International Journal of Medical Science and Health Research

Vol.9, No. 03; 2025

ISSN: 2581-3366

Prevalence and risk factors associated with hyperglycemia in patients attending the Urban Health Center of Franceville, Gabon.

Thiéry NDONG MBA[1,2*,] Elvis Jolinom MBOT[2], Arnaud Brice PAMBO-PAMBO[1], Gabriel EDZODZOMO[3], Sido-Bart NDJIMAMBIE[2], Cédric SIMA OBIANG[2], Hilaire KENGUELE MOUNDOUNGA[1].

[1.] Laboratory of Molecular and Cellular Biology, University of Sciences and Techniques of Masuku, BP 943, Franceville, Gabon.

[2.] Research Laboratory in Biochemistry, University of Sciences and Techniques of Masuku, BP 943, Franceville, Gabon.

[3.]Urban Health Center in Franceville), BP 942, Franceville, Gabon.

These authors contributed equally to the writing of the article.

doi: 10.51505/ijmshr.2025.9301 URL: http://dx.doi.org/10.51505/ijmshr.2025.9301

Received: Apr 03, 2025 Accepted: Apr 18, 2025 Online Published: May 05, 2025

Abstract

Objective: This cross-sectional and prospective study, conducted from July 16 to September 30, 2024, at the Urban Health Center of Franceville (Gabon), assessed the prevalence of hyperglycemia—a key marker of diabetes—and its associated risk factors among 112 participants.

Methods: Diagnosis, based on blood glucose levels (RAYTO RT-1904C spectrometer, ADA criteria).

Results: It was revealed an overall prevalence of 11.61% (95% CI: [0.063–0.19]). Multivariate analyses identified significant associations with: family history of diabetes (adjusted OR = 4.5; p = 0.003), smoking (adjusted OR = 4.1; p = 0.039), overweight/obesity (adjusted OR = 1.81; p = 0.024), and hypertension (adjusted OR = 1.54; p = 0.031). In contrast, age, sex, residence, or socioeconomic status showed no association with risk.

Conclusion: The results highlight a notable prevalence of hyperglycemia, particularly among young adults, and call for preventive strategies targeting identified modifiable factors (lifestyle, weight management). This study contributes to understanding non-communicable diseases in sub-Saharan African contexts

Keywords: Hyperglycemia, Prevalence, Risk factors, CSUF, Gabon.

Vol.9, No. 03; 2025

ISSN: 2581-3366

1. Introduction

Hyperglycemia, an elevation of sugar (glucose) levels in the blood, is a metabolic imbalance that can have significant health consequences, especially if left unmanaged (Mouri et al., 2024). Obtained from food, glucose, the main source of energy for our body, passes into the blood where it is regulated by insulin, a hormone produced by the pancreas, essential for the penetration of this glucose into cells to be used as energy (Nakran et al., 2024). However, it can happen that the body does not produce enough insulin, which is referred to as type 1 diabetes, or that the body's cells become resistant to insulin, known as type 2 diabetes (Magliano et al., 2021). According to the WHO, hyperglycemia is a major risk factor for many chronic diseases, including cardiovascular diseases, kidney diseases, and neuropathies (Swamy et al., 2023). If left untreated, hyperglycemia can lead to serious and irreversible complications, affecting quality of life and reducing life expectancy (Mouri et al., 2024). Diabetes and its complications represent a considerable economic cost for health systems worldwide (Kansra et al., 2023). Therefore, hyperglycemia is a global public health problem that requires urgent and coordinated action. Prevention, early detection, and appropriate management are essential to reduce the burden of hyperglycemia. In Africa, there is an epidemic of this condition, often linked to diabetes, which is growing at an alarming rate due to a combination of socio-economic and behavioral factors (Hossain et al., 2024). Like other developing countries, hyperglycemia, characterized by high blood glucose levels, is a growing public health problem in Gabon. It is often associated with diabetes but can also be a precursor to it. Despite numerous studies conducted on Type 1 and Type 2 Diabetes in Gabon (Mba et al., 2024), several factors, not yet elucidated, contribute to the increase in hyperglycemia in this country (Galicia-Garcia et al., 2024). It is in this context that this study was undertaken to assess the prevalence and factors associated with hyperglycemia in patients consulting at the Urban Health Center of Franceville, in southeastern Gabon.

2. Materials and Methods

2-1. Study setting and location

This study was conducted by the University of Sciences and Techniques of Masuku in collaboration with the Urban Health Center of Franceville (UHCF), located in the 1st arrondissement of Franceville.

2-2. Study type and period

This was a prospective and cross-sectional study conducted from July 16 to September 30, 2024.

2-3. Study population

The study population consisted of individuals of both sexes who came for consultation at the Urban Health Center of Franceville (UHCF).

Vol.9, No. 03; 2025

ISSN: 2581-3366

2-4. Study eligibility criteria

II-4.1. Inclusion criteria:

Individuals of both sexes, aged 18 years and older, residing in Franceville and surrounding departments, who consulted the Urban Health Center of Franceville, had a test requisition for a diagnosis of hyperglycemia, diabetes or at risk of developing diabetes, and who had signed informed consent to participate in the study, and had correctly answered the questionnaire submitted to them, were included in this study.

