Haematological and biochemical profile of children with cerebral palsy in a neurodevelopmental clinic in Lagos, Nigeria

Oluwasikemi T Alalade, Mashudat A Bello-Mojeed, Grace T Ijarogbe, Abisola A Lawal, Opeyemi E Amodu

Abstract

Background: Deranged hematologic and biochemical profile have been associated with cerebral palsy in various ways, including association with aetiology and complication of the illness. We sought to describe haematological and biochemical parameters in children with cerebral palsy. The relationship between the parameters and the children's demographic characteristics was also examined.

Methods: It was a one-year retrospective analytical study of seventy-six children with cerebral palsy assessed at the Child and Adolescent Mental Health Service Centre, Lagos. Haemoglobin, packed cell volume, red blood cell count and its indices, white blood count, electrolytes, urea, creatinine, total protein and albumin, aspartate transaminase, alanine transaminase, and alkaline phosphatase parameters were recorded. The data was analyzed with Statistical Package for Social Sciences (SPSS-26). The mean, standard deviation and interquartile range were analyzed. The level of significance was at $p<0.05$.

Results: The Mean ±SD haemoglobin level, white blood cell count and platelet count were 115.77 mg/dl ± 7.844, 7.486 x 10^9/L ± 2.251, and 305.17 x 10^9/L ± 104.599 respectively. Males had higher mean values for all parameters except mean cell volume, mean corpuscular volume, creatinine and alkaline phosphatase levels. On t-test analysis, anaemia was commoner in children less than 5 years and it was statistically significant ($p=0.045$). Lower alkaline phosphatase values were observed in children older than 9 years old, which was statistically significant ($p=0.030$). Sodium levels were similar across all age groups and did not show any statistically significant difference.

Conclusion: This study found various haematological and biochemical derangements with anaemia observed to be commoner in the younger age group. The findings will help in the assessment and management plan for children with cerebral palsy.

Keywords: haematological, biochemical, cerebral palsy, anaemia

Highland Med Res J 2025;25(2):23-28

https://dx.doi.org/10.4314/hmrj.v25i2.5

Abbreviations

PCV- Packed cell volume
RBC- Red blood cell
WBC- White blood cell
MCV- Mean corpuscular volume
MCH- Mean cell haematocrit
AST- Aspartate transaminase
ALT- Alanine aminotransferase
ALP- Alkaline phosphatase

Introduction

Cerebral Palsy is "a group of permanent disorders of movement and posture, causing activity limitation, that are attributed to non-progressive disturbances that occurred in the developing fetal or immature brain"[1]. Prevalence of cerebral palsy from developed countries range from 2.2-3.3/1,000 while those in Africa are from 2-10/1,000 live births[2].

Deranged hematologic and biochemical profile have been associated with cerebral palsy in various ways, including association with aetiology and complication of the illness. Neonatal encephalopathy, which may precede the diagnosis of cerebral palsy[3], has been associated with haematological abnormalities such as anaemia, thrombocytopenia, and leucocytosis[4,5]. These abnormalities could occur due to organ dysfunction or systemic inflammation that are commonly associated with encephalopathy[5]. These derangements are typically observed in the neonatal period and it remains uncertain whether they persist until the time of cerebral palsy diagnosis.

Poor nutritional status has been associated with cerebral palsy[1]. This malnutrition results from conditions like impaired oral-motor function, contracture of temporomandibular joints, vomiting, and gastro-esophageal reflux disease[6]. These conditions decrease their food consumption thereby decreasing their intake of micronutrients that are essential for a balanced haematological and biochemical status[7]. The health status of children can be affected by nutrition through haematologic, immunologic and biochemical pathways[8]. Malnutrition and micronutrient deficiencies can result in anaemia[9], growth retardation, contractures[10,11], and fractures[12].

The most common haematologic abnormality seen in children and adolescents is Anaemia. Anaemia is defined as a condition in which the number of haemoglobin or red blood cell count are insufficient to meet metabolic and physiologic demands[13]. Almost 2 billion people in the world suffer from anaemia with more than half of them being children below the age of 5 years[14]. Anaemia itself is not a diagnosis but in children,

Child and Adolescent Mental Health Service Center, Federal Neuropsychiatric Hospital, Yaba, Lagos.

