Content available at: https://www.ipinnovative.com/open-access-journals

International Journal of Clinical Biochemistry and Research

Journal homepage: https://www.ijcbr.in/

Original Research Article

Comparison of serum electrolytes among smokers, asthmatic patients, and healthy controls at a tertiary hospital

Hashmi Jakkula[1], Indira Veeranki[1], Sridevi Nutakki[1]*, Madhusudhan Pativada[2], Kirmani Natukula[2], Rakesh Anil Varikuti[3], Ruthamma Pallepogu[2], Satish Palkurthi[2]

[1]Dept. of Biochemistry, Dr NTR University of Health Sciences, Vijayawada, Andhra Pradesh, India
[2]Dept. of Multidisciplinary Research Unit, Siddhartha Medical College, Tumkur, Karnataka, India
[3]Dept. of Community Medicine, Dr NTR University of Health Sciences, Vijayawada, Andhra Pradesh, India

Abstract

Background: Electrolytes, which are ions with electrical charges, are vital in maintaining physiological balance within the human body. They play key roles in cellular processes such as signal transmission in neurons, muscle contractions, hormone activity regulation, bone mineralization, and the stabilization of fluid and pH levels. Smokers and asthmatics have abnormal electrolytes leading to poor functioning of body. Clear understanding of electrolyte imbalances may facilitate early identification of complications and guide clinical decision-making. Among chronic asthma patients, hypomagnesemia has been reported as the most frequently observed electrolyte disturbance. Electrolytes affect airway smooth muscle excitability by modulating ion transport mechanisms, including Na^+/K^+-ATPase pump activity.

Objectives: To assess and compare serum electrolyte levels among healthy controls, smokers and asthmatic patients.

Materials and Methods: This cross-sectional study included 90 participants, divided equally into three groups: smokers, asthmatics, and healthy controls. Recruitment was conducted over a three-month period at a tertiary care hospital using purposive quota sampling, targeting individuals aged 18 to 65 years of both sexes. Serum levels of sodium, potassium, magnesium, calcium, and chloride were measured after taking written informed consent. Ethical clearance along with institutional approval was secured prior to the study. Data were entered in Microsoft Excel and analyzed using ANOVA and post hoc tests via the Jamovi software (free online version).

Results: Asthmatics showed significantly lower levels of sodium, chloride, and magnesium compared to smokers and controls. Post-hoc analysis confirmed significant differences between controls and asthmatics for these electrolytes.

Conclusions: Electrolyte imbalances especially hyponatremia, hypochloremia and hypomagnesemia are prevalent in individuals with asthma. Monitoring and managing electrolyte levels could play vital role in the clinical care of asthmatic patients, especially during acute exacerbations. Our study shows that sodium levels in asthmatics (Group 3) are significantly lower than in smokers (Group 2). However, the difference between controls (Group 1) and asthmatics is borderline significant ($p = 0.053$).

Keywords: Electrolyte imbalance, Smokers, Asthmatics, Hypomagnesaemia.

Received: 21-04-2025; **Accepted:** 17-06-2025; **Available Online**: 02-08-2025

This is an Open Access (OA) journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International License. which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

For reprints contact: reprint@ipinnovative.com

1. Introduction

Electrolytes, which are ions with electrical charges, are vital in maintaining physiological balance within the human body. They play key roles in cellular processes such as signal transmission in neurons, muscle contractions, hormone activity regulation, bone mineralization, and the stabilization of fluid and pH levels. Disruptions in electrolyte concentrations—referred to as imbalances—can arise from various causes including nutritional deficiencies, acid-base irregularities, medication side effects, and acute medical conditions.[1,2]

Among lifestyle factors, cigarette smoking has been associated with shifts in serum electrolyte concentrations.[3] Tobacco smoke comprises a complex mix of harmful substances, including nicotine, carcinogenic tars, and gases like carbon monoxide (CO).[4,5] Repeated inhalation of CO

