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HAEMATOLOGICAL PROFILE OF PATIENTS WITH TYPE 2 DIABETES MELLITUS IN CALABAR, NIGERIA.

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ABSTRACT

OBJECTIVES:
The objective of this study is to identify the hematological profile of patients with diabetes

SETTING:
The study was conducted at the Diabetes Clinic of the University of Calabar Teaching Hospital, Calabar.

METHODS/SUBJECTS:
The study subjects selected for this study consist of 50 type 2 diabetic patients and 25 healthy non-diabetic subjects acted as controls. They were matched for age and sex. The ages in both categories were comparable, the test being 45.2 ±12.3 years and the control 40.2±13.3 years. The hematocrit value (HCT), haemoglobin content, red blood cell count (RBCs) and mean corpuscular volume (MCV) concentration with increased white blood cell counts (WBCs), mean erythrocyte haemoglobin concentration (MCHC), mean corpuscular haemoglobin (MCH), lymphocytes and neutrophils levels were performed

RESULTS
Hematological studies in the diabetic patients showed significantly lower HCT values, haemoglobin content, RBC count and MCV concentration than in the controls. Greater total WBC counts, MCHC concentrations, MCH, lymphocytes and neutrophils counts were observed in the patients than in the controls. The basophil count had a significantly higher value (p=0.033) in the test (0.03±0.02) than the control (0.01±0.01). Haemoglobin levels (11.9±2.2, p=0.001) and mean corpuscular haemoglobin concentration (MCHC) (30.7±1.3, p=0.004) were significantly lower in the test group compared to controls (13.3±0.9, 32.6±1.1). No differences were found between platelet counts in the diabetic patients and the control

CONCLUSION:
There were significant changes in some haematological parameters associated with Diabetes especially Haemoglobin, MCHC and basophil count identified in this study.

INTRODUCTION

Diabetes Mellitus is a chronic metabolic condition characterized by hyperglycemia. This happens when the pancreas does not produce enough insulin, or when the body is unable to effectively utilize the insulin it produces[1'2].

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It is a significant global health issue with an increasing prevalence worldwide. In Nigeria, approximately 3.6 million adults are currently living with diabetes, and this number is expected to rise to about 8 million by 2045[3]. Diabetes affects multiple organ systems and can lead to complications such as cardiovascular disease, neuropathy, nephropathy, and retinopathy[4]. While managing blood sugar levels is the main focus of diabetes care, it also impacts other aspects of health, including haematological parameters

and blood group characteristics[5'6]. The Full Blood Count (FBC) is a common blood test that offers details about the cellular elements of blood, such as red blood cells (RBCs), white blood cells (WBCs), and platelets[7]. Variations in the FBC parameters can indicate underlying health issues or complications. By understanding the potential relationship between diabetes and full blood count (FBC) parameters as well as the ABO and Rhesus "D" blood group system, we can gain insight into the haematological status and blood group distribution among diabetic patients[8'9]

SUBJECTS/ MATERIALS AND METHODS

This research was conducted at the Diabetes Clinic, Department of Internal Medicine, University of Calabar Teaching Hospital, Calabar. A total of 75 subjects were enrolled, including 50 diabetic patients and 25 healthy subjects as controls. The study population comprised adult males and females aged 18 and above. The inclusion criteria was Individuals currently diagnosed with diabetes mellitus, either type 1 or type 2, have given their informed consent as well as obtained approval from the authority. The exclusion criteria was for individuals without diabetes, Individuals with comorbidities or chronic illnesses and Individuals who have not given consent, About 4 mL of blood was collected from the ante-cubital veins of each subject using the standard venipuncture technique. The blood was carefully dispensed into an ethylenediaminetetraacetic acid (EDTA) bottle with a concentration of 2.0 mg/mL of blood. It was then mixed immediately by gentle inversion and labelled with the subjects' details. This number was used throughout the study to facilitate the processing, analysis, and tracking of both the specimens and the results to maintain confidentiality. s were analyzed using Dymind DFF55 full blood count 5-part analyzer for a full blood count, while the standard tube method was used to determine ABO and Rh 'D' blood groups. The coulter counting principle is utilized in the operation of the Automated Hematology Analyzer. The data was analyzed using SPSS version 25. Continuous data were presented as means and standard deviations, or median and interquartile range. Categorical data were presented as frequencies and percentages. Differences between two groups were analyzed using a t-test, while differences between more than two groups were analyzed using analysis of variance (ANOVA). Associations were evaluated using the Chi-square test. An alpha value of 0.05 was used. Statistical analysis were done using SPSS for windows version 18. Appropriate statistics were used to analyze the data. All variables were reported as mean value ± standard deviation for certain valuables. A value of $p<0.5$ was concluded to be statistically significant.

