Journal of Pharmaceutical and Medical Research
ISSN: 2663-1962
DOI: https://doi.org/10.61784/jpmr3019

STUDIES ON GLYCATED HAEMOGLOBIN, PLATELETS, SODIUM AND POTASSIUM IN TYPE II DIABETES PATIENTS ATTENDING FEDERAL UNIVERSITY TEACHING HOSPITAL, OWERRI, NIGERIA

Aloy-Amadi Oluchi C.[1*], Luke Chinonso[1], Akujobi Augustine U.[2], Nwadike Constance N.[1], Edward Ukamaka[1], and Igwilo Anastecia C.[3]
[1]*Department of Medical Laboratory Science, Imo State University, Owerri, Nigeria.*
[2]*Department of Optometry, Imo State University, Owerri, Nigeria.*
[3]*Department of Haematology and Blood Transfusion, University of Calabar Teaching Hospital, Calabar, Cross River State, Nigeria.*
Corresponding Author: Aloy-Amadi Oluchi C., Email: oluchialoy@yahoo.com

Abstract: Diabetes Mellitus is a complex disease characterized by chronic hyperglycemia responsible for complications affecting the kidneys, eyes, peripheral nerves, and micro and macrovascular systems. This study was aimed at evaluating the levels of glycated haemoglobin, platelet count, sodium and potassium in type II diabetes mellitus patients attending federal university teaching hospital, Owerri. All eligible subjects who filled the questionnaire and gave written informed consent for the study period were sampled. The study population consisted of 50 patients diagnosed with diabetes mellitus and an equivalent number of age - matched healthy subjects (50) who served as controls. Seven millilitres of blood samples were collected from the study participants.2 mls was aliquoted into ethylenediaminetetraacetic acid (EDTA) containers and used for platelet counts using nuebauer counting chamber and HBA1c estimation using Fluorescence immunoassay method. 5 mls of blood were dispensed into plain containers and used for sodium and potassium estimations using Flame emission spectrophotometric method. The results of the tests were analyzed using SPSS version 21. The mean values of HBA1c (9.24±2.63)%, potassium (4.49±0.78) mmol/l and platelets (312766.67±90153.01) cells/µl were significantly increased in the diabetics when compared to controls (4.61±1.21)%,(3.91±0.47)mmol/l and (168906.25±55864.67) cells/µl. The mean value of sodium (127.93±10.32)mmol/l was significantly decreased (p=0.002, p=0.000 and p=0.001) in the diabetics when compared to controls (139.28±5.97)mmol/l (p=0.001. There was no significant difference in the mean values of HBA1C, sodium, potassium and platelets in male diabetics(9.11±3.01)%, (131.66±12.06)mmol/l, (4.52±1.17)mmol/l and (382716.97±58153.78)cells/µl when compared to female diabetics (9.02±2.99)%, (132.11±4.88)mmol/l, (4.48±0.92)mmol/l and (368696.25±65864.01)cells/ µl. There was a non - significant positive correlation (r=0.19, p=0.318; r=0.33, p=0.072 and r=0.03, p=0.871) of HBAIc with sodium, potassium and platelets in the diabetics. Glycated haemoglobin, potassium and platelets were significantly increased in the diabetic patients. The study proves that estimation of glycated haemoglobin, sodium ion, potassium ion and platelet will be very useful in diabetes mellitus patients with regard to understanding the pathogenesis and to evaluate diabetic complications.
Keywords: Diabetes; Glycated haemoglobin; Platelets; Sodium; Potassium

1 INTRODUCTION

Diabetes is one of the diseases which frequently lead to electrolyte distortion [1]. The prevalence of diabetes steadily increased worldwide especially in middle-income countries like Nigeria, India and China. By the year 2014, approximately there was a 4-fold increase in the number of diabetic patients, since the year 1980 [2].
Type 2 diabetes is a common and ever-increasing worldwide health problem. Although well described in terms of its hallmarks of insulin resistance and β-cell failure, the proximal cause(s) of type 2 diabetes and the mechanisms underlying its genetic predisposition remain largely unknown. Plausible cases have been made for the primacy of abnormalities in insulin signaling, insulin secretion, activation of stress pathways, mitochondrial dysfunction, hepatic fuel homeostasis, and CNS regulation [1].
Glycated haemoglobin results from a combination of group of glucose or others hexoses (covalently linked) with the amino-terminal valine of the β-chain of haemoglobin, a protein contained in red blood cells [3]. Measurement of glycated hemoglobin (HbA1c) has been recommended for the diagnosis of diabetes and prediabetes, however epidemiological studies have shown significant discordance between HbA1c and glucose-based tests for defining diabetes and prediabetes. For the diagnosis of diabetes, HbA1c showed 24% sensitivity and 99% specificity in the Dutch population [4]. These levels

of sensitivity and specificity were replicated in several other studies, all suggesting poor agreement between HbA1c, fasting plasma glucose (FPG) and 2-h plasma glucose (2 hPG) [5].

