Cardiology Research and Cardiovascular Medicine
Ng'ekieb Mukoso, et al. Cardiolog Res Cardiovasc Med 10: 275.
www.doi.org/10.29011/2575-7083.100275
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Research Article

Determinants of The Incidence of Heart Failure in Diabetics in Goma, North Kivu, the Democratic Republic of the Congo

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Citation: Ng'ekieb Mukoso F, Wembonyama SO, Nkodila AN , Kamuanga ZT, Kapongo RY, et al. (2025) Determinants of The Incidence of Heart Failure in Diabetics in Goma, North Kivu, the Democratic Republic of the Congo. Cardiol Res Cardio vasc Med 10:274. DOI:https://doi.org/10.29011/2575-7083.100274

Received Date: 16 February, 2025; **Accepted Date:** 24 February, 2025; **Published Date:** 26 February, 2025

Citation: Ng'ekieb Mukoso F, Wembonyama SO, Nkodila AN , Kamuanga ZT, Kapongo RY, et al. (2025) Determinants of The Incidence of Heart Failure in Diabetics in Goma, North Kivu, the Democratic Republic of the Congo. Cardiol Res Cardio vasc Med 10:274. DOI:https://doi.org/10.29011/2575-7083.100274

Abstract

Background: Individuals with diabetes mellitus are at increased risk of developing heart failure due to the contributing influence of diabetes mellitus risk factors. But data on African literature are rare. The objective of this study is to evaluate the determinants of heart failure in patients with diabetes mellitus followed in Goma. **Methods:** Asymptomatic diabetics in the city of Goma were cross-sectionally recruited at the Center of the Association of Diabetics in Congo (ADIC) in Goma, DRC during the period from February 5 to 19, 2023. The incidence of heart failure was determined using pulse pressure (PP). A PP value ≥65 mmHg was considered as an incidence of heart failure. The association between the incidence of HF and the independent variables was evaluated by two models using the logistic regression test at the threshold of $p<0.05$. **Results:** The incidence frequency of heart failure was 29.9%. In multivariate analysis, adjusted for all these variables in multivariate in the two whose menopause and sex were collinear, the following variables emerged as determinants of incidence of HF in diabetics: hypertension (aOR: 5.93 IC95 %: 2.42-14.51), DS type 2 (aOR: 3.60 95% CI: 1.63-4.25), menopause (aOR: 5.48 95% CI: 3.03-9, 72) and eGFR<60 ml/min/1.73m² (ORa: 348 95% CI: 1.94-5.30), female sex (aOR: 2.80 95% CI: 1.06-3.80) and pathological fundus (aOR: 2.04, 95% CI: 1.77-5.35). **Conclusion:** The frequency of HF is high in asymptomatic diabetics in Goma. It is determined by gender, menopause, dS type 2, pathological fundus and altered eGFR.

Keywords: Incidence of HF, Diabetes mellitus, determinants, Goma

Introduction

Heart failure (HF) affects up to one in five adults during their lifetime and is associated with considerable mortality and morbidity, despite advances in management [1-3]. Although most of the burden of HF is borne by people aged 65 or older, study reports show an increase in the incidence of HF, especially in younger people [4,5].

Diabetes mellitus (DS) is a progressive and chronic metabolic disorder characterized by insulin resistance and functional failure of pancreatic beta cells [6, 7]. The prevalence of DS has increased intensely over the past decades, with the highest growth rates observed in sub-Saharan Africa [8,9].

The most deleterious consequence of DS is the considerable high risk of developing IC. Diabetic patients have up to 74% increased risk of developing HF and are likely to die [10]. The link between DS and HF is now the subject of many studies in the West and is less so in sub-Saharan Africa, yet DS is a major risk factor for HF [11].

In addition to conventional cardiovascular risk factors leading to the development of HF, individuals with DS are more vulnerable due to the contributing influence of diabetes-related risk factors including chronic hyperglycemia, insulin resistance and collagen deposition in the myocardium, ultimately leading to the so-called "diabetic cardiomyopathy", resulting in left ventricular and diastolic dysfunction [12]. Other than traditional cardiovascular risk factors, diabetic retinopathy (DR) is another common microvascular complication and is associated with cardiovascular events such as stroke, heart failure, and coronary artery disease in patients with type 1 and type 2 diabetes [13]. The elevated risk of HF in diabetic patients compared to non-diabetic patients underscores the need for cardiovascular risk screening in asymptomatic diabetic patients on the premise that earlier identification and stratification would lead to appropriate management of the disease. risk of long-term and short-term heart failure [14]. There is a dearth of comprehensive data on the determinants of HF in patients with diabetes in the Democratic Republic of Congo, particularly in Goma, North Kivu. This study was therefore conducted to assess the determinants of heart failure in patients with diabetes mellitus followed in Goma.

Patients and methods

The study was carried out at the Center of the Association of Diabetics in Congo (ADIC) in Goma, DRC. This site was selected on the basis of a reasoned choice based on the age of the center and the number of diabetic patients seen in one week. This was a cross-sectional and analytical study including all known asymptomatic diabetics in the city of Goma during the period from February 5 to 19, 2023.

The study population consisted of all diabetics who consulted the ADIC Center and those from other hospitals during the study period; after raising awareness in their WhatsApp groups and on the radio. The sample size was calculated from Fisher's formula: $n \geq (Z^2 x(p)(1-p))/d^2$ where n = Sample size, z = 1.96 (confidence coefficient), p = previous prevalence, d = 0.05 (margin of error or range of imprecision reflecting the desired degree of absolute precision). The probability of the risk of IC in diabetics being not yet elucidated in our country, we prefer to take 50% which is the median where the phenomenon is better distributed. So p=0.5 was the prior prevalence used in all studies to calculate the sample size. So the calculated sample size is $n\geq(1.96)2x0.5x0.5/(0.05)2=384$. By incorporating the 10% of non-respondents, we obtain 422

diabetics to be included. During the data collection period in this Center, 408 diabetics met the inclusion criteria.

