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Original Research Article

Etiology of Pediatric Stroke at a Tertiary Care Hospital of Southern Punjab

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Abstract: *Pediatric stroke is an important cause of childhood morbidity with diverse etiological factors that vary across regions. Early identification of underlying causes is essential for timely management and improved outcomes.* ***Objective:*** *To determine the pattern and burden of etiological factors of pediatric stroke at a tertiary care hospital in Southern Punjab.* ***Methods:*** *This descriptive case series was conducted in the Department of Neurology, The Children's Hospital and Institute of the Child Health, Multan, and included 110 children diagnosed with stroke using a non-probability purposive sampling technique. After enrollment, detailed history-taking and thorough clinical examination were performed, followed by appropriate neurological and laboratory investigations to ascertain the aetiology of the stroke. Demographic variables, stroke type, and etiological factors were recorded. Data were analysed using SPSS version 23. Mean and standard deviation were calculated for continuous variables such as age and weight. At the same time, frequencies and percentages were computed for categorical variables, including gender, age groups, residential status, stroke type, and etiological factors.* ***Results:*** *Out of 110 children, 65.5% were males and 34.5% were females, with a mean age of 5.85 ± 2.64 years. Most patients (72.7%) were aged six years or younger. The majority lived in urban areas (70.0%) and were from middle-income families (73.6%). Ischemic stroke was observed in 83.6% of cases, whereas 16.4% had hemorrhagic stroke. The mean body weight was 14.93 ± 4.87 kg, and obesity was noted in 13.6% of children. Infective causes were the most frequent etiological factor (50.9%), followed by vascular (26.4%), haematological (12.7%), cardiac (4.5%), and unknown causes (5.5%).* ***Conclusion:*** *Intracranial infections were the leading etiological factor of pediatric stroke in this setting, followed by vascular and haematological causes. Ischemic stroke was more prevalent than hemorrhagic stroke. Awareness of these patterns may facilitate early Diagnosis, targeted management, and improved prognosis in children with stroke.*

Keywords: Etiology; Hemorrhagic Stroke; Ischemic Stroke; Pediatric Stroke

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Introduction

The aetiology of pediatric stroke is an area of increasing concern, particularly in regions with high prevalence rates of risk factors such as cardiovascular diseases, systemic lupus erythematosus, sickle cell disease, and infections like varicella and meningitis (1, 2, 3). Although strokes were previously deemed rare in children, recent advancements in diagnostic imaging have enabled better identification and categorization of pediatric strokes as a significant cause of morbidity and mortality among the young population (2, 4). Specific subtypes of strokes, including arterial ischemic stroke (AIS) and cerebral venous sinus thrombosis (CVST), have demonstrated varied etiologies that necessitate comprehensive investigation within diverse demographic groups (5,6).
Recent studies conducted in tertiary care settings in Pakistan indicate that various factors, including underlying genetic disorders, hematologic conditions such as anaemia, and acute febrile illnesses, are emerging as essential contributors to the pediatric stroke population (7, 5). Notably, sickle cell disease has been highlighted as a leading risk factor for childhood strokes, with estimated prevalence rates of 11% among children with the disease before aggressive screening protocols (3). Furthermore, the incidence of ischemic strokes has been correlated with hyperlipidemia (8), hypertension, and increasingly, lifestyle factors such as poor dietary habits and lack of physical activity, which may be exacerbated by socio-economic challenges prevalent in low- and middle-income countries, including Pakistan (9, 10).

Understanding the aetiology of pediatric stroke not only informs management strategies but is also critical for the development of preventive initiatives in public health. In Pakistan, where population-based studies have documented gaps in healthcare availability and access (11, 12). Establishing an accurate aetiology for pediatric strokes can facilitate targeted interventions while emphasising the long-term impacts on familial and societal levels.

Due to ongoing healthcare expenditures and lost productivity resulting from childhood disabilities (13, 14). Hence, this research aims to elucidate the causes of pediatric strokes at a tertiary care hospital in Southern Punjab, thereby informing the tailoring of healthcare services to the vulnerable pediatric population and ultimately improving both clinical outcomes and public health strategies across the region.