RESULTS

In Table 1, the demographic characteristics of the diabetic and healthy subjects studied are presented. The mean age of the diabetic subjects was 45.2±12.3 years, while that of the control group was 40.2±13.3 years. However, this age difference was not statistically significant (p=0.395). The age category with the highest representation among the diabetic subjects was 30% (N=15), while the 31-41 years age group had the highest representation in the control group at 60% (N=15). The difference in age category was not statistically significant (p=0.358). Males were predominant in both the diabetic subjects, accounting for 56% (N=28), and the control subjects, accounting for 60% (N=15). However, the difference was not statistically significant (p=0.863).

TABLE 1: DEMOGRAPHIC CHARACTERISTICS OF THE STUDIED DIABETIC SUBJECTS AND THE HEALTHY CONTROL

	SUBJECT CATEGORY			
VARIABLE	**TEST GROUP FREQUENCY [%] N=50**	**CONTROL GROUP FREQUENCY (%) N=25**	**X^2**	**P-Value**
AGE[Years]				
Mean	45.2±12.3	40.2±13.3a	0.857b	0.395
Range	22 – 70	28 – 62		
Median	44.5 (35.0-54.75)c	40.0 (29.5 – 51.0)c		
AGE CATEGORY (Years)				
20-30	7 (14.0)	5 (20.0)		0.358
31-41	14 (28.0)	15 (60.0)	3.225	
42-52	15 (30.0)	0 (0.0)		
≥53	14 (28.0)	5 (20.0)		
SEX				
Male	28 (56.0)	15 (60.0)	0.03	0.863
Female	22 (44.0)	10 (40.0)		
BLOOD GROUP				
A Rh 'D' positive	17 (34.0)	3 (12.0)		
B Rh 'D' positive	8 (16.0)	1 (4.0)	2.087	0.555
AB Rh 'D' positive	1 (2.0)	0 (0.0)		
O Rh 'D' positive	24 (48.0)	21 (84.0)		
DURATION OF ILLNESS (Years)				
1 – 5	28 (56.0)			
6 – 11	15 (30.0)			
≥12	7 (14.0)			
COMORBIDITIES				
Hypertension	8 (16.0)			
Diabetic foot ulcer	1 (2.0)			
None	41 (82.0)			
Note: a= written as Mean ± SD; b= t-values; c= Median and interquartile range.				

TABLE 2: COMPARISON OF SOME HAEMATOLOGICAL VARIABLES BETWEEN THE DIABETIC SUBJECTS AND CONTROL

Variables	Test Group Mean±SD N=50	Control Group Mean±SD N=25	t- value	p- value
Total WBC count (10^9/L)	5.9 ± 2.1	5.5 ±1.5	0.377	0.708
Neutrophil count (10^9/L)	3.2 ± 1.9	2.6 ± 0.8	0.616	0.54
Lymphocyte count (10^9/L)	2.2 ± 0.9	2.3 ± 1.2	0.145	0.886
Monocyte count (10^9/L)	0.3 ± 0.2	0.3 ± 0.1	0.593	0.556
Eosinophil count (10^9/L)	0.2 ± 0.1	0.3 ± 0.1	1.207	0.233
Basophil count (10^9/L)	0.03 ± 0.02	0.01 ± 0.01	2.137	0.033*
RBC count (10^{12}/L)	4.2 ± 0.6	4.3 ± 0.2	0.339	0.736
Hb (g/dl)	11.9 ± 2.2	13.3 ± 0.9	3.899	0.001*
HCT (%)	38.6 ± 6.5	39.4 ± 3.7	0.266	0.791
MCV (fL)	92.1 ± 10.2	91.5 ± 4.9	0.129	0.898
MCH (Pg)	28.2 ± 2.9	29.7 ± 1.2	1.168	0.248
MCHC (g/dL)	30.7 ± 1.3	32.6 ± 1.1	3.034	0.004*
RDW-CV (%)	14.7 ± 1.3	14.6 ± 1.0	0.037	0.871
Platelet count (10^9/L)	204.6 ± 66.3	253.0 ± 69.3	1.553	0.126
MPV (fl)	9.5 ± 0.8	9.0 ± 0.6	1.341	0.186
NLR	1.7 ± 1.5	1.5 ± 1.0	0.254	0.801