All correspondences to:
Oluwasikemi T Alalade,
Email: sychemiey@gmail.com

it is an indicator of poor nutrition or infection. This can result into fatigue, reduced physical capacity, shortness of breath and poor cognitive and motor development in children[14,15]. Classification of anaemia is based on peripheral full blood count findings and size of the erythrocytes. It can be classified into acute or chronic, hemolytic or nonhaemolytic. Anaemia can result from nutrient deficiency such as iron and B vitamins or other metabolic deficits.

A full blood count is essential in evaluating for haematological abnormalities. The red blood cell count, haemoglobin and reticulocyte count are a good measure of anaemia while co-existing derangement in the leucocyte and platelet counts identifies disorders that are not limited to the erythrocytes alone[14].

An optimal electrolyte balance is important for the overall health of a child[16]. Electrolyte imbalance also has significant effect on childhood morbidity and mortality. It can occur in children with chronic illnesses and malnutrition, and when its present, it can affect the outcome[17,18]. These deficiencies can affect the functioning capacity of the children with resultant effect on and their family members well being[13]. Several studies have checked nutritional status in children with cerebral palsy and the causes of the malnutrition seen in these children. However, our studies focuses on describing these haematological and biological parameters.

Methods

The study was conducted at the Child and Adolescent Mental Health Service Center of the Federal Neuropsychiatric Hospital, Yaba, Lagos. The center attends to children below the age of 18 years with various neurodevelopmental and psychiatric conditions. It has an emergency room where new patients are seen every day. Haematologic and biochemical investigations are routine investigations done for all patients at the center.

The study was a one-year retrospective analytical review of children aged 2 to 18 years who had been diagnosed with cerebral palsy at the center. The diagnosis of cerebral palsy was based on clinical evaluation, defined by the presence of motor impairment or activity limitation attributed to a non-progressive disturbance occurring in the developing fetal or infant brain. Eligible participants included children with documented delays in motor milestones. Only those with available investigation results were included in the analysis. Children with chronic illnesses that could affect the haematological and biochemical status such as cardiac and renal diseases were excluded. Ethical approval was obtained from the ethics committee of the Hospital.

Data collection was from case notes of children seen between the period of January to December 2022 for the haematological and biochemical investigations done at presentation.

Hemoglobin, platelet count, white blood count (WBC), red blood cells (RBCs), packed cell volume, RBC indices, and biochemical parameters (urea, creatinine, total bilirubin, total protein, albumin, globulin, aspartate transaminase, alanine transaminase, electrolytes, calcium, and alkaline phosphatase) were analysed.

Analysis of data was done using Statistical Package for the Social Sciences Software (SPSS). The distribution of our continuous variables were assessed. Normally distributed data are presented as mean ± standard deviation, while skewed data are presented as median with interquartile range. The analysis was stratified by age groups and by gender. Comparisons were made between male and female participants, and between different age categories, to identify potential differences in the variables. Level of significance was set at $p < 0.05$.

Results

A total of 125 patients were diagnosed with cerebral palsy in the year of study, however, 76 met the inclusion criteria and were recruited into the study. Figure 1 and 2 showed the age and gender distribution of the study participants. The study participants were aged 2- 14 years with median age of 4(IQR 2-7). Age distribution showed 56.6% of the participants were 2-4 years old, 31.6% were 5-9 years old and 11.8% were 10-14 years old. There were more males (60%) than females (40%).

