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Original Research Article

Diabetes Mellitus and Associated Risk Factors in Urban and Rural Congolese Areas

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Abstract: ***Introduction:*** The global progression of diabetes mellitus (DM) pandemic is a real public health problem. This growth, more remarkable in low- and middle-income countries is linked to risk factors (RF) and urbanization. This study contributes to the updating of epidemiological data on diabetes and its RF in rural and urban areas in Congo. ***Aim of the Study***: To describe epidemiological and diagnostic aspects of DM and its RF in rural and urban areas in Congo. ***Patients and Method*****:** A cross-sectional, retrospective and multicenter study, including patients in 20 centers (urban/rural) from October 2010 to 2017.Studied parameters were: socio-demographic profile, duration of diabetes, anthropometric measurements, RF, types of DM and glycaemia. Data were analyzed by Epi info 7.2.1.0, using Chi-2 and Student, with a significance threshold of 0.05. ***Results*****:** A total of 4758 patients were received, including 4116 patients (86.51%) in urban areas and 642 patients (13.49%) in rural areas. Among them, 2460 men (51.70%) and 2298 women (48.30%), M/F ratio of 1.07. The mean age was 51.67±15.45 years [range 2 to 95 years].3021 patients (63.5%) were known to be diabetic, with a mean duration of 5.97 years and 1737 patients (36.5%) were newly diagnosed. The annual incidence was 248 new cases/year. The socio-professional status was dominated by the unemployed (33.80%), employees (26.2%), students/pupils (12.9%) and retirees (11.9%). T2D (84.72%) and T1D (8.53%) were more represented. RF: Hypertension (39.34%), affects 90.60% of patients in urban areas and 9.40% in rural areas (p = 0.000). Overweight (37.89%) and obesity (27.77%), predominantly urban, female and in T2D (p = 0.000)). Metabolic syndrome of urban predominance was found in 17.12% of patients. The mean glycaemia was 283 ± 14 mg /dl. ***Conclusion*****:** Our study shows that DM and its RFs are common in Congo, with a strong predominance in urban areas, requiring specific strategies to reduce the impact of urbanization.

Keywords: Diabetes, Risk factors, Urban, Rural, Congo.

INTRODUCTION

The exponential growth of morbidity and mortality of diabetes mellitus (DM) in recent decades constitutes a major challenge for the world's health systems.

Indeed, it is currently estimated that 537 million people live with DM in the world, or one in ten adults, and this progression is particularly alarming in developing countries [1].

According to the World Health Organization, over the last 30 years the global prevalence of DM has almost doubled from 4.7% to 8.5% of the adult population (from 108 million in 1980 to 422 million in 2014). This increase is closely linked to modifiable risk factors such as: overweight and obesity, consequences of the epidemiological transition (poor diet, sedentary

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lifestyle) especially in low- and middle-income countries than in developed countries [2].

The overall prevalence of DM in Africa in 2021 is estimated at 5.3% of the adult population (~24 million people). In 2055 this figure will reach 55 million, an increase of 134%, if effective measures to fight against this scourge are not undertaken [1].

Urbanization is considered one of the causes of the increase in DM in Africa because the majority of people living with diabetes (58.8%) live in urban centers, while 61.3% of the African population is rural [1].

However, very few countries have developed effective strategies to contain the progression of DM. In most cases, the lack of data in Africa is a barrier to the implementation of effective diabetes prevention and management programs in disadvantaged populations [3].

The Congolese population is predominantly urban and is found in the two largest cities (58.2%) of the country. [4], the only WHO-STEPS survey conducted in 2004 in Brazzaville and a screening found respectively a prevalence of DM of 7% and 13% of the adult population [5, 6].

Almost all the epidemiological data relating to the morbidity and mortality of DM and its RF in Congo over the last thirty years were collected in the only specialized department of metabolic and endocrine diseases of the University Hospital of Brazzaville [7].

The lack of dynamic epidemiological data of DM in Congo in recent years implies an estimate by extrapolation compared to the data from Cameroon [8-10].

In application of the African strategy to combat DM by strengthening peripheral health centers [11,12], Congo has initiated through a private/public project with a decentralized model for the management of diabetes mellitus, by equipping health centers with screening kits and DM registers, and organizing specialized training and consultations from 2010 to 2017 in several peripheral centers of the 12 regions of the country.

