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DEVELOPING A FRAMEWORK TO IMPROVE GLYCAEMIC CONTROL AMONG PATIENTS WITH TYPE 2 DIABETES MELLITUS IN KINSHASA, DEMOCRATIC REPUBLIC OF THE CONGO

Jean-Pierre Fina Lubaki

A Thesis submitted to the Faculty of Health Sciences, University of the Witwatersrand, in fulfilment of the requirements for the degree of Doctor of Philosophy

Johannesburg, South Africa

20 December 2023

DECLARATION

I, Jean-Pierre Fina Lubaki, declare that this Thesis Report is my own, unaided work. It is being submitted for the degree of PhD Family Medicine at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at any other university.

Signature: 

Jean-Pierre FINA LUBAKI

2023/12/20

DEDICATION

This thesis is dedicated to my parents for their contribution to my knowledge:

My Father, Fina Lubaki Antoine (1940-2000), and Mother, Béatrice Nsunda Basiona.

PUBLICATIONS ARISING FROM THIS RESEARCH PROJECT

1. Fina Lubaki J-P, Omole OB, Francis JM (2022) Protocol: Developing a framework to improve glycaemic control among patients with type 2 diabetes mellitus in Kinshasa, Democratic Republic of the Congo. PLoS ONE. 2022;17(9): e0268177. https://doi.org/10.1371/journal.pone.0268177

My contribution to the paper

Conceived the research project, wrote all drafts of the paper, addressed supervisors' and peer reviewers' comments, and checked proofs for the final accepted and published manuscript.

2. Fina Lubaki JP, Omole OB, Francis JM. Glycaemic control among type 2 diabetes patients in sub-Saharan Africa from 2012 to 2022: A systematic review and meta-analysis. *Diabetol Metab Syndr*. 2022 Sep 20;14(1):134. doi: 10.1186/s13098-022-00902-0

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Conceived the research project, conducted the search and assessment of the studies, performed all the statistical analyses, wrote all drafts of the paper, addressed co-authors' and peer reviewers' comments, and checked proofs for the final accepted and published manuscript.

3. Lubaki J-P F, Francis JM, Omole OB. Perspectives for glycaemic control in type 2 diabetes in Kinshasa, Democratic Republic of the Congo. Health Promotion International. 2023;38(5) https://doi.org/10.1093/heapro/daad128

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6. Lubaki JF, Omole OB, Francis JM. Consensus on potential interventions for improving glycaemic control among patients with type 2 diabetes in Kinshasa, Democratic Republic of the Congo: a Delphi study. Glob Health Action. 2023 Dec 31;16(1):2247894. doi: 10.1080/16549716.2023.2247894.

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ABSTRACT

Diabetes mellitus is a significant problem globally with a higher impact in developing countries. Glycaemic control is one of the main goals of type 2 diabetes treatment, as it delays or avoids the occurrence of diabetes related complications. In sub-Saharan Africa, including the Democratic Republic of the Congo, glycaemic control rates are sub optimal. This study aimed to develop a framework to improve glycaemic control among patients with type 2 diabetes in Kinshasa, Democratic Republic of the Congo.

This project comprises four sub-studies. The first sub-study was a systematic review and meta-analysis of studies published from 2012 to 2022 on the prevalence and factors driving glycaemic control in sub-Saharan Africa. Younger and older age, gender, lower income, absence of health insurance, low level of education, place of residence, family history of diabetes, longer duration of diabetes, pill burden, treatment regimen, side effects, use of statins or antihypertensives, alcohol consumption, smoking, presence of comorbidities/complications, and poor management were associated with poor glycaemic control. On the other hand, positive perceived family support, adequate coping strategies, high diabetes health literacy, dietary adherence, exercise practice, attendance at follow-up visits, and medication adherence were associated with good glycaemic control.

The second sub-study was a concurrent parallel mixed methods cross-sectional analytical study among a total of 643 patients with type 2 diabetes — 23 in the qualitative phase and 620 in the quantitative phase — on factors associated with poor glycaemic control in Kinshasa. Five themes were identified as explanations for poor glycaemic control: financial constraints, limited social and relational support, difficulties with lifestyle changes, beliefs and practices about diabetes, and ability to adapt to caring for the illness. The quantitative phase showed that about two-thirds of the participants (67.8%; n=420) had poor glycaemic control and more than half were on insulin monotherapy (53.9%; n=334). No sociodemographic or lifestyle characteristics were associated with poor glycaemic control. Participants on monotherapy with insulin (AOR: 1.72 (95%CI:1.17-2.55)) had increased odds of poor glycaemic control compared to participants on oral hypoglycaemic drugs. In contrast, participants having and those having uncontrolled blood pressure (AOR: 0.60 (95%CI:0.39-0.92)) were less likely to have poor glycaemic control compared to participants having controlled blood pressure.

The third sub-study was a qualitative study on the perspectives of 16 healthcare providers and 10 patients with type 2 diabetes on improving glycaemic control in Kinshasa. From the healthcare providers statements regarding improving glycaemic control, three themes were identified: strengthening the healthcare system, supporting persons with diabetes/population, and adopting supportive health policies. From the persons with diabetes perspectives three themes were also identified: need for support for caring of the illness, need for enhanced knowledge about diabetes, and the need for better communication with healthcare providers.

Using the results of the first three studies, the fourth sub-study, a Delphi study, brought together 36 experts on the management of diabetes, who developed and agreed on the following strategies for improving glycaemic control in Kinshasa: strengthening the healthcare system, enhancing the awareness of diabetes, alleviating the financial burden of diabetes, enhancing the adoption of lifestyle modifications, and reducing the proportion of undiagnosed diabetes.

These five strategies included a total of 39 potential interventions. Strengthening the healthcare system for better care promotes better organization and provision of services for diabetes care. Enhancing the awareness of diabetes among the population/patients stresses the need to develop and share information about diabetes through the most appreciated channels by the population. Alleviating the financial burden of diabetes targets for the long-term the need for universal health coverage, and meanwhile, encouraging the development of community-based health insurance. It also includes the search for a reduction in costs of diabetes medicines and materials through public-private partnerships. Enhancing the adoption of lifestyle modifications in our setting passes through the provision of accurate information on the content of lifestyle changes, and developing realistic exercise and dietary plans. Reducing the proportion of undiagnosed patients with diabetes needs to increase the detection of diabetes by targeting high risk groups at the level of primary care settings. This study highlighted the need to ensure that patients with type 2 diabetes benefitted from the full package required for diabetes care in a broader framework of managing non-communicable diseases in Kinshasa.

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LIST OF ABBREVIATIONS

AOR: Adjusted Odds Ratio

AUDIT-C: Alcohol Use Disorder Identification Test - Concise

BMI: Body mass index

CEUPC: Ethics Committee of the Protestant University of the Congo

COR: Crude Odds Ratio

COREQ: Consolidated criteria for reporting qualitative research

CRD: Centre for Reviews and Dissemination

DAWN: Diabetes Attitudes, Wishes and Needs second study

DCCT: Diabetes Control and Complications Trails

DDS: Diabetes Distress Score

DM: Diabetes mellitus

DRC: Democratic Republic of the Congo

DSMQ: Diabetes Self-Management Questionnaire

eGFR: estimated Glomerular Filtration Rate

FBG: Fasting Blood Glucose

FBS: Fasting Blood Sugar

GLUT-2: Glucose Transporter-2

GPAQ: Global Physical Activity Questionnaire

HbA1c/ Ghb: Glycosylated haemoglobin

HDL-Cholesterol: High Density Lipoprotein-Cholesterol

HFIAS: Household Food Insecurity Assessment Scale

HIV/AIDS: Human Immunodeficiency Virus/Acquired Immunodeficiency Syndrome

IDF: International Diabetes Foundation

IQR: Inter Quartile Range

JMF: One supervisor

JPF: Principal Investigator

ICMJE: International Committee of Medical Journal Editors

LDL-Cholesterol: Low Density Lipoprotein-Cholesterol

LMICs: low- and middle-income countries

MENA: Middle East and North Africa

MGL: Morisky Green Levine

MH: MesH term

MSPSS: Multidimensional Scale for Perceived Social Support

NCD: Noncommunicable diseases

NICE: National Institute for Health and Care Excellence

NIDDM: Non-insulin dependent diabetes mellitus

NPH: Neutral Protamin Hagedorn

OBO: One supervisor

OHA: Oral Hypoglycaemic Agent

OSF: Open Science Framework

PEN-Plus: Package of Essential Noncommunicable Disease Interventions-Plus

PHC: Primary HealthCare

PHQ-9: Patient Health Questionnaire-9

PPP: Purchasing Power Parity

PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analyses

PROSPERO: International prospective register for systematic reviews

RedCap: Research Electronic Data Capture

SIGN: Scottish Intercollegiate Guidelines Network

SSA: Sub-Saharan Africa

STATA: Statistics and data

STROBE: Strengthening the reporting of observational studies in epidemiology

TW: Text word

T2D: Type 2 Diabetes mellitus

WHO: The World Health Organization

WHO ICCC: World Health Organization Innovative Care for Chronic Conditions

WHO PEN: World Health Organization's Package of Essential Noncommunicable Disease Interventions

CHAPTER ONE - BACKGROUND

Diabetes mellitus is a chronic heterogeneous metabolic disorder with complex pathogenesis; it is characterised by elevated glycaemic levels or hyperglycaemia, resulting from abnormalities in either insulin secretion, its action, or both.[1] The 2019 aetiological classification of diabetes distinguished type 1, type 2, hybrid forms, other specific types, unclassified, and hyperglycaemia first detected during pregnancy.[2] Type 2 diabetes is the most common form of diabetes, representing 98% of all people with diabetes worldwide, with diverse variations across countries and regions.[3]

1.1 Epidemiology of diabetes mellitus

Diabetes is one of four major non-communicable diseases increasing dramatically and significantly impacting morbidity and mortality. These four diseases (cardiovascular diseases, diabetes, cancer, and chronic respiratory diseases) account for 74% of deaths worldwide, with over three-quarters of these in developing countries.[4]

The prevalence of diabetes has almost quadrupled from 1980 to 2014. The disease currently affects 537 million people, and it is estimated that, by 2045, diabetes will affect 783 million individuals.[3] Currently, the prevalence of diabetes is 10.5% for adults aged 20-79 years.[3] In the United States of America, the Centre for Disease Control and Prevention of Diabetes Surveillance System reported a prevalence of diagnosed diabetes of 11.3% of adults in 2022.[5] Given the sharp rise in childhood obesity, the prevalence of type 2 diabetes is expected to continue increasing.[6]

