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Research Article

Fructosamine Profile in Regular Blood Donors at the Bobo-Dioulasso Regional Blood Transfusion Centre, Burkina Faso

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Abstract

Introduction: Fructosamine is a stable ketoamine, formed by the reaction between glucose and the amino group of proteins (mainly albumin, but also globulins and lipoproteins). It indicates average blood glucose concentrations of 2 to 3 weeks for monitoring and controlling diabetes. However, studies on fructosamine based on the characteristics of Burkinab è are still rarely documented. With this in mind, the aim of this study was to investigate the fructosamine profile in regular blood donors from the town of Bobo-Dioulasso (Burkina Faso). *Material and methods:* This was a descriptive and analytical cross-sectional study with a collection period from 10 August 2024 to 10 September 2024. The study population consisted of fasting adult regular blood donors from Burkina Faso residing in the city of Bobo-Dioulasso, collected at the Bobo-Dioulasso Regional Blood Transfusion Centre. Fructosamine was determined by the colorimetric method using the Cobas® 6000 analyser. The data were analysed using R studio 4.3.3 software so that medians were calculated and reference values were determined at the 2.5 thand 97.5 thpercentile. *Results-discussion:* A total of 60 regular blood donors, equally distributed by gender, were selected. The mean age of the regular blood donors was 28.28 ±7.72 years (min = 19 years and max=52 years) while the mean number of donations was 6.97 ±8.50 (min=2 and max=61). Median fructosamine values were 272.5 µmol/L while the 2.5 thand 97.5 thpercentiles were 247.9 µmol/L and 314.77 µmol/L. The fructosamine ranges in our study population were higher than the reference values proposed by the reagent kit manufacturer and those proposed in the literature. There was no significant difference between the mean fructosamine concentrations according to sex, according to the age groups 19 to 36 and 37 to 55 and according to BMI (normal, overweight, obese). *Conclusion:* In a context of limited resources, this study contributes to providing reference ranges with a view to improving the control and monitoring of diabetes mellitus in Burkinabe subjects.

Keywords

Fructosamine, Reference Values, Blood Donor, Bobo-Dioulasso

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1. Introduction

Diabetes mellitus, particularly type 2 diabetes mellitus (T2DM), remains a major global health problem, particularly in Africa, where its prevalence is increasing rapidly. According to the World Health Organisation (WHO), the number of people with diabetes rose from 200 million in 1990 to 830 million in 2022, with prevalence increasing more rapidly in low- and middle-income countries than in high-income countries [1].

Chronic hyperglycaemia is a common effect of uncontrolled diabetes. In the monitoring and control of diabetes, the biochemical marker commonly used to assess glycaemic control is glycated haemoglobin (HbA1c). Although glycated haemoglobin is an indicator of the average concentration of glucose in the blood over a period of around 90 to 120 days, several studies have highlighted a number of limitations in pregnant women and patients with disorders of red cell synthesis (anaemia, haemoglobinopathy) [2, 3]. Haemoglobinopathies are very common, particularly sickle cell anaemia (HbSS) and HbSC variants, the prevalence of which in Black Africa can be as high as 10-40% [4, 5]. As a result, monitoring type 2 diabetes in patients with haemoglobinopathies remains a challenge in our context, as HbA1c is not appropriate in this case. To overcome these limitations, fructosamine has been proposed by several authors [6].

Fructosamine (1-amino-1-deoxy fructose) is a stable ketoamine formed by the reaction between glucose and the amino group of protein (mainly albumin, but also globulins and lipoproteins) [7].

Binding of the aldehyde group of the carbohydrate with the N-terminal amino acid of the protein forms the reversible product known as Schiff base (aldimine intermediate). The Schiff base product can be converted back into glucose and protein, or undergo the Amadori rearrangement to form the stable fructosamine [7]. This process is known as non-enzymatic glycation and is also known as the Maillard reaction [7].

However, in Burkina Faso, as in most African countries, few studies have been carried out on fructosamine and particularly on its reference values. In addition, the country is part of the Lehmann sickle belt, with more than 10% of the Burkinab è population suffering from sickle cell disease, which could result in limitations in the interpretation of HbA1c, demonstrating the value of fructosamine in this context [8]. Also, the reference values for fructosamine defined in reagent kits and in the literature come from studies carried out on American, European or Asian populations [2]. In addition, because of genetic variability, lifestyle, nutritional habits and the geographical environment of Burkina Faso's people, the reference values proposed by Americans, Europeans and Asians may not be applicable to Burkina Faso's people [9]. With this in mind, we conducted this study to investigate the fructosamine profile in regular blood donors at the Bobo-Dioulasso Regional Blood Transfusion Centre (Burkina Faso).