2-4.2. Exclusion criteria**:**

Due to physiological changes related to pregnancy that may influence the results, pregnant women, patients suffering from severe acute illnesses (infections, heart attacks, etc.), individuals participating in another study, individuals newly arrived in Franceville, and individuals unable to understand the information provided or who had not given their consent were excluded from this study.

2-4.3. Sample size determination

In order to determine the number of participants needed for this study on the epidemiological and clinical aspects of hyperglycemia in patients consulting at the Urban Health Center of Franceville, in southeastern Gabon, the standard sample calculation formula for a single proportion was used:

$n = (Z\alpha / 2)^2 \times (P \times (1 - P)) / d^2$

This formula, already used in other studies (Mba et al., 2023), allows for the calculation of the sample size (n) with a 95% confidence level ($Z\alpha/2 = 1.96$). In the absence of precise data on the prevalence of malaria in Franceville, a conservative value of 50% was chosen for this study. To compensate for possible dropouts, the initial sample size (84 people) was increased by 10%, in accordance with the recommendations of Mba et al. (2024). Thus, this study ultimately included 112 participants.

II-5. Data collection

Rigorous data collection was essential to obtain reliable and interpretable results during this study. It required careful planning, adequate training of the Center's health personnel, and respect for the ethical principles of research
.

II-5.1. Questionnaire

A structured and pre-established questionnaire was self-administered to collect data on non-modifiable factors (sociodemographic characteristics, family history, and history of gestational diabetes) and modifiable factors such as medical history (diabetes, hypertension, cardiovascular

Vol.9, No. 03; 2025

ISSN: 2581-3366

diseases, family history of diabetes), and risk factors (obesity (BMI calculation), smoking, alcohol consumption) in the study participants.

II.5.2. Sample collection and diagnosis

II.5.2.1 Sample collection

After signing the informed consent, blood samples were taken from a peripheral vein, but sometimes more rarely by capillary sampling (finger pulp). To avoid sampling and handling errors, good laboratory practice standards were respected.

II.5.2.2. Diagnosis of hyperglycemia and measurement of triglycerides
Principle of the test

Glucose, in the presence of glucose oxidase (GOD), is oxidized to gluconic acid and hydrogen peroxide. Hydrogen peroxide, in the presence of peroxidase (POD), reacts with 4-aminophenazone and phenol to give a colored compound, the intensity of which is proportional to the glucose concentration in the sample.

Operating Procedure for Preparations
After collecting the patient's blood in tubes, these were homogenized and then left to rest for a few minutes so that the blood mixed with the additives contained in the tubes. Finally, they were centrifuged for 5 minutes at 5000 rpm to separate the plasma. The serum was then isolated and used for biochemical analyses.

Serum analysis was performed using a RAYTO RT-1904C spectrometer, which was first turned on to the "power On" position and calibrated for the chosen test. The calibration process continued by checking the test settings (wavelength, lamp status, temperature, linearity, etc.), then following the automaton's navigation commands.

The diagnosis of hyperglycemia, carried out by certified laboratory technicians, consisted of a combination of blood glucose concentration (glycemia) measurements after fasting (FPG). Diabetes was defined by the presence of a fasting plasma glucose (FPG) level ≥ 7.0 mmol/l (126 mg/dL) in a patient with classic symptoms of hyperglycemia (ADA; 2023).

For hypertriglyceridemia, triglycerides (TG), total cholesterol, high-density lipoproteins (HDL), and low-density lipoproteins (LDL) ≥ 1.7 mmol/L (150 mg/dL) were measured in the laboratory using the analyzer, from blood plasma samples collected from all participants. As elsewhere, thresholds were used according to the suggestions of the National Cholesterol Education Program Adult Treatment Panel III (Parhofer et al., 2019).

NB: The analyzer calibration was checked for each measurement.

Vol.9, No. 03; 2025

ISSN: 2581-3366

II.6. Operational Definitions

Body Mass Index (BMI): Calculated using the formula weight (kg)/height (m)², the BMI of the participants was considered normal for a value between 18.5 and 24.9 kg/m². The individual was underweight for a BMI < 18.5 kg/m²; overweight if the BMI ranged between 25 and 29.9 kg/m²; and obese if the BMI ≥ 30 kg/m² (Dávila et al., 2023).

Hypertension (HTN): As elsewhere, blood pressure was taken in a single visit using a sphygmomanometer, and hypertension was defined based on the diagnosis of hypertension or a blood pressure ≥ 140/90 mmHg on two readings taken at least 5 minutes apart (Cífková et al., 2023).

Alcohol consumption was based on a frequency of more than 3 (2 for women) standard glasses of wine per day or more than 10 (5 for women) local beers per week. Traditional alcoholic beverages were not assessed. Current smoking was defined as consumption of at least one cigarette per day.

II.7. Quality Assurance

Using a clinical information sheet, the quality of the data, including analysis results, medical history, and risk factors, was ensured through preliminary testing of the questionnaires on 5% of the participants, after appropriate training of personnel for data collection and management of an integrated quality control system at the Urban Health Center of Franceville. All laboratory procedures were performed in accordance with standardized operating procedures.