The diabetes pandemic is most prevalent in developing countries where more than ¾ of persons with diabetes live.[3] In Africa, 22 million adults live with diabetes; that is, one in 22 adults, and it is predicted to increase by 129% to 55 million by 2045.[3] This situation is dramatic for low- and middle-income countries due to the coexistence of other traditional health priorities (malaria, HIV/AIDS, tuberculosis, child and maternal care), resource constraints, and unprepared health systems.[7] The existence of as yet unresolved clinical and metabolic features of diabetes in Africa is a stumbling block to optimal patient management.[8]

Adopting a Westernised lifestyle and urbanization were blamed for the increase in diabetes.[9] In the Democratic Republic of the Congo (DRC), the prevalence of diabetes was estimated as 4.8% in the adult population, with disparities in prevalence between the eastern and western parts of the country as well as between rural and urban areas.[3,10]

1.2 Pathophysiology of type 2 diabetes

Type 2 diabetes is characterised by two main insulin-related anomalies: insulin resistance and β-cell dysfunction.[11] The dysfunction of β-cells in type 2 diabetes mellitus is currently understood as being due to an integrated interplay of interactions between the environment and different molecular pathways involved in cell biology.[12] In an excessive nutritional state, as in obesity, hyperlipidaemia and hyperglycaemia are often present, favouring insulin resistance and chronic inflammation. Under these circumstances, β-cells, due to differences in their genetic susceptibility, are subject to toxic pressures, including inflammation and inflammatory, endoplasmic reticulum, amyloid and metabolic/oxidative stress, which could potentially lead to a loss of integrity of the islet. Excess free fatty acids and hyperglycaemia lead to β-cell dysfunction by inducing endoplasmic reticulum stress due to activating the apoptotic unfolded protein-response pathways.[13]

Insulin resistance results from the disruption of various cellular pathways, leading to a decreased response or sensitivity of cells to insulin in the peripheral tissues, particularly the muscle, liver, and adipose tissue. In the early stages of the disease, decreased insulin sensitivity triggers β-cell hyperfunction to achieve a compensatory increase in insulin secretion to maintain normoglycaemia.[1] The higher levels of circulating insulin (hyperinsulinaemia) thus prevent hyperglycaemia. However, gradually, the increased insulin secretion by the β-cells cannot compensate sufficiently for the decrease in insulin sensitivity. Moreover, β-cell function begins to decline, and β-cell dysfunction eventually leads to insulin deficiency. As a result, normoglycaemia can no longer be maintained, and hyperglycaemia develops. Although insulin levels are decreased, the secretion of insulin in most cases is sufficient to prevent the occurrence of diabetic ketoacidosis.[11]

Type 2 diabetes leads to macro-vascular complications consisting of accelerated atherosclerosis, leading to severe peripheral vascular disease, premature coronary artery disease, and increased risk of cerebrovascular diseases.[14]

1.3 Impact of type 2 diabetes: morbidity and financial burden

Diabetes is a significant cause of blindness, kidney failure, heart attack, stroke, and lower-limb amputation.[4] In 2021, diabetes was responsible for 6.7 million deaths; one every five seconds globally.[3] The premature morbidity, mortality, reduced life expectancy, as well as financial and other costs of diabetes render it a significant public health condition.[15] Diabetes mellitus leads to macrovascular and microvascular complications directly related to quality of life.[16]

The global cost of diabetes for 2015 was US$131 trillion (95% CI: 1.28–1.36), representing 18% (95% CI: 1.8–1.9) of global gross domestic product. Its indirect costs accounted for 34.7% (95% CI: 34.7–35.0) of the total burden, although substantial variation existed across countries.[8] Diabetes was the reason for at least US$966 billion in health expenditure worldwide.[3]

Flood and colleagues found that, in 55 developing countries, fewer than one in 10 people with diabetes was receiving coverage for guideline-based comprehensive diabetes treatment. In 2021 in Africa, diabetes mellitus was responsible for 416 000 deaths.[17] Kibirige and colleagues,[18] in a systematic review, found that diabetic peripheral neuropathy, retinopathy, diabetic nephropathy, peripheral arterial disease, and foot ulcers had a pooled prevalence of 38% (95% CI: 31 - 45, I2=98.2%), 32% (95% CI: 28 - 36, I2=98%), 31% (95% CI: 22 - 41, I2=99.3%), 19% (95% CI: 12 - 25, I2=98.1%), and 11% (95% CI: 9 - 14, I2=97.4%), respectively. The cost of diabetes may be underestimated in many countries due to a lack of data on the relative contribution of the cost of diabetes complications.[19] Nevertheless, Kirigia and colleagues estimated that, with 7.02 million cases of diabetes reported by the African Region in 2000, there was a total economic loss of International dollars 25.51 billion (Purchasing Power Parity (PPP)).[20]

In the DRC, the morbidity and financial burden of diabetes has not been previously assessed. Mottini and colleagues[21], in a cross-sectional study assessing the occurrence of complications, found that their incidence was related to the financial status of patients, with a trend for facilities located in poor settings to have severe diabetes-related complications. Financial constraints limit access to care and reduce the affordability of treatment as most patients are not covered by health insurance. The authors also noted that managing diabetes and its complications was negatively affected by cultural influences and that the patients' beliefs about diabetes also

dictated their health-seeking behaviors and may result in a delay of the patients presenting at healthcare facilities.

1.4 Glycaemic Control: Prevalence, Driving Factors and Interventions

Blood glucose control is one of the goals of diabetes management. Good control prevents or slows the occurrence of diabetes-related complications.[22] The Diabetes Control and Complications Trials (DCCT) found that a glycosylated haemoglobin (HbA1c) measurement less than 7% could prevent or slow the progression of nephropathy, retinopathy, and neuropathy in patients with type 1 diabetes. This finding was applied to patients with type 1 and type 2 diabetes mellitus, leading to the consensus that normalising glycaemia prevents diabetes mellitus complications.[23] Nevertheless, patients need to adjust many aspects of their lives to achieve glycaemic control.[22] They must adopt healthy diets, physical exercise, stop smoking, manage stress, and limit alcohol consumption.[24] Moreover, they need to follow the scheduled visits, adhere to treatment, and participate actively in the treatment process.[24]

1.4.1 Prevalence of glycaemic control

Worldwide, diabetes control remains a significant challenge for patients with type 2 diabetes. The proportion of patients achieving glycaemic control is around 50%.[25] However, differences in the prevalence of glycaemic control among patients with type 2 diabetes have been noted between countries.

Studies on high-income countries showed higher glycaemic control rates, ranging from 50.5% in the United States[26] to 62.6% in eight European countries.[27] Nevertheless, higher rates of poor glycaemic control have been described among disadvantaged categories in high-income countries mainly those experiencing food insecurity.[28] In low-and-middle-income countries, only 30.1% of persons with diabetes reached glycaemic targets.[29] In sub-Saharan Africa, studies found good glycaemic control rates that ranged from 27% (95% CI: 24 - 30, I2=94.7%) to 32.6% (95%CI: 28.3-36.9).[18,30-33] In the DRC, there was a study that specifically investigated glycaemic control among persons with type 2 diabetes and found that less than 20% of the participants had HbA1c levels of 7.0% or lower.[34]

The differences in the control of diabetes in these different settings are mainly due to the organization of diabetes care. High-income countries are better prepared to offer adequate care

while low- and middle-income countries' health systems, particularly in sub-Saharan Africa, are unprepared and face numerous challenges with diabetes care including financial, and diabetes disease features.[7,35]

1.4.2 Factors associated with glycaemic control

Planning interventions to ensure adequate management of glycaemia necessitates accurate knowledge of the determinants of poor glycaemic control.[26] Optimal glucose control is virtually impossible without a clear understanding of the precise dynamics of poor glycaemic control in people with type 2 diabetes in a particular context.[33] Furthermore, the reasons for poor glycaemic control in patients with type 2 are multiple, variable and interconnected. These factors can involve the patients, healthcare system, and healthcare providers.[26,35-38]

1.4.2.1 Patients' factors

The patients' factors are linked to poor glycaemic control and can be grouped into four categories: sociodemographic, clinical, psychological, and lifestyle.

1.4.2.1.1 Sociodemographic factors

Older age, young age, female gender, low level of education, low socioeconomic level, and food insecurity were associated with poor glycaemic control.[38,39] Older age is associated with poor glycaemic control through insulin resistance and the emergence of diabetes-related complications.[40] With these two conditions, reaching glycaemic targets is challenging. Insulin resistance leads to a vicious circle resulting in exhaustion of the pancreas and need for more insulin.[41] The presence of comorbidities/complications poses a problem with respect to pill burden, adherence to treatment, cost, or as an intricate mechanism linked to the beta-cell function loss. For the young, the association with poor glycaemic control is explained by psychological barriers that interfere with effective self-management and difficulties with making the required changes necessary for living with diabetes and better health outcomes.[42]

Females were more prone to poor glycaemic control than men because of differences in glucose homeostasis, treatment response, and psychological factors.[43] In women, after menopause, there is a decrease in oestrogen levels that occurs concurrently with elevated blood glucose levels.[44] In men, testosterone stimulates lipolysis in adipose tissue, and therefore, low testosterone levels

(as seen in women) are associated with abdominal obesity and insulin resistance in men.[45] The metabolic differences between men and women are mainly due to the pharmacodynamics of diabetes medications (metformin, thiazolinediones, and insulin) that expose women to more side-effects which could decrease adherence.[43] Women manifested higher levels of depression while being treated for diabetes than men.[46] In Africa, it was found that African women are more insulin resistant than Caucasian women. Also, women had poor access to health systems and diabetes clinics mainly in rural areas. Futhermore, cultural beliefs on weight loss, stigmatization of women with diabetes, social values, and financial constraints limit access to care for women in Africa.[47]

The effect of socioeconomic status on glycemic control is mediated through how patients perceive their disease, how they cope with stress related to the illness, their diet, and finally, by their depressive symptoms. Good glycaemic control was associated with higher socio-economic status.[37] In contrast, persons with lower socio economic status have greater difficulty coping with all the requirements related to good management of their illness and is more likely to fall into depression.[48] Depression directly and negatively affects self-efficacy and indirectly affects self-management behaviors, which in turn have direct effects on hemoglobin A1c (HbA1c) levels.[49]

A low level of education and lack of knowledge of the disease could interfere with the understanding of diabetes disease and its treatment and lead to inadequate health-seeking behaviours and poor glycaemic control.[50]

Food insecurity is associated with poor glycaemic control through both a direct and indirect effect on self-care through stress.[51] Apart from the impact that chronic stress can have physiologically, it can also interfere with a person's ability to adhere to the lifestyle changes that is essential for achieving good blood sugar control.[52]

1.4.2.1.2 Clinical factors

Poor glycaemic control is associated with a longer duration of diabetes, renal impairment, hypertension, dyslipidemia, and obesity.[38,39] As diabetes progresses, there is a deterioration of the function of the pancreas due to failure of the beta cells, and the emergence of disease-related complications, which in turn affect glycaemic control.[53]

1.4.2.1.3 Psychological factors

Apart from depression, many other psychological factors were associated with suboptimal glycaemic control. Though not yet fully understood, these factors appear to interfere with the ability of persons with diabetes to self-manage their illness. Resistance to lifestyle measures and poor adherence to medications have also been associated with poor glycaemic control.[38,50] Moreover, a poor attitude towards the disease and poor self-management behaviour were associated with poor glycaemic control.[38]

1.4.2.1.4 Lifestyle factors

Low physical activity[31], smoking[31], alcohol consumption, and an unhealthy diet were associated with poor glycaemic control.

