**Original Article**

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# Evaluating Developmental Progress in Preterm Infants (4-12 Months) Following NICU Stay: An ASQ Analysis

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**ABSTRACT**

**Background:** Premature birth is a principal risk factor for developmental delay in infants. Infants born with a history of hospitalization in the neonatal intensive care unit (NICU) are at higher risk of developmental delay and require close monitoring. This study aimed to investigate and compare the developmental status of preterm infants (4-12 months old) with a history of hospitalization in the NICU using the Ages and Stages Questionnaire (ASQ).

**Methods:** This cross-sectional study was conducted from October 2016 to September 2020 in the NICU of Shahid Sadoughi Hospital in Yazd, Iran. One hundred preterm infants with a history of hospitalization in the NICU were selected using non-random sampling and were assessed at corrected ages of 4, 8, and 12 months. The data collection tool consisted of demographic information questionnaires and ASQ forms. The data were analyzed using SPSS 22 software and Excel.

**Results:** Of the 100 infants studied, 55% were boys and 45% were girls. The mean birth weight was 65.1480 ± 59.501 grams, and the mean discharge weight was 35.1746 ± 94.335 grams. At 4, 8, and 12 months, 16%, 14%, and 13% of the infants, respectively, had developmental delays in at least one domain. The mean length of hospital stay after birth was 83.35 ± 43.26 days, and the mean gestational age was 84.30 ± 97.20 weeks. These means differed significantly between infants with and without developmental delay in at least one domain at 12 months.

**Conclusion:** The presence of developmental delay in preterm infants with a history of NICU hospitalization increases the number of required interventions for these infants. Therefore, regular developmental assessments are essential in the first year of life to detect developmental delay early and provide timely interventions. Moreover, the continuation of growth and development in these infants should be evaluated.

## Introduction

The neonatal period, from birth to the end of the first month, is a critical phase of human development characterized by rapid growth and maturation. This period is of utmost importance, laying the foundation for future cognitive, emotional, and physical development. Premature birth, asphyxia, intrauterine growth restriction, and other perinatal complications can significantly impact the infant's developmental trajectory, increasing the risk of developmental delay.[1,2] Developmental delay refers to a significant deviation from the expected developmental milestones, which can be caused by various factors, including genetic, environmental, and medical conditions. In the context of preterm birth, developmental delay can be attributed to the infant's early birth, which may result in incomplete maturation of the brain and other organs.[3] In Iran, the prevalence of developmental delay in children varies between 18.7% and 22.5% in different cities.[4] Early detection of developmental delay is crucial, as timely intervention can significantly improve the child's developmental outcomes. The Ages and Stages Questionnaire (ASQ) is a widely used screening tool for detecting infant developmental delay. The ASQ has been validated for use in various populations, including preterm infants, and has been shown to have high sensitivity and specificity.[5] The ASQ consists of 19 questionnaires, each covering a specific age range from 4 to 60 months. The questionnaires are designed to assess various domains of development, including gross motor, fine motor, communication, personal-social, and problem-solving skills. The ASQ is a reliable and valid tool for identifying infants at risk of developmental delay.[6,7] In the context of preterm birth, early detection of developmental delay is crucial. Premature infants are at higher risk of developmental delay due to their early birth and potential exposure to perinatal complications. Therefore, it is essential to conduct regular developmental assessments in preterm infants to identify any delays in various domains and provide timely interventions to minimize the delay.[8] This study aims to investigate the developmental status of preterm infants with a history of hospitalization in neonatal intensive care units (NICUs) using the ASQ. The findings of this study will provide valuable insights into the developmental outcomes of preterm infants and inform the development of targeted interventions to support their developmental needs.

