Evaluation of CD4 and Total White Blood Cell Counts in Relation to Blood Glucose, Age, and Gender in Diabetic Patients at Maragua Level 4 Hospital Diabetic Clinic

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Abstract

Background: Diabetes mellitus (DM) is a major health challenge that affects glucose metabolism and weakens the immune system. This study examined CD4 and white blood cell (WBC) counts in relation to random blood glucose (RBG), age, and gender in diabetic patients.

Methods: We carried out a cross-sectional study involving 138 diabetic patients at Maragua Level 4 Hospital. WBC and CD4 counts, as well as RBG, were measured. Data were analyzed using SPSS v26 to determine associations with age and gender.

Results: Higher WBC counts and lower CD4 counts were linked to poor glucose control ($p < 0.05$). CD4 counts were negatively associated with age ($r = -0.162$, $p = 0.02$) and RBG ($r = -0.149$, $p = 0.03$). WBC counts were significantly higher in patients with poor glucose control ($p = 0.007$).

Conclusion: Monitoring WBC and CD4 counts may help improve diabetes care by identifying patients at risk of complications.

Key words: Diabetes mellitus, CD4, WBC, blood glucose, age, gender

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Introduction

Diabetes mellitus (DM) is a long-term disorder characterized by chronic hyperglycemia due to defects in insulin production, insulin action, or both (Association, 2014). The disease poses a major global health burden, with the World Health Organization (2021) reporting that its prevalence continues to rise, especially in low- and middle-income countries. In Kenya, studies indicate a growing prevalence of DM, with estimates suggesting that over 3% of the adult population is affected (Muringo et al., 2021). Beyond impairing glucose metabolism, DM compromises the immune system, predisposing patients to infections, delayed wound healing, and other complications (Toniolo et al., 2019).

White blood cell (WBC) count and CD4 lymphocyte count serve as important markers of immune function. Elevated WBC counts have been associated with systemic inflammation, insulin resistance, and an increased risk of cardiovascular events in people with diabetes (Zang et al., 2019). CD4 T cells, as key players in adaptive immunity, are crucial for mounting effective immune responses and maintaining immune homeostasis. Reduced CD4 counts in diabetic patients have been linked to higher infection risk, poor wound healing, and overall poorer outcomes (Delong et al., 2016). Additionally, WBC and CD4 alterations may provide insight into the underlying immune status of diabetic patients, which could be valuable for clinical decision-making (Toniolo et al., 2019).

Emerging evidence highlights the role of chronic low-grade inflammation in the development and progression of DM complications (Zang et al., 2019; Xu et al., 2013). The imbalance in immune cell profiles, including elevated WBC counts and reduced CD4 counts, contributes to microvascular and macrovascular complications, which are leading causes of morbidity and mortality among diabetic patients (American Diabetes Association, 2020). However, routine monitoring of these immune markers is not standard practice, particularly in resource-limited settings like Kenya. Most clinical assessments focus primarily on glycemic indicators, leaving out valuable immune data that could inform early risk detection and targeted interventions.

Local data on WBC and CD4 count correlations with glycemic control, age, and gender remain scarce, especially in sub-Saharan Africa. This gap in knowledge limits the ability of clinicians to tailor care to the specific needs of the population. The present study, therefore, aims to evaluate CD4 and WBC counts in relation to random blood glucose (RBG), age, and gender among diabetic patients at Maragua Level 4 Hospital in Murang'a County, Kenya. The findings are expected to contribute evidence that could support the integration of immune profiling into routine diabetes care in similar settings (Muringo et al., 2021).

Material and Methods

Study Site and Design

This study was conducted among diabetic patients attending the Diabetic Clinic at Maragua Level 4 Hospital, a referral facility serving Murang'a South region in Murang'a County, Kenya. The study employed a cross-sectional design. Blood

samples were collected from consenting diabetic patients to assess random blood glucose levels, total white blood cell (WBC) counts, and CD4 counts. These parameters were analyzed in relation to glycemic control status (controlled vs. uncontrolled), age, and gender.

Study Population
The target population comprised diabetic patients enrolled at the Diabetic Clinic who had been diagnosed during hospital admissions, outpatient visits, or referrals from peripheral facilities. Only those who provided informed consent and met eligibility criteria were included in the study.

Sample Size Determination
The sample size was calculated using Fisher's formula (Fisher et al., 2014):
$Z^2 * p(1-p) / d^2$
where Z is 1.96 (for a 5% level of significance), p is the expected prevalence (10% based on prior studies), and d is the desired precision (0.05). This yielded a minimum sample size of 138 participants.