Hypotheses of the mechanism(s) of physical activity on glucose control in diabetes include normalization of impaired insulin-stimulated glucose transporter type 4 (GLUT4) translocation associated with people with type 2 diabetes with concomitant increased insulin sensitivity, increased glycogen synthase and hexokinase activity resulting in increased glycogen synthesis and increased nonoxidative disposal of glucose, increased messenger RNA, decreased release and increased clearance of free fatty acids, increased muscle glucose delivery due to increased muscle capillary density, and changes in muscle composition favouring increased glucose disposal.[54]

Smoking is associated with increased insulin resistance and the possible pathways include visceral fat accumulation, increased cortisol and thyroid hormone levels, increased sympathetic activity, and increased systemic inflammation.[55] Previous studies have also suggested that nicotine exposure could induce a reduction in insulin release and loss of pancreatic beta cell mass, apart from negatively affecting insulin action.[55]

In diabetes, alcohol intake is detrimental as it usually affects the ability of the patient to practice self-care for themselves as well as affecting vital body organs.[56]

With respect to diet, it is recommended that persons with diabetes have a daily dietary regimen intake including 30% fat, 45-60% carbohydrates, and 15-35% protein. When they consume

more or less of macronutrients, this can lead to changes in glucose metabolism and a shift from normal levels of insulin secretion. Following a low-fat diet improves glycemic control and decreases HbA1c levels.[57]

Adherence to treatment and lifestyle modifications are essential for the management of diabetes and the reaching of glycaemic targets. Thus, better dietary knowledge, and higher self-efficacy and empowerment were associated with good glycaemic control.[37]

1.4.2.2 Health system factors

The factors associated with poor glycaemic control could be attributed to access (geographical, financial, and cultural), services provided, and healthcare governance.

1.4.2.2.1 Access

Access to diabetes care could be related to geographic, financial or cultural issues.

Long distances to healthcare structures have been associated with poor glycaemic control.[58] Long distances to healthcare facilities reduce physical access and interfere negatively with adherence to treatments, appointments, and subsequent glucose monitoring. Therefore, adherence and care are reduced because of difficulty in access.

Medical costs represent a barrier to care for persons with diabetes to reach glycaemic targets. Worse glycaemic control was associated with higher total health care, hospitalization, and medication costs.[59] In sub-Saharan Africa, studies have shown poor access to medication and glucose monitoring because of financial constraints.[35,60,-61]

Cultural barriers impact access to diabetes care. The beliefs about diabetes in the population which associated it with a mystic origin, and the stigmatization of persons with diabetes in the population are key barriers.

1.4.2.2.2 Services provided

Concerning the health team, the lack of motivation of healthcare providers, and lack of access to multidisciplinary teams are barriers to good glycaemic control.[50] Lack of effective self-

management education, lack of clinical information, and inadequate public health support were identified as barriers to poor glycaemic control.[62]

The provision of adequate services also requires a reliable system for the provision of medications and medical consumables; and the availability of basic medical equipment affects healthcare structures.[63] Overcrowding in clinics was also considered a barrier to good glycaemic control.[64]

1.4.2.2.3 Healthcare governance

A critical issue in health governace is to provide sufficient funding to support all the activities required for diabetes care.[7,35] Moreover, the lack of good organization for the management of chronic diseases, national comprehensive management for diabetes, and access to multidisciplinary care, as well as poor integration of diabetes care into other chronic diseases management programs are all barriers to good glycaemic control.[65,66] In sub-Saharan Africa, an analysis of the health system showed a weak disease management framework with a fragmented health system that makes it difficult for patients to transit through initial screening, outpatient care, inpatient care, and self-management. A proportion of patients diagnosed with diabetes would be left out without treatment or if treated, unable to be monitor their treatment. This fragmentation leads to poor health outcomes.

1.4.2.3 Providers factors

From the factors related to healthcare providers, therapeutic inertia is probably one of the most concerning. It was found to be the cause of poor glycaemic control in half the persons with type 2 diabetes.[50] There is a lack of training for pharmacological management mainly related to diabetes care.[65]

1.4.3 Interventions to improve glycaemic control

There are a variety of quality improvement programmes to improve diabetes care and health outcomes including glycaemic control, especially when multiple strategies are used in combination.[67,68] These strategies are numerous and target patients, the healthcare system, and healthcare providers. An economic evaluation found that these strategies appear to be fair-to-good value for money compared to the usual care.[69]

1.4.3.1 Patients-directed interventions

Diabetes, being a lifestyle disease, requires lifestyle changes which are the cornerstone of the treatment. However, diabetes comes with stress and resistance to the required behavioural change. Psychological therapy could help to address the stress and assist the persons with diabetes to overcome issues that arose in the need to change the behaviours.

Lifestyle modification could be more effective than standard care regarding glycaemic control for patients with type 2 diabetes, mainly when weight loss occurs.[70] Zhang and colleagues[71] suggested focusing on diet and physical activity as these significantly affected blood glucose and weight loss. In low-and middle-income countries, studies to assess the effectiveness of lifestyle interventions were of low quality with significant intervention characteristics heterogeneity.[72] In a systematic review, Rao and colleagues[73] found that physical activity interventions improved glycaemic control among African adults.

In the biopsychosocial management of diabetes, psychological therapy is essential to help the persons with diabetes effectively self-manage their illness. There are four main type of psychological interventions: cognitive-behavioral therapy, motivational interviewing, counseling, and mindfulness-based therapies.[74]

Cognitive-behavioural therapy are various cognitive and behavioral techniques to identify and transform negative thinking patterns. It helps individuals understand barriers to their own self-management and provides them with the skills to cope with these barriers. It is confirmed as being effective in type 2 diabetes.

Motivational interviewing (MI) is a collaborative and goal-oriented therapy that focuses on resolving ambivalence toward change. Motivational interviewing deals with resistance and non-compliance of patients to the instructions for self-management, thus promoting self-efficacy. In diabetes mellitus, motivational interviewing had mixed results.

Counseling interventions promotes self-awareness and self-determination and thus could improve self-management behaviours. It must be used long-term and follow a structured format to be beneficial for glycaemic control.

Mindfulness-based therapies teach meditative practices and promote a non-judgemental awareness of the present moment, including motivating thoughts, emotions, and bodily sensations. The results of the mindfulness interventions have been mixed for glycaemic control.

Overall, patient education, promotion of self-management, and reminder systems were found to be effective qualitative improvement strategies in ambulatory diabetes care to improve glycaemic control.[67] With respect to the patients' education, information from non-health workers was negatively associated with poor glycaemic control. This could be due to the inaccuracy to the information transmitted by non-healthcare workers. Inaccurate information could not have allowed the persons with diabetes to adopt adequate measures for managing their illness. It is important to consider from what source diabetes information could be shared with patients. This implies that there is a need for more accurate information from trained diabetes educators, which is significant for glycaemic control.[75]

1.4.3.2 Healthcare system directed interventions

In many low-and middle-income countries, health systems need to shift from the traditional priorities of prevention and management of infectious diseases to incorporate the management of chronic diseases. Disease management, team changes, electronic registry, facilitated relay, continuous qualitative improvement, enhancing efficiency, and standardizing the care are quality improvement interventions that showed effectiveness at the level of the healthcare system for glycaemic control.[67]

1.4.3.3 Provider directed interventions

Managing noncommunicable diseases requires a change in approach of healthcare providers. Audit and feedback, provider education, provider decision support, incentives for providers, patient-tailored care, patient self-management, patient reminders, and incentives for patients were qualitative improvement interventions that were found to be effective.[67]

1.5 Problem Statement

The target population of this study were patients with type 2 diabetes living in Kinshasa, the capital of the DRC. The DRC is the largest country in sub-Saharan Africa and has a land mass

of over 2,345,000 square kilometres and comprises 102,262,808 inhabitants. [76,77] The World Bank categorizes it as a low-income country with one out of six individuals living in extreme poverty.[76] About a quarter of the population faces acute food insecurity.[78] In 2020, the country's domestic health expenditure was 16.06% of gross domestic product while the out-of-pocket health expenditure was constituted 39.72% of the total spent.[79] Kinshasa is the main city of the DRC (Figure 1.1). It covers an area of 9,965 square kilometres with 16,355,534 inhabitants.[80] The city's population is growing fast due to a rural exodus from the surrounding provinces. Kinshasa is divided into 24 health districts. Diabetes care at the primary healthcare level in Kinshasa is mainly provided by the private sector and organised in a structure named the Kinshasa Primary Healthcare Network which comprises healthcare structures managed by the Catholic Church and the Salvation Army.[81]

In the DRC, the International Diabetes Federation has estimated the prevalence of diabetes to be 4.8% in the adult population.[3] Diabetes is unequally distributed in the country with a preponderance in urban cities.

