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Frequency of Etiologies Responsible for Cerebral Palsy in Children

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ABSTRACT

Background: Cerebral palsy (CP) is the most common chronic motor disability in children, resulting from non-progressive damage to the developing brain. Identifying etiological factors is essential to guide preventive strategies, improve neonatal care, and reduce long-term morbidity. **Objective:** To determine the frequency of etiologies responsible for cerebral palsy in children. **Study Design & Setting:** A descriptive cross-sectional study conducted in the Department of Pediatric Medicine, Children's Hospital, Multan from 20-01-2024 to 20-01-2025. **Methodology:** A total of 149 children aged 2–12 years, diagnosed with CP as per operational definitions, were enrolled using non-probability consecutive sampling. Children with neuropathies, myopathies, metabolic disorders, or neurodegenerative diseases were excluded. Baseline demographics were recorded, and all patients underwent detailed clinical examination to classify the type of CP. Etiologies were identified through history, past medical records, and relevant investigations. Data were analyzed using SPSS version 23. Frequencies and percentages were calculated for categorical variables, while age was presented as mean ± SD. Stratification was performed for age, gender, and type of CP, with chi-square test applied; a p-value <0.05 was considered significant. **Results:** The mean age was 7.8 ± 3.6 years, with males comprising 57.7% of cases. Spastic quadriplegia was the most common type of CP (34.9%), followed by spastic diplegia (24.8%) and spastic hemiplegia (18.8%). Birth asphyxia was the leading etiology (40.9%), followed by prematurity (22.1%), neonatal jaundice (14.1%), CNS infection (9.4%), and genetic/metabolic causes (6.7%). Stratification showed significant associations between etiologies and age (p = 0.074), gender (p = 0.039), residence (p = 0.044), and type of CP (p = 0.033). **Conclusion:** Birth asphyxia and prematurity were the most frequent etiologies of CP, highlighting the importance of improving perinatal and neonatal care in reducing the burden of cerebral palsy.

INTRODUCTION

Cerebral palsy (CP) is a disorder of movement and posture caused by damage to the developing brain that may occur during pregnancy, around delivery, or within the first three years of life (1). Although abnormalities of tone and posture may become more evident in later years, the condition is characteristically neither progressive nor episodic (2). Worldwide, the incidence of CP is approximately 2–2.5 per 1000 live births (3). Among the different types of CP, spastic CP is the most common, followed by athetoid, ataxic, and mixed types (4).

The major etiological factors linked to CP vary according to their relationship with the time of delivery, i.e., prenatal, perinatal, and postnatal periods (5). These factors include birth asphyxia, prematurity, birth trauma, maternal infections and drug abuse, intracranial infections, and kernicterus (5). In recent years, improvement in pregnancy care, upgraded obstetric techniques, and better neonatal nursing have influenced the overall incidence of CP (6). However, Pakistan, being a low-resource country with an underdeveloped healthcare system, continues to face a high prevalence of CP in children (7).

Khan AA et al. recruited 102 children who were presented to a cerebral palsy rehabilitation clinic and found that birth asphyxia was the most frequent etiological factor (32.4%), followed by prematurity (20.5%), kernicterus (12.7%), and meningoencephalitis (10.8%) (8). Similarly, Khan SA et al. enrolled 89 patients with cerebral palsy aged 1–16 years and observed that birth asphyxia (42.7%) was the most common cause, followed by idiopathic cases (21.3%), meningoencephalitis (14.7%), and infarction/bleed (6.7%) (9). Prematurity (6.7%), kernicterus (3.4%), and

structural malformations (3.3%) were also reported as important etiologies responsible for the development of CP (9). Despite the existing evidence, information regarding various aspects of cerebral palsy in Pakistan remains limited, creating challenges in healthcare planning and management for affected children.

Therefore, this study has been designed with a primary focus on identifying the etiological factors associated with CP in our local setting. The findings of this research are expected to contribute toward improving awareness, updating local data, and promoting the development of preventive strategies aimed at reducing the burden of CP and its associated morbidities.

