Original Research Article

One-year follow-up of the distribution of dyslipidemias among Cameroonian diabetic patients in Ngaoundere, 2014-2015

ABSTRACT

Background: Diabetes constitutes an important faction of the health and economic burden worldwide and its occurrence continues to rise especially in developing countries.
Aim: to study the distribution in dyslipidemia occurrence over a period of 1 year in a diabetic and non-diabetic population in Ngaoundere.
Methodology: This was a cross sectional case control study carried out at the Hypertension and Diabetes units of the Ngaoundere Regional and Protestant Hospitals from June 2015 to February 2016. All participants provided a written consent and were subjected to a questionnaire. Blood pressure and anthropometric parameters were measured and venous blood collected for fasting blood glucose, lipid profile, glycated hemoglobin and uric acid analysis using commercially acquired kits. Data were organized and analyzed using an Excel spreadsheet and SPSS version 20.0. respectively, with statistical significance considered at $p < 0.05$.
Results: Of the 321 participants enrolled, 191 were diabetic and 130 non-diabetic having sex ratios (F/M) of 1.3 and 1.1 respectively. Compared to the 73.3% dyslipidemia, 28.9% hypercholesterolemia, 15.6% hypertriglyceridemia and 28.9% mixed hyperlipidemia reported by the authors in the same diabetic population a year earlier, the occurrence of dyslipidemias, hypercholesterolemia, hypertriglyceridemia and mixed hyperlipidemia were 59.7%, 49.5%,7.0%, and 3.2%. Likewise, similar trends were observed with the corresponding non-diabetic control groups. 39 patients (20.4%) and 29 controls (22.3%) had knowledge on cholesterol, while 9.9% of diabetic participants had tested for blood cholesterol levels at some point.
Conclusion: We observed meaningful drops in the occurrence of hypertriglyceridemia, mixed hyperlipidemia, and a rise in hypercholesterolemia among diabetics and nondiabetics, with a low level of awareness on dyslipidemias. Much is needed in sensitizing and controlling cardiometabolic risks towards improving the management of diabetic patients in our context.

Keywords*: Diabetes, Dyslipidemia, cardiometabolic risk, Ngaoundere, Cameroon.*

1. INTRODUCTION

Once considered a rare disease in sub-Saharan Africa, diabetes is clearly expanding [1], being a common cause for consultation in Africa and around the world [2]. The International Diabetes Federation reported in 2013 that the number of adults with diabetes worldwide will increase by 55% (381.8 million in 2013 to 591.9 million in 2035) with sub-Saharan Africa recording the largest increase in the population with diabetes, projecting an expected increase of 109.6% (19.8 million in 2013 to 41.5 million in 2035) [3]. This global expansion of diabetes has become a serious public health problem and in the presence of poor

glycemic control, diabetics run a risk of several metabolic disorders, among which dyslipidemias exercise a preponderant role [1,4].

A previous survey in Northern Cameroon portrays abdominal obesity, physical inactivity, and hypertension respectively as the dominant cardiovascular disease (CVD) risk factors in the general population, with hyperglycemia being an independent determinants of high blood pressure [5]. In a prequel study including diabetic patients attending the Diabetes and Hypertension clinic of the Ngaoundere Regional Hospital, Cameroon, hypercholesterolemia, hypertriglyceridemia, and mixed hyperlipidemias were estimated at 28.9%, 15.6%, 28.9% among diabetic patients compared to 22.2%, 15.6%, 6.7% in nondiabetic controls respectively [6].

As earlier suggested, the level of awareness of lipid abnormalities is still poor in African populations [7] and since it represents a principal determinant of the practice of health promoting recommendations, we were thus motivated to carry out a follow-up study with the goal of to determine the prevalence of selected cardiometabolic risk factors and investigate the variations in the occurrence of dyslipidemias in a diabetic population we previously studied and sensitized on dyslipidemias and CVD risk prevention.

