ISSN Print: 2394-7500
ISSN Online: 2394-5869
Impact Factor (RJIF): 8.4
IJAR 2023; 9(11): 265-268
www.allresearchjournal.com
Received: 21-09-2023
Accepted: 26-10-2023

Bansari H Kathiriya
Student, Microbiology and Biotechnology, L J School of Applied Sciences, L J University, Sarkhej, Ahmedabad, Gujarat, India

Twisha P Patel
Student, Microbiology and Biotechnology, L J School of Applied Sciences, L J University, Sarkhej, Ahmedabad, Gujarat, India

Dhara Patel
Lab Technician, Saraswati Multispeciality Hospital & Trauma Centre, Ahmedabad, Gujarat, India

Nirmal S Sahay
Adjunct Professor, L J School of Applied Sciences, L J University, Sarkhej, Ahmedabad, Gujarat, India

Corresponding Author:
Nirmal S Sahay
Adjunct Professor, L J School of Applied Sciences, L J University, Sarkhej, Ahmedabad, Gujarat, India

Evaluation of haemoglobin and serum electrolyte in the case of glycosuria

Bansari H Kathiriya, Twisha P Patel, Dhara Patel and Nirmal S Sahay

DOI: https://dx.doi.org/10.22271/allresearch.2023.v9.i11d.11390

Abstract
Background: Electrolyte imbalance range in severity of its kind. It primarily affect diabetics because of osmotic fluid changes brought on by hyperglycemia. Numerous writers have discussed it in relation to diabetic and anemic patients, but there hasn't been much discussion of glycosuria, a disease brought on by the proximal tubules of the glomerulus failing to absorb enough sugar or glucose.
Aim: To determine the relationship between electrolyte (Sodium & Potassium), haemoglobin, and urine glucose/glycosuria concentration.
Materials and Method: A total of 170 patients (90 men and 80 women) blood & urine samples were evaluated in the study, which was carried out at Saraswati Multispeciality Hospital & Trauma Centre, Bopal, Ahmedabad between January 2023 and March 2023. The samples were examined using conventional automatic instruments.
Result: The concentration of electrolytes (Sodium and Potassium) had shown an increase with the increase in age from 0 to 30 in the age group of 0 to 5 and 5 to 30 in case of male & female both respectively but the pattern was observed variable after the age of 30 in both the cases (male & female) in the age group of 30 to 50 and above 50. Our observation shows that, in the case of glycosuria, there were no obvious electrolyte imbalances (sodium and potassium) at normal haemoglobin level.
Conclusion: We saw an age- dependent pattern of electrolyte imbalance, but none of them fell within the reference range of hyponatremia, hypernatremia, hypokalemia, and hyperkalemia.

Keywords: Anemia, diabetes, haemoglobin, glycosuria, electrolyte imbalance and serum electrolytes

Introduction
An electrolyte imbalance happens when the levels of some minerals in our blood are either too high or too low. Depending on the type and severity of the electrolyte imbalance, symptoms can include muscle cramps and weakness. Electrolyte imbalance has a significant impact on the body's electrolyte concentration and mostly affects diabetic individuals due to osmotic fluid changes brought on by hyperglycemia. Water movement may have a dilutional effect if internal electrolytes are transported to the extracellular space, lowering extracellular electrolyte concentrations or raising extracellular concentrations, particularly in an insulin-deficient state. According to Saito T *et al* 1999 [1], blood potassium levels and fasting plasma glucose (FPG) have a positive correlation while serum sodium levels and FPG have a negative correlation. Patients with insulin-dependent diabetes mellitus were more likely to notice the changes than those with non- insulin-dependent diabetes mellitus. The relationship between serum potassium, FBS, and the degree of diabetes control was not proven to be significant [2]. Because of these osmotic effects, blood sodium levels (Na+) may be diluted to the point that hyponatremia (a serum Na+ concentration below 135 mmol/l) may develop. Trans-membrane electrical gradients control cellular K+ diffusion out of cells and cellular Na+ diffusion in cells. Serum electrolyte levels are affected by changes in insulin levels of the hormone. In addition to the impairment of their main transport system, Sahid SM and Mahboob T 2008 [3] proposed progressive patterns in electrolyte abnormalities in diabetes mellitus leading to end stage renal disease. Diabetes can lower serum Na+ levels by creating a dilution effect that shifts water from intracellular to extracellular compartments because glucose is osmotically active [4]. In contrast to patients without anemia, people with anemia had lower salt and potassium levels, according to Mansoor F *et al* 2021[5].

