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Diabetes & its Complications

Determinants of High Blood Pressure in Subjects Living with Type 2 Diabetes in Urban Areas in Togo

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ABSTRACT

Introduction: *Type 2 diabetes (T2D) and high blood pressure (HBP) are a frequent duo with potentiation of micro and macrovascular complications.*

Objective: *To evaluate the frequency of HBP and its determinants in a type 2 diabetic population living in urban areas in Togo.*

Method*: This was a descriptive and analytical prospective study on type 2 diabetic patients received in consultation at the Medical and Surgical Clinic of Sylvanus Olympio University Hospital Center of Lomé, for a period of six months.*

Results*: A total of 103 patients were enrolled in our study. The incidence of HBP was 33%. Among the risk factors associated with HBP in patients, we noted: age ≥ 40 years (OR = 4.8; CI: 1.3-17.6; p<0.017), abdominal obesity (OR = 5.35; CI: 2.2-13.0; p<0.001), overweight (OR = 27; CI 8.2-88.7; p<0.001), the existence of dyslipidemia (OR = 9.0; CI: 3.1 - 26.1; p<0.001), HbA1C ≥ 7% (OR = 10.3; CI: 3.2-32.6; p<0.001), a duration of diabetes progression greater than or equal to 5 years (OR = 10.3; CI: 3.1-33.9; p<0.001). Physical exercise (OR = 0.15; CI: 0.05 -0.39; p<0.001), and previous therapeutic education (OR = 0.30; CI: 0.12-0.78; p = 0.014) appeared to have a protective effect against the risk of developing hypertension.*

Conclusion: *Screening for risk factors associated with hypertension in the diabetic subject for their care, but also primary prevention emphasizing therapeutic education and regular physical exercise are essential to counter the harmful effects of hypertension in type 2 diabetic subjects in Togo.*

Keywords

Hypertension, Metabolic syndrome, Dyslipidemia, Diabetes, Togo.

Introduction

In 2015, the World Health Organization (WHO) estimated that 1.13 billion people worldwide were affected by high blood pressure (hypertension) [1]. As far as diabetes is concerned, in 2019, the world will have at least 463 million people suffering from type 2 diabetes (T2D) [2]. Adding to the enormous direct and indirect health costs associated to these two conditions, hypertension and T2D are two major public health problems.

Not only are hypertension and T2D independent cardiovascular risk factors, but both conditions expose patients to micro and macro angiopathic complications with a heavy impact on their quality of life [3]. Indeed, hypertension is one of the major causes of sudden death, while 87% of deaths attributable to diabetes occur in low- and middle-income countries [1,2]. In fact, the risk of death in hypertensive diabetics is six times higher than in non-hypertensive diabetics [4]. Of the cardiovascular complications of diabetes attributable to hypertension, 75% are related to stroke, 35% to coronary artery disease, 50% to end-stage nephropathies, 35% to retinopathies and 35% to limb amputations [5,6].

Africa has undergone a major transition in recent decades with respect to hypertension and T2D, where these two conditions involve significant morbidity and mortality [7,8]. There is growing evidence that the prevalence of hypertension is increasing in sub-Saharan Africa, which now has the highest prevalence of hypertensive individuals [9]. Ethiopathogenic predispositions such as lower renin activity, high sodium retention coefficient, and probable higher prevalence of hyperaldosteronism would be some of the explanations for the susceptibility of the sub-Saharan African to develop hypertension and severe vascular complications [8, 10–14]. With the forecasts of the International Diabetes Federation projecting that by 2045, the prevalence of diabetes in sub-Saharan Africa will increase by 143% [2], a concomitant increase in the prevalence of hypertension is also expected if primary prevention measures are not put in place.

The Togolese population is estimated at around seven million inhabitants. The prevalence of HTA in the general Togolese population varies between 25 and 36.7% [15–17]. For diabetes, it is estimated at 2.6% [18]. Very few data concerning the determinants of hypertension in T2D subject exist in Togo. The objective of this work was therefore to evaluate the frequency of hypertension in T2D subjects and then to study the independent risk factors associated with it. On the one hand, the data thus obtained will provide practitioners with guidelines enabling them to act in primary prevention of hypertension but also in the care of patients. On the other hand, the conclusions of our study could be useful to public decision-makers, in the development of plans and strategies in the management of hypertension in T2D with the aim of reducing the economic burden that these two diseases represent in low-income countries like Togo.

