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LONG-TERM IMPACT OF PEDIATRIC DENGUE ON COGNITIVE FUNCTION IN CHILDREN AGED 10–15 YEARS: A PROSPECTIVE COHORT STUDY

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Abstract

Background: Dengue fever is a significant public health issue in many tropical countries, causing acute illness with recognized neurological complications in severe cases. However, subtle long-term cognitive impacts in children post-dengue infection remain under-investigated. This study aimed to evaluate the longitudinal effects of dengue infection on cognitive functions, including memory, attention, and executive function, in children aged 10 to 15 years.

Methods: In this prospective cohort study conducted at Saveetha Medical College and Hospital, Chennai, India, 34 children who had recovered from dengue infection and 34 age- and sex-matched healthy controls were assessed at 6 and 12 months post-infection. Cognitive domains were assessed using standardized neuropsychological tests, and scores were compared between groups over time.

Results: At both 6 and 12 months, children with prior dengue infection demonstrated significantly lower scores in memory, attention, and executive function compared to controls ($p < 0.001$ for all domains and both time points). Although some improvement was observed at 12 months, deficits remained significant, indicating persistent cognitive impairment.

Conclusion: Pediatric dengue infection is associated with long-lasting deficits in key cognitive domains, which may adversely affect academic performance and psychosocial development. Awareness and longitudinal monitoring of neurocognitive outcomes should be integrated with pediatric dengue care. Further research is essential to elucidate underlying mechanisms and develop rehabilitative strategies.

INTRODUCTION

Dengue fever is one of the most prevalent mosquito-borne viral illnesses in the tropics and subtropics, affecting millions each year and posing a major public health challenge in countries like India[1]. It is caused by the dengue virus and transmitted primarily via *Aedes* mosquitoes, with clinical presentations ranging from mild febrile illness to severe, life-threatening forms such as dengue hemorrhagic fever and dengue shock syndrome[1]. Over the past decade, improvements in acute care have led to better clinical outcomes in pediatric dengue cases. However, the focus has traditionally centered on short-term survival and immediate complications, resulting in under-recognition of long-term sequelae, particularly in the cognitive and neurological domains[1][2].

While acute neurological complications such as encephalopathy, encephalitis, and neuromuscular involvement are well-documented [10–13], the long-term neurocognitive sequelae—particularly in children—are less well characterized.

Dengue is classified among neurotropic viruses, capable of crossing the blood-brain barrier and eliciting neuroinflammation, which can disrupt neurodevelopment and neural circuit integrity in children[2]. This risk is particularly worrisome for the pediatric population, as the developing brain is uniquely vulnerable to inflammatory insults. During childhood and adolescence, key cognitive domains such as attention, memory, and executive functioning are undergoing rapid maturation, and disruptions in these processes can have lasting repercussions on academic achievement, behavior, and psychosocial well-being.

Recent longitudinal research has begun to highlight the potential for persistent cognitive deficits months after dengue infection in children. For instance, deficits observed in attention, memory, and executive functions can undermine school performance, adaptive functioning, and quality of life[3]. Yet, these subtle dysfunctions may be easily missed without formal neuropsychological evaluation, since affected children may not exhibit overt neurological symptoms during the acute illness.

Assessment of pediatric cognitive outcomes must, therefore, utilize robust and sensitive tools. Instruments such as the Conners' Continuous Performance Test (CPT 3) for attention and the Behavior Rating Inventory of Executive Function (BRIEF-2) are validated for this purpose and allow a granular understanding of neurocognitive trajectories following infection.

Recognizing these gaps, this study aims to longitudinally evaluate cognitive functioning—specifically memory, attention, and executive skills—in children aged 10–15 years following recovery from dengue fever, compared to matched healthy controls. By doing so, we seek to elucidate the often-overlooked long-term impact of dengue on neurodevelopment and inform the need for post-recovery cognitive surveillance and intervention in endemic regions.

MATERIALS AND METHODS

Study Design and Setting

This investigation was conducted as a prospective cohort study over a period of 18 months at the Department of Pediatrics, Saveetha Medical College and Hospital, Chennai, India. The longitudinal nature of the study enabled the observation of cognitive changes in children following dengue infection, with repeated assessments at two critical time points.