Increased Na + /K + ATPase activity in anaemic patients compensates for the normal function of this enzyme in the cell and its method for adaptation to patients with low oxygen levels [6, 7]. Changes in membrane- bound enzymes have a direct impact on the levels of Na + and K + in the serum.

Glycosuria, a disorder brought on by the proximal tubules of the glomerulus failing to absorb enough sugar or glucose, is not often associated with changes in electrolyte imbalance. The only cause of glycosuria may or may not be diabetes. Anemia's, iron deficiency anemia, and diabetes are linked to electrolyte imbalance, according to the facts that are now available. However, there is a paucity of information on electrolytes in the case of glycosuria. We have identified the frequency of electrolyte imbalance in glycosuria in this investigation.

Materials and Methods

The study includes 90 male patients and 80 female patients who visited the Saraswati multispecialty hospital & trauma center, Bopal, Ahmedabad - India from January 2023 to March 2023. Table 1 shows the number of patients in different age group tested during the period. The results were analyzed to determine the relationship between electrolyte (Sodium & Potassium), haemoglobin, and urine glucose/glycosuria concentration. The samples were examined using conventional automatic instruments. Electrolyte (Sodium and Potassium) was measured by utilizing the EasyLyte® analyzer from Medica Corporation, an entirely automated, microprocessor-controlled electrolyte device that makes use of ISE (Ion Selective Electrode) technology. The Mindray BC-700 Series, a haematology analyzer that does both complete blood count (CBC) and erythrocyte sedimentation rate (ESR) tests, was used to measure haemoglobin, and the Automatic Abbott SD urometer 120 Analyzer was used to evaluate urine glucose.

Table 1: Age wise Patients detail. The numbers represent the counts of patients in each age group and gender category

Age Group	Male (n=90)	Female (n=80)
0 to 5	11	9
5 to 30	28	11
30 to 50	21	34
50 to above	30	26

Results

The haemoglobin (HB), sodium (Na), potassium (K) and glycosuria values for male patients across different age groups shown in Table 2 indicates that electrolyte imbalance affects haemoglobin and glycosuria values in male. In the age group of 0 to 5 Glycosuria level was 110 mg/dl whereas the haemoglobin level was 11.4 g/dl and sodium & potassium was 130 mmol/L & 2.3 mmol/L respectively. Whereas in the age group of 5 to 30 Glycosuria level was 170 mg/dl with the haemoglobin level 15.2 g/dl and sodium & potassium was 141 mmol/L & 3.9 mmol/L respectively. It had shown an increasing trend with increase in age. With the increase of haemoglobin from 11.4 to 15.2 (g/dl), sodium had shown an increases from 130 to 141 (mmol/L), potassium had shown an increases from 2.3 to 3.9 (mmol/L) and concentration of glucose in urine (Glycosuria) also increased from 110 to 170 (mg/dl) whereas in the age group of 30 to 50 and 50 onwards the trends was showing a decrease in the concentration of haemoglobin and glycosuria but electrolytes trend was showing an increase in case of sodium whereas in case of potassium it decreased from 3.9 to 3.0 (mmol/L) in the age group of 5 -30 to 30-50 and had shown a further increased from 3.0 to 4.6 (mmol/L) in the age group of 30-50 to 50 onwards respectively. The relation of electrolyte with haemoglobin and glycosuria in male patients are represented in Fig. 1.

A one-way ANOVA was conducted to determine the effect of age group on Haemoglobin, Sodium, Potassium and Glycosuria. The result indicates a significant effect ($F=66.25$, $p = 0$). Post Hoc test were conducted using Tukey pairwise multiple comparison test. The comparison revealed significant difference between Sodium and Haemoglobin, Potassium and Sodium, Glycosuria and Haemoglobin whereas it was not significant between Potassium and Haemoglobin & Glycosuria and Sodium at 95% Tukey interval among the male patients. We therefore reject the null hypothesis that different age groups have the same effect on Haemoglobin, Sodium, Potassium and Glycosuria.

