



## Research Article

# Electrolyte Assessment: A Comparison Across Age Group and Sex In Children (0-6 Years) At Federal Teaching Hospital, Owerri, Imo State, Nigeria

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## Article Info

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## Abstract

Electrolyte balance is crucial for maintaining physiological functions such as homeostasis, nerve conduction, muscle function, and acid-base balance. Sick children are particularly vulnerable to electrolyte imbalances. This study aims to compare electrolyte levels across different age groups and sexes in children peer at the Federal Teaching Hospital, Owerri. A cross-sectional design was employed assessing 100 pediatric patients who underwent electrolyte testing at Federal Teaching Hospital, Owerri. The legal guardian and parents provided written consent for their wards' participation. The participants were divided by age groups (< 1 year, 1-3 years, 4-6 years) and sex (male and female). Blood samples were collected into heparin bottles for electrolyte assessment. Key electrolytes assessed included Sodium ( $Na^+$ ), Potassium ( $K^+$ ), Chloride ( $Cl^-$ ), Bicarbonate ( $HCO_3^-$ ), and Calcium ( $Ca^{2+}$ ). Statistical analyses included T-test for sex-based comparisons and ANOVA for age group comparisons. The results revealed no significant differences ( $p$  – value > 0.05) in electrolyte levels across age groups in the pediatrics. Also, there was no significant difference ( $p$  – value > 0.05) in electrolyte levels between male and female of the pediatric subjects except in calcium level that had significant increase in calcium level in male. This study has demonstrated that age and sex do not have any impact of electrolyte levels in pediatric at Federal Teaching Hospital, Owerri although such was not consistent with calcium where male children were reported to have significantly elevated calcium level.

## 1. Introduction

Electrolyte balance plays key role in maintaining homeostasis along with fluids in paediatric patients. The higher and lower value of critical electrolytes like sodium, potassium and chloride can affect cellular processes drastically as it may result in cardiac and neurological complications [1]. This can alter patient status in terms of morbidity and mortality [2, 3] Fluid and electrolyte abnormalities are common in critically ill children and often represent complications from underlying disease states or medications [4]. In pediatrics, the assessment of electrolyte levels is crucial in children, due to their varying developmental stages, then are particularly vulnerable to imbalances which can significantly impact their growth and overall health [5].

In general, electrolyte abnormalities tend to be more common in younger children with acute diarrhea. The most severe threat posed by acute watery diarrheal disease is dehydration [6]. During a diarrheal episode, water and electrolytes (sodium, chloride, potassium, and bicarbonate) are lost through liquid stools, vomit, sweat, urine, and breathing [7]. Also, different pathophysiological mechanisms, including

abnormal fluid and electrolyte transport, decreased absorption, and increased secretion could be involved in children with acute diarrhea [8]. Studies have shown that hyponatremia, hypokalemia, and metabolic acidosis are among the common electrolyte abnormalities in children with acute diarrhea and dehydration are often responsible for mortality [9–12].

Data from the World Health Organization (WHO) and the United Nations Children's Fund showed that there are about 2 billion cases of diarrheal diseases reported annually worldwide, accounting for the deaths of over 1.9 (18%) million children under 5 years of age mostly from developing countries annually [13]. The pediatric population at Federal Teaching Hospital, Owerri, a tertiary healthcare facility in southeastern Nigeria, offers a diverse cohort for examining electrolyte variations [14]. Understanding these variations can aid in the development of targeted medical interventions and preventive strategies, ultimately improving patient outcomes. The primary electrolytes of interest in this study are sodium, potassium, chloride, bicarbonate and calcium, each of which has distinct physiological roles and clinical implications when imbalanced.

Based on previous studies, the most common electrolyte abnormalities noted are low bicarbonate (52.9%) and hyponatremia (39.6%) [5]. Children aged 1-5 years are likely to have the highest prevalence of these abnormalities. Differences in electrolyte profiles between age groups were also observed.

