Evaluation of Co-Morbidity Impact of Diabetic Disorders on Some Haematological Profile of Patients Assayed in Port Harcourt, Niger Delta, Nigeria: A Public Health Concern

Azuonwu O*, Nnenna Ihua and Oritsemisan S

Department of Medical Laboratory Science, Rivers State University of Science and Technology, Nigeria

Submission: June 20, 2017; **Published:** July 10, 2017

*Corresponding author: Azuonwu O, Department of Medical Laboratory Science, Rivers State University of Science and Technology, Nkpolu, Port Harcourt, Nigeria, E-mail: bimajacobs@yahoo.co.uk

Abstract

Introduction: Diabetes is a complex, metabolic disorder marked by either relative or absolute insulin deficiency that leads to irregular and ineffective glucose metabolism resulting to hyperglycaemia which could possibly affect the blood indices in humans. Anaemia is a health problem which signifies a considerable and under recognized burden in patients with chronic diabetes. White blood cell and platelet counts are markers of inflammation and thrombotic disorders (atherothrombosis) respectively which may possibly aid assessment of microvascular and macrovascular complications in diabetes.

Method: A descriptive cross-sectional study design and purposive sampling method was used to examine 50 diabetic and 50 non- diabetic subjects attending Christian Medical Centre, University of Port Harcourt Teaching Hospital and Braithwaite Memorial Specialist Hospital (BMSH) all in Port Harcourt, Rivers State, Nigeria. Male constituted 40% and female constituted 60% between the ages of 30-60 years (Mean 50years) which comprised of 30 females and 20 males. The number of haematological parameters was 5. Hence, blood sample was collected into an anticoagulant ethylene diamine tetraacetic acid (EDTA). bottle A full blood count assay was performed on each sample and the results were analyzed using Graphpad calculator for analysis of the data. Parametric analysis using mean and Standard deviation was done for the variables. For the validation of observations, values below (P<0.05) were considered statistically significant.

Observation: The study revealed a significant (p<0.05) variation in the haematological parameters between the diabetic and control groups. Also, their white blood cell and platelet count varied significantly (p<0.05) within the diabetic group for male and females whereas, others showed no disparity (p>0.05).

Discussion: Anaemia is common in diabetes especially in diabetic nephropathy also; leucocytosis and thrombocytosis are likely occurrences in diabetes as evident in this study.

Conclusion: It is therefore, recommended to include full blood count as one of the routine laboratory tests required in the management of diabetic patients. The cross-sectional design of the study may not have shown causality. Furthermore, unforeseen confounders could likely have affected this present study in a way. Further research is necessary to confirm or refute the present findings and to elucidate the role of these blood indices in chronic diabetes.

Keywords: Haematological profile; Diabetes; Public health concern; Anaemia; Co-morbidity; Port harcourt; Niger delta

Introduction

Diabetes mellitus is a complex, chronic disease of public health importance globally. It is classified as a metabolic disorder in which the body does not produce enough or properly respond to insulin, a hormone produced in the pancreas (IDF Atlas, 2006). It is a complex metabolic derangement characterized by either relative or absolute insulin deficiency that results in disturbance of carbohydrate metabolism leading to excessive glucose in the blood, excretion of glucose in the urine, incomplete oxidation of fats and attending symptoms of thirst, polyuria and wasting remains some of the critical clinical evidence based outcomes [1].

Nonetheless, it is firmly a major health problem cum clinical challenge that results in significant morbidity and mortality from diverse complications. It is estimated that over 170 million people worldwide are suffering from these global public health disease [2] and this represents about 2% of the world's population literally. In Nigeria, about 1-7% of the population is affected, with over 90% of these being non-insulin dependent [3]. The morbidity and mortality associated with diabetes mellitus results from either acute or chronic complications. Moreover, chronic complications are known to give rise to microvascular disorder such as retinopathy, nephropathy, and neuropathy. Other chronic complications include macrovascular disorders such as atherosclerosis [4]. Atherosclerosis is a recognized major cause of mortality in the diabetic population [4] and it is implicated in the circulatory disturbances seen in diabetes disorder. The circulatory disturbances are further compounded by alteration in platelet count and activity, coagulopathy, fibrinolytic aberration, changes in endothelial metabolism, and haemorrheological factors [5]. Based on these interactions of diabetes and other body systems, it has become apparent that the health of the affected populace is at risk of blindness/eye disease, excretory problem of the kidney, cardiovascular issues; this has caught a global attention thus, actions must have to be put in place to properly manage the situation and prevent the health issues where necessary. Initially, diabetes was seen as a societal problem of the socio-economic high class/status but recent evaluations have proven that even the middle/low class are at risk therefore, it is seen as an issue for both developed and developing countries of public health importance that calls for collaborative actions by local, regional and global health agencies.