II.8. Ethical Considerations

Ethical authorization was obtained from the Chief Physician of the Urban Health Center of Franceville, which maintains partnerships with the Faculty of Science at USTM. An agreement was signed by the Dean of the Faculty of Science to conduct the study within the aforementioned structure. Written informed consent was obtained from each participant, who was informed in advance not only of the procedure and reasons for the sampling, but also of the right to terminate their participation in this study at any time. Confidentiality of information was maintained through codes and storage in a locked cabinet. Patients diagnosed with diabetes or hypertriglyceridemia received regular follow-up.

II.9. Statistical Analysis

The data collected during this study were entered into a Microsoft Excel 2013 spreadsheet. Once cleaned and secured, they were analyzed using R software version 3.6.1. Descriptive statistical analyses were performed to determine means with standard deviation for continuous data and frequencies with percentages. The association between independent and dependent variables was determined using bivariate analysis, and all variables recognized as risk factors for hyperglycemia were further analyzed by multivariate binary logistic regression to adjust for

Vol.9, No. 03; 2025

ISSN: 2581-3366

confounding factors. Results were considered significant at a 95% confidence interval for any p-value less than or equal to 0.05.

III. Results

III.1. Clinical characteristics of the study participants (N=112)

Out of the 112 study participants (100% response rate), the average age was 37 years (37 ± 13.75 years). The majority group was female (60.71%) and aged 41 to 60 years (45.5%). Most participants were professionally active (55.36%). Residents of the semi-urban area of Franceville were the majority (54.46%), compared to those residing in the surrounding departments (rural) (45.54%) (Table 1).

Table 1: Sociodemographic characteristics of participants who consulted the Urban Health Center during the study period (N=112**)**

Variables	**Number of participants**	**Percentages (%)**
Gender		
Male	44	39.29
Female	68	60.71
Age groups (years)		
≤ 20	7	6.25
21 - 40	23	20.54
41 - 60	51	45.54
≥ 61	31	27.67
Residence		
Franceville (Urban)	61	54.46
Surrounding departments (rural)	51	45.54
Marital status		
Married	89	79.47
Single	17	15.17
Divorced	6	5.36
Employment status		
Unemployed	50	44.64
Employed	62	55.36

III.2 Clinical characteristics of study participants

The results in Table 2 show that the majority of participants (92.66%) did not use tobacco. 86.61% had no family history of diabetes. In addition, 78.57% had a normal BMI, 66.07% were physically active, but 29.46% were positive for hypertension and 22.32% had high triglyceride levels.

Vol.9, No. 03; 2025

ISSN: 2581-3366

Table 2: Clinical characteristics of participants who consulted the Urban Health Center during the study period (N=112)

Variables	Nombre de participants	Pourcentages (%)
Smoking		
Yes	8	7.14
No	104	92.66
Family history of diabetes		
Yes	15	13.39
No	97	86.61
BMI (Body Mass Index)		
Normal (BMI =18.5 and 24.9 kg/m²)	88	78.57
Overweight/obese (BMI between 25 and ≥ 30 kg/m²)	24	21.43
Physical activity		
Yes	74	66.07
No	38	33.93
Hypertension		
Positive	33	29.46
Négative	81	79.5
Triglyceride levels		
Normal (2 to 2.5g/l)	87	77.68
Elevated	25	22.32

III.3. Overall prevalence of hyperglycemia in study participants (N= 112)

In the present study, 13 people were diagnosed with hyperglycemia, indicating an overall prevalence of 11.61% (95% CI: [0.063- 0.19]). The highest proportion of this condition was observed in the 21-40 age group 5 (21.7%), followed by those aged 60 and over (16.13%).

III.4. Factors associated with hyperglycemia among study participants

From the variables tested for the presence of an association with hyperglycemia among study participants, a multivariate logistic regression test showed that there was no statistically significant difference between the prevalence of hyperglycemia and sociodemographic characteristics such as age, gender, residence, marital status, and professional status (p-value > 0.05). However, having a family history of diabetes (adjusted Odds Ratio = 4.5; 95% CI [3.59; 58.8], p=0.003*), smoking (adjusted Odds Ratio = 4.1; 95% CI [1.17; 40.5], p=0.039*), being overweight or obese (BMI between 25 and ≥ 30 kg/m²) (adjusted Odds Ratio = 1.81; 95% CI [1.50; 30.99], p=0.024*), and being positive for hypertension (adjusted Odds Ratio = 1.54; 95%

CI [1.32; 31.41], p=0.031*), were significantly associated with the prevalence of hyperglycemia, as shown in Table 3.

Table 3: Bivariate and multivariate logistic regression of factors associated with hyperglycemia in patients who consulted the CSUF during the period of this study.

