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CORRELATION ANALYSIS BETWEEN ELECTROLYTES AND MCCLURE-ALDRICH TEST IN PATIENTS WITH BRONCHIAL ASTHMA

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Case histories of 34 (25 females and 9 males) patients with uncomplicated bronchial asthma with frequent attacks were studied. The study provides a longitudinal assessment of electrolyte-water balance interactions across three clinically distinct phases of asthma exacerbation. Dynamics of the McClure-Aldrich test for assessment water balance was studied. All indicators were investigated before (1), during (2) and after (3) bronchial asthma attack. The correlation of the obtained data was studied using the Spearman correlation method. The most important statistically significant finding was the correlation between Chloride 2 and McClure-Aldrich Test 2 ($p=0.417$; $p=0.014$). Strong correlations were also observed among McClure-Aldrich measurements: Test1-Test2 ($p=0.661$), Test1-Test3 ($p=0.681$), and Test2-Test3 ($p=0.647$), suggesting that tissue hydrophilicity may represent an individual physiological trait. Given that the most severe asthma attacks occur at night and early morning, it would be important to study the biorhythms of water and chloride balance in patients.

Key words: bronchial asthma, electrolytes, McClure-Aldrich test, electrolyte-water balance.

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КОРЕЛЯЦІЙНИЙ АНАЛІЗ ВЗАЄМОЗВ'ЯЗКУ ЕЛЕКТРОЛІТІВ ТА РЕЗУЛЬТАТІВ ТЕСТУ МАК-КЛЮРА-ОЛДРИЧА У ПАЦІЄНТІВ ІЗ БРОНХІАЛЬНОЮ АСТМОЮ

Було проаналізовано історії хвороби 34 пацієнтів (25 жінок і 9 чоловіків) з неускладненою бронхіальною астмою, що супроводжувалася частими нападами. У дослідженні проведено поздовжню оцінку взаємозв'язку електролітного та водного балансу у трьох клінічно різних фазах загострення бронхіальної астми. Було досліджено динаміку проби Мак-Клюра-Олдрича для оцінки водного балансу. Усі показники досліджували до (1), під час (2) та після (3) нападу бронхіальної астми. Кореляційний аналіз отриманих даних проводили з використанням методу рангової кореляції Спірмена. Найважливішим статистично значущим результатом була виявлена кореляція між рівнем хлоридів 2 та пробю Мак-Клюра-Олдрича 2 ($p=0,417$; $p=0,014$). Також було виявлено сильну кореляцію між результатами тесту Мак-Клюра-Олдрича: Test1-Test2 ($p=0,661$), Test1-Test3 ($p=0,681$) та Test2-Test3 ($p=0,647$), що дозволяє припустити, що гідрофільність тканин може відображати індивідуальну фізіологічну особливість. З огляду на те, що найважчі напади бронхіальної астми виникають у нічний та ранній ранковий час, важливим є вивчення біоритмів водного та хлоридного балансу у пацієнтів із бронхіальною астмою.

Ключові слова: бронхіальна астма, електроліти, проба Мак-Клюра-Олдрича, електролітно-водний баланс.

Asthma is a common chronic inflammatory disease of the airways characterized by variable respiratory symptoms and variable expiratory airflow limitation. Typical manifestations include wheezing, shortness of breath, chest tightness, and cough, while exacerbations may lead to a substantial temporary deterioration in respiratory function [2, 6, 7]. The global burden of asthma remains considerable, making improvement of both long-term control and management of acute exacerbations an important clinical task [5, 6]. During an exacerbation, airway inflammation, bronchial smooth-muscle contraction, mucus hypersecretion, changes in ventilation, and the effects of pharmacological treatment may be accompanied by disturbances of systemic homeostasis, including changes in electrolyte and water balance [1, 4].