Diabetes has been classified based on the clinical staging and etiology into type I and type II. Type I or Insulin dependent diabetes mellitus (IDDM) or juvenile on-set diabetes is characterized by beta cell destruction leading to absolute insulin deficiency, which may be due to autoimmune mechanism and patients are prone to ketoacidosis [6]. Type 11 or non-insulin dependent diabetes mellitus (NDDM) or adult onset diabetes is predominated by insulin resistance with relative insulin deficiency or an insulin secretary defect. Symptoms of diabetes are polyuria (frequent urination), polydipsia (increased thirst) and polyphagia (increased hunger). Symptoms may develop rapidly (weeks or months) in type 1 diabetes while in type-2 diabetes they usually develop much more slowly and may be subtle or absent respectively. Hyperglycemia is a common effect of uncontrolled diabetes and overtime leads to serious damage to many of the body's system especially the nerves and blood vessels.

The increasing prevalence of diabetes mellitus had generated much concern because the disease puts those afflicted at risk for systems in particular the blood vessels disorder [7]. Most chronic diabetes outcomes are as a result of vascular complications both at macro vascular and micro vascular levels [8]. Recurrent or persistent hyperglycemia during diabetes causes glycation of body proteins which in turn leads to secondary complications affecting eyes, kidneys, nerves and arteries. Glycosylation and stiffening of red blood cells, may be responsible for, or associated with, large vessel disease in diabetes [9]. In diabetes, reduced haemoglobin has been reported which may be accompanied by a fall in the red blood cell count and packed cell volume parameters [10].

Haematological Indices are important parameters for the evaluation of size, number and maturity of the different blood cells in a specific volume of blood. It is important for the evaluation and management of patients with diabetes mellitus; it plays a vital role in our immune system and can be used to determine many abnormalities with either the production or destruction of blood cells. Furthermore, several haematological changes affecting the red blood cells, white blood cells and the coagulation factors are shown to be associated with diabetes mellitus. Some of these are directly related to the diabetic state, while others are simply accidental with the ailment.

Anaemia is one of implications of diabetes, various forms of anaemia have been reported to occur in patients with diabetes mellitus and some of which result as an impediment of long term diabetes, affecting iron uptake as well as its consumption of iron, secondly; absorption of nutrient in the gastro intestinal tract and as a result of diabetic nephropathy are all factors. On the other hand, studies had shown that elevated glucose level may provoke anemia and consequently diabetes may perhaps be one of the crucial cause of anaemia. Also, the anaemia associated with diabetic kidney disease is proportional to over 50% of the renal failure, it is usually normocytic and normochromic. Nevertheless, in the case of iron deficiency anaemia microcytic and hypochromic red cells may possibly be seen. Reticulocyte blood index is reduced in diabetes; the reticulocytopenia seen in diabetes is said to be due to bone marrow suppression. Also, anaemia in diabetes might result from mal-absorption due to development of gastrointestinal neuropathy. In addition, diabetic patients experience changes in ph and in the levels of 2,3-diphosphogycerate (2,3-DPG) which could probably due to electrolyte (salt) having an effect on the oxygen binding capacity to haemoglobin hyperglycaemic state itself, and also alter oxygen delivery since it causes an increase in the concentration of 2,3-DPG. However; this effect is balanced by an increase in a molecule with higher affinity for oxygen element. Chronic diabetes has effect on other blood indices like the white cell population and their functionality causing defective cell migration, phagocytosis, intracellular bactericidal activities and responses to mutagenic substances in diabetes subsequent to infection. Moreover, some of the haematological parameters could possibly vary due to the mode of therapies like diet, insulin therapy and oral medication [11]. Haematological parameters test can be performed by complete blood count (CBC). A complete blood count is a series

of test used to evaluate the composition and concentration of the cellular components of blood. Whole blood is used to determine the haematological parameters [12], some of the haematological parameters include: Estimation of haemoglobin, Red blood cell (RBC) count, White blood cell (WBC) count, Pack cell volume and Platelet Count respectively.

Nevertheless, it has been recently recognized that anaemia is a common complication of diabetes. Anaemia is a health problem which represents a significant and under recognized burden in patients with chronic diabetes. Recent studies have also highlighted an association between anaemia and the development and progression of diabetic nephropathy. There is also, a high cardiovascular risk in patients with diabetic nephropathy and a clear association between anaemia and abnormal cardiac function [13]. Thus, the information obtained from findings from this study will help to clarify the importance of complete haematogram and if necessary the rationale behind its inclusion as a routine investigation in the management of diabetes cases. Furthermore it will also buttress a better understanding of the mechanism of the effect of hyperglycaemia on blood indices. This was achieved by evaluating the haematological parameters of chronic diabetes and comparing them with non-diabetics (control) in order to maintain optimal parameter, the management and treatment of the disease and to lower the risk of developing other haematological malignancies associated with chronic diabetes.