The platelets play significant roles in the integrity of normal homeostasis and atherosclerosis process [6]. They are also closely associated with cardiovascular events. There were numerous studies on the role of platelets in cardiovascular events during last decades, many of them focused on thrombotic complications. The thromboxane generation increased in patients with thrombotic complications, especially in the cardiovascular diseases patients with poor glycemic control [7]. Diabetes mellitus (DM) has been considered as a 'prothrombotic state' with enhanced platelet reactivity, researchers found the morphological changes of platelets and the increased platelet activity occurred in diabetic patients [8].

Electrolytes in the body including sodium (Na+), calcium (Ca2+), potassium (K+), chlorine (Cl-) and magnesium (Mg2+) play important physiological roles in the body such as enhancing enzyme activities, creating electrical gradients, promoting several metabolic and cellular activities, and ensuring normal homeostasis [9]. However, distortion or imbalance of the normal electrolyte level may lead to clinical abnormalities or disorders which are frequently associated with increased morbidity and mortality [10]. This osmotic drift leads to a condition termed as electrolyte disorder or imbalance. Both hyper- and hypo-electrolyte levels are observed in diabetes. Certain studies have shown hyperkalaemia, hypernatraemia,and hypermagnesaemia etc. to occur in diabetic patients as well as hypokalaemia and hyponatraemia are also possible due to osmotic diuresis, antidiabetic agents or exogenous insulin administration [11].

Several authors have documented that increased morbidity and mortality in type 2 Diabetes Mellitus are associated with macro vascular (cardiovascular diseases, stroke, and peripheral arterial disease) and micro vascular (nephropathy, neuropathy and retinopathy) complications due to platelet dysfunction [12]. Since microvascular, complications of type II diabetes are important causes of morbidity and medical expenditure, to determine indicators of these complications such as platelets will be highly beneficial.

Certain studies have shown hyperkalaemia, hypernatraemia, and hypermagnesaemia etc., to occur in diabetic patients as well as hypokalaemia and hyponatraemia are also possible due to osmotic diuresis, antidiabetic agents or exogenous insulin administration. The derangement of sodium and potassium level in diabetes remains unclear as very few studies have evaluated the extent of this electrolyte alteration among various populations [13]. Several studies have estimated the electrolytes levels in diabetes mellitus in several countries and showed the association between electrolytes and hyperglycemia [14]. According to a study done by Javaid et al. (2017), they compared metformin, glibenclamide and combination of these two, to see the effect on electrolyte imbalance and found that low sodium and higher potassium was seen in all these cases with insignificant difference [15]. In another study by Yasmin et al. (2016), they found lower levels of all electrolytes i.e. sodium, potassium, chloride, calcium, magnesium and phosphorus [16]. Since majority of these studies were done in western countries having different race and genetics and according to my knowledge only few of these studies have been done here in Nigeria, that's why this study was aimed at evaluating the levels of glycated haemoglobin, platelet count, sodium and potassium in type II diabetes mellitus patients attending Federal University Teaching Hospital, Owerri.

2 MATERIALS AND METHODS

2.1 Study Area

The study was conducted at the Federal University Teaching Hospital, Owerri. The hospital is located along Orlu road, secretariat, Owerri, Imo state. Owerri is the capital of Imo State in Nigeria, set in the heart of Igboland. It is also the state's largest city. Owerri consists of three Local Government Areas including Owerri Municipal, Owerri North and Owerri West.

2.2 Study Design

A cross-sectional study was carried out from the month of June to August 2023. All eligible subjects who filled the questionnaire and gave a written informed consent for the study period were sampled. The study population consisted of 50 patients with diabetes mellitus who were recruited for the study. An equivalent number of age- matched apparently healthy subjects (50) served as controls. The procedure was carried out at federal university teaching hospital, Owerri. The results of the tests were analyzed using SPSS version 21.