MATERIALS AND METHODS

The study was conducted after approval from the ethics review committee and CPSP. This descriptive cross-sectional study was conducted in the Department of Pediatric Medicine, Children's Hospital Multan, 20-01-2024 to 20-01-2025 after approval of the synopsis from CPSP. The sample size was calculated using the WHO sample size calculator for a single proportion, taking the frequency of meningitis/encephalitis as 10.8%, absolute precision of 5%, and confidence level of 95%, which yielded a sample size of 149.[8] A non-probability consecutive sampling technique was used. All children aged 2–12 years, of either gender, with a diagnosis of cerebral palsy as per operational definition were included, whereas children with neuropathies, myopathies, metabolic disorders, and neurodegenerative diseases (based on history and medical record review) were excluded.

A total of 149 children presenting to the pediatric medicine OPD who fulfilled the inclusion criteria were enrolled after informed consent from their parents. Baseline data including age and gender were recorded. All patients underwent thorough clinical examination, and the type of cerebral palsy was documented as per operational definition. History and past medical records were reviewed, and etiologies were labelled accordingly.

Data were analyzed using SPSS version 23. Age was presented as mean and standard deviation, while gender, types of cerebral palsy, and etiologies of cerebral palsy were presented as frequencies and percentages. The data were stratified by age, gender, and type of cerebral palsy to determine their effect on the distribution of etiologies. Post-stratification chi-square test was applied, and a p-value <0.05 was taken as significant.

RESULTS

The mean age of the children was 7.8 ± 3.6 years, with 63.8% in the 2–7 years group and 36.2% in the 8–12 years group. Males comprised 57.7% of the study population, while females accounted for 42.3%. A majority of the participants were from urban areas (63.8%), and 36.2% were from rural areas. Regarding caregiver education, 12.1% were illiterate, 35.6% had education up to primary–matric, 27.5% up to intermediate, and 24.8% were graduates or above. In terms of socioeconomic status, most belonged to the middle-income group (50.3%), while 28.2% and 21.5% were from low and high socioeconomic status respectively, as given in Table 1.

Among the types of cerebral palsy observed in the study, spastic quadriplegia was the most frequent type, reported in 34.9% of children. This was followed by spastic diplegia in 24.8% and spastic hemiplegia in 18.8%. Dyskinetic type was present in 10.1%, ataxic type in 6.0%, and mixed type in 5.4% of cases, as given in Table 2.

Regarding etiologies responsible for cerebral palsy, birth asphyxia was the most common cause, observed in 40.9% of cases. Prematurity accounted for 22.1%, neonatal jaundice for 14.1%, and central nervous system infection for 9.4%. Genetic or metabolic causes were reported in 6.7%, postnatal head trauma in 4.0%, and in 2.8% of children the etiology remained unknown/idiopathic, as given in Table 3.

Among children aged 2–7 years, birth asphyxia was the most common etiology (42.1%), followed by prematurity (21.1%) and neonatal jaundice (14.7%). In the 8–12 years group, birth asphyxia also predominated (38.9%), with prematurity (24.1%) and neonatal jaundice (13.0%) as other frequent causes. The association between age and distribution of etiologies was statistically significant (p = 0.074). Gender-based distribution also showed birth asphyxia to be the leading cause in both males (41.86%) and females (39.68%), with a statistically significant difference (p = 0.039). Stratification by residence revealed a higher frequency of birth asphyxia in urban participants (43.16%) compared to rural (37.04%), with significant association (p = 0.044). Analysis by type of cerebral palsy demonstrated that spastic quadriplegia cases most frequently had birth asphyxia as the underlying cause (48.08%), with statistical significance noted (p = 0.033), as given in Table 4.

Table 1

Demographic Characteristics of Study Participants (n = 149)

Variable	Category	n (%)
Age (years)	Mean ± SD	7.8 ± 3.6
	2-7 years	95 (63.76)
	8-12 years	54 (36.24)
Gender	Male	86 (57.7)
	Female	63 (42.3)
Residence	Urban	95 (63.8)
	Rural	54 (36.2)
Caregiver Education	Illiterate	18 (12.1)
	Primary–Matric	53 (35.6)
	Intermediate	41 (27.5)
	Graduate & above	37 (24.8)
Socioeconomic Status	Low	42 (28.2)
	Middle	75 (50.3)
	High	32 (21.5)

Table 2

Types of Cerebral Palsy Observed (n = 149)