It is evidenced that a lot of the previous studies during our systematic literature search on Diabetes mellitus did not fairly consider haematological indices in diabetic and the increasing incidence of diabetic anaemia. Nonetheless, inflammatory markers from white cell population and platelet derangement are challenging public health problems especially as it relate to some disease conditions (nephropathy, cardiovascular disease) like in a case of co-morbidity, hence, there is a massive paucity of data with respect to this area particularly in the region of this present study. Thus it is strongly believed that the research of this present study would help to underpin clinical management outcome strategy of the patients affected, especially in our remote communities with sketchy information about the risk factors, causes, diagnosis of the disease and collapsed health infrastructure that has remained palpable to touch over time.

Aim and objectives of the study

The collective aim of this study was to investigate the haematological parameters of chronic diabetes patients in some Rivers State Hospitals; however, the specific aims are as follows:

o   To determine some haematological parameters of the affected subjects.

o   To evaluate the effect of diabetes on haematological parameters of the affected subjects.

o   To ascertain the sex disparity in some of the haematological parameters among the diabetic subjects.

Materials and Methods

Port Harcourt is the capital and urban centre of Rivers state. It is the mainstay of all oil producing states in Niger Delta States and in Nigeria at large. It lies along the Bonny River and is located in the South-South geopolitical zone in Nigeria within Niger Delta region. Port Harcourt has a population of 1,382,592 from the report of the 2006 national population census. Though there seems to be an exponential population increase due to its location as the commercial nerve Centre, the foremost industrial city of the former eastern region of Nigeria and its importance as the centre of social and economic life of Rivers State cum Nigeria. From an area of 15.54km2 in 1914, Port Harcourt grew irrepressibly to an area of 360km2 in the 1980s. The coordinates are: 4°47'24"N, 6°59'36"E (Latitude: 4.772152; Longitude: 6.994514) and time zone is WAT (UTC+1). The city topographies are tropical monsoon climate with lengthy and heavy rains and very short dry season across the year. Occupation of the populace is fishing, crop farming etc. The city been a foremost industrial focal point has a large number of multi-national firms as well as other industrial activities, particularly business related to the petroleum industry (oil and gas). Port Harcourt city has two main oil refineries that process large quantities of crude oil over two hundred thousand barrels daily [14]. The study had its tenet within the two local government areas (Port Harcourt and Obio-Akpor) of the urban area of Rivers state.

Experimental Design

Laboratory investigation involved sample collection of venous blood sample into fluoride oxalate anticoagulant (32g/l) and EDTA container for glucose estimation and full blood count respectively. For glucose estimations, the fasting blood sample was analyzed using glucose oxidase method (enzymatic) with Select raProS fully automated chemistry analyser (Poland). Full blood count was analyzed using Erma 210-PCE automated haematology analyzer (Japan).

The study adopted the cross-sectional designs using descriptive approach. Quantitative method was instrumental in the investigation of the effect of chronic diabetes on haematological parameters. The use of different data sources (primary and secondary) and research triangulation was employed to evaluate and elucidate the same evidence thereby, minimizing the impact of bias and increasing the plausibility and validity of the study in an attempt to map out and explain result fully from various standpoints by taking the strength of each while reducing the weaknesses of the individual critical outcome. For this study, a two stage sampling procedure was adopted. It started with the purposive selection of the Health care facilities within Rivers State urban city (convenience sampling); convenience because of the hard to reach diabetic patients as most facilities could not provide good number of

diabetic patients however, two tertiary hospitals and one private hospital within Port Harcourt metropolis were represented accordingly. This was based on the two local government areas within the study coverage zone. This zone was delineated into Health care facilities in the two main local governments within the municipal of Rivers state (Port Harcourt local government area and Obio-Akpor local government area), categorize into public and private Health care facilities. Furthermore, sample size calculator was used Winpepi version 11.44, under describe program version 2.72 "K Sample size (to estimate proportion/rate/mean, or find cases" [15].

Research instrument included primarily a self-structured questionnaire and information from the patient's folder. From an estimated sample size, the two local government zones had 100 subjects each. The description of the groupings was put into consideration such as the socio-demographics of the subjects. Considering these socio-demo aided the categorization based on age, gender etc. The self-structured instrument titled ''Some Haematological Parameters in Diabetic Patients Questionnaire (SHPDPQ)'' was specifically designed based on socio-demographic data, subject's family/diabetic history etc. As a cross-sectional study, sample collection was at one point, the questionnaire had a self-reporting approach however, those who could neither read nor write were assisted. Classification of diabetic disease was beyond symptom labels, classifying individuals within disease categories based on sympt- estimation test. Selection criteria included consented diabetic patients diagnosed for a minimum period of five years within the Port Harcourt metropolis and non-diabetic subjects used as controls whereas, those who did not consent and those outside the study area (Port Harcourt) were excluded.

Statistical analysis

Statistical data analysis was based on the set objectives and hypothesis of the study. SPSS version 21, Winpepi version 11.44 and Graphpad were used for statistical analysis; mean and standard deviation were used for descriptive statistics and inferential quantitative data were made using independent t test. Also, quantitative data were tested for normal distribution with the use of Shapiro-Wilk (S-W) test statistics and the data were certified to be normally distributed (p>0.05).