Table 3 represent the average value of haemoglobin (HB), sodium (Na), potassium (K) and glycosuria level of female patients in different age groups. It indicates that electrolyte imbalance had also affected in haemoglobin and glycosuria concentration in female. The electrolyte sodium showed an increase continuously from 129 to 147 mmol/L among 0-5 to 50 & above age group whereas potassium increased from age group 0-5 to 5-30 (2.1 mmol/L to 2.3 mmol/L) but decreased in the age group of 5-30 to 30-50 (2.3 mmol/L to 2.1 mmol/L) respectively. It increased further from 2.1 to 2.6 mmol/L in the age group of 30-50 to 50 and above.

Glycosuria also followed the trend of increase similar to sodium and potassium pattern in the age group of 0-5 to 5-30 but decreased further in the age group of 30-50 similar to potassium but increased further in the 50 and above age group. The relation of electrolyte with haemoglobin and glycosuria in female patients are represented in Fig. 2.

A one-way ANOVA was conducted to determine the effect of age group on Haemoglobin, Sodium, Potassium and Glycosuria. The result indicates a significant effect ($F=69.13$, $p = 0$). Post Hoc test were conducted using Tukey pairwise multiple comparison test. The comparison revealed significant difference between Sodium and Haemoglobin, Potassium and Sodium, Glycosuria and Haemoglobin whereas it was not significant between Potassium and Haemoglobin & Glycosuria and Sodium at 95% Tukey interval among the female patients. We therefore reject the null hypothesis that different age groups have the same effect on Haemoglobin, Sodium, Potassium and Glycosuria.

Table 2: Average results of the male patient's haemoglobin, electrolyte (Sodium and Potassium) and Glycosuria (Glucose content in Urine) in different age groups

Male, Age Group	Haemoglobin (g/dl)	Sodium (mmol/L)	Potassium (mmol/L)	Glycosuria (mg/dl)
0 to 5	11.40	130.00	2.30	110.00
5 to 30	15.20	141.00	3.90	170.00
30 to 50	15.10	138.00	3.00	120.00
50 to above	14.20	147.00	4.60	90.00

Table 3: Average results of the female patient's haemoglobin, electrolyte (Sodium and Potassium) and Glycosuria (Glucose content in Urine) in different age groups

Female, Age Group	Haemoglobin (g/dl)	Sodium (mmol/L)	Potassium (mmol/L)	Glycosuria (mg/dl)
0 to 5	10.50	129.00	2.10	115.00
5 to 30	11.90	134.00	2.30	160.00
30 to 50	12.00	139.00	2.10	114.00
50 to above	11.60	147.00	2.60	80.00

Discussion

Glycosuria happens when the glomerulus filters more glucose than the proximal tubule can reabsorb. In normal individuals, glycosuria can be up to 25 mg/dl. More than 25 mg/dl in random fresh urine is considered increased glycosuria and can be due to elevated plasma glucose or renal glucose absorption impairment, or both [8, 9]. Renal glycosuria is the medical term for the condition when glycosuria develops even with normal or low blood sugar levels. The generation of haemoglobin, the function of red blood cells, or the general health of the blood, may be affected by other diseases or circumstances in addition to electrolyte imbalance problems. The reference ranges for Na+ and K+ are 135-145 mmol/l and 3.5-5.2 mmol/l, respectively [10]. Data were organized according to age groups, and the effects of glycosuria on haemoglobin concentration and electrolyte (Na+ and K+) concentration were examined. The relative amounts of sodium and water in plasma are determined by the serum Na+ concentration, and the maintenance of a normal Na+ concentration helps to control the volume of bodily fluids [11]. As a result of electrolyte imbalances, hyponatremia with hypervolemia (Dilutional Syndromes), hypernatremia, hyperkalemia, and hypokalemia are all possible conditions. However, based on the sodium and potassium concentrations in Figure 1 and 2, which illustrate their respective concentrations, our results do not suggest any such disease.

Glycosuria may indicate the presence of diabetes, but it is not diagnostic, nor does the absence of glycosuria exclude diabetes. In individuals with a low renal threshold, glucose may be present in the urine in the absence of hyperglycemia [12]. The concentration of electrolytes (Sodium and Potassium) had shown an increase with the increase in age from 0 to 30 in the age group of 0 to 5 and 5 to 30 both in case of male & female respectively but the pattern was observed variable after the age of 30 in both the cases (male & female) in the age group of 30 to 50 and above 50.

