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Assessment of Renal Erythropoietic Status of the Newly Diagnosed Diabetic Patients without Renal Impairment in Benin City, Nigeria

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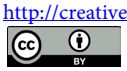
Abstract

Diabetes mellitus is a carbohydrate metabolism disorder which is caused due to impairment in insulin secretion and/or the activity of insulin, leading to chronic hyperglycemia with defective carbohydrate, fat and protein metabolism. This study aimed at assessing the erythropoietin (EPO), hemoglobin and renal parameters levels among the newly diagnosed diabetic patients and providing valuable insights into the management and progression of the disease. A case-control study was conducted on samples of 60 consenting participants including newly diagnosed diabetic patients (n − 30), and healthy controls (n − 30) of age ranging between 20 - 50 years. EPO level was measured using enzyme-linked immunosorbent assay (ELISA), the renal parameters (electrolytes) were measured using Ion-Selective Electrodes. Hemoglobin,



urea and creatinine were measured using cyanmethemoglobin and colorimetric methods respectively under standard protocols. Demographic and clinical data, including age, gender, diabetes duration, iron rich diet consumption, medication history and family history were collected via questionnaires. Independent sample t-test indicated significantly higher mean hemoglobin ($p < 0.05$), packed cell volume ($p = 0.05$) and fasting blood glucose ($p < 0.001$) in newly diagnosed diabetic patients compared with their healthy control. No significant differences were observed in EPO, creatinine, urea, potassium, bicarbonate, sodium, and chloride between the two groups. In this study, the values of haemoglobin, packed cell volume, EPO and all renal biomarkers were normal, this may be due to the early diagnosis of the disease. It also suggests the extensive capacity of the kidney which is able to withstand metabolic disturbances in the newly diagnosed diabetes mellitus condition. Routine medical check and lifestyle modification are recommended to a newly diagnosed diabetic patients. Also further research is warranted to explore the clinical implications of these assessments in predicting diabetes complications, disease progression and guiding therapeutic interventions.

Keywords

Erythropoietin, Renal, Diabetes, Urea, Creatinine, Electrolytes

1. Introduction

Diabetes mellitus is a carbohydrate metabolism disorder which is caused due to impairment in insulin secretion and/or the activity of insulin, leading to chronic hyperglycemia with defective carbohydrate, fat and protein metabolism [1]. There are two (2) types of diabetes mellitus: Type 1 and Type 2 diabetes mellitus. Type 1 diabetes mellitus is often diagnosed in childhood and this form involves the autoimmune destruction of insulin producing beta cells in the pancreas [2] while type 2 diabetes is the most common and usually diagnosed in adults. It is characterized by insulin resistance and relative insulin deficiency, and it is usually associated with factors like obesity, sedentary lifestyle, and genetic predisposition [3]. Insulin resistance in type 2 diabetes and lack of insulin production in type 1 diabetes leads to chronic hyperglycemia, which disrupts normal metabolic processes, thus, affecting fat, protein and carbohydrate metabolism [4].

Epidemiologically, diabetics is a growing global health issue affecting millions worldwide [5]. In Benin City, the prevalence has been steadily rising, reflecting broader trends in urbanization, lifestyle changes, and genetic predisposition [6]. Several complications such as cardiovascular disease, kidney failure, vision loss and neuropathy [1], result from prolonged diabetes and as such, an early diagnosis is crucial to avoid these complications, reduce morbidity and mortality rate and as well as increasing the patient quality of life. While much attention has been devoted to understanding the conventional markers and biomarkers that may provide valuable insights into the disease pathophysiology and prognosis, one

such avenue of investigation involves the assessment of erythropoietin, hemoglobin and renal parameters among newly diagnosed diabetes patients to validate the kidneys efficiency which play a major role in erythropoiesis process.

