A Retrospective Chart Review Study Describing Cerebral Palsy Patients Profile in a Tertiary hospital in Riyadh, Saudi Arabia

Mohammed A. Almuqbil, MD*,**,*** Reem Albuhairan, MD* Shahad Aljebeli, MD* Omar Bokhari, MD**** Reem Bajeri, MD* Fatmah Shamakhi, MD***** Naila A. Shaheen, MD*,**

ABSTRACT

Introduction: Cerebral palsy (CP) is characterized by heterogeneous motor deficits resulting from brain damage during development. The aim of this study is to examine the characteristics and risk factors of CP patients.

Material and Methods: This was retrospective observational cross-sectional study where all data was collected anonymously from the medical electronic records in National Guard Hospital, Riyadh, Saudi Arabia from April 2015-November 2022. All children diagnosed with CP from 2-14 years of age were included. The diagnostic criteria for validating the diagnosis of CP involved a combination of clinical evaluations. Clinical examinations involved recording motor deficits such as spasticity, dystonia, or athetosis, as well as indications of aberrant muscle tone, reflexes, and delays in motor development. The Chi-square test and Fisher's Exact Test were employed to examine whether there is a statistically significant difference in the study outcomes in terms of the characteristics of the study sample.

Results: A total of 220 cases of CP were identified during the study period. The most common type of CP is spastic, accounting for 82.3%. With respect to the duration of pregnancy, the highest incidence of Spastic CP was observed between 38 and 40 weeks. A significant difference among various categories of CP and orthopedic interventions.

Conclusion: Given the prevalence of spastic CP observed, it is imperative that healthcare professionals give precedence to the timely detection and application of targeted management approaches for this particular subtype.

Keywords: Cerebral Palsy, Neurodevelopmental Disorder, Child Neurology, Pediatrics Neurology, Neurodevelopmental Disabilities

INTRODUCTION

Cerebral palsy (CP) is a neurological condition that impacts a significant number of children. It is a disorder characterized by injury to the developing brain, resulting in heterogeneity. Cerebral palsy refers to a group of neurological abnormalities that result in movement impairments in infants. It is a chronic, non-degenerative condition affecting one's posture and movement. Furthermore, it can be categorized into three primary classifications: spastic, dyskinetic, and ataxic, with ataxia being the most widespread [1]. The latest International Classification of Functioning, Disability, and Health (ICF) by the World Health Organization (WHO) highlights the significance of prioritizing the functional outcomes of different health conditions. This has led to the creation of updated functional scales in CP [2]. The classification for patient care is widely recognized as the most superior [3].

Recent population surveys from various regions worldwide indicate that the prevalence of CP varies between 1 and nearly 4 per 1,000 live births or per 1,000 children [4]. Cerebral palsy is distinguished by involuntary shaking, inflexible muscles, and compromised ability to coordinate movements. Additionally, it can be associated with sensory, visual, auditory, swallowing, and speech impairments, as well as seizures, which occur in around one-third of individuals with CP on average. Although the symptoms may become increasingly apparent during the initial years of life, the underlying problem does not worsen.

Underlying health issues, including congenital, neonatal, and postnatal etiologies, can have an impact on the development of cerebral palsy. Moreover, several factors such as genetic predisposition, the occurrence of numerous pregnancies, vascular diseases during pregnancy, premature and post-term birth, and gender can all play a role in the development of cerebral palsy. Gaining insight into the fundamental risk factors is a crucial aspect of determining suitable preventive and therapeutic approaches for CP [5].

Examining the existing body of research reveals various estimates of the prevalence of CP and its associated factors, which vary depending on the approach employed. A previous study was undertaken at Riyadh Military Hospital (RMH) where 99,788 live births were documented, resulting in an incidence ratio of 412 children with CP [6]. Furthermore, a separate study examined the nutritional condition of 74 children

* College of Medicine, King Saud bin Abdulaziz University for Health Sciences (KSAU-HS), Riyadh, Saudi Arabia.
E-mail: muqbilm@ksau-hs.edu.sa; almuqbilmo@ngha.med.sa
** King Abdullah International Medical Research Center (KAIMRC) Ministry of National Guard, Riyadh, Saudi Arabia.
*** Division of Pediatric Neurology, Department of Pediatrics King Abdullah Specialist Children's Hospital (KASCH) National Guard Health Affairs (NGHA), Riyadh.
**** King Fahad General Hospital, Jeddah, KSA.
***** General Practitioner, Ministry of Health, Abha, Saudi Arabia.