Study Population and Participant Selection

A total of 68 children were enrolled, comprised of two equal groups:

Dengue Group: 34 children aged 10–15 years who had recovered from laboratory-confirmed dengue fever infection.

Control Group: 34 healthy children matched for age and sex, with no history of dengue infection, neurodevelopmental disorder, chronic systemic illness, or significant head injury.

Participants were recruited from hospital records and community pediatric outpatient services. Exclusion criteria were rigorously applied to avoid confounding variables, specifically excluding any child with a diagnosis of neurodevelopmental disorder (such as ADHD, learning disability, or autism), pre-existing chronic systemic disease (including epilepsy, diabetes, or rheumatological disorders), or history of clinically significant head trauma.

Informed Consent and Ethical Approval

Prior to enrollment, informed written consent was obtained from the parent or legal guardian of each participant, and assent was obtained from children as appropriate for age and comprehension. The study protocol received approval from the Institutional Ethics Committee of Saveetha Medical College and Hospital, in accordance with the Declaration of Helsinki and local regulatory guidelines.

Study Objectives

Primary Objective: To assess and compare cognitive function—including memory, attention, and executive function—between children with prior dengue infection and healthy controls at 6 and 12 months post-infection.

Secondary Objective: To explore any correlation between the clinical severity of dengue infection and the degree or pattern of cognitive impairment observed over time.

Cognitive Assessment Protocol

Cognitive evaluation was performed by experienced pediatric psychologists who were blinded to group assignment. Standardized and validated neuropsychological instruments appropriate for Indian children were used:

Memory: Assessed via age-appropriate pediatric memory scales, capturing both immediate and delayed recall abilities.

Attention: Measured using the Conners' Continuous Performance Test 3rd Edition (CPT 3), a computerized test assessing sustained and selective attention through reaction time, omission errors, and commission errors.

Executive Function: Evaluated using the Behavior Rating Inventory of Executive Function, Second Edition (BRIEF-2), which includes parent ratings and direct child assessments for skills such as working memory, planning, cognitive flexibility, and inhibitory control.

Each domain was scored according to test guidelines. Assessments were performed at two pre-specified intervals:

6 months post-infection (first follow-up)

12 months post-infection (second follow-up)

Data Collection and Management

Demographic and clinical data, including dengue infection severity (classified according to WHO guidelines), hospital stay duration, and treatment details, were recorded for each dengue-exposed participant. All test results were entered into a secure database, de-identified to maintain confidentiality.

Statistical Analysis

Statistical analyses were performed using SPSS version 25.0 or equivalent statistical software. Continuous variables (cognitive domain scores) were presented as mean ± SD. Group comparisons at each time point were conducted using independent sample t-tests. Paired t-tests assessed changes within the same group over time. Categorical variables were analyzed with chi-square tests as appropriate. A p-value less than 0.05 (two-tailed) was interpreted as statistically significant.

RESULTS

Demographics

Both groups were balanced for age and sex, minimizing bias.

Cognitive Outcomes at 6 Months

At the 6-month follow-up, children in the dengue-exposed group exhibited significantly lower cognitive function scores across all domains—memory, attention, and executive function—compared to controls.

The mean scores and statistical comparisons are summarized in Table 1.

Cognitive Function	Dengue Group (Mean ± SD)	Control Group (Mean ± SD)	p-value	Interpretation
Memory	85.4 ± 5.2	95.2 ± 4.8	<0.001	Memory performance was substantially diminished in dengue-exposed children.
Attention	82.3 ± 6.1	94.5 ± 5.5	<0.001	Attention deficits were notable among the dengue group compared to controls.
Executive Function	78.9 ± 5.3	91.6 ± 5.4	<0.001	Executive function was significantly impaired post-dengue infection.

The results reflect that six months after acute dengue illness, affected children have marked impairments in critical neurocognitive domains that govern learning, concentration, and higher-order cognitive control.