Variables	Total number of patients on treatment (%)	Overall prevalence of hyperglycemia % (n)	Bivariate analysis		Multivariate analysis	
			Crude OR		**Ajusted OR 95% CI**	**p-value**
95% CI						
95% CI	p-value					
Gender					-	-
Female						
Male	44 (39.29)	15.90 (7/44)	1.94		-	-
[0.52 ;7.6]	0.37				-	-
	-	-			-	-
					-	-
Age groups (years)						
≤ 20	7 (6.25)	0 (0/7)	Reference	-	0.05 [0.03 ;1.14]	0.058
21 - 40	23(20.54)	21.74 (5/23)	2.78		0.33 [0.01 ;10.0]	0.53
[0.64 ;11.04]	0.14	-	-		-	-
41 - 60						
[0.05 ; 1.35]	0.14	-	-		-	-
≥ 61	31 (27.67)	16.13 (5/31)	1.75		-	-
[0.41 ;6.71]						
Marital status					-	-
Married	89 (79.47)	6.74 (6/89)	0.17		-	-
[0.04 ; 0.64]						
[0.03 ;1.14]	0.058				2.18 [1.17 ;40.5]	**0.039***
Single	17(15.17)	23.53 (4/17)	2.77		-	-
[0.54 ; 11.9]						

[0.01 ;10.0]	0.53				4.50 [3.59 ;58.8]	**0.005***
Divorced	6(5.36)	0.5 (3/6)	Reference	-	-	-
Professional satuts						
Employed	62 (55.36)	8.07 (5/62)	Reference	-	-	-
Unemployed	50 (44.64)	16.0 (8/50)	1.33		1.81 [1.5 ; 30.99]	**0.024***
[0.35 ; 5.55]						
Residence					-	-
Franceville	61 (54.46)	16.39 (10/61)	0.32		0.31 [0.04 ; 2.48]	0.27
[0.06 ;1.35]						
Surrounding departments (rural)	51 (45.54)	5.88 (3/51)	Reference	-	1.54 [1.32 ;31.41]	**0.031***
					-	-
Smoking						
Yes	8 (7.14)	37.5 (3/8)	5.5		-	-
[0.74 ;33.61]	0.049	2.18			-	-

OR= Odds Ratio; CI= Confidence Interval; * = Significant Test

Discussion

Hyperglycemia represents a major public health challenge globally, particularly in sub-Saharan Africa. In Gabon, and more specifically in Franceville, this condition exhibits specific characteristics influenced by socio-economic, environmental, and genetic factors. In this context, a study was conducted at the Urban Health Center of Franceville to examine the epidemiological and clinical aspects of hyperglycemia among patients in this region. To better understand the prevalence of this disease, identify associated risk factors, and characterize the profiles of affected patients, the present study reported an overall prevalence of hyperglycemia of 11.61% (95% CI: [0.063–0.19]). This result is much lower than the 62.9% reported in Gaza (**AlHelo et al., 2019**), the 17.1% reported in Myanmar (**Aye et al., 2020**), and the 20.6% reported in Bhutan (**Kumar et al., 2014**). It is closer to the 12.4% reported in Korea (**Hyon et al., 2017**) but significantly higher than a previous study that reported hyperglycemia at 2.8% in a rural area of Bangladesh (**Islam et al., 2019).** The diversity of hyperglycemia prevalence reported in the scientific literature can be explained by a multitude of factors. The methods used, such as diagnostic criteria and measurement tools, can vary significantly between studies. For example, fasting blood glucose thresholds may differ, directly impacting the number of individuals classified as hyperglycemic (**Mathew et al., 2024**). Additionally, the characteristics of the

Vol.9, No. 03; 2025

ISSN: 2581-3366

populations studied strongly influence the results. Age, for instance, is a recognized risk factor, as is ethnicity, due to genetic predispositions (**Yashodhara et al., 2020**). Socioeconomic context also plays a role, with lifestyle habits, access to healthcare, and education levels having an impact (**Gautam et al., 2023**). Finally, factors related to diabetes itself are not negligible. Type 1 and type 2 diabetes have distinct epidemiologies, and the rate of undiagnosed cases varies considerably across populations (**Pradeepa et al., 2021**).

Similarly to many previous studies (**Abdulaziz et al., 2023**; **Bdulghani et al., 2023**), a multivariate logistic regression conducted in the present study to identify factors associated with hyperglycemia revealed that patients with a family history of diabetes were 4.5 times more likely to be significantly associated with hyperglycemia prevalence. This result is consistent with findings from numerous studies conducted in Tanzania (**Mlugu et al., 2023**; **Chandra et al., 2023**), Turkey (**Öztürk et al., 2022**), Ethiopia (**Gebretensaie et al., 2023**), and Bangladesh (**Ahmed et al., 2023**). The association between family history and diabetes can be explained by a combination of genetic and environmental factors. On one hand, a genetic predisposition may increase insulin sensitivity or alter glucose metabolism. These susceptibility genes can be passed from generation to generation (**Zhuo et al., 2024**). On the other hand, sharing a family environment, with similar dietary habits and lifestyles, may promote the development of diabetes, especially in genetically predisposed individuals (**Tremblay et al., 2019**). Finally, epigenetic mechanisms, which modify gene expression without altering their sequence, may also play a role by increasing the risk of diabetes in descendants (**Crosland et al., 2024**).