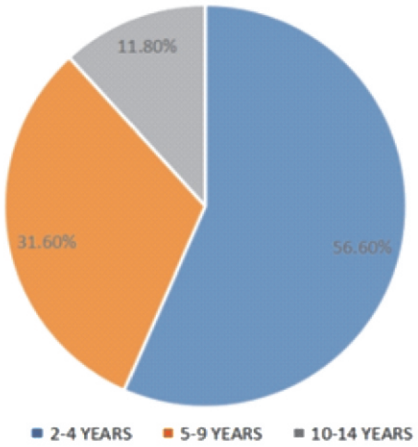

Figure 1: Age Distribution of Study Participants

Table 1 shows the mean, standard deviation, median, and interquartile range of the haematological and biochemical parameters. Table 2 and 3 shows the age and gender based means of the parameters respectively. The average haemoglobin was 115.77mg/dl, average WBC was 7.486 x 10^9/ L and average platelet count was 305.17 x 10^9/L.

Age group 2 – 4 years had lower mean values for all red blood cell indices. They had significantly lower mean scores for haemoglobin (P= 0.045), protein (P= 0.037) and potassium (P=0.045). There was significantly lower value of ALP in age group 10-14 years. The males had higher mean values than females for all parameters except MCV, MCH, ALP and creatinine.

Table 1: Distribution of Haematological and Biochemical Variables

Variable	Mean ± Standard Deviation	Median	Interquartile Range
Haemoglobin	115.77 ± 7.844	116.00	109.00 - 121.00
PCV	0.365 ± 0.016	0.360	0.350 - 0.370
RBC	4.567 ±0.400	4.520	4.30 - 4.80
WBC	7.486 ± 2.251	7.2	6.1-8.3
Platelet	305.17 ± 104.599	306	226-346
MCV	80.26 ± 5.382	81	78-84
MCH	25.477 ± 2.371	25.9	24-27
Urea	2.640 ± 0.916	2.6	1.9-3.3
Creatinine	34.46 ± 11.989	32	28-42
Protein	75.11 ± 5.999	74	71-80
Albumin	42.31 ± 3.818	43	40-45
AST	37.00 ± 23.391	32	24-37
ALT	18.74 ± 9.131	17	12-24
ALP	252.66 ± 99.464	239	189-295
Sodium	137.54 ± 2.393	138	135.75-139.00
Potassium	3.917 ± 0.374	3.9	3.7-4.1

Table 2: Mean Parameters according to Age Group

Variable	<5 years	5-9 years	10-14 years	p- value
Haemoglobin	113.00 ± 10.688	118.13 ± 7.947	115.89 ± 12.564	0.045
PCV	0.366 ± 0.033	0.381 ± 0.026	0.374 ± 0.034	0.714
RBC	4.640 ± 0.482	4.629 ± 0.368	4.453 ± 0.471	0.553
WBC	8.662 ± 3.760	7.175 ± 2.117	6.567 ± 1.005	0.081
Platelet	284.40 ±117.842	257.75 ± 90.866	327.56 ± 120.078	0.258
MCV	78.90 ± 6.447	79.93 ± 4.827	84.75 ± 3.862	0.538
MCH	25.100 ± 2.625	25.371 ± 2.307	27.250 ± 1.139	0.812
Urea	2.733 ± 1.043	2.650 ± 0.956	3.200 ± 0.760	0.595
Creatinine	33.55 ± 11.800	38.67 ± 12.296	50.88 ± 24.787	0.531
Protein	72.56 ± 6.878	77.29 ± 4.723	76.00 ± 5.766	0.037
Albumin	43.39 ± 5.449	44.33 ± 3.749	39.78 ± 8.028	0.058
AST	42.56 ± 22.023	35.42 ± 13.371	30.67 ± 8.246	0.353
ALT	23.02 ± 12.634	19.17 ± 8.869	18.11 ± 5.349	0.429
ALP	219.49 ± 77.599	271.38 ± 110.008	205.00 ± 77.330	0.030
Sodium	136.83 ± 2.459	137.58 ± 2.041	136.50 ± 3.251	0.640
Potassium	3.943 ± 0.366	4.033 ± 0.537	4.163 ± 0.417	0.045

Table 3: Mean Parameters according to Gender

Variable	Male	Female	P value
Haemoglobin	115.93 ± 9.616	113.48 ± 11.246	0.391
PCV	0.375 ± 0.031	0.366 ± 0.031	0.894
RBC	4.621 ± 0.506	4.609 ± 0.254	0.006
WBC	7.996 ± 3.301	7.838 ± 3.005	0.171

