RESEARCH PAPER

Impact of Socioeconomic Status on Neuro developmental Delay in Neonates with Jaundice and the Benefits of Early Intervention Therapy.

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Abstract

Purpose: Socioeconomic status (SES) plays a key role in a family's access to healthcare, with lower SES groups often facing significant barriers, including limited neonatal care and caregiver awareness. Jaundice left untreated can lead to neurodevelopmental delays and other health complications. This study explores the impact of SES on neurodevelopmental delays in newborns with neonatal jaundice and the effectiveness of early intervention therapy in improving outcomes.

Methodology: A total of 103 newborns diagnosed with neonatal jaundice were assessed for neurodevelopmental delays at 90 days using the Developmental Screening Test (DST). SES was determined using the Modified Kuppuswamy Scale (2023). Positive cases underwent early intervention therapy for 9 months, with evaluations conducted at the end of the therapy period.

Results: Among the 103 cases, 24(23.30%) exhibited neurodevelopmental delays. SES distribution was as follows: upper class 16((15.53%), upper middle class19 (18.45%), lower middle class 43(41.75%), upper lower class 20(19.42%), and lower class 5 (4.85%). At the 9-month evaluation, 15(62.50%) cases showed no improvement, 6 (25.00%) improved, and 3(12.50%) showed mild improvement.

Conclusion: Low SES is a significant factor in the prevalence of neurodevelopmental delay in children with neonatal jaundice, especially in cases with bilirubin levels exceeding 15 mg/dL. Early intervention therapy is crucial for preventing or minimizing neurodevelopmental delays in affected newborns.

Keywords: developmental screening test, early intervention, modified kuppuswamy, scale neonatal jaundice, socioeconomic status

How to cite this article: Koonuru MK, Elumalai K, Reddy CV, Arungeethan A, James S, Venugopal SP. Impact of Socioeconomic Status on Neuro developmental Delay in Neonates with Jaundice and the Benefits of Early Intervention Therapy. Int J Drug Deliv Technol. 2026;16(33s):382-387. DOI: 10.25258/ijddt.16.33s.45

1.Introduction

Socioeconomic inequalities exert profound and long-lasting effects across the life course. They are associated with a heightened risk of chronic diseases and reduced life expectancy, often driven by factors such as poor nutrition, unstable housing, financial stress, and limited access to healthcare services [1-4]. Indicators of low socioeconomic status (SES) including lower educational attainment, unemployment, and low household income-have also been strongly linked to adverse pregnancy outcomes that negatively affect both maternal and neonatal health [5].

Previous research has shown that lower SES contributes to developmental delays, largely due to limited awareness, reduced access to essential services and resources, insufficient parental support, and fewer opportunities for social interaction. In contrast, families with higher SES benefit from greater access to health, educational, and developmental resources, while those with lower SES face structural barriers that increase the risk of developmental challenges [6].

In India, SES-related disparities are particularly pronounced due to the wide rural-urban divide. Rural communities generally experience lower educational levels, limited healthcare access, greater reliance on traditional practices, and reduced awareness of modern medical care. Awareness about neonatal health and the availability of early intervention services remain especially poor among low-SES groups, and accessibility is often minimal.

Neonatal hyperbilirubinemia is one of the most common clinical conditions in India, affecting nearly 55% of newborns. The reported incidence of neonatal jaundice ranges from 54.6% to 77% in various studies [7]

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Elevated bilirubin levels, when left untreated, can lead to bilirubin-induced neurological dysfunction, including kernicterus, hearing impairment, cognitive delay, and delayed social development.

Over recent decades, SES has emerged as a critical factor in child health in India. Government initiatives such as the National Rural Health Mission aim to bridge gaps in healthcare access among disadvantaged populations. Numerous studies affirm that SES is a key predictor of child developmental outcomes. Existing literature highlights several SES-linked barriers, including limited healthcare access for early screening, low caregiver awareness about jaundice warning signs, high rates of home births without skilled attendants, inadequate newborn monitoring during the first week of life, maternal malnutrition, and poor breastfeeding practices all more prevalent among low-SES families [8].