Erythropoietin, a glycoprotein hormone primarily known for its role in regulating red blood cell production, has demonstrated pleiotropic effect beyond hematopoiesis, including modulation of glucose metabolism and insulin sensitivity [7]. The production is stimulated by hypoxia (low oxygen levels) and is predominantly produced in the kidneys [8]. Long-term high blood sugar levels, a defining characteristic of diabetes, result to complications such as diabetes nephropathy which causes damage of nephrons in the kidney and impairs their function [9]. The interplay of erythropoietin with diabetes involves several mechanisms of action, which includes a reduced capacity to produce erythropoietin, a hormone crucial for stimulating the bone marrow to produce red blood cells, due to damaged kidney seen in diabetes nephropathy [10]. Also, diabetes is often associated with chronic inflammation. The inflammatory cytokines released can interfere with erythropoietin signaling, thereby diminishing its effectiveness in red blood cell production [11]. In addition, chronic hyperglycemia can lead to increased oxidative stress, which may impair the sensitivity of bone marrow to erythropoietin, thus leading to their decreased production [12]. All these factors contribute to the development of anemia in patients with diabetes complications, particularly those with renal involvement [13]. Also, in chronic hyperglycemia, hemoglobin, the oxygen carrying capacity of blood levels are lowered usually due to reduction in production of erythropoietin usually seen in diabetes nephropathy, chronic low-grade inflammation and increased glycation of hemoglobin with other proteins [14].

Diabetic kidney disease, the most serious microangiopathic complication, affects 30% - 40% of people with diabetes. It is responsible for more than 22.6% of cases of chronic end-stage renal disease in France in 2017, its prevalence was 21.6% among dialysis patients in Morocco and 7.8% in Ivory Coast [15]. In Togo, the hospital incidence of rapid renal function decline in diabetic patients is 35% [16]-[18].

Some renal biomarkers such as creatinine, urea and electrolytes levels are interfered in diabetes. Creatinine, a waste product produced by muscle metabolism levels is increased in chronic hyperglycemia due to glomerular damage in complicated diabetes [19]. Also, blood urea nitrogen increases in cases of chronic hyperglycemia, due to impaired glomerular function in complicated diabetes [20]. Electrolyte such as potassium is increased due to reduced excretion of potassium and increased accumulation in the blood [19].

Hyponatremia (low sodium) occurs in chronic hyperglycemia due to osmotic diuresis, where glucose acts as an osmotic agent in the kidneys, pulling water with it into the urine and thus leading to relative loss of sodium [21]. Bicarbonate ion level is reduced in chronic hyperglycemia. The intricate dance of these processes, provides the importance of studying them concurrently, especially in the early stages of diseases, thus allowing for the identification of early biomarkers that may provide valuable insight into predicting disease severity and progression, for the

management and treatment of newly diagnosed diabetes patients. To the best of our knowledge, no documented work has been carried out on the assessment of the erythropoiesis status of the newly diagnosed diabetic patients in Benin City. This study therefore tends to assess the erythropoiesis status of the kidney among these group of people.

2. Materials and Method

2.1. Study Design

This is a case control study of patients with newly diagnosed diabetes mellitus who were evaluated for erythropoietin, hemoglobin and some renal parameters levels using their blood sample. A well-structured questionnaire was administered to every participant to obtain basic demographic details as well as anthropometric characteristics. This study involved a cohort of 60 individuals, consisting of 30 newly diagnosed diabetes mellitus patients (both males and females) and 30 deemed healthy controls. The study participants consisted of individuals newly diagnosed of diabetes mellitus attending diabetic clinic University Benin Teaching Hospital Benin city. The control group is made up of healthy people without a history of diabetes mellitus. The inclusion criteria excluded those with severe health complications that made them seemed fragile. Furthermore, those who left the study for any reason were excluded as well. A well-structured consent form was sent after providing a detailed explanation to the participant was in agreement with the researchers and the goal of the study before proceeding further.