The selection was made on free informed consent and recorded in writing. The inclusion criteria were asymptomatic diabetic status, residence in the city of Goma and age between 18 years minimum and 90 years maximum. The criteria for non-inclusion included diabetic complications including heart disease undergoing treatment, diabetics on dialysis, with serious complications related to diabetes mellitus.

Data collection was done using a form pre-established by our research group. The parameters of interest were retained and collected by way of questioning for the ethnic group, sex, age and by way of clinical and paraclinical examinations for the anthropometric, biochemical and hemodynamic parameters measured by the equipment indicated in following paragraphs.

Anthropometric data were measured for weight and height using the scale coupled with the Health O meter® brand height rod, model 500KL, SN 5000155271, DATE CODE: 3718, Made in China. A millimeter tape measure was used to measure waist circumference (TT) and hip circumference (TH). Systolic (PAS) and diastolic (PAD) arterial pressures (BP) were measured using an OMRON model M2 Basic electronic blood pressure monitor (HEM-7120-E). The electrocardiogram (ECG) was recorded by a Comen brand device, Model: CM 1200B, SN 92190522018B, manufactured on May 22, 2019, connected to the electric generator, after explaining the technique to the patient, he lies down on the bed examination in dorsal decubitus, undressed in the thorax and shoes, calm. After the identification of the patient, the application of the gel to the sites, the electrodes are placed on the thorax and the limbs, and then an electrocardiogram is printed. The Peguero index was used to look for left ventricular hypertrophy. The electrocardiograms were interpreted by a single cardiologist for better and uniform results.

Biological data included blood data. The venous blood was taken at the level of the fold of the elbow on dry tubes and EDTA tubes for the various analyses, 5ml of venous blood taken was put on an EDTA tube for the analyzes of glycated hemoglobin, BNP, hs-Troponine and hs- CRP. The dry tubes were used for analyzes such as NT-proBNP, Creatinine, Total cholesterol, Cholesterol-HDL, Triglycerides and LDL-cholesterol. The packaging of the samples included first an absorbent paper, an appropriate Biohazard brand specimen transport bag, then in the isothermal container containing the ice packs. All the samples were stored in a blood bank type refrigerator, brand XY130 (in China) between 2 to 4°C. The tubes for biochemical analyze (total-cholesterol, HDL, LDL, creatinine and, triglycerides) were made on a spectrophotometer brand RAYTO 9200 Semi-auto chemistry Analyzer, SN: 602321157 IE (Rayto, Guangming in China). For glycemia was carried out after ring finger disinfection with a brand glucometer 2019TRUE METRIX®Meter,SERIAL:T07123273,LOT:KX0747,EXP DATE:2025-02-06. The dosage of glycated hemoglobin is carried out on whole blood collected on EDTA K2 anticoagulant by nephelometry method on Genrui PA120 Fully-auto Specific Protein Analyzer.SN: 1141030201223, REF 31000003.

Place the three reagents including the 20 ml diluent, the 15 ml latex and the 5 ml anti serum in the machine according to their programmed position in the machine, then you will have to read the Mag card for each Kit (which contains the reagent information), introduce the patient's identity by the patient's number then save, present the whole blood sample to be well homogenized to the probe of the machine and click on the start button, the machine allows 20 µl to be aspirated of the sample, the machine will automatically start the analysis by pipetting the three different reagents and the result appears on the screen of the machine in 60 seconds in a quantitative way in percentage whose reference value is from 4.2-6.5%.

The results were interpreted according to the threshold of reference values containing reagents on each kit as follows: blood sugar had a reference value of 70-110mg/dL, creatinine 0.5 to 1.3mg/dL, total cholesterol <200mg /dL, HDL-c >55mg/dL for men and >65mg/dL for women, LDL-c <100mg/dL, Triglycerides<150mg/dL (Figure 1).

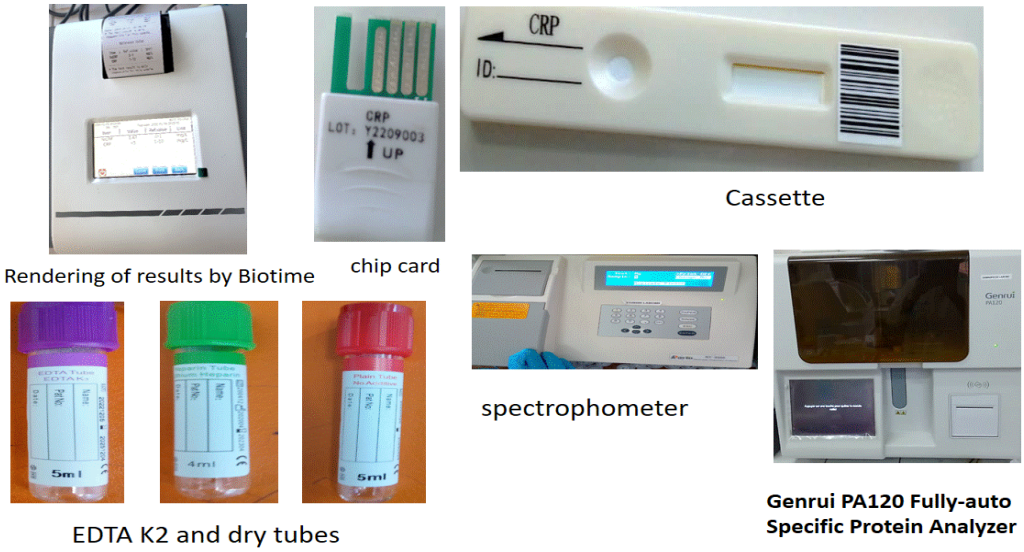


Figure 1: Presentation of sampling tools and biochemical analyzes

In order to guarantee the accuracy of the results, the CIMAK laboratory carried out a commercial internal quality control (IQC) (freeze-dried serum to be reconstituted). These checks were carried out and validated each morning, and adapted to regulatory requirements. ELITROL I (normal references) and ELITROL II (pathological references) control sera were used. CQI results were interpreted taking into account Westgard rules and Levey-Jennings charts. Appropriate corrective measures were taken whenever the values fell outside the defined limits. Depending on the case, these measurements concerned the IQC serum and/or the automaton and/or the reagents and/or the calibration.

