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Factors Associated with High Blood Pressure and Diabetes Cormobidity in Littoral Department of Benin, in 2023

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Abstract

Introduction: The number of people suffering from diabetes and hypertension (HBP) is increasing worldwide and particularly in sub-Saharan Africa, despite the fact that they are preventable. The aim of our study is to determine the factors associated with hypertension and diabetes comorbidity in the Department of Littoral in 2023. **Study Setting and Methods:** Our study took place in the Department of Littoral in Benin. It was a cross-sectional general population study conducted over a three-month period from April 10 to July 10, 2023. It included subjects aged 18 and over with or without a history of hypertension and/or diabetes. The sampling method was probabilistic and the technique used was a WHO three-stage cluster survey. The dependent variable is comorbidity of hypertension and diabetes. A logistic regression model was used to identify factors associated with hypertension-diabetes comorbidity. **Results:** The study population was predominantly female (59.9%). The mean age was 44 ± 17. A total of 48 (8.8%) of the subjects in the study suffered from both diabetes and hypertension. Factors associated with comorbidity of hypertension and diabetes were age ≥ 50 years (OR: 5.48; 95% CI: 2.69 - 12.20; p = 0.001); male sex (OR: 2.98; 95% CI: 1.39 - 6.46; p = 0.005); too much salt or salty sauce consumed (OR: 6.06; 95% CI: 1.56 - 22.20; p = 0.034); abdominal obesity (OR: 6.12; 95% CI: 2.79 - 14.3; p = 0.001). **Conclusion:** Hypertension and diabetes are emerging as major public health problems in Benin. The main associated factors were age, gender, the amount of salt or salty sauce consumed and abdominal obesity. A response is urgently

needed to act on the factors identified in order to avoid possible complications and an increase in prevalence.

Keywords

Comorbidity Hypertension-Diabetes, Associated Factors, Littoral Department, Benin

1. Introduction

The number of people with diabetes and hypertension is increasing worldwide, and particularly in sub-Saharan Africa, despite the fact that they are preventable [1]. Hypertension is a major cause of cardiovascular disease, stroke and ischaemic heart disease, and as such is one of the most important preventable causes of premature morbidity and mortality in both developed and developing countries [2]. It is by far the most common disease and is currently recognized worldwide as a serious public health problem [3]. More than a quarter (26.4%) of the world's adult population suffers from hypertension, and by 2025 this figure is expected to rise to 29.2%, or almost 1.6 billion hypertensives [4]. Numerous studies have shown that hypertension is not only more frequent, but also earlier and more severe in black people [5]. Of the 17 million people who die each year from cardiovascular disease, an estimated 7 to 8 million suffer from hypertension [6].

According to a study carried out in 2014 in Morocco by H. Aynaou *et al.* [7], the frequency of the HBP-Diabetes association is 55% with a female predominance (80%) and an average age of 58.65 years. Macro-angiopathic complications are found in 45% of hypertensive with 11% of non-hypertensives. These complications are in the type of coronary heart disease in 27%, stroke in 9%, and peripheral vascular disease in 6%. Cardiovascular risk factors (CRF) found are android obesity (87%), sedentary (70%), dyslipidaemia (20%) and smoking (15%). The micro-angiopathic complications to admission are a type of neuropathy in 10%, and retinopathy in 6%. The treatment of these patients was: oral anti-diabetic medication in 42%, insulinotherapy in 42%, only diet in 10%, and oral anti-diabetic medication in association with insulinotherapy in 6%. These patients were under hypertensive monotherapy in 57%, dual therapy in 13% and therapeutic abstention in 30%.

In Benin, according to the Sixth Term Survey Examination Paper (STEP) of 2015, the prevalence in Benin of high blood pressure is estimated at 25.9% and that of diabetes mellitus at 12.4% [8]. According to the Health and demographic survey-V in Benin (EDSB 2017-2018), 13% of women and 16% of men had high blood pressure, with a dominance of the light form (8% in women and 11% in men), 0.8% to 2.3% of women aged 15 to 49 were informed by a health professional that they suffered from hyperglycemia or diabetes, while among men aged from 30 to 64, this prevalence varies between 0.9% and 2.7% (National Institute

of Statistics and Demography) [9].

In Benin, there is few detailed epidemiological data on hypertension-diabetes comorbidities to clearly determine the extent of these disorders and their associated factors. The aim of our study was therefore to investigate the factors associated with co-morbidity of hypertension and diabetes in the department of Littoral in 2024.

2. Materials and Methods

The study took place in South Benin, in Cotonou, a cosmopolitan city which is like a door opened on the inside and outside of Benin, with a diversity of food behaviors. It was a descriptive and analytical transversal study relating to a period of three months from April 10 to July 10, 2023. The subjects included aged 18 and over, having or not a HBP and/or diabetes history. The sampling was probabilistic with the three-stage clusters survey technique. From the random distribution of the districts list of Cotonou accompanied by all their respective households, a cumulative calculation of all the households in Cotonou districts according to the order of their appearance in the list was made. The definition of the clusters obtained by the report of the total population was made for all the districts by the total number of clusters (30). A draw was made and the first cluster has been identified. The thirty districts were selected at random depending on their population on the basis of the method proposed by WHO. The number of individuals surveyed in each selected district was proportional to the size of the population. The data were collected from a questionnaire developed for this purpose. Tools contain validated questionnaires in **Appendix**.

