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Type 2 diabetes mellitus among the elderly in Goma, Democratic Republic of the Congo: prevalence, clinical features and complications

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Abstract

Background and aim: Diabetes is one of the leading non-communicable diseases in the world; diabetes is common in the elderly. The aim of this study is to assess the prevalence, clinical features and complications of type 2 diabetes mellitus among the elderly in the *Hôpital Provincial du Nord-Kivu* in Goma. **Subjects and Methods:** A cross sectional study was based on data collected among the elderly from 2013 to 2015 in the Department of Internal Medicine. Overall, 418 elders were included. **Results:** The prevalence of type 2 diabetes mellitus was 8.6% (95% CI: 6.3 – 11.7). Overall, 54% of the elderly were males while 46% were females. Among males, 6.6% were diagnosed with diabetes whereas 11.0% were among females ($p < 0.001$). All elderly diabetic subjects ($n = 36$) were taking anti diabetic drugs such as insulin or oral medications (sulfonylurea and/or biguanide). Among those, 15 (41.7%) were on insulin and 21 (58.3%) on oral anti diabetic. Mean fasting glucose was higher among elderly individuals taking oral medications compared with their counterparts on insulin (104.4 *versus* 157.3 mg/dl, $p < 0.001$). The asthenia (86.1%), the polyuria (13.9%), the coma (11.1%) and the polydipsia (5.6%) were the principal symptoms on admission. The infectious, metabolic, micro vascular and macrovascular complications were diagnosed in this study. **Conclusion:** Our study provides evidence on the high prevalence of type 2 diabetes mellitus among elderly individuals. Moreover, the study found many factors associated with type 2 diabetes mellitus among the elderly and the difficulty of diagnosing diabetes in the elderly. Hence, there is need to enhance the existing prevention programmes with emphasis on social determinants of diabetes, which need to be clarified by broad epidemiological studies at the population level.

Keywords: Diabetes; Type 2; Elderly; Goma; Democratic Republic of the Congo

Résumé

Contexte et objectif : Le diabète est l'une des principales maladies non transmissibles dans le monde. Sa prévalence est élevée chez les personnes de troisième âge. Le but de cette étude est d'évaluer la prévalence, les caractéristiques cliniques et les complications du diabète de type 2 chez les personnes de troisième âge à l'Hôpital Provincial du Nord-Kivu à Goma. **Sujets et méthodes** : Cette étude transversale basée sur les données recueillies auprès des personnes troisième âge a été menée de 2013 à 2015 au Département de médecine interne. Au total, 418 personnes de troisième âge ont été incluses. **Résultats**: La prévalence du diabète sucré de type 2 était de 8,6% (IC à 95% : 6,3 - 11,7). Dans l'ensemble, 54% des personnes de troisième âge étaient des hommes et 46% des femmes. Parmi les hommes, 6,6% étaient diagnostiqués diabétiques alors que 11,0% l'étaient parmi les femmes ($p <0,001$). Tous les sujets diabétiques de troisième âge ($n = 36$) bénéficiaient de traitements antidiabétiques tels que l'insuline ou les antidiabétiques oraux (sulfonylurée et / ou biguanide). Ainsi, 15 (41,7%) étaient sous insuline et 21 (58,3%) sous antidiabétiques oraux. La glycémie à jeun moyenne était plus élevée chez les personnes de troisième âge prenant les antidiabétiques oraux que chez leurs homologues sous insuline (104,4 contre 157,3 mg/dl, $p <0,001$). L'asthénie (86,1%), la polyurie (13,9%), le coma (11,1%) et la polydipsie (5,6%) étaient les principaux symptômes à l'admission. Les complications infectieuses, métaboliques, micro-vasculaires et macro-vasculaires ont été diagnostiquées dans cette étude. **Conclusion**: Notre étude fournit des preuves sur la prévalence élevée du diabète sucré de type 2 chez les personnes de troisième âge. De plus, l'étude a trouvé de nombreux facteurs associés au diabète sucré de type 2 chez les personnes âgées et la difficulté de diagnostiquer le diabète chez les personnes âgées. Par conséquent, il est nécessaire d'améliorer les programmes de prévention existants en mettant l'accent sur les déterminants sociaux du diabète, qui doivent être clarifiés par de larges études épidémiologiques au niveau de la population.

