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RESEARCH ARTICLE

ELECTROLYTE PROFILE FROM PATIENTS WITH COVID-19 AT THE INFECTIOUS AND TROPICAL DISEASES DEPARTMENT OF TREICHVILLE UNIVERSITY HOSPITAL, CÔTE D'IVOIRE

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ABSTRACT

Background: Electrolyte disturbances are frequently reported in patients with COVID-19 and may influence clinical management. This study aimed to assess serum electrolyte profiles in-patients with COVID-19 at Treichville University Hospital, Côte d'Ivoire. **Methods**: A cross-sectional descriptive and analytical study was conducted from March 14 to July 23, 2020, involving 60 patients with confirmed COVID-19. Serum sodium, potassium, and chloride concentrations were measured using an ion-selective electrode method on a Medica Easylyte automated analyzer. **Results:** Men accounted for 56.67% of patients, and the most represented age group was 50–59 years (30%). Serum sodium concentrations differed significantly between hypernatremic, hyponatremic, and normonatremic groups (p<0.0001), without significant sex-related differences. Hyperkalemic patients had higher potassium concentrations than normokalemic patients (p< 0.01), with significantly higher values in men than women within the hyperkalemic group (p< 0.05). Hyperchloremic patients exhibited significantly higher chloride concentrations than normochloremic and hypochloremic patients (p< 0.0001). **Conclusion:** Electrolyte abnormalities were observed among hospitalized COVID-19 patients, highlighting the importance of serum electrolyte assessment and monitoring alongside clinical evaluation.

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INTRODUCTION

Coronavirus disease 2019 (COVID-19), caused by SARS-CoV-2, emerged in China in late 2019 before rapidly spreading worldwide, triggering one of the most significant public health crises of the twenty-first century (Guan *et al*., 2020). The clinical presentation of COVID-19 is highly variable, ranging from asymptomatic infection to severe illness characterized by serious pneumonia, multiple organ failure, and the need for mechanical ventilation (Zhou *et al*., 2020). Initially regarded primarily as a respiratory disease, COVID-19 is now recognized as a systemic illness affecting several organs and systems, particularly the cardiovascular, renal, gastrointestinal, and endocrine systems, with potentially substantial metabolic consequences (Gupta *et al*., 2020). Among these metabolic disturbances, electrolyte imbalances have attracted growing interest since the earliest published clinical series. Numerous studies have shown that abnormalities in sodium, potassium, and chloride levels are common in patients hospitalized with COVID-19, sometimes from admission, and may influence disease severity and survival (Lippi *et al*., 2020). The underlying pathophysiological mechanisms are multiple and interconnected: dysregulation of the renin–angiotensin–aldosterone system related to viral use of the ACE2 receptor, gastrointestinal losses due to diarrhea, prolonged fever, acute kidney injury, inappropriate antidiuretic hormone secretion, and adverse effects of certain treatments, including diuretics and corticosteroids (Ellison and Berl, 2007; Atila *et al*., 2021). Hyponatremia is among the most frequently reported electrolyte abnormalities in patients with COVID-19, with prevalence estimates ranging from 20% to over 50% across studies. It has been associated with more severe disease and increased in-hospital mortality (Hu *et al*., 2021). Conversely, hypernatremia, often developing during hospitalization, appears to be a marker of poor prognosis, particularly among patients treated in intensive care units (Zimmer *et al*., 2020). Hypokalemia is also frequently observed and may result from increased urinary potassium losses secondary to SARS-CoV-2-

induced disruption of the renin–angiotensin–aldosterone system (Chen *et al*., 2020). Although less extensively studied, chloride abnormalities contribute to acid–base disturbances and may reflect the severity of metabolic derangements in hospitalized patients with COVID-19. Despite the extensive evidence from high-income countries, studies conducted in sub-Saharan Africa remain limited. Local factors, including patterns of comorbidity, delays in seeking care, socioeconomic conditions, and hospital resources, may affect the frequency and clinical impact of electrolyte disturbances. In Côte d'Ivoire, the Infectious and Tropical Diseases Department of Treichville University Hospital was one of the main centers managing moderate to severe COVID-19. However, data on electrolyte disturbances among patients hospitalized in this department remain scarce. In this context, a better understanding of electrolyte profiles, particularly sodium, potassium, and chloride levels, in patients with COVID-19 is essential to optimize clinical management, anticipate metabolic complications, and improve prognosis. This study aimed to describe the electrolyte profile of patients hospitalized with COVID-19 at the Infectious and Tropical Diseases Department of Treichville University Hospital, in the African setting.