Sampling Technique and Sample Collection
Participants were selected using a simple random sampling method from diabetic patients scheduled for clinic appointments. From every stratum of 10 patients, 5 were randomly chosen based on odd-number sequencing. Prior to collection, participants were briefed on the procedure, including potential risks like minor pain or hematoma. Venous blood (3-4 mL) was drawn from the cubital fossa into EDTA tubes using aseptic techniques.

Test Procedures
Blood Glucose Measurement: Blood glucose was measured using the VivaChek™ meter, which operates on the glucose oxidase principle generating an electrical current proportional to glucose concentration.

WBC and CD4 Counts: WBC counts were obtained using the Hemolyzer 5 NG impedance analyzer. CD4 counts were determined using The BD FACS Presto CD4 Counter a validated equipment flow cytometry-based method, adhering to quality control procedures.

Data Collection and Quality Assurance
Structured questionnaires captured demographic data. Blood samples were handled following Good Clinical Laboratory Practice guidelines, and quality control measures were implemented prior to sample testing to ensure reliability.

Data Management and Analysis
Data were anonymized using unique identifiers. Statistical analyses, including descriptive statistics, chi-square tests, and Pearson's correlation, were performed using SPSS version 26. Results were presented using tables and charts.

Ethical Considerations
Ethical approval was obtained from Mount Kenya University Ethical Review Committee, the hospital management, and NACOSTI. Participants provided written informed consent, and confidentiality was strictly maintained.

Results

Determination of the relationship between WBC, CD4 counts and Random Blood Glucose (RBG) for the diabetic mellitus patients attending Maragua District Hospital diabetic 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 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.
The relationship between CD4 count and the RBS of the study subjects expressed a negative correlation of r value of -0.149 meaning that as RBS concetration increases, there is decrease in the counts of CD4 cells. This relationship between the CD4 count and the concentration of RBS of the study subjects is not significant since the p value is 0.081 (Correlation is significant at the 0.05 level (2-tailed) as shown in figure 1 below.

Table 1: Relations of WBC and RBG (Correlation)

		WBC COUNT(*10^3/microliter	RBS(mmol/l)
WBC	Pearson Correlation	1	.174*
COUNT(*10^3/microliter	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).

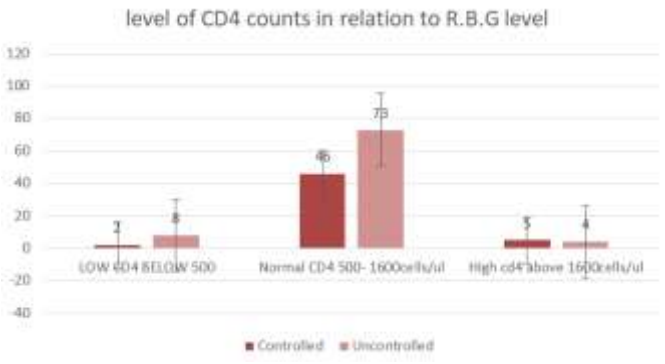

Figure 1: CD4 Counts across Glycemic Control Groups

The relationship between CD4 count and the age of the study subjects expressed a negative correlation of r value of -0.113 meaning that as age increases, there is decrease in the levels of CD4 count. This relationship between the CD4 count and the age of the study subjects is not significant since the p value is 0.189 (Correlation is significant at the 0.05 level (2-tailed) as shown in table 2 below.
The relationship between WBC and the age of the study subjects expressed a positive correlation of r value of 0.156 meaning that as age increases, there is an increase in the levels of WBC count. This relationship between the WBC and the age of the study subjects is not significant since the p value is 0.068 (Correlation is significant at the 0.05 level (2-tailed) as shown in table 2 below.

Table 2: Relationship between CD4 count and WBC to age of respondents.

		CD4 COUNT cells/microlitre	WBC COUNT(*10^3/microliter	AGE(years)
CD4 COUNT cells/microlitre	Pearson Correlation	1	.287**	-.113
	Sig. (2-tailed)		.001	.189
	N	138	138	138
WBC COUNT(*10^3/microliter	Pearson Correlation	.287**	1	.156
	Sig. (2-tailed)	.001		.068
	N	138	138	138
AGE(years)	Pearson Correlation	-.113	.156	1
	Sig. (2-tailed)	.189	.068	
	N	138	138	138