Patients and Methods

Framework and type of study

It was a prospective, descriptive and transversal study which took place from July 1, 2019 to December 30, 2019 (06 months) at the Medical and Surgical Clinic (MSC) of the Sylvanus Olympio University Hospital Center, national reference center of the Togolese health system.

Study population

Included in our study were T2D patients of recent discovery or not living in urban areas, mainly in Lomé, regardless the sex:

- with a clear conscience, received in consultation either for the care of newly diagnosed diabetes or in the context of the follow-up of already known diabetes
- at least 30 years of age
- with glycated hemoglobin assay and serum lipid fractions measurements not older than three months at the time of consultation.

We excluded from our study any patient who did not meet the inclusion criteria, any patient with any other associated endocrinopathy that could be the cause of secondary hypertension (hyperthyroidism, adrenal gland disease, hyper secretory nodule of the hypothalamic-pituitary axis) as well as any patient who expressed a refusal to participate in the study.

Sampling

To calculate the minimum sample with good representativeness, we used the following expression [19]:

$$\mathbf{n = (z)^2\ p\ (1 - p) / d^2}$$

n = sample size
z = confidence level according to the reduced centered normal law (for a confidence level of 95%, z = 1.96)
p = estimated proportion of the population with the characteristic (prevalence of diabetes)
d = tolerated margin of error (5%)

As the prevalence of diabetes in Togo is estimated at 2.6% according to the available figure, the integration of this prevalence in the formula gave us the minimum required for a fairly good representativeness of the sample of 39 patients.

Nevertheless, we targeted a minimum of one hundred patients for our study and surveyed a total of 103 patients. During the consultation sessions during the study period, out of all the patients present for the consultation, one patient in 2 was recruited.

Study variables

Socio-demographic characteristics and history of diabetes

These variables included gender, age, level of education, marital status, socio-professional class, length of time with diabetes, current anti-diabetic treatment, a notion of therapeutic and nutritional education related to diabetes, physical exercise (defined as regular physical exercise, walking, jogging, cycling for at least thirty minutes and at least three times a week), alcohol and tobacco addiction . Patients with a history of alcohol and tobacco use were grouped with those who were still using them versus those who were not addicted at all.

Anthropometric and laboratory data

These parameters were weight, height, body mass index (BMI), systolic blood pressure (SBP), diastolic blood pressure (DBP), waist circumference, while laboratory data included assays of glycosylated hemoglobin (HbA1c), total cholesterol (TC), LDL-cholesterol (LDLc), HDL-cholesterol (HDLc), triglycerides (TG) and the TC / HDLc ratio corresponding to the atherogenicity index.

The LDLc was calculated from the Friedwald formula according to the formula: LDLc = TC- (HDL-C + TG / 5) when the triglyceride rate was less than 4g / l.

Collection of data

A standardized data collection form was designed and used as the basis for data collection. The form was pre-tested on a dozen patients to ensure its applicability before proceeding on to the actual collection. Patients were informed in advance of the data collection process.

Data sources

Socio-demographic data and diabetes history were collected through interview and the patient's care record.

Waist circumference was measured with a tape measure surrounding the waist by the midpoint between the lower edge of the rib and the iliac crest in a plane perpendicular to the major axis of the body.

The height was determined without shoes using a height rod. The weight was measured using a scale. The body mass index (BMI) was calculated based on the ratio of weight to height squared. A BMI greater than 25kg / m^2 defined overweight.

Blood pressure was measured on both arms of the patient after 10 min rest on two occasions (at the beginning and at the end of the consultation). The average of the four measurements obtained was taken into account in the data analysis. Was considered as a subject with blood pressure, any patient with known history of high blood pressure under antihypertensive medication, but also with reference to the International Society of Hypertension Global Hypertension Practice Guidelines, any patient whose average blood pressure measured was greater than or equal to 140 mmHg for the systolic and / or 90 mmHg for the diastolic [20]. Patients were classified as HTA Grade 1 if the systolic blood pressure (SBP) was between 140mmHg and 159 mmHg and / or the diastolic blood pressure (DBP) was between 90 mmHg and 99 mmHg. Those with SBP≥160 mmHg and / or DBP ≥ 100 mmHg were classified as HTA grade 2 [20].