## Materials and Methods

This study is a descriptive-cross-sectional study. The statistical population consisted of all preterm infants hospitalized in the neonatal intensive care unit (NICU) of Shahid Sadoughi Hospital in Yazd, Iran, from October 2016 to September 2019. The sampling method used in this study was non-probability sampling and convenience sampling. The sample size was determined based on a previous study (Dareh) and using the following formula, considering a confidence level of 0.05 and a margin of error of less than 10%:

$$n = (Z_{(1-\alpha/2)})^2 \times P(1-P))/d^2$$

The Ages and Stages Questionnaire (ASQ) was completed for 100 preterm infants at 4, 8, and 12 months of age, and the results were recorded and analyzed. At discharge, parents were educated on the importance of follow-up and the correct way to complete the ASQ form. An informed consent form was obtained from each family at discharge for follow-up screening. The date of completion of the form was determined based on the corrected age for preterm infants and the chronological age for term infants. The forms were collected from parents through phone calls or emails every month, and the date of completion of the form was determined based on the age of the infant. After collecting each form, we scored the answers to the questions and determined the level of the infant in each skill area. When necessary, we educated parents and referred infants to pediatric neurologists. The date for completing the next form was given to the infant. After collecting each form, we

compared the answers to the questions in each skill area with the answers to the previous forms and evaluated the effectiveness of the education provided.

## Results

This study involved 100 infants, with a gender distribution of 55% male (n = 55) and 45% female (n = 45). Table 1 presents descriptive statistics on various health-related variables. Hospital stays ranged from 4 to 128 days, averaging 83.35 days (SD=60.28). The mean length of hospital stay was approximately 3 days shorter for boys compared to girls (34.22 days vs. 37.80 days), although this difference was not statistically significant (P = 0.536). The mean length of stay in the NICU was 35.83 ± 26.43 days, ranging from 4 to 128 days. Birth weights varied from 600 to 2600 grams, with a mean of 1480.65 grams (SD = 501.59). The mean birth weight was 1576.45 ± 518.17 grams for boys and 1363. 56 ± 459.42 grams for girls, with a significant difference observed between the groups (P = 0.034). At discharge, weights improved to between 1120 and 3100 grams, averaging 1746.35 grams (SD = 335.94). The mean discharge weight was significantly higher for boys (1811.45 grams) than for girls (1666.78 grams, P = 0.025). Gestational ages at birth spanned from 23 to 36 weeks, with a mean of 30.84 weeks (SD = 2.97). The gestational age was 31.20 ± 2.97 weeks for boys and 30.40 ± 2.94 weeks for girls, with no statistically significant difference (P = 0.182). These findings highlight the variability in health outcomes and characteristics among preterm infants during the post-NICU period. Pearson correlation analysis revealed significant inverse relationships between the length of hospital stay and birth weight (r = -0.728, P < 0.001), discharge weight (r = -0.245, P = 0.014), and gestational age (r = -0.758, P < 0.001). Additionally, there were significant positive correlations between birth weight and discharge weight (r = 0.659, P < 0.001), birth weight and gestational age (r = 0.827, p < 0.001), and discharge weight and gestational age (r = 0.449, P < 0.001) (Table 2).

Furthermore, developmental assessments using the Ages and Stages Questionnaire (ASQ) showed varying trends across the five domains (communication, gross motor, fine motor, problem-solving, and personal-social) at 4, 8, and 12 months of age. The communication domain scores increased from 4 to 8 months but decreased from 8 to 12 months, with a significant difference between the 8 and 12-month scores (P = 0.021). Fine motor skills showed an increase from 4 to 8 months (p < 0.001) and a decrease from 8 to 12 months (P < 0.001), with the 12-month scores being significantly higher than the 4-month scores (P = 0.039).