with CP. The findings revealed that 56.4% of the children with CP who attended the Prince Sultan Humanitarian City (SBAHC) in Riyadh were found to be malnourished [7]. Several recent studies have specifically examined cerebral palsy and its causes, aiming to provide a detailed description of its clinical characteristics and uncover the elements that contribute to its development. A research investigation was carried out at King Fahd Hospital of the University, Al-Khobar, focusing on Saudi children between the ages of 1 and 3 who have CP. The primary identified risk variables were twin pregnancy, pre-term delivery, extended labor, low birth weight, and a family history of previous CP [8].

Nevertheless, the physical disabilities in individuals with CP are still not curable, and the frequency of occurrence has remained mostly stable [9]. A separate investigation was carried out in Saudi Arabia to elucidate the metabolic and genetic abnormalities that resemble CP. There is an increasing variety of metabolic and genetic illnesses that can cause symptoms and indications that are similar to those of CP. The range from 3 to 12. A thorough analysis identified a minimum of 54 curable inborn errors of metabolism that can be mistaken for CP [10]. As a result of this transformation, the researcher's interest in CP and its complications and causes has grown. This hypothesis provides a concise explanation of the various causative elements, pathophysiology, and contemporary therapeutic strategies for treating CP [11]. It facilitates comprehension and proactive measures against the condition. Prompt identification of CP is essential, as delayed initiation of treatment exacerbates spasticity and restricts the potential for significant improvement [11]. The objective of this study is to identify the prevalence, the etiology, and different forms of CP. However, there is a scarcity of comprehensive study on the risk of CP and its causes in National Guard Hospital-Riyadh.

MATERIAL AND METHODS

Study design

This was retrospective observational cross-sectional study where all data was collected anonymously from the medical electronic records in National Guard Hospital, Riyadh, Saudi Arabia from April 2015-November 2022.

Sample population and settings

All children diagnosed with CP from 2-14 years of age were included. We excluded children diagnosed with CP younger than 2 years of age due the fact that is difficult to diagnose in this age. The diagnostic criteria for validating the diagnosis of CP involved a combination of clinical evaluations. Clinical examinations involved recording motor deficits such as spasticity, dystonia, or athetosis, as well as indications of aberrant muscle tone, reflexes, and delays in motor development. Additional criteria may include indications of non-progressive disruptions in the developing fetal or newborn brain, such as aberrant observations on neuroimaging investigations or signs of brain injury during prenatal or perinatal stages.

Outcome measures

The data collection sheet for the study included comprehensive information on various prenatal, perinatal, and postnatal risk factors, as well as details related to pregnancy, labor and delivery, Apgar scores, resuscitation measures, seizures, family history, physical examination, gestational age, birth weight, biochemical profile, audiology and ophthalmology testing, imaging findings, neurological examination at discharge, etiology, outcomes (including survival, developmental delays, cerebral palsy, epilepsy, and other neurological and developmental issues), feeding and respiratory issues, vision and hearing impairment, and follow-up information.

Sample size

We calculated the sample size using a sample size calculator, with a confidence interval of 95%, margin of error of 5%, and expected proportion of 0.5%, the minimum required sample size was 100.

Statistical Analysis

A comprehensive statistical analysis was conducted on the dataset, encompassing both descriptive and inferential methodologies. Firstly, a descriptive analysis was conducted to summarize the demographic characteristics of the participants using frequencies and percentages, which include age, gender, and other features. The Chi-square test and Fisher's Exact Test were employed to examine whether there is a statistically significant difference in the study outcomes in terms of the characteristics of the study sample. Statistical significance is established at a p-value of 0.05 or lower. All statistical analyses are executed using IBM's SPSS Software, version 29.0.0.

Patient and public involvement

None.

RESULTS

A total of 220 cases of CP were identified during the study period. According to Table 1, the most common type of CP is spastic, accounting for 82.3% (n=181) of all CP patients. The incidence rate for spastic CP is 0.19 per total live births. Ataxic CP is a relatively rare form, accounting for just 0.9% (n=2) of all CP cases, with an incidence rate of 0.002. The frequency of Athetoid/Dyskinetic CP is 3 cases per 1.4% of the population, with an incidence rate of 0.003. There are 34 cases of unspecified CP, which accounts for 15.5% of all CP patients. The incidence rate of unspecified CP is 0.03. Regarding gender distribution, males account for 53.2% (n=117) of the total number of patients with CP, with an incidence rate of 0.15. There are 103 cases of females with cerebral palsy, which represents 46.8% of all cerebral palsy patients. The incidence rate for females is 0.11. The denominator, calculated from the count of live births between May 2008 and February 2021, amounts to 93,678. There was a total of 329 patients with CP throughout this period, which corresponds to an overall incidence rate of 0.0035.