2. Material and Methods

2.1. Framework and Period of Study

This was a cross-sectional study with descriptive and analytical aims. Data collection took place from 10 August 2024 to 10 September 2024 at the Bobo-Dioulasso Regional Blood Transfusion Centre (RBTC) and at the biochemistry department of the Souro SANOU Teaching Hospital Centre (SS-TH) in Bobo-Dioulasso (Burkina Faso).

2.2. Patients

Our study population consisted of regular blood donors who had completed the pre-donation interview, biological qualification and blood bag validation stages at the RBTC. Demographic and anthropometric variables (age, sex, weight, height, BMI, rhesus blood group, number of blood donations, haemoglobin electrophoresis and occupation) were collected during the pre- donation interview and supplemented by an interview with the donors. Exclusion criteria were considered by the RBTC medical team and included diabetes mellitus, glucose intolerance, cardiovascular disease, endocrine disorders, liver disease, infections (HIV, viral hepatitis, syphilis), anaemia and pregnant or breast-feeding women. Then, depending on the availability of our reagents, our sampling was exhaustive, taking into account gender matching (male and female).

2.3. Sample Preparation and Analysis

For each donor, a blood sample in a red-capped tube was collected in the satellite bag at the time of donation. This tube was centrifuged at 5,000 rpm for 5 min to collect the serum, which was aliquoted and then stored at -80 ℃ for 2 weeks before analysis.

For biochemical analysis, the Roche systems Cobas® 6000 (Roche/Hitachi) multiparameter automated system was used. The FRA reagent kit, calibrator (PRECIMAT FRU) and controls (PRECONORM FRU and PRECIPATH FRU) were used for the fructosamine assay. In accordance with the internal procedures of the SS-TH Biochemistry Laboratory, the internal quality controls were validated before the samples were analysed. Thus, the colorimetric method based on the ability of ketoamines to reduce Nitrobleutetrazolium (NBT) in an alkaline medium was used for the determination of fructosamine.

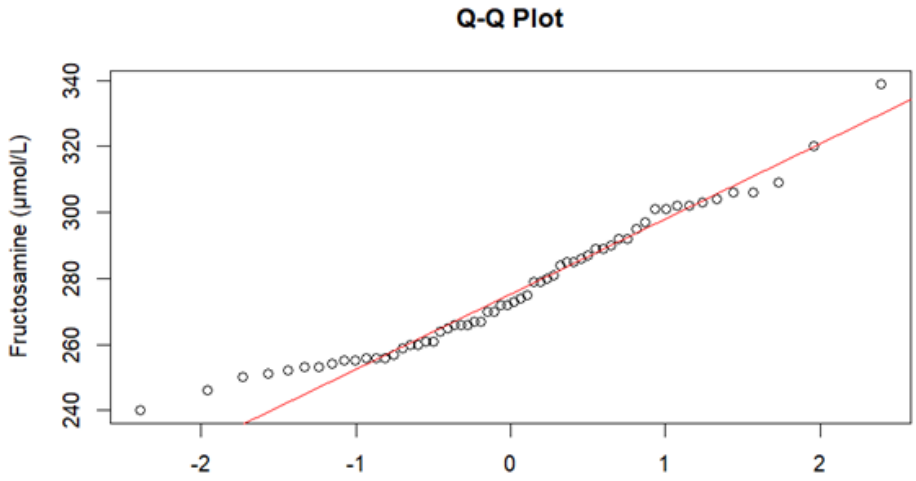

Figure 1. *QQ Plot of fructosamine concentrations in regular blood donors.*

Table 1. *General characteristics of the study population.*

Characteristics		**Blood donors (n=60)**
Ages	Ages, m ±ET (years)	28.28±7.72
	Min (years)	19
	Max (years)	52
Average number of years donated, m±SD		4.08±2.98
Average number of donations, m±SD		6.97±8.50
Anthropometric parameters	Weight, m±SD (kg)	74.22±14.47
	Height, m±SD (m)	1.72±0.08
	BMI, m±SD	25.09±4.30
Haemoglobin level, m±SD (g/dl)		14.26±1.48
Blood glucose, m±SD, (mmol/l)		4.85±0.49
Fructosamine, m±SD, (µmol/l)		276.42±20.75

Table 2. *Correlation of fructosamine with anthropometric variables, age and biochemical markers.*