Electrolytes participate in maintenance of membrane potential, osmotic pressure, acid-base balance, neuromuscular function, and intracellular signaling. Sodium is the principal extracellular cation, potassium is predominantly intracellular, and

chloride is the major extracellular anion; therefore, changes in their concentrations may reflect or contribute to redistribution of body fluids during acute illness [12]. Previous studies of asthma exacerbations have mainly focused on potassium, particularly because repeated or continuous beta2-agonist therapy can be associated with hypokalemia [3, 4]. At the same time, recent clinical observations suggest that the relationship between asthma and electrolyte status is broader and may include sodium, chloride, and other mineral components [1, 8, 13, 16]. Ion transport also has biological relevance to airway and immune-cell function, supporting further study of ionic mechanisms in asthma [15].

Water balance may also be clinically important during an acute asthma attack. Excess positive fluid balance has been associated with increased extravascular lung water and worse clinical outcomes in children hospitalized with severe asthma exacerbation [9]. Conversely, excessive water intake has also been described as a possible precipitating

factor in an individual case of asthma exacerbation, illustrating the potential importance of disturbances in fluid regulation [10]. Despite these observations, few studies have evaluated blood electrolytes together with indices of tissue hydration longitudinally before, during, and after an asthma attack. Therefore, the purpose of the present study was to assess the relationship between serum sodium, potassium, and chloride concentrations and skin hydrophilicity measured by the McClure-Aldrich test before, during, and after bronchial asthma attacks.

The purpose of the study was to access the relationship between some electrolytes and skin hydrophilicity in patients with bronchial asthma before, during and after an asthma attack.

Materials and methods. Archival materials of patients, who were under observation in several clinics (Baku, Azerbaijan) in the period of 2024–2025 were used. Case histories of 34 (25 females and 9 males) patients with uncomplicated bronchial asthma with frequent attacks were studied.

All electrolytes studied by chemical methods: sodium ions in the blood serum of patients were determined by manometric method according to Müller; potassium ions in the blood serum of patients

were determined by method according to Cramer-Pisdall; chlorides (Cl) determined by Rooshnic. The dynamics of the McClure-Aldrich test for assessment water balance was studied. All indicators were investigated before (1), during (2) and after (3) bronchial asthma attack.

Quantitative and qualitative data were analyzed using SPSS 26.0. Variation analysis included calculation median (Me), between-group differences were assessed using the Mann–Whitney U test. The correlation of the obtained data was studied using the Spearman correlation method (ρ). Statistical significance was assessed using a two-sided criterion. The null hypothesis was rejected at $p < 0.050$.

Results of the study. According the results, strong positive correlations were observed between repeated measurements of the same electrolyte, indicating relative intra-individual stability throughout the observation period. Sodium demonstrated strong correlations between Na1–Na2 ($\rho = 0.798$, $p < 0.001$), Na1–Na3 ($\rho = 0.590$, $p < 0.001$), and Na2–Na3 ($\rho = 0.700$, $p < 0.001$). Potassium showed a significant correlation between K1 and K2 ($\rho = 0.478$, $p = 0.004$). The results obtained are reflected in Table 1.