2.2. Questionnaire/Ethical Consideration

The questionnaire comprised inquires specifically formulated to obtain information regarding various ages, genders, state of origin, occupation, marital status, family history of diabetes mellitus, underlying disease condition, type of diabetes mellitus, degree/extent of smoking and alcohol consumption, supplement intake, diet consciousness and involvement on physical activity or exercise. Ethical approval with reference number ADME/E 22/A/VOL.VII/14838152172 was obtained from the Health Research Ethics Committee, University of Benin Teaching Hospital, Benin City, Edo State to carry out this study.

2.3. Sample Collection/Preparation

10 millimeters of venous blood from the participants was collected from the participant's ante-cubital veins using a sterile syringe and needle, and placed into an Ethylene diamine tetra-acetic (EDTA), fluoride oxalate, lithium heparin and plain containers respectively under aseptic conditions. The samples in the ethylenediaminetetra-acetic (EDTA) container were used to examine for hemoglobin and packed cell volume immediately. The samples in the fluoride oxalate container were used to estimate the fasting blood glucose level of the participants. The samples in the lithium heparin container were centrifuged at 5000 rpm for 5 minutes to separate the serum from the clot and used to estimate the electrolyte, urea and

creatinine levels. The samples in the plain container were left to clot for a few minutes and centrifuged at 4000 rpm for 5 minutes to separate the serum from the clot. The serum was then dispensed into another clean dry plain container and used to estimate for erythropoietin level of the subjects. All samples were stored at −80˚C prior analysis.

3. Laboratory Investigation

3.1. Determination of Hemoglobin Level

Hemoglobin levels of the participants were determined using cyanmethemoglobin method, according to the manufacturer's instruction [22].

3.2. Determination of Packed Cell Volume

The Packed Cell Volume was determined using microhematocrit method, according to the manufacturer's instruction [23].

3.3. Determination of Glucose Level

Glucose levels of the participant was determined using glucose oxidase method while using a Randox glucose reagent with LOT number GAB2002R, and the test was done following the manufacturer's instructions [24].

3.4. Determination of Urea Level

The urea levels of the participants were determined using colorimetric method, according to the manufacturer's instructions. The reagent was commercially purchased from Randox company, United Kingdom with LOT number 637861 [25].

3.5. Determination of Creatinine Level

Creatinine level was determined by Jaffe's method, according to the manufacturer's instruction [26]. Creatinine reagent was gotten from Randox company with LOT number 630901.

3.6. Determination of Electrolytes Level

Electrolytes levels were determined using ion selective electrode method, using ISE Model 4000; S/N 04020488 from France, according to the manufacturer's instructions [27].

3.7. Determination of Erythropoietin Level

Erythropoietin level was determined using Elabscience ELISA kit with LOT number ER164VFB1442, according to the manufacturer's instructions [28].

3.8. Statistical Analysis

Descriptive data were expressed as mean and standard deviation for continuous variables and as percentages for categorical variables. Comparative analysis between two groups was done using independent sample t-test. Association between

two continuous variables was done using the Pearson's bivariate correlation test. Statistical significance was set at $p \leq 0.05$. All statistics were performed using SPSS for windows (version 25.0).

4. Results

Table 1 shows the socio-demographic characteristics of the study population. The study population comprises 60 participants (newly diagnosed diabetics, n = 30, and healthy controls, n = 30) of age ranging between 20 - 50 years (mean ± SD, 37.17 ± 6.24 years). A greater percentage of the participants were males (54.1%), <40 years (67.2%), married (59%), employed (57.4%), had tertiary education (95.1%) and from Bini kingdom (39.3%).

Some selected life-styles of the study population are shown in Table 2. Data shows that a greater percentage of the healthy control (90.3%) and patients living with newly diagnosed with diabetes (90%) do not smoke. Majority of the control (67.7%) and patients newly diagnosed with diabetes (73.3%) do not drink alcohol. Majority of the participants (control, 29.0%); patients living with newly diagnosed diabetes, (33.3%) stated that they eat diet containing iron. All the control reported that they are not on regulated food diet, while all the diabetic patients said their diets were regulated. Most of the participants (control, 51.6%; newly diagnosed diabetics, 63.3%) reported that they engage in moderate exercise.