Abbreviations: SD; standard deviation, WBC; white blood cells, RBC; red blood cells, HB ; haemoglobin, HCT; haematocrit, MCV; mean corpuscular volume, MCH; mean corpuscular haemoglobin, MCHC' mean corpuscular haemoglobin concentration, RDW-CV; red cell distribution width coefficient of variation, MPV; mean platelet volume, NLR; neurophil/lymphocyte ratio

In Table 2, there is a comparison of haematological parameters between diabetic patients and healthy control subjects. The results indicate that the mean and standard deviation of basophil count, haemoglobin, and Mean Cell Haemoglobin Concentration (MCHC) showed significant differences. Specifically, the basophil count had a significantly lower value (p=0.033) in the test group (0.03±0.02) than in the control group.

TABLE 3: COMPARISON OF HAEMATOLOGICAL PARAMETERS OF THE DIABETIC SUBJECTS BASED ON DURATION OF ILLNESS

Variables	Duration (Years)			f-ratio	p-value
	Mean±SD 1-5 N=28	Mean±SD 6-11 N=15	Mean±SD ≥12 N=7		
Total WBC count (10^9/L)	6.1 ± 1.9	5.7 ± 2.7	5.1 ± 1.2	0.693	0.505
Neutrophil count (10^9/L)	3.2 ± 1.6	3.4 ± 2.6	2.4 ± 1.0	0.793	0.459
Lymphocyte count (10^9/L)	2.4 ± 1.0	1.8 ± 0.6	2.2 ± 0.8	2.374	0.104
Monocyte count (10^9/L)	0.3 ± 0.1	0.3 ± 0.2	0.3 ± 0.1	0.935	0.400
Eosinophil count (10^9/L)	0.2 ± 0.1	0.1 ± 0.1	0.3 ± 0.2	1.540	0.225
Basophil count (10^9/L)	0.03 ± 0.02	0.03 ± 0.02	0.03 ± 0.02	0.209	0.813
RBC count (10^{12}/L)	4.2 ± 0.8	4.2 ± 0.4	4.2 ± 0.4	0.017	0.983
Hb (g/dl)	11.7± 2.4	11.8± 2.2	12.3± 0.9	0.237	0.790
HCT (%)	38.4± 7.2	38.6± 6.5	39.4± 2.8	0.064	0.938
MCV (fL)	92.0 ±9.8	91.7± 12.9	92.9± 4.9	0.034	0.966
MCH (Pg)	27.9± 2.5	28.1± 4.0	29.1± 1.4	0.459	0.634
MCHC (g/dL)	30.5± 1.5	30.7±1.2	31.4± 0.5	1.309	0.280
RDW-CV (%)	14.8±1.2	14.7±1.7	14.1±0.6	0.878	0.422
Platelet count (10^9/L)	206.2±48.6	189.3±95.5	230±37.0	0.942	0.397
MPV (fl)	9.5±0.8	9.7±1.0	9.5±0.8	0.282	0.756
NLR	1.6±1.1	2.3±2.1	1.1±0.6	1.735	0.187

In Table 3, the haematological parameters of diabetic subjects are compared based on the duration of their illness. The study found that various white blood cell counts, red blood cell count, haemoglobin levels, and other factors did not show significant differences among the three duration groups (1-5 years, 6-11 years, and 12 years or more).