Variable	Male	Female	P value
Platelet	284.60 ± 102.489	275.11 ± 124.134	0.458
MCV	79.72 ± 6.699	80.23 ± 3.789	0.170
MCH	25.20 ± 2.757	25.862 ± 1.661	0.077
Urea	2.931 ± 0.982	2.486 ± 0.957	0.573
Creatinine	35.33 ± 11.047	39.79 ± 18.778	0.104
Protein	74.82 ± 6.673	74.07 ± 6.181	0.582
Albumin	43.39 ± 5.244	43.07 ± 5.813	0.690
AST	40.34 ± 20.757	36.53 ± 15.224	0.838
ALT	21.34 ± 11.743	20.93 ± 9.847	0.956
ALP	233.07 ± 89.593	236.73 ± 96.731	0.317
Sodium	137.00 ± 2.532	137.10 ± 2.289	0.391
Potassium	4.002 ± 0.464	3.986 ± 0.389	0.310

Discussion

A total of 76 participants were recruited into the study within the ages of 2-14 years. There were more children within the ages of 2-4 years compared to other age groups. Older age has been implicated as a factor for non-clinic attendance[19]. This is because as children grow older, their family and caregivers may become more familiar at managing conditions at home and such reduced clinic visits. Also caregivers may believe that condition is stable and does not require much medical oversight. Mobility can also make frequent clinic visits difficult.

There were more males than females with cerebral palsy in the study. There is a biological vulnerability of male sex in Cerebral Palsy and other neuro-developmental disorders such as genetic predisposition and potential influence of female hormones in reducing risk of brain damage. This likely reflects the exposure to maternal/placenta estrogens and progesterones in utero rather than high endogenous hormone levels in young female children[20].

The gender based analysis revealed higher haemoglobin, packed cell volume, and red blood cell count in males compared to females, although only the difference in red blood cell count reached statistical significance. Mean corpuscular volume and mean corpuscular haemoglobin were slightly higher in females, but these differences were not statistically significant. Pluncevic et al. in their study of red cell variables in children and adolescents in Macedonia reported similar findings to this study[21]. Similar higher red cell indices were also reported by Behera and Bulliyya[22] in Indian children and Al-Jafar[23] in Kuwaiti children in their exploration of haematological reference ranges in children and adolescents. Furthermore, regional pediatric reference studies from Nigeria showed higher haemoglobin and red blood cells values in males compared to females. Although sex differences in red cell indices are often attributed to the stimulatory effect of androgens during and after puberty, smaller differences have also been observed in prepubertal children. These may be explained by sex-related variation in lean body mass and circulating blood volume, and possible differences in nutritional status or iron availability between boys and girls[-]

Although the mean haemoglobin levels across age groups in this study were within the expected reference ranges, further analysis of individual values revealed that anaemia was most prevalent in children under five years. According to WHO criteria, anaemia is defined as haemoglobin levels < 110 mg/dL in children under 5 years, < 115 mg/dL in those aged 5–11 years, and < 120 mg/dL in those aged 12–14 years. Using these thresholds, anaemia was reported in 55.2% of children under 5 years, 10.5% in those aged 5-11years and 6.6% in those aged 10-14 years, despite the group mean appearing normal. The higher anaemia burden among under-fives is consistent with global reports that identify this age group as the most vulnerable due to rapid growth, increased physiological iron requirements, and higher exposure to nutritional deficiencies and infectious diseases such as malaria and helminthiasis. In contrast, children aged 5–9 years and 10–14 years had relatively fewer cases of anaemia, aligning with evidence that the risk decreases with age as dietary intake stabilises and risk of tropical diseases reduces. These findings emphasize the need for age-specific interpretation of haematological parameters in clinical practice.