2.3 Method of Recruitment

A total of one hundred subjects were recruited for the study (50 patients and 50 healthy subjects). The study participants were given an informed consent form to fill, and subjects who gave a written informed consent and completed the questionnaire were recruited for the study.

2.4 Sample Collection

Seven milliliters (7 mls) of venous blood sample was collected at the ante-cubital vein aseptically, 2ml was dispensed into Ethylenediaminetetraacetic acid containers, while 5ml was dispensed into plain containers. The EDTA and plain containers was properly labeled with the subject's name, sample number and date of collection. The blood sample dispensed into the EDTA containers were stored in a refrigerator at 40C while the serum was stored in a freezer at -200C prior to use.

2.5 Ethical Consideration

The study was approved by the ethics committee of federal university teaching hospital, Owerri. All study participants who gave informed consent were enrolled in the study and samples were taken.

2.6 Selection criteria

2.6.1 Inclusion criteria

(1) Subjects suffering from Diabetes Mellitus.
(2) Subjects who gave their informed consent.
(3) Those without any other infection such as HIV, HBsAg, HCV, Syphilis et cetera.
(4) Age-matched healthy subjects who served as controls.

2.6.2 Exclusion criteria

(1) Subjects who did not give their informed consent were excluded from the study.
(2) Those with other infections such as HIV, HCV, HBsAg and syphilis.

2.7 Laboratory Methods

A. Glycated Haemoglobin (HBA1c): This was determined using the Fluorescence immunoassay method.
B. Platelet count: The Platelet count was estimated using manual method with neubaeur counting chamber.
C. Sodium and Potassium :These were performed using Flame Emission Spectrophotometer.

2.8 Statistical Analysis

Statistical analysis was performed using statistical package for the social sciences (SPSS), version 21. Results were expressed as mean ± standard deviation, and presented in tables. Pearson correlation test was used to determine the correlations among the study parameters.The level of significance was set at $p < 0.05$.

3 RESULTS

The mean values of HBA1C (9.24±2.63)%, potassium (4.49±0.78)mmol/l and platelets (312766.67±90153.01) cells/µl were significantly increased in diabetics when compared to controls (4.61±1.21)%, (3.91±0.47)mmol/l and (168906.25±55864.67) cells/µl. (t=9.01, p=0.002; 12±3.53, p=0.000 and t=7.61, p=0.001). The mean value of sodium (127.93±10.32)mmol/l was significantly decreased in diabetics when compared to controls (139.28±5.97)mmol/l.(t=5.34, p=0.001) (Table 1).

Table 1 Mean Values of Glycated Haemoglobin (HBAIc), Sodium, Potassium and Platelet in Diabetics Versus Controls

Parameter	Test N=50	Control N=50	t-value	p-value
HBA1C (%)	9.24±2.63	4.61±1.21	9.01	0.002
Na (mmol/l)	127.93±10.32	139.28±5.97	5.34	0.001
K (mmol/l)	4.49±0.78	3.91±0.47	3.53	0.000
Platelet (cells/µl)	312766.67±90153.01	168906.25±55864.67	7.61	0.001

Keys: HBAIC= Glycated Haemoglobin, Na+= Sodium, K+= Potassium

There were no significant differences in the mean value of (HBA1C) (9.11±3.01)% sodium (131.66±12.06)mmol/l, potassium (4.52±1.17)mmol/l and platelets (382716.97±58153.78)cells/µl in male diabetics when compared to female diabetics (9.02±2.99)%,(132.11±4.88)mmol/l, (4.48±0.92)mmol/l and (368696.25±65864.01)cells/ µl (t= 12.86, P=0.504; t=14.77, p=0.801; t=10.98, p=0.472; and t=22.70, p=0.645) (Table 2).

Table 2 Mean Value of Glycated Haemoglobin (HBA1C), Sodium, Potassium and Platelet in Male Diabetics Versus Female Diabetics (Mean±SD)

Parameter	Male N=25	Female N=25	t-value	p-value
HBA1C (%)	9.11±3.01	9.02±2.99	12.86	0.564

Na^+ (mmol/l)	131.66±12.06	132.11±4.88	14.77	0.801
K (mmol/l)	4.52±1.17	4.48±0.92	10.98	0.472
Platelets (cells/µl)	382716.97±58153.78	368696.25±65864.01	22.70	0.645

Keys: HBAIC= Glycated Haemoglobin, Na+= Sodium, K+= Potassium

There was a non-significant positive correlation of HBAIc with Sodium, Potassium and Platelet in Diabetics (r=0.19, p=0.318; r=0.33, p=0.072 and r=0.03, p=0.871) (Table 3).