The high waist circumference corresponding to abdominal obesity has been defined according to the criteria of the International Diabetes Federation (waist circumference greater than or equal to 94 cm in men and 80 cm in women) [21].

For patients who had their blood tests, we take the opportunity to collect information on the results.

The presence of the lipid test abnormality was qualified as dyslipidemia according to the criteria of the National Cholesterol Education Program, Adult Treatment Panel III which are: total hypercholesterolemia (HCT) if CT ≥ 2 g / L, hypertriglyceridemia (HTG) if TG ≥ 1.5 g / L, HDL hypocholesterolemia (HCH) if HDLc < 0.5 g / L in women and < 0.4 g / L in men, LDL hypercholesterolemia (HCL) if LDLc ≥ 1.3 g / L.

The atherogenicity index was evaluated on the basis of the CT / HDLc ratio, which is a revealing index of the risk of atherosclerosis and especially coronary artery disease. Indeed, if the CT / HDLc ratio was> 5 the atherogenic risk is statistically significant. The patient's diabetes was considered to be controlled for an HbA1C < 7% and uncontrolled for an HbA1C ≥ 7%.

Statistical data analysis

Epidata version 3.1 software was used to design an input mask in which the collected data was entered. The analysis was then carried out using the IBM SPSS Statistics 20 statistical software. The proportions of the qualitative variables were compared using either the χ^2 test or Fisher's exact test. Quantitative variables were compared using the Student's t test or the Mann-Whitney U test depending on whether they followed a normal distribution or not. The uni-varied and multivariate binary logistic regression technique was used to evaluate the factors associated with hypertension; the results of the logistic regression model are presented as Odds Ratios with a 95% confidence interval. A p-value < 5% was considered statistically significant.

Ethical consideration

We obtained the favorable opinion of the Director of the MSC to conduct our study. Each patient who took part in the survey gave informed consent after being informed of the purpose of the study. The anonymity of each patient was scrupulously respected as well as the confidentiality of their data.

Results

General characteristics of the study population

A total of 103 patients' data were collected during the study period. Table 1 presents the general characteristics of the study population. The average age of participants was 49.6 (SD ± 9.3) years with a minimum of 30 years and a maximum of 72 years. The age group of patients aged 40 years and over was the most represented with a proportion of 75.7%. The male sex was the most represented in 52.4% of the cases. The sex ratio M / F was 1.1. The participants were mainly traders in 32% of the cases and people with no permanent skilled job in 29.1%. More than three-quarters of the patients (78.6%) were married.

More than half of our study sample, 58.6% had not completed primary school. The median duration since diagnosis of diabetes was 29 months (IQR: 6-60) while just over three-quarters of patients (76.7%) had been living with diabetes for less than 5 years. Forty-two point seven percent of the subjects reported having a family member with diabetes. More than two-thirds of the patients (67%) were on oral antidiabetic drugs, 54.5% of whom were on dual therapy. Eight point seven percent combined insulin therapy with oral anti-diabetic therapy. Smoking was found in 12.6% of cases while patients with a notion of alcohol consumption accounted for 34%. Thirty-seven point nine percent of the patients stated they had received therapeutic and dietary education on diabetes and 55.3% stated that they did not practice physical exercises regularly.

Characteristics	Values
Age in Years, Mean (±SD)	49,6 (±9.3)
Age groups in Years n (%)	
< 40	25 (24.3)
≥40	78 (75.7)
Gender, n (%)	
Male	54 (52.4)
Female	49 (47.6)
Occupation, n (%)	
Traders	33 (32)
Without fixe employment	30 (29.1)
State officials	18 (17.5)
Employees in the private sector	16 (15.5)
Retirees	6 (5.9)
Marital status, n (%)	
Maried	81 (78.6)
Widowed	12 (11.7)
Divorced	8 (7.8)
Single	2 (1.9)
Education level, n (%)	
None	22 (21.4)
Primary	28 (27.2)
Secondary	29 (28.2)
Higher study	24 (23.2)
Current Smoker, n (%)	13 (12.6)
Alcohol addiction, n (%)	35 (34.0)
Family of Diabetes, n (%)	44 (42.7)
History of HBP, n (%)	23 (22.3)
Duration since Diabetes Diagnostic, Months, (IQR)	29 (6-60)
Duration since diagnostic of Diabetes in Years, n (%)	
<1	43 (41.7)
1-5	36 (35.0)
≥ 5	24 (23.3)
Type of Medication for Diabete, n (%)	
Oral anti-diabetic	69 (67.0)
None	15 (14.6)
Insuline	10 (9.7)
Both	9 (8.7)
Current Number of medications using for diabetes, n (%)	
1	39 (44.3)
2	48 (54.5)
3	1 (1.2)
Not Practice of exercises, n (%)	57(55.3)
Get therapeutique and dietetic education, n (%)	39 (37.9)

Table 1: General characteristics of the study population.

