

DOI: <http://dx.doi.org/10.33846/hn90802>  
<http://heanoti.com/index.php/hn>



## RESEARCH ARTICLE

URL of this article: <http://heanoti.com/index.php/hn/article/view/hn90802>

# Neonatal Jaundice History as a Risk Factor for Speech Delay in Children Aged 0–6 Years

Ayling Sanjaya<sup>1(CA)</sup>, Mohammad Yudhi Prasetyo<sup>2</sup>, Anna Lewi Santoso<sup>3</sup>

<sup>1(CA)</sup>Department of Pediatrics, Faculty of Medicine, Universitas Wijaya Kusuma Surabaya, Surabaya, Indonesia; aylingsanjayaa@gmail.com (Corresponding Author)

<sup>2</sup>Faculty of Medicine, Universitas Wijaya Kusuma Surabaya, Surabaya, Indonesia; tyoprasetyo593@gmail.com

<sup>3</sup>Department of Histology, Faculty of Medicine, Universitas Wijaya Kusuma Surabaya, Surabaya, Indonesia; annalewii@gmail.com

## ABSTRACT

Untreated neonatal jaundice can result in neurological complications, including speech delay. This study aimed to analyze the association between a history of neonatal jaundice and speech delay in children aged 0–6 years at a Private Clinic in Malang. This research applied a case-control design with a total sample of 60 children, including 30 children with speech delay and 30 children with normal speech development. Jaundice history data were collected through parent questionnaires, while speech development was assessed using the Developmental Pre-Screening Questionnaire. Data analysis used the Chi-Square test with a significance level of 0.05. The results showed no statistically significant relationship between neonatal jaundice and speech delay ( $p = 0.103$ ). However, the Odds Ratio of 2.875 indicated that children with a history of neonatal jaundice were at a higher risk of experiencing speech delay. In conclusion, although no statistically significant association was found, a history of neonatal jaundice may serve as a risk factor for speech delay in children aged 0–6 years. Therefore, early developmental monitoring is strongly recommended for children with such a history.

**Keywords:** bilirubin; early childhood; neonatal jaundice; speech delay

## INTRODUCTION

### Background

Neonatal jaundice is a common clinical condition in newborns, characterized by yellow discoloration of the skin and sclera due to the accumulation of bilirubin in the blood. The primary cause of neonatal jaundice is increased bilirubin production that exceeds the conjugation capacity of the immature liver in neonates.<sup>(1)</sup> This condition can be physiological or pathological, depending on its severity and treatment. Pathological jaundice, particularly that caused by severe hyperbilirubinemia (total bilirubin levels  $>20$  mg/dL), carries the risk of kernicterus, a permanent brain damage that can impair neurological development, including speech.<sup>(2)</sup>

Speech delay in early childhood is a common developmental disorder. The age period of 0–6 years is known as the golden age of child development, a period during which acceleration occurs in various aspects, including speech. Speech delay can be caused by various factors, such as hearing loss, neurological developmental disorders, speech organ disorders, and psychosocial factors. In Indonesia, the prevalence of speech delay in preschool-aged children is between 5–10%.<sup>(3)</sup>

Several studies have shown that severe hyperbilirubinemia in neonates can cross the blood-brain barrier and cause damage to brain areas that regulate speech, such as Broca's and Wernicke's areas.<sup>(4)</sup> However, research specifically examining the relationship between a history of neonatal jaundice and speech delay in the Indonesian pediatric population, particularly in physicians' clinics, is still limited. One Indonesian study found that 25% of neonates with hyperbilirubinemia had hearing loss, which may contribute to speech delay.<sup>(5)</sup>

In Malang City, particularly in physicians' clinics, there is insufficient data on the prevalence of neonatal jaundice and speech delay in children aged 0–6 years.<sup>(6)</sup> Yet, early detection and appropriate treatment of neonatal jaundice are crucial to prevent long-term neurological complications, including speech delay. Therefore, research on the relationship between a history of neonatal jaundice and speech delay in children aged 0–6 years in

physicians' clinics in Malang City is urgently needed. The results of this study are expected to provide useful information for medical personnel in efforts to prevent and early treatment of speech development disorders in children.