This study also focuses on assessing differences in electrolyte patterns between male and female pediatric patients less than 6 years. Understanding sex-based variations in electrolyte levels can help guide age and sex-specific reference intervals and management strategies. This study aims to compare electrolyte levels across different age groups and sexes in 0-6 years at the Federal Teaching Hospital, Owerri, providing insights into the prevalence and patterns of electrolyte imbalances in this population. By systematically examining electrolyte levels across different pediatric age groups and sexes, this study seeks to enhance our understanding and contribute to the optimization of pediatric healthcare practices at Federal Teaching Hospital, Owerri, which is expected to potentially inform broader clinical guidelines for pediatric electrolyte management.

## 2. Methodology

### Study Design

This study will utilize a cross-sectional retrospective design, analyzing medical records of pediatric patients who have undergone electrolyte testing at Federal Teaching Hospital, Owerri. A total of 100 pediatrics participated in the study and samples were collected for electrolyte assessment. The results were compared based on age groups and gender.

### Study Area

The study was conducted at Federal Teaching Hospital, Owerri located at 105 Orlu Rd, 460281, Owerri-Municipal LGA, Imo State. The Federal Teaching Hospital is a tertiary government run health facility that serves the entire Imo State in the South-East geopolitical zone in Nigeria.

### Ethical Consideration

Approval for ethical compliance of the study was obtained from the Ethics Committee, Federal Teaching Hospital, Owerri. In addition, written informed consent was provided by the legal guardian, parents of participants because they are children.

### Eligibility Criteria

The inclusion and exclusion criteria are stated as follows.

#### Inclusion Criteria

This research included pediatric patients registered with Federal Teaching Hospital, Owerri, whose parents or guardians were willing to provide at least oral/written consent. Individuals with no known pre-existing medical conditions or medications which may affect electrolyte levels were included to ensure the accuracy of biochemical assessments.

#### Exclusion Criteria

Patients who have received acute interventions like IV fluids or electrolyte replacements prior to the test, which could skew the natural electrolyte levels were excluded. Also, patients not registered with the facility were excluded from the study, as well as patients whose parents or legal guardian declined consent.

#### Sampling Method

A simple random sampling technique was employed to recruit participants for this study. This was chosen to ensure a fair and unbiased representation of the target population [15].

#### Sample Collection

A structured questionnaire was distributed to all participants to collect their information. Blood samples were obtained by venepuncture, drawing 2mls of blood from each participant's cubital vein using sterile disposable syringes. These samples were then placed in lithium heparin bottles and was separated by centrifugation at 3500 r.p.m for 5 minutes using a Low-Speed Centrifuge. The plasma samples were stored frozen at 4 – 8°C until the analysis time. The electrolytes were assayed using ion selective electrode [16, 17].

**Table 1:** Demographic Characteristics of Subjects.

Characteristics of test Subjects	Number of Subjects	Percentage of the subjects (%)
<b>Gender</b>		
Male	64	64
Female	36	36
<b>Age</b>		
<1	65	65
1 – 3	23	23
4 – 6	12	12

### Statistical Analysis

The data generated from this study was analyzed using SPSS (Statistical Package for the Social Sciences) version 23, and statistical significance was defined as a p-value less than or equal to 0.05 at a 95% confidence interval. The electrolyte levels were represented as mean  $\pm$  SD. T-test was used to compare the various electrolyte levels between male and female. Analysis of variance (ANOVA) was used to compare the various electrolyte level among the different age groups.

### 3. Results

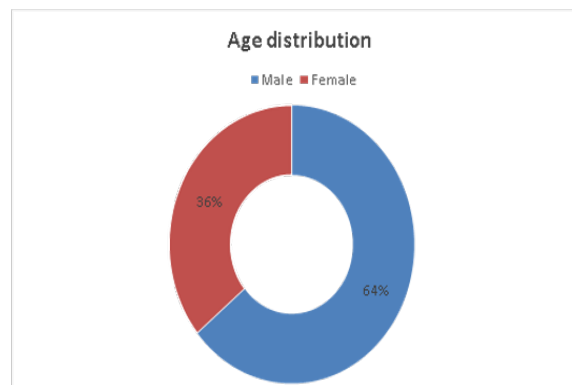
**Figure 1:** Gender distribution of participating pediatric subjects

Figure 1 showed the gender distribution of the subjects. The result showed that males had the highest participation of 64% compared to females with 36%.