Table 1

Correlation between electrolyte levels in patients with bronchial asthma

N 34	Na 1	Na 2	Na 3	K1	K2	K3	Cl 1	Cl 2	Cl 3
Na 1 $\rho(\text{Rho})$ p	1.000	0.798** 0.000	0.590** 0.000	-0.054 0.760	0.226 0.199	0.057 0.749	-0.273 0.118	-0.093 0.603	-0.225 0.201
Na 2 $\rho(\text{Rho})$ p	0.798** 0.000	1.000	0.700** 0.000	-0.122 0.493	-0.023 0.898	0.024 0.894	-0.182 0.302	0.021 0.905	-0.181 0.305
Na 3 $\rho(\text{Rho})$ p	0.590** 0.000	0.700** 0.000	1.000	0.037 0.835	0.139 0.432	-0.176 0.320	-0.387* 0.024	-0.220 0.211	-0.334 0.053
K1 $\rho(\text{Rho})$ p	-0.054 0.760	-0.122 0.493	0.037 0.835	1.000	0.478** 0.004	0.232 0.188	0.049 0.785	-0.008 0.963	0.043 0.809
K2 $\rho(\text{Rho})$ p	0.226 0.199	-0.023 0.898	0.139 0.432	0.478** 0.004	1.000	0.023 0.897	-0.265 0.129	-0.058 0.744	-0.206 0.242
K3 $\rho(\text{Rh})$ p	0.057 0.749	0.024 0.894	-0.176 0.320	-0.176 0.320	0.023 0.897	1.000	0.583** 0.000	0.534** 0.001	0.355* 0.039
Cl 1 $\rho(\text{Rho})$ p	-0.273 0.118	-0.182 0.302	-0.387* 0.024	0.049 0.785	-0.265 0.129	0.583** 0.000	1.000	0.613** 0.000	0.559** 0.001
Cl 2 $\rho(\text{Rho})$ p	-0.093 0.603	0.021 0.905	-0.220 0.211	-0.008 0.963	-0.058 0.744	0.534** 0.001	0.613** 0.000	1.000	0.361* 0.036
Cl 3 $\rho(\text{Rho})$ p	-0.225 0.201	-0.181 0.305	-0.334 0.053	0.043 0.809	-0.206 0.242	0.355* 0.039	0.559** 0.001	0.361* 0.036	1.000

Chloride concentrations were strongly correlated across all stages:

Cl1–Cl2 ($\rho = 0.613$, $p < 0.001$),

Cl1–Cl3 ($\rho = 0.559$, $p = 0.001$),

Cl2–Cl3 ($\rho = 0.361$, $p = 0.036$).

These findings suggest that electrolyte

homeostasis remained relatively preserved during the asthma attack, despite acute physiological stress.

The results of correlations of electrolytes with the McClure-Aldrich test and between test measurements were presented in Table 2.

Table 2

Correlations of electrolytes with the McClure-Aldrich test and between test measurements

N 34	McClure-Aldrich test 1 $\rho(\text{Rho})$ p	McClure-Aldrich test 2 $\rho(\text{Rho})$ p	McClure-Aldrich test 3 $\rho(\text{Rho})$ p
Na 1	0.344* 0.050	0.175 0.321	0.086 0.628
Na 2	0.304 0.085	0.203 0.249	0.011 0.951
Na 3	0.290 0.101	-0.041 0.818	0.031 0.863
K1	-0.212 0.236	-0.266 0.128	-0.123 0.490
K2	0.149 0.408	-0.086 0.627	0.153 0.387
K3	-0.153 0.395	0.167 0.346	-0.110 0.535
Cl 1	-0.022 0.904	0.305 0.079	0.160 0.365
Cl 2	0.023 0.900	0.417* 0.014	0.208 0.237
Cl 3	-0.064 0.722	0.279 0.110	0.208 0.239
McClure-Aldrich test 1	1.000	0.661** 0.000	0.681** 0.000
McClure-Aldrich test 2	0.661** 0.000	1.000	0.647** 0.000
McClure-Aldrich test 3	0.681** 0.000	0.647** 0.000	1.000

A statistically significant positive correlation was identified between baseline sodium concentration and the baseline McClure–Aldrich test result:

Na1 vs. McClure–Aldrich Test 1:

$\rho=0.344$, $p=0.050$

This relationship suggests that higher serum sodium concentrations before an asthma attack were associated with greater tissue hydrophilicity or altered fluid retention. Since sodium is the major extracellular osmotic ion, its association with tissue water balance is physiologically plausible.

No significant correlations were observed between sodium concentrations measured during or after the attack and the corresponding McClure–Aldrich test values ($p>0.05$), indicating that sodium may have a limited influence on dynamic fluid redistribution occurring during acute bronchospasm.

No statistically significant correlations were found between potassium concentrations and McClure–Aldrich test results at any stage of observation (all $p>0.05$).