It is in this context that we conducted this first multicenter epidemiological study, based on the analysis of DM data in Congo and taking into consideration the clinical-epidemiological pecularities of cases of screened and treated diabetes and associated risk factors.

Aim of the Study: To describe the epidemiological aspects of diabetes and associated risk factors in urban and rural Congolese areas.

PATIENTS AND METHOD

Study Setting

This is a multicenter study conducted in the twelve (12) regions of the Republic of The Congo, based on the collection of data from patients admitted in hospitalization or outpatient consultation with confirmed diabetes in the specialized services of Pointe-Noire and Brazzaville and in the "pilot" diabetes centers and peripheral hospitals, previously trained on the diagnosis and management of diabetes mellitus and having a referral trained healthcare professional(HCP) as part of the diabetes care decentralization program. This program was conducted in three (3) stages:

2010-2012: Training of HCP and provision of screening kits (glucometers and registers)

2013-2015: Formative supervisions, specialized consultations of screened patients

2015-2017: Continuation of specialized consultations and data collection (survey forms)

A total of twenty (20) centers were included in the 12 regions and distributed as follows:

Pointe-Noire (2), Brazzaville (DT1 care center), Bouenza (5), Niari (2) Lékoumou (1), Pool (1), Kouilou (1), Plateaux (1), Cuvette-ouest (1), Cuvette centrale (3) Sangha (1), Likouala (1).

Type of Study and Duration

This is a retrospective, descriptive cross-sectional study carried out over the period from October 2010 to October 2017 (patient recruitment period) and creation of the database.

Inclusion and Exclusion Criteria

a- Inclusion Criteria

All patients admitted to hospital or seen in outpatient consultation, in whom the diagnosis of diabetes mellitus was confirmed after measuring a capillary or venous blood glucose level on a fasting or casual basis according to the criteria (ADA 1997/WHO 1999).

The definition of types of diabetes is based on clinical, epidemiological and evolutionary arguments under treatment. Type 2: patient with a history of diabetes in the family, overweight or obese, sometimes with acanthosis nigricans (looked for in the youngest ~ 40 years old) whose onset is insidious or also sudden (Ketosis / ketoacidosis) and responding to treatment with ADO.

Type 1:

Child or adolescent without family history of diabetes started suddenly, with obvious signs and without overweight or obesity, requiring insulin therapy.

Other Types: Diabetes induced by a condition (treatment) or pathology for which we have a certain diagnosis or a cause-effect link

b- Exclusion Criteria

All patients in whom the diagnostic criteria for diabetes mellitus have not been confirmed or have been unconvincing. All incomplete files due to the absence of interpretable data.

METHOD

The Parameters Studied Were:

Sociodemographic (age, sex, socio-professional status), Anthropometric (Weight, Height, Body Mass Index (BMI), Waist Circumference), Clinical and biochemical (type of diabetes, duration of diabetes, blood sugar)

Data Collection

The data were collected during supervisions and consultations by a uniform survey collection sheet including all the variables studied, transmitted to referent HCP of each center.

The anthropometric measurements (Weight, Height, Waist Circumference) were measured by standardized methods and calibrated equipment.

Blood pressure was measured twice with an interval of five minutes by a reliable manual or automatic blood pressure monitor. The average of the figures was calculated, in case of doubtful figures, a third reading was applied.

Body Mass Index (BMI) was categorized as follows: underweight (in kg/m2) <18.5, normal BMI ,18.5 and <25, overweight BMI ≥25 and <30, obesity I BMI ≥30 and < 35, obesity II BMI ≥35 and < 40 and obesity III BMI > 40

Hypertension was defined as a systolic pressure of 140 mm Hg or more and a diastolic pressure of 90 mm Hg, or a patient on antihypertensive treatment beyond two weeks in the history.

Statistical Analysis

The data were collected by Epi-data 3.0 software, then data converted on an Excel sheet and analysis made by Epi-info 7.2.1.0 software of the CDC of Atlanta (USA)

The quantitative variables are presented in mean ± standard deviation and proportions (frequencies) for qualitative (categorical) values.