Studies conducted to assess the rate of glycaemic control showed an extremely low prevalence of good glycaemic control. Blum et al. in a cross-sectional study in a rural setting near Kinshasa found a 14% prevalence of good glycaemic control.[34] Sagastume, in a retrospective analysis of a database of primary healthcare centres, found a 32% prevalence of good glycaemic control.[82]

The factors associated with suboptimal glycaemic control were age greater than or equal to 40 years, abdominal or general obesity associated with advanced age, high blood pressure, and a family history of diabetes.[34,81-83] Other contributing factors could be the lack of good integration of diabetes care in the health system.[83,84] There is no existing management protocol or framework that guides the provision of healthcare services to people wih diabetes in the DRC. Persons with diabetes are seldom covered by health insurance, and most are poor.



Figure 1.1 Study setting map

Although there is not a good collection of data in the country to accurately assess the burden of diabetes, the impact of the disease is seen in the increasing number of patients consulting for diabetes-related complications.

Diabetes disease is costly and there is no support from the Government. The burden of diabetes is a real hindrance to the wellness of patients and their families.[84] The majority of the population

are not covered by health insurance and have to use out of pocket payments. Families spend a large portion of their income on diabetes care. The burden becomes more significant when glycaemic control is not achieved, and complications arise. The healthcare system has little available resources that are mostly directed towards infectious diseases and is therefore unprepared to face the challenges raised by chronic diseases.

Not only are data on glycaemic control in the DRC scarce,[85] there has been little focus on describing the lived experiences and perspectives of patients with diabetes on their own glycaemic control, leading to a gap in our knowledge. This knowledge could increase our understanding of this disease and assists in addressing poor glycaemic control in this setting.[86] The factors associated with glycaemic control in Kinshasa are not fully known as there are only few studies that have been conducted in this setting. Futhermore, there is no management framework in place to improve glycaemic control among patients with type 2 diabetes mellitus. Considering these gaps, all stakeholders in diabetes management need to work collaboratively towards achieving the goal of better glycaemic control.[84]

In the DRC, few interventions are directed explicitly at glycaemic control.[85] Models for chronic care applied to diabetes recognize the importance of restructuring health systems to ensure greater empowerment of patients, involvement of their families and communities in their care, the need for more resources, and necessary policy changes.[87,88] Innovative interventions that consider the specificities and context of care for patients with diabetes are therefore essential and required. Table 1 presents the key features of diabetes in sub-Saharan Africa including the DRC.

Table 1. Key features of diabetes in sub-Saharan Africa including the Democratic Republic of the Congo

	Key features
Epidemiology	Increase in the prevalence of diabetes mellitus Increased exposure to diabetogenic diets and sedentary lifestyle High proportion of undiagnosed diabetes Lack of comprehensive data
Impact	High financial and economic burden but limited data in many countries including the DRC High morbidity and mortality in people aged < 60 years Preponderance of complications No accurate estimate of the impact
Management	Unprepared healthcare systems Poor coordination of response to epidemic and care at national level Resource constraints Late diagnosis and poor care Poor self-management Poor health outcomes High rates of poor glycaemic control
Interventions	Limited data on the effectiveness of interventions

1.6 Research questions

1.6.1 What are the factors associated with poor glycaemic control among persons with type 2 diabetes in sub-Saharan Africa?

1.6.2 What are the factors associated with poor glycaemic control among persons with type 2 diabetes in Kinshasa, DRC?

1.6.3 What are the perspectives of patients and healthcare providers on approaches to improve glycaemic control among patients with type 2 diabetes?

1.6.4 What are the potential interventions to optimize glycaemic control among patients with type 2 diabetes in Kinshasa, DRC?

1.7 Research aim and objectives

1.7.1 Overall aim

To develop a framework to improve glycaemic control for patients with type 2 diabetes mellitus in Kinshasa, DRC.

1.7.2 Objectives

1.7.2.1 To determine the factors associated with glycaemic control among patients with type 2 diabetes in sub-Saharan Africa.

1.7.2.2 To determine the factors associated with poor control among patients with type 2 diabetes in Kinshasa, DRC.

1.7.2.3 To explore the perspectives of patients and healthcare providers on approaches to improve glycaemic control for patients with type 2 diabetes mellitus in Kinshasa, DRC.

1.7.2.4 To develop an intervention package to optimise glycaemic control among patients with type 2 diabetes mellitus in Kinshasa, DRC.

1.8 Conceptual framework

Blood glucose control in patients with type 2 diabetes is a multifactorial problem. Blood glucose control results from the interactions of many factors, depending on the characteristics of the patient and available support, the health system, community/society, and the policy environment. Figure 1.2 illustrates the interactions of these different factors and their impact

on health costs and outcomes. This model has been adapted from the World Health Organisation Innovative Care for Chronic Conditions Framework (WHO ICCC Framework),[89] which was developed as a roadmap for the management of chronic conditions in developing countries.

The WHO ICCC emphasizes the role of patients, families, and communities and has eight essential elements: support a paradigm shift, manage the political environment, build integrated healthcare, align sectoral policies for health, use health care personnel more effectively, centre care on the patient and family, support patients in their communities, and emphasize prevention. These elements are key to improving diabetes care in Africa.

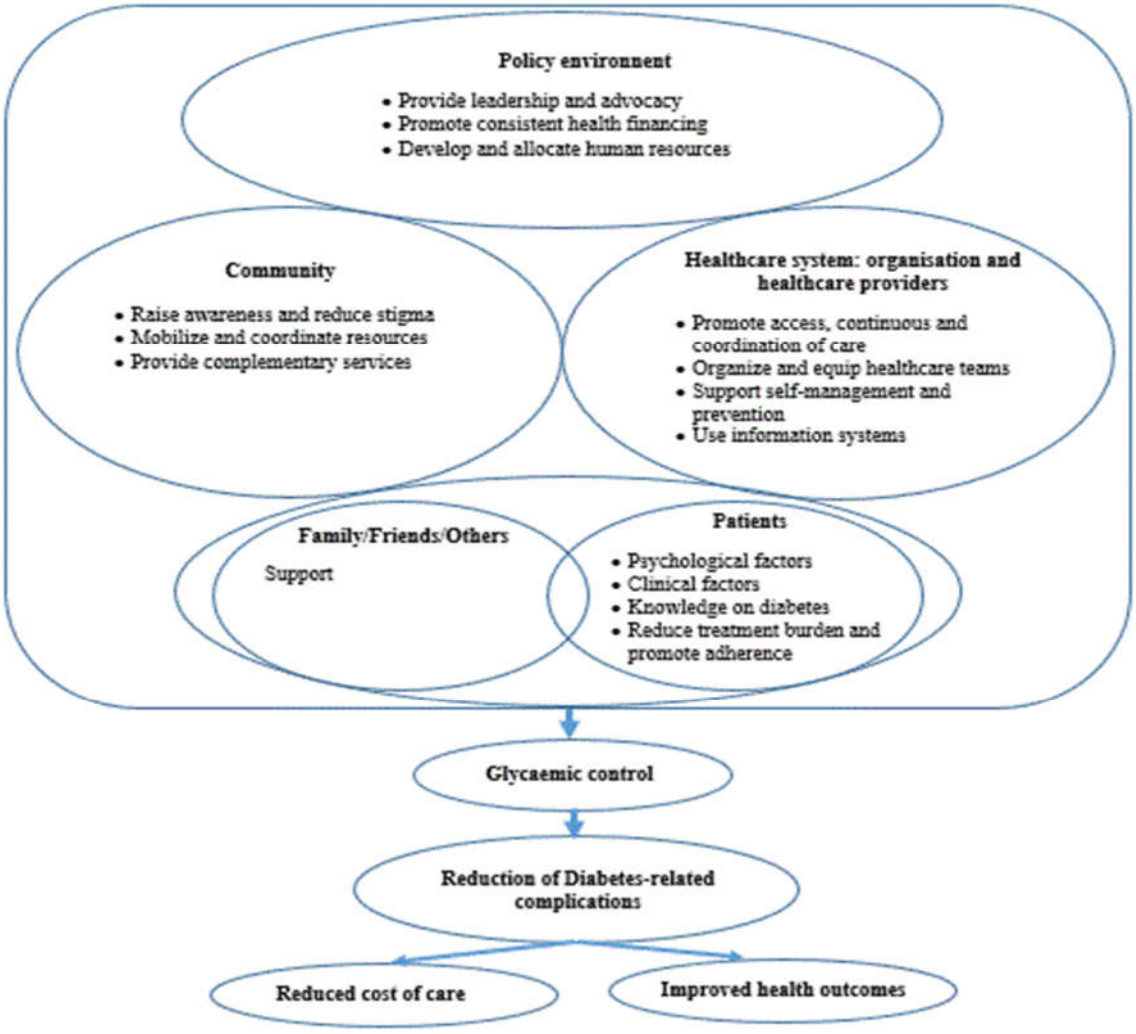

Figure 1.2 Conceptual framework for glycaemic control among patients with type 2 diabetes in Kinshasa, Democratic Republic of the Congo

1.9 Thesis structure

This thesis consists of seven chapters.

Chapter 1 provides an overview of type 2 diabetes and glycaemic control and explores the problem of blood glucose control as it arises in Kinshasa, DRC. At the end, the chapter identifies the key research questions for this project and describes the objectives of the research project, the project significance, and the conceptual model underlying its approach.

Chapter 2 gives an overview of the methodology used in the four sub-studies of this thesis with further descriptions provided in the chapters for each sub-study. It consists of four main parts. The first part describes a systematic review and meta-analysis of the prevalence and control factors of blood glucose in sub-Saharan Africa. The second part details a cross-sectional study with mixed methods on poor glycaemic control in Kinshasa, DRC. The third part presents a qualitative study of the perspectives of patients with type 2 patients and health professionals on lived blood glucose improvement in Kinshasa, DRC. The last part describes a Delphi study for a consensus on blood glucose control interventions in Kinshasa. The research paper published for the dissemination of methodologies of the last three sub-studies is placed in the Appendix 1.

In Chapter 3, the results of the meta-analysis and systematic review of the prevalence and control factors of blood glucose are presented in the published article of this study.

Chapter 4 describes the results of the mixed-method, cross-sectional, study of glycaemic control factors in patients with type 2 diabetes in Kinshasa. The chapter presents the two papers submitted for this sub-study. The first paper describes the qualitative component of the study, and the second paper presents the quantitative component. The published papers for the two components are placed in the appendices 3 (qualitative component) and 4 (quantitative component).

