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## Research Article,

# Correlation between the Biochemical and Haematological Profile of Type 2 Diabetics Living With HIV in Ivory Coast

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## Abstract:

### Background

Diabetes is up to four times more common in HIV-infected individuals exposed to antiretroviral therapy. Haematological parameters are important indicators for the assessment and management of patients with diabetes. The aim of this study was to determine the correlations between biochemical and haematological parameters in type 2 diabetic patients living with HIV.

### Methods

A total of 260 participants consisting of 100 HIV-positive and 160 HIV-negative diabetics. Blood samples were obtained from fasting subjects by venipuncture at the elbow. They were used to obtain plasma and serum after centrifugation at 3000 rpm for 15 minutes. Creatinine, total cholesterol, HDL cholesterol, LDL cholesterol, triglycerides, C-reactive protein, magnesium, phosphorus, urea, uric acid and cystatin C, glycated haemoglobin, blood glucose and blood count were measured.

### Results

The correlation between the biochemical and haematological profile showed that blood glucose correlated positively with white blood cell count (r=0.204, p=0.042), red blood cell count (r=0.216, p=0.031), neutrophil count (r=0.265, p=0.008), basophil count (r=0.229, p=0.022), monocyte count (r=0.271, p=0.006) and lymphocyte count (r=0.205, p=0.041). This correlation was negative for mean blood volume (r=-0.202, p=0.043). Phosphorus was negatively correlated with mean corpuscular haemoglobin concentration (r=-0.245, p=0.014) and monocyte count (r=-0.24, p=0.016), but positively correlated with eosinophil count (r=0.256, p=0.010).

### Conclusion

Disturbances in the biochemical and haematological profiles were observed in diabetics living with HIV. The correlations found in these two associated chronic pathologies showed the link of blood glucose with many of haematological parameters.

**Keywords:** Correlation, biochemical and haematological profile, type 2 diabetes mellitus, HIV.

## Introduction:

Diabetes is becoming a major health problem in Africa. Type 2 diabetes (T2DM) is the most prevalent and its prevalence is increasing rapidly [1]. Like other regions of the world, sub-Saharan Africa is experiencing a growing prevalence of diabetes as is the case with other non-communicable diseases [2]. Furthermore, several infectious diseases such as HIV are very present in sub-Saharan Africa with 25.7 million people living with HIV [3] and its corollaries of co-infection or association with non-communicable diseases such as diabetes, hypertension. At the same time, there are cardio-metabolic

complications attributable to HIV itself and its treatment [4]. People living with HIV (PLHIV) are dying from non-AIDS related conditions, including type 2 diabetes and chronic kidney disease (CKD) [5]. Diabetes is associated with abnormalities in carbohydrate, fat and protein metabolism. Chronic exposure to hyperglycaemia can lead to dysfunction and failure of various organs, particularly the eyes, kidneys, nerves, heart and blood vessels. Long-term micro and macro vascular complications of type 2 diabetes include retinopathy, nephropathy, neuropathy, myocardial infarction and stroke [6]. People with type 2 diabetes are at increased risk of myocardial infarction, stroke and haematological disease [7]. In type 2 diabetes, hyperglycaemia disrupts haematological parameters and is associated with well-known risk factors that can lead to degenerative complications. Alterations in these haematological parameters have been shown to be closely associated with glycated haemoglobin (HbA1c) levels and some of these parameters are associated with complications in people with diabetes [8]. Several studies have reported an increase in the prevalence and incidence of metabolic disorders such as impaired glucose tolerance and diabetes mellitus in HIV-infected individuals [9,10]. This increase is up to four times higher in HIV-infected people exposed to antiretroviral therapy [11,12]. An epidemiological study indicated a close relationship between white blood cell count and components of the metabolic syndrome [13]. These abnormalities have been shown to be associated with markedly increased blood viscosity which adversely affects the microcirculation, leading to microangiopathy [14]. Studies have revealed that higher numbers of white blood cells, as one of the main components of the inflammatory process, contribute to the progression of atherosclerosis and cardiovascular disease [13-15]. Haematological parameters are important indicators for the assessment of variations in the size, number and maturity of different blood cells. They are important for the assessment and management of patients with diabetes [15].