Alkaline phosphatase (ALP) levels had tendency to decline significantly with advancing age in this study. ALP has been used as a biochemical marker for bone growth and formation, hence its levels increase as a children grows till they become fully grown adults[25]. However, in children with cerebral palsy, immobilization, decreased sun exposure and lack of weight bearing are factors that could cause fragile bones thereby limiting bone growth[5,26]. This is evidenced by the identified lower levels of ALP as they grow older.

The mean serum sodium values observed across all age groups (136.5–137.6 mmol/L) were within the expected pediatric reference range (135–145 mmol/L). The lack of statistically significant differences (p=0.640) indicates that serum sodium remained stable across age groups in our cohort, consistent with normal physiological homeostasis.

A major limitation of this study is the retrospective data collection which accounted for some missing data. However, the study was able to describe the haematological and biochemical parameters in the children and identify associated significant factors. Authors also recommend that future prospective case–control studies be undertaken to provide a more direct comparison between children with cerebral palsy and their age and gender-matched controls.

Conclusion

This study has highlighted the influence of age and gender on haematological and biochemical parameters in children with cerebral palsy. Understanding these variations is important because it helps clinicians distinguish between changes that are due to normal developmental physiology and those that may signal underlying pathology. For example, the recognition that younger children have lower haemoglobin values can prompt earlier nutritional assessment and targeted interventions, while awareness of gender differences in biochemical indices may guide individualized monitoring. In this way, our findings can support more accurate interpretation of laboratory results, timely diagnosis of treatable conditions such as anaemia, and ultimately improve the quality of life of affected children through earlier and more tailored care.

Conflict of Interest

None declared.

Acknowledgement

The authors acknowledge all staff of the Child and Adolescent Mental Health Service Center of the Federal Neuropsychiatric Hospital, Yaba, Lagos for the support during the data collection.

References

1. Patel DR, Neelakantan M, Pandher K, Merrick J. Cerebral palsy in children: A clinical overview. Transl Pediatr. 2020;9(1):S125–35.
2. Eyong KI, Asindi AA, Torty C. Aetiology and comorbidities of cerebral palsy in a developing country. Int J Res Med Sci. 2018;6(10):3246.
3. Garfinkle J, Wintermark P, Shevell MI, Platt RW, Oskoui M. Cerebral palsy after neonatal encephalopathy: How much is preventable? J Pediatr [Internet]. 2015;167(1):58-63.e1. Available from: http://dx.doi.org/10.1016/j.jpeds.2015.02.035
4. Kalteren WS, Ter Horst HJ, Den Heijer AE, De Vetten L, Kooi EMW, Bos AF. Perinatal Anemia is Associated with Neonatal and Neurodevelopmental Outcomes in Infants with Moderate to Severe Perinatal Asphyxia. Neonatology. 2018;114(4):315–22.
5. Isweisi E, Moore CM, Hurley T, Sola-Visner M, McCallion N, Ainle FN, et al. Haematological issues in neonates with neonatal encephalopathy treated with hypothermia. Semin Fetal Neonatal Med. 2021;26(4):1–8.
6. Tomoum HY, Badawy NB, Hassan NE, Alian KM. Anthropometry and body composition analysis in children with cerebral palsy. Clin Nutr [Internet]. 2010;29(4):477–81. Available from: http://dx.doi.org/10.1016/j.clnu.2009.10.009
7. Hillesund E, Skranes J, Trygg KU, Bøhmer T. Micronutrient status in children with cerebral palsy. Acta Paediatr Int J Paediatr. 2007;96(8):1195–8.
8. Foster BA, Lane JE, Massey E, Noelck M, Green S, Austin JP. The impact of malnutrition on hospitalized children with cerebral palsy. Hosp Pediatr. 2020;10(12):1087–95.
9. Benfer KA, Weir KA, Bell KL, Ware RS, Davies PSW, Boyd RN. Oropharyngeal dysphagia and gross motor skills in children with cerebral palsy. Pediatrics. 2013;131(5).
10. Lopes PAC, Amancio OMS, Araújo RFC, Vitalle MS de S, Braga JAP. Food pattern and nutritional status of children with cerebral palsy. Rev Paul Pediatr. 2013;31(3):344–9.
11. Sullivan PB, Juszczak E, Bachlet AME, Thomas AG, Lambert B, Vernon-Roberts A, et al. Impact of gastrostomy tube feeding on the quality of life of carers of children with cerebral palsy. Dev Med Child Neurol. 2004;46(12):796–800.
12. Davis E, Shelly A, Waters E, Boyd R, Cook K, Davern M. The impact of caring for a child with cerebral palsy: Quality of life for mothers and fathers. Child Care Health Dev. 2010;36(1):63–73.
13. Chaparro CM, Suchdev PS. Anemia epidemiology , pathophysiology , and etiology in low- and middle-income countries. 2019;1450:15–31.
14. Gallagher PG. Anemia in the pediatric patient. 2022;140(6):571–93.
15. World Health Organization. Anaemia [Internet]. Newsletter. 2024. Available from: https://www.who.int/news-room/fact-sheets/detail/ANAEMIA
16. Ekpe E., Uhegbu K., Orji I., Uhegbu V., Osuji K., Ejikem Eke C. Pattern of Electrolyte Profile among admitted children (1-18 years) at the University of