The following definitions were used in this work:

Hypertension was defined, for some studies, by blood pressure (BP) taken in the office, including systolic ≥ 140 mmHg and/or diastolic ≥ 90 mmHg and/or the presence of a personal history of hypertension [15]. Diabetes mellitus was defined by the following criteria: a fasting blood glucose level ≥ 126 mg/dl (7.0 mmol/l) and/or a personal history of known diabetes mellitus and/or a glycated haemoglobin level ≥ 6.5% (48 mmol/mol) [16]. Smoking by cigarette will be defined by a regular intake of tobacco by cigarette for at least 30 days before the present study, regardless of the number of cigarettes [17]. Excessive alcohol consumption will be defined by taking more than 2 glasses of beer/day or an equivalent for at least a year [18]. Overweight will be defined by a BMI ≥ 25 kg/m2, overweight by a BMI between 25 and 30 kg/m2 and overall obesity by a BMI ≥ 30 kg/m2 [19]. Abdominal obesity was defined by a TT > 94 Cm for men and > 80 Cm for women [20]. Dyslipidaemia was defined as HDL cholesterol level <1.03 mmol/L for men or <1.04 mmol/L for women, LDL cholesterol level ≥ 3.38 mmol/L, total cholesterol level ≥ 5.17 mmol/L and/or a triglyceride level ≥ 1.69 mmol/ [21]. The incidence of heart failure in diabetics was defined with a pulse pressure ≥65mmHg [22]. The ophthalmological evaluation will be carried out by examination of the retinography, using an Intucan45, SN: AAIVL 19008, Model: GSM36E12, Made in China taking the 45-degree image of the retina. Image acquisition was performed by an experienced operator. Each patient had two images for each eye, one centered on the papilla and the other on the macula. Intraocular pressure was measured using an Icare TA01i rebound tonometer (normal intraocular pressure varies between 10 and 22 mmHg). The elements sought were diabetic macular edema (DME) including retinal thickening and/or lipid exudate in the macular region, diabetic retinopathy (vascular and cellular damage). Diabetic macular edema is defined by the presence of retinal thickening and/or fluid accumulation in the macular region. Diabetic retinopathy was defined by deterioration of retinal vessels and cells using the international classification of the American Society of Ophthalmology (AAO).

Statistical analyses

The data was compiled in an Excel 2010 database and then transferred to SPSS for Windows version 25 software for analysis. Descriptive statistics were presented as mean (plus or minus standard deviation) for continuous variables with normal distribution and as median (IQS: Interquartile Space) for continuous data with non-Gaussian distribution. The normality test (Kolmogorov-Smirnov or Shapiro-Wilk) was used to differentiate

normally distributed and non-normally distributed quantitative variables. Absolute (n) and relative (%) frequencies were expressed for categorical variables. Student's t-test, Mann-Whitney U-test, and Pearson's chi-square or Fischer's exact test were performed, respectively, to compare means, medians, and proportions in the two groups. Logistic regression was used to find the determinants of the incidence of heart failure in univariate and multivariate analysis with calculation of the OR and their 95% confidence interval. Two final models were developed by identifying collinear variables (gender and menopause). The VIF coefficient (variance inflation factor) made it possible to identify the collinear variables, a value of VIF greater than 10 indicated a high multi-collinearity between the factors. For all the tests used, the value of $p < 0.05$ was considered as the threshold of statistical significance.

Ethical considerations

Before the start of this study: the protocol was submitted for approval by the Medical Ethics Committee of the University of Goma at No. UNIGOM/CEM/09/2022. Informed consent must be obtained from the patient. During the course of the study, we will conduct our study based on the 3 main principles of ethics, namely: respect for the human person, benevolence and justice.

Results

Figure 2 illustrates the flow of participants in the present study where, out of 450 diabetics who responded to the call launched at Center ADIC, 20 were not included in the study for the following reasons: not being a resident of Goma, followed for IC and presenting with visible pregnancy. Of the 430 diabetics included in the study, 22 were excluded for not having carried out an ECG and the entire assessment. At the end of the study, the sample analyzed is 408 (Figure 2).

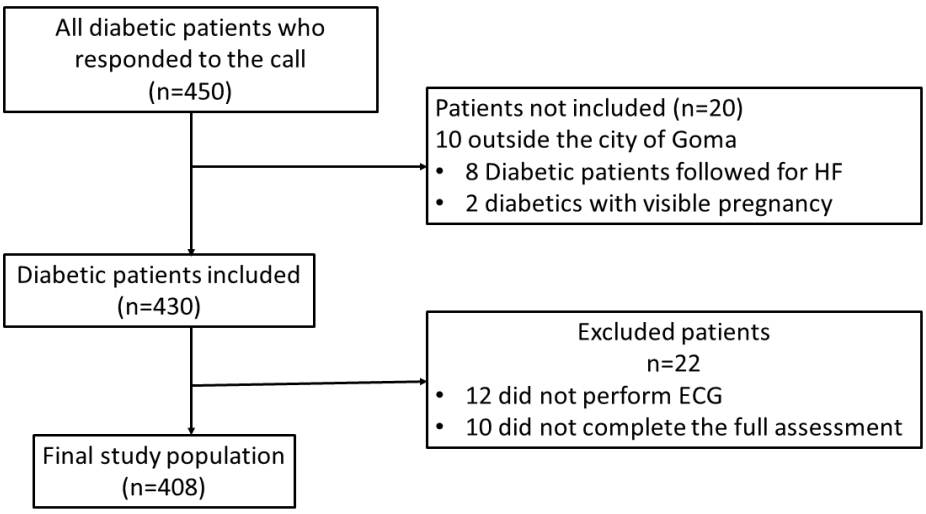
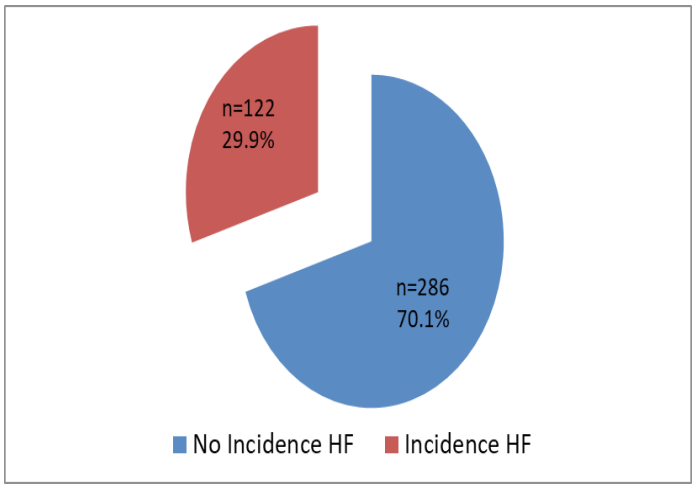