The aim of this study is to determine the correlations between biochemical and haematological parameters in type 2 diabetic patients living with HIV.

## Material and methods

### Study population

The study population consisted of two groups of people including HIV-positive diabetics (T2HIV+) and HIV-uninfected diabetics (T2HIV-).

### Ethical approval and consent

The study was conducted after approval from the National Ethics Committee for Life Sciences and Health of Côte d'Ivoire (CNESVS). All participants signed an informed consent form prior to the implementation of the study.

### Patient recruitment

The selection of patients was based on the analysis of medical records in two main centres: the Abidjan Antidiabetic Centre (CADA) and the NGO Ruban Rouge, which is an NGO fighting against HIV/AIDS.

### Inclusion criteria

Type 2 diabetic with or without HIV infection and over 15 years of age;

### Non-inclusion criteria

Type 1 diabetics and pregnant women;

The other information was completed with a questionnaire at the interview of the patients after they had given their free and informed consent. The data collected included socio-demographic characteristics, information on HIV infection (age of diagnosis and type of HIV), diabetes (age of diagnosis, therapy, micro- and macro-angiopathic complications), and the presence of comorbidity. A total of 260 participants consisting of 100 HIV-positive and 160 HIV-negative diabetics

### Blood samples

Blood samples were obtained from fasting subjects by venipuncture at the elbow. They were used to obtain plasma and serum for the determination of biochemical and haematological parameters.

*A- Serum:*

A volume of 5 ml of blood was collected in dry tubes without anticoagulant. These tubes were centrifuged at 3000 rpm for 15 minutes. The collected serum was used for the determination of creatinine, total cholesterol, HDL-Cholesterol, LDL-Cholesterol, triglycerides, C-reactive protein, magnesium, phosphorus, urea, uric acid and cystatin C.

*B- Plasma:*
Whole blood was collected in EDTA and fluoride tubes. The EDTA tubes were used for glycated haemoglobin determination and for blood count while the whole blood from the fluoride tube was used for blood glucose determination.

## Methods:

Biochemical and haematological parameter determinations
Biochemical parameters such as : Blood glucose, creatinine, total cholesterol, HDL-cholesterol, LDL-cholesterol, triglycerides, magnesium, phosphorus, urea, uric acid were measured by Cobas® c311 automated assays using specific Cobas® c311 reagents from Roche Diagnostics as well as the immunoassay of HbA1c using Roche Cobas C311 monoclonal antibody-based reagents.
Cystatin C was determined by immunoturbidimetry using the RANDOX CYS4004 kit (UK). The principle is based on the formation of a latex agglutination complex which forms between cystatin C and latex particles. The reading was taken at 570 nm with a spectrophotometer.
The determination of haematological parameters was performed with the SYSMEX 1800i haematological analyser using the combined system technique of independent variation and flow cytometry [16].

### Data analysis

Data were entered and analysed using (SPSS) software version 20 (IBM Corporation, Armonk, NY, USA). They were reported as mean and standard deviation for continuous variables, and as counts and percentages for categorical variables. The relationship or association between the variables was determined by studying the correlations using Pearson's correlation coefficient. A P-value <0.05 and <0.01 was considered statistically significant.