In Table 4, the comparison of various haematological variables among diabetic subjects based on age is presented. The total white blood cell count, neutrophil count, lymphocyte count, monocyte count, eosinophil count, basophil count, red blood cell count, haemoglobin, hematocrit, mean cell volume (MCV), mean cell haemoglobin (MCH), MCHC, PDWCV, mean platelet volume (MPV), and neutrophil/lymphocyte ratio (NLR) did not show significant differences among the four age groups (29-30 years, 31-41 years, 42-52 years, and 53 years and older)

TABLE 4: COMPARISON OF SOME HAEMATOLOGICAL VARIABLES BETWEEN THE DIABETIC SUBJECTS AND CONTROL

Variables	Age (Years)				F-ratio	p-value
	Mean ±SD 20-30 N=7	Mean ±SD 31-41 N=14	Mean ±SD 42-52 N=15	Mean ±SD ≥53 N=14		
Total WBC count (10^9/L)	7.1±1.6	5.3±1.7	5.7±2.7	5.9±1.7	1.129	0.347
Neutrophil count (10^9/L)	3.7±1.7	2.7±1.4	3.2±2.6	3.3±1.4	0.575	0.634
Lymphocyte count (10^9/L)	2.8±0.7	2.2±0.9	2.0±1.0	2.1±0.7	1.252	0.302
Monocyte count (10^9/L)	0.3±0.1	0.3±0.1	0.4±0.2	0.3±0.1	0.587	0.627
Eosinophil count (10^9/L)	0.2±0.2	0.2±0.1	0.1±0.1	0.2±0.2	0.605	0.615
Basophil count (10^9/L)	0.04±0.01	0.02±0.01	0.04±0.02	0.02±0.02	2.649	0.06
RBC count (10^{12}/L)	4.2±0.9	4.3±0.7	4.1±0.5	4.1±0.5	0.355	0.785
Hb (g/dl)	11.1±2.0	12.2±2.6	11.9±1.9	11.8±2.2	0.351	0.789
HCT (%)	35.9±5.3	40.1±8.0	38.7±5.3	38.2±6.7	0.667	0.577
MCV (fL)	87.1±8.8	92.2±9.3	94.6±11.3	91.7±10.4	0.847	0.475
MCH (Pg)	26.8±1.7	27.9±2.6	28.9±3.3	28.3±3.1	0.9	0.449
MCHC (g/dL)	30.9±2.0	30.4±1.4	30.6±1.1	30.9±1.2	0.454	0.716
RDW-CV (%)	14.8±1.2	14.6±1.2	14.9±1.6	14.4±1.2	0.391	0.76
Platelet count (10^9/L)	234.6±27.5	185.5±45.9	179.3±65.9	235.6±82.2	2.924	0.44
MPV (fl)	9.3±0.9	9.5±0.7	9.9±0.8	9.2±0.9	1.621	0.198
NLR	9.5±1.0	1.3±0.9	2.1±2.2	1.8±1.2	0.584	0.629

In Table 5, we can see the comparison of blood cell deficiencies among diabetic patients and control subjects. In terms of white blood cell deficiencies, the following percentages of test subjects had: leucopenia 6%, leucocytosis 2%, neutropenia 18%, neutrophilia 4%, lymphopenia 10%, lymphocytosis 16%, monocytosis 8%, eosinophilia 6%, basophilia 8%, low NLR (1-2) 22%, and high NLR (1-2) 18%.

For red blood cell deficiencies, the percentages of test subjects affected were: anaemia 64%, low MCV 12%, high MCV 24%, low MCH 24%, low MCHC 74%, and high RDW (anisocytosis) 20%. In addition, 8% of test subjects had thrombocytopenia and 2% had thrombocytosis.