Two comparative statistical tests were used:

The Student t-test was used to compare the means between groups and the associations between a qualitative variable and a quantitative variable.

The Chi-square test was used to evaluate the associations between 2 qualitative variables, allowing to compare the frequencies of the two unpaired groups.

The difference was considered significant for a p value less than 0.05

Approval of the Ethics Committee

The trainings of HCP in the trained centers and specialized consultations in the regions were officially authorized and accompanied by the Ministry of of health and population within the framework of a private-public partnership.

An exceptional authorization, regarding the non-experimental nature of this study, was granted to us by the office of the Minister of Health and the General Inspectorate of Health.

RESULTS

In total, during the study period 4758 patients were received in 20 centers of the 12 regions of Congo, among which 3182 patients (66.88%) in outpatient care and 1576 patients (33.12%) in hospitalization. **Table 1** summarizes the general characteristics of the study population.

The mean age of 51.67±15.45 years [range 2 to 95 years], with a male predominance (M/F ratio of 1.07).
There is no statistically significant difference in age between men and women (P=0.46).
The mean duration of diabetes was 3.98 years [range 0 to 44 years]

Table 1: General characteristics of the study population

Population	M	F	Urban	Rural	Total (%)	p
Known n (%)	1583 (52.4%)	1438 (47.6%)	2490 (82.4%)	531 (17.6%)	3021 (63.5%)	0.05
New n (%)	877 (50.5%)	860 (49.5%)	1626 (93.6%)	111 (6.4%)	1737 (36.5%)	0.000
N (%)	2460(51.7%)	2298(48.3%)	4116 (86.5%)	642(13.5%)	4758 (100%)	0.000
Mean age	51.51±14.37	51.84±16.52	51.53±15.56	52,53±14.7	51.67±15.45	0,12

Known Diabetic Population (n= 3021):

The mean age in patients with known diabetes was 54.76±13.48 years [range 2 to 95 years] and the mean duration of diabetes was 5.97 years [range 0.1 to 44 years], including an urban population (n=2490), composed of 48.15% women and 51.85% men, with a mean age of 54.83±13.63 years [range 2 to 92 years] and a rural population (n=531), composed of 45.0% women and 55.0% men with a mean age of 54.41 years [range 14 to 95 years]

The mean duration of diabetes in patients with known diabetes in the urban population was 6.42 years [range 0.1 to 44 years] and in the rural population 3.83 years [range 0.1 to 22 years], p= 0.00.

Newly Diagnosed Diabetic Patients (n=1737):

The mean age of newly diagnosed diabetics is 46.30±17.09 years [range 2 to 95 years] including 93.6% (n=1626) in urban areas composed of 49.00% women and 51.00% men, with a mean age of 46.49±16.91 years [range 4 to 95 years] and 6.4% (n=111) in rural areas, composed of 57.66% women and 42.34% men with a mean age of 43.54±19.38 years [range 2 to 94 years]

T2DM represents 75.53% of newly diagnosed patients with a mean age of 51.96±12.99 years, in urban areas the mean age is 51.82±13.06 years and in rural areas 54.41±11.145 years (p=0.09)

The socio-professional status of patients is as follows: unemployed/housewives (33.80%); non-civil servant employees (13.80%); pupils/students (12.9%), civil servants (12.4%), retired (11.9%), traders/salespeople (7.5%), small skilled trades/workers (4.6%), fishermen/breeders/farmers (3.1%).

The average annual incidence of diabetes:

The annual incidence is 248 new cases per year

The evolution of the annual incidence of diabetes is shown in Figure 1.