Methodology

This descriptive case series was conducted at the Department of Neurology, The Children's Hospital and Institute of the Child Health, Multan, over 6 months from November 2024 to April 2025. The study was conducted after obtaining formal approval from the institutional Ethics Committee. Children were enrolled using a non-probability purposive sampling technique.
The sample size was calculated using the WHO sample size calculation software. An anticipated proportion of etiological factors in pediatric stroke of 80% was assumed based on previously published literature, with a margin of error of 7.5% and a confidence level of 95%, resulting in a required sample size of 110 patients.
Children aged between 6 months and 12 years of either gender were included if they presented with a sudden onset of focal neurological

deficit persisting for more than 24 hours and had radiological confirmation of stroke on computed tomography or magnetic resonance imaging. Patients diagnosed with transient ischemic attack, Down syndrome, paraplegia or paraparesis, venous stroke, brain tumours, or stroke secondary to head trauma were excluded to maintain homogeneity of the study population.

After registration, a detailed clinical history was obtained from caregivers, followed by a comprehensive physical and neurological examination. Relevant laboratory investigations and neuroimaging studies were performed as indicated to establish the underlying aetiology of stroke. Etiological classification was based on clinical findings, imaging results, and supporting laboratory evidence, categorising cases into infective, vascular, haematological, cardiac, or undetermined causes. All collected data were entered and analysed using the Statistical Package for the Social Sciences version 23. Continuous variables such as age were summarised as the mean with standard deviation. In contrast, categorical variables, including gender, age groups, residential status, stroke subtype, and etiological factors, were expressed as frequencies and percentages. This analytical approach was adopted to comprehensively describe the demographic and clinical profile of pediatric stroke patients included in the study.

Results

A total of 110 children diagnosed with stroke were included in this study. There was a male predominance, with 72 patients (65.5%) being male and 38 (34.5%) female. The mean age of the study population was 5.85 ± 2.64 years, ranging from 1 to 11 years. Most children were younger than 6 years, accounting for 72.7% of the cohort (n = 80). Regarding residence, 77 children (70.0%) lived in urban areas, while 33 (30.0%) lived in rural areas. The majority of participants (73.6%, n = 81) were from middle-income families. (Table 1)

Ischemic stroke was the predominant subtype, observed in 92 children (83.6%), whereas hemorrhagic stroke was identified in 18 children (16.4%). The mean body weight of the patients was 14.93 ± 4.87 kg. Obesity was documented in 15 children, representing 13.6% of the study population. (Table 2)

Etiological evaluation revealed that infective causes were the most common, identified in 56 patients (50.9%). Vascular etiologies were found in 29 children (26.4%), followed by haematological causes in 14 (12.7%) and cardiac causes in 5 (4.5%). In 6 children (5.5%), no definitive aetiology could be established. (Table 3).

Table 1. Demographic and Socioeconomic Characteristics of Children with Stroke (n = 110)

Variable	Frequency (n)	Percentage (%)
Gender		
Male	72	65.5
Female	38	34.5
Age group (years)		
≤ 6 years	80	72.7
> 6 years	30	27.3
Residence		
Urban	77	70.0
Rural	33	30.0
Socioeconomic status		
Middle income	81	73.6
Other	29	26.4

Table 2. Clinical Characteristics of the Study Population (n = 110)

Characteristic	Mean ± SD / n	Percentage (%)
Age (years)	5.85 ± 2.64	
Weight (kg)	14.93 ± 4.87	
Obesity	15	13.6
Stroke type		
Ischemic	92	83.6
Hemorrhagic	18	16.4

Table 3. Etiological Distribution of Pediatric Stroke (n = 110)

Etiology	Frequency (n)	Percentage (%)
Infective	56	50.9
Vascular	29	26.4
Hematological	14	12.7
Cardiac	5	4.5
Unknown	6	5.5