MATERIALS AND METHODS

Study design and setting ; This was a cross-sectional descriptive study conducted at the Infectious and Tropical Diseases Department of Treichville University Hospital from March 14 to July 23, 2020.

Study population : The study population comprised 60 adult male and female patients hospitalized with confirmed SARS-CoV-2 infection during the study period.

Inclusion criteria

The following patients were included:

- Patients hospitalized at the Infectious and Tropical Diseases Department of Treichville University Hospital;
- Patients with COVID-19 confirmed by SARS-CoV-2 RT-PCR or an antigen test.

Non-inclusion criteria

The following patients were not included:

- Patients with incomplete medical records;
- Patients with underlying medical conditions likely to affect serum sodium, potassium, or chloride levels independently of SARS-CoV-2 infection.

Statistical Analysis ; Data were analyzed using GraphPad Prism 10 software. Quantitative variables were expressed as mean ± standard deviation (SD). Comparisons between groups were performed using appropriate statistical tests. A p-value < 0.05 was considered statistically significant.

Ethical Considerations : The study was conducted in accordance with the principles of the Declaration of Helsinki. Patient confidentiality and anonymity were strictly maintained.

Electrolyte analysis : These parameters were measured using the ion-selective electrode method on a Medica Easylyte® automated analyzer.

Principle : Each electrode is specific to a given ion and has a membrane selectively permeable to that ion. Upon contact with serum, ion exchange occurs at the membrane surface, generating an electrical potential difference related to ion concentration according to the Nernst equation. The analyzer converts this potential into an ionic concentration.

RESULTS

Sociodemographic characteristics

Sex: The study population comprised 56.67% men and 43.33% women, yielding a male-to-female ratio of 1.30.

Age : The most represented age group was 50–59 years, whereas patients younger than 30 years were the least represented (Figure 1).

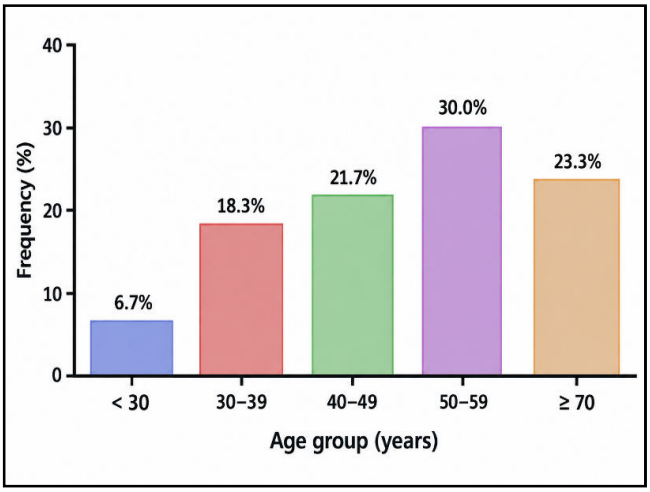


Figure 1. Distribution of patients by age group

Biochemical findings

Changes in serum sodium: Mean sodium concentrations differed significantly among the three groups (normonatremia, hypernatremia, and hyponatremia). Patients with hypernatremia had significantly higher mean sodium concentrations than patients with normal values ($p < 0.0001$). Likewise, patients with hyponatremia had significantly lower sodium concentrations than normonatremic patients ($p < 0.0001$) (Figure 2).

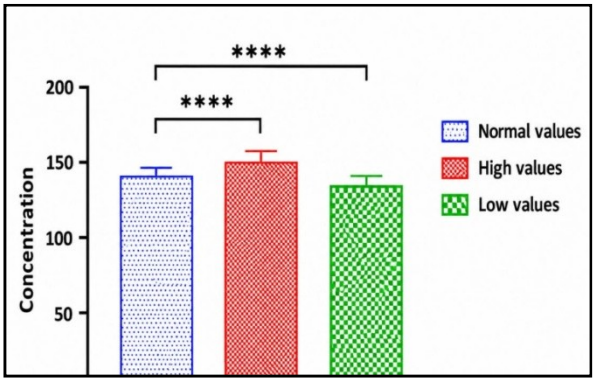


Figure 2. Distribution of serum sodium according to sodium status

Within each sex, patients with hypernatremia had significantly higher mean sodium concentrations than those with normal values, both among men ($p < 0.0001$) and women ($p < 0.001$), indicating highly significant within-sex differences. In contrast, comparisons between sexes showed no statistically significant differences in sodium concentrations, whether in the normonatremic or hypernatremic groups or in the overall population, indicating comparable sodium distributions between men and women. Furthermore, comparison of the hypernatremic group with the total population, stratified by sex, showed significantly higher mean sodium concentrations among hypernatremic patients, both in men ($p < 0.0001$) and women ($p < 0.001$) (Figure 3).