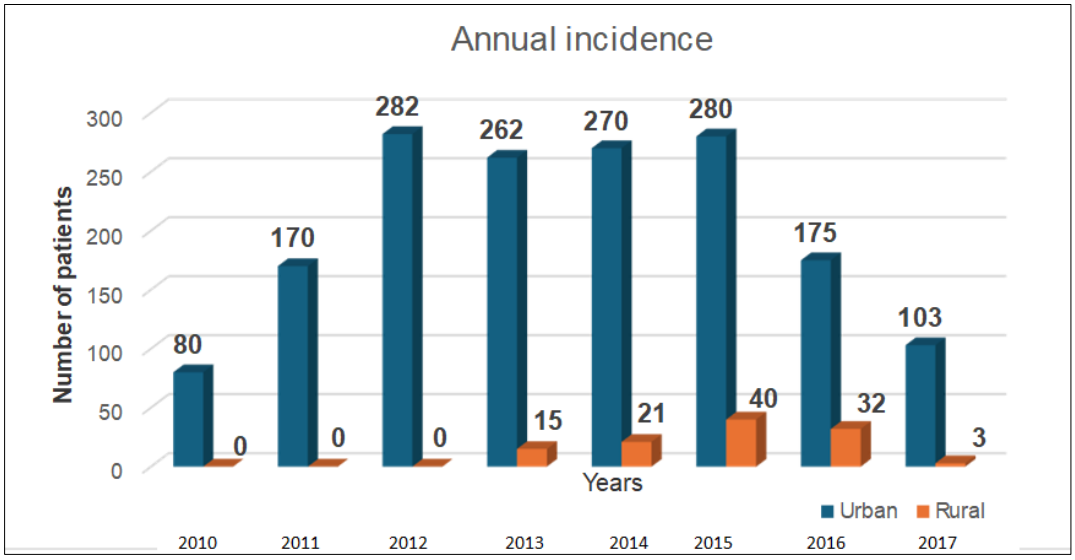

Figure 1: Annual incidence of diabetes in urban and rural areas

Table 2: Shows the types of diabetes

Type of diabetes	Urban n (%)	Rural n (%)	N (%)
Type 2	3489(73,33)	542(11,39)	4031 (84,72)
Type 1	359 (7,55)	47(0,99)	406 (8,53)
Ketosis prone Type 2	148 (3,11)	31(0,65)	179(3,76)
Other types	71 (1,49)	10(0,21)	81(1,70)
Diabetes in pregnancy/Gestational	40(0,84)	6(0,13)	46(0,97)
Pre-diabetes	9 (0,19)	6(0,13)	15(0,32)
Total	**4116 (86,51)**	**642 (13,49)**	**4758 (100)**

Table 2 : Distribution of the population by type of diabetes and place of residence

Risk Factors Associated with Diabetes

High blood pressure (HBP) affects 39.34% of diabetic patients, including 90.60% of patients in urban areas and 9.40% in rural areas (p=0.000). It affects 45.18% (n=1761) of T2D patients, including 90.33% of patients in urban areas and 9.65% in rural areas, P=0.000.

Metabolic syndrome was found in 17.12% of patients, with a strong urban predominance (89.2% in urban areas and 10.80% in rural areas, P = 0.000)

Figure 2 shows the distribution of patients by body mass index (BMI)

Obesity at all stages was present in 29.84% of type 2 patients, particularly in 92.0% in urban areas and 8.0% in rural areas, p = 0.000

In type 2 diabetic patients, overweight was found in 40.23% of patients, particularly in 89.0% in urban areas and 11.0% in rural areas, p = 0.00

In newly diagnosed type 2 diabetics, overweight was found in 43.63% of patients, particularly in 94.5% in urban areas and 5.5% in rural areas, p =

0.000. Obesity affects 30.89% of patients (95.0% in urban areas and 5.0% in rural areas, p = 0.000)

The mean waist circumference in women (n = 704) was 96.64 ± 12 .67 [range 49 to 144 cm]. Among them, 89.20% had a TT > 80 cm (abdominal obesity)

In the urban area it was 97.06 ± 12.31 cm and in the rural area 92.18 ± 15.42 cm.

The mean waist circumference in men (n = 878) is 96.72 ± 11.63 cm [range 59 to 140 cm]. Among them 59.00% had a TT> 94cm (abdominal obesity)

In urban areas it was 97.03±11.60 cm and in rural areas 91.67 ±10.94 cm.