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Introduction

Diabetes is one of the leading non-communicable diseases in the world, contributing to the increasing disease burden among elderly individuals. The International Diabetes Federation (IDF) estimates that 450 million people are living with diabetes, with 5.1 million dying from it annually worldwide [1, 2]. The prevalence of diabetes is expected to double by 2030 from 8.3 to 17.6% globally [1-3], excluding the high numbers of undiagnosed cases estimated at 175 million [1, 4]. In sub-Saharan Africa, 21.5 million people are living with diabetes leading to approximately half a million diabetes-related deaths in 2013 [1]. The prevalence of diabetes varies in different age groups with the older population being at a higher risk compared to the young population [5]. The number of older adults with diabetes is increasing in sub-Saharan Africa due to increased lifespan and the increased prevalence of diabetes in the geriatric population [6]. Despite the demographic transition occurring in Africa, few studies have focused on understanding the magnitude of diabetes among older adults in specific countries [7, 8]. For instance, the prevalence of diabetes has been estimated to be between 3.4 to 4.6%, 7.7 to 20%, and 5 to 8.8% for adults aged 50 years and more in Ghana, Kenya and South Africa respectively [9-11]. In addition, more diabetic people live in urban than in rural areas [12]. Diabetes is a major cause of morbidity and mortality in elderly individuals, with the latter largely attributable to macrovascular complications [13]. Elderly diabetic subjects also carry a disproportionate burden of microvascular complications, presumably related to longer duration of diabetes [13]. Age and weight are both risk factors for the development of diabetes [14]. It has been noted that in normal aging there is a 2 mg/dL/decade rise in fasting plasma glucose, lacing elderly patients at increased risk for the development of diabetes [15]. Weight gain and decreased muscle mass are often seen with rising age, resulting in worsened insulin resistance at the level of muscle and fat. Hence, beta cell function is taxed not only by impaired function with age per se, but also through worsening insulin resistance. Additionally, in the elderly there are often concomitant diseases, decreased activity, and medications which can worsen insulin resistance [15]. Because elderly patients with diabetes are living longer and are likely to use increasing amounts of scarce health care resources in the next several decades, diabetes in aged adults may ultimately prove to be the most important epidemic of the 21st century [6]. In order to provide more evidence about the magnitude of diabetes among the elderly individuals, the aim of this study was to assess the prevalence, clinical features and complications of type 2 diabetes mellitus among elderly in the *Hôpital Provincial du Nord-Kivu* in Goma.

Subjects and Methods

Study design and setting of the study.

This study was a cross-sectional study based on data collected in an on-going longitudinal study of elderly from 2013 to 2015 in the Department of Internal Medicine of the *Hôpital Provincial du Nord-Kivu* in Goma, in the Democratic Republic of the Congo. The *Hôpital Provincial du Nord-Kivu* is a reference health institution of all the other health structures of the province of Nord-Kivu (general hospitals and health centres). The *Hôpital Provincial du Nord-Kivu* cares for people with diabetes from the various diabetic support groups in Goma city.

Study population and sample

Study population consisted of any patient consulting this department for treatment. The inclusion criteria were: (i) aged ≥ 65 years; (ii) to receive care in the Department of Internal Medicine of the *Hôpital Provincial du Nord-Kivu;* (iii) willing

Table 1: Demographic, anthropometric, and lifestyle risks behaviour characteristics of elderly with and without diabetes.