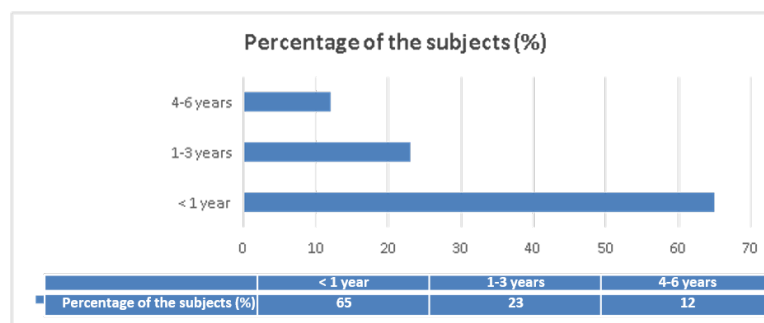
**Figure 2:** Age Distribution of Participants

Figure 2 showed the demographic characteristics of the subjects. The result showed that patients with less than one year had the highest participation (65%) while those between 4 to 6 years had the lowest participation of 12%. Table 2 showed the comparison of electrolyte levels among age groups (<1 year, 1-3 year, and 4-6 year). The tabular result showed that there was no significant difference (p-value > 0.05) in the electrolyte levels across the age groups.

Table 3 showed the comparison of electrolyte levels between males and females. The tabular result showed that there was no significant difference (p-value > 0.05) in the electrolyte levels between male and female groups but there was a significant increase in calcium level in male group.

**Table 2:** Comparison of Electrolytes Levels among Age Groups.

AGE	$Na^+$ (mmol/L)	$K^+$ (mmol/L)	$Cl^-$ (mmol/L)	$HCO_3^-$ (mmol/L)	$Ca^{2+}$ (mmol/L)
<1 year	133.8 ± 17.5	5.1 ± 6.7	104.3 ± 6.1	19.1 ± 5.1	2.8 ± 2.8
1- 3	129.4 ± 28.2	3.9 ± 0.1	98.5 ± 21.9	22.1 ± 7.3	4.3 ± 6.2
4 - 6	128.0 ± 36.1	4.35 ± 0.5	105.6 ± 4.1	20.7 ± 4.3	2.4 ± 0.1
f- value	0.537	0.376	2.406	2.532	1.482
p- value	0.585	0.687	0.095	0.084	0.232
Remark	NS	NS	NS	NS	NS

NS: Not significant

**Table 3:** Comparison of Electrolytes Levels between Male and Female Groups.

GENDER	$Na^+$	$K^+$	$Cl^-$	$HCO_3^-$	$Ca^{2+}$
Male	129.9 ± 28.2	4.2 ± 0.9	101.9 ± 13.9	19.3 ± 6.3	3.6 ± 4.7
Female	136.1 ± 5.4	5.7 ± 9.0	105.4 ± 5.9	21.1 ± 4.1	2.4 ± 0.3
T-value	- 1.720	- 0.957	- 1.747	- 1.733	1.973
p- value	0.344	0.344	0.083	0.086	0.05
Remark	NS	NS	NS	NS	SS

NS: Not significant

SS: Statistically significant

## 4. Discussion

This study analyzed electrolyte levels among pediatric patients aged 1-6 years at Federal Teaching Hospital, Owerri, focusing on variations across age groups and sexes. The key electrolytes assessed included Sodium ( $Na^+$ ), Potassium ( $K^+$ ), Chloride ( $Cl^-$ ), Bicarbonate ( $HCO_3^-$ ), and Calcium ( $Ca^{2+}$ ).