Ethical consideration

Ethical approval was obtained from the Rivers State Ministry of Health, Hospital management Board. Furthermore, ethical committees of the Braithwaite Memorial Specialist Hospital and University of Port Harcourt teaching Hospital gave approval as well as all Health care facilities heads that were included in this Study. Participants consent was paramount both oral and written consents were obtained from all participants and confidentiality was highly guaranteed and sustained.

Results

The study investigated the effect of diabetes on the haematological parameters. The tests that were carried out include the determination of Total Red Cell Count, Haemoglobin estimation (Hb), Packed Cell Volume (PCV), Total White Cell Count, Differential leucocytes count and Platelet Count respectively.

A total of one hundred participants were recruited into the study in an equal distribution into each stratum of controls and diabetic patients. These participants further pass through a gender based categorization into male and female in a disproportionate manner comprising of twenty (20) males and thirty (30) females for each group giving a male to female ratio of 2.3. Furthermore, the result from this study shows the age and sex distribution of all participants. Participants were aged between 30 and 60 years. Females constituted 60% while males constituted 40%. There were 60 females and 40 males. However, this gives the percentage distribution between male and females diabetic and control subjects. The diabetic subjects studied were between the ages of 30-60 years. The control subjects were also similar in age and sex distribution Table 1.

Table 1: Percentage distribution of Age and Sex of the diabetic and Control subjects

Age Group(Years)	Diabetic (N=50)		Control (N=50)	
	Male (N=20)	Female (N=30)	Male (N=20)	Female (N=30)
31-40	3 (15%)	5 (16.7%)	4 (20%)	2 (6.7%)
41-50	5 (25%)	9 (30%)	6 (30%)	9 (30%)
51-60	12 (60%)	16 (53.3%)	10 (50%)	19 (63.3%)

Table 2: Mean, Standard Deviation and independent t-test Distribution of Diabetics and Controls.

Parameters	Diabetic Subjects (N=50)	Control Subjects (N=50)	t - value	DF	P – Value	Remark
HB (g/dl)	11.94 ± 1.84	14.32 ± 2.10	06.03	98	P<0.05	Sig
RBC (x10^{12})	3.60 ± 0.91	5.54 ± 0.86	10.96	98	P<0.05	Sig
WBC (x10^{9})	5.45 ± 0.36	4.31 ± 0.21	19.34	98	P<0.05	Sig
PLT (x10^{9})	377 ± 18	205.8 ± 8.9	60.29	98	P<0.05	Sig
PCV (%)	30.80 ± 3.26	40.25 ± 3.56	13.84	98	P<0.05	Sig

Key: HB=Haemoglobin, RBC=Red Blood Cell, WBC=White Blood Cell, PLT=Platelet, PCV=Packed Cell Volume NS=No Significant, Sig= Significant

The result obtained from the diabetic haematological parameters showed mean values of 11.94±1.84g/dl, 3.60±0.91x10^{12}/L, 5.45±0.36x10^{9}/L, 377±18x10^{9}/L, 377±18x10^{9}/L and 30.80±3.26% for Hb, RBC, WBC, PLT and PCV

respectively. Comparatively, the control group had 14.32±2.10g/dl, 5.54±0.86 10^{12}/L, 4.31±0.21x10^9/L, 205.8±8.9x10^9/L and 40.25±3.56x10^9/L for Hb, RBC, WBC, PLT and PCV indices accordingly. The results of the independent t-test showed marked variation with a statistically significant mean difference ($p<0.05$) for all the haematological indices evaluated in this study (Table 2), (Figure 1). Relatively, evaluation of the haematological parameters within group specifically the diabetic group for male and female showed disparities ($p<0.05$) for WBC and PLT only; whereas, other haematological indices showed no significant differences as shown on Table 3.
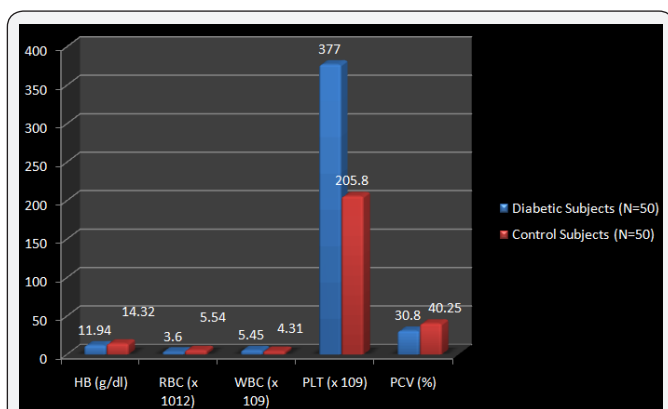

Figure 1: Mean Distribution of Haematological Parameters of Diabetic and Control.

Table 3: Showing t-tests of Diabetic Male and Diabetic Female Haematological Parameters.

