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Original Research Article

Comparison of Serum Electrolyte Levels in Anaemic and Non-Anaemic Adults: A Hospital-Based Cross-Sectional Study

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Abstract:

Background: Anaemia may be associated with alterations in serum electrolytes and physiological parameters. However, the relationship between Haemoglobin concentration and electrolyte levels remains incompletely understood.

Objective: To compare serum sodium, potassium, and chloride levels between Anaemic and non-Anaemic individuals and to assess the correlation of Haemoglobin with serum sodium, potassium, and chloride in both groups.

Results: Sixty-three Anaemic and 63 non-Anaemic individuals were compared. Mean age, body mass index, pulse rate, systolic blood pressure, temperature, and serum sodium did not differ significantly between the groups. Diastolic blood pressure was significantly lower in the Anaemic group (73.0 ± 8.8 vs. 76.4 ± 8.4 mmHg, p = 0.028), as was respiratory rate (19.9 ± 2.0 vs. 20.6 ± 1.5 breaths/min, p = 0.027). Haemoglobin was markedly lower in Anaemic individuals (9.4 ± 2.4 vs. 14.0 ± 1.1 g/dL, p< 0.001). Serum potassium was higher in the Anaemic group (3.9 ± 0.3 vs. 3.7 ± 0.4 mEq/L, p< 0.001), while chloride was also significantly higher (102.7 ± 5.9 vs. 100.2 ± 4.9 mEq/L, p = 0.008). No significant correlation was observed between Haemoglobin and sodium, potassium, or chloride in either group.

Conclusion: Anaemia was associated with significant differences in diastolic blood pressure, respiratory rate, Haemoglobin, potassium, and chloride, although Haemoglobin showed no significant correlation with individual electrolyte concentrations.

Keywords: Anaemia, Serum Electrolytes, Sodium, Potassium, Chloride.

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Introduction

Anaemia is a common haematological condition characterized by a reduction in haemoglobin concentration below the level required to meet the physiological oxygen demands of tissues. The World Health Organization defines anaemia according to Haemoglobin concentration, with diagnostic thresholds varying according to age, sex, pregnancy status, and other physiological factors.[1,2] Anaemia may result from nutritional deficiencies, chronic disease, blood loss, impaired erythropoiesis, or increased destruction of red blood cells.[1]

The physiological consequences of Anaemia are primarily related to reduced oxygen-carrying capacity. In response, compensatory mechanisms may include changes in cardiovascular and respiratory function. The severity and clinical manifestations depend on the degree and duration of Anaemia and the underlying cause.[1] In addition to haematological changes, alterations in serum electrolyte concentrations have been reported among individuals with Anaemia. Rajagopal et al. reported perturbations in serum electrolyte levels in patients with iron deficiency Anaemia, suggesting that Anaemia may be accompanied by changes in electrolyte homeostasis.[3]

Mansoor et al. also evaluated serum electrolytes in patients with Anaemia and reported differences in selected electrolyte parameters compared with non-Anaemic individuals.[4] Similarly, Ashraf et al. investigated serum calcium and electrolyte levels among Anaemic women and suggested an

association between Anaemia and electrolyte alterations.[5] Electrolytes such as sodium, potassium, and chloride are essential for maintenance of cellular membrane potential, neuromuscular activity, fluid balance, and acid-base homeostasis. Even relatively small alterations may have physiological consequences. Nevertheless, the relationship between Haemoglobin concentration and individual serum electrolyte levels is not fully established.

Therefore, the present study compared serum electrolyte levels between Anaemic and non-Anaemic individuals and evaluated the correlation between Haemoglobin concentration and serum sodium, potassium, and chloride levels in both groups.

Materials and Methods

Study Design and Setting: A hospital-based analytical cross-sectional study was conducted at Karwar Institute of Medical Sciences, Karwar, Karnataka, India, over a period of one year.