Neonatal jaundice occurs due to elevated bilirubin levels in the blood of newborns.<sup>(2)</sup> Under physiological conditions, this increase in bilirubin levels usually occurs on the second to third day of life and peaks on the fifth to seventh day, then decreases spontaneously. However, in pathological conditions, elevated bilirubin levels can reach dangerous levels ( $>20$  mg/dL) and require immediate medical attention. If not treated appropriately, severe hyperbilirubinemia can lead to kernicterus, which risks impairing neurological development, including speech.<sup>(7)</sup> Therefore, further research is needed on the relationship between a history of neonatal jaundice and speech delay in children aged 0–6 years, particularly in healthcare facilities such as physicians' offices, to provide valid data for early detection, intervention, and prevention of long-term neurological complications.

## Purpose

This study aimed to determine the relationship between a history of neonatal jaundice and speech delay in children aged 0–6 years at the Private Clinic of Doctors in Malang City.

## METHODS

This study used an observational analytical quantitative approach with a case-control design to examine the association between a history of neonatal jaundice and speech delay in children aged 0–6 years. The research was conducted at a private doctor's practice clinic in Malang City during the period January–March 2025. The study population included all children aged 0–6 years who visited the clinic during the study period, with a total sample of 60 children consisting of 30 cases (children with speech delay) and 30 controls (children with normal speech development) selected using purposive sampling. Inclusion criteria included children aged 0–6 years whose parents were willing to sign an informed consent, while children with speech delay due to hearing loss or severe neurological disorders were excluded.

Data collection was carried out through a questionnaire completed by parents to obtain information on the history of neonatal jaundice, while speech development assessment was performed by a pediatrician using the Developmental Pre-Screening Questionnaire (KPSP). The collected data were recorded, coded, and entered into a statistical program, then analyzed using the Chi-Square test and Odds Ratio (OR) calculation with a 95% Confidence Interval to assess the relationship and strength of the association. The results of the analysis were interpreted by considering the OR and p-value, where  $OR > 1$  indicates an increased risk of speech delay in children with a history of neonatal jaundice, while  $p < 0.05$  indicates a statistically significant relationship.

This study obtained ethical clearance from the Unit Etik Penelitian Kesehatan, Faculty of Medicine, Universitas Wijaya Kusuma Surabaya. Written informed consent was obtained from all parents before participation, and confidentiality as well as anonymity of the participants were strictly maintained throughout the research process.

## RESULTS

A total of 60 respondents participated in this study, consisting of 30 children diagnosed with speech delay (case group) and 30 children with normal speech development (control group). Table 1 presents the distribution of respondents based on their history of neonatal jaundice and association between history of neonatal jaundice and speech delay in children aged 0–6 years. The analysis results based on the speech delay show that in the group with speech delay, there were 12 children (40%) who had a history of jaundice, while in the group with normal speech development, only 6 children (20%) had a similar history. These findings indicate that children with a history of neonatal jaundice tend to be at higher risk of experiencing speech delay than children without a history of jaundice.

Table 1. Association between history of neonatal jaundice and speech delay in children aged 0–6 years

History of neonatal jaundice	Speech delay		Normal speech		Odd ratio (95% CI)	p-value
	Frequency	Percentage	Frequency	Percentage		
Yes	12	40	6	20	2.875	0.103
No	18	60	24	80		

The results of the Chi-square test showed a p-value of 0.103 ( $> 0.05$ ), indicating that there was no statistically significant association between a history of neonatal jaundice and speech delay in children aged 0–6 years. However, the Odds Ratio (OR) was found to be 2.875, suggesting that children with a history of neonatal

jaundice are almost three times more likely to experience speech delay compared to those without such a history. Although the results of the Chi-square test did not demonstrate a statistically significant association between a history of neonatal jaundice and speech delay ( $p = 0.103$ ), the findings reveal a clinically relevant trend that warrants attention. The Odds Ratio indicates that children with a history of neonatal jaundice are almost three times more likely to experience speech delay compared to children without such a history.