Parameters	Diabetic Male (N=20)	Diabetic Female (N=30)	t - value	DF	P – Value	Remark
HB (g/dl)	12.43 ± 1.57	11.45 ± 2.10	1.78	48	P>0.05	N/S
RBC (x10^{12})	3.66 ± 0.96	3.54 ± 0.86	0.46	48	P>0.05	N/S
WBC (x10^9)	8.31 ± 0.21	8.59 ± 0.51	2.69	48	P<0.05	Sig
PLT (x 10^9)	389 ± 20	365 ± 15	4.85	48	P<0.05	Sig
PCV (%)	31.36 ± 2.96	30.25 ± 3.56	1.15	48	P>0.05	N/S

Key: HB=Haemoglobin, RBC=Red Blood Cell, WBC=White Blood Cell, PLT=Platelet, PCV= Packed Cell Volume, NS=No Significant, Sig=Significant.

Discussion

Based on the pragmatic evidence bases research outcome established in this study, anaemia is one of the obvious defects that could possibly be induced by chronic diabetes as reported in this present study; red cell and its indices including haemoglobin concentration and reticulocyte counts were markedly reduced among the diabetic patients when matched side by side with the control group. The finding from this study which has been able to correlate diabetes with the likely risk of anaemia share similarity with previous studies [16-19] that reported the incidence of diabetic anaemia. In the same way, [17-19] in their previous separate studies supported evidence of anaemia in diabetes [18-20]. In addition, a prior comparative study by Ruchi & Pradeep [20] the haematological indices of diabetic subjects were decreased compared to the control subjects although, the study was limited to type 1 diabetes (Figure 2) [21].
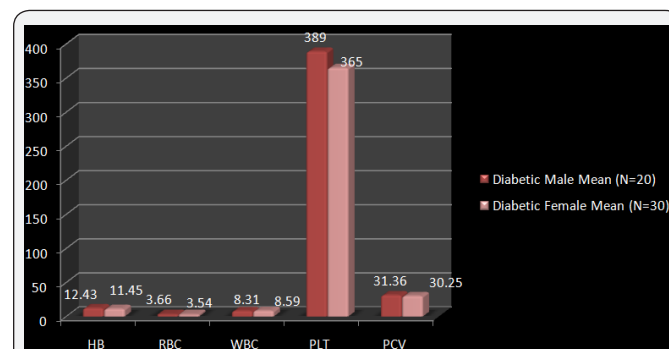

Figure 2: Mean Distribution of Diabetic Male and Diabetic Female Haematological Parameters.

Anaemia and its rising colossal consequences is a Public Health issue as it is one of the causes of high morbidity and mortality in any given population, and it serves as one of the Public Health indicators used in measuring the health status of an individual particularly in children and pregnant women, as well as those individual with special ailment like diabetes. In the time past, pregnant women and children to a great extent have been the target and lots of studies have been carried out and recommendations on how to reduce the high prevalence of anaemia in this vulnerable groups,, but of late it is becoming paramount and critical to consider anaemia in other groups and among people with particular diseases like geriatrics, diabetes and nephropathy etc. Diabetes been a disease with no known cure for now; have been implicated to cause and make its victim at risk of developing anaemia as obtained in this study thus, there is need to focus on how to curb diabetic anaemia, thus incorporating it as part of the management/therapeutic strategy for a better outcome because diabetes is a global Public Health issues that cut across the socio-economic classes of high/middle/low, sex (male and female) and age (juvenile and elderly). In view of this, it calls for an urgent attention as the hyperglycaemic mounts tension on the blood parameters which in-turn alters the blood indices on prolonged exposure, and these chronic effects of high blood sugar or adverse effects of its treatment process (diabetic medications) could possibly have its consequences on the haematological parameters causing anaemia if it is not diagnosed and managed in good time [22].

Red cell count, packed cell volume (haematocrit) and haemoglobin were used in this study as a marker for anaemia and the concentrations of these anaemic markers have shown a relationship with diabetes mellitus as asserted by some scholars [23-28].

Packed cell volume which is typically known as the blood level was reported to be correlated with high level of blood insulin; moreover, it is known that packed cell volume is determinant factor of blood viscosity [23-28]. A study done in the 1980s showed that higher blood level which is basically seen as high haematocrit level infer higher blood viscosity; this might predispose to insulin resistance and diabetes by limiting delivery of glucose, insulin and oxygen to metabolically active tissues though this was reported in type-2 diabetes [29]. This literally agrees with earlier studies which have found that haematological parameters play an important role in insulin resistance according to researches done in China by Wang et al. [29] and Korean based study by Choi et al. [30,31]. Besides, the underlying principle and mode of action by which haematocrit could possibly influence glucose metabolic activity is though not entirely and clearly understood, specifically with regards to its pathophysiology however, Hilsted & Christensen [31] reported dual effects of insulin on plasma volume and trans-capillary albumin mobility stating an inverse relationship between trans-capillary movement of albumin and plasma volume, due to insulin which will in-turn affect the blood volume [32]. Moreover, the quest to understand the cause and incidence of diabetic anaemia kept researchers studying and making findings so as to appreciate further the occurrence of anaemia in diabetes, this lead to two different studies which attributed its cause to a non-enzymatic glycosylation of erythrocyte membrane proteins as such, high blood glucose is associated with has a direct relationship with non-enzymatic glycosylation of erythrocyte membrane protein (Figure 3) [16,17].
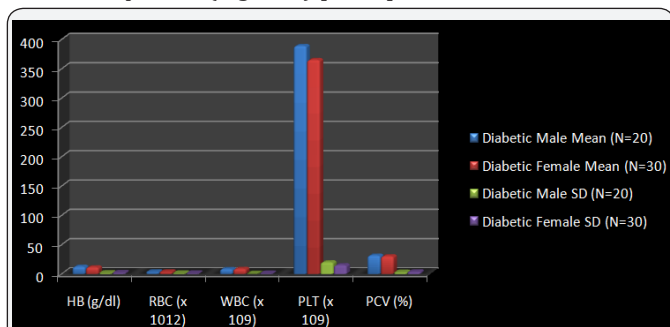
Figure 3: Bar Chart of Mean and Standard Deviation of Haematological Parameters of Diabetes and Control Groups