Alcohol Dependence (ALCOHOL USE DISORDERS IDENTIFICATION TEST), this questionnaire was developed under the aegis of the WHO in collaboration with primary care medicine.

The FAGERSTRÖM test has good reliability with an internal consistency considered moderate: its Cronbach's Alpha coefficient ranges from 0.55 to 0.74 depending on the study, with good test studies, with a good test-retest reliability of 0.90. The validity of the test is good, with sensitivity of around 75% and specificity of around 80% [10].

Assessment of the usual level of physical activity using the Ricci and Gagnon questionnaire: The self-assessment questionnaire is used to determine your profile: inactive, active or very active. The questionnaire developed in Canada, after J. Ricci and L. Gagnon, and used by certain nutrition services. The Ricci and Gagnon questionnaire was chosen for its simplicity, instant production.

Inclusion criteria

Subjects aged 18 and over with or without a history of hypertension and/or of diabetes.

Sampling size

The minimum sample size was determined according to the following Daniel Schwartz's formula:

$$N = (Z^2pq)k/i^2$$

N = sample size;

p = prevalence of high blood pressure; p = 27.90% [11];

q = 1-p;

α = risk of error accepted (5%);

Z_α^2 = difference reduced to risk α (1.96);

i = desired precision (5%); Cluster effect, k = 1.5;

$N = (1.96)^2 \times 0.2790 \times 0.721 \times 1.5/(0.05)^2$ or 510 subjects.

HBP and diabetes have been detected respectively by the mesure of blood pressure and glycemia capillary. The measurement of the tension was carried out on patients seated after 15 minutes of rest, using an automatic digital tensiometer provided with a armband (belonging to the list of blood pressure signs validated by the French company of hypertension). It was after the installation of the interviewee that the tensiometer has been placed on the naked right arm, placed on a table, palm turned upwards. Three measures were taken at five-minute intervals and the average of the last two measures has been the final blood pressure. This one is considered high when it is greater or equal to 140/90 mmhg. The hypertensive subjects had been reviewed a week after the first measure to confirm the elevation of the tension figures. Glycemia was measured from a blood glucose monitor on fasting subjects and then confirmed by a levying in the laboratory. Diabetes was defined as blood sugar greater or equal to 7 mmol/l (or >1.26 g/l).

2.1. Study Variables

The dependent variable was comorbidity HBP-diabetes and has two modalities: yes and no. Comorbidity was retained by the presence of HBP-Diabetes comorbidity.

The independent variables were:

- Socio-demographic and economic data (age, gender, level of education, matrimonial situation, residence, occupation, monthly income);
- Behavioral data:
  - Alcohol-dependence (Alcohol uses Disorders Identification Test);
  - Tobacco dependence (FAGERSTRÖM test);
  - Consumption of sugar and salt, consumption of fruits and vegetables;
  - Practice of physical activity.
- Anthropometric data: weight, size, abdominal perimeter;
- History of hypertension, diabetes;
- Operational definition of variables:
  - Age is the age of the participant in the revolution year
  - Official is the set of subjects that occupy permanent employment in a public administration.
  - Monthly income is the declarative one including salary and parallel activities;

- Daily fruit portions is the equivalent of a middle fruit like an apple, a banana that the subject consumed a day;
- Salt supplement is the adding of salt or a salty sauce like soy sauce before or while eating;
- Quantity of salt or salted sauce consumed is the amount of salt or salt sauce evaluated by the interviewee himself;
- Fat used is the type of oils used most often for the preparation of meals at home;
- Intensity of physical activity is the daily assessment of sport activities, the intensity of physical activity that work requires ;
- Usual level of physical activity is the evaluation of the usual level of physical activity by the Ricci and Gagnon questionnaire (less than 18: inactive, between 18 and 35: active, more than 35: very active);
- Current smoking: this is the consumption currently of tobacco products such as cigarettes, cigars or pipes;
- Alcohol-dependence is the evaluation of alcohol-dependence (low risk if score < 6, risk of harmfulness if score between 6 - 12 and alcoholo-depending if score > 12);
- Abdominal obesity is the measurement of the abdominal circumference (abdominal obesity has been retained for a waist that exceeds 102 cm in men and 88 cm in women);
- BMI is the body mass index that allows to quickly assess the corpulence with body weight and size, whatever the gender. It is equal to the weight (in kg) on the squared size (m): from 18.5 to 25 it is the ideal weight, from 25 to 30 it is overweight, 30 and more is obesity.

2.2. Collection Materials and Tools

A structured interview guided by a questionnaire was used to gather information on the co-morbidity of hypertension and diabetes. This tool was developed by the corresponding author of this article and has been read and approved by all other authors. The reliability of the questionnaire was measured by the Cronbach alpha index.