## Results:

Epidemiological analysis of the study population
Table I shows the characteristics of the study population composed of 260 diabetic patients, 100 of whom were HIV-infected and 160 uninfected. The number of women (154 or 59.2%) was higher than that of men (106 or 40.8%). The average age of the whole population was 48.72±12.50 years with an average weight of 72.11±15.20 Kg. However, the mean age of HIV-positive diabetics (45.14±12.68 years) was significantly lower (P < 0.05) than that of HIV-negative diabetics (50.96±11.88 years). The population was generally overweight with a mean BMI of 26.18±5.36 kg/m2. However, the mean BMI of HIV-negative diabetics (27.06±4.76) was significantly higher (P<0.001) than that of HIV-positive diabetics (24.78±5.97). There was no significant difference (P = 0.209 > 0.05) between the durations of diabetes in the two groups.

**Table I: Characteristics of the study population.**

| Parameters | DT2VIH- | DT2VIH+ | Total | P value |
|---|---|---|---|---|
| **N** | **160** | **100** | **260 (100%)** | **Sig. p<0.05** |
| Ages (years) | | | | |
| Average | 50.96±11.88 | 45.14±12.68 | 48.72±12.50 | 0.000 |
| Sex | | | | |
| Men | 78 (48.8%) | 28 (28%) | 106 (40.8%) | |
| Women | 82 (51.2%) | 72 (72%) | 154 (59.2%) | |
| Weight (Kg) | 75.49±14.41 | 66.71±14.95 | 72.11±15.20 | 0.000 |
| Size (m) | 1.67±0.08 | 1.63±0.07 | 1.65±0.08 | 0.000 |
| BMI Kg/m2 | | | | |
| 18,5 to 25 | 102 (63.7%) | 55 (55%) | 157 (60.4%) | |
| 25 to 30 | 43 (26.9%) | 23 (23%) | 66 (25.4%) | |

| | | | | |
|---|---|---|---|---|
| > 30 | 15 (9.4%) | 22 (22%) | 37 (14.2%) | |
| Average | 27.06±4.76 | 24.78±5.97 | 26.18±5.36 | 0.001 |
| Duration of diabetes | | | | |
| >5years | 121 (75.6%) | 63 (63%) | 184 (70,8%) | |
| 5 to 10years | 23 (14,4%) | 28 (28%) | 51 (19,6%) | |
| >10years | 16 (10%) | 9 (9%) | 25 (9,6%) | |
| Average | 5.11±5.30 | 4.36±3.31 | 4.82±4.64 | 0.209 |
| Duration of HIV | | | | |
| <3years | | 79 (70%) | | |
| 3 to 5years | | 17 (17%) | | |
| >5years | | 4 (4%) | | |
| Average | | 3.37±2.58 | | |

### *Study of correlations*

In bivariate analysis, we studied correlations in order to study the links between biochemical parameters on the one hand and between biochemical and haematological parameters on the other. We noted those that were significant according to Pearson's parametric method (significance level < 0.01 and < 0.05).

### Correlations between biochemical parameters in T2D/HIV-

In this category of diabetics, all significant correlations were positive. We observed a correlation between glycated haemoglobin and blood glucose (r=0.202, p =0.010) on the one hand and between glycated haemoglobin and HDL-cholesterol (r=0.287; p =0.004) on the other. Cystanin C was correlated with creatinine (r=0.510; p =0.000) and triglycerides (r=0.214; p=0.033). Total cholesterol was correlated with creatinine (r=0.211; p=0.007), LDL cholesterol (r=0.961; p=0.000) and triglycerides (r=0.232; p=0.003). Another significant correlation was observed between calcium and creatinine (r=0.220; p=0.005).

**Table II: Correlations between biochemical parameters (HIV-uninfected diabetics: N=160)**

| Biochemical Parameters | Biochemical Parameters | Pearson Correlation | P value |
|---|---|---|---|
| HBA1c | | | |
| | Gly | r=0.202* | p =0.010< 0.05 |
| | HDL-C | r=0.287** | p =0.004< 0.01 |
| CYST | | | |
| | Creat | r=0.510** | p =0.000< 0.01 |
| | Trigly | r=0.214* | p=0.033<0.05 |
| CHOL-T | | | |
| | Creat | r=0.211** | p =0.007< 0.01 |
| | LDL-C | r=0.961** | p =0.000< 0.01 |
| | Trigly | r=0.232** | p=0.003<0.05 |
| Ca | Creat | r=0.220** | p =0.005< 0.05 |

**. The correlation is significant at the 0.05 level (two-tailed).*
***. Correlation is significant at the 0.01 level (two-tailed).*

## Correlations between biochemical and haematological parameters in T2D/HIV-

In this group the positive correlations observed were for blood glucose with white blood cells (p =0.035), neutrophils (p =0.037) and eosinophils (p =0.010).