Furthermore, two other studies showed a relationship between haemoglobin level and metabolic syndrome [33,34] and diabetes is one of the metabolic disease characterized with metabolic derangement of glucose impairment. Haemoglobin is one of the indices and significant markers of anaemia and its role cannot be undermined; it has a modulatory role in which case, it modulates bioavailability of nitric oxide thereby regulating endothelial activity [35]. Also, Haemoglobin concentration can be correlated with sCD40L level, one of the pro-inflammatory markers released by activated platelets, which predicts cardiovascular events in patients with high-risk atherosclerotic lesions and is increased diabetes as accounted by some studies [36-38].

Anaemia as a disorder seen in diabetes; so, diabetic anaemia could be seen as a co-morbidity which increases the populace disease burden, this is exemplified in anaemia in diabetic nephropathy. Some studies have reported anaemia in diabetic nephropathy as seen in streptozotocin induced diabetic rats according to [16] nonetheless; it was an animal based study. Other studies have as well shown that anaemia in diabetes is a predictive haematological tool seen in diabetic complications like renal dysfunction, cardiovascular disease etc. Diabetic anaemia as seen in the case of co-morbidity could further be attributed to a mal-function in the compensatory mechanism in the erythropoietic process in which case the renal organ (kidney) fail to respond to decreased haemoglobin level, due to inadequate production of erythropoietin. Furthermore, Hadjadj and colleagues [38] in their study "Erythropoietin-dependent anaemia: a possible complication of diabetic neuropathy" have opined that erythropoietin-deficiency diabetic anaemia could be effectively be corrected with the use of recombinant human erythropoietin [39].

In addition, the white cell population is a useful predictive tool; white blood cell is a biological inflammatory marker though non-specific marker. Diabetes is a condition characterized with inflammation and chronic inflammation is involved in the pathogenesis process and data from epidemiological studies suggests a relationship between total white blood cell count and the risk of developing diabetes [40]. Results obtained from this study showed an increased WBC in hyperglycaemic state (diabetes) as this present study reported an increase in the WBC count of the diabetic patients when compared to the control subjects. This finding is in accordance with prior studies suggestive of a relationship between WBC count and diabetes [19,41-44]. WBC count is a marker of systemic inflammation and might likely be involved in the pathophysiology of prediabetic states and subsequently in the manifestation of diabetes [41,42].

From the last objective "ascertaining the sex disparity in some of the haematological parameters among the diabetic subjects" comparatively, it was reported that diabetic females had higher white cell count than diabetic males on the other hand, diabetic males had a considerable difference in the platelet counts which vary from the result of the female diabetic patients. Whereas, the other haematological parameters evaluated in this study did not show discrepancy in the male female results meaning there was no gender specific particularities observed in reticulocytes, haemoglobin and packed cell volume of the diabetic subjects.

Platelet count was increased in diabetic patients when compared with control subjects. This is in line with other studies. Nonetheless, a Turkish based cohort study in 2009 reported predictors of amputation in diabetic foot ulcer due to low haemoglobin concentration, high leukocyte count, elevated

erythrocyte sedimentation rate, increased platelet counts and other acute phase reactants. Similarly, Dalla & Faglia [17] shared same view in their study on overview of treatment strategies for diabetic foot ulcer [18,20]. Thrombocytosis (high platelet) as reported in this study is one of the consequences of diabetes; however, diabetes mellitus have a high risk of atherothrombotic health outcome. Other abnormalities like thrombosis which is common in thrombocytosis have placed diabetic patients at high risk of atherothrombosis, which causes occlusion of blood vessels as well as contributes to initiation and progression of both microvascular and macrovascular complications [14].