Table 1. Incidence Rate of different Cerebral Palsy among gender and CP types

	Incidence Rate		
	Frequency	**Out of Total CP Patients**	**§ Out of Total live Birth**
Cerebral Palsy types			
Spastic	181	82.3	0.19
Ataxic	2	0.9	0.002
Athetoid/Dyskinetic	3	1.4	0.003
Unspecified	34	15.5	0.03
Gender			
Males	117	53.2	0.15
Females	103	46.8	0.11

§ Denominator (Number of Children born during May 2008 to Feb 2021) which is: Incidence rate of CP patients
(Total live births 2011-2021 = 93, 678**,** CP pts 2011-2021 = 329, Incidence = 0.00351203)

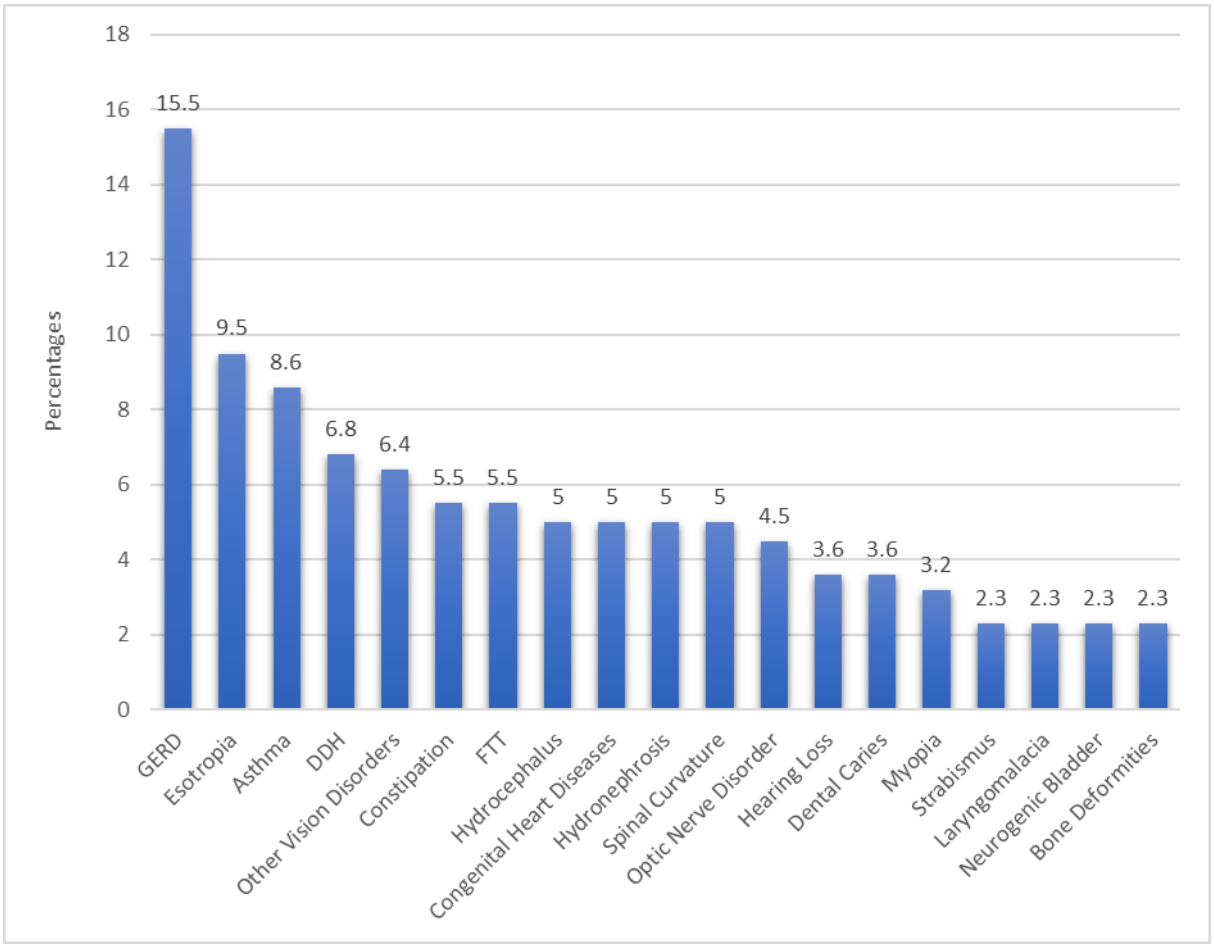

Figure 1. The prevalence rate of comorbidities among the study sample.

Table 2. Prenatal, Perinatal, neonatal, and infant-related risk factors stratified by types of CP

	Spastic (N=181)	Athetoid/ Dyskinetic (N=2)	Ataxic (N=3)	Unspecified (N=34)	Overall (N=220)	p-value
Duration of Pregnancy						
< 28 Weeks	22 (12.2%)	0	2 (66.7%)	6 (17.6%)	30 (13.6%)	0.177
28-32 Weeks	55 (30.4%)	0	0	10 (29.4%)	65 (29.5%)	
33-37 Weeks	24 (13.3%)	0	1 (33.3%)	6 (17.6%)	31 (14.1%)	
38-40 weeks	80 (44.2%)	2 (100.0%)	0	12 (35.3%)	94 (42.7%)	
Delivery Mode						
Vaginal	63 (34.8%)	2 (100.0%)	3 (100.0%)	14 (41.2%)	82 (37.3%)	0.275
C-Section	58 (32.0%)	0	0	12 (35.3%)	70 (31.8%)	
Birth Weight (g)						
<1000	19 (10.5%)	0	1 (33.3%)	4 (11.8%)	24 (10.9%)	0.090
1000-1499	11 (6.1%)	0	1 (33.3%)	4 (11.8%)	16 (7.3%)	
1500-2499	24 (13.3%)	0	1 (33.3%)	6 (17.6%)	31 (14.1%)	
2500-4000	8 (4.4%)	0	0	4 (11.8%)	12 (5.5%)	
>4000	119 (65.7%)	2 (100.0%)	0	16 (47.1%)	137 (62.3%)	

Comorbidities prevalent among patients with CP are summarized in Figure 1. Gastroesophageal Reflux Disease (GERD) is the most frequently observed comorbid condition, impacting 15.5% of the population. Following esotropia, an eye misalignment disorder, with a prevalence rate of 9.5%. Around 6.8% of patients with CP have Developmental Dysplasia of the Hip (DDH), whereas 8.6% have asthma. The prevalence rates for other vision disorders, constipation, and Failure to Thrive (FTT) are comparable, standing at 6.4% and 5.5% correspondingly.