The study found no statistically significant differences in electrolyte levels for sodium, potassium, chloride, bicarbonate, and calcium across these age groups at Federal Teaching Hospital, Owerri. This suggests that age may not be a critical factor influencing electrolyte balance in this population. The uniformity in electrolyte levels could further validate the clinical practice in managing electrolyte levels across different pediatric age groups. However, the high proportion of infants under one year (65%) in the sample may have masked potential differences in older children. Infants have unique physiological characteristics compared to older children, such as differences in renal function, hormonal regulation, and dietary intake. These factors can influence electrolyte homeostasis [18]. Thereafter the skewed age distribution in the sample may have prevented the detection of age-related variations in electrolyte levels.

The study revealed no significant differences in sodium, potassium, chloride, and bicarbonate levels between male and female pediatric patients (0-6 years) at Federal Teaching Hospital, Owerri. This suggests that sex may not be a critical factor influencing electrolyte balance in this population [2]. However, calcium levels showed a statistically significant increase in males. This finding warrants further investigation to understand the underlying mechanisms and clinical implications. Calcium homeostasis is regulated by various factors, including hormones, dietary intake, and bone metabolism [19]. Sex-based differences in calcium levels may be related to differences in growth patterns, body composition, and hormonal profiles between males and females [20]. The high proportion of infants under one year in the study sample highlights the need for cautious interpretation of the findings. Infants have different physiological characteristics compared to older children, which could influence their electrolyte levels. Future studies should aim for a more balanced sample size across all pediatric age groups to detect potential variations more accurately.

A study by Ajose [21] established reference values for plasma electrolytes (sodium, potassium, bicarbonate) and urea in healthy Nigerian children and adolescents residing in Abeokuta, a location different from FMC Owerri. The mean values and reference intervals for sodium, potassium, bicarbonate, and urea were reported for both children (1-12 years) and adolescents (13-19 years). Sodium and urea levels were significantly higher in adolescents compared to children. Potassium and urea levels were significantly higher in male children and adolescents compared to females. This is in contrast to the results of this study suggesting that gender may influence electrolyte levels in children. The present study evaluated children 0-6 years in contrast to the Abeokuta study in children 1-12 years. The relative number of children less than 6 years and those 1-12 years may have contributed to the observed differences in the two studies. It is pertinent to observe that some pediatric patients aged 10-12 years may be undergoing peri- pubertal and adolescent hormonal changes which may have influenced the observed results. The study by Uzuogbu [22] assessed serum electrolyte and urea changes in Nigerian children infected with Plasmodium falciparum malaria, including those receiving care at FMC Owerri. There was no significant change in serum electrolyte levels (sodium, potassium, chloride, bicarbonate) between malaria-infected children and healthy controls. However, children within the 1-5 years age group had higher electrolyte levels compared to those under 1 year of age. These results suggest that while malaria infection may not directly impact overall electrolyte levels, there may be age-related differences in electrolyte homeostasis in this pediatric population, which is relevant to this study.

The study found no significant differences in electrolyte levels across age groups and sexes, except for calcium, suggesting that standard management protocols may be applicable to the pediatric population at Federal Teaching Hospital, Owerri. However, the high proportion of infants in the sample and the single-center nature of the study warrant cautious interpretation and further research with a more balanced sample size across age groups. Future studies should aim to elucidate the complex relationships between age, sex, and electrolyte levels in children.

## 5. Conclusion

This study provides valuable insights into the electrolyte balance among pediatric patients at Federal Teaching Hospital, Owerri. The study has revealed that gender and sex do not have any impact on the electrolyte levels in children 0-6 years at Federal Teaching Hospital except for calcium where males were reported to have higher levels compared to their female counterpart.

## Recommendations

Future studies should include larger and more balanced patient participation across different pediatric age and gender groups to provide a more comprehensive understanding of electrolyte balance. Also, further consideration of other sociodemographic factors is recommended to a broader understanding of the role of sociodemographic characteristics on electrolyte distribution in pediatrics.

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