These findings suggest that serum potassium levels were not directly associated with tissue hydration status in the studied patients. Potassium is predominantly an intracellular ion, and serum measurements may not adequately reflect intracellular fluid shifts occurring during asthma exacerbations.

Among all electrolytes studied, chloride demonstrated the strongest associations with both electrolyte regulation and tissue hydration.

Strong positive correlations were observed between chloride measurements obtained at different stages:

Cl1–Cl2: $\rho=0.613$, $p<0.001$

Cl1–Cl3: $\rho=0.559$, $p=0.001$

Cl2–Cl3: $\rho=0.361$, $p=0.036$

These findings indicate consistent chloride regulation throughout the asthma attack and recovery period.

A significant positive correlation was found between chloride concentration during the asthma attack and the McClure–Aldrich test measured during the same period:

Cl2 vs. McClure–Aldrich Test 2:

$\rho=0.417$, $p=0.014$

This result suggests that increased serum chloride levels during acute bronchial obstruction are associated with greater tissue hydrophilicity and altered water distribution.

Because chloride is the principal extracellular anion and closely participates in osmotic regulation, this association may reflect inflammatory edema and extracellular fluid redistribution accompanying asthma exacerbations.

No significant relationships were observed between chloride levels and McClure–Aldrich test results before or after the attack.

Several significant correlations between electrolytes were observed:

Na3 vs. Cl1: $\rho=-0.387$, $p=0.024$

This inverse association may reflect compensatory electrolyte adjustments occurring during recovery from an asthma attack.

Positive correlations were observed between potassium measured after the attack and chloride concentrations:

K3 vs. Cl1: $\rho=0.583$, $p<0.001$

K3 vs. Cl2: $\rho=0.534$, $p=0.001$

K3 vs. Cl3: $\rho=0.355$, $p=0.039$

These findings suggest coordinated regulation of potassium and chloride during the recovery phase and may reflect restoration of acid–base and electrolyte balance following acute respiratory dysfunction.

The McClure–Aldrich test results demonstrated strong correlations across all three observation periods:

Test1–Test2: $\rho=0.661$, $p<0.001$

Test1–Test3: $\rho=0.681$, $p<0.001$

Test2–Test3: $\rho=0.647$, $p<0.001$

These strong correlations indicate that tissue hydrophilicity remained a relatively stable individual characteristic despite acute asthma exacerbation.

Discussion. The present study demonstrates that the relationships between electrolyte concentrations and tissue water balance in bronchial asthma are not uniform across the different phases of an attack. Repeated measurements of sodium, potassium, and chloride were generally correlated with one another, indicating a considerable degree of intra-individual stability of electrolyte homeostasis despite the acute physiological stress associated with bronchospasm. This observation is consistent with the concept that clinically meaningful electrolyte disturbances in asthma are influenced not only by the disease itself, but also by attack severity, ventilation changes, hydration status, and treatment, particularly beta2-agonist exposure [1, 3, 4]. Accordingly, the absence of major generalized electrolyte instability in our cohort of patients with uncomplicated asthma does not contradict previous reports of electrolyte abnormalities during more severe exacerbations.

The sodium results deserve separate consideration. We found a positive association between Na1 and McClure–Aldrich Test 1 ($\rho=0.344$; $p=0.050$), whereas sodium measured during and after the attack was not significantly related to the corresponding tissue-hydration indices. Sodium is the dominant extracellular cation and is a major determinant of extracellular osmolality and water distribution [12]. The baseline association observed in our study may therefore reflect an individual relationship between sodium status and tissue water binding before acute bronchial obstruction develops. At the same time, the lack of a consistent association during the attack suggests that serum sodium alone may not adequately characterize dynamic fluid redistribution in acute asthma. Studies comparing asthmatic patients with control groups have also indicated that electrolyte changes are heterogeneous and cannot be reduced to a single universal pattern [1, 8].