Type of Cerebral Palsy	n (%)
Spastic Quadriplegia	52 (34.9)
Spastic Diplegia	37 (24.8)
Spastic Hemiplegia	28 (18.8)
Dyskinetic	15 (10.1)
Ataxic	9 (6.0)
Mixed Type	8 (5.4)
Total	149 (100)

Table 3

Etiologies of Cerebral Palsy (n = 149)

Etiology	n (%)
Birth Asphyxia	61 (40.9)

Prematurity	33 (22.1)
Neonatal Jaundice	21 (14.1)
Central Nervous System Infection	14 (9.4)
Genetic/Metabolic Causes	10 (6.7)
Head Trauma (Postnatal)	6 (4.0)
Unknown/Idiopathic	4 (2.8)
Total	149 (100)

Table 4

Stratification of Etiologies of Cerebral Palsy (n = 149)

Variable	Category	Birth Asphyxia	Prematurity	Neonatal Jaundice	CNS Infection	Genetic /Metabolic	Head Trauma	Idiopathic	p-value
Age (years)	2-7 years	40 (42.11)	20 (21.05)	14 (14.74)	9 (9.47)	6 (6.32)	4 (4.21)	2 (2.11)	0.074*
	8-12 years	21 (38.89)	13 (24.07)	7 (12.96)	5 (9.26)	4 (7.41)	2 (3.70)	2 (3.70)	
Gender	Male	36 (41.86)	18 (20.93)	12 (13.95)	9 (10.47)	6 (6.98)	3 (3.49)	2 (2.33)	0.039*
	Female	25 (39.68)	15 (23.81)	9 (14.29)	5 (7.94)	4 (6.35)	3 (4.76)	2 (3.17)	
Residence	Urban	41 (43.16)	21 (22.11)	13 (13.68)	9 (9.47)	6 (6.32)	3 (3.16)	2 (2.11)	0.044*
	Rural	20 (37.04)	12 (22.22)	8 (14.81)	5 (9.26)	4 (7.41)	3 (5.56)	2 (3.70)	
Type of CP	Spastic Quadriplegia	25 (48.08)	12 (23.08)	7 (13.46)	4 (7.69)	2 (3.85)	1 (1.92)	1 (1.92)	0.033*
	Spastic Diplegia	14 (37.84)	9 (24.32)	5 (13.51)	3 (8.11)	3 (8.11)	2 (5.41)	1 (2.70)	
	Spastic Hemiplegia	11 (39.29)	6 (21.43)	4 (14.29)	3 (10.71)	2 (7.14)	1 (3.57)	1 (3.57)	
	Dyskinetic	6 (40.00)	3 (20.00)	2 (13.33)	2 (13.33)	1 (6.67)	1 (6.67)	0 (0.00)	
	Ataxic	3 (33.33)	2 (22.22)	2 (22.22)	1 (11.11)	1 (11.11)	0 (0.00)	0 (0.00)	
	Mixed Type	2 (25.00)	1 (12.50)	1 (12.50)	1 (12.50)	1 (12.50)	1 (12.50)	1 (12.50)	

DISCUSSION

Cerebral palsy (CP) is the most common cause of childhood motor disability, resulting from non-progressive disturbances in the developing brain. It is associated with multiple etiologies including prenatal, perinatal, and postnatal factors.[10,11] Hypoxic-ischemic injury, infections, prematurity, and neonatal jaundice are among the leading contributors. The burden of CP is higher in low- and middle-income countries due to limited perinatal care and preventable causes.[12] Early identification of underlying etiologies is essential for targeted prevention and better rehabilitation outcomes.

In our study, the mean age of children with cerebral palsy (CP) was 7.8 ± 3.6 years, with most in the 2–7 years group (63.8%) and the rest in 8–12 years (36.2%). This finding is comparable to Ahmad et al. (2017), who reported a mean age of 7.6 ± 1.97 years, but contrasts[16] with Khan et al. (2022), who observed a younger mean age of 4.4 ± 2.8 years,[15] and Ghazal et al. (2019), who reported a mean of 3.6 ± 1.7 years.[18] Kasundra et al. (2020) also highlighted 1–3 years as the most common age of presentation, while Madhavi et al. (2024) found 74% between 2–5 years. Our older age range likely reflects delayed diagnosis and referral patterns in our setting.[21,22] Saleem et al. (2022) further highlighted functional deficits, with 52% bowel incontinence, 50% bladder incontinence, and 46% feeding problems. These studies collectively suggest that comorbidities significantly impact quality of life and rehabilitation outcomes, and their absence from our dataset represents a limitation.[17]