In Chapter 5, the perspectives of patients with type 2 diabetes and healthcare professionals on improving glycaemic control are described.

Chapter 6 presents the manuscript describing the Delphi study that aimed to obtain consensus among key stakeholders interventions needed in Kinshasa, DRC. The published paper for this sub-study is placed in the Appendix 5.

Chapter 7 presents a summary of the main results of this project, their implications and discusses them in the context of the existing literature.

CHAPTER TWO - METHODOLOGY

2.1 Introduction

Based on the conceptual framework, this project was designed to produce an intervention package for improving glycaemic control in Kinshasa, Democratic Republic of the Congo (DRC). To achieve this aim, the factors determining glycaemic control in sub-Saharan Africa and Kinshasa were determined from a systematic review and meta-analysis, and a mixed cross sectional study respectively. In addition, a qualitative study explored the perspectives of patients and healthcare providers regarding ways to improve glycaemic control in Kinshasa. Thereafter, interventions were defined from the findings of these studies and subjected to a Delphi group to build consensus on interventions that could respond to the different factors identified and improve glycaemic control and diabetes in Kinshasa, DRC. Figure 2.1 summarises the design of the study.

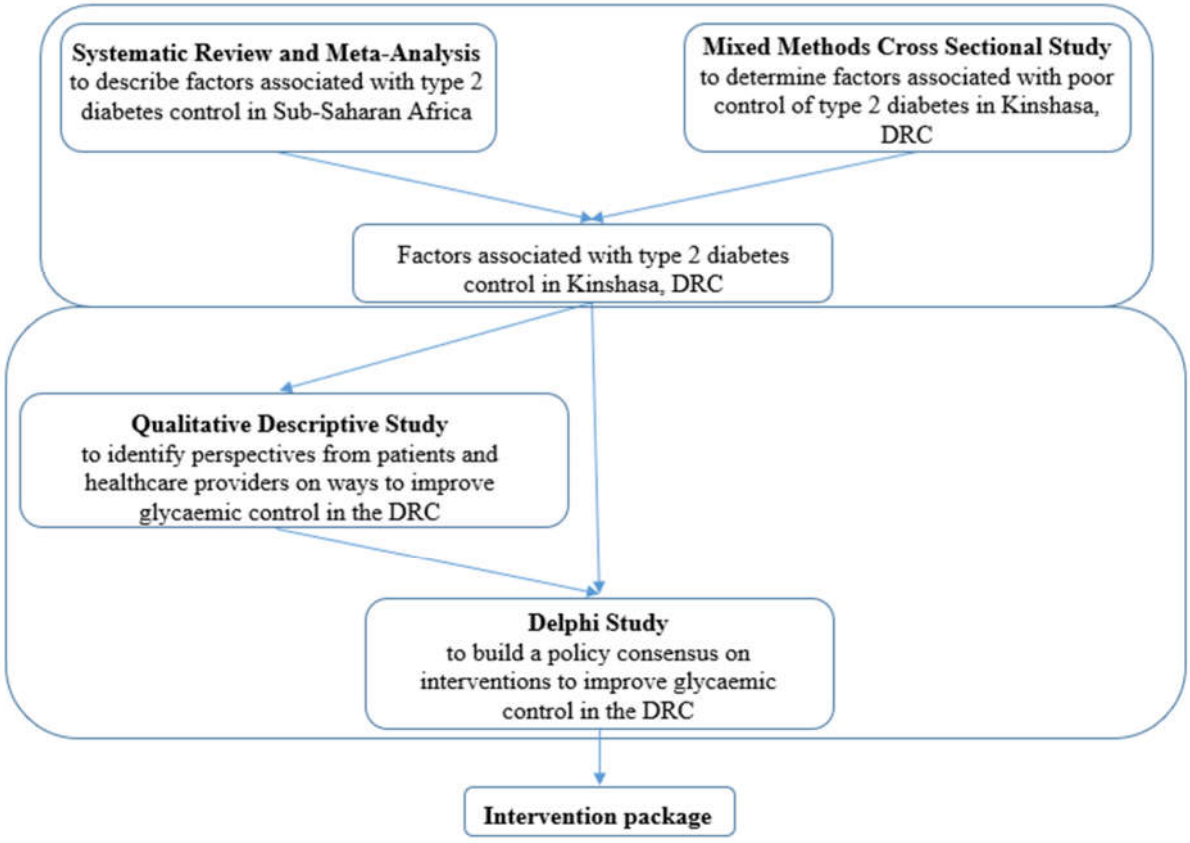

Figure 2.1 The research plan

The PhD study comprised four sub-studies. The first sub-study was a systematic review and meta-analysis of factors associated with glycaemic control for patients with type 2 diabetes in sub-Saharan Africa, based on 52 studies. The meta-analysis determined the prevalence of good glycaemic control in selected studies from 2011-2022. Over the same period, a systematic review identified factors related to glycaemic control in sub-Saharan Africa. For each study, the type of study, year, factor studied, association of the factor studied with glycaemic control, and the direction of the link between the factor and glycaemic control were determined.

The second sub-study was a mixed methods cross-sectional study of factors associated with poor glycaemic control among patients with type 2 diabetes in Kinshasa, DRC. A qualitative study of the perspectives and considerations of patients with type 2 diabetes in Kinshasa on glycaemic control was conducted. The study included 23 purposively selected patients, and a thematic analysis was performed. The study identified explanatory themes for blood glucose control. The quantitative study was an analytical cross-sectional study of 620 patients randomly selected in a two-stage process. The data collection was conducted from November 2021 to September 2022. Sociodemographic, clinical, psychological, and lifestyle variables related to poor glycaemic control were assessed using a multiple logistic regression. The significance level was $p<0.05$.

The third was a descriptive study of patients' and healthcare providers' perspectives on improving glycaemic control in the DRC. The study focused on providers and patients with type 2 diabetes. A thematic analysis determined the themes for improving blood glucose control for type 2 diabetes patients in Kinshasa.

Finally, the fourth Delphi study defined a consensus on interventions to improve glycaemic control in the DRC. Experts in diabetes management were invited to discuss interventions for improving glycaemic control. At the end of the interactions, a package of interventions was defined.

The research methodology for the objectives 2-4 have been summarized in a published paper (Appendix 1).

2.2 Research Methodology for Objective 1: A systematic review and meta-analysis on the prevalence and factors associated with glycaemic control for patients with type 2 diabetes in sub-Saharan Africa.

2.2.1 Research questions

What are the factors associated with poor glycaemic control among persons with type 2 diabetes in sub-Saharan Africa?

What are the prevalence of glycaemic control among persons with type 2 diabetes in sub-Saharan Africa?

2.2.2 Study design

The protocol for this systematic review and meta-analysis was registered on PROSPERO with the reference Centre for Reviews Dissemination (CRD) 41021237941. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines were used to report the entire process.[90]

2.2.3 Eligibility criteria

Eligible studies reported glycaemic control in persons with type 2 diabetes mellitus in sub-Saharan Africa. Only peer-reviewed articles were used to ensure the inclusion of valid research studies and avoid false data. Data from January 2012 to May 2022 without language restrictions were included. As it was planned to estimate the prevalence and identify factors associated with glycaemic control, the following study designs were considered: randomised controlled trials, quasi-experimental trials and cohort, case-control, and cross-sectional studies. Only studies that reported a multivariate analysis were included in the systematic review.

2.2.4 Information sources

The search was conducted in five databases: African Index Medicus, Africa-Wide Information, Global Health, PubMed, and Web of Science. In addition, the reference lists of the selected articles were reviewed for any other eligible articles. The last search date was 02 May 2022.

2.2.5 Search strategy

The search term domains were “Type 2 diabetes mellitus”, “glycaemic control”, and “sub-Saharan Africa”.

2.2.6 Selection process

Two investigators (JPF and JMF) independently reviewed the studies using the eligibility criteria and selected studies for inclusion in the review. The first investigator (JPF) reviewed all articles, and the second investigator (JMF) randomly assessed 10% of the selected papers. Differences in selection were evaluated by consensus. The software used for the selection and recording of decisions was EndNote 20.

2.2.7 Data extraction

The data from eligible studies were captured using a Microsoft Excel file. The first investigator (JPF) performed the data extraction on all the articles, and the second investigator (JMF) randomly assessed 10% of the extracted information. Any differences of opinion between individual judgments were resolved by consensus. For the meta-analysis of the proportions of glycaemic control, eight authors were contacted for missing information and clarification. One provided the study dataset, and another explained how to access the information needed to calculate glycaemic control.

2.2.8 Study variables

2.2.8.1 Main outcomes

Reported glycaemic control: pooled prevalence of samples reported to have glycaemic control. Exposure: reported independent risk factors for glycaemic control.

2.2.8.2 Data items

The following information was extracted from the published studies: the last name of the first author, study design, publication year, country, study population, total sample size, glycaemic

level assessment method, glycaemic control definition, number or proportion of persons with good glycaemic control, factors associated with glycaemic control, and measure of association for glycaemic control.

2.2.9 Study risk of bias assessment

The methodological quality of the selected studies was assessed by two reviewers (JPF and JMF) using the Joanna Briggs Institute Critical Appraisal Tools;[91] and any differences of opinion between the two reviewers were resolved by consensus. The Joanna Briggs Institute Critical Appraisal Tools were used to classify each selected study as good, moderate, or poor regarding the risk of bias. The percentage of 'Yes' votes was equal to or less than 50%, 51-80%, and more than 80% for poor, moderate, or good quality, respectively.[92] The assessment of an item was marked 'Yes' if the description met the criteria set for the assessment. If the description did not meet the criteria, the assessment was 'No'. If the description was insufficient, the assessment was 'Unknown'.

2.2.10 Synthesis methods

A meta-analysis with the random-effects model of the proportions of good glycaemic control was performed to estimate the overall prevalence of glycaemic control. The statistical software used was Stata 17.0.[93] A total of 51 studies were eligible for estimating the prevalence of glycaemic control as randomised control trials, quasi-experimental, and case-control studies were excluded. A high heterogeneity of the studies was observed as shown by the I^2,[94] and therefore, the pooled prevalence estimate and the glycaemic control patterns in sub-Saharan Africa were reported. Forest plots were used to display the results of the individual studies and syntheses visually. The heterogeneity was explored by performing subgroup analyses of the prevalence by sub-Saharan African region (Eastern, Western, Central, and Southern), study type (case-control, cohort, cross-sectional, quasi-experimental, and randomised control trial), and method (glycosylated haemoglobin, and glycaemia) used to assess the control.

