ORIGINAL RESEARCH ARTICLE

Neurodevelopmental Status of Children Born During COVID-19 Pandemic in Belagavi City: A Cross-Sectional Study

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DOI: 10.55489/njcm.160520254860

ABSTRACT

Background: The implementation of containment measures during the COVID-19 pandemic significantly reduced outdoor activities for children. Previous research has suggested that these restrictions negatively affected children's psychological well-being and heightened the risk of developmental delays. The study aims to assess the neurodevelopmental status of children born during the COVID-19 pandemic in Belagavi city, using the Bayley Scales of Infant and Toddler Development (BSID IV).

Method: This cross-sectional study enrolled 48 participants from pre-schools in Belagavi city between August 2023 and January 2024. BSID IV was used to assess neurodevelopment across various domains. Central tendency measures were calculated for demographic data. Independent sample t-tests and one-way ANOVA were employed to compare categorical and continuous demographic characteristics of the study participants, mothers, fathers, and families with BSID IV scores.

Result: The neurodevelopmental status of the participants revealed the following mean scores: Cognitive domain (115.1±10.7), Language domain (101.9±10.5), Fine motor domain (102.9±10.3), Communication domain (93.1±8.6), Socio-emotional domain (103.0±11.6), Socialization (100.2±8.1), Daily living skills (97.08±6.98), and Adaptive behavior (95.6±7.6).

Conclusion: The neurodevelopmental status of children born during the COVID-19 pandemic in Belagavi city shows variations across domains. Cognitive development is within the average range, but language development is somewhat lower, with communication skills particularly affected.

Key-words: Child development, COVID 19, Social isolation, Pre Schoolers, Motor skills, cognitive development

ARTICLE INFO

Financial Support: This study was supported by KLE Academy of Higher Education and Research (29092319).

Conflict of Interest: The authors have declared that no conflict of interests exists.

Received: 14-11-2024, **Accepted**: 14-04-2025, **Published**: 01-05-2025

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How to cite this article: Kalgutkar P, Deshpande V. Neurodevelopmental Status of Children Born During COVID-19 Pandemic in Belagavi City: A Cross-Sectional Study. Natl J Community Med 2025;16(5):501-506.
DOI: 10.55489/njcm.160520254860

www.njcmindia.com | pISSN: 0976-3325 | eISSN: 2229-6816 | Published by Medsci Publications

INTRODUCTION

A global pandemic has profound and immediate effects, particularly on the developmental trajectories of young children. The COVID-19 pandemic led to prolonged indoor confinement, depriving children of essential social and physical activities such as playing in parks, attending in-person classes, and participating in neighborhood sports.[1] Studies have shown that this isolation significantly impacted infants' neurodevelopment. Huang et al. found that socially isolated infants, especially firstborns, exhibited developmental delays.[2] At the same time, Deoni et al. reported lower verbal, nonverbal, and overall cognitive scores in infants born during the pandemic, regardless of birth order.[3] Furthermore, maternal exposure to viral infections during pregnancy has been linked to potential neurological growth issues in infants.[4] Both studies found that pandemic-related factors were linked to a higher probability of delays in the physical and linguistic areas of development.[2,3] These findings suggest that COVID-19 had a significant and potentially long-lasting impact on children's development. While existing research covers countries such as China, Spain, Chile, Colombia, and the U.S., there is a lack of evidence from this region. To bridge this gap, the present study aims to assess the neurodevelopmental status of children born during the COVID-19 pandemic in this part of the country using the Bayley Scales of Infant and Toddler Development (BSID IV).

METHODOLOGY

A cross-sectional study was conducted in Belagavi city, Karnataka, India between August 2023 to January 2024. Approval for the study was obtained from KAHER Institute of Physiotherapy(KIPT/896/10-08-2023), Belagavi, Karnataka and Clinical Trial Registration was done (CTRI/2023/10/058762). Participants recruited if Children born between March 2020 to May 2021 (age 24-42 months), had gestational age >37 weeks and birth weight >2.5 Kgs in both genders and parents who were willing to provide consent for voluntary participation of their child. While, Children diagnosed with any hearing or visual impairments, none of the children or their mothers were reported positive with COVID-19, No neurological trauma in the infant, diagnosed with neurological disorder like epilepsy, autism, brain tumors, cerebral palsy were excluded.

A sample size of 48 was obtained using the formula $n = (Z_{1-\alpha/2})^2 p(1-p)/d^2$, where, Significance Level (5%), Anticipated neuro development status (15%) and Precision (10%).