Study Population: The study included adult participants aged 18–45 years. A total of 126 participants were recruited, comprising 63 Anaemics and 63 non-Anaemics. The Anaemic group consisted of patients attending the inpatient and outpatient department at Karwar institute of medical sciences, Karwar who fulfilled the WHO criteria for Anaemia. The comparison group consisted of age- and sex-matched non-Anaemic subjects selected from patient attendants accompanying patients at the same institution. sample size was calculated using formula and accordingly, 63 participants were included in each group, giving a total sample size of 126 participants. Reference values used for the sample-size calculation by formula were obtained from a pilot study conducted at the same institute.

Inclusion Criteria

Participants were included if they fulfilled the following criteria:

1. Adults aged 18–45 years.
2. Patients diagnosed with Anaemia according to WHO criteria, irrespective of etiology.
3. Age- and sex-matched non-Anaemic subjects selected from patient attendants accompanying patients at the study institution.
4. Participants willing to provide written informed consent.

Exclusion Criteria

Participants were excluded if they:

1. Were younger than 18 years or older than 45 years.
2. Were pregnant.
3. Had malignancy, chronic kidney disease, or viral hepatitis.
4. Had diabetes mellitus or tuberculosis.
5. Had a recent infection.
6. Who were unwilling to participate in the study.

Ethical Considerations: The study was initiated after obtaining approval from the Institutional Ethics Committee. Written informed consent was obtained from all participants before enrolment. The health status of participants was assessed through detailed history taking and clinical examination.

Anthropometric and Clinical Assessment: Body weight was measured using a calibrated weighing machine with participants wearing light clothing and no footwear. Height was measured in centimetres using a wall-mounted measuring scale. Body mass index (BMI) was calculated using the formula: Body weight(kg)/ height(m^2). Pulse rate, systolic blood pressure (SBP), diastolic blood pressure (DBP), respiratory rate, and body temperature were also recorded.

Laboratory Investigations: Venous blood samples were collected from all participants.

Haemoglobin concentration in both groups was estimated using an automated haematology analyzer (SYSMEX XN-500) in the pathology laboratory. Serum sodium, potassium, and chloride concentrations were analyzed using an EC 90 electrolyte analyzer based on the biosensor principle with direct measurement in the biochemistry laboratory.

Statistical Analysis: The collected data were compiled in Microsoft Excel and analyzed statistically. Continuous variables were expressed as mean ± standard deviation (SD), and categorical variables were expressed as frequencies and percentages.

Differences in continuous variables between Anaemic and non-Anaemic groups were assessed using the independent Student's t-test. Categorical variables were compared using the chi-square test. A p-value <0.05 was considered statistically significant.

Results

Table 1: Comparison of General Physical Characteristic and Haemoglobin Levels Between Anaemics and Non-Anaemics

Study parameters		Mean	Std. Deviation	Std. Error of Means	Independent 't' test	p-value
Age (in years)	Anaemic (63)	33.7	7.7	1.0	1.027	0.306
	Non-Anaemic (63)	32.3	7.5	0.9		
BMI (Kg/m^2)	Anaemic (63)	23.2	2.7	0.3	0.348	0.729
	Non-Anaemic (63)	23.4	2.5	0.3		
Pulse (beats/min)	Anaemic (63)	83.3	12.2	1.5	0.218	0.827
	Non-Anaemic (63)	82.9	10.6	1.3		
SBP (mmHg)	Anaemic (63)	115.4	10.7	1.3	1.551	0.123
	Non-Anaemic (63)	118.2	9.7	1.2		
DBP (mmHg)	Anaemic (63)	73.0	8.8	1.1	2.219	0.028*
	Non-Anaemic (63)	76.4	8.4	1.1		
RR (breaths/min)	Anaemic (63)	19.9	2.0	0.3	2.238	0.027*
	Non-Anaemic (63)	20.6	1.5	0.2		
Temp (·C)	Anaemic (63)	36.7	0.6	0.1	0.59	0.556
	Non-Anaemic (63)	36.7	0.6	0.1		
Haemoglobin (gm/dL)	Anaemic (63)	9.4	2.4	0.3	14.011	< 0.001*
	Non-Anaemic (63)	14.0	1.1	0.1		

Statistically significant at p <0.05. BMI: body mass index; SBP: systolic blood pressure; DBP: diastolic blood pressure; SD: standard deviation.