*Corresponding author: Sridevi Nutakki
Email: nutakkisridevi74@gmail.com

https://doi.org/10.18231/j.ijcbr.v.12.i.2.11
© 2025 The Author(s), Published by Innovative Publications.

may lead to its accumulation in body tissues.[6] Prolonged, low-level CO exposure contributes to reduced oxygen delivery by forming carboxyhemoglobin, thereby causing tissue hypoxia.[7,8] This hypoxic state is linked to cellular damage and growth inhibition due to diminished oxygen-carrying capacity in the blood.[9] An increase in carboxyhemoglobin coupled with a reduction in oxyhemoglobin can induce respiratory acidosis, potentially triggering disturbances in electrolyte levels.[10,11]

Asthma, a chronic inflammatory disease of the airways, is characterized by episodic symptoms such as wheezing, breathlessness, coughing, and chest tightness. These symptoms are the result of airway inflammation that promotes excess mucus secretion, bronchial muscle hyperreactivity, and structural airway changes.[12] Severe asthma attacks can emerge suddenly and progress rapidly, posing serious health risks.[13] Electrolyte abnormalities in individuals with asthma may be influenced by poor dietary intake or the pharmacologic effects of asthma treatments.[14] For instance, hypokalemia is a commonly observed early imbalance, often linked to beta-2 agonists or aminophylline usage.[15] Electrolytes affect airway smooth muscle excitability by modulating ion transport mechanisms, including Na^+/K^+-ATPase pump activity. One hypothesis for bronchial hyper responsiveness involves the direct impact of electrolyte levels on smooth muscle tone, as well as osmotic changes that may enhance the release of inflammatory mediators from mast cells.[16] Among chronic asthma patients, hypomagnesaemia has been reported as the most frequently observed electrolyte disturbance.[17]

Although numerous studies have examined electrolyte imbalances in smokers and individuals with asthma separately, limited research exists comparing both populations with healthy individuals, particularly in tertiary care settings where these groups are often encountered. A clearer understanding of these biochemical shifts may facilitate earlier identification of complications, guide clinical decision-making, and emphasize the value of routine electrolyte monitoring. Therefore, the present study aims to assess and compare serum levels of sodium, potassium, calcium, magnesium, and chloride among smokers, asthma patients, and healthy controls, to detect any meaningful statistical or clinical differences.

2. Aims and Objectives

1. To assess the serum electrolyte levels among controls, smokers and asthmatics.
2. To compare the serum electrolyte levels among the three groups.

3. **Materials** and Methods

3.1. Study design and setting

This cross-sectional observational study was conducted over a period of six months at the Government General Hospital, Vijayawada. Sample collection was carried out over two months, from January to February 2024, with participant recruitment occurring during routine outpatient visits.

3.2. Sample size calculation

The required sample size was estimated using a one-way analysis of variance (ANOVA) framework involving three independent groups. Assuming a moderate-to-large effect size (Cohen's $f = 0.35$), a significance level (α) of 0.05, and a statistical power of 80% ($1 - \beta = 0.80$), the estimated sample size was calculated based on the F-distribution model. According to this model, a minimum of 28 participants per group (total $n = 84$) is required to detect statistically significant differences among the groups. To ensure adequate power and account for possible data loss, the sample size was rounded up to 30 participants per group, resulting in a final sample of 90 participants.

This effect size was selected based on previously published studies [18, 19] examining the influence of smoking on biochemical parameters, where group differences were found to be moderate to large. The calculation was verified using G*Power (version X.X), a software widely used alongside SPSS for statistical planning, which performs exact power analysis for fixed-effect one-way ANOVA using noncentral F-distribution methods. Additionally, the Central Limit Theorem supports the use of sample sizes ≥30 per group to allow for valid statistical inference using parametric tests.