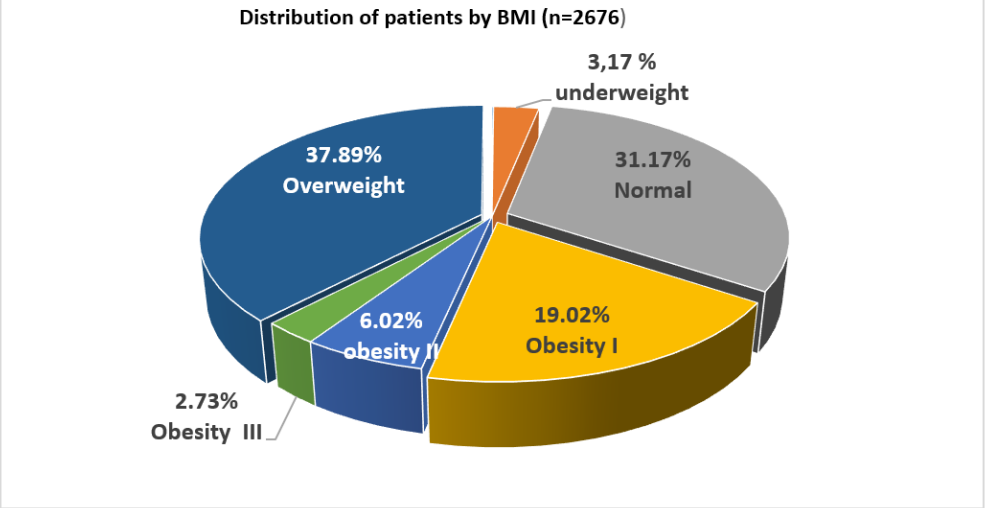

Figure 2: Distribution of patients by BMI

The analysis of BMI in the group of patients aged over 40 years is as follows:

Table 3: Distribution of patients aged over 40 years by BMI

Category	**n**	**(%)**
Underweight	41	1,84
Normal	678	30,75
Overweight	867	39,37
Obesity I	425	19,27
Obesity II	132	6,0
Obesity III	61	2,77
Total	**2204**	**100**

The overall prevalence of obesity in this group is 28.04%.

Hypertension affects 46.00% of this population, 90.37% in urban areas and 9.63% in rural areas, p=0.000

The mean blood sugar level was 283±141 mg/dl [from 20 to +600 mg/dl], In 43.25% of patients, blood sugar was higher than 300 mg/dl.

In newly diagnosed patients, it was 330 mg/dl (335 mg/dl in urban areas and 262 mg/dl in rural areas, p=0.000)

DISCUSSION

Our study is hospital-based and multicenter and concerns patients received in outpatient consultation or admitted to hospital for management of known or newly diagnosed diabetes.

Distribution of Diabetic Patients

We found an unequal distribution of patients with a strong predominance of diabetes in urban areas (86.51%) of cases and (13.49%) in rural areas.

This predominance of diabetes in urban areas has been found in the various studies of diabetes screening in urban and rural areas in developing countries, notably by Munganyinka Bavuma *et al*., (Rwanda, 2022) [13], Aung *et al*., (Myanmar, 2018) [14], and other series reported in sub-Saharan Africa [15-20].

However, Chiwanga *et al*., (Uganda, 2017) [21], found a high prevalence of diabetes in rural Uganda compared to urban areas (16.1% vs. 7.8%)

This high prevalence of diabetes in urban areas in Congo, a country with a large urban population (58.2%) [4], reflects the consequences of urbanization, the change in eating habits linked to it and sedentary lifestyle.

Mean Age

The mean age of patients in our study was 51.67±15.45 years, with no significant difference in urban (51.53±15.56 years) and rural (52.53±14.70 years) areas, which was close to the mean age of 53.2 years reported by Assita Yao *et al*., [22]. The multicenter studies by Chinenye *et al*., (Nigeria, 2012) [23], and Balde *et al*., (Guinea, Cameroon) [24], reported respectively 57.1 ± 12.3 years and 56.2 ± 12.6 years higher than our study.

This age is correlated with the predominance of type 2 diabetes, for which age remains a very important risk factor.

The studies of Seck *et al*., (Senegal, 2012) [25], and Aung *et al*., (Myanmar, 2017) [14], reported respectively mean age of 46.8 years and 42.8 years which is lower than that of our study. This difference can be explained by the inclusion criteria, our study included known diabetic patients unlike these two studies.

