Evaluation of Total White Blood Cells Counts of Diabetic Patients Attending Maragua District Hospital Diabetic Clinic in Kenya

Martin Weru Muriithi[1*], Kennedy Muna Kuria[2] and Stanley Kinge Waithaka[1]

[1]Department of Medical Laboratory Science, Mount Kenya University, Kenya.
[2]Department of Medical Laboratory Science, Murang'a University of Technology, Kenya.

Abstract

Background: Diabetes mellitus (DM) is a chronic glucose metabolism disorder marked with hyperglycemia which is associated with health complications both short and long term. Diabetes affect people of all ages with several types of diabetes being identified and categorized. Understanding the dynamics of diabetes could not only improve on the course of management but also improved life expectancy and quality of life

Methods: A cross sectional study involving a total of 138 diabetic patients, enrolled at Maragua district hospital diabetic clinic attending routine clinic checkup. There total white blood counts and random blood glucose status were analyzed.

Result: Among 138 respondents who were sampled 72 (52.2%) were female while 66(47.8%) were male. The age range was 18 to 82 years. Of all the 138 respondents 38.4 % had controlled blood glucose level while 61.6% had uncontrolled glucose level. The controlled blood glucose level group had a white blood cell count (WBC) mean of $6.84*10^3$cells/ul while the group with uncontrolled blood glucose level had a WBC mean of $7.87*10^3$cells/ul this gave a P. Value of 0.007.

Conclusion: The findings demonstrated existence of a positive correlation relationship between WBC counts and Blood Glucose control Level of the respondents, it is therefore important to incorporate these tests as part of regular checkup among diabetic clinic patients.

Keywords: Diabetes mellitus, Blood Glucose, White Blood Cells count, WBC.
* Corresponding author: mmuriithi120@gmail.com

1. Introduction

Diabetes Mellitus (D.M) is ranked as one of the 4 priority non-communicable diseases(NCD) by world health organization (WHO) Worldwide, its estimated that 43% of all deaths due to elevated levels of blood glucose occur before the age of 70 years and 8.3% worlds adults population are living with diabetes (Muringo et al., 2021) with the figure rising to 425million adults(20-79 years) in 2017 where there were 4million deaths of ages 20-79years due to diabetes(Mohamed *et al*., 2018). In the year 2017, there were more than 16 million people with diabetic in International Diabetes Federation (IDF) Africa region with Kenya hosting about 458,900 cases of diabetic in adults in the year 2017 giving a prevalence of 2% among the adult population. (*International Diabetes Federation 2020*). among the Kenyan population some of the studies have given a much higher prevalence of 4.0% women being most affected with 4.2% prevalence in contrast to their male counterpart who had a 3.8% prevalence(Hocaoğullari, 2019). This numbers are a matter of public health concern considering its economic burden and also the health related complications involved in diabetic condition (Hocaoğullari, 2019; Mohamed et al., 2018; Pastakia et al., 2018). In 2017, healthcare expenditure related to D.M was about 850 billion USD (Toniolo *et al*., 2019). Understanding the dynamics of diabetes could not only improve on the course of management but also improved life expectancy and quality of life(Pastakia *et al*., 2018).

Pathogenesis of DM have largely been associated with the immune system where immune system have been showed to play a role in the development of both type 1 diabetes mellitus (T1DM) and type 2 diabetes mellitus (T2DM)(Jia et al., 2016; Shah et al., 2017; Zhou et al., 2018).following the development of DM, hyperglycemic condition have been shown to cause immune dysfunction(Toniolo *et al*., 2019).