Parameters	**r**	**t**	**95% confidence interval**		***p-value***
			Min	**Max**	
Anthropometric variables and ages					
Age of patients, (years)	0.005	0.039	-0.249	0.258	0.968
Number of years donated (years)	-0.055	-0.426	-0.305	0.200	0.671
Number of donations, m±SD	0.151	1.165	-0.106	0.390	0.248
Weight (kg)	-0.145	-1.155	-0.389	0.108	0.252
Height, (m)	0.046	0.352	-0.210	0.296	0.725
BMI, (kg/m^2)	-0.204	-1.587	-0.435	0.052	0.117

Parameters	r	t	95% confidence interval		*p-value*
			Min	Max	
Anthropometric variables and ages					
Markers					
Glucose, (mmol/L)	0.037	0.287	-0.218	0.288	0.774
Haemoglobin, (g/dl)	0.141	1.086	-0.116	0.381	0.281

*p<0.05

Table 3. *Transthyretin profile of hemodialysis CKD patients at CHU-SS.*

Characteristic		Values			
		Effectif	Median, (µmol/L)	2.5th Percentile, (µmol/L)	97.5thPercentile, (µmol/L)
Age group (years)	[19 - 36]	52	273.5	247.3	305.4
	[37 - 55]	08	271	251.22	335.67
Sexe	Female	30	274.5	244.35	306.82
	Male	30	269.5	251.72	325.22
Profession	Student	33	280	250	306.6
	Non-formal sector	15	261	245.25	303.3
	Government official	08	278	254.92	335.67
	Housewife	04	272.5	251.5	303.67
BMI (kg/m^2)	Normal (BMI ≤25)	35	281	252.7	310.65
	Overweigh (BMI 25.1-29.9)	16	270	242	299.2
	Obese (>30)	09	269	248	326.62
Rh Blood Group	O+	25	270	251.8	321
	O-	2	270	255.75	284.25
	B+	16	269.5	247.87	313.25
	A+	12	281.5	244.4	299.25
	AB+	05	292	260.5	302.8
Hb electrophoretic phenotype	AA	48	270	250.17	318.07
	AC	11	281	248.25	301.75
	AS	1	253	253	253
Number of blood donations	0-3	30	274.5	248.9	317.25
	4-10	17	270	244.8	301.6
	>11	13	272	251.6	314.9
Published reference values	Fructosamine (µmol/L) (our study in Burkina Faso)	60	272.5	247.9	314.77
	Xun Chen et al. [2] (China)	1497		215.45	290.00

Characteristic		Values			
		Effectif	**Median, (µmol/L)**	**2.5th Percentile, (µmol/L)**	**97.5thPercentile, (µmol/L)**
	Roche Kit manufacturer [12]	555		205	285
	Selvin et al. [13] (USA with 14.5% black)	1799		194.8	258.0
	Pedrosa et al. [14] (Brazil)	466		M=196 F=186	M=269 F=248
	Zhou et al. [15] (China)	458		220	298

2.4. Ethical Considerations

This study was approved by the Comité Interne de Revue Scientifique (CIRS) of the Centre National de Transfusion Sanguine (CNTS) (N°2024/000515/MSHP/SG/CNTS/DG/DCSISS). Confidentiality of donor results was maintained throughout the study by assigning a unique identifier to samples.

2.5. Data Analysis and Processing

Data were collected using Excel 2016 and statistical analysis was performed using R Studio version 4.3.3. The distribution of the data was assessed using the QQ plot (Figure 1) and the Shapiro Wilk normality test which was found to be non-Gaussian. Non-parametric methods were used to calculate the reference ranges. Reference ranges were determined in accordance with Clinical and Laboratory Standards Institute (CLSI) guidelines C28-A2 [10, 11]. Medians were calculated and reference values determined at the 2.5th and 97.5th percentiles. Mann-Whitney and ANOVA tests were used for data comparisons. Probability levels below 0.05 were considered significant.

3. Results

3.1. General Characteristics of the Patients Studied

A total of 60 regular blood donors were recruited in our study. The characteristics of the study population are presented in Table 1. The mean age of the donors was 28.28 ±7.72 years, with extremes ranging from 19 to 52 years. The average number of years donated was 4.08 ±2.98 years, while the average number of donations was 6.97 ±8.50 donations, with a maximum of 61 donations. For anthropometric parameters, the mean BMI was 25.09 ±4.30 kg/m^2.

3.2. Correlation Tests of Fructosamine with Anthropometric Variables

Correlation tests of fructosamine with anthropometric variables, age, blood glucose and haemoglobin levels showed no significant association (Table 2).

3.3. Distribution of Fructosamine in Our Study Population

Table 3 presents fructosamine concentrations according to the median and the 2.5th and 97.5th percentiles.