2.3. Data Collection and Analysis

The data was analyzed using R 3.6.1 software with the RStudio environment. The quantitative variables were expressed on average with their standard deviation and the qualitative variables in proportion. Khi2 and Fisher tests were used to determine the association between two qualitative variables. A statistically significant association has been established for a value of $p < 0.05$. A logistical regression model has been used to highlight the factors associated with HBP-diabetes comorbidity. The variables associated in univariate analysis ($p < 0.25$) were introduced into the multivariate analysis model. The potential predictor variables have been identified from the analysis of binary logistical regres-

sion with determination of Odds Ratio (OR) and their 95% confidence intervals (CI 95%).

2.4. Ethical Considerations

Before carrying out the study, an authorization (N°2188/MS/DC/SGM/DFRS/SRSSA of May 19, 2023) was obtained from Minister of Health after submission of the research protocol to the Directorate of Training and research of the ministry and integration of amendments. Participants were informed of the objectives and methods of the study and gave their verbal consent. Data confidentiality have been ensured and analyzed anonymously.

3. Results

3.1. Description of the Study Population

The data analysis focused on 543 subjects residing in the city of Cotonou, in 2023. The population studied was predominantly female (59.9%), with a sex-ratio (M/F) of 0.67. The average age was 44 ± 17 years with extremes of 18 and 107 years. The subjects aged 18 to 29 were more represented (22.5%). More than half of the subjects (59.7%) had declared that they were married and 40.5% had a secondary level (Table 1). Of the 543 subjects, 25.2% did not have income and 44.2% had a monthly income less than 52,000 FCFA. Then, 235 had presented HBP (43.3%), 48 diabetes (8.8%) and 48 presented both HBP and diabetes either a prevalence of comorbidity in 2023 of 8.8%.

3.2. Factors Associated with HBP-Diabetes Comorbidity

From univariate analysis, age ($p < 0.001$), type of household ($p = 0.017$), occupation ($p = 0.036$), salt supplement ($p = 0.001$), quantity of salt or salted sauce consumed ($p = 0.007$), excessive oil consumption (0.023), overweight ($p = 0.033$), abdominal obesity ($p < 0.001$) were significantly associated with HBP-Diabetes comorbidity (Tables 2-4).

It has been found also from univariate analysis that occupation ($p = 0.036$) would be associated with HBP/Diabetes comorbidity. However, the professional status, activitiy area, study level, monthly income or the number of dependent people are not associated with.

Then, we notice also that salt supplement ($p = 0.001$), salt quantity or salted sauce consumed ($p = 0.007$) and fat consumption ($p = 0.023$) promote the comorbidity of two diseases significantly.

The variables IMC ($p = 0.033$) and abdominal obesity ($p = 0.001$) are also associated with HBP-Diabetes comorbidity (see Table 5).

In multivariate analysis, age ≥ 50 years old (OR: 5.48; IC à 95%: 2.69 - 12.20; $p = 0.001$); male gender (OR: 2.98; IC à 95%: 1.39 - 6.46; $p = 0.005$); too much salt quantity or salted sauce consumed (OR: 6.06; IC à 95%: 1.56 - 22.20; $p = 0.034$) and abdominal obesity (OR: 6.12; IC à 95%: 2.79 - 14.3; $p = 0.001$) have been positively associated with factors associated with HBP-Diabetes comorbidity (Table 6).

Table 1. Distribution of respondents by sociodemographic characteristics, in Cotonou in 2023 (n = 543).

	Size	Percentage
Gender		
Male	218	40.1
Female	325	59.9
Age range		
18 - 49	323	59.5
≥ 50	220	40.5
Marital status		
Married	324	59.7
Single	107	19.7
Divorced/separated	16	2.9
Free union	44	8.1
Widow (er)	52	9.6
Professional status		
Unemployed	137	25.2
Working	383	70.5
Retiree	23	4.2
Occupation		
Official	63	11.6
Artisan and worker	125	23.0
Farmer and fisherman	5	0.9
Trader	201	37.0
Driver	12	2.2
Unemployed	137	25.2
Activity area		
Public	44	8.1
Private	362	66.7
Unemployed	137	25.2
Study level		
Uneducated	117	21.7
Primary	131	24.1
Secondary	220	40.5
Higher	74	13.6

Table 2. Univariate analysis of factors associated with HBP-Diabetes comorbidity in Littoral department of Benin, in 2023.

	HBP/Diabetes comorbidity		ORb (IC to 95%)	p
	Yes n (%)	No n (%)		
Age range (year)				**0.0001**
18 - 49	10 (20.8)	313 (63.2)	1	
≥50	38 (79.2)	182 (36.8)	6.53 (3.30 - 14.15)	
Gender				0.704
Female	27 (56.3)	298 (60.2)	1	
Male	21 (43.8)	197 (39.8)	1.17 (0.64 - 2.13)	
Religion				0.848
Christian	38 (79.2)	398 (80.4)	1	
Endogenous	3 (6.3)	22 (4.4)	1.42 (0.37 - 4.36)	
Muslim	7 (14.6)	75 (15.2)	0.97 (0.38 - 2.14)	
Marital status				0.107
Single/divorced/widow	10 (20.8)	165 (33.3)	1	
Married/free union	38 (79.2)	330 (66.7)	1.90 (0.95 - 4.11)	
Type of household				**0.017**
Monogamy	33 (68.8)	414 (83.6)	1	
Polygamy	15 (31.3)	81 (16.4)	2.32 (1.17 - 4.40)	

Table 3. Univariate analysis of factors associated with HBP-Diabetes comorbidity in Littoral department of Benin, in 2023.