Characteristics	Diabetes (n = 36)	No diabetes (n = 382)	Total (n = 418)	p-value
Sex				
Male	15 (6.6%)	212 (93.4%)	227	< 0.001
Female	21 (11.0 %)	170 (89.0%)	191	
Age (years)				
65 – 75	31 (8.2%)	348 (91.8%)	379	0.351
> 75	5 (12.8%)	34 (87.2%)	39	
Age means (years)	70.5 ± 4.6	71.1 ± 4.4	71.0 ± 4.3	0.343
Provenance				
Urban	35 (8.6%)	369 (91.3%)	404	0.821
Rural	1 (7.1%)	13 (92.9%)	14	
Marital status				
Never married	1 (6.7%)	14 (9.3%)	15	
Married or cohabiting	11 (10.2%)	97 (89.2%)	108	0.123
Separated, divorced or widowed	24 (8.1%)	271 (91.9%)	295	
Mean BMI (kg/m2)	29.1 ± 4.3	28.8 ± 4.2	28.9 ± 4.1	0.167
Mean waist circumference (cm)	102.4 ± 29.1	100.8 ± 28.9	100.9 ± 28.9	0.223
Modifiable cardiovascular risk factors				
None	5 (2.4%)	204 (97.6%)	209	< 0.001
Overweight/obesity	31 (27.4%)	82 (72.6%)	113	< 0.001
Smoking	8 (12.9%)	54 (87.1%)	62	< 0.001
Alcohol consumption	14 (20%)	56 (80%)	70	< 0.001
Hypertension	28 (8.7%)	102 (31.8%)	321	< 0.001

give an oral informed consent to participate in the study. The exclusion criteria were not follow-up protocol instructions. Thus, overall, 418 consecutive elderly diabetic and non-diabetic patients were included according to their day of consultation during the period between 2013 and 2015.

Data collection.

Socio-demographics variables

The investigators recorded the patients' sex as either male or female based on the investigators' observations while the patients reported their age in years. Information on the area of residence (rural/urban) and their marital status (never married, currently married or cohabiting, and separated, divorced or widowed) were also collected.

Health behaviours

Alcohol consumption was assessed by asking, "Do you now consume alcoholic beverages?" Smoking status was determined using answers to this question, "Do you now smoke cigarettes?" The health behaviours related to blood pressure was assessed by asking, "Has a health professional told you in the past that you had high blood pressure?"

Anthropometric variables:

The patients' weight and height were measured using standard equipment Seca® (Seca, Germany). Body Mass Index (BMI) was calculated based on weight in kilogram (kg) and height in squared metres (m^2). The waist circumference was evaluated with a measuring tape.

Assessment of diabetes, treatment characteristics, and complications

Undiagnosed diabetes was defined as a fasting glucose ≥ 126 mg/dl in the subsample of individuals without a diagnosis of diabetes who attended the morning examination session and were fasting ≥ 8 hours, using the spectrophotometer SP-300 (Optima, Tokyo, Japan). Individuals diagnosed with diabetes were defined as self-reported physician diagnoses, especially in elderly diabetics. Age of diagnosis of diabetes was determined from the question, "How old were you when a doctor or health professional first told you that you had diabetes or sugar diabetes?" Hypertension was defined as a mean systolic blood pressure of ≥ 140mmHg, a mean diastolic blood pressure of ≥ 90 mmHg, or a physician's diagnosis of high blood pressure using mercury sphygmomanometer Reister® (Reister, Germany) with incorporated cuff 24-32 cm arm circumference. Mean blood pressure comprised up to four readings on two separate occasions. The main symptoms of admission were assessed by a specialist in internal medicine. Clinical and para-clinical data (urinalysis and chest x-ray and Ziehl Neelsen stain) were used to diagnose urinary, pulmonary and gangrenous complications. Any patient with blood lactate > 6 mmol/L and arterial blood pH ≤ 7.35 was considered as presenting a lactic acidosis; and any patient with a presence of ketones in the urine and an arterial blood pH ≤ 7.35 was considered as presenting ketoacidosis. Blood glucose lower than 60 mg/dl was considered as hypoglycaemia. The diagnosis of hyperosmolar coma was clinical, after assessing by a specialist in internal medicine. Peripheral neuropathy was determined via monofilament testing of foot sensation and examinations for foot abnormalities and lesions by trained health technicians, and was defined as one or more insensate areas in either foot. Retinopathy was assessed by ophthalmoscopy after pupil dilatation. The WHO criteria were used to objectify retinopathy [16]. Diabetic nephropathy was diagnosed in all patients with retinopathy whose diabetes has been evolving for more than five years and who had proteinuria and serum creatinine greater than 120 mmol/L [13]. Myocardial infarction was diagnosed with the electrocardiogram (Cardimax®, Tokyo, Japan) by ST elevation ≥ 1mm or ST depression ≥ 1 mm and the troponin (TnT) assay with the venous blood (normal threshold < 0.1 ng/mL). The stroke was diagnosed on CT scan of the brain.