3.3. Sampling technique

A purposive sampling method using a quota approach was employed. On each working day during the data collection period, one eligible participant from each group was selected to ensure balanced recruitment. Participants aged 18 to 65 years, of either sex, visiting the hospital as a patient or an attender was included.

3.4. Inclusion criteria

1. Smokers**:** Individuals consuming 8–12 cigarettes per day with a smoking history of ≥5 years, maintaining a normal diet and not on any medication.
2. Asthmatics**:** Clinically diagnosed patients with bronchial asthma confirmed by spirometry and GINA diagnostic guidelines for Asthma 2023/2024.[20]
3. Healthy controls**:** Individuals with no history of smoking or respiratory illness and not on any medication.

3.5. Exclusion criteria

1. Smokers & Controls - Participants with other known respiratory diseases**,** systemic disorders, those on medications that may alter serum electrolytes.
2. Pregnant and lactating women
3. Asthmatics and controls with any history of smoking

3.6. Ethical considerations

Prior to study initiation, ethical and institutional permissions were obtained. All participants were fully informed about the study objectives, procedures, and risks. Written informed consent was obtained from each participant. A detailed clinical and systemic examination was performed to rule out any underlying co morbidities.

3.7. Data collection procedures

Routine investigations such as complete blood count (CBC) and chest X-ray were conducted to ensure eligibility. For biochemical analysis:

1. 3 ml of venous blood was collected from each participant.
2. Blood samples were centrifuged to separate the serum.
3. Serum levels of sodium, potassium, magnesium, calcium, and chloride were measured using a fully automated analyzer**.**

3.8. Data management and Statistical analysis

All collected data were recorded and maintained in Microsoft Excel**.** Statistical analysis was conducted using Jamovi (a free and open-source statistical software).

1. One-way ANOVA was used to assess differences in serum electrolyte levels among the three groups as it is the standard method for analyzing continuous variables across more than two groups.
2. As the assumption of homogeneity of variances was not met, Games–Howell post hoc tests were applied to evaluate pair-wise group differences.
3. A p-value < 0.05 was considered statistically significant.

4. Results

Among the 30 participants in each group, there were 8 females in the control group, 2 in the smokers group, and 7 in the asthmatic group.

Asthmatics have lower Sodium, Chloride, Potassium, and Magnesium levels compared to other two groups. There is no marked difference in calcium levels among the groups. (**Table 1**)

Table 1: Descriptives

Group Descriptives					
	Category	**N**	**Mean**	**SD**	**SE**
Sodium	Controls	30	138.50	6.112	1.1160
	Smokers	30	139.03	5.543	1.0120
	Asthmatics	30	133.47	9.779	1.7855
Chloride	Controls	30	102.00	4.433	0.8094
	Smokers	30	103.13	4.240	0.7742
	Asthmatics	30	96.10	7.889	1.4403
Potassium	Controls	30	4.16	0.416	0.0759
	Smokers	30	4.33	0.668	0.1219
	Asthmatics	30	3.94	0.692	0.1264
Magnesium	Controls	30	2.05	0.249	0.0454
	Smokers	30	2.20	0.446	0.0814
	Asthmatics	30	1.72	0.263	0.0480
Calcium	Controls	30	9.42	0.718	0.1311
	Smokers	30	9.76	0.770	0.1405
	Asthmatics	30	9.67	0.724	0.1322

Table 2: Anova

One-Way ANOVA (Welch's)				
	F	**df1**	**df2**	**p**
Sodium	3.80	2	55.7	0.028
Chloride	9.23	2	55.4	<.001
Potassium	2.45	2	54.5	0.096
Magnesium	18.30	2	55.6	<.001
Calcium	1.74	2	57.9	0.185