Elevation of plasma glucose has been linked to chronic inflammation processes and vulnerability to infections, which occurs following dysfunction of immune system like immune cells and cytokine signaling processes(Toniolo et al., 2019) infections can worsen glycemic control and converse(Toniolo *et al*., 2019). White blood cell (WBC) count is used to evaluate inflammation and metabolic related disorders, it's also used as risk marker for insulin insensitivity, DM (Zang et al., 2019). Several studies have demonstrated immune dysfunction in hyperglycemic conditions(Bajpai & Tilley, 2018; Delong et al., 2016; Toniolo et al., 2019; Zhou et al., 2018) and it is thus necessary to determine the total counts of white blood cells of diabetic patients so as to determine the effect that diabetic has on the immune cells. Such findings are critical as it shall give insights on proper utilization of the WBC counts not only as indicators of immune competence but also predictors of response to diabetic management.

2. Materials and methods

2.1 Study site and design

The study was carried out among diabetic patients enrolled in Maragua District Hospital Diabetic Clinic. Maragua District Hospital is the referral health facility for Murang'a South region in Murang'a County- Kenya. The design was a cross sectional study where blood samples of sampled diabetic patients enrolled at Maragua District Hospital Diabetic Clinic were evaluated for blood glucose level, total white blood cell (WBC) count data analyzed in relation to controlled and uncontrolled groups.

2.2 Study population

The study was conducted among diabetic patients enrolled in Maragua District Hospital Diabetic clinic who consented and were eligible to take part in the study. The Diabetic Clinic offer services to Diabetic clients who have been confirmed to be diabetic either during a hospital inpatient admissions or outpatient visits or referral from the peripheral facilities. Once one is confirmed to be diabetic the patient is enrolled at the diabetic clinic and given an appointment day.

2.3 Sample size determination

Sample size was determined using the Fishers *et al* 2014 Wolters Kluwer formula:

$\mathbf{Z_{1-\alpha/2}^2 p(1-p)/ d^2}$

$\mathbf{Z_{1-\alpha/2}}$where the standard normal variate with a type one error at 5%, P value P<0.05 then the standard normal variate was 1.96

P is the expected proportion in population which based previous studies was 10%(Muringo et al., 2021)

d is the precision or the absolute error =0.05

Therefore, the substitution was: 1.96^2*0.10(1-0.10)/0.05^2 =138 participants.

2.4 Sampling technique and sample collection

Enrolled Diabetic Out-Patient Clinic (DOPC) patient whose eligibility was determined by the clinician based on patient's state of health and meet the inclusion criteria were informed of the objectives of the study and the anonymity of their data. Patients who consented to be included were sampled using simple random sampling technique to obtain the sample size. This was achieved by categorizing booked patients per clinic of which per every clinic thirty (30) patients are booked, into five (3) strata whereby the patient with the odd number in every strata was selected for the study i.e. group of ten (10) of which five (5) participants were selected. The data was collected till the sample size of 138 participants was achieved.

The subjects were prepared before sample collection, advised on how samples were to be collected and the potential risks which may occur after sample collection(there might be a little pain and or hematoma at the site of sample collection).Tourniquet was applied on the arm so as to locate the cubital fossa vein, which was then alcohol swabbed. 3-4 ml of blood was drawn from vein into an EDTA vacutainer bottle using closed system method.

2.5 Test procedures

Blood Glucose Testing

Blood glucose status of the blood sample was determined using VIVACHECK^{TM}INO blood glucose meter.

Principle of test

Vivacheck^{tm} blood glucose test strips contain glucose oxidase and a mediator reagents system, the two (2) work with the glucose meter which quantitatively measures the glucose concentration based on the electric current generated by the reaction of glucose with the reagents on the electrodes of the test strip. Electrons are generated producing current that is proportional to the glucose concentration of the sample.

Method:

The blood sample drawn from the subject was inverted 8-10 times. Then a Vivacheck^{tm} valid test strip was inserted on the Vivacheck^{tm} blood glucose meter slip slot. The sample tube was opened and slightly inverted so as to the tip of the strip could touch the sample. A beep sound was produced by the meter once sufficient sample was sucked through the strip. The tube was then tightly closed and preserved. The results were displayed on the test meter screen within 5 seconds. They were recorded. The used test strip was discarded on an infectious waste bin.