Total cholesterol was negatively correlated with mean corpuscular volume (r=-0.225, p=0.004), mean corpuscular haemoglobin content (r=-0.184, p=0.020). It was positively correlated with the number of blood platelets (r=0.257, p=0.001) and TCD4 lymphocytes (r=0.164, p=0.042).

**Table III: Correlations between biochemical and haematological parameters (HIV-uninfected diabetics: N=160)**

| Biochemical Parameters | Hematological Parameters | Pearson Correlation | P value |
|---|---|---|---|
| Gly | | | |
| | WBC | r=0.167* | p =0.035< 0.05 |
| | Neut | r=0.165* | p =0.037< 0.05 |
| | Eos | r=0.203* | p =0.010< 0.05 |
| CHOL-T | | | |
| | MCV | r=-0.225** | p =0.004< 0.01 |
| | MCH | r=-0,184* | p=0.020<0.05 |
| | PLT | r=0.257** | p =0.001< 0.01 |
| | CD4 | r=0.164* | p=0.042<0.05 |

**. Correlation is significant at the 0.05 level (two-tailed).*
***. Correlation is significant at the 0.01 level (two-tailed).*

## Correlations between biochemical parameters in T2D/HIV+

As in HIV-uninfected diabetics, here all significant correlations observed were positive. We observed a correlation between glycated haemoglobin and blood glucose (r=0.248; p =0.013) on the one hand and between glycated haemoglobin and HDL cholesterol (r=0.287; p =0.004) on the other. Cystanin C was correlated with creatinine (r=0.510; p =0.000) and triglycerides (r=0.214; p=0.033). Total cholesterol was correlated with creatinine (r=-0.249; p =0.012), LDL cholesterol (r=0.926; p =0.000). Another significant correlation was observed between phosphorus and magnesium (r=0.256; p =0.010).

**Table IV: Correlations between biochemical parameters (HIV-infected diabetics: N=100)**

| Biochemical Parameters | Biochemical Parameters | Pearson Correlation | Pvalue |
|---|---|---|---|
| HbA1c | | | |
| | Gly | r=0.248* | p =0.013< 0.05 |
| | HDL-C | r=0.287** | p =0.004< 0.01 |
| Cyst | | | |
| | Creat | r=0.510** | p =0.000< 0.01 |
| | Trigly | r=0.214* | p=0.033<0.05 |
| CHOL-T | | | |

| | | | |
|---|---|---|---|
| | Creat | r=-0.249* | p =0.012< 0.05 |
| | LDL-C | r=0.926** | p =0.000< 0.01 |
| Phosp | Mag | r=0.256* | p =0.010< 0.05 |

**. Correlation is significant at the 0.05 level (two-tailed).*
***. Correlation is significant at the 0.01 level (two-sided).*

## Correlation between biochemical and haematological parameters in T2D/HIV+

The correlation between the biochemical and haematological profile showed that blood glucose correlated positively with white blood cell count (r=0.204, p=0.042), red blood cell count (r=0.216, p=0.031), neutrophil count (r=0.265, p=0.008), basophil count (r=0.229, p=0.022), monocyte count (r=0.271, p=0.006) and lymphocyte count (r=0.205, p=0.041). This correlation was negative for mean blood volume (r=-0.202, p=0.043).