The prevalence of prenatal, perinatal, neonatal, and infant-related risk factors associated with various categories of CP cases is detailed in Table 2. With respect to the duration of pregnancy, the highest incidence of Spastic CP was observed between 38 and 40 weeks (N=80), indicating that there was no significant difference between the two types of CP (p=0.177). The majority of cases diagnosed with Spastic CP (N=119) had a birth weight greater than 4000g (g); however, there was no statistically significant difference between CP types based on birth weight (p=0.090).

An analysis of resuscitative parameters for different types of CP is presented in Table 3. In relation to the quantity of patients resuscitated, it was found that all cases of Athetoid/Dyskinetic were effectively revived, with the majority being revived in the Spastic and Unspecified cohorts; no statistically significant difference was observed (p=0.369). Although bag-mask ventilation was utilized in five out of five cases of spastic CP, there was no statistically significant difference (p=1.000) between CP types. Positive Pressure Ventilation (PPV) was implemented with notable frequency, specifically in the Spastic group (57 out of 68 cases), yet the difference with regard to CP type failed to achieve statistical significance (p=1.000). Significant rates of intubation were observed in the unspecified group (11 out of 80) and the Spastic group (67 out of 80), albeit not statistically significant (p=0.703). The prevalence of oxygen supplementation was comparable across all groups (51 out of 62), and CP type did not significantly differ (p=0.590). In brief, although there are discrepancies in resuscitative measures among the various categories of CP in this study population, the p-values indicate that these differences were not statistically significant.