Potassium is traditionally the electrolyte receiving the greatest attention in acute asthma because beta2-adrenergic stimulation can shift potassium into cells and produce clinically relevant hypokalemia, particularly during intensive or continuous albuterol treatment [3, 4]. In the present study, however, potassium concentrations showed no significant direct correlations with the McClure–Aldrich test at any of the three stages. This finding may be explained in part by the predominantly intracellular distribution of potassium, because serum concentrations may change independently of tissue hydrophilicity [12]. Nevertheless, potassium should not be considered clinically unimportant. Recent data have linked potassium status with outcomes in patients with asthma, supporting continued attention to this electrolyte in both acute and chronic disease [13]. In our cohort, significant correlations between K3 and chloride measurements during the recovery phase may indicate coordinated restoration of ionic and acid-base homeostasis after the attack rather than a direct relationship between potassium and tissue hydration.

The most notable finding of the study concerned chloride. A statistically significant positive correlation was observed between chloride concentration during the asthma attack and the McClure–Aldrich test measured at the same phase (Cl2 vs. McClure–Aldrich Test 2: $\rho=0.417$; $p=0.014$). Chloride is the principal extracellular anion and contributes directly to electroneutrality, osmotic regulation, fluid distribution, and acid-base balance [12]. Although sodium and potassium are more frequently emphasized in clinical discussions of electrolyte disturbances in asthma [3, 4], chloride has received comparatively less attention. The present result therefore suggests that chloride may be particularly informative when the aim is to evaluate the interaction between electrolyte regulation and tissue water redistribution during acute bronchial obstruction. The significant correlations among Cl1, Cl2, and Cl3 further indicate that chloride regulation remained individually consistent throughout the observation period, while still showing a phase-specific relationship with hydrophilicity during the attack.

This chloride-hydration association is also physiologically compatible with data emphasizing the importance of fluid balance during severe asthma. Kantor et al. showed that positive fluid balance in children hospitalized with acute asthma exacerbation was associated with increased extravascular lung water, longer treatment duration, increased oxygen requirement, and worse clinical outcomes [9]. Their findings support the concept that fluid redistribution can interact with the altered respiratory mechanics of acute airway obstruction. A published case report has additionally described asthma exacerbation associated with excessive water intake [10]. These studies differ substantially from our investigation in

design and patient population, and they do not directly assess the McClure-Aldrich test or serum chloride in the same manner. Nevertheless, together with our findings they indicate that water balance should not be regarded as a passive background variable in asthma and may deserve more systematic assessment during exacerbations.

The biological relevance of ionic regulation in asthma extends beyond simple serum electrolyte concentrations. Ion channels participate in immune-cell activation, airway smooth-muscle behavior, epithelial function, and inflammatory signaling, and their role in asthma is an active area of investigation [15]. In addition, broader research on mineral and micronutrient status in asthma illustrates that disturbances of inorganic elements may influence inflammatory and immune pathways [11, 14, 16]. These observations do not establish a direct causal role for chloride in the present cohort, but they provide a wider mechanistic context in which the relationship between electrolyte composition and asthma pathophysiology can be considered. Our results should therefore be interpreted as evidence of association rather than proof that chloride changes cause altered tissue hydration or increased asthma severity.

Another important observation was the strong reproducibility of the McClure-Aldrich measurements across all three study periods: Test1-Test2 ($\rho=0.661$; $p<0.001$), Test1-Test3 ($\rho=0.681$; $p<0.001$), and Test2-Test3 ($\rho=0.647$; $p<0.001$). These correlations suggest that tissue hydrophilicity may represent a relatively stable individual physiological characteristic, even when measured during clinically different phases of asthma exacerbation. At the same time, the specific correlation of the second McClure-Aldrich measurement with Cl2 indicates that this stable individual background may be modified by phase-dependent electrolyte-water interactions during the attack. Longitudinal assessment is therefore a strength of the present study, since a single measurement obtained only during an exacerbation would not allow separation of stable individual characteristics from attack-associated changes.