Figure 2: Participant Flowchart

Heart failure incidence

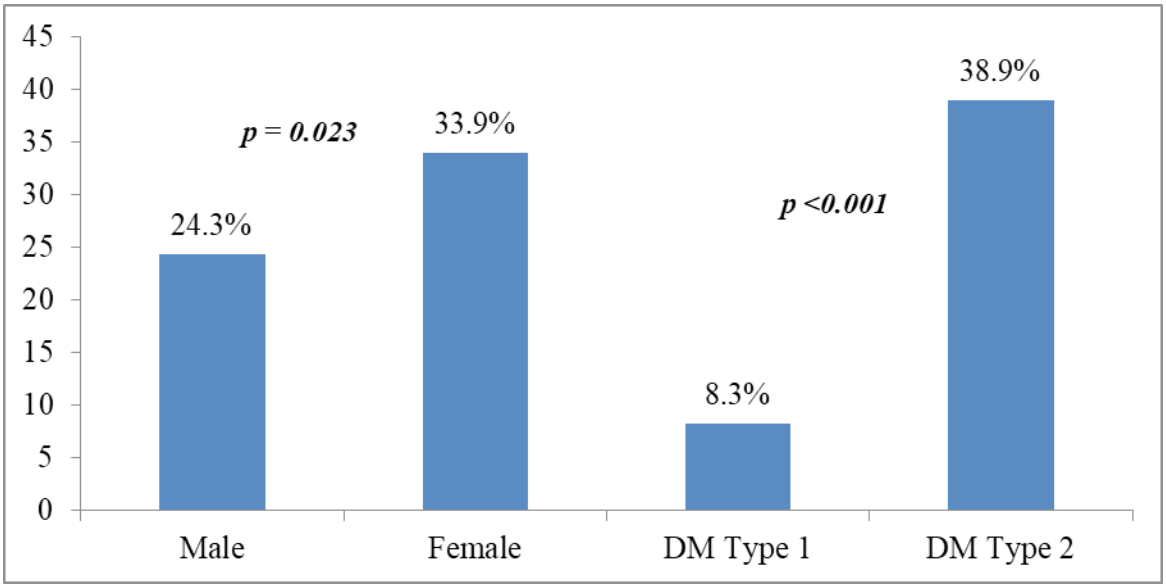
Of a total of 408 diabetic patients examined, 122 had an incidence of heart failure, a frequency of 29.98% (Figure 3).



HF: heart failure

Figure 3: Distribution of patients according to incidence of heart failure

In Figure 4, we note that women had a significantly higher proportion of incidence of insufficiency than men (33.9% vs 24.3% in men, p = 0.023). The same figure shows that patients with type 2 diabetes mellitus had a significantly higher proportion of incidence of heart failure than those with type 1 (p<0.001).



DM : Diabete Mellitus

Figure 4: Frequency of incidence of heart failure by sex and type of diabetes

By comparing the subjects with incidence of HF to those without incidence of HF ; we note that the patients with incidence of HF included a greater proportion of women, subjects with stroke, and with a background of pathological eye. Mean values of subjects with incidence of heart failure were higher than those with no incidence of heart failure for age, SBP, DBP, MBP, PP, HR, BMI, circumference hip and WC/Waist ratio (Table 1).

Variables	All patients n=408	No incidence HF n=286	Incidence HF n=122	P
Age. years	53.9±14.5	50.0±13.9	63.0±11.5	<0.001
female sex	239(58.6)	158(55.2)	81(66.4)	**0.023**
DM Duration (years)	8.0 (7.0-9.0)	6.0 (5.0-8.0)	10.0 (10.0-12.0)	<0.001
stroke	15(3.7)	7(2.4)	8(6.6)	**0.046**
Dyslipidemia	15(3.7)	10(3.5)	5(4.1)	0.482
sleep time				0.883
<8 hours	253(62.0)	176(61.5)	77(63.1)	
8 hours	90(22.1)	65(22.7)	25(20.5)	
> 8 hours	65(15.9)	45(15.7)	20(16.4)	
SBP (mmHg)	137.4±25.9	125.5±17.4	165.1±20.8	<0.001
DBP (mmHg)	84.1±13.5	81.7±12.6	89.7±13.7	<0.001
MBP (mmHg)	101.9±16.4	96.3±13.6	114.9±15.0	<0.001
PP (mmHg)	53.3±18.4	43.8±9.9	75.4±14.1	<0.001
HR (bpm)	82.1±12.8	83.1±12.5	79.8±13.2	0.015
BMI (Kg/m2)	27.7±5.7	27.1±5.6	28.9±5.6	0.003
WC (cm)	95.4±14.7	94.5±14.3	97.4±15.5	0.074
HC (cm)	103.0±14.4	101.9±14.0	105.6±14.9	0.016
WC/HC	0.93±0.09	0.93±0.09	0.92±0.09	0.452
WC/W	0.65±0.10	0.64±0.09	0.68±0.10	0.001
Classification FO AAO				**<0.001**
No apparent DR	274(82.5)	206(87.7)	68(70.1)	
Minimal RDNP	24(7.2)	11(4.7)	13(13.4)	
Moderate RDNP	1(0.3)	0(0.0)	1(1.0)	
Proliferative R&D	4(1.2)	0(0.0)	4(4.1)	
Non visible	29(8.7)	18(7.7)	11(11.3)	
Macular edema	29(8.7)	13(5.5)	16(16.5)	**0.002**

RD: Diabetic retinopathy, RDNP: Non-proliferative diabetic retinopathy, OM: Macular edema.