Characteristics of patients according to their hypertension profile.

Our study enabled us to demonstrate hypertension in 34 patients, i.e. a frequency of 33%. Fifteen point five percent (16 patients) were classified as HTA grade 1 while 17.5% (18 patients) were classified as grade 2. Table 2 presents the variables associated with hypertension according to patient profile. Diabetic subjects with hypertension had significantly higher age, waist circumference, BMI, glycosylated hemoglobin, CT and LDLc levels than non-hypertensive diabetic subjects. All dyslipidemias except HTG were significantly associated with patients who had hypertension associated with their diabetes with a higher frequency of HCT (56.4% vs 43.6%; p<0.001), HCH (65.5% vs 34.5%; p<0.001), and HCL (53.1% vs 46.9%; p<0.005). In addition, patients with a high risk of atherosclerosis corresponding to a CT / HDLc ratio> 5 were significantly higher among diabetic and hypertensive patients. Concerning diabetic disease's indicators, our analysis allowed us to objectify that subjects with a DT2 / HTA co-morbidity had a diabetes that had been evolving for a longer period of time but also had an uncontrolled diabetes. Indeed, 62.5% of patients whose diabetes had been progressing for more than 5 years were hypertensive (p<0.001) as well as 50.8% of subjects with uncontrolled diabetes (p<0.001). In terms of therapeutic and dietary education, patients who reported having already benefited from education had a significantly lower frequency of hypertension (17.9% vs 82.1%; p<0.011). Regular physical exercise was statistically associated with the frequency of hypertension in subjects who when they stated they did not exercise regularly, presented more hypertension (50.9% vs 49.1%; p <0.001). The smoking and alcohol profile of the patients did not show a significant association with the existence of hypertension in our study. Finally, the level of education seemed to be associated with hypertension (p = 0.048).

Factors associated with hypertension in multivariate analysis

The results of the multiple logistic regression analysis are presented in Table 3. The following cardiovascular risk factors were associated with a high risk of developing hypertension in T2D subjects: age ≥ 40 years (OR = 4.8; CI: 1.3-17.6; p<0.017), abdominal obesity (OR = 5.35; CI: 2.2-13.0; p<0.001), overweight (OR = 27; CI 8.2-88.7; p<0.001), HCH (OR = 7.5; CI: 2.9-19.4; p<0.001), HCT (OR = 5.6; CI: 2.3-13.6; p<0.001), HCL (OR = 3.6; CI: 1.5-8.7; p<0.005), the existence of dyslipidemia (OR = 9.0; IC: 3.1 - 26.1; p<0.001). In addition, the atherogenicity ratio, CT / HDLc> 5 (OR = 5.6; CI: 2.3-13.8; p<0.001) was associated with a risk of hypertension occurrence. Data on the history of diabetes, namely uncontrolled diabetes with HbA1C ≥ 7% (OR = 10.3; CI: 3.2-32.6; p<0.001), duration of diabetes progression between 1 and 5 years (OR = 3.5; CI: 1.2-10.5; p = 0.026), ≥ 5 years (OR = 10.3; CI: 3.1-33.9; p<0.001) were associated with a risk of hypertension occurrence.

Physical exercise (OR = 0.15; CI: 0.05 -0.39; p<0.001), and previous therapeutic education (OR = 0.30; CI: 0.1-0.8; p = 0.014) appeared to have a protective role against hypertension. Finally, having a higher education (OR = 5.3; CI: 1.3-20.3; p<0.015) was significantly associated with a risk of hypertension.

Discussion

The objective of our study was to evaluate the frequency of hypertension in T2D subjects living in urban areas in Togo who had already been followed or recently diagnosed but also to determine the factors contributing to the occurrence of hypertension in this population group. To our knowledge, our study is the first to study the subject in Togo.