Conclusion

In the present study, a statistical significant difference exists between the haematological parameters of the diabetic patients and the control. Also, a gender cantered analysis showed an indication of statistical significant difference in diabetic white cell count and platelet counts only. Furthermore, the findings from this study showed anaemia, leucocytosis and thrombocytosis for the diabetic subjects as opposed to their control counterparts. It is therefore, an important observation that the development of anaemia in diabetes may predict many possible abnormalities in renal function. Furthermore, understanding the mechanism by which this occurs may provide the opportunity to develop therapeutic options that may improve patient outcome and curb the Public Health threat of increasing incidence of co-morbidity especially in our remote communities. The findings in the present study have implications for diabetic patients, thus it strongly suggested the need for routine full blood counts option in the diagnosis and management of chronic diabetes. Therefore, it is firmly recommended that diagnostic laboratories and clinicians should include full blood count as one of the routine critical laboratory tests required in the management and monitoring of diabetic patients and the treatment of diabetes should target at maintaining an optimal haematocrit in order to prevent other disease risk factors like nephropathy and cardiovascular disease etc.

Acknowledgement

References

1. Vinik AI, Erbas T, Park TS, Nolan R, Pittenger GL (2001) Platelet dysfunction in type 2 diabetes. Diabetes Care 24(8): 1476-1485.

2. Wokorna RS (2002) Diabetes and hypertension in Africa, an overview. Diabetes International 12(12): 36-40.

3. Fabiyi AK, Kolaroole AA, Adeshinto O, Ikem RT (2002) The impact of knowledge attitude practice and belief of type 2 Nigeria Diabetes patients on drug compliance. Diabetes international 12(1): 15-17.

4. Bennett PH (1999) Impact of the New WHO classification and diagnostic criteria. Diabetes Obes Metab 1(2): S1-S6.

5. Famodu AA, Reid HI (2001) Platelet count in diabetic Nigerian. Journal of Physiology Arid Science 6: 913.

6. WHO (1999) Diabetes Mellitus and its complication. Report of WHO Consultation Part 1: Diagnosis and classification of diabetes mellitus. Bulletin of World Health Organization 99(2): 1-58.

7. Gerich JE (2001) Matching treatment of Pathophysilogy in type 2 diabetes. Clin Ther 23(5): 646-659.

8. Hogan P, Dall T, Nikolov P (2003) Economic Cost of diabetes in the USA. Diabetic Care 26(9): 17-932.

9. Guthrie, DW, Guthrie RA (2002) Nursing management of diabetes mellitus In: A guide to the pattern approach (5th edn), New York, USA.

10. Mohammed A, Adelaiye AB, BakanAG, Mabrouk MA (2009) Anti-diabetic and some haematological effects of ethylacetate and nbutanol fractions of ganodermaLucidum aqueous extract in alloxan-jndd diabetic Wisar rats. International Journal of medical science 1: 5330.

11. Ochie J, Koiiiatkar A (2000) Medical laboratory Science In: Theory and practice (2nd edn). McGraw Hill, New delhi, India.

12. Chidum E, Altheia JL, Meka N, Dawn S, Fidelis 0 (2008) Anaemia and kidney dysfunction in Caribbean Type 2 diabetic parents. Cardiovascular Dibetology 10(4): 20-21.

13. Ihua N, Azuonwu O, Azuonwu T (2016) Evaluation of Haemostatic Parameters of Diabetic Patients Accessing Care in some Selected Health Care Facilities in Port Harcourt Metropolis, Nigeria. Current Studies in Comparative Education, Science and Technology 2(3): 119-134

14. Cochran WG (1977) Sampling techniques. (3rd edn), John Wiley & Sons, New York, USA.

15. Oyedemi SO, Yakubu MT, Afolayan AJ (2011) Antidiabetic activities of aqueous leaves ex- tract of Leonotisleonurus in streptozotocin induced diabetic rats. J Med Plant Res 51: 119-125.

16. Thomas S, Rampersad M (2004) Anaemia in diabetes. Acta Diabetol 41(1): S13-S17.

17. Dalla PL, Faglia E (2006) Treatment of diabetic foot ulcer: an overview strategies for clinical approach. Curr Diabetes Rev 2(4): 431-447.

18. Uko EK, Erhabor O, Isaac IZ, Abdulrahaman Y, Adias TC, et al. (2013) Some Haematological Parameters in Patients with Type-1 Diabetes in Sokoto, North Western Nigeria. J Blood Lymph 3(1): 1-4.

19. Yesil S, Akinci B, Yener S, Bayraktar F, Karabay O, etal. (2009) Predictors of amputation in diabetics with foot ulcer: single center experience in a large Turkish cohort. Hormones (Athens) 8(4): 286-295.

20. Ruchi Kothari, Pradeep Bokariya (2) A comparative study of haematological parameters in type 1 diabetes mellitus patients & healthy young adolescents. Int J Biol Med Res 3(4): 2429-2432.

21. Azuonwu O, Nnenna I, Uwuma OE (2017) Evaluation of Haematological Profile of Geriatric Subjects in Port Harcourt Metropolis of Niger Delta of Nigeria. J Clin Lab Med 2(1).