Cognitive Outcomes at 12 Months

At the 12-month assessment, modest improvements in scores were observed in the dengue-exposed group relative to their 6-month performance (Table 2). However, cognitive deficits relative to the healthy controls persisted, with all domains remaining significantly lower.

Cognitive Function	Dengue Group (Mean ± SD)	Control Group (Mean ± SD)	p-value	Interpretation
Memory	88.1 ± 4.9	96.0 ± 5.1	<0.001	Partial recovery in memory noted, but performance remained inferior to controls.
Attention	86.7 ± 5.9	95.8 ± 5.2	<0.001	Attention scores improved somewhat yet remained significantly impaired compared to controls.
Executive Function	82.0 ± 5.1	93.0 ± 5.3	<0.001	Executive function deficits persisted, indicating ongoing neurocognitive vulnerability.

Though the improvements indicate some degree of neuroplastic recovery, the sustained statistically significant differences emphasize the lasting impact of dengue infection on cognitive development, especially in executive function which governs planning, problem-solving, and self-regulation.

Cognitive Scores Comparison

Figure 1: Memory Score Comparison

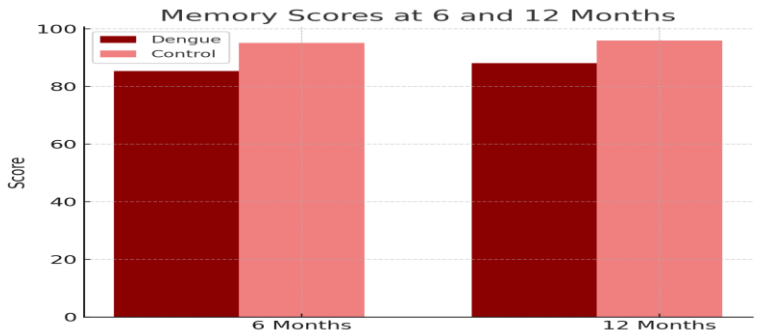


Figure 2: Attention Score Comparison

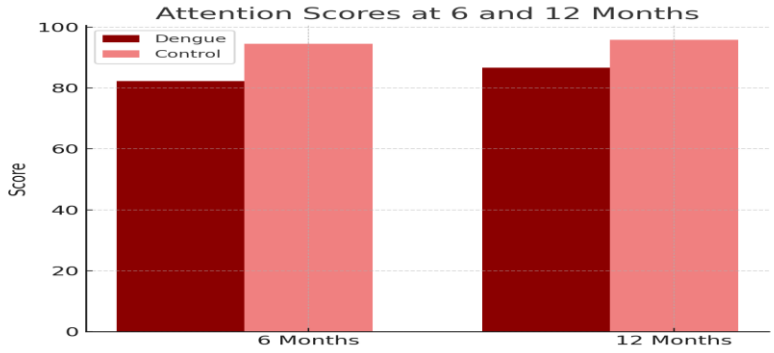
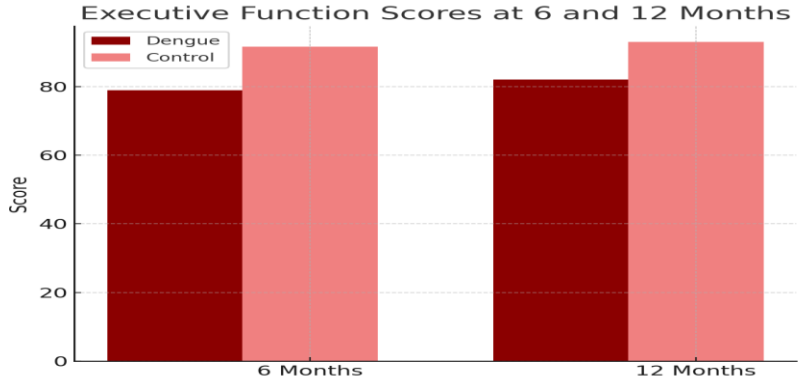


Figure 3: Executive Function Score Comparison



Comparison of Cognitive Domains Over Time

The longitudinal trajectory indicates that while memory and attention show relative improvement over time, executive functioning recovers more slowly or incompletely within the first year post-infection. This pattern is clinically relevant as poorer executive function may adversely influence everyday adaptive behavior and academic achievement even after memory and attention deficits start to resolve.