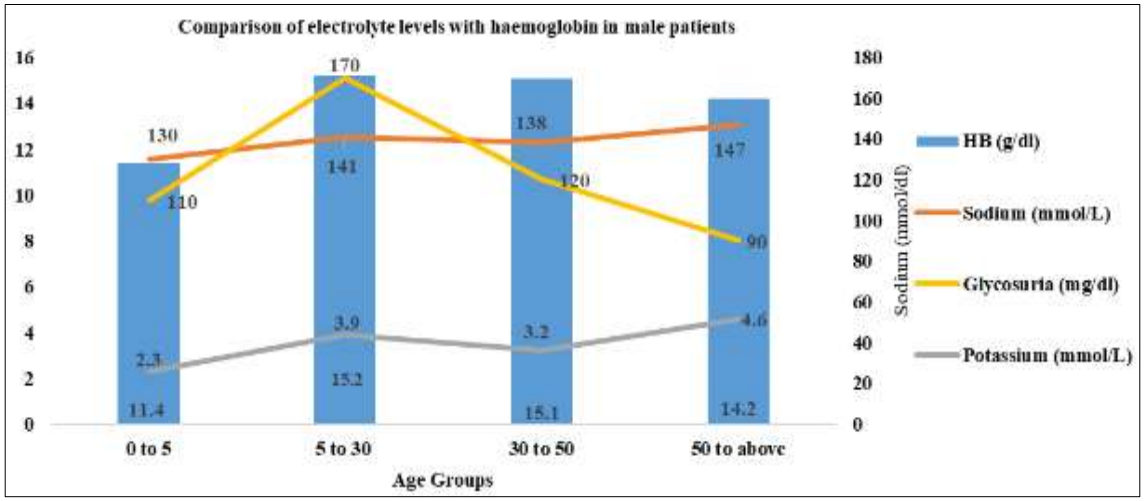

Fig 1: Bar diagram shows the concentration of haemoglobin in different age group of male patients in correlation with concentration of sodium & potassium and glycosuria of respective groups

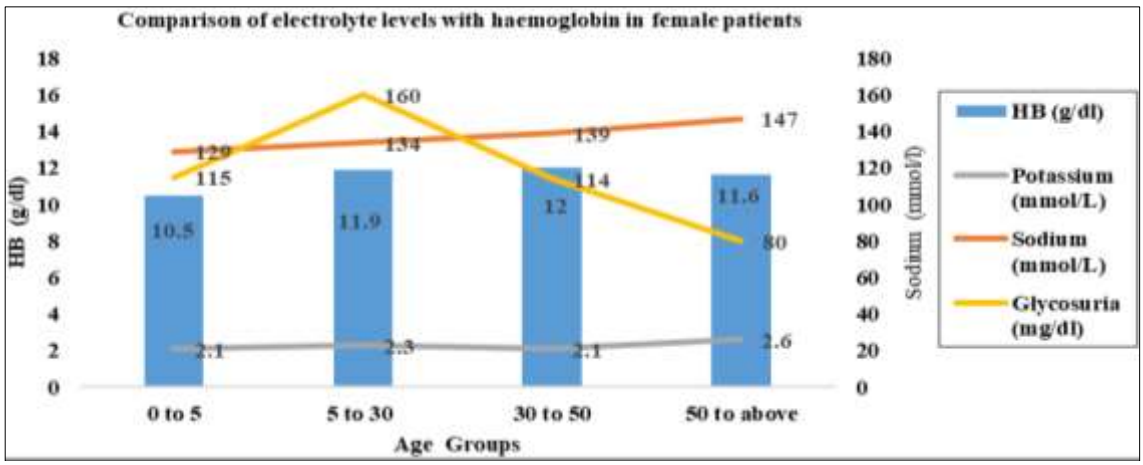

Fig 2: Bar diagram shows the concentration of haemoglobin in different age group of female patients in correlation with concentration of sodium, potassium and glycosuria of respective groups

Conclusions

We have observed an age-dependent pattern of electrolyte imbalance in proportion to haemoglobin concentration in the case of glycosuria, however none of them fell within the reference range of hyponatremia, hypernatremia, hypokalemia, and hyperkalemia. In all the examined samples, the haemoglobin concentration was optimal in both the male and female cases. That is to say, in the instance of glycosuria, there were no obvious electrolyte imbalances (sodium and potassium) at normal haemoglobin content.

Acknowledgements

We are thankful to the mentor of Saraswati Multispeciality Hospital & Trauma Centre, Bopal, Ahmedabad to allow our student Bansari H Kathiriya and Twisha P Patel, to work as inter during January to March 2023. I also extend my sincere gratitude to the participants who visited for their test.

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