TABLE 5: COMPARISON OF BLOOD CELL DIFFERENTIALS AMONG THE DIABETIC AND CONTROL SUBJECTS

Variables	Frequency (%) Test Group N=50	Frequency (%) Control Group N=25	X^2	p-value
WBC				
Leucopenia(3.5-9.5*10^3/µL.)	3 (3.0)	0 (0.00)	0.431	0.806
Leucocytes (3.5-9.5*10^3/µL)	1 (2.0)	0 (0.00)	0.431	0.806
Neutropenia (1.80-6.30*10^3µL)	9 (18.0)	1 (4.0)	0.212	0.899
Lymphopenia (1.10-3.20*10^3/µl)	5 (10.0)	0 (0.00)	0.566	0.753
Lymphocytosis 1.10-3.20*10^3/µl)	8 (16.0)	1 (4.0)	0.566	0.753
Monocytosis (0.10-0'60*10^3/µl)	4 (8.0)	0 (0.00)	0.936	0.626
Eosinophilia (0.02-0.52*10^3/µl)	3 (6.0)	0 (0.00)	0.53	0.76
Basophilia (0.00-0.06*10^3/µl.)	4 (8.0)	0 (0.00)	0.431	0.511
Low NLR (1-2)	11 (22.0)	2 (8.0)	0.946	0.623
High NLR (1-2)	9 (18.0)	1 (4.0)	0.946	0.623
RBC				
Anaemia (<12g/dL[a]/13g/dL[b])	32 (64.0)	1 (4.0)	7.013	0.031
Low MCV (microcytosis)(82-100fl)	6 (12.0)	0 (0.00)	2.676	0.262
High MCV (macrocytosis) (82-100fl)	12 (24.0)	0 (0.0)	2.676	0.262
Low MCH (27-34pg)	12 (24.0)	0 (0.0)	1.535	0.574
Low MCHC (31.6-35.4g/dl)	37 (74.0)	0 (0.0)	11.306	0.002
High RDW (anisocytosis) (11-16%)	10 (20.0)	0 (0.0)	1.222	0.269
PLATELET				
Thrombocytopenia (125-350*10^3/µl)	4 (8.0)	0 (0.0)	0.562	0.755
Thrombocytosis (125-350*10^3/µl)	1 (2.0)	0 (0.0)	0.562	0.755

Note: a = control for females; b = control for males

DISCUSSION

Hematological changes are a common complication of diabetes mellitus and represent a significant and under-recognized burden in patients[10]. This study provides information on demographic and clinical characteristics between diabetic patients and healthy controls. The mean age showed minimal difference between diabetic subjects (45.2±12.3 years) and healthy control subjects (40.2±13.3 years) with no statistical significance (p=0.395).

In this study, we found significant differences in the mean value of basophil count, MCHC, and haemoglobin levels. Our findings are consistent with studies conducted in Nigeria[11'12]. We observed a significantly lower haemoglobin level in diabetic patients compared to the control group, which is in line with previous studies in Bangladesh[13] and Nigeria[14]. However, our prevalence estimate differs from studies conducted in India[15] possibly due to differences in the study population and sample size.

Additionally, basophil count values were higher in diabetic patients compared to controls, consistent with studies conducted in Saudi Arabia[17] and Bangladesh[13]. The study by Varazova[17] reported a relationship between WBC and diabetes mellitus due to increased inflammatory mediators and the critical signals of abnormalities in human blood components.

Furthermore, MCHC values were lower in diabetic patients compared to the controls, similar to findings in studies conducted in Saudi Arabia[16] and Sudan[18]. The decreased MCHC may indicate hypothermia, a common finding in conditions like iron deficiency anaemia, thalassemia, and anaemia due to inflammation[19].

However, total white blood cell count, neutrophil count, lymphocyte count, monocyte count, eosinophil count, red blood cell count, hematocrit, MCV, RDW, platelet count, MPV, and NLR were not significantly different in our study, contrary to findings in Ethiopia which showed significant differences in these parameters in diabetic patients compared to control.

In our study, several haematological abnormalities were observed with statistical significance among diabetic patients, including anaemia and low MCHC. This aligns with a study conducted in Egypt[20]. However, this finding differs from studies conducted in India, Malaysia, and other regions, possibly due to variations in the development level, geographical altitude, ethnicity, and age of the study participants.

CONCLUSION

In conclusion, haematological parameters can be used to distinguish between patients with diabetes mellitus and healthy individuals. The study found that basophil count was significantly higher, while haemoglobin and MCHC levels were statistically lower in diabetic patients compared to the healthy controls. However, there were no significant variations in blood group distributions. Additionally, age and duration of illness did not have a significant impact on haematological parameters.

DECLARATION OF PATIENT CONSENT

The authors certify that they have obtained all appropriate patient consent forms. In the form the patients have given their consent for their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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CONFLICT OF INTEREST

There is no conflict of Interest

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