2. METHODOLOGY

2.1 Study design

We carried out a cross sectional case control study from June 2015 to February 2016 in Ngaoundere, Adamawa region of Cameroon. 191 diabetic persons were consecutively recruited at the Hypertension and Diabetes units of both the Ngaoundere Regional and Protestant Hospitals, among whom 5 participants were excluded post-laboratory analysis for triglyceride levels > 400 mg/dL, affecting LDL calculation thus. A control population was included in this study constituting of 130 healthy non-diabetic participants selected from the general population following a two-staged sampling procedure as previously described [5]. Individuals who refused to consent to this study, infected with HIV, on corticosteroid therapy, pregnant and breast feeding women were excluded from this study.

2.2 Specimen and data collection

Prior to specimen collection, participants were adequately informed on the study and were expected to sign a written consent. Each participant thereafter filled a questionnaire through which data on sociodemography, therapy, disease awareness and complications were obtained. Blood pressure measurements were subsequently recorded and 5 ml of fasting whole venous blood collected for glucose and other biochemical analysis. Blood glucose levels were determined, while the rest of the blood samples were divided equally into an EDTA tube for immediate glycated hemoglobin measurement, and a dry tube to clot. The dry tubes were subsequently centrifuged at 3000 rpm for 5 minutes, with serum separated into Eppendorf tubes and frozen at -20˚C prior to weekly analysis.

2.3 Study variables

Parameters of interest included serum lipids, glycated hemoglobin (HbA1 and HbA1c), fasting blood glucose (FBG), and blood pressure (BP).

2.3.1 Blood Pressure

Participants' blood pressures were estimated using a manual mercury sphygmomanometer (ADC Prosphyg, model 770) in accordance with the WHO STEPs recommendations [8]. Measurements were performed on both the left and right arms after a 15–20 minutes rest period with the patient assuming an upright sitting posture. High blood pressure was defined as BP values ≥ 140/90mmHg.

2.3.2 Biochemical Measurements

Blood glucose levels were measured using a glucometer (Accu-Chek, Performa) after an 8 to 12-hour overnight fast. In accordance with WHO recommended glucose threshold, hyperglycemia was defined as FBG ≥ 126 mg/dL [8]. Using EDTA whole blood samples, glycated hemoglobin (HbA1) levels were estimated following an ion exchange resin method as previously described [9], and calculation of the HbA1c fraction ensued as 80% of HbA1. Frozen serum samples were thawed prior to analysis and total cholesterol, triglyceride, and high density lipoprotein cholesterol (HDLc) performed with the aid of a semi-auto biochemistry analyser (Mindray BA-88A, BH7AB2710, China). All measurements were performed using commercially acquired kits based on previously described methods [10,11]. Total cholesterol measurement was based on the CHOD-PAP method, with normal ranges defined as < 200 mg/dL. Serum triglycerides were determined based on the TGO-PAP method with reference values stated as males: 40-160 mg/dL and females: 35-135 mg/dL. HDL concentration was estimated following a two-step method consisting firstly of separation and precipitation of low density lipoprotein cholesterol (LDLc) and very low density lipoprotein (VLDL) lipoprotein fractions facilitated by a divalent cation-dependent polysaccharide sulphate and next by cholesterol estimation in the HDLc containing supernatant. Reference values were considered as; males > 55 mg/dL and females > 65 mg/dL. LDLc levels were estimated with the aid of the Friedwald's formula as follows: LDLc (mg/dL) = TC - TG/5 – HDLc, for all corresponding triglyceride levels < 400 mg/dL [12], where TC = total cholesterol and TG = triglycerides. Values less than 130 mg/dL were considered normal. We also estimated participants' Cholesterol ratio using the formula TC/HDLc, with normal values considered as < 4.85 [13].

2.3.3 Estimation of Cardiovascular (CV) Risk

Ten year CV risk estimates were determined using the Framingham SCORE model for all participants older than 20 years old, which takes into consideration 5 principal factors including age, gender, smoking (at least 10 cigarettes daily), total cholesterol level and systolic BP. These calculations were carried out on the www.cardiorisk.fr website and risk levels were explored accordingly Low < 5%, Moderate 5-10%, Intermediate 10-20%, high risk > 20-40% and Very high > 40% [14].