Due to the heterogeneity of the studies, a narrative synthesis of reported factors was performed to assess the factors driving glycaemic control. Each factor reported is presented in the studies in which it was evaluated, with the measure of the association (and its confidence interval) with glycaemic control. The factors were categorised into six groups: sociodemographic, lifestyle, clinical, treatment modalities, adherence, and interventions.

2.3 Research Methodology for Objective 2: A concurrent parallel mixed-methods cross-sectional analytic study among patients with type 2 diabetes mellitus in Kinshasa, DRC.

2.3.1 Research questions

What are the factors associated with poor glycaemic control among persons with type 2 diabetes in Kinshasa, DRC?

What are the prevalence of glycaemic control among patients with type 2 diabetes in Kinshasa, DRC?

2.3.2 Study design

To achieve research objective 2, which aimed to describe the factors associated with poor glycaemic control in Kinshasa, a convergent mixed methods cross-sectional study was designed. This section presents the methods used for the qualitative and the qualitative phases. The integration of the findings of the two phases was performed in the interpretative stage.

2.3.3 Qualitative phase

This study engaged a qualitative approach to explore the perspectives of persons with type 2 diabetes mellitus regarding diabetes treatment in Kinshasa, DRC. A total of 23 participants were included in the study and one-on-one in-depth interviews were used to collect the data. This study is part of a larger project investigating glycaemic control in Kinshasa.[95] The study is reported according to the consolidated criteria for reporting qualitative research (COREQ).[96]

Study setting

This study was conducted in seven health centres in the city of Kinshasa, the capital of the DRC. Kinshasa has an estimated population of about 15 million and is spread over an area of 9,965 km^2.[97] The seven health centres in the city are Bondeko, 2eme Rue, Mokengeli, Saint Ambroise, Saint-Pierre, Etonga, and Kikimi. These health centres are part of the Kinshasa Primary Healthcare Network comprising hospitals and health centres mainly from the Catholic Church and Salvation Army.[81,82] These health centres are distributed in the 24 health districts

and have integrated diabetes care. At the facilities, persons with type 2 diabetes do not have access to specialists in diabetes care, and were managed by generalists trained in diabetes care who visited them once monthly. Between visits, some patients with diabetes could return to the health centres for blood glucose monitoring and advice from the nurses. For this study, seven health centres were purposively selected to ensure the diversity of patients in terms of socioeconomic, illness duration, and experiential contexts. These were the facilities where patients who were likely to share their perspectives had been identified and they also provided a conducive environment for interviews to be held.

Study population, sample size and sampling

The study population comprised persons with type 2 diabetes mellitus attending the seven selected healthcare facilities in Kinshasa, DRC. The inclusion criteria were age ≥ 18 years, being diagnosed with type 2 diabetes, and being on treatment for at least six months. Pregnant women, those with difficulty communicating due to mental disability, and patients with diabetes emergencies were excluded.

Consecutive and purposefully selected information-rich persons with type 2 diabetes were recruited from the seven facilities to satisfy the need for diversity in sex, duration of diagnosis/illness, socioeconomic strata treatment categories, and levels of glycaemic control.[98] Information-rich persons were those who by virtue of their experience, were able to contribute substantially to the topic explored. Health facilities' teams who were well acquainted with the patients helped in their recruitment. The role of the health facilities teams was to point out persons with diabetes open to effectively discuss their perspectives on glycaemic control. Members of the health facilities teams were not involved in contacting the persons with diabetes for the study. Only the interviewer was responsible for presenting the study to the participants and inviting them to join the study. Recruitment continued until data saturation. Data saturation was reached when no new element of the codes was identified.[99] After each interview, the data were analysed to identify codes. In subsequent interviews, a search for new aspects, dimensions, or nuances of the codes was performed until novel findings were uncommon. In total, 23 interviews of persons living with type 2 diabetes were conducted. None of the patients approached refused to participate or were excluded.

Data collection

Only the study staff were involved in the organization of the interviews. The interviews were then conducted by the principal investigator in a quiet room where the confidentiality of the

participant's statements was guaranteed. The interviews were one-on-one in-depth interviews. The interview was facilitated by exploring the clarity of the participants' statements. The interviews were guided by an interview schedule (S1 Appendix) and were conducted in French or Lingala depending on the preferences of the participants. All interviews were audio recorded and lasted at most 45 minutes. As the interviews were conducted during the COVID-19 pandemic, there was a strict observation of the COVID-19 rules. The data collection took place from December 2021 to March 2022.

Data management and analysis

The recorded interviews were transcribed verbatim and then translated into English by a language expert. The principal researcher, who is fluent in French and Lingala, verified the translation and transcription by listening to the audio while reading the transcripts. The data coding and thematic analysis were performed using the MAXQDA 2022.[100] The analysis went through the six steps described by Braun and Clarke[101], which included familiarization with the data, generating initial codes, searching for themes, reviewing potential themes, defining and naming the themes, and producing the report.

In MAXQDA, the researcher uploaded the transcripts of the interviews. When he identified a code during the readings, he created it in the system and wrote a memo to describe its meaning. Thereafter, all the words, parts of sentences, sentences, or groups of sentences related to this code were associated with this particular code. A word, part of a sentence, a sentence, or a group of sentences could also be associated with more than one code. Then, the different codes identified were grouped into sub-themes, and finally into themes. The coding was performed independently by the principal researcher (JPF) and a supervisor (OBO) in selected interviews without any preconceived theoretical framework. The integration of the themes identified was performed using social cognitive theory[102,103]

Research team and reflexivity

The principal investigator is a male physician who conducted all the interviews. At the time of the study, he was working at the Protestant University of Congo as a senior lecturer and had experience conducting qualitative inquiries. For this study, he had no prior relationship with the participants. Information about the researcher was shared with the participants for research purposes only. The principal investigator was assisted by two supervisors in conceptualizing this research study, analysing the data, and reporting the findings.

Ethical considerations

The study was approved by the Ethics committee of the Protestant University of Congo (reference number: CEUPC 0067; Date: 05/02/2021) and the Human Research Ethics Committee (Medical) of the University of the Witwatersrand (reference number: M210308; Date: 26/08/2021) and conducted according to the ethical guidelines of the Declaration of Helsinki. Permission was obtained from the Kinshasa Primary HealthCare Network to conduct the study. Before the interviews, the Principal Investigator provided the study information summarized on a leaflet to potential study participants and obtained their written informed consent. A copy of the leaflet and the signed consent form (to participate in the study and for the audio recording) was provided to each participant. Data collection was performed with strict adherence to local COVID-19 regulations. Participants were not paid for their participation in the study, but were reimbursed for their transport costs to the healthcare facilities. Participants received the equivalent of US$5 for transport to the health facility. An informed consent for the publication of the study results was obtained from each participant.

2.3.4 Quantitative phase

This was a cross sectional study, a component of a larger research project on glycaemic control among persons with type 2 diabetes in Kinshasa, DRC, for which the study protocol was previously published.[104]

Study setting

The study was multisite within Kinshasa, DRC, a city of about 15 million inhabitants spread over an area of 9,965 km^2.[97] Participants were recruited from 20 randomly selected health facilities in Kinshasa. The study was conducted in health facilities belonging to the Catholic Church and the Salvation Army. With a total of 66 health facilities (one referral hospital and 65 health centres) distributed across 24 health districts, these organisations own most of the facilities that have integrated diabetes care in primary care in Kinshasa.

Study population

The study population consisted of persons with type 2 diabetes attending health centres that offer diabetes care in the Kinshasa Primary Care Network, with about 7,326 persons with diabetes registered in 2020. The inclusion criteria were age ≥ 18 years, receiving diabetes

treatment for at least six months and consenting to the study. The exclusion criteria were pregnancy, and having difficulty communicating due to mental disability.

Sample size estimation

The estimated minimum sample size was computed using Epi info version 7.2.2.2. Assuming that the prevalence of poor glycaemic control was 68%,[105] at a 95% confidence level and a power of 80%, then 59,2% of persons with diabetes who had a diabetes duration ≤ 7 years (unexposed) will have presented with poor glycaemic control, and 74,4% of those who had a diabetes duration > 7 years (exposed) will have presented with poor glycaemic control.[106] The unexposed to exposed ratio is 0.47.[106] The minimum estimated sample size was 368. Adjusting for a design effect of 1.5, a sample size of 552 was calculated. To account for an estimated 10% non-response rate, the minimum required sample size was 614 persons with diabetes, rounded up to 620.

Sampling of participants

Participant selection was a two-stage process. The first stage was the random selection of 20 of the 48 healthcare facilities. As the healthcare facilities have an unequal number of persons with diabetes, the participants were selected by probability proportional to the patient population size. The second stage consisted of the selection of the participants; 31 patients were selected from each selected healthcare facility using systematic sampling. The research assistant used the record of the first patient on a clinic day to assess their eligibility and subsequently used the record of every third patient for questionnaire administration. If the first or the third patient selected was not eligible, the research assistant then selected the next patient(s) until an eligible patient was obtained, and then continued with the selection of each third patient. This process ensured that each patient had the same probability of selection.

Data collection

The data collection process occurred from November 2021 to September 2022. For each participant, the research team performed physical and anthropometric measurements. These measurements were taken once by trained staff members on the same portable equipment at all the health facilities. The questionnaire consisted of pre-existing standardised tools translated from English into French and Lingala (S2 and S4 Appendix). The questionnaire was pre-tested before data collection, and no changes to the tools were deemed necessary for this study. At the end of the interview, two millilitres of venous blood was collected in a tube with EDTA from the participant. The tube was labelled and stored at 2-8 ºC in a refrigerator, when the centre had

a fridge, or directly in the prepared isotherm box. At the end of the visit, all samples were transferred to the laboratory in the isotherm box. The questionnaire was administered using REDCap (Research Electronic Data Capture) on a tablet or smartphone.[107] Information captured during the interview on the history of diabetes was verified with what was recorded in the patient medical records.