Ethical considerations.

The ethical clearance for this study was granted by the Ethics Committee of the University of Kisangani. Furthermore, permission was obtained from provincial divisions of health of the province of *Nord-Kivu* in the Democratic Republic of the Congo. All participants gave their verbal informed consent to participate to this study.

Statistical analysis.

Descriptive statistics were computed. Means and standard deviations (SD) were calculated for quantitative variables and proportions for categorical variables. The Pearson's χ_2 test was used for comparison of the frequencies, while Fisher's exact test was used when there was a theoretical proportion less than five. Comparisons of means used the Student's *t* test or Mann-Whitney's test when the validity conditions of the latter test were not verified. The P-value < 0.05 was considered as statistically significant. The results were presented as a 95% confidence interval (CI) using the Wilson score bounds. All data were entered into an Excel spreadsheet and analyzed using SPSS 20.0 (Chicago IL, USA).

Results

Prevalence of diabetes in elderly individuals.

Overall, among 418 individuals aged ≥ 65 included in this study, 36 were diagnosed with diabetes mellitus. Thus, the prevalence of type 2 diabetes mellitus was 8.6% (95% CI: 6.3 – 11.7). Five among

the 36 were newly diagnosed. Thus, the prevalence of undiagnosed diabetes (fasting glucose ≥ 126 mg/dl) was 13.8% (95% CI: 6.0 – 28.5).

Demographic characteristics.

The demographic, anthropometric, and health-related behavioural characteristics are illustrated in **Table 1**. Overall, 54% of the elderly individuals were males (*n* = 227) while 46% (*n* = 191) were females. Among males, 6.6% (*n* = 15) were diagnosed with diabetes whereas 11.0% (*n* = 21) were among females (p < 0.001). The mean age of elderly individuals with diabetes was 70.5 years (SD: 4.6) compared with 71.1 among elderly individuals without diabetes. The majority (31/36) of elderly individuals with diabetes were aged between 65 to 75 years (13/15 among males *versus* 18/21 among females). The prevalence of diabetes among participants aged between 65 and 75 years and more than 75 years were 8.2% and 12.8% respectively (p = 0.351). The elderly individuals coming from urban areas were highly affected by diabetes (8.6%) while those who came from rural areas were less affected (7.1%). In our series, the separated, divorced or widowed elderly (24/36) were more affected than those who were never married (1/36) and married or cohabiting (11/36). According to the anthropometric characteristics, mean BMI were 29.1 kg/m^2 (SD: 4.3) and 28.8 kg/m^2 (SD: 4.2) in diabetes elderly and no diabetes elderly, respectively (p = 0.167). Nevertheless, the mean waist circumference was 102.4 cm (SD: 29.1) in diabetes elderly and 100.8 cm (SD: 28.9) in no diabetes elderly. According to the health-related lifestyle risk behaviour, 31/36 elderly with diabetes were overweight or obese, and 28/36 elderly had hypertension. The prevalence of diabetes mellitus in these two population groups with overweight or obesity and hypertension were 27.4% and 8.7%, respectively. Finally, 14/36 cases of alcohol consumption and 8/36 cases of smoking were assessed in elderly diabetics. The prevalence of diabetes mellitus in "alcohol consumption" group and "smoking" group was 20% and 12.9%, respectively.