Table 1. Socio-demographic characteristics of the participants.

Characteristics		Frequency	Percent (%)
Sex	Females	28	45.9
	Males	32	54.1
Age group	<40 years	41	67.2
	≥40 years	19	32.8
Ethnicity	Akoko Edo	7	11.5
	Bini	24	39.3
	Esan	15	26.2
	Etsako	6	9.8
	Igbo	7	11.5
	Urobo	1	1.6
Marital Status	Divorced	2	3.3
	Married	35	59.0
	Single	23	37.7
Occupation	Employed	35	57.4
	Retired	4	6.6
	Unemployed	21	36.1
Educational Status	Primary	3	4.9
	Tertiary	57	95.1

Table 2. Selected life-style characteristics of the study population.

Lifestyle Variables		Groups		Total
		Control (n = 30)	Newly Diagnosed Diabetics (n = 30)	
Smoking	No	28 (90.3%)	27 (90.0%)	55 (90.2%)
	Yes	2 (9.7%)	3 (10.0%)	6 (9.8%)
Alcohol	No	21 (67.7%)	22 (73.3%)	43 (70.5%)
	Yes	9 (32.3%)	8 (26.7%)	18 (29.5%)
Iron Diet	Frequently	9 (29.0%)	10 (33.3%)	19 (31.1%)
	Occasionally	13 (41.9%)	11 (36.7%)	24 (39.4%)
	Rarely	8 (29.0%)	9 (30.0%)	18 (29.5%)
Regulated Food	No	30 (100%)	0 (0%)	31 (50.8%)
	Yes	0 (0%)	30 (100%)	30 (49.2%)
Exercise	Lightly	11 (35.5%)	9 (30.0%)	20 (32.8%)
	Moderate	15 (51.6%)	19 (63.3%)	35 (57.4%)
	Sedentary	0 (0%)	1 (3.3%)	1 (1.6%)
	Vigorous	4 (12.9%)	1 (3.3%)	5 (8.2%)

The clinical characteristics of the patients living with newly diagnosed diabetes mellitus is shown in Table 3. Overall diabetes patients' data indicated that majority (70%) of the patients were suffering from type 2 diabetes. A greater percentage (53.3%) of the patients had a family history of diabetes. Most of the patients (86.7%) had suffered diabetes for a period of 1 to 6 months. As at the time of the study, 73.3% of the patients had no underlying disease conditions. However, ten percent of the patients were suffering from frequent dehydration and 6.7% were suffering from ulcer. None of the patients was reported taking diabetes medications.

Table 4 shows the mean levels of erythropoietin, hemoglobin, packed cell volume and renal parameters in patients with newly diagnosed diabetes mellitus and their healthy control. Independent sample t-test indicated significantly higher mean hemoglobin ($p < 0.05$), packed cell volume ($p = 0.05$), and fasting blood glucose ($p < 0.001$) in newly diagnosed diabetic patients compared with their healthy control. In contrast, no significant differences were observed in erythropoietin, urea, creatinine, potassium, bicarbonate, sodium, chloride between the two groups.

Table 5 shows the relationship among the renal biomarkers in healthy control group. Peardon's bivariate correlation test indicated no significant relationships between erythropoietin and other parameters of renal function. Hemoglobin indicated significant positive correlations with Hb ($p < 0.001$), urea ($p = 0.009$), and creatinine ($p < 0.001$), but not with K^+, HCO_3^-, Na^+, Cl^- and FBG. Packed cell

volume indicated significant positive correlations with urea (p = 0.008), and creatinine, but not K^+, HCO_3^-, Na^+, Cl^- and FBG. Urea was positively associated with creatinine (p = 0.003) and potassium (p = 0.040), but not with HCO_3^-, Na^+, Cl^- and FBG. Creatinine was positively associated with bicarbonate (p = 0.045), but not with K^+, Na^+, Cl^- and FBG. Potassium was positively associated with bicarbonate (p < 0.001), chloride (p = 0.010) and fasting blood glucose (p = 0.022), but not with Na^+. Bicarbonate indicated significant correlation with fasting blood glucose (p = 0.005) but not with Na^+, and Cl^-. Sodium indicated positive correlation with chloride (p = 0.004), but not with FBG. There was no significant relationship between Chloride and FBG.