DM: diabetes mellitus, SBP: systolic blood pressure, DBP: diastolic blood pressure, PM: mean blood pressure, PP: pulse pressure, HR: heart rate, BMI: body mass index, WT: waist circumference, TH: hip circumference; HbA1c: glycosylated hemoglobin ; AAO: American Ophthalmological Association.

Table 1: Clinical characteristics according to incidence of heart failure

The comparison of cardiovascular risk factors in diabetics with incidence of heart failure with those without incidence of heart failure had shown that diabetics with incidence of heart failure had a higher frequency of subjects over 40 years of age, hypertension, type 2 diabetes mellitus, physical inactivity, menopause, stroke, obesity and metabolic syndrome (Table 2).

Variables	All patients n=408	No incidence HF n=286	Incidence HF n=122	p
Age≥4 0 years	339(83.1)	222(77.6)	117(95.9)	**<0.001**
Tobacco	30(7.4)	24(8.4)	6(4.9)	0.153
Alcohol	172(42.2)	126(44.1)	46(37.7)	0.140
Hypertension	178(43.6)	89(31.1)	89(73.0)	**<0.001**
DM Type 2	288(70.6)	176(61.5)	112(91.8)	**<0.001**
Physical inactivity	242(59.3)	160(55.9)	82(67.2)	**0.022**
Goutte	28(6.9)	20(7.0)	8(6.6)	0.532
Menopause	135(56.5)	69(43.7)	66(81.5)	**<0.001**
Stroke	15(3.7)	7(2.4)	8(6.6)	**0.046**
Dyslipidemia	15(3.7)	10(3.5)	5(4.1)	0.482
Overweight	142(34.8)	97(33.9)	45(36.9)	0.320
Obesity	127(31.1)	80(28.0)	47(38.5)	**0.028**
Abdominal obesity	275(67.4)	187(65.4)	88(72.1)	0.111
RAH	259(63.5)	184(64.3)	75(61.5)	0.330
RCM	386(94.6)	268(93.7)	118(96.7)	0.160
Metabolic syndrome	241(59.1)	141(49.3)	100(82.0)	**<0.001**

Table 2: Traditional risk factors according to the incidence of HF

HTA : Hypertension artérielle, DS : Diabète sucré, AVC : Accident vasculaire cérébral, RAH : rapport hauteur hanche, RCM : Risque cardiométaboliques.

With regard to (Table 3), we note that diabetic subjects with incidence of heart failure had a very high mean or median for Hb1AC, total cholesterol, creatinine than their counterparts who had no incidence of heart failure. cardiac. The proportion of Hb1AC ≥7%, CT ≥185 mg/dl and eGFR <60 ml/min/1.73m² were higher in diabetic subjects with incidence of heart failure.

Variables	All patients n=408	No incidence HF n=286	Incidence HF n=122	p
Fasting glucose (mg/dL)	172.0 (163.0-180.0)	175.5 (164.5-188.0)	164.0 (151.0-179.0)	0.143
HbA1C (%)	9.26±2.06	9.43±2.06	8.87±2.0	**0.022**
LDLc mg/dl	112.7 (106.1-117.7)	108.5 (102.0-115.9)	124.5 (108.5-129.7)	0.080
Triglyceride mg/dl	98.0 (90.9-103.9)	94.9 (85.6-103.4)	104.1 (92.5-115.7)	0.636
HDLc mg/dl	50.2 (49.1-52.2)	50.0 (48.6-51.7)	52.4 (49.1-54.4)	0.117
Total Cholesterol mg/dl	186.7 (182.8-193.0)	182.2 (176.7-189.9)	200.8 (187.6-209.4)	**0.002**
Creatinine mg/dl	0.90 (0.80-0.90)	0.80 (0.79-0.90)	0.90 (0.89-1.00)	**<0.001**
Fasting glucose ≥110mg/dl	350(85.8)	241(84.3)	109(89.3)	0.116
Hb1AC≥7%	297(87.4)	214(89.9)	83(81.4)	**0.025**
LDL≥135	121(29.7)	78(27.3)	43(35.2)	0.068
TG≥150	105(25.7)	73(25.5)	32(26.2)	0.487

HDLc<40H/<50F	127(31.1)	91(31.8)	36(29.5)	0.367
TC≥185	213(52.2)	138(48.3)	75(61.5)	**0.009**
eGFR<60ml/min/1.73m²	46(11.3)	19(6.6)	27(22.1)	**<0.001**

HbA1c: Glycosylated hemoglobin, eGFR: Estimated glomerular filtration rate, NYHA: New York Heart Association; BNP: Bread Natriuretic Peptide, LDL-c: Low density lipoproteins cholesterol; HDL-c: High Density lipoproteins cholesterol, TC: Total Cholesterol.

Table 3: Biological characteristics according to incidence of heart failure

By introducing alone to test the association between the incidence of heart failure and the independent variables, it was noticed that only age ≥40 years, female gender, hypertension, type 2 diabetes mellitus, physical inactivity, obesity, menopause, Hb1AC≥7%, hypercholesterolemia, eGFR<60 ml/min/1.73m² and pathological FO were directly associated with the incidence of HF.

In multivariate analysis, adjusted for all these variables in multivariate without introducing sex into the model (model 1), hypertension (aOR: 5.93 95% CI: 2.42-14.51), SD type 2 (aOR: 3.60 95% CI: 1.63-4.25), menopause (aOR: 5.48 95% CI: 3.03-9.72) and eGFR<60 ml/min/1.73m² (ORa: 348 95% CI: 1.94-5.30) were the independent determinants of heart failure incidence.