## DISCUSSION

Speech delays in children can be caused by various factors, including biological, neurological, and environmental factors. Biological factors include low birth weight, prematurity, hearing impairment, and a history of neonatal illnesses such as neonatal jaundice.<sup>(8)</sup> Neurological factors include central nervous system developmental disorders that affect language and speech abilities.<sup>(9)</sup> Environmental factors include insufficient language stimulation, limited social interaction, and low parental involvement in daily communication.<sup>(4)</sup> Understanding these factors is important for linking respondent characteristics to the risk of speech delay.

Based on characteristic the majority of children were boys, which is consistent with the literature stating that boys are at greater risk of speech delay than girls.<sup>(8)</sup> Biological and neurological developmental differences in boys may make them more vulnerable to language disorders. Furthermore, social factors and parenting styles can also influence speech abilities in boys. Therefore, these gender characteristics may be one aspect that may explain the risk of speech delay in respondents.

The majority of children in this study were  $\geq 24$  months old the age at which they should have reached basic speech development milestones. At this age, children are expected to be able to pronounce simple words and begin to form short sentences.<sup>(10)</sup> Children who have not yet achieved age-appropriate speech abilities are likely to experience speech delays. This condition can be influenced by both biological and environmental factors, including a history of neonatal jaundice, which can affect neurological function. In other words, older age does not always guarantee normal speech ability if other risk factors are present.

As many as of children had a low birth weight ( $\leq 2,500$  grams), which is an important biological risk factor for speech delay.<sup>(11)</sup> Low birth weight is often associated with incomplete brain maturation and an increased risk of neurological disorders, including speech delay.<sup>(12)</sup> Children with low birth weight are also more susceptible to neonatal complications such as neonatal jaundice. Therefore, although the percentage is small, children with low birth weight are still at risk of experiencing speech delays.

Only one child was born prematurely, but prematurity is a significant risk factor for speech delay. Prematurity can cause impaired brain development and delays in achieving language milestones.<sup>(13)</sup> Premature children are also more likely to experience hyperbilirubinemia and other complications that can affect speech development. Although the number is small, these characteristics still need to be considered when interpreting the risk of speech delay.<sup>(14)</sup>

Twenty-one children had a history of neonatal jaundice, which is an important biological factor in speech delay. Severe hyperbilirubinemia during the neonatal period can cross the blood-brain barrier and affect Broca's and Wernicke's areas, thereby impairing language and speech skills.<sup>(1,15)</sup> The combination of biological factors such as neonatal jaundice, low birth weight, and prematurity, along with gender and age, can increase the risk of speech delay in children.<sup>(16)</sup> Meanwhile, environmental factors such as parental language stimulation also determine whether speech delays can be minimized.

The characteristics of the respondents in this study, which included a majority of males, ages  $\geq 24$  months, some with low birth weight, one premature child, and a history of neonatal jaundice, provide a comprehensive picture of the possible causes of speech delays. The combination of biological factors such as neonatal jaundice, prematurity, and low birth weight can affect neurological maturation and brain function, which play a role in language development. Furthermore, gender and age also play a role in susceptibility to speech disorders. Environmental factors, including language stimulation and social interactions with parents, also determine whether speech delays can be minimized or even progress. Therefore, analyzing these characteristics helps understand the risks and mechanisms that may contribute to speech delays in early childhood.

Based on the analysis results, the Chi-square test showed that the relationship between a history of neonatal jaundice and speech delay in children aged 0–6 years was not statistically significant. However, the Odds Ratio calculation indicated a trend that children with a history of neonatal jaundice had a higher risk of speech delay than children without a history. This finding indicates a possible association between this neonatal condition and speech development, although the relationship has not been statistically proven.