2.3.4 Classification of Dyslipidemia

We adopted the GENNES and Fredrickson classification of dyslipidemias [15] as follows

Hypercholesterolemia, Type IIa: LDL> 160mg/dL and TG <200mg/dL

Hypertriglyceridemia, Type V, IV, I: LDL< 160mg/dL and TG >200mg/dL

Mixed hyperlipidemias, Type III, IIb LDL> 160 mg/dL and TG>200mg/dL

2.4 Quality assurance

Recommended glass and plastic ware were used throughout the study with sample collection, transport, storage and analysis performed in accordance with standard procedures. Method calibration was performed using the Calimat calibrator (reference: 62321, lot number: 1003001280 Biomérieux, France) and analytical quality was ensured using the LyotrolTM N/P quality control serum (reference: 62373, lot number: 1003001280 Biomérieux, France) in conformity with Levey-Jennings and Westgard's rules. An electronic blood pressure meter (Omron HEM712C, 6416799LF, China) and a second semi-automated spectrophotometer (SECOMAM Basic/70V B0358, SN: 1790) were used to verify the reproducibility BP and biochemical measurements at random intervals.

2.5 Ethical consideration

This study was approved by the Ngaoundere Regional Hospital ethical committee (Ref: 2015/113/UN/DFS/CD_SBM). Interested persons were given adequate information about the study in a language of best comprehension prior to obtaining a written consent and subsequent enrollment. Participation was voluntary and confidentiality was maintained and those with abnormal results were referred to a Cardiologist.

2.6 Data management and analysis

Statistical analyses were performed using the statistical package for social sciences (SPSS for Windows, version 20.0, SPSS Corporation Inc. Chicago IL USA) and results compared with those obtained using R version 3.0.2 software. With statistical significances considered at $p < 0.05$, ANOVA or Mann-Whitney U/Wilcoxon W tests were used to compare means, while chi-square or Fisher's exact tests were used to compare proportions.

3. RESULTS

3.1 General Characteristics of the Study Population

A total of 321 participants were enrolled in the study, one hundred ninety one were diabetic (study group) and one hundred and thirty non-diabetic (control group). Both the diabetic and non-diabetic participants portrayed equivalent sex ratios (F/M) of 1.3 and 1.1 respectively. The average age of diabetics was 55.30 ± 12.38 years (men: 57.05 ± 13.05 years, women: 53.96 ±11.7 years). The majority (69.12%) of the study group participants were over 50 years of age, whereas 82.31% of the control group were 50 years and below. Worth noting was the predominance of housewives and married persons in both groups, Muslims among diabetic patients and Christians in the control group. 20.94% of the diabetic population possessed at least a secondary level of education compared to 52.31% of non-diabetics. Sociodemographic characteristics of the study participants are presented table 1.

Table 1: Sociodemographic characteristics of the study population

Variables		Patients		Controls	
		n	%	n	%
Age (years)					
	< 30	6	3.14	46	35.38
	30 – 50	53	27.75	61	46.92
	> 50	132	69.12	23	17.69
Level of Education					
	Uneducated	20	10.47	30	23.08
	Koranic School	76	39.79	2	1.54
	Primary	55	28.80	30	23.08
	Secondary	31	16.23	46	35.38
	University	9	4.71	22	16.92
Marital Status					
	Single	27	14.14	18	13.85
	Married	128	67.02	89	68.46
	Divorced	7	3.66	4	3.08
	Widows/Widowers	29	15.18	20	15.38
Religion					
	Christians	56	29.32	117	90.00
	Muslims	135	70.68	13	10.00
Profession					
	Formal sector	28	14.66	28	21.54
	Trader	22	11.52	14	10.77
	Housewives	72	37.70	49	37.69
	Informal sector	47	24.61	25	19.23
	Retired	18	9.42	2	1.54
	Student	4	2.10	12	9.23

Comparing the means of selected clinical and biochemical parameters, only TG and HDLc did not demonstrate statistical differences between diabetic and non-diabetic participants contrary to other studied variables which recorded significantly higher values in diabetic persons (table 2). Value for TG portrayed a high degree of variation, owing to four diabetic participants recording triglyceride levels of more than 1000mg/dL, and one above 4000mg/dL.