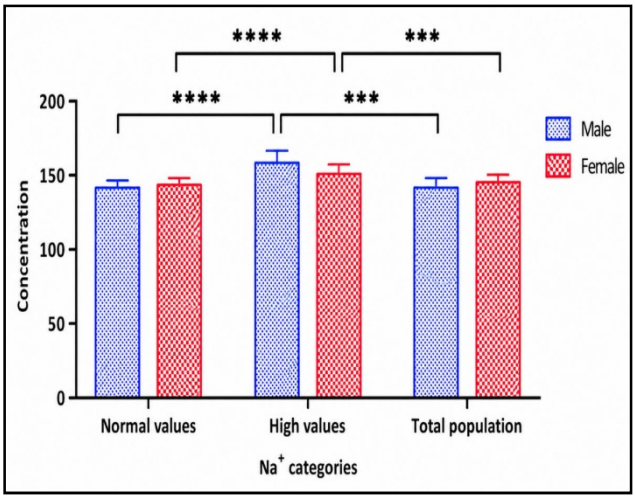


Figure 3. Comparison of serum sodium by sex and sodium status

Patients with hyperkalemia had significantly higher mean serum potassium concentrations than those with normokalemia ($p < 0.01$). Conversely, no statistically significant difference was observed between patients with hypokalemia and those with normokalemia ($p > 0.05$) (Figure 4).

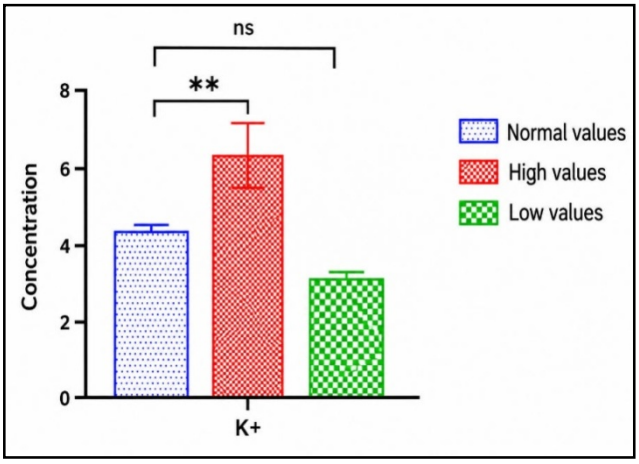


Figure 4. Distribution of serum potassium according to potassium status

The highest mean potassium concentrations were observed in patients with hyperkalemia, whereas the lowest concentrations were recorded in those with hypokalemia, regardless of sex. No statistically significant differences were observed between males and females with hypokalemia or normokalemia. However, among patients with hyperkalemia, mean serum potassium concentrations were significantly higher in males than in females ($p < 0.05$). Furthermore, comparisons across the different potassium categories and with the overall study population revealed several statistically significant differences, with *p*-values ranging from < 0.05 to < 0.0001 (Figure 5). A highly statistically significant difference was observed between patients with normal and elevated serum chloride concentrations, as well as between those with elevated and decreased serum chloride concentrations ($p < 0.0001$). In contrast, no statistically significant difference was found between patients with normal and decreased serum chloride concentrations (Figure 6).