Table 3: Post HOC test

Games-Howell Post-Hoc Test – Sodium		Controls	Smokers	Asthmatics
Controls	Mean difference	—	-0.533	5.030
	p-value	—	0.933	0.053
Smokers	Mean difference		—	5.570
	p-value		—	**0.025**
Asthmatics	Mean difference			—
	p-value			—
Games-Howell Post-Hoc Test – Chloride		**Controls**	**Smokers**	**Asthmatics**
Controls	Mean difference	—	-1.130	5.901
	p-value	—	0.572	**0.002**
Smokers	Mean difference		—	7.031
	p-value		—	**<0.001**
Asthmatics	Mean difference			—
	p-value			—
Games-Howell Post-Hoc Test – Potassium		**Controls**	**Smokers**	**Asthmatics**
Controls	Mean difference	—	-0.173	0.217
	p-value	—	0.455	0.314
Smokers	Mean difference		—	0.390
	p-value		—	0.076
Asthmatics	Mean difference			—
	p-value			—
Games-Howell Post-Hoc Test – Magnesium		**Controls**	**Smokers**	**Asthmatics**
Controls	Mean difference	—	-0.150	0.330
	p-value	—	0.252	**<0.001**
Smokers	Mean difference		—	0.480
	p-value		—	**<0.001**
Asthmatics	Mean difference			—
	p-value			
Games-Howell Post-Hoc Test – Calcium		**Controls**	**Smokers**	**Asthmatics**
Controls	Mean difference	—	-0.343	-0.253
	p-value	—	0.183	0.368
Smokers	Mean difference		—	0.090
	p-value		—	0.887
Asthmatics	Mean difference			—
	p-value			—

Table 2 presents the ANOVA results, indicating that magnesium levels differed significantly among the groups ($p < 0.001$), representing the most statistically robust association observed. Sodium ($p = 0.028$) and chloride ($p < 0.001$) levels also showed statistically significant differences, with chloride exhibiting a particularly strong association across groups. Potassium levels ($p = 0.096$) did not reach statistical significance, though the p-value suggests a possible trend that may warrant further investigation in larger or more targeted studies. In contrast, calcium levels ($p = 0.185$) showed no significant differences among the groups, indicating limited clinical or statistical relevance in this context.

The Games-Howell post-hoc test (**Table 3**) shows significant differences for sodium, chloride, and magnesium between groups, particularly between controls and asthmatics (e.g., chloride: $p < 0.001$**,** sodium: $p = 0.025$, magnesium**:** $p < 0.001$**).** Potassium and calcium show no significant differences across groups **(**$p > 0.05$**).** Overall, asthmatics have lower sodium, chloride, and magnesium levels compared to smokers and controls**.**

5. Discussion

Our study demonstrated significant alterations in serum electrolyte levels among smokers, asthmatics, and healthy controls. Sodium levels were relatively similar between healthy controls (Group 1) and smokers (Group 2), but were significantly lower in asthmatics (Group 3) compared to smokers ($p = 0.028$). The difference between asthmatics and controls approached statistical significance ($p = 0.053$), suggesting a potential trend toward hyponatremia in asthma patients. This finding may reflect fluid or electrolyte imbalances associated with asthma itself or with common treatments such as corticosteroids, diuretics, or theophylline. The significant difference between smokers and asthmatics is likely due to a combination of sodium-retaining mechanisms in smokers—possibly mediated by nicotine's effect on the renin–angiotensin–aldosterone system—and sodium-depleting factors in asthmatics, creating a more pronounced contrast than that observed between asthmatics and controls. Consistent with our findings, Latha et al.[21] also reported reduced sodium levels in asthmatic patients compared to controls. Similarly, Mohammad HA[22] observed decreased sodium concentrations in asthmatics, though more marked alterations were seen in other electrolytes. Amin R[23] further supports this trend, suggesting that theophylline use may contribute to hyponatremia through increased renal excretion of water and electrolytes.