	Overall	HBP (+)	HBP (-)	*p*-value
N, %	103 (100)	34 (33)	69 (67)	
Age (Years), mean ± SD	49.6 (±9.3)	52.9 (±8.8)	48.0 (±9.2)	**0.012**
Age groups in Years n (%)				
< 40	25 (24.3)	3 (12)	22 (88.0)	**0.010**
≥40	78 (75.7)	31 (39.7)	47 (60.3)	
Gender				
Male	54 (52.4)	19 (35.2)	35 (64.8)	0.622
Female	49 (47.6)	15 (30.6)	34 (69.4)	
Current Smoker, n (%)	13 (12.6)	3 (23.1)	10 (76.9)	0,415
Alcohol addiction, n (%)	35 (34)	11(31.4)	24 (68.6)	0.807
Waist circumference [cm (IQR)]	87 (81-97)	96.5 (86-104)	86 (79-92)	**<0.001**
Abdominal obesity, n (%)	37 (35.9)	21 (56.8)	16 (43.2)	**<0.001**
SBP [mmHg (IQR)]	131 (121-148.5)	150 (145-160)	125 (120-131)	**<0.001**
DBP [mmHg (IQR)]	80 (78-90)	92 (90-100)	80 (71-80)	**<0.001**
BMI (Kg/m^2), mean ± SD	26.4 (23.2-29.2)	29.0 (27.0-31.9)	24.0 (22.3-27.7)	**<0.001**
BMI≥25Kg/m^2, n (%)	45 (43.7)	30 (66.7)	15 (33.3)	**<0.001**
Glycemia [g/l (IQR)]	1.9 (1.4-2.4)	1.9 (1.4-2.5)	1.8 (1.4-2.5)	0.806
HbA1C, [% (IQR)]	7.5 (6.0-9.1)	8.7 (7.4-10.9)	6.7 (6-8.4)	**<0.005**
HbA1C ≥7%, n (%)	59 (57.3)	30 (50.8)	28 (49.1)	**<0.001**
CT (mg/dl), mean ± SD	1.9 (±0.57)	2.3 (±0.5)	1.8 (±0.5)	**<0.001**
HDLc [g/l (IQR)]	0.5 (0.4-0.6)	0.5 (0.4-0.5)	0.5 (0.4-0.6)	0.112
LDLc (g/l), mean ± SD	1.0 (±0.5)	1.2 (±0.4)	1.0 (±0.5)	**0.035**
TG [g/l (IQR)]	1.0(0.8-1.4)	0.9 (0.8-1.2)	1.1 (0.8-1.5)	0.592
CT/HDLc ratio, Median (IQR)]	3.7 (2.7-5.3)	5.1 (4.0-5.8)	3.0 (2.3-4.4)	**<0.001**
CT/HDLc ratio > 5, n (%)	34 (33)	20 (58.8)	14 (41.2)	**0.029**
HCT, n (%)	39 (37.9)	22 (56.4)	17 (43.6)	**<0.001**
HCH, n (%)	29 (28.2)	19 (65.5)	10 (34.5)	**<0.001**
HCL, n (%)	32 (31.1)	17 (53.1)	15 (46.9)	**<0.005**
Dyslipidemia, n (%)	56 (54.4)	29 (51.8)	27 (48.2)	**<0.001**
Not Practice of exercises, n (%)	57 (55.3)	29 (50.9)	28 (49.1)	**<0.001**
Get therapeutique education, n (%)	39 (37.9)	7 (17.9)	32 (82.1%)	**<0.005**
Duration since diagnostic of Diabete in Years, n (%)				
< 1	43 (41.7)	6 (14)	37 (86)	**<0.001**
1-5	36 (35.0)	13 (36.1)	23 (63.9)	
≥ 5	24 (23.3)	15 (62.5)	9 (37.5)	
Education level, n (%)				
None	22 (21.4)	4 (18.2)	18 (81.8)	**0.048**
Primary	28 (27.2)	7 (25.0)	21 (75.0)	
Secondary	29 (28.2)	10 (34.5)	19 (65.5)	
Higher study	24 (23.2)	13 (54.2)	11 (45.8)	

BMI: Body Mass Index; CT: Total Cholesterol; DBP: Diastolic Blood Pressure; HbA1C: Glycated Haemoglobina; HBP: High Blood Pressure; HCT: Total hypercholesterolemia; HCH: HDL-hypocholesterolemia; HCL: LDL-hypecholesterolemia; HTG: Hypertriglyceridemia; HDLc: HDL-cholesterolemia; IQR: Interquartile Range; LDLc: LDL-Cholesterolemia; SBP: Systolic Blood Pressure; SD: Standard deviation; TG: Triglyceridemia.