Variables of the study

Outcome

The main outcome variable was poor glycaemic control, defined as HbA1c ≥ 7%,[85,108] and obtained from the blood sample assayed at the School of Medicine laboratory at the Protestant University of Congo in Kinshasa. The assay was performed using an automated Genuis WP 21B with the antibody-based immunoassay method of Cypress Diagnostics.[109]

Exposures

The possible determinants for glycaemic control considered in this study were sociodemographic parameters (age, sex, marital status, educational attainment, occupation, income, use of health insurance, access to food, and distance from place of residence to health centre), lifestyle parameters (smoking and problematic alcohol consumption), clinical parameters (duration of diabetes, height, weight, body mass index, waist circumference, presence of comorbidities, blood pressure, treatment, and duration of treatment), and psychological parameters (adherence to treatment, depression, diabetes distress, social support, self-management, and knowledge).

Measurement tools, operational definitions, and references for the exposures

Sociodemographic parameters

The distance from the participant's place of residence to the health centre of < five kilometres or < one hour was considered as nearby, while > five kilometres or > one hour was deemed distant.

A daily income < 3800 Congolese Francs (< US$1.9) was set as the threshold for poverty. [110]

The food security status was assessed using the Household Food Insecurity Scale (HFIAS), a nine-item measurement tool. It reported the experience of the past four weeks.[111] The HFIAS has showed a good internal consistency (Cronbach's alpha values of 0.76 and 0.73 in two

rounds) in an Ethiopian study and the authors concluded that although the tool was simple that an adaptation of the questions and wording, as well as additional examples before the application could be necessary.[112] Our sample data displayed a good internal consistency (Cronbach's alpha: 0.96). The HFIAS categorises households into four levels of food access: food secure, mild food insecure, moderately food insecure, and severely food insecure.[113] A food secure household experiences none of the food insecurity conditions, or just experiences worry, but rarely. A mildly food insecure household worries about not having enough food sometimes or often, and/or is unable to eat preferred foods, and/or eats a more monotonous diet than desired and/or some foods considered undesirable, but only rarely; but it does not cut back on quantity nor experience any of three most severe conditions (running out of food, going to bed hungry, or going a whole day and night without eating). A moderately food insecure household sacrifices quality more frequently, by eating a monotonous diet or undesirable foods sometimes or often, and/or has started to cut back on quantity by reducing the size of meals or number of meals, rarely or sometimes; but it does not experience any of the three most severe conditions. A severely food insecure household has graduated to cutting back on meal size or number of meals often, and/or experiences any of the three most severe conditions (running out of food, going to bed hungry, or going a whole day and night without eating), even as infrequently as rarely; in other words, any household that experiences one of these three conditions even once in the last four weeks (30 days) is considered severely food insecure.[113]

Clinical parameters

For physical measurements, trained staff members measured clinical parameters (height, weight, waist circumference, and blood pressure) using validated equipment. The height of the participant was measured with a stadiometer on which the participant stands bare feet with his or her back against the vertical scale, feet parallel to each other, toes pointing forward and the soles of feet flat on the floor. The measurement was read on the vertical scale to the nearest centimetre. Weight was assessed using a SECA scale 260 with the participant wearing light clothing, in bare feet, minus outer clothing, no heavy jewellery, and empty pockets. Weight was expressed in kilograms. The waist circumference was measured with the patient standing upright with feet slightly apart and arms hanging loosely on each side. A tape was placed just above the hip bones to measure the middle and was taken just after the participant breathed out, to the nearest centimetre.[114] The blood pressure was measured seated using an EDAN automatic sphygmomanometer (EDAN Instruments) at the upper extremity three times separated of five minutes and the mean calculated.

The BMI was calculated as weight (Kg)/height (squared meters) and was categorised as follows: underweight/overweight (BMI < 25 Kg/m^2), and overweight/obese (BMI ≥ 25 Kg/m^2).[115] For the waist circumference, normal values were defined according to sex: men < 102 centimetres; and women < 88 centimetres.[116] Controlled blood pressure was defined as a systolic blood pressure level < 130 mm Hg and a diastolic blood pressure < 80 mm Hg.[117]

The duration of diabetes was separated into three categories: less than 5 years, 5 to 10 years, and 10 years or more. The duration of the treatment has two categories: less than 7 years, and 7 years or more. There were three options for treatment regimens: insulin alone, oral hypoglycaemic drugs, and mixed treatment (insulin plus oral hypoglycaemic drugs).

Psychological parameters

Knowledge of diabetes was assessed with the Simplified Diabetes Knowledge Scale, a true/false response format of the Revised Diabetes Knowledge Scale of the Michigan Diabetes Research Center.[118,119] It contained 20 items with three related to insulin users. It has an internal reliability of 0.71, an item correlation of 0.26–0.58, and corrected item-total correlation of > 0.2 for all items, except for items 7, 8, and 20.[118]

Treatment adherence was assessed by using the four-item Morisky Green Levine (MGL) test.[120] The four-item MGL test has an alpha reliability of 0.61. The scale is a yes/no scale with 'yes' coded as 1, and 'no' as 0. The MGL test divides patients into adherence categories: high, medium, and low with 0, 1–2, and 3–4 points, respectively.

Social support was assessed by applying the Multidimensional Scale for Perceived Social Support (MSPSS).[121] The MSPSS is a brief self-report questionnaire that contains 12 items rated on a five-point Likert-type scale. The MSPSS assessed three subscales of social support: family, friends, and significant others. The internal consistency of the total scale was 0.87: the subscales were 0.84 (friends), 0.85 (family), and 0.74 (significant others).[121] For the MSPSS, the mean scores were calculated as follows: Significant Others Subscale - sum across items 1, 2, 5 and 10, divided by 4; Family Subscale - sum across items 3, 4, 8 and 11, divided by 4; and Friends Subscale - sum across items 6, 7, 9 and 12, divided by 4. The total scale was calculated as the sum across all 12 items, divided by 12. Any mean scale score ranging from 1–2.9 could

be considered low support, a score of 3–5 as moderate support, and a score from 5.1–7 as high support.

A screening for depression was performed with the Patient Health Questionnaire-9 (PHQ-9).[122] The PHQ-9 is the nine-point depression module of the full PHQ and is a screening tool and measure of depression severity. The Cronbach's alpha was 0.89 in a primary healthcare study.[123] Depression screening with PHQ-9 determined the following categories: moderate depression (12–14), moderately severe depression (15–19), and severe depression (20–27).[122]

The diabetes distress score was measured using the Diabetes Distress Scale (DDS),[124] a 17-item scale that captures four critical dimensions of distress: emotional burden (five items), regimen distress (five items), interpersonal distress (three items), and physician distress (four items). The internal consistency expressed by Cronbach's α was 0.93 for the total score, 0.88 for emotional burden, 0.88 for physician-related distress, 0.88 for regimen-related distress, and 0.88 for interpersonal-related distress scales.[124] For the DDS and its subscales, a mean item score of 2.0–2.9 is considered 'moderate distress,' while a mean item score > 3.0 is considered 'high distress'.

Diabetes self-management was described with the use of the Diabetes Self-Management Questionnaire (DSMQ), a 16-item questionnaire comprising four subscales: dietary control (four items), glucose management (five items), physical activity (three items), and physician contact (three items). Low adherence was defined as a score of dietary control < 4, a score of glucose management < 5, a score of physical activity < 3, and a score of physician contact < 3.[125] The overall internal consistency (Cronbach's alpha) was good (0.84) and consistencies of the subscales were acceptable (glucose management [0.77]; dietary control [0.77]; physical activity [0.76]; and physician contact [0.60]).[125]

Lifestyle parameters

For lifestyle parameters, substance use was investigated. Alcohol use with the Alcohol Use Disorders Identification Test-Concise (AUDIT-C), where a score ≥ 4 (in men) or ≥ 3 (in women) represents health-risk consumption.[126] The internal consistency of AUDIT-C was 0.75, and its test-retest reliability was 0.93.[127]

The history of smoking was obtained from the participants and focused only on current smoking.

Data analysis

All analyses were performed using survey data analysis with STATA 17 to account for the study design characteristics.[128] We expressed age as median with interquartile range (IQR), as it was not normally distributed. The other variables were analysed as categorical variables and expressed as frequency (n) and percentage (%). Bivariate analysis was performed to compare uncontrolled versus controlled participants in terms of glycosylated haemoglobin using the Chi-square/Fisher exact test for categorical variables. A multivariable logistic regression was performed to assess factors associated with glycaemic control. Age, sex, duration of treatment, and food security were included in the regression model a priori. Other variables with a p-value < 0.2 in the univariate analysis were also included in the model. A p-value of < 0.05 was considered statistically significant.

Potential limitations and biases

Potential biases included selection bias as only patients who attended the diabetic clinics in the period of the study could be included in the study; recall bias as for some responses, the participants might refer to their history with the possibility of lost memory or omitted details for some events; interviewer bias as the data collectors could have influenced the participants by how they asked questions or reacted to the answers; and social desirability bias as participants could have given answers that made them look good to respondents and not talked about their true experiences.[129] These biases were minimised by ensuring effective training of the data collectors to ensure that the aim and objectives of the study were clearly stated to the participants, and that questions were asked in a non-judgemental way.

Ethical considerations

This study was conducted after the approval from the ethics committee of the Protestant University of Congo (reference number: CEUPC 0067; Date: 05/02/2021) and the Human Research Ethics Committee (Medical) of the University of the Witwatersrand (reference number: M210308; Date: 26/08/2021). An informed consent was obtained from each participant, including an informed consent for the publication of the study results. Patients or the public were not involved in the design, conduct, reporting, or dissemination plans of the study.

2.4 Research Methodology for Objective 3: A qualitative study on the perspectives of patients with type 2 diabetes and healthcare providers on ways to improve glycaemic control in Kinshasa, DRC.

2.4.1 Research question

What are the perspectives of patients and healthcare providers on approaches to improve glycaemic control among patients with type 2 diabetes?

2.4.2 Research design

This was a qualitative study that explored the perspectives of persons with type 2 diabetes mellitus and health providers regarding ways to improve glycaemic control in Kinshasa, DRC. This study was part of a broader project with a published protocol.[95]

2.4.3 Study setting

Kinshasa is the capital of the Democratic Republic of the Congo. It has 16,315,534 inhabitants in 2023.[130] The Democratic Republic of Congo is a low-income country located in Central Africa. A large majority of the population lives below the poverty line and experienced food insecurity.[131] Resources are scarce and only 4% of the budget is devoted to health.[132] Patients contribute more than 70% of health expenditure as universal health coverage is not fully implemented, leaving most people uninsured.