A total of 126 participants were included in the study, with 63 participants in each group. The mean age of Anaemicparticipant was 33.7 ± 7.7 years, whereas that of non-Anaemic participants was 32.3 ± 7.5 years. The difference in mean age between the two groups was not statistically significant (p = 0.306). Among the 63 Anaemic participants, 35 (55.6%) were female and 28 (44.4%) were male. Among the non-Anaemic participants, 33 (52.4%) were female and 30 (47.6%) were male. The difference in sex distribution between the groups was not statistically significant (p = 0.721). The distribution of BMI categories also did not differ significantly between the groups (p = 0.144). Most participants in both groups had normal BMI. The mean Haemoglobin concentration was significantly lower among Anaemic participants than among non-Anaemic participants (9.4 ± 2.4 vs. 14.0 ± 1.1 g/dL, p< 0.001), confirming a significant difference in Haemoglobin concentration between the two groups. The mean DBP was significantly lower in Anaemic participants compared with non-Anaemic participants (73.0 ± 8.8 vs. 76.4 ± 8.4 mmHg, p = 0.028). Respiratory rate was also significantly lower among Anaemic participants (19.9 ± 2.0 vs. 20.6 ± 1.5 breaths/min, p = 0.027). There were no statistically significant differences in age, BMI, pulse rate, SBP, or body temperature.

Table 2: Comparison of Serum Electrolyte Concentrations Between Anaemic and Non-Anaemic Participants

Sodium (mEq/L)	Anaemic (63)	133.2	4.3	0.5	1.193	0.235
	Non-Anaemic (63)	135.8	17.2	2.2		
Potassium (mEq/L)	Anaemic (63)	3.9	0.3	0.0	3.681	< 0.001*
	Non-Anaemic (63)	3.7	0.4	0.0		
Chloride (mEq/L)	Anaemic (63)	102.7	5.9	0.7	2.678	0.008*
	Non-Anaemic (63)	100.2	4.9	0.6		

Serum Electrolyte Findings: Mean serum sodium concentration was lower among Anaemic participants than non-Anaemic participants (133.2 ± 4.3 vs. 135.8 ± 17.2 mEq/L); however, the difference was not statistically significant (p = 0.235). In contrast, mean serum potassium concentration was significantly higher among Anaemic participants compared with non-Anaemic participants (3.9 ± 0.3 vs. 3.7 ± 0.4 mEq/L, p< 0.001).

Similarly, mean serum chloride concentration was significantly higher among Anaemic participants than non-Anaemic participants (102.7 ± 5.9 vs. 100.2 ± 4.9 mEq/L, p = 0.008).

Table 3: Correlation of Haemoglobin with Serum Electrolyte Levelsin both Anaemic and Non- Anaemic Group

Parameters	Anaemic (63)		Non- Anaemic (63)	
	r-value	p-value	r-value	p-value
Sodium(mEq/L)	-0.017	0.896	-0.062	0.627
Potassium(mEq/L)	0.032	0.801	-0.098	0.444
Chloride (mEq/L)	0.045	0.726	-0.120	0.347

Haemoglobin levels did not demonstrate a statistically significant linear correlation with serum sodium, potassium, or chloride levels in either the Anaemic or non-Anaemic groups(all $p > 0.05$). The correlation coefficients were close to zero, indicating little or no linear association between Haemoglobin and the evaluated serum electrolytes.

Discussion

The present study compared 63 Anaemic individuals with 63 non-Anaemic individuals and evaluated selected physiological and biochemical parameters, with particular emphasis on serum electrolytes and their relationship with Haemoglobin concentration. The findings demonstrated significant differences in diastolic blood pressure, respiratory rate, Haemoglobin, potassium, and chloride between the two groups, whereas age, BMI, pulse rate, systolic blood pressure, temperature, and sodium did not differ significantly.