Child development encompasses the acquisition of age-appropriate skills across physical, cognitive, language, social, and emotional domains, ultimately contributing to functional and behavioural maturity. Low SES can influence neurodevelopment through multiple pathways: reduced early stimulation, undiagnosed health issues (such as hearing deficits or developmental disorders), and restricted access to timely medical care. Missed opportunities for early screening and intervention further contribute to suboptimal developmental outcomes [9,10].

Although existing literature has explored the independent relationships between neonatal jaundice and neurodevelopmental delay, SES and child development, and SES and health outcomes, there is a lack of research addressing the combined interaction among socioeconomic status, neonatal jaundice, and neurodevelopmental delay. Evidence specifically focusing on these relationships in newborns is limited. Therefore, the present study aims to examine the impact of SES on neurodevelopmental delay in neonates with jaundice and bilirubin levels exceeding 15 mg/dL, and to evaluate the effectiveness of early interventional therapy in improving developmental outcomes.

2.Materials And Methods

The study was conducted on 103 full-term newborn infants. Infants were enrolled after obtaining return informed parental consent all the data was collected using a structure proforma including gestational age, birth weight, sex, mode of delivery, age at presentation, serum bilirubin levels and treatment details. The data was collected from the Hospital and treated at child development center, The study includes all infants with hyperbilirubinemia and treated for neonatal jaundice. Infants with congenital anomalies, meningitis, sepsis, intra cerebral haemorrhage, asphyxia, hypoglycaemia, cholestasis, epilepsy, malnutrition, hypothyroidism, and Down syndrome were excluded from the study. As these conditions were considered as interfering factors and result in the negative development of the infant, were removed from the research study..

Neonatal jaundice was managed by phototherapy double surface/triple surface/antibiotics and blood exchange transfusion according to the guidelines published by the American Academy of Pediatrics subcommittee [11] in all cases.

The socioeconomic status of the family was assessed using the modified Kuppuswamy scale, [12] which considers income, education, and occupation (Table *1*). In parallel, data on the duration of hospital stay, treatment protocols, and breastfeeding practices were also recorded. Weekly follow-up was recommended and consistently conducted.

As these conditions were considered as interfering factors and result in the negative development of the infant, were removed from the research study.

Education of Head of family	Score	Occupation of head of family	Score	Total per capita family income per month (as given originally in 1976)	Score	**Socioeconomic class**	**Total score**
Professional degree	7	Professional	10	> 20,482	12	Upper class	26-29
Graduate	6	Semi profession	6	10,241 - 20481	10	Upper middle	16-25
Intermediate/diploma	5	Clerical/shop/farm	5	7681 - 10.240	6	Lower middle	11-15
High school	4	Skilled worker	4	5120 - 7680	4	Upper lower	5-10
Middle school	3	Semiskilled worker	3	3072 -5119	3	Lower	Below 5
Primary school	2	Unskilled worker	2	1034 - 3071	2		
Illiterate	1	Unemployed	1	<1033	1		

Table 1: Modified Kuppuswamy Socioeconomic Status Scale, 2023 (Consumer price index - 132.8, February)

On completion of 90 days of post-natal age 103 infants were evaluated for neurodevelopmental delay by the standard Development screening test scale was used for assessment it was developed by Barath raj,s in

the year of 1983, [13] to measures child development between 0 to 15 yrs The test developed to identify the Motor, social - personal and speech - language development of child. This assessment was done in five domains: motor, hearing, speech sounds, social smile and vision. Infants having problem with any of the one domain or more than one is considered as positive for neurodevelopmental delay.

Early intervention refers to specialized supports and services for infants and young children (typically ages 0-3) who have developmental delays, disabilities, or are at risk. Its goal is to build a strong foundation for lifelong health and independence by addressing needs in physical, cognitive, communication, self-help, and social-emotional development through therapy, education, and family-centered support. [14] Early interventional therapy was given to positive children from 91 days to 270 days (9 months). The therapy included motor postural control, sensory stimulation and early language stimulation. The treatment

protocol was designed specifically for each child depending on the requirement of the child. The therapy was advised at child health care center and at home.**"The study procedures were carried out in compliance with the guidelines and regulations established by the National Institute for the Empowerment of Persons with Intellectual Disabilities, India."**

2.1Treatment Protocol:

At the Early Intervention Centre - children were treated for postural control, facilitating Head control, sensory stimulation (Tactile, Auditory, Visual) and early language stimulation.