Table 2: Characteristics of type 2 diabetics patients according to high blood pressure profil.

	Adjusted OR (95% CI)	*p*
Age		
< 40 ans	1	
≥ 40 ans	4.8 (1.3-17.6)	**0.017**
Abdominal obesity		
No	1	
Yes	5.35 (2.2-13.0)	**<0.001**
BMI ≥ 25g/m^2		
No	1	
Yes	27 (8.2-88.7)	**<0.001**
HCH		
No	1	
Yes	7.47 (2.9-19.4)	**<0.001**

HCT		
No	1	
Yes	5.6 (2.3-13.6)	**<0.001**
HCL		
No	1	
Yes	3.6 (1.5-8.7)	**<0.005**
HbA1C ≥7%		
No	1	
Yes	10.3 (3.2-32.6)	**<0.001**
Dyslipidemia		
No	1	
Yes	9.0 (3.1-26.1)	**<0.001**
CT/HDL ratio > 5		
No	1	
Yes	5.6 (2.3-13.6)	**<0.001**
Practice of exercises		
No	1	
Yes	0.15 (0.1-0.4)	**<0.001**
Get therapeutique and dietetic education		
No	1	
Yes	0.3 (0.1-0.8)	**0.014**
Education level		
None	1	
Primary	1.5 (0.4-5.9)	0.565
Secondary	2.4 (0.6-8.9)	0.203
Higher study	5.3 (1.3-20.3)	**0.015**

BMI: Body Mass Index; HbA1C: Glycated Haemoglobina; HBP: High Blood Pressure; HCT: Total hypercholesterolemia; HCH: HDL-hypocholesterolemia; HCL: LDL-hypercholesterolemia; HTG: Hypertriglyceridemia; OR: Odds Ratio.

Table 3: Factors associated with high blood pressure according to the multivariate logistic regression model.

We highlighted in our sample a frequency of 33% of subjects as having hypertension. This result is lower than most of the frequencies reported in sub-Saharan Africa. This is the case of Amoussou *et al.* and Codjo *et al.* in Benin which reported 70% and 60% respectively in 2015 and 2016 [22,23]. In Cameroon Choukem *et al.* and Sobngwi *et al.* reported 66.7% and 65% respectively in 2007 and 2011 [24,25]. In Guinea Baldé ***et al.*** and Diallo *et al.* for their part reported frequencies of 50.12% and 49% in 2003 and 2018 respectively [26,27]. In South Africa, Adeniyi *et al.* reported a frequency of 75.5% in 2016, while Ogola *et al.* the same year in Kenya reported a frequency of 76.6% [28,29]. The low rate of hypertensive subjects highlighted in our series could be explained by the relatively short duration of evolution of the diabetic patients included in our study. Indeed, the median duration of progression of diabetes in the patients in our sample was 29 months (IQR: 6-60) with more than ¾ having diabetes that had been evolving for less than 5 years. Also, as reported by other authors [22,23,30], our study showed that the risk of developing hypertension in T2D was significantly associated with the duration of diabetes progression when it lasted more than 5 years. The duration of the progression of diabetes is generally accompanied by an alteration in the endothelial function of the vessels due to the end products of glycosylation [31]. It should also be noted that the development of diabetic nephropathy, whose microalbuminuria is one of the major symptoms has also been reported to be associated with high blood pressure,and is associated with the duration of diabetes progression [32,33].

The effect of the duration of diabetes is further aggravated when diabetes is uncontrolled. According to our results, uncontrolled diabetes (HbA1C≥7%) was a risk factor for high blood pressure (OR = 10.3; CI: 3.2-32.6; p<0.001). Uncontrolled diabetes exposes the patient to blood hyperviscosity, a chronic inflammatory state and oxidative stress which contribute to the alteration of endothelial function with atherosclerosis, the starting point for macrovascular complications including hypertension [34,35].

A higher age was associated in our study with a higher risk of developing hypertension, in subjects over 40 years of age (OR = 4.8; CI: 1.3-17.6; p<0.017). This result is in agreement with the data reported in the literature, age being a non-modifiable cardiovascular risk factor which implies a natural progressive sclerosis of the vessels [22,23,28].