Table 3. Clinical characteristics of patients living with newly diagnosed diabetes mellitus.

Characteristics		Frequency	Percent (%)
Type of Diabetes Mellitus	Type 1	9	30.0
	Type 2	21	70.0
Family History	No	14	46.7
	Yes	16	53.3
Duration of Diabetes Mellitus	1 - 6 Months	26	86.7
	7 - 12 Months	4	13.3
Underlying Disease	None	22	73.3
	Congenital Issues	1	3.3
	Excessive Sweating	1	3.3
	Frequent Dehydration	3	10.0
	Joint pain	1	3.3
	Ulcer	2	6.7
Medication	No	30	100.0

Table 4. Mean levels of erythropoietin, hemoglobin, packed cell volume and renal parameters in patients with newly diagnosed diabetes mellitus and their healthy control.

Variables	Groups	N	Mean	Std. Deviation	T-Statistics	p-Value
EPO (IU/L)	Control	30	6.95	1.06	0.20	0.837
	Newly Diagnosed Diabetics	30	6.90	1.00		
HB (g/dl)	Control	30	14.59	1.87	−2.26	0.027
	Newly Diagnosed Diabetics	30	15.84	2.39		
PCV (%)	Control	30	43.91	5.50	−1.97	0.05
	Newly Diagnosed Diabetics	30	47.38	8.00		
Urea (mg/dl)	Control	30	25.25	3.60	1.51	0.15
	Newly Diagnosed Diabetics	30	29.44	8.53		

Continued

Creatinine (mg/dl)	Control	30	0.67	0.08	−1.17	0.245
	Newly Diagnosed Diabetics	30	1.53	4.05		
Potassium (mmol/L)	Control	30	4.06	0.38	1.09	0.280
	Newly Diagnosed Diabetics	30	3.92	0.62		
Bicarbonate (mmol/L)	Control	30	21.64	1.79	0.09	0.925
	Newly Diagnosed Diabetics	30	21.57	4.01		
Sodium (mmol/L)	Control	30	135.97	2.07	0.91	0.364
	Newly Diagnosed Diabetics	30	132.46	21.19		
Chloride (mmol/L)	Control	30	101.64	2.69	−0.30	0.762
	Newly Diagnosed Diabetics	30	102.06	7.20		
FBG (mg/dl)	Control	30	87.32	13.41	−9.48	<0.001
	Newly Diagnosed Diabetics	30	177.83	51.36		

Table 5. Relationship among the renal biomarkers (erythropoietin, urea, creatinine, and electrolytes levels), hemoglobin, PCV and FBG in healthy control group.

		EPO	HB	PCV	UREA	Cr	K^+	HCO_3^-	Na^+	Cl^-	FBG
EPO	R	1									
	p										
HB	R	0.195	1								
	p	0.294									
PCV	R	0.189	0.998**	1							
	p	0.308	<0.001								
Urea	R	0.171	0.460**	0.469**	1						
	p	0.356	0.009	0.008							
Cr	R	0.088	0.669**	0.662**	0.512**	1					
	p	0.637	<0.001	<0.001	0.003						
K^+	R	0.031	0.085	0.072	0.371*	0.256	1				
	p	0.869	0.650	0.699	0.040	0.164					
HCO_3^-	R	0.176	0.087	0.077	0.210	0.362*	0.606**	1			
	p	0.344	0.642	0.680	0.257	0.045	<0.001				
Na^+	R	0.010	0.336	0.339	0.113	0.262	0.172	0.131	1		
	p	0.958	0.065	0.062	0.546	0.154	0.355	0.483			
Cl^-	R	0.029	0.067	0.070	0.243	0.213	0.454*	0.228	0.506**	1	
	p	0.876	0.719	0.709	0.187	0.250	0.010	0.217	0.004		
FBG	R	0.056	-0.104	-0.117	0.124	0.110	0.411*	0.495**	-0.107	0.248	1
	p	0.763	0.576	0.531	0.505	0.557	0.022	0.005	0.565	0.179	