At home instruction were given to follow the massage daily before bath (slow and feather), use Jula for supine and prone position to improve vestibular function, light and sound toys (avoiding red color), mother has to use big Bindi on her face, talk to the baby minimum 10 minutes for every 3 hours, maintain contact and swaddle the baby, slow motor moments and allow child to turning, carrying with proper position, enteral nutrition, breast milk expression if mother suffered with maternal sleep disturbance at night, encourage social smile by talking to child.

The collected data was subjected to statistical analysis to assess the overall distribution of cases. Out of 103 cases evaluated, the percentage of positive cases was specifically calculated. Out of these 103 cases, the identified positive cases represent a specific proportion of the total sample. The percentage of positive cases was determined to quantify the prevalence of the condition, providing a clear statistical insight into the distribution of outcomes within the sample population. This percentage calculation serves as a key indicator of the occurrence rate of positive cases in relation to the total number of cases studied.

Consent to participate:

Informed consent for participation, treatment, and open-access publication was obtained from all participants or their legal guardians,

Consent for publication

Consent for publication was obtained from all participants or their legal guardians, where applicable.

3.Results

Out of the total 103 cases, 56 (54.36%) were male and 47 (45.64%) were female. Of these, 24 cases (23.30%) exhibited signs of neurodevelopmental delay in one or more domains, while 79 infants (76.79%) showed complete normal development. In all 24 cases with neurodevelopmental delay, bilirubin levels were higher than 15 mg/dL. Among the neurodevelopment delayed cases, 54.17% (n=13) were male and 45.83% (n=11) were female. (Table:2)

Total cases	Male	Female
103	56(54.36%)	47(45.64%)
NDD -24(23.3%)	13(54.17%)	11(45.83%)

Table2 : Demographic characteristics of Neuro Developmental Disorder patients"

SES of the families of 103 infants based on Kuppuswamy's modified scale indicate 16 (15.53%) families belonged to upper class, 19 (18.45%) to upper middle class, 43 (41.75%) to lower middle class, 20 (19.42%) to upper lower class and 5 (4.85%) to lower class (Figure *1*).

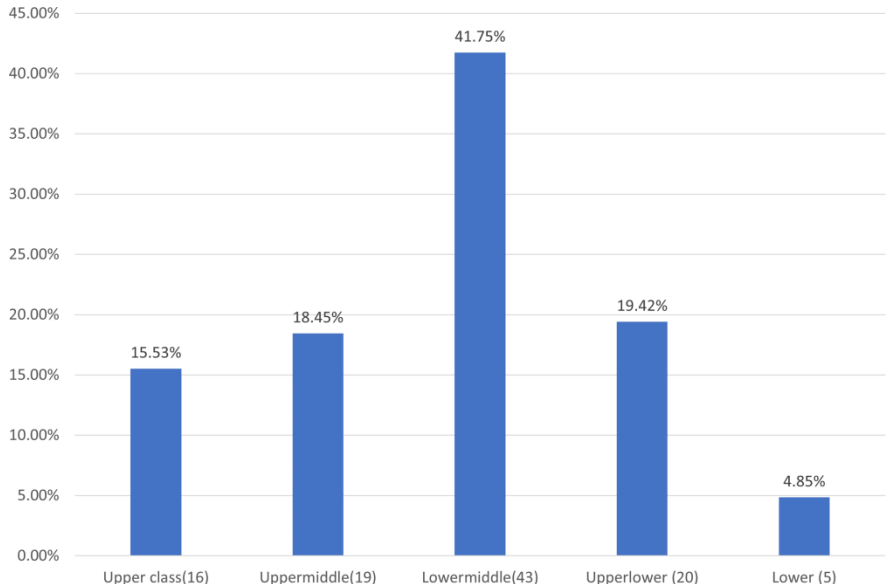

FIGURE 1: Showing the distribution of families to different Socio-economic status based on Kuppuswamy's modified scale

Out of 24 positive cases 20 (83.33%) cases belonged to lower and lower middle SES, 2 (8.33%) cases belonged to upper middle class while 2 (8.33%) cases to upper class. Early intervention therapy was provided to the 24 children with positive findings, starting from 91 days to 9 months of age. Upon evaluation at 9 months, 6 cases showed complete improvement, 3 cases showed mild improvement, and and 15 cases exhibited no improvement (Table 3).