Participants were recruited from pre-schools in Belagavi city using two stage cluster sampling. In the 1st stage Preschools were divided into 5 clusters (North, South, East, West and Central regions), within each chosen cluster, randomly 2 preschools were selected and then in 2nd stage five children were randomly selected from each school based on the inclusion and exclusion criteria.

The Bayley Scales of Infant and Toddler Development (BSID IV) was used as an outcome measure to assess neurodevelopment of the children. BSID IV is a detailed formal developmental assessment instrument designed to identify developmental deficits in young children up to age three years. It evaluates Cognitive, Motor, language and socioemotional domains of development. The scale has reliability of (r = 0.81- 0.85) for the cognitive, language and motor, while (r = 0.72-0.87) for socioemotional domain.

For each age participant, a single trained physical therapist did the assessments with a window period of ±2 weeks. A clearly demarcated area in the Institute was modified child-friendly with minimum distractions and all assessments were conducted in this arena. All the evaluation were reviewed by the supervising physical therapist (who has an experience of more than 10 years) for quality control purposes.

All BSID-IV forms were double-checked for errors including administrative, coding and calculation errors. Statistical analysis was performed using SPSS Version 26. Measure of Central Tendency was used for the demographic data, independent sample “t” test and One way ANOVA test were used for comparing the categorical and continuous demographic characteristics of the study participants, parent and family with BSID IV scores. The results were considered when the p value was <0.05.

RESULTS

The table 1 presents a detailed breakdown of various child characteristics among a sample population, highlighting gender distribution, type of delivery, body mass index (BMI) interpretation, place of play school, and birth order.

Table 1: Child characteristics among a sample population (n=48)

Child characteristics	No of children (%)
Gender	
Male	23 (47.92)
Female	25 (52.02)
BMI Interpretation	
Under weight	11 (22.92)
Normal	34 (70.83)
Over Weight	3 (6.25)
Birth order	
First	21 (43.75)
Second	25 (52.08)
Third	2 (4.17)
Type of delivery	
Caesarean section	14 (29.17)
Normal Delivery	34 (70.83)
Place of Play School	
Kindergarten	22 (45.83)
Anganwadi	23 (47.92)
Montessori	3 (6.25)

Table 2: Demographic Characteristics of Parents

Parental characteristics	Mother (%)	Father (%)
Age in years (Mean ± SD)	**32.21 ± 4.33**	35.29 ± 3.57
<=30years	18 (37.50)	5(10.42)
31-35years	17(35.42)	19(39.58)
36-40 years	13(27.08)	21(43.75)
>=41years	0	3(6.25)
Education		
Middle School	5(10.42)	
High School	13(27.08)	11(22.92)
Diploma	17(35.42)	17(35.42)
Professional degree	13(27.08)	20(41.67)
Occupation		
Unemployed	19(39.58)	
Clerical worker	10(20.83)	11(22.92)
Skilled worker	-	4(8.33)
Semi Professional	9(18.75)	11(22.92)
Professional	10(20.83)	22(45.83)

%: Percentage,

Table 3: Demographic Characteristics of Families

Family Characteristics	Participants (%)
No of adults living together	
Two	20(41.67)
Three	18(37.50)
Four	6(12.50)
Five	4(8.33)
Monthly family income (Rs)	
29,973-49,961	14(29.17)
49,962-74,755	2(4.17)
49,962-74,755	20(41.67)
74,755-99,930	12(25)
No of children living together	
One	20(41.67)
Two	25(52.08)
Three	3(6.25)
Socio Economic status (Kuppu swamy scale 2019)	
Upper middle	35(72.92)
Lower middle	12(25)
Upper lower	1(2.08)

Rs: Indian Rupees

Table 2 and 3 presents a detailed overview of the demographic characteristics of parents and their families, highlighting various factors such as age, education, occupation, family income, and the number of children living together.

Table 4 presents the results of the BSID IV, focusing on various subtest domains in a sample population. Each subtest is accompanied by its mean standard score and standard deviation, as well as the distribution of participants categorized into two groups: those scoring within the normal range (standard score <85) and those identified as having a delay (standard score >85).