Table 4 presents the imaging abnormalities observed in patients diagnosed with various forms of CP. A noteworthy finding is the substantial disparity between aberrant imaging and the Spastic type of CP; 153 out of 181 cases displayed abnormalities (p=0.011*). Specific imaging abnormalities exhibited variability among different forms of CP, with periventricular leukomalacia being more prevalent in the Spastic group (72 cases). In addition, substantially more patients with the Spastic form of CP had Germinal Matrix Hemorrhage (71 cases) (p=0.045*). Additional irregularities, including intraventricular hemorrhage, hypoxic ischemic encephalopathy, and cerebral malformation, exhibited differing frequencies among different types of CP.

Table 5 shows the outcomes of patients with different types of CP. Notably, Microcephaly, Global Developmental Delay, Intellectual Disability, Developmental Language Impairment, Gross Motor Delay, Autistic Spectrum, Learning Disability, ADHD, and Epilepsy were examined. Microcephaly was observed in 23 cases within the Spastic group, but the difference between CP types was not statistically significant (p=0.888. Global Developmental Delay showed no significant difference, with 133 cases in the Spastic group (p=0.904). Similarly, Intellectual Disability, Developmental Language Impairment, Gross Motor Delay, Autistic Spectrum, Learning Disability, ADHD, and Epilepsy did not exhibit significantly differ between specific CP types.

Table 6 details the orthopedic interventions performed on various forms of CP. An intriguing finding surfaces, indicating a significant difference among various categories of CP and orthopedic interventions (p=0.010*). Significantly, out of the total 123 cases, 109 cases in the Spastic group were treated with such interventions, representing a considerable proportion. This highlights a significant difference between the Spastic form of CP and the one that necessitates orthopedic interventions. A total of 53 cases were treated with Botox, and no statistically significant difference was observed between the various forms of CP (p=0.097). A similar conclusion can be drawn regarding Baclofen, which had 25 cases overall and 22 cases in the Spastic group; there was no significant difference between CP types (p=0.784). Involving 58 out of 66 cases in the Spastic group, Tendon Release interventions failed to demonstrate a statistically significant difference between CP categories (p=1.000). There was an absence of significant differences among CP categories in hip surgeries, including Rotation/Derotation, as a mere seven cases were identified in total (p=1.000).

Table 7 shows different comorbidities among individuals with distinct types of CP. The overall number of patients with comorbidities does not significantly differ between CP types (p=0.905). However, out of 150 patients with comorbidities, 123 patients have Spastic CP type, highlighting the prevalent challenges faced by this cohort. While Hydrocephalus exhibits a trend, the difference between CP types was not statistically significant (p=0.098). Visual comorbidities, including Myopia, Esotropia, Strabismus, Other Vision Disorders, and Optic Nerve Disorders, do not show significant difference across different CP types. However, Caries exhibits significant difference across CP types (***p=0.047****). The Spastic group has a higher prevalence of Dental Caries. For other health conditions like Asthma, Laryngomalacia, Congenital Heart Diseases, GERD, and Constipation, no significant difference was found across CP types. In genitourinary comorbidities, hydronephrosis did not significantly differ between CP types (p=0.079), with a higher prevalence in the spastic group. Neurogenic Bladder, however, does not show a significant difference. Orthopedic comorbidity like Spinal

Table 3. Different Resuscitative measure by the type of CP

	Spastic (N=181)	Athetoid/ Dyskinetic (N=2)	Ataxic (N=3)	Unspecified (N=34)	Overall (N=220)	p-value
No. of Patients Resuscitated						
Yes	103 (56.9%)	0	3 (100.0%)	20 (58.8%)	126 (57.3%)	0.369
No	37 (20.4$)	1 (50.0%)	0	6 (17.6%)	44 (20.0%)	
Bag Mask						
Yes	5 (2.8%)	0	0	0	5 (2.3%)	1.000
No	77 (42.%)	0	3 (100.0%)	13 (38.2%)	93 (42.3%)	
PPV						
Yes	57 (31.5%)	0	2 (66.7%)	9 (26.5%)	68 (30.9%)	1.000
No	25 (13.8%)	0	1 (33.3%)	4 (11.8%)	30 (13.6%)	
Intubation						
Yes	67 (37.0%)	0	2 (66.7%)	11 (32.4%)	80 (36.4%)	0.703
No	15 (8.3%)	0	1 (33.3%)	2 (5.9%)	18 (8.2%)	
Oxygen						
Yes	51 (28.2%)	0	3 (100.0%)	8 (23.5%)	62 (28.2%)	0.590
No	31 (17.1%)	0	0	5 (14.7%)	36 (16.4%)	