	Positive at 3rd month	Post treatment improvement at 9th month		
		Improved	Mild improvement	No improvement
Upper class	2(8.3%)	0	0	2(8.3%)
Upper middle	2(8.3%)	1 (4.1%)	0	1(4.1%)
Lower middle	12(50%)	2 (8.3%)	3 (12.5%)	7(29.1%)
Upper lower	7(29.1%)	2 (8.3%)	0	5(20.8%)
Lower	1(4.1%)	1 (4.1%)	0	0
Total	24	6 (25%)	3 (12.5%)	15(62.5%)

Table 3:Distribution of positive cases across different Socio-economic status and effect of early intervention therapy at the end of 9th month.

3.1 Discussion

The relationship between the neonatal jaundice with bilirubin levels higher than 15 mg/DL and neurodevelopmental delay is established. The results of the present study indicate a relationship between the SES and neurodevelopmental delay in the neonatal jaundice children. Further, the present study reveals that the lower and lower middle SES have more impact on the interrelationship between neonatal jaundice and neurodevelopmental delay. The growth and development of brain is very rapid in early 3 years of life. During this period opportunities for the brain to grow, develop and achieve optimal development are high, hence the brain becomes susceptible to environmental factors. Previous studies suggest that socioeconomic status (SES) plays a crucial role in predicting neurocognitive performance, especially in areas such as language and executive function. Furthermore, SES-related differences are found in neural processing, even when performance levels are comparable [15] The association of lower and lower middle SES with neurodevelopmental delay in newborn children established in the present study correlates with the earlier studies, which states that preschool children from low socioeconomic backgrounds were found to have a significantly higher risk of adverse neurodevelopmental outcomes, particularly in cognitive and language domains. These disparities became evident in early childhood and tended to widen as they aged [16]. Research has shown that children from lower socioeconomic backgrounds often exhibit atypical patterns in neural processing and cognitive performance [17,18]. This highlights that the effects of socioeconomic status extend beyond social standing and access to healthcare and education, influencing brain function, cognitive abilities, and overall educational outcomes [19]. Another study has developed a comprehensive framework that clarifies the complex relationships between child poverty, delayed neural development, compromised language and educational outcomes, and negative mental health effects. This framework emphasizes the critical role of broad-ranging

consequences of socioeconomic status on early childhood brain development, [20].

Studies have shown the detrimental effects of low socioeconomic status (SES) on brain structure. Using fetal MRI, research has revealed that 1-month-old infants from low SES families have smaller volumes of grey matter [21,22]. Lower SES is also linked to decreased cognitive performance and structural brain changes, including reduced cortical surface area, grey matter volume, and a shrinkage of key brain regions such as the amygdala and hippocampus [23,24].

This study demonstrates a clear relationship between socioeconomic status (SES) and neurodevelopmental delays in children affected by neonatal jaundice, a finding that is consistent with the existing literature.

Further, this study reveals that early interventional therapy to the positive neurodevelopmental delay children from the age of 91 days resulted in improvement in their condition in 40% cases belonged to lower and lower middle SES. This is encouraging an indicative that early interventional therapy if started early can probably prevent or improve the neurodevelopmental delay caused due to neonatal jaundice and SES.

Limitation of the present study are a small sample size which was limit generalizability the use of single center approach which may not reflect broader population dynamics.

4.Conclusions

This study demonstrates a clear link between socioeconomic status and developmental delay, emphasizing the critical role of early intervention therapy in mitigating or preventing such delays. Notably, our approach involved initiating therapy at an earlier stage than most previous studies, offering a unique perspective. We recommend making early intervention therapy mandatory for children with neonatal jaundice and bilirubin levels exceeding 15 mg/dL, especially those from low socioeconomic backgrounds. This research serves as a foundation for future studies aimed at refining therapeutic strategies for this issue.

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