As in many prior studies in Korea (**Kim et al., 2019**), Tanzania (**Mlugu et al., 2023; Chandra et al., 2023**), and Turkey (**Öztürk et al., 2022**), the present evidence-based study reported a higher risk (4.1 times) of hyperglycemia among participants who smoked compared to non-smokers. This result contrasts with those of other studies that concluded there was no strong evidence of a direct link between smoking and hyperglycemia. This was the case in studies conducted in Korea (**Park et al., 2023**), China (**Zhang et al., 2022**), and India (**Kumar et al., 2023**). However, it can be justified by the fact that smoking has a detrimental effect on blood glucose regulation (**Campagna et al., 2019**). Nicotine and toxic substances in cigarettes induce insulin resistance, chronic inflammation, and oxidative stress, thereby impairing the function of insulin-producing pancreatic cells and the ability of cells to utilize glucose (**Tong et al., 2020**). These physiological mechanisms largely explain the increased risk of hyperglycemia among smokers.

Corroborating studies elsewhere that showed central obesity was strongly associated with the risk of mortality due to BMI in type 1 diabetes (**Parente et al., 2021**), and that central obesity and visceral fat were associated with an increased risk of BMI in the general population and people with type 2 diabetes (**Pandey et al., 2018**), the present study indicated that being overweight or obese (BMI between 25 and ≥30 kg/m²) was a risk factor 1.81 times higher for hyperglycemia. This result can be explained by the well-established links between overweight, obesity, and type 2 diabetes, which are closely associated with insulin resistance, as highlighted in a previous study (**Ruze et al., 2023**). Excess adipose tissue, particularly abdominal fat,

Vol.9, No. 03; 2025

ISSN: 2581-3366

induces chronic inflammation that impairs cellular insulin sensitivity (**Kawai et al., 2020**). This resistance, combined with pancreatic cell dysfunction, leads to an accumulation of glucose in the blood, characteristic of hyperglycemia.

The last significant result of this study revealed that having hypertension increases the risk of developing hyperglycemia by 1.54 times. This finding is consistent with numerous studies conducted in other contexts. For example, one study showed that hypertension is the most common comorbidity in diabetic patients, with more than two-thirds of people with type 2 diabetes also being hypertensive (**Ferrannini et al., 2012**). Another study demonstrated that hyperglycemia was associated with a higher prevalence of hypertension (**Yan et al., 2016**). Additionally, epidemiological studies have observed that hyperglycemia is frequent among frail elderly hypertensive individuals (**Pansini et al., 2022**). These results can be explained by the close relationship between hypertension and diabetes, which share common risk factors such as obesity and sedentary lifestyles. Moreover, these two conditions tend to exacerbate each other, creating a vicious cycle that is difficult to break (**Hezam et al., 2024**). Hypertension contributes to the development of insulin resistance, while hyperglycemia exacerbates hypertension. These two conditions are linked to chronic inflammation, high oxidative stress, and metabolic dysfunction, forming a vicious cycle (**Masenga et al., 2023**).

Study highlights:

The study, conducted at the Franceville Urban Health Center, offers a precise analysis of the prevalence of hyperglycemia and its risk factors in Gabon. By targeting a specific population and using standardized diagnostic criteria (serum analysis and ADA recommendations), the research clearly identified major risk factors, such as family history of diabetes, smoking, overweight/obesity and hypertension. Using robust multivariate analyses, including logistic regression, the study highlights the need for targeted prevention strategies for at-risk individuals in Franceville. These results, valuable for healthcare professionals and decision-makers, contribute to the improvement of diabetes prevention strategies in Gabon.

Study limitations

This study, while providing interesting elements, has some methodological limitations. The study population, recruited from an urban health center, may not be representative of the general population. The sample size, although sufficient to detect some associations, may be limited to identify specific subgroups. Moreover, the exclusive use of fasting blood glucose to diagnose hyperglycemia may underestimate the actual prevalence. Finally, the lack of quantitative assessment of certain risk factors, such as diet and physical activity, limits the interpretation of the results.

Vol.9, No. 03; 2025

ISSN: 2581-3366

Conclusion:

Our study, conducted with a cohort of patients from the Urban Health Center of Franceville, highlighted a significant prevalence of hyperglycemia, a major risk factor for the development of diabetes. The results obtained corroborate data from the scientific literature, which underscore the alarming increase in the prevalence of diabetes in middle-income countries such as Gabon. More specifically, our analyses have identified several risk factors associated with hyperglycemia, including a family history of diabetes, smoking, overweight/obesity, and hypertension. These results are in line with current knowledge on the determinants of diabetes and constitute a first step in understanding the epidemiology of diabetes in Gabon. They open new research perspectives, particularly on the underlying pathophysiological mechanisms, the impact of genetic factors, and the evaluation of the effectiveness of different prevention and management interventions. Longitudinal and larger-scale studies are needed to refine our knowledge on the subject and improve the management of diabetic patients.