Chloride levels were also significantly lower in asthmatics compared to both healthy controls and smokers, with the most marked difference observed between smokers and asthmatics ($p < 0.001$). This pattern suggests a disturbance in acid–base homeostasis among asthmatic individuals. Post hoc analysis confirmed that asthmatics had significantly reduced sodium and chloride levels relative to the other groups. The observed reduction in chloride may be influenced by medications commonly used in asthma management, such as salbutamol, which can alter electrolyte balance.[24] Additionally, during asthmatic exacerbations, hyperventilation is common and can lead to respiratory alkalosis. This condition, characterized by decreased arterial carbon dioxide levels, often results in compensatory shifts in serum chloride levels.[25]

Potassium levels were mildly elevated in smokers and reduced in asthmatics; however, these differences did not reach statistical significance ($p = 0.096$). This variation may be influenced by factors such as dietary intake, renal regulation, or the effects of asthma medications, particularly beta-agonists. At the outset of the study, we hypothesized that there would be statistically significant differences in potassium levels among the groups. However, the results did not support this assumption. While the difference between smokers and asthmatics approached significance ($p = 0.076$), it did not meet the conventional threshold ($p < 0.05$). This trend is supported by previous research: Deenstra M[26] reported hypokalemia associated with theophylline use, which may lower plasma potassium levels. Similarly, Ajeet Sawhney[27] observed mild hypokalemia in asthmatic patients. In contrast, Padmavathi P[28] found significantly elevated potassium and calcium levels in chronic smokers compared to healthy controls, suggesting smoking-related alterations in electrolyte handling.

Magnesium levels were highest in smokers and significantly lower in asthmatics (Group 3) compared to both healthy controls (Group 1) and smokers (Group 2), with post hoc analysis confirming these differences ($p < 0.001$). Given magnesium's critical role in bronchial smooth muscle relaxation, its deficiency may contribute to bronchial hyperreactivity and poor asthma control. Our findings align with those of Mohammad HA,[22] who reported that hypomagnesaemia was more prevalent in asthmatics than either hypokalemia or hypocalcaemia. Several studies have associated magnesium deficiency with increased airway hyper responsiveness,[4] highlighting its essential role in various biochemical and physiological processes that support lung function. Furthermore, low dietary magnesium intake has been linked to wheezing and impaired pulmonary performance,[29] whereas magnesium supplementation may help alleviate asthma symptoms.[30] The observed hypomagnesemia in asthmatics may result from multiple factors, including increased urinary losses related to beta-agonist or theophylline use, insufficient dietary intake, and the systemic effects of chronic inflammation and oxidative stress. These mechanisms likely contribute to magnesium depletion, potentially worsening bronchial reactivity and compromising disease control.

Calcium levels were marginally higher in both smokers and asthmatics compared to healthy controls; however, this difference was not statistically significant ($p = 0.185$), suggesting limited clinical relevance. In our study, no significant differences in calcium levels were observed among the three groups. Nevertheless, these findings underscore the importance of routine electrolyte monitoring, particularly in asthmatic patients, as imbalances may influence clinical outcomes and guide therapeutic decisions. Mohd Faisal[31] reported a significant difference in calcium concentrations between asthmatics and controls, though this difference became non-significant after adjusting for treatment. Additionally, hypocalcaemia has been documented in healthy individuals following intravenous administration of $\beta 2$-agonists, potentially due to increased urinary calcium excretion.[32]

6. Conclusion

Our study identifies significant differences in serum electrolyte levels—particularly sodium, chloride, and magnesium—among asthmatic patients compared to smokers and controls. The findings suggest that electrolyte imbalances especially hyponatremia, hypochloremia and hypomagnesaemia are prevalent in individuals with asthma, potentially influenced by disease pathology and medication use. Although potassium and calcium levels did not show statistically significant differences, previous research indicates that these electrolytes may still play a role in respiratory function.

Interestingly, the results concerning smokers did not show statistically significant differences for most electrolytes when compared to controls. This may suggest a more subtle impact or variability within the smoker group that was not captured due to the limited sample size.