Table 2: Comparison of means of variables between diabetic patients and controls

Variables	Patients (Mean ± SD)	Control (Mean ± SD)	*P value*
Age (years)	55.30 ± 12.38	37.09 ± 13.63	**< .001**
Glucose (mg/dL)	175.93 ± 93.87	86.99 ± 11.72	**< .001**
Total cholesterol (mg/dL)	239.21 ± 73.65	212.03 ± 56.08	**< .001**
Triglyceride (mg/dL)	192.69 ± 743.21	92.23 ± 39.45	.125
HDLc (mg/dL)	43.26 ± 15.87	46.43 ± 11.64	.053
LDLc (mg/dL)	168.28 ± 68.89	145.24 ± 53.75	**.002**
Cholesterol Ratio	5.99 ± 2.51	4.80 ± 1.60	**< .001**
HbA1 (%)	13.13 ± 4.26	7.68 ± 1.32	**< .001**
HbA1c (%)	10.51 ± 3.41	6.14 ± 3.06	**< .001**
SBP (mmHg)	142.01 ± 27.14	133.16 ± 20.55	**.002**
DBP(mmHg)	91.96 ± 15.80	87.49 ± 11.96	**.007**
Cardiovascular risk	21.60 ± 9.74	6.18 ± 7.00	**< .001**

3.2 Distribution of Dyslipidemias and Cardiovascular Risk in the Study Population

The prevalence of dyslipidemias was 59.7% and 36.2% among patients and controls respectively, with hypercholesterolemia, hypertriglyceridemia and mixed hyperlipidemia observed at 49.5%, 7.0%, 3.2% in patients and 33.1%, 2.3%, 0.8% in controls respectively. The difference in the distribution of dyslipidemias between diabetic and non-diabetic participants was not statistically significant (table 3).

Significant differences in the distribution of CV risk were observed between diabetic and non-diabetic participants, with high CV risk being more prevalent among former compared to the latter population (62.7% versus 5.4%) (table 3).

Table 3: Distribution of dyslipidemias and cardiovascular risk between patients and controls.

Variables		**Patients n (%)**	**Controls n (%)**	***P value***
Dyslipidemias	Yes	111 (59.7)	47 (36.2)	.054
	No	75 (40.3)	83 (63.8)	
	Total	**186 (100)**	**130 (100)**	
Type of Dyslipidemias	Hypercholesterolemia	92 (82.9)	43 (91.5)	.231
	Hypertriglyceridemia	13 (11.7)	3 (6.4)	
	Mixed hyperlipidemia	6 (5.4)	1 (2.1)	
	Total	**111 (100)**	**47 (100)**	
Cardiovascular Risk	Low	11 (5.9)	86 (66.2)	**< .001**
	Moderate	27 (14.6)	24 (18.5)	
	Intermediate	31 (16.8)	13 (10.0)	
	High	116 (62.7)	7 (5.4)	
	Total	**186 (100)**	**130 (100)**	

Antidiabetic pharmacotherapy represents a primary component in management of full-blown diabetes. In this study, it was discovered that 15.2% diabetic patients were not on any form drug therapy. Persons who were strictly on conventional pharmacotherapy or traditional therapy constituted 39.8% and 11% of our patients respectively, while 33% were simultaneously on both. In addition, the occurrence of dyslipidemias was highest among diabetics without therapy (72.4%) and those strictly on traditional regimen (76.2%) (table 4). Several treatment categories were poorly represented in our sample population, making their results non-representative for dyslipidemia distribution.