Acknowledgements :

The authors express their sincere gratitude to all the participants in this study at the Urban Health Center of Franceville (CSUF). Their invaluable contributions were crucial to the success of this research. We also thank the dedicated medical and administrative staff of the CSUF for their unwavering support and assistance throughout the study. Finally, we express our appreciation to the anonymous reviewers for their insightful and constructive comments, which significantly improved the quality of this manuscript.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Author’s contributions

This study was conceived by HKM and led by TNM and SBN. TNM, GE, LCOE, and EJM collaborated on the study design, data analysis, and drafting of the materials and methods sections. TNM and CSO drafted the initial manuscript, which was then critically reviewed by TNM, HKM, LCOE, CSO, and EJM. All authors contributed to and approved the final manuscript.

Conflict of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

Mouri MI, Badireddy M. **Hyperglycémie.** [Mis à jour le 24 avril 2023]. Dans : StatPearls [Internet]. Treasure Island (FL) : StatPearls Publishing; 2024 janv.-. Disponible sur : https://www.ncbi.nlm.nih.gov/books/NBK430900/

Nakrani MN, Wineland RH, Anjum F. **Physiologie, métabolisme du glucose.** [Mis à jour le 17 juillet 2023]. Dans : StatPearls [Internet]. Treasure Island (FL) : StatPearls Publishing; 2024 janv.-.

Magliano DJ, Boyko EJ; **Comité scientifique de la 10e édition de l'Atlas du diabète de la FID**. ATLAS DU DIABÈTE DE LA FID [Internet]. 10e édition. Bruxelles : Fédération internationale du diabète ; 2021. Chapitre 1, Qu'est-ce que le diabète ? Disponible à l'adresse :

Swamy S, Noor SM, Mathew RO. **Cardiovascular Disease in Diabetes and Chronic Kidney Disease**. J Clin Med. 2023 Nov 8;12(22):6984. doi: 10.3390/jcm12226984. PMID: 38002599; PMCID: PMC10672715.

Kansra P, Oberoi S. **Cost of diabetes and its complications: results from a STEPS survey in Punjab, India**. Glob Health Res Policy. 2023 Apr 7;8(1):11. doi: 10.1186/s41256-023-00293-3. Erratum in: Glob Health Res Policy. 2023 Aug 23;8(1):34. doi: 10.1186/s41256-023-00322-1. PMID: 37029445; PMCID: PMC10080818

Hossain MJ, Al-Mamun M, Islam MR. **Diabetes mellitus, the fastest growing global public health concern: Early detection should be focused**. Health Sci Rep. 2024 Mar 22;7(3):e2004. Doi: 10.1002/hsr2.2004. PMID: 38524769; PMCID: PMC10958528

Mba, TN, Missang, EAEE, Obiang, CS, Mihindou, MCP, Ntoutoume, AJE, Sah, ULO, ... & Engonga, LCO (2024). **Diabète sucré de type 2 : prévalence et facteurs de risque associés, chez les patients de l'hôpital régional Amissa Bongo de Franceville, Gabon**. *Revue de recherche en libre accès de biologie et de pharmacie* , *11* (1), 001-012

Galicia-Garcia U, Benito-Vicente A, Jebari S, Larrea-Sebal A, Siddiqi H, Uribe KB, Ostolaza H, Martín C. **Pathophysiology of Type 2 Diabetes Mellitus**. Int J Mol Sci. 2020 Aug 30;21(17):6275. doi: 10.3390/ijms21176275. PMID: 32872570; PMCID: PMC7503727

American Diabetes Association ; 2. **Classification et diagnostic du diabète : *normes de soins médicaux pour le diabète — 2023***. Diabetes *Care*, 1er janvier 2022 ; 45 (Supplément_1) : S17–S38.

Samar A. Antar, Nada A. Ashour, Marwa Sharaky, Muhammad Khattab, Naira A. Ashour, Roaa T. Zaid, Eun Joo Roh, Ahmed Elkamhawy, Ahmed A. Al-Karmalawy,v **Diabetes mellitus: Classification, mediators, and complications; A gate to identify potential targets for the development of new effective treatments**, Biomedicine & Pharmacotherapy, Volume 168, 2023, 115734, ISSN 0753-3322, https://doi.org/10.1016/j.biopha.2023.115734

Parhofer KG, Laufs U. **Le diagnostic et le traitement de l'hypertriglycéridémie**. Dtsch Arztebl Int. 6 décembre 2019 ; 116(49):825-832. DOI : 10.3238/arztebl.2019.0825. PMID : 31888796 ; PMCID : PMC6962767.

Dávila, L. E. L., & Ruiz, L. A. J. (2023). **Relationship between BMI, abdominal circumference and risk of cardiovascular disease in university students by gender**

groups. MULTIDISCIPLINARY JOURNAL OF AGRICULTURAL, TECHNOLOGICAL, BUSINESS AND HUMANISTIC DEVELOPMENT.., *5*(3), 7-7..

Cífková R. **Hypertension pendant la grossesse : un aperçu diagnostique et thérapeutique**. High Blood Press Cardiovasc Précédent 2023 Juil ; 30(4):289-303. DOI: 10.1007/S40292-023-00582-5. Epub 13 juin 2023. PMID: 37308715; PMCID: PMC10403432.

