, the rate and completion of physical catch-up alone may not adequately indicate the status of neural development catch-up, rendering it insufficient for neurodevelopmental assessments of premature infants.

There is limited research on the corrected age for neurodevelopmental assessments in premature infants within both domestic and international contexts. Existing studies often report brief follow-up periods and involve limited numbers of patients. Although some studies have suggested that premature infants exhibit early signs of neural developmental catch-up, a significant disparity in neural development persists between premature and full-term infants by the age of 2 years (18-21). A recent multicenter study conducted on premature infants with a gestational age of <33 weeks and without high-risk factors revealed that at 18 months of chronological age, the Mental Development Index (MDI) of the Bayley Scales of Infant Development (2nd edition) was 17.3 points lower when assessed using chronological age than when assessed by corrected age (22). The Psychomotor Development Index showed a difference of 11.8 points. Even at the age of 7 years, there remained a statistically significant difference (1.9 points in intelligence quotient scores), as measured by the Weschler Abbreviated Scale of Intelligence. These findings indicate that premature infants may require a longer period to fully catch up in cognitive development than previously believed, underscoring the more

Table 3 Comparison of DQ in each developmental functional area of Gesell Developmental Scale in each group of premature infants at different ages

Groups	Age	N	Gross motor DQ	Fine motor DQ	Adaptation DQ	Language DQ	Personal-social DQ
Late	6 months	478	70 [62, 78]	76 [71, 82]	73 [67, 79]	76 [71, 82]	74 [69, 79]
	12 months	605	84 [76, 89]*	83 [78, 87]*	83 [78, 87]*	75 [71, 82]	82 [77, 88]*
	18 months	285	87 [82, 96]*	86 [81, 92]*	83 [77, 92]	80 [72, 89]*	83 [80, 87]
	24 months	237	89 [86, 95]	87 [81, 92]	87 [81, 93]	81 [73, 88]	84 [77, 89]
	36 months	104	89 [85, 97]	87 [79, 93]	84 [78, 91]	83 [76, 91]	84 [79, 93]
	48 months	15	85 [77, 90]	84 [73, 86]	85 [71, 86]	85 [71, 90]	85 [79, 91]
	H		515.378	343.827	361.209	76.083	262.277
	P		<0.001	<0.001	<0.001	<0.001	<0.001
Middle	6 months	113	62 [56, 69]	71 [67, 74]	67 [63, 72]	72 [68, 77]	68 [65, 72]
	12 months	137	79 [70, 85]*	79 [75, 84]*	79 [75, 83]*	73 [67, 79]	77 [73, 81]*
	18 months	78	82 [78, 90]	82 [79, 88]	79 [73, 85]	77 [71, 83]	80 [77, 83]
	24 months	58	85 [80, 90]	85 [80, 90]	85 [76, 89]	78 [69, 87]	79 [75, 87]
	36 months	28	80 [75, 92]	80 [78, 84]	80 [77, 84]	74 [71, 78]	81 [73, 89]
	48 months	6	90 [80, 95]	89 [82, 94]	77 [70, 92]	77 [65, 92]	89 [79, 94]
	H		151.324	152.569	144.456	19.086	126.534
	P		<0.001	<0.001	<0.001	0.002	<0.001
Early	6 months	69	56 [50, 63]	64 [59, 67]	60 [53, 67]	62 [58, 68]	63 [57, 65]
	12 months	93	70 [61, 78]*	73 [67, 77]*	71 [65, 77]*	67 [62, 72]	70 [65, 78]*
	18 months	46	78 [72, 89]*	79 [74, 84]*	76 [70, 82]*	73 [65, 83]	79 [75, 84]*
	24 months	51	87 [81, 91]	80 [75, 86]	81 [75, 87]	78 [72, 84]	79 [74, 86]
	36 months	25	85 [81, 93]	83 [77, 86]	78 [75, 81]	79 [70, 86]	82 [76, 85]
	48 months	7	88 [83, 92]	82 [81, 98]	82 [74, 88]	79 [74, 88]	88 [80, 96]
	H		136.280	122.155	109.277	74.711	105.772
	P		<0.001	<0.001	<0.001	<0.001	<0.001