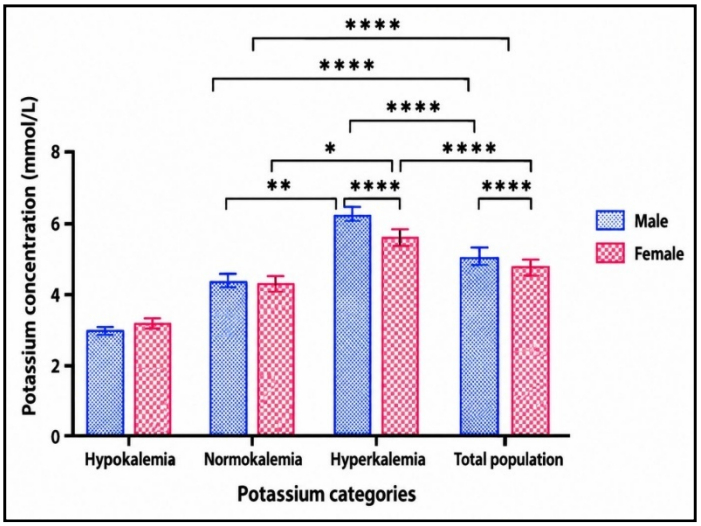


Figure 5. Comparison of serum potassium by sex and potassium status

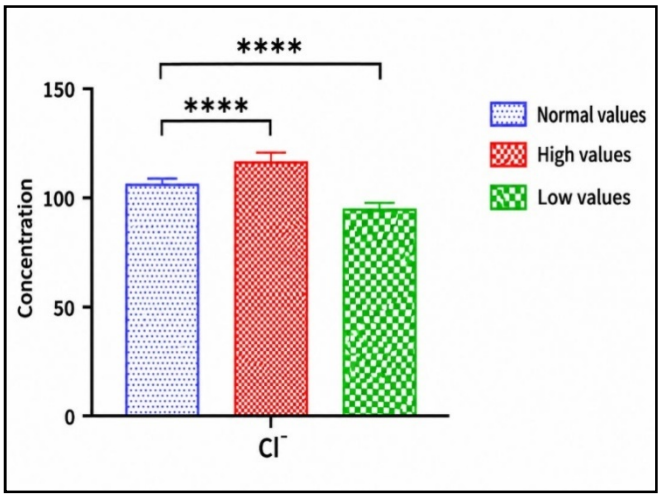


Figure 6. Distribution of serum chloride according to chloride status

DISCUSSION

Sociodemographic characteristics: This cross-sectional study of 60 patients hospitalized with COVID-19 at Treichville University Hospital found a predominance of men (56.67%) and a substantial proportion of patients aged 50–59 years (30%). These characteristics are consistent with the male predominance described in the early cohorts reported by Guan *et al*. (2020) and Zhou *et al*. (2020). In Africa, the multicenter ACCCOS study (ACCCOS Investigators, 2021), conducted in ten countries, also highlighted the importance of individual characteristics and hospital resources in outcomes among critically ill patients. Comparisons remain difficult, however, because hospitalization criteria, participant ages, and

recruitment methods differ across centers. Gupta *et al*. (2020) also emphasized that COVID-19 is a systemic disease capable of disrupting several organ functions, including fluid and electrolyte homeostasis.

The greater representation of patients aged 50–59 years may be related to the hospital-based recruitment of our study. Indeed, advancing age and certain comorbidities, particularly diabetes and cardiovascular diseases, have been associated with adverse COVID-19 outcomes (Zhou *et al*., 2020; Williamson *et al*., 2020). These factors may increase the likelihood of hospitalization among older patients, while younger individuals with mild disease may be underrepresented.

Serum sodium and dysnatremia: In our study, mean sodium concentrations differed significantly across the hyponatremic, normonatremic, and hypernatremic categories. No significant between-sex difference was observed within the analyzed categories. These differences in mean values are largely expected because the categories themselves are defined by serum sodium concentration; they do not, on their own, provide information about the frequency or severity of dysnatremia. Lippi *et al*. (2020) described electrolyte imbalances in severe COVID-19, while Hu *et al*. (2021) and Atila *et al*. (2021) examined the clinical significance of sodium abnormalities. Khidir *et al*. (2022), in a systematic review and meta-analysis conducted by a Sudanese team, reported an overall hyponatremia prevalence of 25.8% and an association with increased mortality (OR = 1.97). Akbar *et al*. (2021) also reported an association between hyponatremia and adverse outcomes. Song *et al*. (2023), in a meta-analysis of observational studies, confirmed the prognostic relevance of dysnatremia while emphasizing heterogeneity among populations.