(p value is calculated by Fisher's Exact Test, p <0.05 is significant)

Table 4. Imaging abnormalities according to different the type of CP

	Spastic (N=181)	Athetoid/Dyskinetic (N=2)	Ataxic (N=3)	Unspecified (N=34)	Overall (N=220)	p-value
No. of Patients with Abnormal Imaging	153 (84.5%)	0	3 (100.0%)	24 (70.6%)	180 (81.8%)	***0.011****
Periventricular Leukomalacia	72 (39.8%)	0	1 (33.3%)	9 (26.5%)	82 (37.3%)	0.148
Germinal Matrix hemorrhage	71 (39.2%)	0	0	16 (47.1%)	87 (39.5%)	***0.045****
Cerebral Malformation	9 (5.0%)	0	0	0	9 (4.1%)	0.413
Cerebrovascular Accidents	4 (2.2%)	0	0	1 (2.9%)	5 (2.3%)	1.000
Deep Brain Encephalopathy	2 (1.1%)	0	0	0	2 (0.9%)	1.000
Superficial Encephalopathy	0	0	0	0	0	-
Diffuse Encephalopathy	3 (1.7%)	0	0	0	2 (0.9%)	1.000
Hypoxic Ischemic Encephalopathy	33 (18.2%)	0	0	3 (8.8%)	36 (16.4%)	0.202
Intracranial Hemorrhage	1 (0.6%)	0	0	0	1 (0.5%)	1.000
Intraventricular Hemorrhage	22 (12.2%)	0	1 (33.3%)	7 (20.6%)	30 (13.6%)	0.095
Infection	3 (1.7%)	0	0	3 (8.8%)	6 (2.7%)	0.152
Ventriculomegaly	33 (18.2%)	0	1 (33.3%)	2 (5.9%)	36 (16.4%)	0.026
Non-Specific	13 (7.2%)	0	1 (33.3%)	3 (8.8%)	17 (7.7%)	0.356

*(p value is calculated by Fisher's Exact Test, *p <0.05 is significant)*

Table 5. Outcome of patients in different type of CP

	Spastic (N=181)	Athetoid/Dyskinetic (N=2)	Ataxic (N=3)	Unspecified (N=34)	Overall (N=220)	p-value
Microcephaly	23 (12.7%)	0	0	3 (8.8%)	26 (11.8%)	0.888
Global Developmental Delay	133 (73.5%)	2 (100.0%)	2 (66.7%)	25 (73.%)	162 (73.6%)	0.904
Intellectual Disability	39 (21.5%)	1 (50.0%)	1 (33.3%)	4 (11.8%)	45 (20.5%)	0.344
Developmental Language Impairment	75 (41.4%)	1 (50.0%)	1 (33.3%)	8 (23.5%)	85 (38.6%)	0.486
Gross Motor Delay	86 (47.5%)	1 (50.0%)	1 (33.3%)	9 (26.5%)	97 (44.1%)	0.134
Autistic Spectrum	2 (1.1%)	0	0	1 (2.9%)	3 (1.4%)	0.447
Learning Disability	38 (21.0%)	1 (50.0%)	1 (33.3%)	4 (11.8%)	44 (20.0%)	0.341
ADHD	6 (3.3%)	0	0	2 (5.9%)	8 (3.6%)	0.475
Epilepsy	61 (33.7%)	1 (50.0%)	0	16 (47.1%)	78 (35.5%)	0.260

*(p value is calculated by Fisher's Exact Test, *p <0.05 is significant)*

Table 6. Orthopedic interventions according to different type of CP among patients

	Spastic (N=181)	Athetoid/Dyskinetic (N=2)	Ataxic (N=3)	Unspecified (N=34)	Overall (N=220)	p-value
Orthopedic Intervention	109 (60.2%)	1 (50.0%)	0	13 (38.2%)	123 (55.9%)	***0.010****
Botox	53 (29.3%)	0	0	3 (8.8%)	59 (26.8%)	0.097
Baclofen	22 (12.2%)	0	0	3 (8.8%)	25 (11.4%)	0.784
Tendon Release	58 (32.0%)	0	1 (33.3%)	7 (20.6%)	66 (30.0%)	1.000
Hip Surgery (Rotation/Derotation)	7 (3.9%)	0	0	0	7 (3.2%)	1.000

Curvature didn't reveal significant difference between CP types (p=0.118) with Spastic CP groups shows 10 out of 11 cases with spinal curvature. All other comorbidities also didn't show statistically significant difference.