	HBP-Diabetes comorbidity		ORb (IC to 95%)	p
	Yes n (%)	No n (%)		
Professional status				0.329
Unemployed	11 (22.9)	126 (25.5)	1	
Working	33 (68.8)	350 (70.7)	1.08 (0.54 - 2.29)	
Retiree	4 (8.3)	19 (3.8)	2.41 (0.61 - 7.89)	
Occupation				**0.036**
Official	9 (18.8)	54 (10.9)	1	
Artisan/worker	6 (12.5)	119 (24)	0.30 (0.09 - 0.88)	
Famer/fisherman	2 (4.2)	3 (0.6)	4.00 (0.47 - 27.62)	
Trader	18 (37.5)	183 (37)	0.59 (0.25 - 1.44)	
Driver	2 (4.2)	10 (2)	1.20 (0.16 - 5.59)	
Unemployed	11 (22.9)	126 (25.5)	0.52 (0.20 - 1.36)	

Continued

Activity area				0.225
Private	30 (62.5)	332 (67.1)	1	
Public	7 (14.6)	37 (7.5)	2.09 (0.80 - 4.86)	
Unemployed	11 (22.9)	126 (25.5)	0.96 (0.45 - 1.93)	
Study level				0.732
Educated	39 (81.3)	386 (78)	1	
Uneducated	9 (18.8)	109 (22)	0.81 (0.36 - 1.66)	
Monthly income (F CFA)				0.359
52,000 and more	19 (39.6)	147 (29.7)	1	
Less than 52,000	18 (37.5)	222 (44.8)	0.62 (0.31 - 1.23)	
No income	11 (22.9)	126 (25.5)	0.67 (0.30 - 1.45)	
Number of dependent people				0.116
None	5 (10.4)	122 (24.6)	1	
1 - 4	26 (54.2)	228 (46.1)	2.78 (1.12 - 8.38)	
5 - 9	14 (29.2)	130 (26.3)	2.62 (0.97 - 8.32)	
10 et +	3 (6.3)	15 (3.0)	4.87 (0.92 - 22.03)	

Table 4. Univariate analysis of factors associated with HBP-Diabetes comorbidity in Littoral department of Benin, in 2023.

	HBP-Diabetes comorbidity		ORb (IC to 95%)	p
	Yes n (%)	No n (%)		
Current smoking				0.164
No	44 (91.7)	479 (96.8)	1	
Yes	4 (8.3)	16 (3.2)	2.72 (0.75 - 7.80)	
Daily fruits portions				0.696
5 and more	1 (2.1)	19 (3.8)	1	
Less than 5	40 (83.3)	419 (84.6)	1.81 (0.36 - 33.01)	
None	7 (14.6)	57 (11.5)	2.33 (0.37 - 45.08)	
Salt supplement				**0.001**
Never	35 (72.9)	425 (85.9)	1	
Rarely	4 (8.3)	43 (8.7)	1.12 (0.32 - 2.99)	
Sometimes	9 (18.8)	27 (5.5)	4.04 (1.68 - 9.01)	

Continued

Salt quantity or salted sauce consumed				**0.007**
Quantity needed	36 (75)	437 (88.3)	1	
Few	7 (14.6)	49 (9.9)	1.73 (0.67 - 3.89)	
Too much	5 (10.4)	9 (1.8)	6.74 (1.98 - 20.62)	
Fat consumed				**0.023**
No particularity	2 (4.2)	90 (18.2)	1	
Vegetal oil	46 (95.8)	405 (81.8)	5.11 (1.54 - 31.65)	
Intensity of physical activity				0.984
Light	27 (56.3)	278 (56.2)	1	
Medium	17 (35.4)	179 (36.2)	0.97 (0.50 - 1.82)	
Intense	4 (8.3)	38 (7.7)	1.08 (0.30 - 2.96)	
Usual level of physical activity				0.531
Active	17 (35.4)	204 (41.2)	1	
Inactive	31 (64.6)	291 (58.8)	1.27 (0.69 - 2.41)	

Table 5. Univariate analysis of factors associated with HBP-Diabetes comorbidity in Littoral department of Benin, in 2023.