The data indicates a predominance of normal developmental scores across cognitive (115.10 ± 10.74) with all participants scoring within the normal range, with no individuals exhibiting cognitive delays. The mean scores for motor were 102.92 (SD = 10.32) and social-emotional 103.02 (SD = 11.66), with 93.75% of participants in the normal range and 6.25% exhibiting delays, respectively, in each domain. The language subtest yielded a mean score of 101.92 (SD = 10.56), where 97.92% of participants scored within the normal range, while a small fraction (2.08%) was classified as having a delay. For the adaptive behaviour scale subtest, the communication subtest revealed a mean score of 93.13 (SD = 8.60), where 91.67% of participants were classified as normal, while 8.33% were identified with delays. In the daily living skills subtest, the mean score was 97.08 (SD = 6.98), with all participants scoring within the normal range. The socialization subtest had a mean score of 100.27 (SD = 8.12), with 95.83% of participants in the normal range and 4.17% showing delays. Lastly, the adaptive behavior subtest reported a mean score of 95.63 (SD = 7.60), with 93.75% of participants scoring normally and 6.25% classified as having delays. This suggests that the majority of the assessed population is developing within expected parameters, although attention may be warranted for those few individuals who scored below the normative thresholds.

The results of other variable analyses conducted other than the pre-specified are presented here. The independent sample t-test was used to compare the mean of two independent groups and determined whether there was a significant difference between them or not. A comparative analysis of the nutritional status of children categorized as underweight versus those with normal weight, as assessed through various subtests of the BSID IV showed that most subtests did not reveal significant differences between underweight and normal-weight children.

Table 4: BSID IV and Adaptive Behaviour Scale subtests standard scores and distribution of participants as normal or delayed development

BSID 4 Subtest	Standard Scores (Mean± SD)	NORMAL (when BSID IV Standard score is <85) (%)	DELAY (when BSID IV Standard score is >85) (%)
Cognitive	115.10 ± 10.74	48(100)	0(0)
Language	101.92 ± 10.56	47(97.92)	1(2.08)
Motor	102.92 ± 10.32	45(93.75)	3(6.25)
Social Emotional	103.02 ± 11.66	45(93.75)	3(6.25)
Adaptive behaviour Scale			
Communication	93.13 ± 8.60	44(91.67)	4(8.33)
Daily living skills	97.08 ± 6.98	48(100)	0(0)
Socialization	100.27 ± 8.12	46(95.83)	2(4.17)
Adaptive Behaviour	95.63 ± 7.60	45(93.75)	3(6.25)

SD: standard deviation, n=Sample in the study, %: Percentage

In contrast, the motor skills subtest showed a significant difference, with underweight children scoring a mean of 97(SD = 12.65) compared to 104.85 (SD = 9.26) for normal-weight children. The t-value of -2.2304 and a p-value of 0.0310 indicate that this difference is statistically significant ($p < 0.05$), suggesting that underweight children may experience notable challenges in motor skill development. For the developmental parameters between children attending Kindergarten (105.32 ± 9.00) and those enrolled in Anganwadi (97.96 ± 11.18) programs. The analysis reveals that only language skills (t= 2.42 and a p = 0.02) demonstrated a statistically significant advantage for children in kindergarten, highlighting that the kindergarten program may be more effective in fostering language development. The remaining parameters did not show significant differences. Most parameters show no significant differences across educational attainment, as evaluated by the ANOVA test. However, the social-emotional skills parameter stands out as having a statistically significant variance with the middle school group scoring the lowest (95.38 ± 12.49) and the diploma group scoring the highest (107.65 ± 7.10). The F-value of 3.22 and a p-value of 0.03, suggesting that educational background may play a crucial role in this aspect of development. A noteworthy finding emerges in the social-emotional parameter with different occupational categories where semi-professionals (107.27 ± 7.20) and professionals (105.00 ± 11.13) outperform clerical workers (90.00 ± 21.98). The F-value of 3.0384 and a p-value of 0.0389 suggest that the differences in social-emotional skills are statistically significant, highlighting a potential area of disparity among the occupational groups. While, the measures did not exhibit meaningful variation.

Discussion

The present study provides a comprehensive analysis of cognitive, motor, language, social-emotional, and adaptive behavior development in 2-3-year-old children using BSID-IV. The results indicate that the majority of children demonstrate developmental scores within the normal range across all domains, with a small percentage exhibiting delay. These findings are largely consistent with existing literature, though they also highlight key areas for intervention and further research.

Cognitive Development: The cognitive domain exhibited a mean score within the normal range. This suggests a generally positive trend in early cognitive development among the sampled children. However, studies indicate that cognitive delays are prevalent in certain populations and may manifest over time. For example, research in rural Western China found that 41% of children experienced cognitive deterioration before age three.[5] This underscores the importance of continuous monitoring and early intervention to ensure sustained cognitive progress.