Discussion

In our study examining pediatric stroke, we documented significant demographic and clinical characteristics among 110 children diagnosed with this condition. A male predominance was evident, with 65.5% being male, aligning with findings from several studies that report a higher incidence of stroke in males during childhood Woods et al. (15,16). This male predominance is consistent with the prevailing literature, which suggests that hormonal and genetic differences may contribute to this disparity (17). The mean age of our cohort was 5.85 years, with a substantial majority (72.7%, n=80) younger than six years. This resonates with findings by Miyamoto et al., indicating that strokes predominantly affect younger children and often present unique diagnostic and management challenges in this age group (16).

Table 1 further illustrates that the majority of our study population came from urban areas (70%), which is supported by the literature, which suggests a trend of increasing stroke incidence in urban settings due to factors such as higher exposure to risk determinants, including infections and environmental stressors (18, 19). Our socioeconomic data show that 73.6% of participants belonged to middle-income families, which may implicate the accessibility of healthcare resources and highlight the need for health policies tailored to these demographics, given the social determinants of health influencing pediatric stroke outcomes (20).

In terms of stroke subtypes, ischemic events were predominant, occurring in 83.6% of the children, while hemorrhagic strokes were notably less frequent at 16.4%. This distribution aligns with the growing consensus in pediatric literature, where ischemic strokes are reported to outnumber hemorrhagic strokes in children (21). Comparatively, studies such as those by Ni et al. have documented similar ratios of ischemic to hemorrhagic events, demonstrating a consistent epidemiological pattern across diverse populations (22).

In our investigation of etiological factors, we found that infective causes emerged as the most prevalent reason behind pediatric strokes, responsible for 50.9% of cases. This correlates with existing studies highlighting the link between infections—particularly Mycoplasma pneumoniae and certain viral infections—and increased stroke risks in the pediatric population (22). Vascular causes contributed to 26.4% of etiologies, resonating with studies indicating that genetic and vascular malformations, alongside systemic infections, significantly contribute to pediatric strokes. The notable incidence of haematological causes (12.7%), including conditions such as sickle cell disease, reinforces the importance of early screening and management of predisposing factors (23) with investigations in similar cohort studies identifying haematological abnormalities as critical determinants of stroke risk in children (24, 25).

Our findings regarding a lack of identifiable aetiology in 5.5% of the cases underline the complexity and heterogeneous nature of pediatric stroke. This highlights the necessity of comprehensive diagnostic evaluations to understand and potentially identify previously unrecognised or rare etiological factors that may not be well captured in the current literature (26, 27, 28).

In conclusion, our study aligns with and reinforces findings from recent literature across various demographics, emphasising certain high-risk groups for both ischemic and hemorrhagic strokes in children. Such insights underline the pressing need for foundational research, tailored prevention strategies, and enhanced healthcare policy interventions aimed at reducing the burden of pediatric stroke within the socio-economic landscape of Pakistan.

Conclusion

Intracranial infection was the major etiological factor of pediatric stroke in our setting, followed by vascular aetiology and haematological disorders. Ischemic stroke was more prevalent than hemorrhagic stroke in these children. All clinicians treating such patients can anticipate these factors to enable early Diagnosis, leading to proper management and improving the prognosis of the illness and their quality of life.

Declarations

Data Availability statement

All data generated or analysed during the study are included in the manuscript.

Ethics approval and consent to participate

Approved by the department concerned. (IRBEC-24)

Consent for publication

Approved

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Conflict of interest

The authors declared the absence of a conflict of interest.

Author Contribution

AT (FCPS (Pediatrics))
Manuscript drafting, Study Design,
FH (Paediatric critical care fellow)
Review of Literature, Data entry, Data analysis, and drafting article.
IUR (FCPS (Pediatrics))
Conception of Study, Development of Research Methodology Design,
SS (Principal Research Officer)
Study Design, manuscript review, critical input.

All authors reviewed the results and approved the final version of the manuscript. They are also accountable for the integrity of the study.

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