Table 3 Correlation of HBAIc with Sodium, Potassium and Platelets in Diabetics

Variable	n	r	p-value
Sodium	30	0.19	0.318
Potassium	30	0.33	0.072
Platelets	30	0.03	0.871

4 DISCUSSION

Type 2 diabetes mellitus is the most common metabolic disorder, characterized by chronic hyperglycemia resulting from defects in insulin secretion, insulin action, or both.In the present study, the mean value of HBA1C was significantly increased in diabetics when compared to controls. Glycated hemoglobin is a form of hemoglobin which is measured primarily to identify the average plasma glucose concentration over prolonged periods of time [17].

It is formed in a non-enzymatic glycation pathway by hemoglobin's exposure to plasma glucose and binding to the N-terminal of valine of βchain of hemogobin. Normal levels of glucose produce a normal amount of glycated hemoglobin. As the average amount of plasma glucose increases, the fraction of glycated hemoglobin increases in a predictable way. This serves as a marker for average blood glucose levels over the previous months prior to the measurement [1]. The result is similar to the findings of Carr (2016), who observed that the mean glycated haemoglobin level was significantly higher among diabetic subjects compared to non-diabetic controls [6]. The current study reveals that serum sodium concentration was significantly reduced in diabetics when compared to controls. Glucose is an osmotically active substance. Hyperglycemia increases serum osmolality, resulting in movement of water out of the cells and subsequently in a reduction of serum sodium levels ([Na+]) by dilution [18]. The result of this study is in agreement with the report by Liamiset al. (2019), who stated that uncontrolled DM can also induce hypovolemic-hyponatremia due to osmotic diuresis [13].

From the result of the present study, potassium concentration was significantly increased in diabetics when compared to controls. The increase in potassium is termed hyperkalemia. The most common causal factor of chronic hyperkalemia in diabetics is the reduced tubular secretion of K+ due to the syndrome of hyporeninemichypoaldosteronism. Hyporeninemic hypoaldosteronism is more frequently observed in diabetic and elderly patients as well as in those with chronic renal impairment. The result of this study is in consonance with the study carried out by Liamiset al. (2019), who stated a similar result [13].

The finding from this study reveals that the mean values of platelet count was significantly increased in diabetic patients when compared to controls. Platelet counts are indicators of thrombotic potential, and risk factors for microvascular complications in diabetics. The result suggests that the platelet count is the net result of the interplay of platelet survival and platelet production rate. This was in consonance with the findings by Thomas et al. (2021) [19]. It is however in contrast with the findings of a study conducted by Hekimsoy et al. (2014) [20]. The discordant result may be accounted for by the fact that the majority of diabetics used for their study may have been on treatment and in particular antiplatelet medications like clopidogrel and vasoprin for varying durations.

There was no significant difference in the mean values of serum sodium, potassium, HBA1C and platelet, in male diabetic patients when compared to female diabetic patient. But the result clearly indicates that sex doesn't have an effect on HBA1C, sodium and potassium. This is in line with the report by Ripsin et al. (2017) [21].

Lastly, there was a non-significant positive correlation (of HBAIc with Sodium, Potassium and Platelet in Diabetics. The result clearly implies that glycated haemoglobin cannot be used to determine the level sodium, potassium and platelet in diabetics.

5 CONCLUSION

Glycated haemoglobin, potassium and platelets were significantly increased in diabetic patients, while serum sodium concentration was significantly decreased in diabetic patients. The study has proven that estimation of glycated haemoglobin, sodium ion, potassium ion and platelets will be useful indicators for diabetes mellitus and will help in the management of this condition to avoid complications.

6 RECOMMENDATION

Sodium and potassium ions should be considered as part of the routine and mandatory investigations in the assessment of diabetes mellitus patients. Similar studies with larger sample size including patients with co-morbidities should be carried out to further present an expanded view of the current situation.

COMPETING INTERESTS

The authors have no relevant financial or non-financial interests to disclose.