Several limitations should be considered. The study included 34 patients and was based on archival clinical material, which limits the ability to establish causal relationships and to control for all potential confounders. Information on the intensity and timing of bronchodilator therapy, dietary electrolyte intake, renal function, exact fluid administration, and other

factors capable of influencing serum electrolytes and hydration may also affect the observed correlations. In addition, the McClure-Aldrich test reflects tissue hydrophilicity indirectly and is not equivalent to contemporary instrumental methods for quantifying body-fluid compartments or extravascular lung water. For these reasons, the identified Cl2-McClure-Aldrich Test 2 relationship should be confirmed in larger prospective cohorts using parallel modern measures of hydration and fluid distribution.

Despite these limitations, the study provides a longitudinal assessment of electrolyte-water balance across three clinically distinct phases of bronchial asthma exacerbation and highlights chloride as a potentially relevant marker of fluid redistribution during the attack. Current asthma guidelines focus primarily on assessment of airway obstruction, symptom severity, and pharmacological management [2, 6]; electrolyte and fluid monitoring are generally guided by the severity of illness and treatment context rather than used as a routine marker of asthma activity. Our findings support further investigation of whether selected patients, especially those with frequent or severe attacks, may benefit from more detailed evaluation of electrolyte-water interactions. Given the well-recognized tendency for asthma symptoms and severe attacks to worsen at night or in the early morning [6, 7], future studies should also examine circadian variation in water balance and chloride regulation. Such research may clarify whether biorhythms of tissue hydration and electrolyte homeostasis contribute to individual susceptibility to exacerbations and may help refine personalized approaches to prevention and supportive care.

Limitations. Potential confounding factors, including the timing and intensity of bronchodilator therapy, dietary electrolyte intake, renal function, fluid administration, and other conditions affecting serum electrolyte concentrations or hydration status, could not be fully controlled. In addition, the McClure-Aldrich test provides an indirect assessment of tissue hydrophilicity and is not equivalent to modern instrumental methods for evaluating body-fluid compartments or extravascular lung water. Therefore, the observed association between Cl2 and McClure-Aldrich Test 2 should be interpreted cautiously and confirmed in larger prospective studies using standardized treatment protocols and contemporary methods for assessing hydration and fluid distribution.

Conclusion

The present study demonstrates that electrolyte-water interactions in bronchial asthma vary across the phases of an exacerbation while retaining considerable intra-individual stability. The most important finding was a significant positive correlation between chloride concentration during the attack and the simultaneous McClure-Aldrich test result (Cl2 vs. Test 2: $\rho=0.417$; $p=0.014$), suggesting a possible relationship between chloride regulation and tissue water redistribution during acute bronchial obstruction. Strong correlations between repeated McClure-Aldrich measurements (Test1-Test2: $\rho=0.661$; Test1-Test3: $\rho=0.681$; Test2-Test3: $\rho=0.647$) indicate that tissue hydrophilicity may also represent a relatively stable individual physiological

characteristic. Sodium and potassium showed less consistent associations with tissue hydration. These findings support further prospective investigation of chloride and water balance in asthma, including their circadian variation. Studying these parameters during night-time and early-morning periods may improve understanding of exacerbation mechanisms and contribute to more individualized monitoring, prevention, and supportive management of patients with frequent asthma attacks.