Total White Blood Cell Estimation

Hemolyzer 5 NG a 60 tests/hour impedance-based hematology analyzer for laboratory testing of full hemogram was used for total white blood cell estimation. The equipment uses H5 pack reagents to perform 5-population analysis of anti-coagulated human whole blood samples introduced using either in open or closed vials system based on user preference. Sample test was run through the execution menu. Then the sample unique identification number was typed using the on-screen keyboard. Sample profile was selected by tapping the profile list. The closed sample tube was placed the closed sample vial opening on the top of the analyzer. Tapping the analyzer symbol in the center, the sample analysis was initiated. Hemolyzer 5 NG lowered the sample vial into the sampling mechanics and took a sample with its built-in cap piercing needle. Once the sample was taken the vial was taken back to the operator. Results were printed automatically.

2.6 Data collection, assurance and control

Informed consent was sought from all participants. A structured questionnaire was administered to the participants to obtain demographic information. This checked for consistency. Well labelled Blood samples were collected from the participants in EDTA tubes. Good Clinical Laboratory Practices and standard operating procedures were adhered to so as to protect personnel from infection and ensure sample integrity and validity of the results. Bin liners and sharp boxes for proper waste segregation and disposal so as to protect both the personnel and the environment were used. Quality Control materials were run prior to running the participants samples to ensure the integrity and reliability of the results.

2.7 Data Management, analysis and presentation

Data collected was entered and cleaned using SPSS version 26. Unique Identifiers were used instead of names to maintain confidentiality, integrity and retrieval of the data of the study subjects. Descriptive statistics which included mean were analyzed. Data was analyzed using chi square and cross tabulation for the association between the two categorical variables and verified using Pearson's coefficient correlation. Descriptive information was presented using graphs and charts while data analyzed using inferential statistics was presented using tables.

2.7 Ethical Considerations

The right concerning voluntary consent, values of anonymity and confidentiality and the necessity of the study through data collection in regards to total ethical consideration was achieved through authorization from Mount Kenya University Ethical Review Committee, Maragua District Hospital Health Management Team and Department of trainings, and National Commission for Science Technology and Innovation (NACOSTI).

3. Results

The relationship between WBC and the RBS of the study subjects expressed a positive correlation of r value of 0.174 meaning that as RBS increases, there is an increase in the counts of total WBC. This relationship between the WBC and the concentration of RBS of the study subjects is significant since the p value is 0.041 (Correlation is significant at the 0.05 level (2-tailed) as shown in table 1 below.

Table 1: Relations of WBC and RBG (Correlations)

		WBC COUNT (*10^3/microliter)	RBS (mmol/l)
WBC COUNT (*10^3/microliter	Pearson Correlation	1	.174*
	Sig. (2-tailed)		.041
	N	138	138
RBS (mmol/l)	Pearson Correlation	.174*	1
	Sig. (2-tailed)	.041	
	N	138	138

*. Correlation is significant at the 0.05 level (2-tailed).

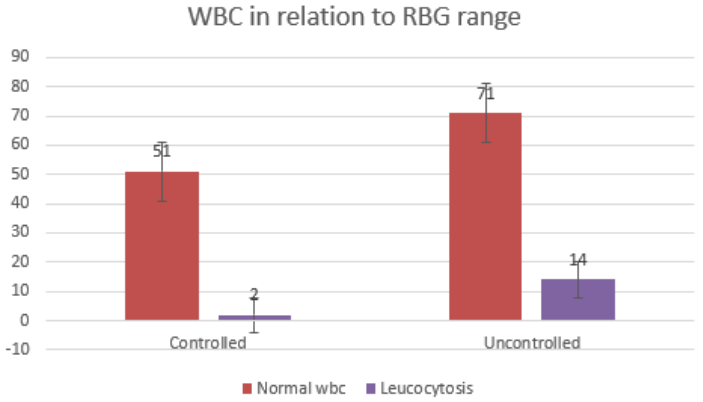

Figure1: WBC in relations to RBG range. When the RBG was categorized into 2 group; controlled blood glucose and the non-controlled blood glucose, the findings show that there is a significant difference in the WBC counts in relation to the RBS control level among the patients

WBC relations to Grouped RBS.