**Table 1.** Descriptive Statistics of Variables for Infants in This Study

| Variable | Mean | Standard Deviation | Minimum | Maximum |
|---|---|---|---|---|
| Length of Stay (days) | 83.35 | 60.28 | 4 | 128 |
| Birth Weight (grams) | 1480.65 | 501.59 | 600 | 2600 |
| Discharge Weight (grams) | 1746.35 | 335.94 | 1120 | 3100 |
| Gestational Age (weeks) | 30.84 | 2.97 | 23 | 36 |

**Table 2.** Pearson Correlation Coefficients Between Variables

| | Length of Stay | Birth Weight | Discharge Weight | Gestational Age |
|---|---|---|---|---|
| Length of Stay | 1 | -0.728** | -0.245* | -0.758** |
| Birth Weight | | 1 | 0.659** | 0.827** |
| Discharge Weight | | | 1 | 0.449** |
| Gestational Age | | | | 1 |

*: P < 0.05 **: P < 0.01

The problem-solving domain increased from 4 to 8 months and decreased from 8 to 12 months. Personal-social skills showed a decreasing trend from 4 to 12 months, with a significant difference between the 4 and 12-month scores (P = 0.012) (Table 3). Comparison with standardized ASQ cut-off scores (1 and 2 standard deviations below the mean) for Iranian children revealed that at 8 months, the cut-off scores for all five domains in our study were lower than the standardized scores (Table 4). Based on the one standard deviation cut-off, 31% of infants at 4 months, 31% at 8 months, and 28% at 12 months were identified as having developmental delays. Using the two standard deviation cut-offs, these percentages were 16%, 14%, and 13%, respectively (Table 5). Out of the 100 infants, 78 (78%) showed normal development across all three time points and all domains, while 22 (22%) experienced delays in at least one assessment period. Among those with delays, nine infants had delays in one assessment period, 5 in two periods, and 8 in all three periods (Table 6). Infants with delays at 8 and 12 months had significantly extended hospital stays and lower gestational ages than those with customary development (P < 0.05). While

**Table 3.** Descriptive Statistics of ASQ Domain Scores at 4, 8, and 12 Months

| Domain | Age (Months) | Minimum | Maximum | Mean | Standard Deviation |
|---|---|---|---|---|---|
| Communication | 4 | 15 | 60 | 50.30 | 12.04 |
| | 8 | 10 | 60 | 50.95 | 12.59 |
| | 12 | 0 | 60 | 48.60 | 14.25 |
| Gross Motor | 4 | 20 | 60 | 51.25 | 11.42 |
| | 8 | 5 | 60 | 49.55 | 13.35 |
| | 12 | 0 | 60 | 49.00 | 15.11 |
| Fine Motor | 4 | 10 | 60 | 49.00 | 12.37 |
| | 8 | 0 | 60 | 54.15 | 12.67 |
| | 12 | 0 | 60 | 51.40 | 13.20 |
| Problem-Solving | 4 | 0 | 60 | 53.19 | 10.14 |
| | 8 | 0 | 60 | 53.65 | 13.02 |
| | 12 | 0 | 60 | 51.95 | 14.21 |
| Personal-Social | 4 | 15 | 60 | 52.02 | 10.55 |
| | 8 | 0 | 60 | 50.30 | 14.37 |
| | 12 | 0 | 60 | 48.60 | 15.65 |

**Table 4.** Number (Percentage) of Infants with Scores Below Standardized ASQ Cut-offs

| Domain | Age (Months) | Below 2 SD n (%) | Below 1 SD n (%) | Normal n (%) |
|---|---|---|---|---|
| Communication | 4 | 6 (6) | 10 (10) | 84 (84) |
| | 8 | 8 (8) | 7 (7) | 85 (85) |
| | 12 | 8 (8) | 4 (4) | 88 (88) |
| Gross Motor | 4 | 7 (7) | 6 (6) | 87 (87) |
| | 8 | 7 (7) | 9 (9) | 84 (84) |
| | 12 | 6 (6) | 12 (12) | 82 (82) |
| Fine Motor | 4 | 3 (3) | 13 (13) | 84 (84) |
| | 8 | 11 (11) | 4 (4) | 85 (85) |
| | 12 | 9 (9) | 3 (3) | 88 (88) |
| Problem-Solving | 4 | 5 (5) | 10 (10) | 85 (85) |
| | 8 | 9 (9) | 3 (3) | 88 (88) |
| | 12 | 9 (9) | 4 (4) | 87 (87) |
| Personal-Social | 4 | 4 (4) | 8 (8) | 88 (88) |
| | 8 | 9 (9) | 12 (12) | 79 (79) |
| | 12 | 8 (8) | 8 (8) | 84 (84) |