The mean Haemoglobin concentration was substantially lower in the Anaemic group than in the non-Anaemic group (9.4 ± 2.4 vs. 14.0 ± 1.1 g/dL; $p < 0.001$). This marked difference is consistent with the classification of participants according to Anaemia status and is in accordance with the established role of Haemoglobin concentration in the diagnosis and assessment of Anaemia. [1,2]

A significant difference was observed in diastolic blood pressure, with lower mean values in the Anaemic group (73.0 ± 8.8 vs. 76.4 ± 8.4 mmHg; $p = 0.028$). Respiratory rate was also significantly lower among Anaemic participants (19.9 ± 2.0 vs. 20.6 ± 1.5 breaths/min; $p = 0.027$). Although Anaemia can produce physiological compensatory responses because of reduced oxygen-carrying capacity, [1] the relatively small differences observed in these parameters should be interpreted cautiously and may be influenced by factors other than Haemoglobin concentration. Among the electrolytes studied, serum potassium was significantly higher in the Anaemic group than in the non-Anaemic group (3.9 ± 0.3 vs. 3.7 ± 0.4 mEq/L; $p < 0.001$). Serum chloride was also significantly higher in Anaemic individuals (102.7 ± 5.9 vs. 100.2 ± 4.9 mEq/L; $p = 0.008$). In contrast, serum sodium did not differ significantly between the groups (133.2 ± 4.3 vs. 135.8 ± 17.2 mEq/L; $p = 0.235$). These findings indicate that the association between Anaemia and electrolyte status may not be uniform across individual electrolytes.

Previous studies have also investigated electrolyte disturbances in Anaemia. Rajagopal et al. reported perturbations in serum electrolyte levels among patients with iron deficiency Anaemia.[3] Mansoor et al. similarly evaluated serum electrolyte levels in Anaemic patients and highlighted alterations in selected electrolytes.[4] Ashraf et al. also reported changes in serum calcium and electrolyte parameters among Anaemic women.[5] The present findings are broadly consistent with the observation that electrolyte alterations may accompany Anaemia, particularly with respect to potassium and chloride. Differences between studies may be related to variations in study populations, causes and severity of Anaemia, dietary factors, comorbidities, and other clinical characteristics.

Despite the significant differences in potassium and chloride between the two groups, correlation analysis showed no significant relationship between Haemoglobin concentration and any of the electrolytes studied. In the Anaemic group, Haemoglobin showed very weak correlations with sodium ($r = -0.017$, $p = 0.896$), potassium ($r = 0.032$, $p = 0.801$), and chloride ($r = 0.045$, $p = 0.726$).

Similarly, in the non-Anaemic group, no significant correlations were observed with sodium ($r = -0.062$, $p = 0.627$), potassium ($r = -0.098$, $p = 0.444$), or chloride ($r = -0.120$, $p = 0.347$). Thus, although group-level differences were observed for potassium and chloride, the present data do not demonstrate a direct linear association between Haemoglobin concentration and these electrolyte concentrations.

The absence of significant correlations suggests that the observed electrolyte differences may not be explained solely by the degree of reduction in Haemoglobin. Electrolyte concentrations are regulated by multiple physiological mechanisms involving renal function, hormonal regulation, dietary intake, hydration, and cellular distribution. Therefore, Anaemia and electrolyte alterations may coexist without a simple concentration-dependent relationship.

Overall, the findings demonstrate that Anaemic individuals had significant differences in selected physiological and biochemical parameters, particularly Haemoglobin, potassium, and chloride. However, the lack of significant correlations between Haemoglobin and electrolytes indicates that further studies incorporating Anaemiaetiology,

iron status, renal function, nutritional status, medication use, and other potential confounding factors would be useful to clarify the mechanisms underlying these observations.

Strengths

The study included age- and sex-matched Anaemic and non-Anaemic groups and evaluated multiple serum electrolytes using standardized laboratory methods. The study also assessed the relationship between Haemoglobin concentration and individual electrolyte levels.

Limitations

The cross-sectional design and relatively small sample size limit causal interpretation and generalizability. Information regarding Anaemiaetiology, iron status, renal function, dietary intake, hydration, and medication use was not evaluated, which may have influenced electrolyte levels.

Conclusion

Anaemic individuals showed significantly higher serum potassium and chloride levels than non-Anaemic individuals, while serum sodium did not differ significantly. However, Haemoglobin concentration showed no significant correlation with sodium, potassium, or chloride. Further studies with larger samples and assessment of potential confounding factors are warranted.

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