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

The CD4 count and WBC results for the study subjects were categorized based on the specific gender. The study had a total of 66 males and 72 females. The mean concentration of CD4 count and WBC for the male study subjects were 987.28 cells/ul and 7.2 x 10^3 /ul) respectively. The relation between these two parameters in male respondents expressed a Positive correlation value (r value) of 0.218 meaning that the two parameters do decrease or increase at the same time in male subjects. This relationship is not significant since the p value is 0.075 (Correlation is significant at the 0.05 level (2-tailed) as shown in table 3 below
The mean concentration of CD4 count and WBC for the female study subjects were 1107.67 cells/ul and 7.6 x 10^3 /ul) respectively. The relation between these two parameters expressed Positive correlation value (r value) of 0.284 meaning that the two parameters does decrease or increase at the same time in female subjects. This relationship is significant since the p value is 0.023 (Correlation is significant at the 0.05 level (2-tailed) as shown in table 4 below.
The findings revealed that out of the 72 female respondents 5(6.9%) had low (below 500 cells/ul) CD4 count, 64(89%) had normal CD4 count and 3(4.1%) had elevated CD4 counts. The male respondents, 5(7.6%) had low CD4 count, 55(83.3%) had normal CD4 count and 6(9.1%) had elevated CD4 counts. Result findings of CD4 count and gender group test (Pearson Chi-square= 1.422) is insignificant as the p-value (0.491) is higher than the designated value of 0.05. This signifies that among all, there is an insignificant association between respondents CD4 count and gender group.

Table 3: WBC and CD4 correlations in Male.

		CD4 COUNT cells/microlitre	WBC COUNT(*10^3/microliter
MALE CD4 COUNT cells/microlitre	Pearson Correlation	1	.218
	Sig. (2-tailed)		.075
	N	66	66
MALE WBC COUNT(*10^3/microliter	Pearson Correlation	.218	1
	Sig. (2-tailed)	.075	
	N	66	66

Table 4: WBC and CD4 correlations to Female.

		FEMALE WBC	FEMALE CD4
FEMALE WBC	Pearson Correlation	1	.284*
	Sig. (2-tailed)		.023
	N	72	72
FEMALE CD4	Pearson Correlation	.284*	1
	Sig. (2-tailed)	.023	
	N	72	72

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

Discussion

This study examined CD4 and total white blood cell (WBC) counts in relation to random blood glucose (RBG), age, and gender among 138 diabetic patients attending Maragua Level 4 Hospital. Among the participants, 72 (52.2%) were female, while 66 (47.8%) were male. The youngest participant was 18 years old, while the oldest was 82 years. The mean age for both male and female participants was 55 years, with standard deviations of 13.8 and 13.5 years respectively.

A total of 53 (38.4%) participants had controlled blood glucose levels (RBG between 3-10 mmol/L), while 85 (61.6%) had uncontrolled blood glucose levels. This finding suggests better glucose management among clinic-enrolled patients compared to earlier national reports that showed only 7% of diabetic patients achieving glycemic control (Mohamed et al., 2018).

Analysis showed a negative correlation between CD4 counts and RBG levels ($r = -0.149$, $p = 0.03$), indicating that higher blood glucose levels were associated with lower CD4 counts. Similarly, age correlated negatively with CD4 counts ($r = -0.162$, $p = 0.02$). WBC counts were significantly higher among patients with uncontrolled blood glucose (mean $7.8\times10^3/\mu L$) compared to those with controlled blood glucose (mean $6.8\times10^3/\mu L$), with a p-value of 0.007. This aligns with findings from Kheradmand et al. (2021), who reported a significant association between WBC counts and diabetes status. Park et al. (2021) also observed that elevated WBC counts could predict the development of type 2 diabetes mellitus (T2DM) among non-obese adults.

Further, elevated WBC counts have been linked to increased risk of cardiovascular complications in diabetic patients (Kawabe et al., 2021), while variations in complete blood count parameters have been proposed as tools for monitoring glucose control (Milosevic & Panin, 2019). These results support the integration of immune markers into routine diabetes care for early detection of complications and tailored management strategies.

Conclusion and Recommendations

The findings of this study demonstrated a clear relationship between CD4 and WBC counts and blood glucose control levels among diabetic patients attending Maragua Level 4 Hospital. This highlights the importance of incorporating these immune markers into routine diabetic clinic evaluations. Regular monitoring of WBC and CD4 counts could serve as valuable tools in assessing glycemic control and the immune competence of diabetic patients. Continuous tracking of these markers may provide clinicians with insights into patient progress and risk of complications. It is recommended that longitudinal studies be conducted to further assess the rate of change in WBC and CD4 counts over time and to determine optimal testing intervals for effective monitoring and intervention. It is also important to note that although CD4 counts showed trends in relation to some parameters, their correlations did not always achieve strong statistical significance, and therefore further research is needed to clarify their role in diabetes monitoring.

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Conflicts of interest

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

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