In model 2 without introducing menopause, female gender (aOR: 2.80 95% CI: 1.06-3.80), hypertension (aOR: 3.99 95% CI: 2.16-7.41), DS type 2 (aOR: 5.72 95% CI: 1.77-8.52), eGFR <60 ml/min/1.73m² (aOR: 3.10 95% CI: 1.87-5.09) and fundus pathology (aOR: 2.04, 95% CI: 1.77-5.35) were the independent determinants of the incidence of heart failure (Table 4).

Variables	**Univariate analysis**			**Model multivariate 1**			**Model multivariate 2**	
	p	OR (IC95%)		p	aOR (IC95%)		p	aOR (IC95%)
Age≥40 years								
No		1			1			1
Yes	<0.001	6.75 (2.64-9.22)		0.803	1.35 (0.13-4.38)		0.878	1.12 (0.25-4.99)
Female gender								
No		1						1
Yes	0.037	1.60 (1.03-2.49)		-	-		**0.032**	2.80 (1.06-3.80)
HTA								
No		1			1			1
Yes	<0.001	5.97 (3.73-9.57)		**<0.001**	5.93 (2.42-14.51)		**<0.001**	3.99 (2.16-7.41)
DM type 2								
No		1			1			1
Yes	<0.001	7.00 (3.51-9.47)		**0.001**	3.60 (1.63-4.25)		**0.004**	5.72 (1.77-8.52)
Physical inactivity								
No		1			1			1
Yes	0.035	1.61 (1.04-2.52)		0.796	1.13 (0.45-2.83)		0.264	1.43 (0.76-2.69)
Menopause								

No		1			1			
Yes	<0.001	5.68 (2.98-9.79)		**<0.001**	5.48 (3.03-9.72)		-	-
Obesity								
No		1			1			1
Yes	0.036	1.61 (1.03-2.52)		0.253	1.67 (0.69-4.04)		0.429	1.30 (0.68-2.46)
Hb1AC≥7%								
No		1			1			1
Yes	0.032	2.04 (1.06-3.92)		0.140	1.90 (0.70-4.89)		0.385	1.49 (0.61-3.62)
TC≥185 mg/dL								
No		1			1			1
Yes	0.015	1.71 (1.11-2.64)		0.104	2.10 (0.86-5.15)		0.380	1.32 (0.71-2.45)
eGFR<60 ml/min								
No		1			1			1
Yes	<0.001	3.99 (2.12-7.51)		**0.003**	3.48 (1.94-5.30)		**0.010**	3.10 (1.87-5.09)
FO pathology								
No		1			1			1
Yes	0.012	1.92 (1.04-2.41)		0.904	1.22 (0.25-3.44)		**0.016**	2.04 (1.77-5.35)

HTA: Hypertension; DM: Diabetes Mellitus, HbA1c: Glycosylated Hemoglobin, eGFR: Estimated Glomerular Filtration Rate, TC: Total Cholesterol, aOR: Adjusted Odd Ratio, CI: Confidence Interval, DR: Diabetic Retinopathy.

Table 4: Determinants of heart failure incidence in diabetics

Discussion

In this study, the objective was to identify the main determinants of the incidence of heart failure in diabetic patients followed in Goma. It was carried on 408 participants, we showed important different traditional cardiovascular risk factors on the occurrence of incidence of heart failure. Our results support the hypothesis that both modifiable and non-modifiable clinical risk factors are determinants of heart failure and carry both a higher odds ratio and a higher population attributable risk in patients with diabetes.

A total of 29.9% of the total attributable risk of heart failure was found in all diabetic patients. The incidence of heart failure was higher in patients with DS type 2. Rate ratios adjusted by type of diabetes with increasing age and also over time. However, the frequency of heart failure was even higher in female diabetics (p=0.023). Our results suggest that prevention of HF should be done in patients with T2DM. Treatment of hypertension and hyperglycemia, prevention of coronary artery disease by lowering cholesterol, and smoking cessation prevent heart failure. The value of treating hypertension has been demonstrated in the UKPDS study [23, 24]. A reduction in hospitalizations for HF was demonstrated in a study of statin treatment of patients with diabetes [25].

In this study, the independent determinants of the incidence of heart failure in asymptomatic diabetic patients were female gender, menopause, hypertension, renal failure, type 2 diabetes and pathological fundus. There are some data from the literature explaining the occurrence of heart failure by these factors.

When it comes to sex and menopause, some studies have shown that diabetic women tend to be more likely to develop heart failure than diabetic men. There are several possible reasons for this, female hormones like estrogen can have a protective effect on the heart. After menopause, when estrogen levels decline, this protective factor also declines [26]. Women with diabetes may have other cardiovascular risk factors, such as high blood pressure, abdominal obesity and high LDL (bad) cholesterol, chronic kidney

disease and depression, which may contribute to a risk higher rate of heart failure [27].

Kidney failure can have a significant impact on heart function and lead to the development of heart failure. There are several underlying mechanisms that explain this relationship. Kidney failure prevents the kidneys from efficiently removing sodium and water from the body, leading to excessive fluid retention. This fluid overload can increase the workload of the heart and lead to progressive cardiac dysfunction [28]. Kidney failure leads to a buildup of toxins in the body, such as urea and creatinine. These substances can be toxic to heart cells and damage heart function [29]. Chronic renal failure activates the RAA system, which plays a key role in regulating blood pressure and fluid homeostasis. Chronic activation of this system can cause constriction of blood vessels and increase afterload of the heart, which can eventually lead to heart failure [30]. Patients with chronic kidney disease often have low production of red blood cells, which leads to anemia. Anemia decreases the blood's ability to carry oxygen to tissues, including heart muscle, which can lead to heart dysfunction [31].

Type 2 diabetes is a major risk factor for the development of heart failure. In type 2 diabetes, cells become insulin resistant, which means they cannot effectively use glucose for energy. This leads to increased blood sugar and glucose overload of the heart, which can damage heart cells and lead to heart dysfunction [32]. High blood glucose levels in people with type 2 diabetes can lead to increased oxidative stress. This causes cell damage and inflammation, which can contribute to the progression of heart failure [33]. Type 2 diabetes is often associated with high blood pressure, which puts extra pressure on blood vessel walls and heart muscle. This chronic hypertension can lead to cardiac enlargement and cardiac dysfunction [34]. Inflammatory processes can be activated in type 2 diabetes, including the activation of cytokines and inflammatory growth factors. This inflammation contributes to the progression of heart failure by promoting cardiac fibrosis and endothelial dysfunction [35].