Sex

Our study found male predominance, with M/F ratio of 1.07 like Monabeka *et al*., (Brazzaville, 2003) [26], Oga *et al*., (Cote- d'Ivoire, 2006) [27], and other authors [28, 29].

On the other hand, in the STEPS survey conducted in Brazzaville (Kimbally-Kaky, 2004) [5], there was female predominance among diabetic patients, this trend was found in our study in the group of newly diagnosed patients in rural areas (57.66% of women).

Chinenye *et al*., (Nigeria) [23], Baldé *et al*., (Guinea, Cameroon) [24], and Seck *et al*., (Senegal) [25], found female predominance respectively at (60.6%), (59.8%) and (65.7%) as well as other authors [30, 31].

Socio-Professional Status

The socio-professional status of our patients was dominated by the unemployed/housewives (33.80%), followed by private/public employees (26.2%), students/pupils (12.9%) and retirees (11.9%). Mbandinga-Mupangu *et al*., [32], in Brazzaville found disparate proportions with similarities to our data and dominated by the unemployed (26.4%), farmers (25.6%), workers (18.7%), students (13.5%) and executives (15.8%)

In the study by Tchicaya *et al*., (Cote d'Ivoire 2003) [33], the professional profile was dominated by civil servants (55%), employees in the formal private sector (35%) and 10% in the informal sector. This removes the false ideas that diabetes is a disease of the wealthy, which currently affects all social classes, each exposed differently to the risk factors of diabetes (unbalanced diet, sedentary lifestyle, lack of physical activity, etc.)

Diabetes Duration

In our study, 63.5% of patients were previously diagnosed, with mean diabetes duration of 5.97 years (6.42 years in urban areas and 3.83 years in rural areas).

The mean duration of diabetes in Congo is lower than that reported by Baldé *et al*., (Guinea/Cameroon) [24], Chinenye *et al*., (Nigeria) [23], and Assita Yao *et al*., (RCI) [22], who reported a mean duration of 7.4 years, 8.8 years and 14.7 years respectively. In the majority of people living with diabetes, the diagnosis is recent.

Types of Diabetes

The types of diabetes in our study were similar to other studies, dominated by T2DM from 85 to 95%, followed by T1DM (5-11.5%) as reported by other authors [23-27].

We found a frequency of specific diabetes of 1.70% close to 2.2% reported by Monabeka *et al*., (Brazzaville, 2003) [26].

These forms are still encountered in clinical practice, the most remarkable being diabetes due to fibrocalculous pancreatopathy that we found in rural areas.

We did not perform immunogenetic analyses for ethiological diagnosis of diabetes (bias), knowing that negativity does not exclude type 1 diabetes in young adults as reported in the literature [34].

Gestational diabetes was found very low in our study slightly lower than the frequency of 1.5% reported by Mamabolo *et al.,* (2006) [35], who performed oral glucose tolerance test in rural pregnant women that was not performed in our study.

The average annual incidence of diabetes of 248.4 new cases/year was lower than the 335 patients/year reported by Assita Yao *et al*., (Côte d'Ivoire, 2020) [22].

Hypertension

Our study found a prevalence of hypertension of 39.3% which was similar to that of 39.1% reported in the Senegalese population by Seck *et al*., [25], with a predominance in urban areas.

However, Chinenye *et al*., (Nigeria) [23], Akré *et al*., (Ivory Coast) [36], reported a higher prevalence of HBP of 60.9% and 48% respectively, Among T2DM, hypertension concerned 45.8% of cases, which is higher

than the data of Monabeka *et al*., (Brazzaville, 2003) [26], Dembélé *et al*., [37], (Mali), Lokrou *et al*., [38], (Ivory Coast) and Akintewe (Nigeria) [39], who reported a prevalence of HBP in T2DM of 34%, 29%, 31% and 31% respectively.

Obesity/Overweight

The overall prevalence of obesity in our study was 27.77%, with large female predominance and in urban environment.

Our result is similar to that of Seck *et al*., [25], which found 23.4%, predominantly urban and was significantly higher than that reported by Oga *et al*., [27], Akré *et al*., [36] who found 16.1% and 17.44% obesity.

On the other hand, Monabeka *et al*., [26], in Brazzaville reported a prevalence of obesity of 43.1% (among T2DM and T1DM) higher than that of our study.