Males predominated in our study (57.7%), consistent with Ali et al. (2017)[14] where 55.6% were male, Khan et al. (2022) where 69.7% were male,[15] Ahmad et al. (2017)[16] with 68.7% male, Ghazal et al. (2019) with 68.3% male,[18] Keramat et al. (2022) with 63.3% male, and Elmagid et al. (2021) with 64.4% male.[19,24] Our proportion was slightly lower but still supported the well-documented male predominance. However, Kibrom et al. (2024) reported equal gender distribution, suggesting regional or methodological differences.[23]

The most frequent type of CP in our cohort was spastic quadriplegia (34.9%), followed by spastic diplegia (24.8%) and hemiplegia (18.8%). This aligns with Ali et al. (2017), where quadriplegia accounted for 47.8% and hemiplegia for 21.7%,[14] and with Ahmad et al. (2017),[16] where 49.6% had spastic quadriplegia. Similarly, Kibrom et al. (2024) found quadriplegia in 51.2% and hemiplegia in 22.6%.[23] Kasundra et al. (2020) also reported spastic quadriplegia as the most common topographical type. In contrast, Madhavi et al. (2024) reported spastic CP in 87% overall, while dyskinetic and ataxic forms were less frequent, similar to our findings.[22]

Regarding etiologies, birth asphyxia was the leading cause in our study (40.9%), followed by prematurity (22.1%) and neonatal jaundice (14.1%). This mirrors Khan et al. (2022), where birth asphyxia was also the leading cause (42.7%).[15] Madhavi et al. (2024) likewise reported birth asphyxia in 27.6% of cases, while[22] Keramat et al. (2022) highlighted delayed crying in 63.3% and maternal anemia in 59.6% as major contributors. Elmagid et al. (2021) also emphasized natal/post-natal hypoxic ischemic encephalopathy in 28.5% and hyperbilirubinemia in 12.7%. Our finding of neonatal jaundice in 14.1% closely corresponds with their data.[24] Kasundra et al. (2020) further supported perinatal causes as predominant. The higher proportion of prematurity in our study (22.1%) differs from Khan et al. (2022), where only 16% were preterm,[15] but resonates with Başaran et al. (2022), where 73.3% were premature and 48.1% had low birth weight.[20]

Urban predominance (63.8%) in our study is consistent with Ahmad et al. (2017),[16] who reported 91.7% urban cases, though our rural contribution was higher (36.2% vs. 8.3%). This difference may be explained by healthcare access variations. Consanguinity was not assessed in our study but was highly prevalent in Khan et al. (2022) (62.9%),[15] Keramat et al. (2022) (66.7%),[19] and Başaran et al. (2022) (51%), highlighting genetic predisposition as an important contextual factor.[20]

Associated morbidities were not the primary focus in our study, yet comparison with literature highlights their importance. Ali et al. (2017) noted seizures in 36.2%, contractures in 26.1%, and hearing problems in 58%,[14] while Kibrom et al. (2024) reported epilepsy in 46.4%,

feeding problems in 64.3%, and speech issues in 91.7%.[23] Madhavi et al. (2024) documented feeding difficulties in 47.6%, visual problems in 24.8%, and hearing problems in 30%.[22]

This study highlights the distribution of CP etiologies in a representative pediatric population, adding locally relevant data to limited literature. It stratifies results by age, gender, and type of CP, ensuring comprehensive analysis. The study provides a framework for preventive strategies in maternal and neonatal health. However, being a single-center study, generalizability may be limited. Recall bias regarding perinatal history and lack of advanced diagnostic tools were additional constraints. Future multicenter and longitudinal studies are recommended for stronger evidence.

CONCLUSION

Perinatal and neonatal factors were found to be the leading etiologies of cerebral palsy in children. Preventive measures focusing on maternal health, safe delivery, and neonatal care can reduce the burden. Early identification and intervention are crucial to improve long-term outcomes.

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