High blood pressure (HTA) is one of the main risk factors for heart failure. In hypertensive patients, the body has to work harder to pump blood through the narrow arteries. This increased workload of the heart can gradually lead to structural and functional alterations that favor the development of heart failure [36]. (increase in size) of the left ventricle and cardiac remodeling thus leading to heart failure [37,38].

Retinopathy, which is an eye condition affecting the blood vessels in the retina, can potentially lead to heart failure due to its implications for blood flow and oxygen delivery to tissues [39].

During retinopathy, blood vessels in the retina may dilate and grow abnormally [40]. At the same time, this damaged retina sends distress signals to other parts of the body, including the cardiovascular system [41]. In response to these distress signals, the cardiovascular system increases its blood pressure to try to compensate for the decreased blood flow to the retina. This increase in blood pressure can overload the heart, which has to work harder to pump blood through the narrow blood vessels. Over time, this overload can lead to heart failure [42].

Although the present study has contributed important data to our understanding of the independent determinants of the incidence of HF in diabetics, some limitations cannot, however, be excluded. The present study gathered data taken in a cross-sectional manner, thus it excludes any conclusion on the causal relationships between the incidence of HF and the independent variables. It is therefore important to take this variable into account in the analyses. This is not a prospective cohort study, but participation over a well-defined period. The analysis incorporated a method with multiple models in multivariate logistic regression allows adjustments by many variables, but other important factors might not be observed.

Conclusion

The present study showed that despite its cross-sectional nature, a high frequency of incidence of heart failure in diabetics. The determinants of this incidence of heart failure are unique to those found in the literature. Thus, an innovation in Sub-Saharan Africa regarding the influence of diabetic retinopathy in the occurrence of heart failure has been demonstrated. All the emerging factors plead for good management in order to limit the progression to HF in any diabetic.

Acknowledgements

The authors would like to express their deepest gratitude to the Administrative Authorities of ADIC Center for their invaluable assistance. We are deeply indebted to all the participants who make this survey possible through their informed consent. We would like to particularly thank all our promoters for their commitment for the success of the present survey.

Availability of Data and Materials

The data and analyses carried out for this study are available.

Declarations

Ethics approval and consent to participate.

The study protocol was approved by the ethics committee of the University of Goma (UNIGOM/CEM/09/2022) and the study was conducted in accordance with the Helsinki principles. All participants signed written informed consent forms before enrollment.

Author's Contributions

All authors contributed to data analysis, drafting or revising the article, have agreed on the journal to which the article will be submitted, gave final approval of the version to be published, and agree to be accountable for all aspects of the work.