Statistical Significance and Clinical Implications

All comparisons between dengue and control groups at both time points yielded highly significant p-values (<0.001), underscoring the robustness and consistency of findings across multiple cognitive domains. The data suggest the need

for targeted neurocognitive monitoring and intervention strategies following pediatric dengue infection to mitigate long-term educational and psychosocial consequences.

DISCUSSION

This prospective cohort study demonstrates that children aged 10–15 years who have recovered from dengue infection exhibit significant and persistent impairments in key cognitive domains—memory, attention, and executive function—when compared to healthy matched controls. These neurocognitive deficits were evident at both 6 and 12 months post-infection, although some partial improvement was noted at 12 months, cognition in the dengue group remained significantly inferior to that of controls.

The findings align with growing evidence suggesting that dengue virus has neurotropic potential and can cause both acute and chronic neurological sequelae[1][2]. Prior clinical reports have documented severe neurologic manifestations such as encephalopathy and seizures during acute dengue illness[1], but this study highlights more subtle, long-term cognitive impairments that are less overt yet potentially impactful. The virus's ability to cross the blood-brain barrier, coupled with immune-mediated neuroinflammation, may disrupt neuronal signaling and synaptic plasticity essential for cognitive development, particularly during critical childhood and adolescent periods[1][3].

The pediatric brain's heightened plasticity renders it both resilient and vulnerable. Cognitive domains such as memory, attention, and executive functions—the latter encompassing skills vital for planning, problem-solving, and self-regulation—involve areas of the brain that undergo rapid maturation during adolescence[2]. Disruption in these areas due to infectious insults may lead to deficits persisting well beyond the acute illness[3]. This is consistent with research linking systemic viral infections to long-term neurocognitive alterations via mechanisms including inflammatory cytokine cascades and microglial activation[4].

The significant impairments seen in attention and executive function in our cohort are particularly concerning due to their direct influence on academic performance and social adaptation. These domains require sustained mental effort and cognitive flexibility, which are gradual to develop and essential for complex learning tasks. Deficits here could explain poor school outcomes and behavioral issues observed anecdotally in children post-dengue in endemic regions.

Our observation of partial recovery over one year suggests some neuroplastic compensation or resolution of inflammation, yet the persistence of deficits highlights the potential for chronic neurocognitive impact. This trajectory mirrors reports from other viral encephalitides and childhood infections where full cognitive restoration remains incomplete for many[3]. Chang et al. (2021), for example, reported a higher incidence of dementia following dengue fever in a Taiwanese nationwide cohort, while Chien et al. (2023) reaffirmed the dengue-dementia association in follow-up research[14]. These findings underscore the possibility that dengue may initiate or accelerate neurodegenerative processes, possibly mediated by chronic inflammation or direct neuronal damage.This underscores the pressing need for structured cognitive monitoring and early interventions such as cognitive rehabilitation or educational support tailored to affected children.

Despite these insights, limitations include the modest sample size, lack of neuroimaging or biomarkers to elucidate pathophysiology, and potential residual confounding related to socioeconomic and nutritional factors. Future larger multicenter studies incorporating advanced neuroimaging, inflammatory markers, and functional assessments will improve understanding of mechanisms and guide targeted therapies.

In the context of expanding dengue prevalence associated with global climate change and urbanization, recognizing and addressing long-term pediatric cognitive consequences will be critical to prevent substantial public health and societal burdens[5][3].

CONCLUSION

This study comprehensively demonstrates that pediatric dengue infection is associated with significant long-term neurocognitive impairments in memory, attention, and executive functions persisting at least 12 months post-infection. The persistence of these deficits—despite partial improvements—may adversely affect academic achievement and psychosocial functioning in children. These findings highlight the necessity of integrating cognitive evaluations into dengue post-recovery care protocols and underscore the need for further research into rehabilitation strategies to mitigate these impacts. Early identification and intervention could improve the quality of life of affected children in endemic regions.

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