Treatment characteristics

As shown in **Table 2**, all elderly diabetic subjects (*n* = 36) were taking glucose-lowering medications such as insulin or oral medications (sulfonylurea and/or biguanide). Among those, 15 (41.7%) were taking insulin and 21 (58.3%) oral medications. Mean fasting glucose was higher among elderly individuals taking oral medications compared with elderly on insulin (104.4 versus 157.3 mg/dl, p < 0.001). Similar trends were observed for glycemic control, as measured by Hgb A_{1C}. Elderly diabetic subjects taking oral medications such as sulfonylurea and/or biguanide had substantially worse glycemic control compared with either elderly taking insulin, the mean Hgb A_{1C} values were 7.5% *versus* 6.4% (p = 0.003), respectively. Among elderly diabetic subjects diagnosed within the last five years, 66.7% were taken oral medications while only 13.3% took insulin. By contrast, among elderly diabetic subjects diagnosed within more than ten years, 73.4% were taking insulin and only 19.0% took oral medication (p = 0.01).

Principal symptoms in admission

In our series, the asthenia (86.1%), the polyuria (13.9%), the coma (11.1%) and the polydipsia (5.6%) were the principal symptoms in admission. In admission, mean systolic blood pressure was in general 149 mmHg (SD: 27.4) simultaneously mean diastolic blood pressure was 87 mmHg (SD: 20.6) in all elderly diabetic subjects (see **Table 2**).

Complications

The infectious, metabolic, microvascular and macrovascular complications were diagnosed in this study. Regarding the infectious complications of diabetes mellitus in the elderly in our series, urinary tract infections (22.2%) were the most common than pneumonia (5.6%), pulmonary tuberculosis (8.3%) and gangrene (5.6%). There was a significant difference in the frequency of

infectious complications in patients treated with insulin compared to those treated with oral medication. Indeed, a significant difference was also found in these two groups (insulin versus oral medication) for metabolic and vascular complications as shown in **Table 2**. For metabolic complications, overall, hypoglycaemia (58.3%) was more common than hyperosmolar coma (38.9%), lactic acidosis (30.5%), and ketoacidosis (5.6%). Among microvascular complications in elderly diabetic subjects, the prevalence of diabetic retinopathy (75.0%) and diabetic neuropathy (69.4%) was high, while the prevalence of diabetic nephropathy (19.4%) was low. However, the prevalence of macrovascular complications was low in our series, with 2.8% for myocardial infarction and 5.6% for stroke (see **Table 2**).

Discussion

This cross-sectional study provides an overall picture of the prevalence of diabetes among the elderly individuals. Moreover, the study sought to assess the demographic, health behaviour, anthropometric, treatment, principal symptoms in admission, and complications characteristics associated to type 2 diabetes mellitus among elderly in the *Hôpital Provincial du Nord-Kivu* in Goma. The overall prevalence was 8.6% with statistically significant differences by sex (6.6% among male versus 11.0% among female, $p < 0.001$). The prevalence of diabetes among elderly in our series was comparable to the range of the prevalence of diabetes in rural South African community (5 to 8.8%) [11]. Nevertheless, the prevalence rate was higher in comparison to Ghana and Nigeria, and lower in comparison to Kenya, which could be due to differences in population size, exposures to risk factors and study designs [9, 10, 17-20]. Opposite to our study, most studies in Africa have found no statistical difference in diabetes between men and women [8-10, 17].

According to the age, the prevalence of diabetes among the elderly increased with age from 8.2 to 12.8% among 65 to 75 years and upper 75 years, respectively. This is a pattern observed in other studies in Africa, which could reflect the ageing population in Africa [8, 17]. By contrast, in our study, this association was not statically significant. Indeed, in other settings, old age was found to be associated with increased risk of diabetes only among males [9]. This association could be explained by the cumulative effect of early life exposure to biological, social and behavioural determinants of diabetes [21]. We also found that the prevalence of diabetes was not significantly increased with the place of origin; prevalence varied depending on urban (8.6%) or rural (7.1%) residences. These results are explained by the diaspora in the Province of Nord-Kivu caused by over 20 years of war in the Eastern DRC. Nevertheless, in a study conducted in Ghana, there was no statistically significant difference between prevalence of diabetes mellitus among elderly residents of rural areas versus those living in urban areas [9]. In our study, we did not find an association between marital status and the prevalence of diabetes, this association was found in other studies in Africa [7-10]. This can be explained by the fact that married seniors are most often conscientious in the face of different medical recommendations than those who live alone. Thus, home assistance is very important in supporting diabetic elderly.