Conflicts of Interest

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

References

1. Conrad N, Judge A, Tran J, Mohseni H, Hedgecott D, et al. (2018) Temporal trends and patterns in heart failure incidence: a population-based study of 4 million individuals. Lancet, 391:572-580.
2. Zannad F (2018) Rising incidence of heart failure demands action. Lancet, 391:518-519.
3. Khan SS, Ning H, Shah SJ, Yancy CW, Carnethon M, et al. (2019) 10-Year Risk Equations for Incident Heart Failure in the General Population. J Am Coll Cardiol,73:2388-2397.
4. Rosengren A, Åberg M, Robertson J, Waern M, Schaufelberger M, et al. (2017) Body weight in adolescence and long-term risk of early heart failure in adulthood among men in Sweden. Eur Heart J, 38:1926-1933.
5. Christiansen MN, Køber L, Weeke P, Vasan RS, Jeppesen JL, et al. (2017) Age-Specific Trends in Incidence, Mortality, and Comorbidities of Heart Failure in Denmark, 1995 to 2012. Circulation,135:1214-1223.
6. Lemma DR, Assefa T, Yohanes A (2021) Prevalence of Cardiovascular Disease and Associated Factors among Type 2 Diabetes Patients in Selected Hospitals of Harari Region, Eastern Ethiopia. Front. Public Health, 8:532719.
7. Nolan CJ, Ruderman NB, Kahn SE, Pedersen O, Prentki MJD (2015) Insulin resistance as a physiological defense against metabolic stress: implications for the management of subsets of type 2 diabetes. Diabetes. 64:673–86.
8. Bandello F, Zarbin MA, Lattanzio R, Zucchiatti I (2017) Management of diabetic retinopathy. Dev Ophthalmol. 60:1–5.
9. Mensah GA (2013) Descriptive epidemiology of cardiovascular risk factors and diabetes in Sub-Saharan Africa. Prog Cardiovasc Dis. 56:240–50.
10. Gaurav SG, Lavanya A, Gerry PM (2019) Diabetic cardiomyopathy: prevalence, determinants and potential treatments. Therapeutic Advances in Endocrinology and Metabolism.
11. Ndemnge AL, Dzudie A, Kengne AP (2016) Prevalent diabetes mellitus in patients with heart failure and disease determinants in sub-Saharan Africans having diabetes with heart failure: a protocol for a systematic review and meta-analysis. BMJ Open, 6: e010097.
12. Pienaar E, Grobler L, Busgeeth K, Eisinga A, Siegfried N (2011) Developing a geographic search filter to identify randomised controlled trials in Africa: finding the optimal balance between sensitivity and precision. Health Inf Libr J, 28:210–15.
13. Xiao-Hong X, Bo S, Shan Z, Dong-Dong W, Ze H, et al. (2020) Diabetic retinopathy predicts cardiovascular mortality in diabetes: a meta-analysis. BMC Cardiovascular Disord, 20: 478-486.
14. Tesfaye A, Josef H, Bizuayehu WT, Girma Z, Negasa B, et al. (2020) Magnitude of, and Factors Associated with Cardiovascular Disease Among Type Two Diabetes Mellitus Patients. Diabetes, Metabolic Syndrome and Obesity: Targets and Therapy, 13 :4123-4129.
15. Whelton PK, carey RM, Aronow WS, Casey DE Jr, Collins KJ, et al. (2018) 2017 ACC/AHA/AAPA/ABC/ACPM/AGS/APhA/ASH/ASPC/NMA/PCNA Guideline for the Prevention, Detection, Evaluation, and Management of High Blood Pressure in Adults: A Report of the American College of Cardiology/American Heart Association Task Force on Clinical practice guidelines. Hypertension. 71: e 13-e 115.
16. ChadhaC, pittasAG, Lary CW, Knowler WC, Chatterjee R, et al. (2020) Reproducibility of aprediabetes classification in a contemporary population. Metabol Open. 6: 100031.
17. Ryan H, Trosclair A, Gfroerer J (2012) Adult current smoking: differences in prevalence estimates-NHIS and NSDUH, 2008.J Environ Public Health. 2012 :918368.
18. Moos RH, Schutte KK, Brennen PL, Moos BS (2009) Older adults' alchol late-life drinking problems: a 20-year perspective.Addiction. 104: 1293-302.
19. Chiu M, Austin PC, Manuel DG, Shah BR, Tu JV (2011) Deriving ethnic-specific BMI cutoff points for assessing diabetes risk. DiabetesCare, 34: 1741-1748.
20. Hu FB (2002) Dietary patern analysis: a new direction in nutritional epidemiology. Lipidol.13:3-9.
21. Wu L, Parhofer KG (2014) Diabetic dyslipidemia. Metabolism. 63: 1469-79.
22. Pandey A, Vaduganathan M, Patel KV, Ayers C, Ballantyne CM, et al. (2021) Biomarker-Based Risk Prediction of Incident Heart Failure in Pre-Diabetes and Diabetes. JACC: Heart Failure, 9: 215-23.
23. Klas W, Pietil A, Veikko S (2019) Incidence and prognosis of heart failure in persons with type2 diabetes compared with individuals without diabetes–a nation-wide study from Finlandin1996–2012. Annals Of Medicine, 51:174–181.
24. UK Prospective Diabetes Study Group (1998) Tight blood pressure control and risk of macrovascular and microvascular complications in type2 diabetes: UKPDS 38. BMJ. 317: 703–713.
25. Shepherd J, Barter P, Carmena R, Deedwania P, Fruchart JC, et al. (2006) Effect of lowering LDLchol sterol substantially below currently recommended levels in patients with coronary heart disease and diabetes: the Treating to New Targets (TNT) study. Diabetes Care. 29: 1220–1226.
26. De Groote P, Lamblin N, Mouquet F, Plichon D, McFadden EP, et al. (2004) Impact of diabetes mellitus on long-term survival in patients with congestive heart failure. European heart journal, 25:656-662.
27. MacDonal MR, Petrie MC, Hawkins NM, Petrie JR, Fisher M, et al. (2008) Diabetes, left ventricular systolic dysfunction, and chronic heart failure. European heart journal, 29:1224-1240.
28. Ronco C, McCullough P, Anker SD, Anand I, Aspromonte N, et al. (2010) Cardio-renal syndromes: report from the consensus conference of the Acute Dialysis Quality Initiative. Eur Heart J. 31:703-711
29. Damman K, Valente MAE, Voors AA, O'Connor CM, van Veldhuisen DJ, et al. (2014) Renal impairment, worsening renal function, and outcome in patients with heart failure: an updated meta-analysis. Eur Heart J. 35:455-469.
30. Ronco C, haapio M, house AA, Anavekar N, Bellomo R, et al. (2008) Cardiorenal syndrome. J Am Coll Cardiol. 52:1527-1539.
31. Shlipak MG, Katz R, Kestenbaum B, Siscovick D, Fried L, et al. (2009)

Rapid decline of kidney function increases cardiovascular risk in the elderly. J Am Soc Nephrol. 20:2625-2630.

32. Nichols GA, Gullion CM, Koro CE, Ephross SA, Brown JB (2004) The incidence of congestive heart failure in type 2 diabetes: an update. Diabetes care, 27:1879-1884.

33. Boudina S, Abel ED (2007) Diabetic cardiomyopathy revisited. Circulation. 115:3213-3223.

34. Bugger H, Abel ED (2014) Molecular mechanisms of diabetic cardiomyopathy. Diabetologia. 57:660-671.

35. Hsueh W, Abel ED, Breslow JL, et al. (2007) Myocardial ischemia in conscious dogs with insulin-resistance and hypertriglyceridemia. Cardiovasc Res. 73:530-7.

36. Jia G, Hill MA, Sowers JR (2018) Diabetic cardiomyopathy: An update of mechanisms contributing to this clinical entity. Circ Res. 122:624-638.

37. Yancy CW, Jessup M, Bozkurt B, Butler J, Casey Jr DE, et al. (2017) 2017 ACC/AHA/HFSA focused update of the 2013 ACCF/AHA guideline for the management of heart failure: a report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines and the Heart Failure Society of America. Circulation. 136: e137-e161.

38. Braunwald E (2015) The war against heart failure: the Lancet lecture. Lancet. 385: 812-824.

39. Go AS, Mozaffarian D, Roger VL, Benjamin EJ, Berry JD, et al (2014) Heart disease and stroke statistics—2014 update: a report from the American Heart Association. Circulation, 129: e28-e292.

40. Wong TY, Rosamond W, Chang PP, Couper DJ, Sharrett AR, et al. (2005) Retinopathy and risk of congestive heart failure. JAMA, 293: 63-69.

41. Ding J (2009) Retinal arteriolar narrowing and subsequent development of heart failure in African Americans and whites: the Atherosclerosis Risk in Communities Study. JAMA Cardiology, 153: 368-374.

42. Wong TY, Coresh J, Klein R, Muntner P, Couper DJ, et al. (2004) Retinal microvascular abnormalities and renal dysfunction: the Atherosclerosis Risk in Communities Study. J Am Soc Nephrol, 15: 2469-76.