DISCUSSION

The purpose of this study was to investigate the prevalence, the etiology, and different forms of CP. Our investigation found that the most common kind of CP was spastic, accounting for 82.3% of all CP patients. This is consistent with the findings of a recent study conducted by Al-Jabri et. al. at a university hospital in Jeddah, where spastic CP accounted for 47.5% of cases [12]. Additionally, a previous study conducted at Prince Sultan Military Medical City supported a comparable finding with a percentage of 61.51% [4]. Spastic CP accounts for around 42% to 92% of all cases of CP globally. This is the most prevalent kind of CP observed in many nations [13]. Additionally, this study revealed that CP was primarily observed in male children, with a male to female ratio of 53.2% to 46.8%. Previous research conducted in Saudi Arabia indicated that CP primarily affects males, with a male-to-female ratio of 62.62% to 37.38% [5]. Global data also indicated that CP is more prevalent in males than females, with a distribution of 58% and 42% respectively [14].

Our study has revealed that the most prevalent co-morbid condition is GERD, with a prevalence rate of 15.5%. This finding aligns with previous literature, which has reported prevalence rates ranging from 15% to 77% [15-17]. The high incidence of this condition can be attributed to several variables. One contributing aspect is that many patients with CP spend a significant amount of time in a chronic supine position. Additionally, scoliosis, which is common in CP patients, can displace the stomach and induce straining of the

Table 7. Different comorbidities faced according to different type of CP among patients

	Spastic (N=181)	Athetoid/ Dyskinetic (N=2)	Ataxic (N=3)	Unspecified (N=34)	Overall (N=220)	p-value
Number of patients with other comorbidities	123 (68.0%)	1 (50.0%)	2 (66.7%)	24 (70.6%)	150 (68.2%)	0.905
Hydrocephalus	7 (3.9%)	0	1 (33.3%)	3 (8.8%)	11 (5.0%)	0.098
Myopia	5 (2.8%)	0	0	2 (5.9%)	7 (3.2%)	0.412
Esotropia	18 (9.9%)	0	0	3 (8.8%)	21 (9.5%)	1.000
Strabismus	5 (2.8%)	0	0	0	5 (2.3%)	0.632
Other Vision Disorders	12 (6.6%)	0	1 (33.3%)	1 (2.9%)	14 (6.4%)	0.249
Optic Nerve Disorders	10 (5.5%)	0	0	0	10 (4.5%)	0.487
Hearing Loss	6 (3.3%)	0	1 (33.3%)	1 (2.9%)	8 (3.6%)	0.174
Dental Carries	7 (3.9%)	1 (50.0%)	0	0	8 (3.6%)	***0.047****
Asthma	16 (8.8%)	0	0	3 (8.8%)	19 (8.6%)	1.000
Laryngomalacia	4 (2.2%)	0	0	1 (2.9%)	5 (2.3%)	1.000
Congenital Heart Diseases	8 (4.4%)	0	0	3 (8.8%)	11 (5.0%)	0.514
GERD	25 (13.8%)	0	0	9 (26.5%)	34 (15.5%)	0.266
Constipation	10 (4.4%)	0	0	2 (5.9%)	12 (5.5%)	1.000
Hydronephrosis	8 (2.8%)	1 (50.0%)	0	2 (5.9%)	11 (5.0%)	0.079
Neurogenic Bladder	5 (2.8%)	0	0	0	5 (2.3%)	0.632
DDH	14 (7.7%)	0	0	1 (2.9%)	15 (6.8%)	0.612
Spinal Curvature	10 (5.5%)	0	1	0	11 (5.0%)	0.118
Bone Deformities	5 (2.8%)	0	0	0	5 (2.3%)	0.632
FTT	10 (5.5%)	0	1	1 (2.9%)	12 (5.5%)	0.202

lower esophageal sphincter. Furthermore, the spasticity leads to an elevated intra-abdominal pressure [18]. Esotropia has a prevalence of 9.5% in our population. The incidence of asthma is 8.6%, which is rather low compared to a study conducted in the US where at least 1 in 5 children with cerebral palsy had a frequency of 21.9% [19]. In our study, we have found that the majority of cases of spastic cerebral palsy occur between 38 and 40 weeks of pregnancy. This contradicts the common belief that preterm deliveries are a primary cause of cerebral palsy. Moreover, a comprehensive study conducted on a significant population in Sweden revealed a negative correlation between the duration of pregnancy and the likelihood of CP. The most significant association was reported for pregnancies lasting between 22 and 24 weeks [20].