Overweight or obesity, hypertension, and smoking have been identified as independent risk factors to diabetes in previous studies in Africa [7-10]. This was also supported by our study where overweight or obesity (31/36), hypertension (28/36), and smoking (8/36) were associated with diabetes mellitus in elderly. Some studies have also found obesity among women as a key risk factor for diabetes in Africa and have attributed it to a perception of large body size being viewed

positively and healthy [19, 22, 23]. The increasing level of obesity in Africa has been attributed to the changing demographic dynamics, urbanization, poverty, nutrition transition and changing lifestyles [12, 23, 24]. Obesity is also associated with an increase in the body's energy requirement hence the associated increase in blood glucose and saturated fatty acids and possibly insulin resistance [25]. Literature also shows physical inactivity is associated with increase in the risk of obesity by increasing the amount of saturated fatty acids in the body and hence triggering insulin insensitivity [25]. But in our study, we did not evaluate this characteristic in the elderly. An interesting finding in our study was the association between consumption of alcohol and prevalence of diabetes in elderly. Same studies have found elderly in low socioeconomic positions to be less educated and to have poor access to nutrition [26]. Finally, the association between hypertension and diabetes was high in our study. Current clinical guidelines for the treatment of hypertension recommend explicitly that the same principles outlined for the general care of hypertension should be followed for older individuals. Hypertension occurs in more than two-thirds of elderly individuals, and multiple drugs are often needed to achieve recommended blood pressure goals [1]. Nonetheless, these guidelines caution that orthostatic hypotension is a risk in individuals with diabetes and in elderly individuals, especially when multiple medications are used. The American Diabetes Association (ADA) and the American Geriatrics Society (AGS) additionally recommend that that blood pressure should be lowered gradually to avoid complications in elderly hypertensive patients with diabetes, but no specific recommendations have been made regarding during what period of time blood pressure should be lowered [27, 28].

The diagnostic criteria for diabetes remain constant across all ages. Diabetes is diagnosed with fasting glucose greater than (FPG) or equal to 126 mg/dl; symptoms of hyperglycaemia and a random glucose equal to or greater than 200 mg/dl; a 75 gram oral glucose tolerance test with a two hour value equal to or greater than 200 mg/dl; or Hgb A_{1C} > 6.5%. For diagnosis, each of these tests must be confirmed on another day unless unequivocal symptoms of hyperglycaemia are present [27]. In an elderly population, screening for diabetes should be considered in light of its increased prevalence. The ADA recommends that all adults over age 45 are screened for diabetes and prediabetes, and if the results are normal, it can be repeated in three years. If the patient is found to have prediabetes (impaired fasting glucose with FPG 100-125 mg/dl, impaired glucose tolerance with 2-hour glucose 140-199 mg/dl on 75 gram oral glucose tolerance test, or Hgb A_{1C} 5.7-6.4%,), screening is recommended yearly [27]. Because the clinical manifestations of diabetes mellitus in the elderly are often atypical, one half of older persons with diabetes are unaware they have the illness, suggesting that symptoms of hyperglycaemia are rarely present in this patient population. This may be because the renal threshold for glucose increases with age, so that no sugar is spilled into the urine until the glucose level is markedly elevated. In addition, because thirst is impaired with normal aging, polydipsia is unlikely in elderly patients with diabetes, even if they are hyperosmolar as a result of marked hyperglycaemia [28]. In our series, asthenia (86.1%), polyuria (13.9%), comas (11.1%) and polydipsia (5.6%) were the principal symptoms in admission. The American Geriatrics Society's (AGS) guidelines for the management of diabetes in the elderly identify syndromes which elderly patients with diabetes are at increased risk of having in comparison to age matched nondiabetic patients. Those syndromes are polypharmacy, depression, cognitive impairment, urinary incontinence, injurious falls, vision impairment, and pain [29].