	HBP-Diabetes comorbidity		ORb (IC to 95%)	p
	Yes n (%)	No n (%)		
Time of light activities (hour)				0.347
Less than 2	34 (70.8)	314 (63.4)	1	
3 to 4	10 (20.8)	151 (30.5)	0.61 (0.27 - 1.22)	
5 and more	4 (8.3)	30 (6.1)	1.23 (0.35 - 3.35)	
Time of walking (minute)				0.900
30 and more	20 (41.7)	209 (42.2)	1	
Less than 30	28 (58.3)	286 (57.8)	1.02 (0.56 - 1.88)	
Sitting position per day (hour)				0.359
Less than 3	14 (29.2)	183 (37)	1	
3 and more	34 (70.8)	312 (63)	1.42 (0.75 - 2.80)	

Continued

Number of working hours per day (hour)				0.103
Less than 8	5 (10.4)	109 (22)	1	
8 and more	32 (66.7)	260 (52.5)	2.68 (1.10 - 8.00)	
Unemployed	11 (22.9)	126 (25.5)	1.90 (0.66 - 6.19)	
BMI classification				**0.033**
Less than 25 kg/m^2	16 (33.3)	250 (50.5)	1	
25 kg/m^2 and more	32 (66.7)	245 (49.5)	2.04 (1.10 - 3.90)	
Abdominal obesity				**0.001**
No abdominal obesity	13 (27.1)	310 (62.6)	1	
Abdominal obesity	35 (72.9)	185 (37.4)	4.51 (2.38 - 9.05)	
Alcoolo-dependence				0.135
No dependence	40 (83.3)	451 (91.1)	1	
Dependence	8 (16.7)	44 (8.9)	2.05 (0.84 - 4.45)	

Table 6. Multivariate analysis of factors associated with HBP-Diabetes comorbidity in Littoral department of Benin, in 2023.

	ORa (IC to 95%)	p
Age range (year)		0.001
18-49	1	
≥50	5.48 (2.69 - 12.20)	
Gender		0.005
Female	1	
Male	2.98 (1.39 - 6.46)	
Salt quantity or salted sauce consumed		0.034
Quantity needed	1	
Few	1.41 (0.52 - 3.39)	
Too much	**6.06 (1.56 - 22.20)**	
Abdominal obesity		**0.001**
No abdominale obesity	1	
Abdominale obesity	**6.12 (2.79 - 14.3)**	

4. Discussion

4.1. Prevalence of HBP/Diabetes Comorbidity

The 543 subjects surveyed, 235 had presented an HBP (43.3%), 67 diabetes (12.33%) and 48 presented both HBP and diabetes, a prevalence of comorbidity 8.8%.

In our study, the prevalence of HBP (43.3%) is greater than the one reported by the 2015 STEP survey according to which the prevalence in Benin of HBP is estimated at 25.9%. However, the prevalence of diabetes (8.8%) is lower and that of diabetes mellitus (12.4%) reported by the same investigation [8].

A study on type 2 diabetes in 2010 reported a prevalence of 3% (Mbanya *et al.*, 2010). Then, 2 years later, it was around 4.2% (Djrolo *et al.*, 2012). However, there is no information relating to the prevalence of type 1 diabetes in Benin [7]. This shows a presumption of the diabetes increasing in the population.

The high prevalence found in our study reflects an increasing burden of non-transmitted diseases in the general population of Cotonou, as should happen as countries in development adopt western lifestyles [12]. Two facts support this point of view: firstly, there seems to have been a gradual increase in the prevalence of hypertension in subjects of Cotonou, with a reported prevalence of 25.64% about 15 years ago and 32.3% 7 years later in a similar population [13]. The same observation is done on the prevalence of diabetes in the same population from 2.4% to 19.2% during the same period. Secondly, the city of Cotonou is the economic capital of Benin, with a cosmopolitan population and the highest per capita income in the country [14]. We can therefore expect a greater inclination of its residents to a western lifestyle with health implications that result from it. It should also be added that in some, it is rather the poor diet that is responsible for non-transmitted disease, especially the overeating. This one is responsible for a daily calorie contribution too high, which is related to food such as the burger, pizza and hot dog, essentials of fast food in Benin.

4.2. Factors Associated with HBP/Diabetes Comorbidity

The risk factors associated with HBP/diabetes comorbidity in our study were age over 50, high salt consumption, abdominal obesity and male sex.

The results agree with the literature ones.

In Benin, diabetes and high blood pressure are measured in different surveys. They have been constantly increasing in recent years. An ageing population, accelerated urbanization, changes in eating habits and smaller physical activity are the factors which could explain the evolution of these two diseases [15]. The coexistence of obesity, hypertension and diabetes has been associated with an increased risk of cardiovascular mortality and all causes combined. People living with diabetes and/or high blood pressure are more likely to have additional disease. Studies have shown that 75% of people who have co-morbid hypertension and diabetes, had at least more comorbidity at the time of their diagnosis of their diagnosis of type 2 and 44% diabetes had at least two others [16].

In our study, the risk of comorbidity HBP/diabetes was 5.48 times higher in subjects aged over 50. This factor could be explained by a constant increase of the prevalence of diabetes and HBP associated with the age, in the general population [17] [18]. In a study by Khadija Diyane [19], on the characteristics of the association diabetes type 2 and hypertension in the subject aged 65 and over, the seniority of diabetes was 9.3 ± 6.7 years, this explains the current threat that constitutes the advanced age, in particular of over 50 years. According to the United Nations data, world life expectancy at birth for both sexes increased from 46.5 years in 1950 to 71.7 years in 2022 and should reach 77.3 years in 2050 [20]. And according to a WHO report in 2022, healthy life expectancy experienced an increase of almost ten years in Africa [21]. Indeed, infectious diseases constituted a major public health concern, the causes of which were almost always unknown. With the progress of antibiotics, vaccines and hygiene, there has been a remarkable decrease in the incidence of these diseases. Today, the epidemiological transition has led to a gradual disappearance of infectious diseases in favor of chronic and degenerative diseases and accidents. The big public health load lies in non-transmitted diseases (NTD). Transmitted diseases and epidemics which formerly constituted the most important part of morbidity and mortality burden in the world now give way to chronic and degenerative diseases as well as all kinds of accidents.