In our study, vaginal birth was more prevalent than the use of c-section. Despite the long-standing argument that c-section can lower the incidence of CP, there is no supporting evidence in the literature. Our findings also indicate no statistical significance in this regard [21]. Regarding birth weight, the majority of patients of Spastic CP had a weight exceeding 4,000 g. However, a previous study found a statistically significant association between low birth weight and CP [22]. The results of our study indicate that nearly all of our patients (n=153) exhibited an aberrant imaging outcome (p=0.011). Using primarily brain MRI, we identified predominantly white matter injury of prematurity in our study. Specifically, we observed periventricular leukomalacia in 82 individuals and hypoxic-ischemic encephalopathy in 36 patients. Similarly, Bax et al. observed that 81.4% of their patients underwent a brain MRI, which revealed immaturity-related white-matter injury in 42.5% of cases [23]. Furthermore, the Himmelmann et al. study, which examined the neuroimaging patterns in patients with CP, revealed that the predominant observations were white matter injury, occurring in 49.1% of cases [23,24]. Assessing the outcomes in children with cerebral palsy presents several challenges, as mentioned in the Vargus-Adams study [25].

Our study findings showed that 162 of our patients experienced a global developmental delay to some extent, while 92 patients exhibited a gross motor delay. Seventy-five of our patients experienced developmental language impairment, and sixty-five of them also acquired epilepsy. The study by Bax, M et al. indicates that signs of motor impairments associated with CP can be observed within the first 18 months of a child's life [23]. However, it is worth noting that many infants who are finally diagnosed with CP have already received medical attention for newborn issues and require comprehensive care from several disciplines [23].

Orthopedic procedures are frequently performed in people with CP. The majority of the actions are executed in the lower limbs rather than the upper limbs [26]. In our analysis, 56.8% of the patients had orthopedic interventions, with the most common procedure being tendon release (n=58). Similarly, in Rehbein et al.'s investigation, tendon releases were performed in 237 patients [27]. Regarding the various comorbidities experienced by our patients with CP, it is common to observe visual impairments and difficulties with eye movement. These may include conditions such as nearsightedness (myopia), inward deviation of the eyes (esotropia), misalignment of the eyes (strabismus), diseases of the optic nerve, and other eye-related disorders. In total, 57 of our patients had a combination of these ocular conditions. A separate investigation corroborated our findings, indicating that visual abnormalities and ocular motility disorders are prevalent (28%) among children with CP. Evidence indicates that children with CP caused by periventricular leukomalacia are at a higher risk of experiencing visual perception difficulties [28].

Additional research is required to determine the underlying causes of cerebral palsy, including investigating the potential impact of infection during the prenatal period. Furthermore, it is necessary to explore the application of modern brain imaging techniques based on the specific clinical characteristics of the condition. This study has limitations. This is a single center study; which restrict the generalizability of the study

findings. Besides, the use of cross-sectional study design restricted the ability to examine causality among the study variables.

CONCLUSION

Our study on CP prevalence, etiology, and associated diseases has led to various suggestions for current management and further research. Considering that spastic CP was the predominant kind seen, healthcare practitioners should prioritize early identification and implementation of targeted management methods for this specific subtype. Moreover, the significant occurrence of GERD in individuals with CP highlights the importance of routine screening and efficient treatment plans to alleviate symptoms and enhance quality of life. It is necessary to conduct additional research in the future to examine the factors that contribute to the development of CP, such as prenatal infections. Efforts should be made to investigate contemporary brain imaging methods in order to gain a deeper comprehension of the neurological foundation of CP and direct more focused therapies. Furthermore, it is necessary to conduct longitudinal studies in order to evaluate the long-term results and effectiveness of various management strategies in enhancing the quality of life for individuals with CP.

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Ethics Approval*:* This study was approved the research committee of King Abdullah International Medical Research Centre (KAIMRC) in Riyadh, Saudi Arabia, (NRC22R/457/09).

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