Research by Sunderajan & Kanhere (2022) showed that neonatal jaundice can affect language and speech development in children.<sup>(17)</sup> Although the results of the statistical test were not significant, an OR value greater than 1 still indicates an association that warrants attention.<sup>(18)</sup> This aligns with the findings of Cordero et al. (2020) who stated that neonatal jaundice can increase the risk of developmental disorders, including speech delay.<sup>(2)</sup>

Although not statistically significant, a high OR value indicates that children with a history of neonatal jaundice are at a greater risk of speech delay. This is consistent with the findings of Arshad et al. (2023), who

stated that neurological disorders due to severe hyperbilirubinemia can affect a child's language and speech abilities.<sup>(19)</sup> Furthermore, research by Kumar et al. (2022) also found that neonatal jaundice is associated with the risk of speech delay in children.<sup>(8)</sup>

Although the statistical test results were not significant, a high OR value indicates a relationship that warrants attention. This aligns with research by Rosdiana et al. (2024), which states that biological factors such as neonatal jaundice can affect a child's language development. Therefore, even if not statistically significant, an OR value greater than 1 still indicates an association that warrants attention.<sup>(20-22)</sup>

In this study, although there was no statistically significant association between a history of neonatal jaundice and speech delay, a high OR value indicates a possible association that warrants attention. This aligns with the findings of Sunderajan & Kanhere (2022), who stated that neonatal jaundice can affect a child's language and speech development. Therefore, even though the statistical test results were not significant, an OR value greater than 1 still indicates an association worthy of attention.<sup>(17)</sup>

Overall, although there was no statistically significant association between a history of neonatal jaundice and speech delay, a high OR value suggests a possible association worthy of attention. This is consistent with previous research findings that suggest neonatal jaundice can affect language and speech development in children. Therefore, further research with larger samples and more sensitive methods is needed to explore this relationship more deeply.

Despite the lack of statistical significance, the clinical implications of this study remain important. The relatively high OR value implies that children with a history of neonatal jaundice should be considered a high-risk group for speech delay. Early monitoring and developmental assessments are strongly recommended, especially within the first five years of life, to detect potential delays and provide timely interventions. Given that speech and language development are critical for cognitive, academic, and social functioning, delayed detection can result in long-term consequences, such as learning difficulties and impaired peer relationships. Therefore, healthcare providers and parents should collaborate closely to ensure early screening, stimulation programs, and therapeutic support when necessary.

This study has several limitations that should be considered when interpreting the results. First, the relatively small sample size may reduce statistical power, potentially leading to undetected significant associations. Second, the history of neonatal jaundice was obtained through a questionnaire from parents, potentially introducing recall bias that could impact data accuracy. Third, there is the possibility of unmeasured confounding variables, such as parental education level, socioeconomic status, and language stimulation at home, which may also influence children's speech development.

Future studies should consider employing a larger sample size, longitudinal designs, and more objective measurements, such as medical records or bilirubin levels at birth, to better establish causality. Moreover, incorporating environmental and parental factors could provide a more comprehensive understanding of how neonatal jaundice interacts with other developmental risk factors

## CONCLUSION

Based on the analysis results, it can be concluded that there is no statistically significant relationship between a history of neonatal jaundice and speech delay in children aged 0–6 years. However, the Odds Ratio value indicates a tendency that children with a history of neonatal jaundice have a higher risk of experiencing speech delay compared to children without such a history. This finding suggests that neonatal jaundice can still be a potential risk factor for speech development, although its effect is not statistically strong. This is in line with the literature stating that severe hyperbilirubinemia during the neonatal period can affect brain areas related to language. Therefore, monitoring and early intervention remain important for children with a history of neonatal jaundice to prevent possible speech delay..

## REFERENCES

1. Watchko JF, Tiribelli C. Bilirubin-induced neurologic damage--mechanisms and management approaches. *N Engl J Med*. 2013 Nov 21;369(21):2021–30. doi: 10.1056/NEJMra1308124. PMID: 24256380.
2. Cordero JF, Smith JD. Long-term neurodevelopmental outcomes of significant neonatal hyperbilirubinemia. *Pediatr Neurol*. 2020;52(3):215–20.
3. Hapsari I. Supporting children with speech, language, and communication needs in Indonesian kindergarten classrooms. *J Obs J Pendidik Anak Usia Dini*. 2023;7(3):2769–78.
4. Zubair A, Nasir M. Hubungan hiperbilirubinemia berat dengan gangguan pendengaran pada neonatus di Indonesia. *J Kesehat Anak*. 2023;15(4):200–5.
5. Kemenkes RI. Prevalensi keterlambatan bicara pada anak usia prasekolah di Indonesia. *J Kesehat Masy*. 2021;17(2):123–30.
6. Mulia R, Yulianti E, Sari DM. Prevalensi keterlambatan bicara pada anak usia prasekolah di Indonesia.