Table 4: Distribution of diabetic persons following treatment protocol and dyslipidemia

Treatment protocol	Proportion of patients n (%)	Hyperchole-sterolemia n (%)	Hypertrigly-ceridemia n (%)	Mixed Dyslipidemia n (%)	Total Dyslipidemias n (%)
None	29 (15.2)	18 (62.1)	1 (3.4)	2 (6.9)	21 (72.4)
Monotherapy	42 (22.0)	15 (35.7)	3 (7.1)	1 (2.4)	19 (45.2)
Bitherapy	29 (15.2)	14 (48.3)	3 (10.3)	-	17 (58.6)
Tritherapy	1 (0.5)	-	-	-	-
Insulin	3 (1.6)	-	1 (33.3)	-	-
Monotherapy + Traditional	33 (17.3)	14 (42.4)	-	2 (6.1)	16 (48.4)
Bitherapy + Traditional	28 (14.7)	16 (57.1)	-	1 (3.6)	17 (60.8)
Insulin + Traditional	2 (1.0)	1 (50.0)	1 (50.0)	-	-
Oral + Insulin	1 (0.5)	-	-	-	-
Oral + Insulin + Traditional	2 (1.0)	1 (50.0)	1 (50.0)	-	-
Traditional only	21 (11.0)	13 (61.9)	3 (14.3)	-	16 (76.2)

3.3 Knowledge of Dyslipidemias and Other Diabetes Complications

We performed a simple assessment of the level of awareness of both diabetic and non-diabetic participants on “cholesterol”, and it was observed to be equivalently low in both sub-populations (20.4% and 22.3% respectively). However, a small proportion of diabetic persons (9.9%) had previously performed a cholesterol test compared to the controls (Table 5).

Furthermore, we recorded current diagnosis of some CVDs and other diabetes complications among patients where after, hypertension (66.5%) was observed to be the most frequent, followed by retinopathy (39.8%) (table 5).

Table 5: Knowledge on cholesterol and complications of diabetes among participants

Variables	Patients		Controls	
	Yes n (%)	No n (%)	Yes n (%)	No n (%)
Knowledge on Dyslipidemias				
Have you ever heard about cholesterol?	39 (20.4)	152 (79.6)	29(22.3)	101 (77.7)
Have you ever done a cholesterol test?	19 (9.9)	172 (90.1)	-	130 (100)
Knowledge on Diabetes Complications				
Hypertension	127 (66.5)	64 (33.5)	-	130 (100)
Retinopathy	76 (39.8)	115 (60.2)	6(4.6)	124 (95.4)
Cardiac insufficiency	8 (4.2)	183 (95.8)	-	130 (100)
Diabetic ulcer	7 (3.7)	184 (96.3)	-	130 (100)
Polyneuropathy	29 (15.2)	162 (84.8)	-	130 (100)
Obstructive Arteriopathy of lower limbs	18 (9.4)	173 (90.6)	-	130 (100)
Coronaropathy	40 (20.9)	151 (53.7)	-	130 (100)

4. DISCUSSION

Diabetes continues to pose a metabolic burden in afflicted persons, multiplying thus the risk of dyslipidemias and cardiovascular events, especially in developing countries where specialized care is rarely available or non-extensive. Dyslipidemias are the most significant modifiable CVD risk factors and are one of the leading causes of morbidity and mortality in most developed and developing countries [16-18]. Obesity, glucose intolerance, diabetes and metabolic syndrome are often commonly associated with atherogenic dyslipidemia,

implying an increase in long-term risk of developing CVD [19]. Metabolic anomalies frequently occur among diabetics, especially in those with a type 2 diabetes. Such anomalies are usually characterized principally with raised levels of total blood cholesterol (and/or LDLc), triglycerides, and reduced HDLc concentration [3].

Following a previous survey which we carried out in 2014 [6], this study aimed at assessing the trends in the occurrence of dyslipidemias over a 1-year period. Compared to the 73.3% dyslipidemia, 15.6% hypertriglyceridemia and 28.9% mixed hyperlipidemia reported by the authors in the previous study [6], the current study recorded relatively lower occurrences of 59.7%, 7.0%, and 3.2% respectively. Conversely, hypercholesterolemia increased from 28.9% to 49.5% in the same study. Likewise, the prevalence of dyslipidemia, hypercholesterolemia, hypertriglyceridemia and mixed hyperlipidemia observed variations from 44.4%, 22.2%, 15.6%, 6.7% to 36.2%, 33.1%, 2.3%, 0.8% respectively in the corresponding nondiabetic control participants. Excluding the effect an increased sample size in this follow-up study, the recorded changes probably reflect significant reductions in triglyceride-rich lipoproteins levels. These changes could possibly be attributed to an increased adherence to recommended lifestyle modifications including but not exclusive to frequent regular physical exercise, dietary adjustments, and reduced alcohol and tobacco consumption, which are known to lower plasma lipoprotein levels [20,21]. Considerable decreases in prevalence were principally confined to hypertriglyceridemia and mixed hyperlipidemia, while the occurrence of hypercholesterolemia increased: these probably reflect significant reductions in triglyceride-rich lipoproteins levels.