ACKNOWLEDGMENTS

The authors wish to express their thanks to the management of federal university teaching hospital, Owerri for their permission for sample collection and support during the research study.

REFERENCES

[1] Luscher TF, Creager MA, Beckman JA, et al. Diabetes and vascular disease: pathophysiology, clinical consequences and medical therapy. Circulation, 2017, 108(13): 1655–1661.
[2] Saira B, Prashant J, Poonam L. Correlation of Serum Urea and Serum Creatinine in Diabetics patients and normal individuals. International Journal of Clinical Biochemistry and Research, 2020, 7(1): 45–48.
[3] Mahajan RD, Mishra B. Using Glycated Hemoglobin HbA1c for diagnosis of Diabetes mellitus. An Indian perspective. International Journal of Biological Medicinal Research, 2021, 2(2): 508-512.
[4] Van't R, Alssema M, Rijkelijkhuizen JM. Relationship between A1C and glucose levels in the general Dutch population: the new Hoorn study. Diabetes Care, 2020, 33: 61–66.
[5] Cowie CC, Rust KF, Byrd-Holt DD. Prevalence of diabetes and impaired fasting glucose in adults in the U.S. population: National Health And Nutrition Examination Survey. Diabetes Care, 2016, 29: 1263–1268.
[6] Carr ME. Diabetes mellitus: A hypercoagulable State. Journal of Diabetes complications, 2016, 15(1): 44–54.
[7] Beckman JA, Creager M, Libby P. Diabetes and atherosclerosis: epidermiology, pathophysiology and management. American medical association Journal of the American Medical Association, 2012, 287(19): 2570–2581.
[8] Colwell JA, Nesto RW. The platelets in diabetes: Focus on prevention of ischaemic events. Diabetes Care, 2013, 26 (7): 2181–2188.
[9] Linder G, Funk GC. Hypernatremia in critically ill patients. Journal of Critical Care, 2021, 28: 11-20.
[10] Liamis G, Rodenburg EM, Hofman A, et al. Electrolyte disorders in community subjects: Prevalence and risk factors. American Journal of Medicine, 2013, 126: 256-263.
[11] Sarguru D, Vanaja R, Balaji R. Evaluation of serum electrolytes in type II diabetes mellitus. International Journal of Pharmaceutical Science Review Research, 2016, 40 (1): 251-253.
[12] Ferroni P, Basil S, Falco A, et al. Platelet activation in type 2 diabetes mellitus. Journal of Thrombotic haemostasis, 2014, 2(8): 1282–1291.
[13] Liamis G, Rodenburg EM, Hofman A, et al. Electrolyte disorders in community subjects: prevalence and risk factors. America Journal of Medicine, 2019, 126: 256-263.
[14] Kitabchi AE, Umpierrez GE, Murphy MB, et al. Hyperglycemic crisis in adult patients with diabetes:A consensus statement from the American diabetes association. Diabetes Care, 2016, 29: 2739–2748.
[15] Javaid A, Hasan R, Zaib A, et al. A comparative study of the effects of hypoglycemic agents on serum electrolytes in diabetic patients. Pakistan Journal of Pharmaceutical Science, 2017, 20(1): 67–71.
[16] Yasmin F, Haleem DJ, et al. Intraerythrocyte and serum electrolytes in diabetic patients with hypertension. Journal of College Physicians Surgery Pakistan, 2016, 16 (7): 445–449.
[17] Krentz AJ, Bailey CJ. Oral antidiabetic agents: current role in type 2 diabetes mellitus. Drugs, 2015, 65 (3): 385–411.
[18] Sarwar N, Gao P, Seshasai SR, et al. Diabetes mellitus, fasting blood glucose concentration, and risk of vascular disease:a collaborative meta-analysis of 102 prospective studies. Emerging Risk Factors Collaboration. Lancet, 2016, 375(9733): 2215–2222.
[19] Thomas AK, Udaya KM, Suraksha BR, et al. Mean platelet volume in type 2 diabetes mellitus. Journal of laboratory physicians, 2021, 4(1): 5–9.
[20] Hekimsoy Z, Payzinb B, et al. Mean platelet volume in Type 2 diabetic patients. Journal of Diabetes Complications, 2014, 18(3): 173–176.
[21] Ripsin CM, Kang H, Urban RJ. Management of blood glucose in type 2 diabetes mellitus. American Family Physician, 2017, 79 (1): 29–36.