**Table 5.** Number (Percentage) of Infants with Developmental Status

| Developmental Status | 4 Months n (%) | 8 Months n (%) | 12 Months n (%) |
|---|---|---|---|
| Normal | 84 (84) | 86 (86) | 87 (87) |
| Mild Delay | 9 (9) | 3 (3) | 4 (4) |
| Moderate Delay | 5 (5) | 1 (1) | 2 (2) |
| Severe Delay | 2 (2) | 10 (10) | 7 (7) |
| Total | 100 (100) | 100 (100) | 100 (100) |

**Table 6.** Comparison of Mean Variables by Developmental Status at 8 and 12 Months ($P < 0.05$)

| Variable | Age (Months) | Developmental Status | N | Mean | Standard Deviation | Sig. |
|---|---|---|---|---|---|---|
| Length of Stay | 8 | Delay | 14 | 59.14 | 38.54 | 0.005 |
| | | Normal | 86 | 32.03 | 24.94 | |
| | 12 | Delay | 13 | 55.77 | 33.71 | 0.008 |
| | | Normal | 87 | 32.85 | 26.73 | |
| Birth Weight | 8 | Delay | 14 | 1262.86 | 447.49 | 0.071 |
| | | Normal | 86 | 1516.10 | 503.31 | |
| | 12 | Delay | 13 | 1259.23 | 468.05 | 0.081 |
| | | Normal | 87 | 1513.74 | 500.54 | |
| Gestational Age | 8 | Delay | 14 | 29.14 | 2.68 | 0.018 |
| | | Normal | 86 | 31.12 | 2.94 | |
| | 12 | Delay | 13 | 29.15 | 2.64 | 0.023 |
| | | Normal | 87 | 31.09 | 2.95 | |

birth weight tended to be lower in infants with delays, this difference was not statistically significant. At 4 months, delays were most frequent in gross motor skills (6 infants), followed by communication (1 infant), problem-solving (2 infants), and combinations of domains (7 infants). The patterns of delays and their persistence across the three assessment periods were tracked for each infant. Some infants had transient delays, while others had persistent delays in one or more domains. (Table 5).

## Discussion

Maintaining normal development is the ultimate goal for all personnel involved in the care of preterm infants.9 Prematurity and hospitalization in the NICU can predispose infants to various morbidities, including brain injury, bleeding, and multiple organ dysfunction, potentially leading to significant long-term complications, particularly developmental delays.10 Therefore, having a method to assess the developmental status of these infants is crucial for early detection and timely intervention. The ASQ is a widely used tool for this purpose. This study investigated the developmental status of 100 preterm infants admitted to the Shahid Sadoughi Hospital NICU in Yazd, Iran, using the ASQ. Parents completed the ASQ for their infants at corrected ages 4, 8, and 12 months. The results indicated that 16% of infants experienced delays in at least one developmental domain at 4 months, 14% at 8 months, and 13% at 12 months. Notably, 0% of infants had delays in all domains at 4 months, 3% at 8 months, and 4% at 12 months. At 4 months, 9% of infants had mild, 5% moderate, and 2% severe delays. At 8 months, 3% had mild delays, 1% had moderate delays, and 10% had severe delays. At 12 months, the corresponding figures were 4%, 2%, and 7%, respectively. A study by Kazerooni et al., which evaluated 80 children at 4, 6, and 12 months using the ASQ, found that most infants were in the 4-month age range (54%), with a mean birth weight of 1734.38 grams and a mean gestational age of 32.5 weeks. That study reported that 7.5% of infants had developmental delays in all domains, and approximately 62.5% were developing typically.