Life can be reinforced and durable if we manage to control the non-transmitted diseases (NTD) and particularly HBP and diabetes. Non-transmitted diseases (myocardial infarction, cerebrovascular accidents, cancers, diabetes and chronic respiratory diseases) are responsible for almost 74% of deaths in the world. Then, almost three-quarters of all deaths due to non-transmitted diseases and 86% of the 17 million premature deaths (death before 70 years old) occur in countries with low or intermediate income [22]. Thus, there is a close link between people living with multiple NTDs and advanced age. The world's population aged 65 and over is expected to reach 1.5 billion people in 2050; so, it is no longer possible to ignore it in global health and development debates [23] [24].

Age being a non-modifiable risk factor, it can potentiate the effect of other risk factors. The challenge of current NTD programs must be the eviction of HBP and/or diabetes before the age of 60. Let us not forget that diabetes and high blood pressure are closely linked due to their common risk factors such as obesity, vascular inflammation and hypercholesterolaemia. This means that people living with diabetes are likely to have also hypertension and vice versa [16].

Talking about common risk factors to HBP and diabetes, in our study, abdominal obesity shows a risk of 6.1. The obesity epidemic affects also the African continent. Obesity is growing fastly in Africa: between 2000 and 2016, the number of overweight adults in Africa almost doubled (from 7.9% in 2000 to 12.8% in 2016). Trends are the same for children: 28% of worldwide overweight children aged under five live in Africa. This is due to unhealthy eating habits, lack of

physical activities and other factors [25]. The problem is complex and multifactorial. In fact, increasing urbanization, sedentary behaviour and nutritional transition are not the only factors contributing to obesity. Environmental factors, representations favourable to obesity and a potential genetic predisposition are also thought to be present [26].

In 2019, Kambasu Demaison *et al.* [27] reported an obesity prevalence of 35.8 % in Benin, of which 28% were women and 7.7% were men. Thus, obesity is an epidemic in the world and particularly in Africa. It benefits from a social representation of ease that maintains the high prevalence. The risk of comorbidity in obese subjects deserves special attention in the response to comorbidity. This response must focus on food (poor nutrition), physical activities, sedentary living and social representation of obesity. One study reported that obese patients with diabetes and concomitant hypertension did not achieve treatment objectives significantly [19]. The results obtained through interventions related to lifestyle such as diet regimens and regular physical activity will help obese people to better control their blood pressure and blood glucose levels and thus reduce complications.

In our study, high salt consumption shows a risk of comorbidity HTA diabetes of 6.06. The relationship between HBP-salt consumption is no longer to be demonstrated. Also the relationship between the occurrence of diabetes in patients HBP is known.

Adults should not ingest more than 5 g of salt per day, according to WHO. For children, the dosage is even lower: 2 g of salt per day. However, the daily salt consumption in the region is currently between 8 and 19 g, which exceeds this recommendation. It is estimated that reducing salt consumption by 15% would prevent 8.5 million premature deaths in 10 years in countries with low and intermediate income, and to make savings in high income countries [28]. Reducing salt consumption by 30% as agreed by countries by 2025, as a priority intervention to fight non-transmitted diseases, may have an impact on the occurrence of comorbidity [28]. Awareness raising is already focusing on reducing salt consumption in Benin. It is important to intensify it through repressive measures on the quality and quantity of salt contained in our foods and offered for sale through various products, especially cans ones, to reach the objective of reducing NTDs.

5. Conclusion

The emergence of non-communicable diseases, especially cardiovascular disease (hypertension) and diabetes, poses a major public health problem. Hypertension increases cardiovascular morbidity and mortality in the presence of diabetes. This association therefore calls for intensified therapy aimed at better control of all associated cardiovascular risk factors. This study will enable us to obtain an epidemiological profile of this association, identify the factors influencing this comorbidity and carry out accurate follow-up of patients in order to propose

health policies for better control of these pathologies. Comorbidities increase the health and social costs of care.

The Limits of the Study

Although blood glucose measure was done in the morning and the team has made sure the subjects were fasting, we had no certainty about the statements of the inquiries. Nevertheless, the suspect subjects were confirmed by a second sample. Our study did not take into account the quality-of-life habits. Thus, the consumption of sugar, salt, fruit, vegetables and vegetable oil has not been quantified. It should be added that most behavioural data are based on declaration which could induce a bias of social desirability. Then, our study did not assess the working environment. Also, we could not determine the meaning of the HBP-diabetes association, if HBP is prior to diabete or vice-versa. It is therefore impossible for us to confirm that our subjects are hypertensive diabetic or diabetic hypertensive, one being more invasive in kidney complications than the other. This could have contributed to the oriented response.