Abbreviations: EPO, Erythropoietin; Hb, hemoglobin, PCV, Packed Cell Volume; Cr, Creatinine; K^+ Potassium; HCO_3^-, Bicarbonate; Na^+, Sodium; Cl^-, Chloride; FBG, Fasting Blood Sugar; R, Correlation coefficient, p, Significant value. **. Correlation is significant at the 0.01 level; *. Correlation is significant at the 0.05 level.

5. Discussion

Diabetes, also referred to as diabetes mellitus, is a collection of common endocrine disorders characterized by persistently elevated levels of glucose in the bloodstream [29] [30]. Erythropoietin (EPO) is a glycoprotein classified as a cytokine, a signaling molecule involved in intercellular communication [31]. Primarily produced and secreted by specialized cells within the kidneys, EPO plays a vital role in erythropoiesis, the physiological process of red blood cell production. The production of EPO is tightly regulated by oxygen homeostasis. When oxygen levels in tissues fall below a certain threshold, hypoxia-inducible factors (HIFs) are activated within the kidney [32]. Therefore, EPO serves as a critical regulator of red blood cell homeostasis, ensuring adequate oxygen delivery to tissues throughout the body.

Recent studies suggest a potential link between erythropoietin (EPO) levels, kidney function, and newly diagnosed diabetes. Hyperglycemia, a hallmark of diabetes, and chronic inflammation may suppress EPO production in the kidneys, a key organ for EPO synthesis. This could contribute to anemia, frequently observed in diabetics. Moreover, reduced kidney function, measured by GFR, might further decrease EPO, creating a vicious cycle.

In this study, the greater proportion of newly diagnosed uncomplicated diabetic patients are of age ranging between 20 - 50 years. This is in accordance with Bai *et al.* (2021) [33], that the advancement of diabetes to complicated diabetes increased with advanced age. And also, a study conducted by Sosale *et al.* (2014) [34], reported that majority of newly diagnosed patients with T2D are from the age group of ≤50.

Also in this study, the selected life-style characteristics of the study population is shown in **Table 2**, it revealed that all the healthy non-diabetic control reported that they eat non-regulated food diet, while all the diabetic patients said their diets were regulated, while both groups reported that they engage in moderate exercise. This is in agreement with a study by Zhang *et al.* (2018) [35], that calorie restriction and a focus on nutrient-dense foods, such as fruits, vegetables, and whole grains, have been demonstrated to effectively lower blood sugar levels by preventing postprandial hyperglycemia and that regular physical activity enhances insulin sensitivity through mechanisms involving increased skeletal muscle glucose uptake and improved insulin signaling.

In this study, the clinical characteristics of newly diagnosed diabetic patients was shown in **Table 3**, which shows that 70% of the patients were suffering from Type 2 diabetes. This result is in agreement with a study conducted by Sosale *et al.* (2014) [34], which also reported a high prevalence of T2DM among newly diagnosed diabetic patients. And this study also reported a high prevalence of diabetes in individuals with a family history of the disease, which is also in agreement with a study conducted by Annis *et al.* (2005) [36], which reported that family history of diabetes was a significant predictor of self-reported diabetes among diabetic patients. And that adults with a family history of diabetes in a parent or

sibling had four times the odds of having diabetes than adults without a family history of the disease. The study also reported that Family history of type 2 diabetes is recognized as an important risk factor of the disease. Individuals who have a family history of diabetes can have two to six times the risk of type 2 diabetes compared with individuals with no family history of type 2 diabetes. Of the thirty 30 (100%) newly diagnosed diabetic patients in this study, 16 (53.3%) have family history of the disease, while 14 (46.7%) do not have.