Data are presented as M [P25, P75]. *, indicates a statistically significant difference compared with the previous chronological age in each group (P<0.05). DQ, developmental quotient; M, median; P25, 25th percentile; P75, 75th percentile.

pronounced impact of premature birth on cognitive rather than motor development. Hence, the author of this study proposed that the termination age for neurodevelopmental evaluation in premature infants should be extended to 3 years (22). Regrettably, the study lacked consistent follow-up and data collection for neurodevelopmental assessments at critical intervals for premature infants between 18 months and 7 years, including 1, 2, and 3 years. Consequently, there is a lack of specific guidelines regarding the appropriate cessation of the corrected age.

In contrast to previous studies, our study extended the follow-up duration and included a larger sample of premature infants without high-risk factors. Our findings indicate a significant distinction in neurodevelopment between late premature and full-term infants up to 36 months of age and between middle- and early-premature infants up and full-term infants to 48 months. This suggests that setting the termination of neurodevelopmental corrected age in premature infants before 36 months may be inadequate, particularly for early- and middle-premature infants born before 34 weeks of gestation. Therefore, it may be more stringent to set the termination point of the corrected age for neurodevelopmental assessment at 24 months, as recommended for physical developmental assessment of premature infants in China. Prior research conducted in China has indicated variations in the catch-up period for neuropsychological development among premature infants of different gestational ages, with those born at younger gestational ages generally requiring a longer duration to achieve full catch-up (23,24). Therefore, pediatricians should consider setting different termination ages for neurodevelopmental assessments depending on the gestational age of premature infants to ensure equitable evaluation.

Our research indicates significant variations in the rate of catch-up growth across different functional domains in the neurodevelopmental progress of premature infants. Comparative analysis of DQ within the same functional area among premature infants of varying ages indicated a notable trend of catch-up neurological development before 48 months. Specifically, catch-up in gross motor, fine motor, adaptability, and personal-social functional areas began earlier, with younger premature infants catching up faster. However, a complete catch-up did not occur until around 24 months. On the other hand, language development shows a gradual catch-up process after 12 months without a distinct period of rapid advancement. A recent study from China revealed that premature infants exhibited a lower total DQ at 18–24 months compared to full-term infants but did not show significant differences in the personal-social functional domains (20). The justification for conducting the analysis lies in the observation that premature infants exhibit accelerated catch-up in personal-social functional areas early on, potentially due to increased family attention and parent-child interaction post-birth (25). Conversely, delayed catch-up in language development aligns with typical developmental patterns in infants. As such, tailoring neurodevelopmental interventions for premature infants based on the timing of rapid catch-up in various functional domains could optimize clinical outcomes for this patient group.

Although this study introduces novel perspectives, it has some limitations. Firstly, the study participants were drawn from a specific region in China; hence, they may not represent general or international populations. Secondly, owing to the loss of follow-up, the number of premature infants decreased after 36 months. Finally, due to the retrospective nature of this study, there was a lack of prospective follow-up and systematic collection of evaluation data for all age groups. To enhance the reliability of our findings, future studies with larger sample sizes and multicenter prospective designs are needed to establish high-quality evidence and serve as a reference for monitoring the neurodevelopment of premature infants.

Conclusions

The rates and completion of neurodevelopmental catch-up in premature infants differ notably from those of their physical development. As a result, termination of corrected age for neurodevelopmental assessments in premature infants should be extended beyond 36 months of age, particularly for early- and middle-premature infants born before 34 weeks of gestation.

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Footnote

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Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by the ethics committee of the Second Affiliated Hospital of Army Medical University (2023-Research No. 098-02), and informed consent was exempted by the ethics committee due to the retrospective nature of this study. The other hospitals were informed and agreed with this study.

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