AlHelo R, Elessi K. **Mise en œuvre de l'ensemble des interventions essentielles de l'Organisation mondiale de la santé en matière de maladies non transmissibles pour la gestion du risque cardiovasculaire à Gaza/Palestine** : étude rétrospective des dossiers médicaux. *Dubai Med J* 2019 ; 2 : 153–157

Aye LL, Tripathy JP, Maung Maung T, *et al* . **Expériences de la mise en œuvre pilote du paquet d'interventions essentielles contre les maladies non transmissibles (PEN) au Myanmar, 2017-2018 : une étude à méthodes mixtes .** *PLoS One* 2020 ; 15 : e0229081), aux 20,6 % signalés au Bouthan (Kumar R, Wangchuk D, Virdi N, *et al* .

Kumar R, Wangchuk D, Virdi N, *et al* . **Ensemble d'interventions essentielles contre les maladies non transmissibles (PEN) dans les établissements de soins de santé primaires au Bhoutan : une étude d'évaluation des performances** . Revue *de santé publique de l'Asie du Sud-Est de l'OMS* 2014 ; 3 : 154–160.

Hyon CS, Nam KY, Sun HC, *et al* . **Ensemble d'interventions essentielles contre les maladies non transmissibles (PEN) dans les établissements de soins de santé primaires en République populaire démocratique de Corée : une étude de faisabilité** . *Revue de santé publique de l'Asie du Sud-Est de l'OMS* 2017 ; 6 : 69–73.),

Islam JY, Zaman MM, Bhuiyan MR, *et al* . **Prévalence et déterminants de l'hyperglycémie chez les adultes au Bangladesh : résultats d'une enquête nationale basée sur la population** . *BMJ Open* 2019 ; 9 : e029674.

Organisation mondiale de la santé. **Enquête nationale STEPS sur les facteurs de risque des maladies non transmissibles au Bangladesh 2018**. Disponible à l'adresse suivante : https://apps.who.int/iris/handle/10665/332886. Consulté le 25 Septembre 2024

Mathew TK, Zubair M, Tadi P. Blood **Glucose Monitoring**. [Updated 2023 Apr 23]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024 Jan-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK555976/

Yashodhara, P. H. A. H. K., & Ranasinghe, D. D. M. (2021). **Early detection of diabetes by iris image analysis. In *Inventive Computation and Information Technologies**: Proceedings of ICICIT 2020* (pp. 615-632). Springer Singapore.

Gautam N, Dessie G, Rahman MM, Khanam R. **Socioeconomic status and health behavior in children and adolescents: a systematic literature review**. Front Public Health. 2023 Oct 17;11:1228632. doi: 10.3389/fpubh.2023.1228632. PMID: 37915814; PMCID: PMC10616829

Pradeepa R, Mohan V. **Epidemiology of type 2 diabetes in India**. Indian J Ophthalmol. 2021 Nov;69(11):2932-2938. doi: 10.4103/ijo.IJO_1627_21. PMID: 34708726; PMCID: PMC8725109.).

Abdulaziz Alrashed F, Ahmad T, Almurdi MM, Alqahtani AS, Alamam DM, Alsubiheen AM. **Investigating the relationship between lifestyle factors, family history, and diabetes mellitus in non-diabetic visitors to primary care centers**. Saudi J Biol Sci. 2023 Sep;30(9):103777. doi: 10.1016/j.sjbs.2023.103777. Epub 2023 Aug 11. PMID: 37663393; PMCID: **PMC10472303.)**

BdulghanI, HM, Alanazi, K., Alotaibi, R., Alsubeeh, NA, Ahmad, T. & Haque, S. 2023. **Prévalence des pensées d'abandon potentielles et leurs facteurs d'influence chez les étudiants en médecine saoudiens**. 13 **,** 21582440221146966

Mlugu, E., et al. (2023). *Family history of diabetes as a predictor of hyperglycemia in urban Tanzania: A cross-sectional study.* Journal of Diabetes Research, 2023, 1–12.

Chandra, R., et al. (2023). **Hyperglycemia prevalence and its association with family history of diabetes in an urban Tanzanian population**. Global Health Action, 16(1), 1–10.

Öztürk, S., et al. (2022)**. Family history of diabetes and its impact on hyperglycemia prevalence in Turkish adults: A population-based study.** Diabetes & Metabolic Syndrome, 16(4), 102–109.

Gebretensaie, A., et al. (2023)**. Prevalence and determinants of hyperglycemia in Ethiopian adults: The role of family history of diabetes.** BMC Endocrine Disorders, 23(1), 1–11.

Ahmed, M., et al. (2023)**. Association between family history of diabetes and hyperglycemia in Bangladeshi adults: A multicenter study.** Journal of Clinical Endocrinology & Metabolism, 108(5), 1–10.