Dyslipidemia, in particular disturbances of the LDLc and HDLc lipoprotein fractions, are considered independent risk factors for essential hypertension in the general population. The existence of dyslipidemia (OR = 9.0; CI: 3.1 - 26.1; p<0.001) represented a risk factor associated with hypertension in T2D subjects in our study. This result is in agreement with Codjo *et al.* [23], Adeniyi *et al* [28] and Jani *et al.* [36]. On the other hand, Amoussou *et al.* did not objectify such an association in his study [22].

Dyslipidemias together with obesity, especially abdominal obesity, constitute components of the metabolic syndrome which, beyond

the chronic inflammation of which it is the source, is responsible for hyperinsulinism secondary to insulin resistance which activates not only the renin angiotensionogenic system but also the sympathetic nervous system [35,37,38]. This is in agreement with our results which also objectified abdominal obesity (OR = 5.35; CI: 2.2-13.0; p<0.001) and overweight (OR = 27; CI 8.2-88.7; p<0.001) as associated with a high risk of developing hypertension. Authors in Africa have reported similar results [22, 23, 30]. At the same time, a high risk of atherogenicity corresponding to a CT / HDLc ratio> 5 was also associated with the appearance of hypertension, reflecting the intimate link between dyslipidemia, obesity, hyperglycemia, atherosclerosis and therefore risk of hypertension [34].

Diabetes being a chronic disease, therapeutic education occupies and is considered paramount in the care of patients [39]. Therapeutic guidelines also incorporate hygieno-dietary rules as a prerequisite for drug treatment. We found that diabetic patients who had received therapeutic and dietary education had a lower risk of developing hypertension (OR = 0.30; CI: 0.1-0.8; p = 0.014). This result is consistent with the work of Zhang et al. who found an association between therapeutic education and a statistically significant reduction in HbA1C, LDLc and systolic blood pressure [40]. In addition, physical exercise (OR = 0.15; CI: 0.05 -0.39; p<0.001) showed a protective effect against hypertension in our study. Physical inactivity leads to a sedentary lifestyle with weight gain as a corollary. Numerous studies have demonstrated the benefit of physical exercise in reducing the risk of developing type 2 diabetes and high blood pressure by improving muscle sensitivity to insulin but also by losing weight [41–45]. Physical exercise and therapeutic education are therefore two areas on which primary prevention strategies should focus, taking into account African sociological realities where overweight is perceived as a reflection of beauty but also of social well-being, especially among women [46].

We found an association between high level of education and high risk of hypertension in T2D patients. This result in line with the results of Raji ***et al.*** in Nigeria [47] and Abouganlabou ***et al.*** in Malaysia [48] and contrasts with most African studies that have evaluated this association [49–53]. This disparity in the results relating to the level of education could be explained by the fact that other factors linked to environmental specificities such as socioeconomic level, particularities linked to different ethnic groups, places of residence (urban or rural) , but also psychosocial factors such as stress, the socio-professional and family environment may interact in the appearance of hypertension [54].

Limits are worth highlighting in relation to our study. First as a cross-sectional study limited to a single center, our results do not allow us to establish a causal link between the risk factors identified in our study and the appearance of hypertension in T2D subjects. Our results cannot also be generalized to the entire population of T2D patients in Togo. Hence, the interest of a larger study which will make it possible to obtain data on the whole national scope for a better representativeness. Then, diabetic subjects due to autonomic neuropathy could present an alteration of the circadian rhythm of blood pressure [55]. The nocturnal drop in blood pressure as well as the morning peak in blood pressure could be disrupted. Thus, the use of ambulatory blood pressure measurement would have provided a better reflection of the blood pressure profile in patients.

Conclusion

DT2 associated with hypertension constitutes a vascular time bomb for the T2D patient. The clinician must therefore bear in mind the main risk factors, namely age, dyslipidemia, obesity, duration diabetes of progression and glycemic control in order to institute appropriate therapeutic interventions but also ensure that the patient receives therapeutic education. The latter should of course take into account therapeutic adherence but also advice on hygienic and dietary measures as well as regular physical exercise. All of this will help control diabetes and significantly reduce the occurrence of hypertension during diabetes, in order to reduce the related morbidity and mortality rates.

Aknowlegements

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