References

1. Abdulla RA, Ali Murad KM. Electrolyte imbalance in patient with asthma exacerbation in Sulaymaniyah city. *J Cardiovasc Dis Res.* 2021;12(3):2321-2328.
2. Cloutier MM, Dixon AE, Krishnan JA, Lemanske RF Jr, Pace W, Schatz M. Managing Asthma in Adolescents and Adults: 2020 Asthma Guideline Update From the National Asthma Education and Prevention Program. *JAMA.* 2020 Dec 8;324(22):2301-2317. doi: 10.1001/jama.2020.21974.
3. Cox C, Patel K, Cantu R, Akmyradov C, Irby K. Hypokalemia Measurement and Management in Patients With Status Asthmaticus on Continuous Albuterol. *Hosp Pediatr.* 2022 Feb 1;12(2):198-204. doi: 10.1542/hpeds.2021-006265.
4. Das A, Patil S, Nair G, Uppe A. Electrolyte disturbances in patients with acute exacerbation of bronchial asthma JMSCR Volume 06 Issue 09 September 2018 Page 315-319 DOI: <https://dx.doi.org/10.18535/jmscr/v6i9.55>.
5. GBD 2019 Diseases and Injuries Collaborators. Global burden of 369 diseases and injuries in 204 countries and territories, 1990-2019: a systematic analysis for the Global Burden of Disease Study 2019. *Lancet.* 2020 Oct 17;396(10258):1204-1222. doi: 10.1016/S0140-6736(20)30925-9. Erratum in: *Lancet.* 2020 Nov 14;396(10262):1562. doi: 10.1016/S0140-6736(20)32226-1.
6. Global Initiative for Asthma. Global strategy for asthma management and prevention: 2024 update. Fontana: Global Initiative for Asthma; 2024. Available online: <https://ginasthma.org/>
7. Goldin J, Cataletto ME. Asthma. [Updated 2024 May 3]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2026 Jan-. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK430901/>
8. Jakkula H, Veeranki I, Nutakki S, Pativada M, Natukula K, Varikuti RA, et al. Comparison of serum electrolytes among smokers, asthmatic patients, and healthy controls at a tertiary hospital [Internet]. *Int J Clin Biochem Res.* 2025 [cited 2026 Aug 20];12(2):125-131. Available from: <https://doi.org/10.18231/j.ijcbr.v.12.i.2.11>.
9. Kantor DB, Hirshberg EL, McDonald MC, Griffin J, Buccigrosso T, Stenquist N, et al. Fluid Balance Is Associated with Clinical Outcomes and Extravascular Lung Water in Children with Acute Asthma Exacerbation. *Am J Respir Crit Care Med.* 2018 May 1;197(9):1128-1135. doi: 10.1164/rccm.201709-1860OC.
10. Lv S, Jiao H, Qu Y, Zhang M, Wang R, Li Y, et al. A Case Report of Asthma Exacerbation Induced by Excessive Drinking Water. *Clin Med Insights Case Rep.* 2024 May 12;17:11795476241253107. doi: 10.1177/11795476241253107.
11. Peroni DG, Hufnagl K, Comberiati P, Roth-Walter F. Lack of iron, zinc, and vitamins as a contributor to the etiology of atopic diseases. *Front Nutr.* 2023 Jan 9;9:1032481. doi: 10.3389/fnut.2022.1032481.
12. Shrimanker I, Bhattarai S. Electrolytes. [Updated 2023 Jul 24]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2026 Jan-. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK541123/>
13. Xie C, Yang S, Chen J, Zhang N. Potassium and survival outcomes in asthma patients: evidence from a retrospective cohort study. *J Thorac Dis.* 2025 Sep 30;17(9):6569-6580. doi: 10.21037/jtd-2025-245.
14. Xue M, Wang Q, Pang B, Zhang X, Zhang Y, Deng X, et al. Association Between Circulating Zinc and Risk for Childhood Asthma and Wheezing: A Meta-analysis on 21 Articles and 2205 Children. *Biol Trace Elem Res.* 2024 Feb;202(2):442-453. doi: 10.1007/s12011-023-03690-4.
15. Yan L, Zhang L, Ogunniyi K, Hong L. Ion Channels in the Immune Response of Asthma. *J Respir Biol Transl Med.* 2024 Dec;1(4):10019. doi: 10.70322/jrbtm.2024.10019.
16. Zajac D. Mineral Micronutrients in Asthma. *Nutrients.* 2021 Nov 10;13(11):4001. doi: 10.3390/nu13114001.

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