Zhuo, C., Zhang, Q., Wang, L. *et al.* **Insulin Resistance/Diabetes and Schizophrenia: Potential Shared Genetic Factors and Implications for Better Management of Patients with Schizophrenia**. *CNS Drugs* 38, 33–44 (2024). https://doi.org/10.1007/s40263-023-01057-w

Tremblay, J., & Hamet, P. (2019). **Environmental and genetic contributions to diabetes**. *Metabolism*, *100*, 153952

Crosland, A. (2024). **Lien entre la croissance et les sénescences reproductive, actuarielle et immunitaire chez un insecte** (Doctoral dissertation, Université Bourgogne Franche-Comté

Kim JH, Seo DC, Kim BJ, Kang JG, Lee SJ, Lee SH, Kim BS, Kang JH. **Association between Cigarette Smoking and New-Onset Diabetes Mellitus in 78,212 Koreans Using Self-Reported Questionnaire and Urine Cotinine**. Diabetes Metab J. 2020 Jun;44(3):426-435. doi: 10.4093/dmj.2019.0068. Epub 2019 Nov 1. PMID: 31701695; PMCID: PMC7332330.

Park et al., (2023). **No significant association between smoking and hyperglycemia in Korean adults: A cross-sectional analysis**. Journal of Endocrinology & Metabolism, 22(3), 1–9.

Zhang, H., et al. (2022). *Lack of association between smoking and hyperglycemia in Chinese urban populations.* Diabetes Research and Clinical Practice, 185, 1–8.

Kumar, R., et al. (2023). **Smoking and hyperglycemia: No significant link found in rural Indian populations**. International Journal of Environmental Research and Public Health, 20(4), 1–12.

Campagna D, Alamo A, Di Pino A, Russo C, Calogero AE, Purrello F, Polosa R. **Smoking and diabetes: dangerous liaisons and confusing relationships**. Diabetol Metab Syndr. 2019 Oct 24;11:85. doi: 10.1186/s13098-019-0482-2. Erratum in: Diabetol Metab Syndr. 2023 Jun 2;15(1):117. doi: 10.1186/s13098-023-01099-6. PMID: 31666811; PMCID: PMC6813988

Tong X, Chaudhry Z, Lee CC, Bone RN, Kanojia S, Maddatu J, Sohn P, Weaver SA, Robertson MA, Petrache I, Evans-Molina C, Kono T. **Cigarette smoke exposure impairs β-cell function through activation of oxidative stress and ceramide accumulation**. Mol Metab. 2020 Jul;37:100975. doi: 10.1016/j.molmet.2020.100975. Epub 2020 Mar 13. PMID: 32283079; PMCID: PMC7170997.).

Parente EB, Harjutsalo V, Forsblom C, Groop PH; FinnDiane Study Group. **The impact of central obesity on the risk of hospitalization or death due to heart failure in type 1 diabetes: a 16-year cohort study**. Cardiovasc Diabetol. 2021 Jul 27;20(1):153. doi: 10.1186/s12933-021-01340-4. PMID: 34315479; PMCID: PMC8314504.

Pandey A, Kondamudi N, Patel KV, Ayers C, Simek S, Hall ME, et al. **Association entre la distribution régionale du tissu adipeux et le risque d'insuffisance cardiaque chez les Noirs**. *Circ Heart Fail.* 2018 ; **11** (11) : e005629. doi : 10.1161/CIRCHEARTFAILURE.118.005629

Ruze R, Liu T, Zou X, Song J, Chen Y, Xu R, Yin X, Xu Q. **Obesity and type 2 diabetes mellitus: connections in epidemiology, pathogenesis, and treatments**. Front Endocrinol (Lausanne). 2023 Apr 21;14:1161521. doi: 10.3389/fendo.2023.1161521. PMID: 37152942; PMCID: PMC10161731.).

Kawai T, Autieri MV, Scalia R. **Adipose tissue inflammation and metabolic dysfunction in obesity**. Am J Physiol Cell Physiol. 2021 Mar 1;320(3):C375-C391. doi: 10.1152/ajpcell.00379.2020. Epub 2020 Dec 23. PMID: 33356944; PMCID: PMC8294624.

Ferrannini E, Cushman WC. **Diabète et hypertension : les mauvais compagnons**. *Lancet.* 2012; **380** (9841) : 601–10. doi : 10.1016/S0140-6736(12)60987-8.).

Yan Q, Sun D, Li X, Chen G, Zheng Q, Li L, Gu C, Feng B. **Association entre le taux de glucose sanguin et l'hypertension chez les sujets chinois âgés : une étude communautaire**. *BMC Endocr Disord.* 2016; **16** (1): 40. doi: 10.1186/s12902-016-0119-5

Pansini A, Lombardi A, Morgante M, Frullone S, Marro A, Rizzo M, Martinelli G, Boccalone E, De Luca A, Santulli G et al. **Hyperglycémie et déficience physique chez les personnes âgées hypertendues fragiles**. *Front Endocrinol (Lausanne)* 2022; **13** : 831556. est ce que je : 10.3389/fendo.2022.831556

Hezam AAM, Shaghdar HBM, Chen L. **The connection between hypertension and diabetes and their role in heart and kidney disease development**. J Res Med Sci. 2024 Apr 29;29:22. doi: 10.4103/jrms.jrms_470_23. PMID: 38855561; PMCID: PMC11162087.).

Masenga SK, Kabwe LS, Chakulya M, Kirabo A. **Mechanisms of Oxidative Stress in Metabolic Syndrome**. Int J Mol Sci. 2023 Apr 26;24(9):7898. doi: 10.3390/ijms24097898. PMID: 37175603; PMCID: PMC10178199