Calabar Teaching Hospital, Nigeria. Med Res Chronicles. 2020;7(2394):6–12.
17. Raza M, Kumar S, Ejaz M, Azim D, Azizullah S, Hussain A. Electrolyte Imbalance in Children With Severe Acute Malnutrition at a Tertiary Care Hospital in Pakistan: A Cross-Sectional Study. 2020;12(9).
18. Naseem F, Saleem A, Mahar IA, Arif F. Electrolyte imbalance in critically ill paediatric patients. 2019;35(4).
19. Paget SP, McIntyre S, Goldsmith S, Ostojic K, Shrapnel J, Schneuer F, et al. Non-attendance at outpatient clinic appointments by children with cerebral palsy. Dev Med Child Neurol. 2022;64 (9):1106–13.
20. Romeo DM, Venezia I, Pede E, Brogna C. Cerebral palsy and sex differences in children: A narrative review of the literature. J Neurosci Res. 2023;101(5):783–95.
21. Pluncevic Gligoroska J, Gontarev S, Dejanova B, Todorovska L, Shukova Stojmanova D, Manchevska S. Red blood cell variables in children and adolescents regarding the age and sex. Iran J Public Health. 2019;48(4):704–12.
22. Behera S, Bulliyya G. Magnitude of Anemia and Hematological Predictors among Children under 12 Years in Odisha, India. Anemia. 2016;2016:3–12.
23. Al-jafar HA. Provisional Kuwaiti Children Hematology Reference Range. J Hematol Thromb. 2016;2(2).
24. Khandelwal R, Manjunath VV, Mehta L, Mangajjera SB. Hematological and biochemical profiles in children with cerebral palsy: A cross-sectional study. J Pediatr Rehabil Med. 2023; 16(1):171–7.
25. Turan S, Topcu B, Gökçe I, Güran T, Atay Z, Omar A, et al. Serum alkaline phosphatase levels in healthy children and evaluation of alkaline phosphatase z-scores in different types of rickets. JCRPE J Clin Res Pediatr Endocrinol. 2011;3 (1):7–11.
26. Houlihan CM, Stevenson RD. Bone Density in Cerebral Palsy. Phys Med Rehabil Clin N Am. 2009;20(3):493–508.
27. Aydin K, Aydin K, Akbas Y, Unay B, Arslan M, Cansu A, et al. A multicenter cross-sectional study to evaluate the clinical characteristics and nutritional status of children with cerebral palsy. Clin Nutr ESPEN. 2018;26:27–34.
28. Mei C, Hodgson M, Reilly S, Fern B, Reddihough D, Mensah F, et al. Oromotor dysfunction in minimally verbal children with cerebral palsy: characteristics and associated factors. Disabil Rehabil [Internet]. 2022;44(6):974–82. Available from: https://doi.org/10.1080/09638288.2020.1788179
29. Adamson TA. Descriptive national survey of substance use in Nigeria. J Addict Res Ther. 2015;06(03).