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Ethics

This study was approved by an authorization from the Minister of Health after submission of the research protocol to the Directorate of training and research of the Ministry and integration of amendments before carrying out the study. Participants were informed of the objectives and modalities of the study and gave their verbal consent. The confidentiality of data was ensured and the data were analysed anonymously. The anonymity and confidentiality of collected data were in accordance with the ethical principles applicable to medical research on human subjects contained in the declaration of the Helsinki World Medical Association.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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Appendix

Operational definitions of variables

Terms	Definition of variable	Modality
IDENTIFICATION OF PARTICIPANT		
Age (year)	Age of participant in last year (it will be categorical)	
Sex	Biological sex	Male Female
I. SOCIO-DEMOGRAPHIC CARACTERISTICS		
Marital situation	Marital situation	Single Cohabitation Separated Married Divorced Widow (er)
Type of household	Type of household	1. Monogamic household 2. Polygamic household
Number of dependent people	Number of dependent people	
Educated level	Educated level	0. Uneducated 1. Primary 2. Secondary 3. Higher 4. Alphabetized
Professional status	Professional status	0. Unemployed 1. Working 2. Retiree
SOCIO-ECONOMIC CHARACTÉRISTICS		
Monthly income (FCFA)	Declarative: monthly income taking into account salaries and parallel activities	No income Less than 52,000 ≥52,000
BEHAVIORAL FACTORS		
TOBACCO CONSUMPTION		
Do you smoke currently product from tobacco such as cigarettes, cigares of pipes?	Recent smoker	Yes/no

Continued

In average, how many times per day do you consume the following products?	Average consumption	Tobacco to snuff (oral canal) |__|__||__| Tobacco to chew (oral canal) |__|__||__| Tobacco to masticate |__|__||__| Other (specify |_____|) |__|__||__|
ASSESSMENT OF TOBACCO-DEPENDENCE: TEST OF FAGERSTRÖM		
On morning, how many times after waking up, do you smoke your first cigarette?	On morning, how many times after waking up, does the survey smoke his/her first cigarette?	5 minutes 6 - 30 minutes 31 - 60 minutes More than 60 minutes
Do you find that it is difficult to not smoke in space where it is forbidden? (Ex.: cinemas, libraries)	Measurement of dependence level	Yes/no
From which cigarettes would you give up hardly?	Type of cigarettes	Manufactured cigarettes = 1 Rolled cigarettes = 2 Pipes = 3 Cigares, cigarillos = 4 Others = 5
How many cigarettes do you smoke per day in average?	Average of sticks	10 or less 11 to 20 21 to 30 31 or more
Do you smoke more in closed intervalls during early hours of the morning than in the rest of the day?	Progression of dependence in day	No Yes
Do you smoke when you feel sick and obliged to be laid almost the day?	Assessment of absolute dependence	No Yes
Interpretation		Between 0 et 2: no dependence Between 3 et 4: low dependence Between 5 et 6: medium dependence Between 7 et 10: high or very high dependence
A. ALCOHOL CONSUMPTION		
Did you consume an alcoholic drink such as beer, wine, liqueur, cider or local alcoholic drinks these later twelve months?	Assessment of alcohol consumption	Yes/no

Continued

AUDIT (ALCOHOL USE DISORDERS IDENTIFICATION TEST): Assessment of Alcoolo-dependence		
To which frequency do you consume alcoholic drinks?	Assessment scale	Never At least 1 time per month 2 to 4 times per month 2 to 3 times per week 4 times or more per week
How many standard glasses of alcohol do you drink in a week?	Assessment scale	1 or 2 3 or 4 5 or 6 7 or 8 9 or 10
At the same period, how many times do you drink six standard glasses of alcohol or more?	Assessment scale	Never Less than 1 time per month 1 time per month 1 time per week Always or almost
During the later twelve months, how many times did you observe that you were not ever able to stop drinking after starting?	Assessment scale	Never Less than 1 time per month 1 time per month 1 time per week Always or almost
During the later twelve months, how many times drinking alcohol inhibited you to do what you were supposed to do?	Assessment scale	Never Less than 1 time per month 1 time per month 1 time per week Always or almost
During the later twelve months, how many times did you feel guilty or had regrets after drinking alcohol?	Assessment scale	Never Less than 1 time per month 1 time per month 1 time per week Always or almost

Continued

During the later twelve months, how many times were you unable to remind about previous night because you drunk alcohol?	Assessment scale	Never Less than 1 time per month 1 time per month 1 time per week Always or almost
Were you hurt or did you hurt someone because you had drunk?	Assessment scale	No Yes, but not last year Yes, last year
Was a parent, a friend or another health worker concerned about your alcohol consumption and advised you to reduce it?	Assessment scale	No Yes, but not last year Yes, last year
Interpretation (AUDIT) : Sum of quotation from A2-A11	Interpretation of assessment scale	Low risk (if score <6) Risk of harm (if score between 6 - 12) Alcoolo-dependence (if score >12)
FOOD HYGIENE [77]		
Usually how many days per week do you consume fruits?	Days number of fruits consumption per day	|__|__| if no day, go to D3
How many fruits portions do you consume in a day?	Number of fruits portions per day	|__|__|
Usually, how many days per week do you consume vegetables?	Days number of vegetables consumption per day	|__|__| if no day, go to D5
How many vegetables portions do you consume in a day?	Number of vegetables portions per day	|__|__|
Do you add sometimes salt or salted sauce such as soya sauce before or during eating?	Assessment of salt supplement in need to satisfy appetite	Never Always Often Sometimes Rarely
According to you, which quantity of salt or salted sauce do you consume?	Assessment of salt consumption	Quantity needed A bite Too little Too much Very too much