Phosphoraemia was negatively correlated with mean corpuscular haemoglobin concentration (r=-0.245, p=0.014) and monocyte count (r=-0.24, p=0.016) but positively correlated with eosinophil count (r=0.256, p=0.010).

**Table V: Correlations between biochemical and haematological parameters (HIV-infected diabetics: N=100)**

| Biochemical Parameters | Hematological Parameters | Pearson Correlation | P value |
|---|---|---|---|
| Gly | | | |
| | WBC | r=0.204* | p =0.042< 0.05 |
| | RBC | r=0.216*, | p =0.031< 0.05 |
| | MCV | r=-0.202* | p =0.043< 0.05 |
| | Lymph | r=0.205* | p =0.041< 0.05 |
| | Neut | r=0.265** | p =0.008< 0.01 |
| | Baso | r=0.229* | p =0.022< 0.05 |
| | Mono | r=0.271** | p =0.006< 0.01 |
| Phos | | | |
| | MCHC | r=-0.245* | p=0.014<0.05 |
| | Mono | r=-0.24* | p=0.016<0.05 |
| | Eos | r=0.256* | p=0.010<0.05 |

**. Correlation is significant at the 0.05 level (two-tailed).*
***. Correlation is significant at the 0.01 level (two-sided).*

## Discussion:

The biochemical profile of our diabetic study population (N=260), showed a positive correlation between HbA1c and HDL-C in HIV infected (N=100) and uninfected (N=160) diabetics. These results are in agreement with Singh and Kumar (2011) and Naeem et al (2015) who also described a positive relationship between HbA1c and HDL-C [17]. Naqvi et al (2017) reported that for patients with T2DM, one of the most common complications related to poor glycaemic control is dyslipidaemia [18]. Our study showed a correlation between cystatin C and triglycerides. The study by Servais et al (2008) showed that cystatin C was associated with metabolic syndrome in dyslipidemic patients. We also found a correlation between cystatin C and creatinine. Our results are similar to those found by Nyanzi (2014) who found correlations of cystatin C with creatinine and triglycerides [19]. Cystatin C, a predictive marker of renal dysfunction may be an interesting marker of metabolic syndrome and

increased cardiovascular and renal risk [20]. In the haematological profile, there was a correlation between white blood cells and glycoregulatory parameters in both groups, similar to other studies that have shown an association between white blood cells and impaired glycaemic control [21]. However, we observed differences in the correlations between the two groups studied. The chronic inflammatory state due to the action of insulin on adipose tissue, muscle and liver promotes the differentiation and maturation of white blood cells via pro-inflammatory cytokines [22]. White blood cells (WBCs) play an important role in immune functions and phagocytic action to defend the body against foreign bodies and microorganisms. Platelets (thrombocytes) have a fundamental role in haemostasis to stop bleeding and coagulation [22]. When the Pearson-Moment correlation test was used to investigate the existence of any significant relationship between haematological parameters and different biochemical parameters in the participants, we found that in HIV-negative diabetics, there was a strong positive correlation between blood glucose and three haematological parameters (consisting especially of white blood cell populations).

In HIV-positive diabetics, the correlation was between blood glucose and seven haematological parameters including red blood cells. In contrast, phosphorus was correlated with three haematological parameters, namely MCHC, monocytes and neutrophils.

Total cholesterol was correlated with four haematological parameters including platelets and TCD4 lymphocytes in seronegative diabetics. A similar study on the relationship between platelets and glycaemic control in diabetics showed a negative but not significant correlation [23].

## Conclusion:

Disturbances in biochemical and haematological profiles have been observed in diabetics living with HIV. As both profiles are associated, the combined effects of HIV infection and T2DM constitute a heavy burden for the patients. The correlations found in these two associated chronic conditions showed the link of blood glucose with the majority of haematological parameters. Thus, apart from the HIV status which is already well controlled in these patients, strict glycaemic control could prevent haematological disorders and the occurrence of complications.

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