7. Recommendations

Studies with larger sample sizes are recommended to further evaluate and clarify the potential electrolyte disturbances in chronic smokers.

Monitoring and managing electrolyte levels could be important in the clinical care of asthmatic patients, especially during exacerbations or in those on long-term bronchodilator or theophylline therapy.

Further research is warranted to explore the underlying mechanisms and long-term clinical implications of these findings.

8. Conflict of Interest

No conflicts of Interest.

9. Source of Funding

None.

10. Acknowledgement

We would like to express our sincere gratitude to the Multidisciplinary Research Unit (MRU), Government Siddhartha Medical College, Vijayawada for providing the necessary Infrastructure, resources and support throughout the course of this research. The technical assistance and valuable guidance offered by the MRU team were instrumental in the successive completion of this study.

References

1. Lee J. Fluid and electrolyte disturbances in critically ill patients. *Electrolyte Blood Press*. 2010;8(2):72–81.
2. Timerga A, Kelta E, Kenenisa C, Zawdie B, Habte A, Haile K. Serum electrolytes disorder and its associated factors among adults admitted with metabolic syndrome in Jimma Medical Center, South West Ethiopia: facility based crossectional study. *PLoS One*. 2020;15(11):e0241486.
3. Al-Fawaeir S. Association of smoking with serum electrolytes, liver enzymes, and haematology parameters: A single-centre experience from Jordan. *N Z J Med Lab Sci*. 2024;78(3):126–30.
4. Bokhoven C, Niessen HJ. Amounts of oxides of nitrogen and carbon monoxide in cigarette smoke, with and without inhalation. *Nature*. 1961;192:458–9.
5. Benowitz NL, Hall SM, Stewart S, Wilson M, Dempsey D, Jacob P 3rd. Nicotine and carcinogen exposure with smoking of progressively reduced nicotine content cigarette. *Cancer Epidemiol Biomarkers Prev*. 2007;16(11):2479–85.
6. Wan-Kuen J, Jung-Wook O. Evaluation of CO exposure in active smokers while smoking using breath analysis technique. *Chemosphere*. 2003;53(2):207–16.
7. Sagone AL Jr, Lawrence T, Balcerzak SP. Effect of smoking on tissue oxygen. *Blood*. 1973;41(6):845–51.
8. Casasola GG, Alvarez-Sala JL, Marques JA, Sanchez-Alarcos JM, Tashkin DP, Espinos D. Cigarette smoking behavior and respiratory alterations during sleep in a healthy population. *Sleep Breath*. 2002;6(1):19–24.
9. Zhang X, Li J, Sejas DP, Pang Q. Hypoxia-reoxygenation induces premature senescence in FA bone marrow hematopoietic cells. Blood. 2005;106(1):75–85.
10. Deming Q, Gerbode F. Observations on sodium balance in patients undergoing mitral valvotomy. *Surg Forum*. 1953;4:18–22.
11. Nguyen MK, Kurtz I. Determinants of plasma water sodium concentration as reflected in the Edelman equation: role of osmotic and Gibbs-Donnan equilibrium. *Am J Physiol Renal Physiol*. 2004;286(5):F828–37.
12. Hammad H, Lambrecht BN. The basic immunology of asthma. *Cell*. 2021;184(6):1469–85.
13. Ukena D, Fishman L, Niebling W. Bronchial asthma: Diagnosis and long-term treatment in adults. *Dtsch Arztebl Int*. 2008;105(21):385–94.
14. Gustafson T, Boman K, Rosenhall L, Sandström T, Wester PO. Skeletal muscle magnesium and potassium in asthmatics treated with oral beta2-agonists. *Eur Respir J*. 1996;9(2):237–40.