According to the treatment, in our series, all elderly diabetic subjects were taking glucose-lowering

medications (insulin or oral medications). Among those, 15 (41.7%) were taking insulin and 21 (58.3%) oral medications. Treatment goals in older diabetics should be individualized based on patient and/or family goals, comorbidities, life expectancy and willingness to comply with medication and lifestyle recommendations [30]. For all elderly patients, treatment goals should reflect a high level of concern over the risks associated with hypoglycaemia [31]. The AGS and ADA recommend an Hgb A_{1C} target of 7.5-8% in older adults, and 8-9% in frail adults with multiple comorbidities and with a life expectancy less than 5 years [27, 29]. Lower Hgb A_{1C} (7.5%) may be appropriate in older adult with few comorbidities and good functional status [27, 29]. In our series, elderly diabetic subjects taking oral medications such as sulfonylurea and/or biguanide substantially worse glycemic control compared with either elderly taking insulin, the mean Hgb A_{1C} values were 7.5% *versus* 6.4% ($p = 0.003$), respectively. Exogenous insulin replaces or augments the total insulin present to achieve glycaemic control. Insulin can be added to oral therapy in the elderly diabetic population as a basal injection of intermediate or long acting insulin. However, if this does not achieve glycaemic control, a transition can be made to an insulin regimen with basal and prandial components; in this case, most oral diabetes medications can be discontinued, thus helping to eliminate polypharmacy [32]. In elderly patients with variable appetites, one can dose the prandial insulin post-meal based upon grams of carbohydrate consumed to reduce the risk of hypoglycemia [33]. Because of the high risk of hypoglycemia in the elderly population, simplified regimens using long acting morning basal insulin may be preferred to prevent nocturnal hypoglycemia; further, there should be greater caution when titrating the insulin dose [33]. Insulin therapy can be especially burdensome for an elderly patient because of the complexity of the treatment. However, in this cross-sectional study, taking insulin was associated with the duration of diabetes mellitus diagnostic. Among elderly diabetic subjects diagnosed since under-five years, 66.7% were taking oral medications while only 13.3% insulin. By contrast, among elderly diabetic subjects diagnosed since more 10 years, 73.4% were taking insulin and only 19.0% took oral medication ($p = 0.01$).

Diabetes is the sixth most common cause of death among elderly adults. However, its role in mortality in the elderly population is probably understated, because when patients die of cardiovascular causes, diabetes is often not listed as a contributing cause of death [23, 31-35]. The principal cause of death in elderly patients with diabetes is cardiovascular disease, and these patients have nearly twice the mortality rate of age-matched controls without diabetes. The risk of macrovascular events (cardiovascular disease, cerebrovascular disease, and peripheral vascular disease) is doubled in elderly patients with diabetes when compared with controls [33]. In our series, among microvascular complications in elderly diabetic subjects, the prevalence of diabetic retinopathy (75.0%) and diabetic neuropathy (69.4%) was high, while the prevalence of diabetic nephropathy (19.4%) was low. The risk of microvascular complications is also increased in elderly persons, and, again, there is a strong correlation between the risk of these complications and Hgb A_{1C}, duration of diabetes, hypertension and hyperlipidemia [23, 33]. However, the prevalence of macrovascular complications was low in our series, with 2.8% for myocardial infarction and 5.6% for stroke.

Study limitation

Our study was conducted exclusively at the *Hôpital Provincial du Nord-Kivu*, including successively the elderly subjects according to their day of consultation. This study design is limited because of the many selection biases. Patients who were treated with insulin also received oral medication in

their antecedents, and vice versa. This therapeutic transition has not been clearly determined in this cross-sectional study. Thus, classification bias is possible. Finally, other important parameters of the management of diabetes mellitus such as physical activity, fruit consumption, etc. have not been evaluated in this study. And those could have been possible confounder

Table 2: Clinic, paraclinic characteristics and complications of elderly diabetic subjects treated with insulin and oral medication.