Parameters	*Mean ±SD controlled n=x*	*Mean ±SD uncontrolled n=x*	*T value*	*P value*
T. WBC× 10³ cells/ul	6.836923	7.868493	-2.729	0.007

4. Discussion

The study shows the findings of total WBC and RBS levels of 138 study subjects enrolled in Maragua District Hospital Diabetic Clinic who consented to take part in the study. 72 participants were female (52.2%) while 66(47.8) were male. The participant with the least age had 18 years while the eldest had 82 years. Male respondents had a mean age of 55 years and an age range of 18-79 years and a standard deviation of 13.8. The female respondents had a mean age of 55 years and an age range of 20-82 years and a standard deviation of 13.5.

Of all the participants, 53 (38.4%) had controlled blood sugar ranging between 3-10mmol/l. this is a positive improvement in comparison to the findings of previous study on prevalence of Diabetes in Kenya which showed only 7% had controlled blood glucose level(Mohamed et al., 2018) while 85 (61.6%) had uncontrolled blood sugar levels. This is a positive finding where it can be observed that there was a great improvement in the level of Blood glucose control for diabetic patients enrolled in a clinic as compared to those who are yet to be in a blood sugar management and control clinic.

The relationship between WBC and the RBS of the study subjects expressed a positive correlation of r value of 0.174 meaning that as RBG concentration increases, there is an increase in the counts of WBC. This relationship between the WBC and the concentration of RBS of the study subjects is significant since the p value is 0.041 (Correlation is significant at the 0.05 level (2-tailed). Further, a comparative analysis on respondents categorized into controlled and non-controlled RBG, the non-controlled group had a WBC count mean of $7.8*10^3$ while the group with controlled RBG had a WBC mean of $6.8*10^3$where their analysis gave a P value of 0.007.Thus the study findings shows that among the Diabetic patients attending Maragua District Hospital, as the RBG concentration increased, there was a consecutive elevation of the counts of WBC and among the respondents with controlled RBG the WBC counts was lower but within the normal range. Similar findings were also demonstrated in an study on association of WBC and Diabetes conducted in Tabari which indicated that there was a significant association between WBC and Diabetes (Kheradmand et al., 2021). A study on parameters of Blood indicated that WBC counts, neutrophils, lymphocytes, eosinophils, basophils, red blood cells, Platelets and mean platelet volume (MPV) were increased in T2DM in comparison to a control group (Arkew et al., 2021). A study on WBC as a predictor of Heart Failure condition in diabetic patients demonstrated findings showing that elevated WBC correlated with increased chances of concurrent T2DM hospitalization due to Heart Failure(Kawabe et al., 2021). A study on Parameters of Complete Blood Counts in relations to Glucose control of Diabetic patients, didn't indicate the exact correlations of this parameters but rather, it suggested that some indices in CBC were critical tools of following glucose management of diabetic patients(Milosevic & Panin, 2019). Prior to DM development, relationship of WBC count and T2DM was demonstrated by a study on non-obese adults living in Korea where the study showed that increased WBC count could be used as a predictor of development of T2DM on non-obese respondents(Park et al., 2021).

Conclusion and recommendations

The study having demonstrated existence of a relationship between WBC counts and Blood Glucose control Level of the respondents, it is therefore important to incorporate these tests as part of regular checkup among diabetic clinic patients. Continuous tracking of WBC counts of clinic patients should be used as a monitor of blood glucose control response. WBC counts should be done on diabetic patients to assess their progress and their immune-competence. A longitudinal study should be done to evaluate rate of changes on WBC counts of diabetic individuals so as to determine frequencies the tests should be done.

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Conflicts of interest

The authors declared no conflicts of interest during and after the study.

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