Motor and Social-Emotional Development: The study found that the average motor and social-emotional scores were within the typical range, with most participants developing normally and a small percentage showing delays. This aligns with research indicating that while most children develop typically, motor and social-emotional delays can be significant in at-risk populations.[6] Studies report that developmental delays in these domains range from 20% to 61% in children under three years.[7] The presence of delays in a minority of children highlights the necessity for effective screening using tools such as the Rapid Neurodevelopmental Assessment and the Ages and Stages Questionnaire.[8,9]

Language Development: The language subtest showed an average score within the typical range, with the vast majority of participants developing normally and a small fraction experiencing delays. While this percentage is lower than the estimated 15% of two-year-olds experiencing expressive vocabulary delays[10], it still underscores the need for vigilance in identifying at-risk children. Language delays can significantly impact later academic and social development.[11] Early screening tools such as the MacArthur-Bates Communicative Development Inventories have been recommended to ensure timely intervention.[12]

Adaptive Behavior and Daily Living Skills: Adaptive behavior assessments indicated that communication skills were generally within the expected range, though a small percentage of participants showed delays. These findings align with research demonstrating that adaptive behavior deficits are often observed in children with neurodevelopmental disorders, such as Autism Spectrum Disorder (ASD).[13] The daily living skills subtest showed an average score within the typical range, with all participants demonstrating expected development. However, while the overall sample performed well, research suggests that environmental and socioeconomic factors can influence daily living skills, necessitating individualized support.[14]

Nutritional Status and Motor Development: A significant finding of this study was the impact of nutritional status on motor skill development. Underweight children demonstrated significantly lower motor skill scores compared to their normal-weight peers, with the difference being statistically significant. Malnutrition and stunting are known to impair motor development, with research showing that 38.7% of stunted children exhibit delayed motor skills.[15] This finding reinforces the importance of nutritional interventions in early childhood to prevent motor delays.

Educational Environment and Language Skills: Children attending kindergarten exhibited stronger language skills compared to those in Anganwadi programs, with the difference being statistically significant. Structured educational settings with trained teachers have been shown to enhance language ac-

quisition through storytelling and interactive learning.[16] These findings support the need for improvements in early childhood education programs, particularly in Anganwadi centers.

Social-Emotional Development and Parental Education: Social-emotional skills differed significantly based on parental education, with children of middle school-educated parents scoring the lowest and those of diploma-educated parents scoring the highest. Higher parental education levels are associated with enriched home environments that promote emotional regulation and social skills.[17] These findings suggest that parental education initiatives could play a crucial role in supporting social-emotional development.

Socioeconomic Disparities in Social-Emotional Skills: Social-emotional skills varied significantly across occupational groups, with children of semi-professionals and professionals scoring higher than those of clerical workers. Socioeconomic factors play a critical role in child development, as research indicates that children from higher socioeconomic backgrounds demonstrate stronger social-emotional competencies.[18] Gender disparities have also been noted, with boys from higher socioeconomic statuses showing increasing gaps in social-emotional development.[19] These findings highlight the need for targeted interventions to support disadvantaged populations.

This study has several strengths. First, it is a funded project, ensuring that financial constraints were not a limiting factor in conducting assessments and data collection. Second, participant assessments were conducted using the BSID-IV, the latest version of the Bayley Scales, which is considered a gold standard outcome measure for assessing child development. Third, to the best of the authors' knowledge, no prior studies have been conducted on this topic for this specific age group in this part of the country, making this research a valuable contribution to the field. Lastly, previous research has often excluded adaptive behavior and the socio-emotional scale, whereas the present study has included these crucial domains, providing a more comprehensive understanding of early childhood development.

Despite its strengths, this study has certain limitations. It was conducted exclusively in Belagavi City, which limits the generalizability of the findings to broader populations. Additionally, while BSID-IV is a widely used and validated tool for developmental assessment, it does not provide normative values specific to the Indian population, which may influence the interpretation of results.

Conclusion

The findings of this study underscore the overall positive developmental outcomes in 2-3-year-old children while also identifying key areas where early intervention is necessary. The observed disparities based on nutritional status, educational environment, parental education, and socioeconomic background emphasize the multifaceted nature of child development. Future research should explore longitudinal outcomes and the effectiveness of targeted interventions to enhance developmental trajectories in at-risk children. Ensuring equitable access to quality early childhood education, nutritional support, and parental guidance programs will be essential in promoting optimal developmental outcomes for all children.

Acknowledgement: We are thankful to the participants of the study.

Individual Authors' Contributions: PK and VD Contributed to the conception and design of the study, PK contributed to the collection of data, interpretation of the data and drafting the manuscript. VD contributed in supervision of data analysis and critically reviewed the manuscript for important intellectual content. Both the authors read and approved the final manuscript.

No use of generative AI tools: This article was prepared without the use of generative AI tools for content creation, analysis, or data generation. All findings and interpretations are based solely on the authors' independent work and expertise.

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