We used Fredrickson's classification of dyslipidemias in the current study, but this was not the case in the previous one. Despite an increase in cut-off levels for classification of dyslipidemias in the current study compared to the previous, the frequency of hypercholesterolemia significantly increased, most likely due in parts to the availability of cholesterol-rich dairy foods characterizing this geographical region. Moreover, exogenous influences on diet and metabolic capacity such as the transient effects of Ramadan fasting characteristic of our study area where the Muslim religion is widely practiced, may explain the observed changes in lipid profile [21-23]. In the current study, just like the previous, hypercholesterolemia was the commonest type of dyslipidemia followed by hypertriglyceridemia, concurring with the findings of other authors [17,24,25].

The existence of a considerable number of diabetic participants without any form of antidiabetic therapy (15.2%) or on under-researched indigenous therapies (traditional medicine) (45%) could inadvertently and/or nonspecifically affect lipid metabolism.

Knowledge and practice are independent determinants of disease risk, control and complications. Our simple assessment of the “knowledge of cholesterol” and “testing cholesterol levels” recorded 20.4% and 9.9% among diabetic persons compared to 22.3% and 0% among nondiabetic controls respectively for a “yes” response. This is indicative of an overall low level of awareness in both the high risk and general populations. In a Canadian study, 57% of diabetic individuals had no knowledge on dyslipidemias [25]. Likewise, in Burkina-Faso, only 27.4% of diabetics knew that age, physical inactivity, hypertension, dyslipidemia and obesity could be associated with diabetes and CV risk [26]. Generally, with diabetic persons being more likely to develop CVDs compared to the general population, they are expected to be more informed as they obtain information from trained clinical practitioners, while the general population are predominantly informed by means of the media [27]. Our results could be due in parts to suboptimal sensitization and/or inappropriately adapted methods, as well as the level of education observing that more than three quarters of the diabetic participants possessed a maximum of primary education.

Total cholesterol levels and blood pressure represent 2 vital intersecting factors in the determination of CV risk. Hence, our findings on the increasing trends of hypercholesterolemia justify to at least 50% the exaggerated increase in CV risk > 5% observed over a period of one year: that is, from 25.2% to 94.1% in diabetic patients and 18.2% to 33.8% in nondiabetic controls.

5. CONCLUSION

This study demonstrated meaningful decreasing trends in hypertriglyceridemia, mixed hyperlipidemia, and increases in hypercholesterolemia over a one-year period, with a low level of awareness on dyslipidemias in both the diabetic and non-diabetic populations. Much is needed in sensitizing both high risk groups, medical personnel, care givers, and the general population at large on current methods in diabetes management and prevention of diabetes complications, while appropriately adapting these methods to specific populations.

STUDY LIMITATIONS

This study was aimed primarily at examining the trends in the prevalence of dyslipidemias, as such we constituted another sample of the same population of diabetic patients studied a year earlier without particular interest on sample population overlaps. Since the sample population contained persons who were not enrolled in the previous survey (trend), the observed variations were approximatively compared to if the same participants (cohort) were studied a second time.

FURTHER RESEARCH AND PERSPECTIVES

The rising economic and public health burden of diabetes in sub-Saharan Africa is a call for prompt efforts in reinforcing and adapting management strategies to the specific sociocultural and economic activities of different population settlements. More work is envisaged in determining the periodic clinical and biochemical variations in high CVD risk cohorts towards evaluating the performance of and adherence to recommended therapy.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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