The female predominance was 63.4% in Monabeka *et al*., and 60% in the studies of Ndiaye Badiane *et al*., [40]. Akintewe *et al*., [39].

Our study found in the T2DM population a prevalence of obesity of 29.84% (30.89% in newly diagnosed patients) which is close to that reported by Monabeka *et al*., (30.4%) [26]. Overweight was found in 37.89% of our patients, which is higher than the reported prevalence of 30.4% by Oga *et al*., (Ivory Coast) [27].

Price *et al*., (Malawi, 2018) [41], found a predominance of overweight at 44% (vs 27% in rural areas) women in urban areas higher than that of our study. The trend towards overweight is reported by Chinenye *et al*., [23], who found an average BMI of 27.2 ± 5.4 kg/m²

Obesity tends to increase with age in our population (39.37% overweight and 28.04%) in patients over 40 years old more in urban than rural areas as reported by Mbanya *et al*., [42].

Among women, 89.20% had a waist circumference greater than 80 cm suggesting abdominal obesity, predominantly urban with an average waist circumference of 96.64±12.67 cm. Seck *et al*., [25], found an average waist circumference of 90.6±16.1 cm and a prevalence of abdominal obesity lower than that of our study at 53.1%. The morphotypes of African women in these two populations being different.

A population study carried out in Cameroon by Fezeu *et al*., [43], found a prevalence of abdominal obesity in women (67%) much higher than that of men (18%), African women, often multiparous, are exposed to a tendency to abdominal obesity, which would call into question the diagnostic criteria for abdominal obesity according to the IDF [44].

Furthermore, a sedentary lifestyle and the dietary transition (overconsumption of fat and sugar) are causes of the explosion of this scourge in urban areas.

And finally, the cultural perception commonly spread throughout Africa where overweight or obesity are accepted as a sign of well-being, of wealth, especially a criterion of beauty in women. [45], Gning *et al*., [46].

Metabolic Syndrome

The metabolic syndrome was found at 17.12%, with an urban predominance in our study. Gemeda *et al*., (Ethiopia, 2022) [47], and Abagre *et al*., (Ghana, 2022) [48], found this female predominance in urban areas but with a prevalence much higher than that of our study respectively at 68.3% and 68.6% in women (vs 58% in men)

Taking into account the high prevalence of abdominal obesity in women in our study, the difficulty in carrying out the biochemical assessment would be an explanation for the underestimation of the metabolic syndrome, also the inclusion criteria in the other studies differ in our studies.

Blood Sugar

The mean blood sugar of 283±141mg/dl was similar to that of 285 ±102 mg/dl reported by Oga *et al*., (Côte-d'Ivoire) [27], much higher than that reported by Chinenye *et al*., [23], with a fasting average of 145 mg/l and 190 mg/dl postprandial.

On the other hand, Assita Yao *et al*., [22], reported a glycemic average of 400 mg/gl, higher than that found in our study, the difference which is explained by the inclusion criteria (the study included only hospitalized patients).

The high blood sugar in our patients indicates a late diagnosis of diabetes, especially for patients admitted to hospital, with glycemic level above 600 mg/dl.

CONCLUSION

This study shows that diabetes mellitus and its risk factors are common in all social classes in Congo. These pathologies, often associated with cardiovascular complications, predominate in the Congolese urban environment. Their late diagnosis indicates a lack of prevention and early screening policies. There is a need to build strategies to reduce the impact of urbanization.

Limitations of the Study

Inclusion was not global in Brazzaville due to lack of reliable source (non-existence of the register), or exists the specialized service, we included only the T1D of the La Maison Bleue Center.

The incidence between 2010 and 2013 is biased by the delay in providing the kits.

The difficulty of carrying out the paraclinical assessment (supported by the patient) constitutes a limit for a complete diagnosis of patients (especially in rural areas).

The typing of diabetes mellitus is based on epidemiological, clinical and evolutionary arguments under treatments. Immunogenetic tests were not carried out.

Conflicts of Interest: The authors have not conflicts of interest to declare

Authors' Contributions: All authors contributed in designing of the study, wri ting the article and approved the final version.

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