Characteristics	Insulin	Oral medications	Total	p-value
	(*n* = 15)	(*n* = 21)	(*n* = 36)	
Mean fasting glucose (mg/dl)	104.4 ± 27.7	157.3 ± 34.7	131.2 ± 34.7	< 0.001
Mean Hgb A_{1C} values (%)	6.4 ± 5.5	7.5 ± 6.7	7.1 ± 6.4	0.003
Blood pressure (mmHg)	148/84 ± 27.2/20.9	151/89 ± 27.5/20.6	149/87 ± 27.4/20.6	0.071
Years since diagnosis of diabetes				
< 5 years	2 (13.3%)	14 (66.7%)	16 (44.4%)	0.01
5 – 10 years	2 (13.3%)	3 (14.3%)	5 (13.9%)	
> 10 years	11 (73.4%)	4 (19.0%)	15 (41.7%)	
Principal symptoms on admission				
Asthenia	11 (73.3%)	20 (95.2%)	31 (86.1%)	< 0.001
Polyuria	4 (26.7%)	1 (4.8%)	5 (13.9%)	< 0.001
Coma	3 (20.0)	1 (4.8%)	4 (11.1%)	< 0.001
Polydipsia	2 (13.3%)	0 (0.0%)	2 (5.6%)	< 0.001
Infectious complications				
Urinary infection	3 (20.0%)	5 (23.8%)	8 (22.2%)	< 0.001
Pneumonia	0 (0.0%)	2 (9.5%)	2 (5.6%)	< 0.001
Pulmonary tuberculosis	1 (6.7%)	2 (9.5%)	3 (8.3%)	< 0.001
Gangrene	2 (13.3%)	0 (0.0%)	2 (5.6%)	< 0.001
Metabolic complications				
Ketoacidosis	2 (13.3%)	0 (0.0%)	2 (5.6%)	< 0.001
Hyperosmolar coma	4 (26.7%)	10 (47.6%)	14 (38.9%)	< 0.001
Lactic acidosis	2 (13.7%)	9 (42.9%)	11 (30.5%)	< 0.001
Hypoglycemia	10 (66.7%)	11 (52.4%)	21 (58.3%)	< 0.001
Microvascular complications				
Diabetic retinopathy	12 (80.0%)	15 (71.4%)	27 (75.0%)	< 0.001
Diabetic nephropathy	3 (20.0%)	4 (19.0%)	7 (19.4%)	< 0.001
Diabetic neuropathy	11 (73.3%)	14 (66.7%)	25 (69.4%)	< 0.001
Macrovascular complications				
Myocardial infarction	0 (0.0%)	1 (4.8%)	1 (2.8%)	< 0.001
Stroke	0 (0.0%)	2 (9.5%)	2 (5.6%)	< 0.001

Study limitation

Our study was conducted exclusively at the *Hôpital Provincial du Nord-Kivu*, including successively the elderly subjects according to their day of consultation. This study design is limited because of the many selection biases. Patients who were treated with insulin also received oral medication in at some point in the past, and vice versa. This therapeutic transition has not been clearly determined in this cross-sectional study.

Thus, classification bias is possible. Finally, other important parameters of the management of diabetes mellitus such as physical activity, fruit consumption, etc. have not been evaluated in this study. And those could have been possible confounders.

Conclusions and perspectives.

In conclusion, our study provides evidence on the high prevalence of type 2 diabetes mellitus among the elderly individuals. Moreover, the study sought to assess the demographic, health behaviour, anthropometric, treatment, principal symptoms in admission, and complications characteristics associated to type 2 diabetes mellitus among elderly in the *Hôpital Provincial du Nord-Kivu* in Goma (Democratic Republic of the Congo). More research on exploring the best strategy to early diagnose and correctly take care of the elderly diabetes subjects is therefore needed. Hence, there is a need to enhance the existing prevention programmes with an emphasis on social determinants of diabetes, which need to be clarified by broad epidemiological studies at the population level.

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Authors' contributions: PKM, SBA, STW and CKT conceived and designed the present research; PKM was in patients' recruitment, follow-ups and data collection; JPMM analysed the data; PKM, SBA, STW and CKT interpreted the findings and drafted the first manuscript; all authors accepted the submitted version of the manuscript.

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