In this study, the erythropoietin mean value was observed to be non-statistically significant, this is in agreement with a study conducted by Volker and Radko, (2018) [37], that the kidney complications observed in diabetes mellitus is dependent on how advanced the disease is and how long the patient have been diagnosed of the disease. There are many factors that can stimulate the production of EPO. They include smoking, iron level and exercise. In this study, 3 (10%) of the thirty newly diagnosed diabetes patients do smoke, while 27 (90%) stated in the questionnaire that they do not smoke. Also, of the total number, 10 (33.3%) frequently take iron rich diet, 11 (36.7%) occasionally do take, while 9 (30%) rarely take iron rich diet. 9 (30%) of the newly diagnosed diabetes mellitus indulged in light exercise, 19 (63.3%) moderate, while 1 (3.3%) represent those involved in vigorous exercise and sedentary life respectively.

Also, the result shows that there is higher mean value of hemoglobin ($p < 0.05$), packed cell volume ($p = 0.05$), and fasting blood glucose ($p < 0.001$) in newly diagnosed diabetic patients compared with their healthy control. In contrast, no significant differences were observed in urea, creatinine, potassium, bicarbonate, sodium, chloride between the two groups. The high mean value of fasting blood glucose of 177.83 mg/dl reported in this study (**Table 4**), is in agreement with a study conducted by Nahar *et al.* (2011) [38], which also reported a high value of fasting blood glucose among newly diagnosed type 2 diabetes patients.

In this study, greater percentage of the newly diagnosed diabetic patients had a high mean value of hemoglobin which is also in agreement with a study by Lee *et al.* (2018) [39], their study reported a high value of hemoglobin among type 2 diabetic patients when compared with the healthy non-diabetic group and also in this study, it was reported that the study participants were on iron rich diets which is an important requirement needed by the body for the production of hemoglobin. It is established that the value of hemoglobin and PCV are inter-related and are directly proportional, as an increase in hemoglobin will also lead to increase in PCV value, hence the increase in PCV value in this study. The high level of hemoglobin and packed cell volume may be due to fact that majority of the patients consumed iron rich diet, which is necessary for the erythropoiesis. All the 30 (100%) newly diagnosed patients admitted to be involved in lifestyle modifications such as moderate physical exercise which is shown to improve blood circulation, and oxygen delivery to tissues, which can stimulate the production of red blood cells and increase hemoglobin levels overtime. Exercise is known to stimulate the production of EPO which in turn stimulates the production of red blood

cell.

In this study, it was also observed that there were no significant differences in mean creatinine level between the control group and newly diagnosed diabetic patients. This is in disagreement with a study conducted by Schneider *et al.* (2016) [40] which reported that high creatinine level in the blood is associated with diabetic nephropathy, which is mostly seen in advance cases of diabetes or in complicated diabetes. It was also shown that the urea and electrolytes level were not statistically significant. The reason for the above results may be due to the fact that the patients in this study were diagnosed on time, as none of them has shown any signs of diabetic derangement at the point of diagnosis. Early diabetes mainly affects how the body uses blood sugar for energy, with no direct impact on kidneys. However, uncontrolled diabetes can lead to high blood sugar levels damaging the kidneys in later stages.

6. Conclusion

In this study, the values of hemoglobin, packed cell volume, EPO and all renal biomarkers were normal, this may be due to the early diagnosis of the disease. It also suggests the extensive capacity of the kidney which is able to withstand metabolic disturbances in the newly diagnosed diabetes mellitus condition. Routine medical check, including the assessment of renal status and lifestyle modification are recommended to a newly diagnosed diabetic patients, and all their offspring and family members. Also, further research is warranted to explore the clinical implications of these assessments in predicting diabetes complications, disease progression and guiding therapeutic interventions.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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