Furthermore, 12.5% had delays in four domains, 5% in three, and 0% in two domains.

In the present study, the mean length of stay in the NICU was 35.83 ± 26.43 days, and the mean gestational age was 30.84 ± 2.97 weeks. These means were significantly different between infants with and without developmental delays at 8 and 12 months. The mean birth weight was 1480.65 grams. In contrast, Kazerooni et al. found no statistically significant association between gestational age and developmental outcomes, possibly due to the higher mean gestational age in their sample.5 Fernandes et al.8, in a study of 134 two-year-old children with a mean birth weight of 1677 grams and a mean hospital stay of 51 days, reported that 66.5% had normal development and 8.2% had significant impairments, with developmental outcomes significantly associated with length of stay and gestational age. In our study, while the mean birth weight of infants without developmental delays at 12 months was higher than that of infants with delays (1513.74 grams vs. 1259.23 grams), this difference was not statistically significant (p = 0.081). A similar non-significant trend was observed at 8 months (1516.10 grams vs. 1262.86 grams, p=0.071). However, an important finding was that while there was no significant association between birth weight and specific domains of development, it was observed that higher birth weight was associated with more appropriate scores in the communication domain.

Furthermore, developmental trends differed across the domains, with communication, gross motor, problem-solving, and personal-social skills scores generally decreasing from 4 to 12 months, while fine motor skills scores improved over the same period. In a study by Fallah et al.11 which followed 50 preterm infants aged 6 to 12 months admitted to the same NICU in Yazd, lower birth weight was associated with lower scores in gross motor skills and social interaction at 6 and 12 months. Furthermore, the study by Doreh et al.4 on 62 preterm infants (mean gestational age 26.9 weeks) showed a significant association between gestational age and motor development, which aligns with the significant difference in mean gestational age observed in our study between infants with and without developmental delays at 8 and 12 months. Comparison of ASQ cut-off scores (using two standard deviations below the mean) between our sample and standardized Iranian data revealed that at 4 months, our sample had lower cut-off scores only in the communication domain, while at 8 and 12 months, our sample had consistently lower cut-off scores across all domains, with differences of approximately nine units in fine motor, problem-solving, and personal-social domains at 8 months, and 9-10 units in fine motor and problem-solving domains at 12 months. A study by Zhu et al.12 in rural China found a higher prevalence of developmental delays in moderately to severely preterm infants (31.3%) compared to term infants (21.3%), supporting the increased risk of delays in preterm infants. Similarly, a study by Varghese et al.13 in Singapore highlighted the high ability ASQ-3 in screening gross and fine motor skills at 6 and 12 months. The follow-up of infants at the corrected ages of 4, 8, and 12 months emphasizes the necessity of continuous developmental monitoring of preterm infants discharged from the NICU, as they require continuous developmental assessment in the first year of life for early detection of developmental delays and timely interventions.

## Conclusion

This study highlights the importance of early developmental screening in preterm infants, particularly in the first year of life. More prolonged hospital stays and lower gestational ages are associated with an increased risk of developmental delays. Despite normal development in most preterm infants with a history of NICU admission, a significant number experience developmental delays, highlighting the need for early assessment to prevent future complications. Therefore, these infants should undergo continuous developmental appraisal in the first year of life for early detection of developmental delays

and timely interventions. This will ensure that early identification of potential developmental delays leads to prompt intervention and optimized long-term outcomes.

## Conflict of Interest

The authors declare no conflicts of interest.

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## Ethical Considerations

The present study was approved by the Shahid Sadoughi University Ethics Committee (IR.SSU.SPH.REC.1397.165).

## Author's Contribution

Conceptualization, A.D., S.G.; methodology, A.D. and Z.GH.; formal analysis, A.D.; investigation, A.D., S.G.; original draft preparation, A.D.; review and editing, Z.GH., H.M.; supervision, A.D. All authors have read and agreed to the published version of the manuscript.

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