Continued

Which kind of fat do you use frequently to cook meals at home?	Assessment of lipids consumption	None particularly Vegetable oil Bacon or fat Butter Margarine Other (specify)
B. PHYSICAL ACTIVITY (Assessment of usual level of physical activity with the questionnaire Ricci et Gagnon)		
SEDENTARY BEHAVIORS		
How many times do you spend sat per day (hobbies, television, computer, work, etc.)?	Assessment of sedentariness	<2 h 2 to 3 h 3 to 4 h 4 to 5 h ≥5 h
DAILY ACTIVITIES		
Which intensity of physical activity does your work require?	Assessment of daily sportive activities	Light Moderate Medium Intense Very intense
Apart your work, how many hours do you spend a week for light tasks: DIY, gardening, housework, etc…?	Assessment of daily sportive activities	<2 h 3 to 4 h 5 to 6 h 7 to 9 h ≥10 h
How many minutes per day do you spend to walk?	Assessment of daily sportive activities	<15' 16 to 30' 31 to 45' 45 to 60' ≥61'
How many floors, in average, do you go up per day?	Assessment of daily sportive activities	<2 3 to 5 6 to 10 11 to 15 ≥16

Continued

ACTIVITES SPORTIVES ET RECREATIVES		
Do you practise regularly one or more physical or recreational activities?	Daily assessment of recreational and sportive activity	No Yes
To which frequency do you practise all these physical activities?	Daily assessment of recreational and sportive activity	1 to 2/month 2/week 3/week ≥4/week
How minutes do you spend in average to each section of physical activity?	Daily assessment of recreational and sportive activity	<15' 31 to 45' 45 to 60' ≥61'
Usually, how do you perceive your effort?	Daily assessment of recreational and sportive activity	Very easy Easy Less easy Difficult
Interpretation	Interpretation of recreational and sportive activities	Less than 18: inactive Between 18 et 35: active More than 35: very active
PHYSICAL MEASURES		
SBP1	Systolic blood pressure	
DBP1	Diastolic blood pressure	
SBP2	Systolic blood pressure	
DBP2	Diastolic blood pressure	
Size	Measure of size in meter	
Weight	Taking of weight in kilogramme	
Brachial circumference	Brachial circumference	|__|__|__| cm
Abdominal circumference	Abdominal circumference	|__|__|__| cm
Taking time of capillary glycemia	Completion time of capillary glycemia	Hours Minutes
Capillary glycemia	Value	|__|.|__|__| g/l
Venous glycemia	Value	|__|.|__|__| g/l
II. CLINICAL AND THERAPEUTIC CHARACTERISTICS		
A. HISTORY OF HIGH BLOOD PRESSURE		
Did a doctor or another health worker already measure your blood pressure?	Confirmation of HBP status	No (if no, go to H7) Yes

Continued

Did a doctor or another health worker already tell you that you had a high blood pressure or you were suffering hypertension?	Confirmation of HBP status	Non (if no, go to H7) Yes
Did they tell you these later 12 months?	Confirmation of HBP status	No Yes
Since how many time are you known hypertensive?	Confirmation of HBP status	Less than 1 year 1 to 05 years 5 to 10 years More than 10 years Do not know
Are you currently under a medical treatment?	Confirmation of HBP status	No Yes
If yes, which one?	Confirmation of HBP status	Do not know Specify the name
During later 2 weeks, did you take drugs prescribed by a doctor or another health worker for your high blood pressure?	Confirmation of HBP status	No Yes
Did you already consult a traditional healer for your high blood pressure?	Confirmation of HBP status	No Yes
Do you currently take a traditional drug or herbal drug for you high blood pressure?	Confirmation of HBP status	No Yes
B. HISTORY OF DIABETES		
Did a doctor or another health worker already measure your glycemia?	Confirmation of diabetes	No (if no, go to M1) Yes
Did a doctor or another health worker already tell you had diabetes?	Confirmation of diabetes	No (if no, go to M1) Yes
Did they tell you late 12 months?	Confirmation of diabetes	No Yes
Since how many time are you known diabetic?	Confirmation of diabetes	Less than 1 year 1 to 05 years 5 to 10 years More than 10 years Do not know

Continued

Are you currently under a medical treatment?	Confirmation of diabetes	No Yes
If yes, which one?	Confirmation of diabetes	Do not know Specify the name
During later 2 weeks, did you take drugs prescribed by a doctor or another health worker for your diabetes?	Confirmation of diabetes	No Yes
Did you already consult a traditional healer for your diabetes?	Confirmation of diabetes	No Yes
Do you currently take a traditional drug or herbal drug for you diabetes?	Confirmation of diabetes	No Yes