4. Discussion

The main objective of this study was to investigate the fructosamine profile in regular blood donors at the Bobo-Dioulasso CRTS (Burkina Faso). According to the strict eligibility criteria established by the CRTS, regular blood donors give blood regularly several times a year. This makes them a presumably healthy population. Knowledge of the fructosamine profile of this population could contribute to better monitoring of glycaemic control by defining reference ranges for a subject in apparent good health. In our study, the proposed ranges indicate higher fructosamine concentrations in Burkinabe subjects compared with those established in other studies. In fact, Table 3 shows the variability of this reference range, both in the reagent manufacturers' leaflets and in the literature on various populations (American, European and Asian). Several authors have identified significant differences in fructosamine levels according to race (skin colour) [13, 14].

Fructosamine is formed by the reaction between glucose and the amino group of proteins (mainly albumin, but also globulins and lipoproteins). The high reference ranges in our study compared with other studies on American, European and Asian populations could be explained by the fact that Black African subjects have higher total protein concentra-

tions. In fact, a diffuse hypergammaglobulinemia resulting from perpetual infectious attacks (bacterial and parasitic) has been observed by several authors [9, 16, 17]. Glycation of gamma globulins in black subjects could therefore increase serum fructosamine concentrations.

In our cohort, no significant effect of sex on fructosamine concentrations was found. Several authors have also found differences that were not statistically significant according to sex [2, 13, 15]. However, the team of Pedrosa et al. found in a Brazilian population, 186-248 µmol/L of fructosamine for women and 196-269 µmol/L for men with statistically significant differences [14].

Our study shows average fructosamine concentrations increased with age, with no statistically significant difference. These concentrations were higher in the 37-55 age group. Several studies have also found that the reference ranges for fructosamine were higher in patients aged over 65 [2, 14]. Chen et al. suggested in their Beijing study that the reference ranges published by fructosamine assay kit manufacturers were not applicable to elderly Beijing residents because they were lower [2].

Our study shows a negative correlation between BMI and fructosamine concentrations with no significant difference, suggesting low fructosamine concentrations in people with a high BMI. Pedrosa et al. and Selvin et al. also found low fructosamine concentrations in people with a high BMI [13, 14]. Studies have shown that the pathophysiology of obesity appears to modify circulating blood lipoprotein concentrations [18]. Thus, dyslipidaemia in obesity could be characterised by high concentrations of triglyceride-rich lipoproteins and low levels of high-density lipoprotein cholesterol (HDL-c) [19-22]. In addition to genetic predisposition and environmental influence, lifestyle, stress and minor physical activity may also be of particular importance in establishing reference values.

This study had its limitations. The fructosamine assay was quick and easy to perform on the COBAS® 6000 automated system, but problems with reagent availability prevented us from recruiting a larger number of regular Burkina Faso blood donors. Hence the difficulty in extrapolating our results to the general population. In addition, due to a lack of reagents, serum albumin and lipid profiles were not available. Low concentrations of albumin and lipoproteins are known to affect the concentration of fructosamine [2, 15]. Furthermore, the regular blood donors chosen for this study were free of liver infection and in apparent good health. Some authors describe a minor effect of lower albumin on fructosamine in healthy individuals [13, 15, 23].

5. Conclusion

Given the difficulties in using glycated haemoglobin (sickle cell anaemia, anaemia, pregnant women, etc.), the results of our study could be of interest in monitoring glycaemic control in Burkina Faso. In fact, it provides an estimated overview of blood glucose control in the 2 weeks preceding the test. Finally, our study shows that fructosamine concentrations in black Burkinabe subjects are higher than those reported in the literature. Further studies are needed to extrapolate the results to the general population.

Abbreviations

BMI	Body Mass Index
CIRS	Comité Interne de Revue Scientifique
CLSI	Clinical and Laboratory Standards Institute
CNTS	Centre National de Transfusion Sanguine
RBTC	Regional Blood Transfusion Centre
SS-TH	Souro Sanou Teaching Hospital

Author Contributions

Arnaud Kouraogo: Conceptualisation, Data curation, Formal analysis, Fundraising, Survey, Methodology, Resources, Writing - original version

Marie Fabienne Soudre: Conceptualisation, Formal analysis, Survey, Methodology, Writing - original version

Raoul Karfo: Writing - revision and editing

Alice Kiba-Koumare: Data curation, formal analysis

Ollo Da: Visualization, formal analysis

Zida Abibata: formal analysis

Elie Kabre: Supervision, writing - revision and editing

Jean Sakande: Conceptualisation, data curation, formal analysis, fundraising, research, methodology, resources, writing - original version, supervision

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Data Availability Statement

The data are available from the corresponding author upon reasonable request.

Conflicts of Interest

The authors declare no conflicts of interest.

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