Conversely, hypernatremia may indicate dehydration or free-water losses, particularly in the presence of fever, impaired consciousness, or inadequate fluid intake. Saad *et al*. (2021) also published two Tunisian case reports of dysnatremia in patients with COVID-19. Zimmer *et al*. (2020) described hypernatremia in patients with COVID-19; Shrestha *et al*. (2022), in a meta-analysis, associated it with adverse outcomes. Tzoulis *et al*. (2021a) highlighted the value of longitudinal sodium monitoring rather than a single measurement. From a pathophysiological perspective, non-osmotic vasopressin secretion, gastrointestinal losses, and fluid imbalance are plausible but unverified hypotheses in our study. The review by Tzoulis *et al*. (2021b) also discusses the pathophysiology and management of dysnatremia. The mechanisms of inappropriate antidiuresis should be interpreted in the light of endocrine and renal data (Ellison and Berl, 2007). A Nigerian study of 144 non-ICU patients with COVID-19 simultaneously examined sodium, potassium, chloride, bicarbonate, and renal markers in relation to viral load (Okwor *et al*., 2023). This combined approach highlights the value of interpreting the electrolyte panel alongside creatinine and clinical context, rather than assessing each electrolyte in isolation.

Serum potassium and dyskalemia: Mean potassium concentrations were higher in the hyperkalemic group than in the normokalemic group ($p < 0.01$). Among hyperkalemic patients, mean potassium was higher in men than in women ($p < 0.05$), with no significant between-sex difference reported in the other categories. This descriptive finding does not demonstrate an independent effect of sex: renal function, age, treatments, and comorbidities may play a role.

African data provide a particularly useful comparison. In Nigeria, Amadi *et al*. (2023) identified hypokalemia in 323 of 515 patients infected with SARS-CoV-2 (62.8%), with associations between severe hypokalemia and markers of disease severity. The Ethiopian publication by Letemu *et al*. (2025), primarily focused on arrhythmias in ICU patients with COVID-19, provides cardiovascular context but is not a direct comparison of dyskalemia prevalence. Chen *et al*. (2020) proposed that hypokalemia observed during COVID-19 could be related, at least in part, to disruption of the ACE2–renin–angiotensin–aldosterone system, promoting urinary potassium losses. Conversely, hyperkalemia may accompany acute kidney injury, acidosis, or certain treatments. Renal and extrapulmonary mechanisms of the disease were discussed by Gupta *et al*. (2020). These hypotheses cannot be considered established mechanisms in our population without serum creatinine, acid–base measurements, treatment data, and assessment of potentially hemolyzed samples.

Serum chloride and acid–base balance: Serum chloride was significantly higher in the hyperchloremic group than in the normochloremic and hypochloremic groups ($p < 0.0001$), whereas the comparison between the latter two groups was not significant. As with sodium and potassium, differences between groups defined by chloride concentrations are expected. Pathophysiological interpretation requires information on bicarbonate levels, renal function, hydration status, and administered intravenous fluids. Chloride disturbances have been studied less extensively in COVID-19 than dysnatremia. Nevertheless, Lippi *et al*. (2020) and Song *et al*. (2023) included several electrolytes in their reviews. The Nigerian study of 144 patients (Okwor *et al*., 2023) also assessed chloride and bicarbonate. The Ethiopian reference by Letemu *et al*. (2025) primarily concerns arrhythmias and cannot, by itself, substantiate previously reported proportions of hypochloremia and hyperchloremia. Differences between studies may reflect laboratory thresholds, treatments, and disease severity. These findings support an integrated interpretation of serum chloride rather than directly attributing changes to SARS-CoV-2.

Clinical implications and perspective: The practical value of an electrolyte panel lies in identifying potentially correctable abnormalities, particularly in patients with renal, gastrointestinal, or respiratory disorders. The findings of Tzoulis *et al*. (2021a), Khidir *et al*. (2022), Song *et al*. (2023), and Shrestha *et al*. (2022) support the clinical value of sodium monitoring in other populations, without demonstrating that correction of an isolated abnormality improves prognosis. This study contributes evidence from Côte d'Ivoire, but its descriptive results do not allow causal conclusions regarding infection and electrolyte disturbances.

CONCLUSION

This study of 60 patients hospitalized with COVID-19 at Treichville University Hospital demonstrated differing sodium, potassium, and chloride profiles across the biochemical categories examined. Comparison by sex revealed no significant difference in sodium concentrations; however, a difference in potassium concentrations was observed between

men and women in the hyperkalemic group. These findings highlight the usefulness of serum electrolyte testing in the biochemical assessment and monitoring of hospitalized patients, alongside clinical and renal evaluation. Prospective multicenter studies with clearly reported sample sizes and diagnostic thresholds would help characterize the frequency and clinical significance of these abnormalities in Côte d'Ivoire.

COMPETING INTERESTS : Authors have declared that no competing interests exist.

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