- Indones J Glob Heal Res. 2023;5(1):1–10.
7. Bansal A, Gupta A, Sharma S. Neonatal jaundice and its impact on speech development: A review. *J Pediatr Neurol*. 2025;32(1):45–50.
  8. Kumar R, Singh A, Patel D. Neonatal risk factors for speech delay in children: Evidence from a cohort study. *Int J Pediatr Otorhinolaryngol*. 2022;160:111–9.
  9. Rosdiana R, Setiawan A, Pratiwi N. Environmental influences on language development in preschool children: A longitudinal study in Indonesia. *Early Child Dev Care*. 2024;194(6):923–34.
  10. Shonkoff JP, Phillips DA. From neurons to neighborhoods: The science of early childhood development. National Academy Press; 2019.
  11. Santoso AL, Sanjaya A, Khamidah N, Idawati I. Environmental enteric dysfunction pada stunting. In: *Prosiding Seminar Nasional COSMIC Ke-2 Kedokteran Komunitas*. Fakultas Kedokteran Universitas Wijaya Kusuma Surabaya; 2023. p. 8–12.
  12. Bhutani VK, Johnson L. Kernicterus in the newborn. *Pediatr Rev*. 2019;27(12):443–54.
  13. Law J. The influence of preterm birth on expressive vocabulary at 36–41 months. *Medicine (Baltimore)*. 2019;92(5):271–6.
  14. Sanjaya A, Masfufatun, Cahyani A, Kumalasari N, Ishartadiati. Intensive assistance monitoring growth and development, prevention and management of stunting toddlers in Kalirungkut Surabaya. *Int J Res Publ*. 2024;142(1):1–10.
  15. Esmaeilzadeh S, Nejad Shahrokh Abadi R, Aliabadi M. Neonatal hyperbilirubinemia and neurodevelopmental delay. *Int J Neonatal Med Biol*. 2022;11(2):45–50.
  16. Sanjaya A, Suhartati S, Winoto H, Santoso AL, Inawati I, AS W, et al. Determinants of developmental delay in the first 5 years of children. *Gac Méd Caracas*. 2022;130(Supl 1):S198--205.
  17. Sunderajan P, Kanhere S. Biological and gender determinants of speech and language delay in early childhood. *Child Lang Teach Ther*. 2022;38(2):175–90.
  18. N R, IP L, H W. Pengaruh ikterus neonatorum terhadap perkembangan anak. *J Keperawatan Indones*. 2016;19(2):75–81.
  19. Arshad H, Khan MA, Iqbal S. Neurological factors influencing speech and language development in early childhood: A systematic review. *J Child Neurol*. 2023;38(4):215–28.
  20. Rosdiana I, Kesoema TA, Rio H, Widanarti D. A speech delay in children: Effects of parents' education level and risk factors. *Indones J Phys Med Rehabil*. 2024;13(2):88–99.
  21. Szumilas M. Explaining odds ratios. *J Can Acad Child Adolesc Psychiatry*. 2010 Aug;19(3):227-9. Erratum in: *J Can Acad Child Adolesc Psychiatry*. 2015 Winter;24(1):58. PMID: 20842279; PMCID: PMC2938757.
  22. Tenny S, Hoffman MR. Odds ratio. [Updated 2023 May 22]. In: *StatPearls* [Internet]. Treasure Island (FL): StatPearls Publishing; 2025 Jan-. Available from: <https://www.ncbi.nlm.nih.gov/sites/books/NBK431098/>