15. Bodenhamer J, Bergstrom R, Brown D, Gabow P, Marx JA, Lowenstein SR. Frequently nebulized β-agonists for asthma: Effects on serum electrolytes. *Ann Emerg Med*. 1992;21(11):1337–42.
16. Mickleborough T, Gotshall R, Rhodes J, Tucker A, Cordain L. Elevating dietary salt exacerbates hyperpnea-induced airway obstruction in guinea pigs. *J Appl Physiol (1985)*. 2001;91(3):1061–6.
17. Alamoudi OS. Electrolyte disturbances in patients with chronic, stable asthma: effect of therapy. Chest. 2001;120(2):431–6.
18. Ditre JW, Heckman BW, Zale EL, Kosiba JD, Maisto SA. Acute analgesic effects of nicotine and tobacco in humans: a meta-analysis. *Pain*. 2016;157(7):1373–81.
19. Sezgin Yılmaz. Evaluation of Serum Biochemical Parameters and Metabolism in Smokers: A Case Control Study [Preprint]. *Res Square*. 2022.
20. Global Initiative for Asthma. Global Strategy for Asthma Management and Prevention [Internet]. 2023 update. Fontana, WI: GINA; 2023. Available from: https://ginasthma.org/wp-content/uploads/2023/07/GINA-2023-Full-report-23_07_06-WMS.pdf
21. Latha P. A study of serum electrolytes abnormality in asthmatics. *IOSR J Biotechnol Biochem*. 2017;3(4):52–6.
22. Mohammad HA, Abdulfttah MT, Abdulazez AO, Mahmoud AM, Emam RM. A study of electrolyte disturbances in patients with chronic stable asthma and with asthma attacks. *Egypt J Chest Dis Tuberc*. 2014;63(3):529–34.
23. Amin R, Alyasin S, Rahmani G. Theophylline-induced alteration in serum electrolytes and uric Acid of asthmatic children. *Iran J Allergy Asthma Immunol*. 2003;2(1):31–7.
24. Vasileiadis I, Alevrakis E, Ampelioti S, Vagionas D, Rovina N, Koutsoukou A. Acid-Base Disturbances in Patients with Asthma: A Literature Review and Comments on Their Pathophysiology. *J Clin Med*. 2019;8(4):563.
25. Bosamak NER, Shahin MH. Beta2 Receptor Agonists and Antagonists. [Updated 2023 Jul 3]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2025.
26. Deenstra M, Haalboom JR, Struyvenberg A. Decrease of plasma potassium due to inhalation of beta-2-agonists: absence of an additional effect of intravenous theophylline. *Eur J Clin Invest*. 1988;18(2):162–5.
27. Sawhney A. Assessment of Electrolyte Disturbance in Asthmatic Patients: A Tertiary Care Hospital Based Study. *Int J Med Res Prof*. 2016;2(5):254–7.
28. Padmavathi P, Reddy VD, Varadacharyulu N. Influence of chronic cigarette smoking on serum biochemical profile in male human volunteers. *J Health Sci*. 2009;55(2):265–70.
29. Husemoen LLN, Glümer C, Lau C, Pisinger C, Mørch LS, Linneberg A. Association of obesity and insulin resistance with asthma and aeroallergen sensitization. *Allergy*. 2008;63(5):575–82.
30. Ramsay S, Dagg K, McKay I, Lipworth BJ, McSharry C, Thomson NC. Investigations on the renin-angiotensin system in acute severe asthma. *Eur Respir J*. 1997;10(12):2766–71.
31. Lutfi MF. Electrolytes levels in asthmatic patients. *Asian J Biomed Pharm Sci*. 2013;3(20):1–4.
32. Bos W, Postma D, Doormaal J. Magnesiuric and calciuric effects of terbutaline in man. *Clin Sci*. 1988;74(6):595–7.

Cite this article: Jakkula H, Veeranki I, Nutakki S, Pativada M, Natukula K, Varikuti RA, Pallepogu R, Palkurthi S. Comparison of serum electrolytes among smokers, asthmatic patients, and healthy controls at a tertiary hospital. *Int J Clin Biochem Res*. 2025;12(2):125-131.