22. Medalie JH, Papier CM, Goldbourt U, Herman JB (1975) Major factors in the development of diabetes mellitus in 10,000 men. Arch Intern Med 135(6): 811-817.

23. Wilson PW, McGee DL, Kannel WB (1981) Obesity, very low density lipoproteins, and glucose intolerance over fourteen years: The Framingham Study. Am J Epidemiol 114(5): 697-704.

24. Wannamethee SG, Perry IJ, Shaper AG (1996) Hematocrit and risk of NIDDM. Diabetes 45(5): 576-579.

25. Nakanishi N, Suzuki K, Tatara K (2004) Haematocrit and risk of development of Type 2 diabetes mellitus in middle-aged Japanese men. Diabet Med 21(5): 476-482.

26. Tulloch-Reid MK, Hanson RL, Saremi A, Looker HC, Williams DE, et al. (2004) Hematocrit and the incidence of type 2 diabetes in the pima indians. Diabetes Care 27(9): 2245-2246.

27. Tamariz LJ, Young JH, Pankow JS, Yeh HC, Schmidt MI, et al. (2008) Blood viscosity and hematocrit as risk factors for type 2 diabetes mellitus: the atherosclerosis risk in communities (ARIC) study. Am J Epidemiol 168(10): 1153-1160.

28. Stuart J, Kenny MW (1980) Blood rheology. J ClinPathol 33: 417-429.

29. Wang YY, Lin SY, Liu PH, Cheung BM, Lai WA (2004) Association between hematological parameters and metabolic syndrome components in a Chinese population. J Diabetes Complications 18(6): 322-327.

30. Choi KM, Lee J, Kim YH, Kim KB, Kim DL, et al. (2003) Relation between insulin resistance and hematological parameters in elderly Koreans-Southwest Seoul (SWS) Study. Diabetes Res Clin Pract 60(3): 205-212.

31. Hilsted J, Christensen NJ (1992) Dual effect of insulin on plasma volume and transcapillary albumin transport. Diabetologia 35(2): 99-103.

32. Lohsoonthorn V, Jiamjarasrungsi W, Williams MA (2007) Association of Hematological Parameters with Clustered Components of Metabolic Syndrome among Professional and Office Workers in Bangkok, Thailand. Diabetes Metab Syndr 1(3): 143-149.

33. Lin JD, Chiou WK, Chang HY, Liu FH, Weng HF, et al. (2006) Association of hematological factors with components of the metabolic syndrome in older and younger adults. Aging Clin Exp Res 18(6): 477-484.

34. Jia L, Bonaventura C, Bonaventura J, Stamler JS (1996) S-nitrosohaemoglobin: a dynamic activity of blood involved in vascular control. Nature 380(6571): 221-226.

35. Bautista LE, Atwood JE, O'Malley PG, Taylor AJ (2004) Association between C-reactive protein and hypertension in healthy middle-aged men and women. Coron Artery Dis 15(6): 331-336.

36. Tasci I, Dogru T, Sonmez A, Genc H, Kilic S, et al. (2006) Soluble CD40 ligand levels in otherwise healthy subjects with impaired fasting glucose. Mediators Inflamm 2006(5): 32508.

37. Gokulakrishnan K, Deepa R, Mohan V, Gross MD (2006) Soluble P-selectin and CD40L levels in subjects with prediabetes, diabetes mellitus, and metabolic syndrome--the Chennai Urban Rural Epidemiology Study. Metabolism 55(2): 237-242.

38. Hadjadj S, Torremocha F, Fanelli A, Brizard A, Bauwens M, et al. (2001) Erythropoietin-dependent anaemia: a possible complication of diabetic neuropathy. Diabetes Metab 27(3): 383-385.

39. Bi Y, Wang T, Xu M, Xu Y, Li M, et al. (2012) Advanced research on risk factors of type 2 diabetes. Diabetes Metab Res Rev 28(2): 32-39.

40. Du X, Zhu B, Hu G, Mao W, Wang S, et al. (2009) U-shape association between white blood cell count and the risk of diabetes in young Chinese adults. Diabet Med 26(10): 955-960.

41. Ford ES (2002) Leukocyte count, erythrocyte sedimentation rate, and diabetes incidence in a national sample of US adults. Am J Epidemiol 155(1): 57-64.

42. Gokulakrishnan K, Deepa R, Sampathkumar R, Balasubramanyam M, Mohan V (2009) Association of leukocyte count with varying degrees of glucose intolerance in Asian Indians: the Chennai Urban Rural Epidemiology Study (CURES-26). Metab Syndr Relat Disord 7(3): 205-210.

43. Nakanishi N, Yoshida H, Matsuo Y, Suzuki K, Tatara K (2002) White blood-cell count and the risk of impaired fasting glucose or Type II diabetes in middle-aged Japanese men. Diabetologia 45(1): 42-48.

44. Twig G, Afek A, Shamiss A, Derazne E, Tzur D, et al. (2013) White blood cells count and incidence of type 2 diabetes in young men. Diabetes Care 36(2): 276-282.