The management of diabetes in Kinshasa is largely provided by a structure called the Kinshasa Primary Healthcare Network that combines health structures of the Catholic Church and the Salvation Army. The diabetes clinics in these structures are managed by nurses and once monthly, a doctor comes to visit persons with diabetes.

2.4.4 Study population and sample

For this study, we recruited health providers and persons with type 2 diabetes in the Kinshasa Primary Healthcare Network, in the state and private healthcare facilities. Persons with type 2 diabetes and healthcare providers aged ≥ 18 years were invited to participate. Participants were

purposively selected ensuring that both controlled and uncontrolled individuals, diversity of sociodemographic characteristics, and the duration of the disease are taken into account. Persons with type 2 diabetes selected were those who have been followed for at least six months for diabetes and care was taken to select those who were willing to discuss their views on improving blood glucose control. With regard to healthcare providers, care was taken to select participants who were diverse in experience, sex, and categories (doctors and nurses). The participants were excluded if they had difficulty communicating due to a mental disability or refused to give consent.

The selection of the participants took place from 21 October 2022 to 31 March 2023. A total of 26 participants were included in the study; 10 persons with type 2 diabetes and 16 healthcare providers. None of the participants invited for inclusion in the study refused or was excluded.

2.4.5 Data collection

The data collection was conducted through face-to-face in-depth interviews. The interviews were guided by an interview schedule (S4 appendix). At the respective facilities, the principal investigator interviewed the participants in a quiet room where the confidentiality of the participants' statements was guaranteed. In the room, during the interview, only the principal investigator and the participant were present. All interviews were audio recorded and lasted about 40-50 minutes. Notes were taken during the interviews. For each category of participants, persons with type 2 diabetes or healthcare providers, we stopped recruitment when data saturation was reached.[98]

2.4.6 Data management and analysis

The recorded interviews were transcribed verbatim and then translated into English by a language expert based in Kinshasa. The principal researcher who is fluent in French and Lingala verified the translation and transcription by listening to the audio recordings while reading the transcripts. The coding was performed independently by the principal researcher (JPF) and one supervisor (OBO) in selected interviews without any preconceived theoretical framework. The analysis was performed using the MAXQDA 2022 software.[100] The analysis went through the six steps described by Braun and Clarke[101] - familiarization with the data, generating initial codes, searching for themes, reviewing potential themes, defining and naming the themes, and producing the report.

In MAXQDA, the researcher uploaded the transcripts of the interviews. When he identified a code during the readings, he created it in the system and wrote a memo to describe its meaning. Thereafter, all the words, part of sentences, sentences or group of sentences related to this code were associated to this particular code. A word, part of a sentence, sentence, or group of sentences could be associated with more than one code. Thereafter, the different codes identified were grouped into sub-themes and finally in themes. The integration of the themes identified was performed using the WHO Innovative Care for Chronic Conditions Framework (WHO ICCC Framework).[89]

Theoretical framework

The WHO Innovative Care for Chronic Conditions Framework (WHO ICCC Framework)[89] was developed by the WHO to adapt the use of the Chronic Care Model[133] in low- and middle-income countries. It recognizes three levels of care (micro, meso, and macro) and incorporates six principles: evidence-based decision making, population focus, prevention focus, quality focus, integration, flexibility, and adaptability.

Research team and reflexivity

The principal investigator (first author), is a male physician with experience in qualitative research who conducted all the interviews. At the time of the study, he was working at the Protestant University of Congo as a senior lecturer and had experience conducting qualitative enquiries. For this study, he had no previous relationship with the participants. The information about the researcher was shared with the participants for research purposes only.

2.4.7 Ethical considerations

This study was conducted after approval from the ethics committee of the Protestant University of Congo (reference number: CEUPC 0067; Date: 05/02/2021) and the Human Research Ethics Committee (Medical) of the University of the Witwatersrand (reference number: M210308; Date: 26/08/2021). Informed consent was obtained from each participant as well as an informed consent for the publication of study results. Patients or the public were not involved in the design, conduct, reporting, or dissemination plans of the study.

2.5 Research Methodology for Objective 4: A Delphi study of stakeholders in the management of diabetes for a consensus on potential interventions to improve glycaemic control in Kinshasa, DRC

2.5.1 Research question

What are the potential interventions to optimize glycaemic control among patients with type 2 diabetes in Kinshasa, DRC?

2.5.2 Research design

This was a two round, electronic, anonymous Delphi study seeking policy consensus from important stakeholders in diabetes management in Kinshasa to develop a package of interventions for improving glycaemic control. The Delphi study is part of a larger project aimed at developing a framework for improving glycaemic control for patients with type 2 diabetes in Kinshasa, DRC, the protocol of which has been published.[134] Previously in the project, factors associated with glycaemic control in sub-Saharan Africa were determined in a meta-analysis.[95] Additionally, the factors associated with poor glycaemic control in Kinshasa, DRC, were determined in a cross-sectional study and substantiated with findings from a qualitative study of the perspectives of patients and healthcare providers on the factors that affect glycaemic control and proposed interventions in Kinshasa. Informed by these studies, experts were brought together to define a package of interventions to improve glycaemic control among type 2 patients in the DRC through consensus. This Delphi study is reported according to the Guidance on Conducting and Reporting Delphi Studies (CREDES).[135]

2.5.3 Context

The proposed interventions are for patients with type 2 diabetes in Kinshasa, the capital city of the DRC. The country is a low-income country with a population of 95,894,118 inhabitants.[131] In 2019, the country spent 4% of its Gross Domestic Product on health expenditure.[132] In 2022, about 64% of the population were living on less than $US2.15 a day.[131] Most of the population are not covered by health insurance and have to rely on out-of-pocket payments. Kinshasa has a population of approximately 15 million within an area of 9,965 square kilometres.[80] In recent

years, the population of Kinshasa is growing fast due to a rural exodus resulting from the destruction of economic infrastructure of the surrounding provinces.

The care for diabetes patients is mainly organized via the Kinshasa Primary Care Network uniting health structures belonging to the Catholic Church and the Salvation Army.[81] Other facilities organising diabetes care are privately owned and some are State health structures. The problem in this context is that there is no real integration or control of activities, with each stakeholder trying to find its own way with whatever resources it can muster. The national diabetes programme is not yet really effective on the ground. Data on the impact of diabetes is not well organised.

2.5.4 Subjects

The Delphi study included representatives of stakeholders in diabetes management in Kinshasa, DRC. Two approaches were used to select the experts. The first was to contact the heads of institutions involved in diabetes and ask them to nominate representatives for the Delphi study. In the second approach, individuals known for their expertise in diabetes were contacted. We selected six health services managers, eight clinicians, seven representatives from universities, nine members of the staff of the National Programme against Diabetes, and six people from Non-Government Organizations working on diabetes in Kinshasa and in Africa. The clinicians were persons qualified in the clinical practice of medicine, namely, five doctors and three nurses, and taking care of diabetes; managers were individuals in charge of a healthcare structure (hospital or health centre) or a group of healthcare structures providing diabetes care; representatives of universities were diabetologists or internal medicine specialists; NGO partners were persons within organisations participating in the management of diabetes by providing financial or technical support; representatives from the Ministry of Health were individuals working in the National Programme against Diabetes. Participants were purposively selected by the research team (principal researcher and supervisors) based on their interest in the subject and expertise in diabetes control. Contact was made with the structures organising or providing support for diabetes care to ensure that participants were experts in the issue; known experts in diabetes management were contacted directly through e-mail, telephone and WhatsApp.

All the participants had an age ≥ 18 years; experts were local and international experts with preference given to those who currently or previously worked in the DRC, and those with

known expertise in diabetes. The exclusion criterion was conflict of interest in study participation.

Thirty-six participants were included in the first round of the Delphi from a total of 62 experts invited, representing a response rate of 58.1%. In the second round, of the 36 participants who took part in the first round, two dropped out, and the response rate was of 94.4%.

2.5.5 Data collection

E-mail was used to send an information document describing the purpose and objectives of the study to eligible people. They were requested to agree electronically to participate in the study. Once they accepted to participate in the study, a second e-mail informed them of the results of previous sub-studies of this project.

This Delphi study included two rounds. In the first round, each stakeholder was asked to use the 4-point Likert scale to indicate by how much he/she agreed or disagreed with the statements constructed based on the findings of previous studies in sub-Saharan Africa and Kinshasa on factors associated with glycaemic control and perspectives for improving glycaemic control. The questionnaire also comprised open questions for the participants to suggest additional interventions for improving glycaemic control or to comment on the proposed interventions. The questionnaire was designed using Redcap 13.4.13[107] and shared with the participants through e-mail and WhatsApp. The questions were constructed using a 4-point Likert scale (‘strongly agree’, ‘agree’, ‘disagree’, and ‘strongly disagree’).

The participants’ responses in the first round were used to perform an initial assessment of the extent to which they agreed with the recommendations. At the end of the first round, the researcher summarized the rankings from the participants and their motivations and used these for the second round. Only recommendations that were strongly agreed to by the participants and those suggested by the participants were used in the second round. The reliability of the survey tool used in the second round was assessed using the Cronbach’s alpha coefficient; the result was 0.97 indicating high internal consistency.

In the second round, the experts were asked to re-rank the statements after reconsidering their opinions or judgements in light of other group members’ responses and again to motivate their choice or suggest other interventions. No new themes were identified by the participants. For

the majority of participants, the positions or responses did not vary substantially from those expressed in the first round. Their ratings consisted of assessing each intervention again according to a 4-point Likert scale ('strongly agree', 'agree', 'disagree', and 'strongly disagree'). At the end of the second round, the researchers sorted a list ranking the remaining interventions along with minority opinions achieving consensus. Expert contributions were anonymous.

2.5.6 Data analysis

For each round and for all proposed interventions, the frequencies of all responses of the 4-Likert were summarized to determine the mode. The means and standard deviations were used to describe group responses to each statement. For each statement, the overall interpretation used was: 4.00-3.00: strongly agree; 2.99-2.00: agree; 1.99-1.00: disagree; 1.00-0.99: strongly disagree.[136,137]

At the end of a round, only recommendations with an average score above 3.00 were considered for the next round. Between rounds, the data were analysed to identify convergence and change of experts' opinions or judgements. Consensus was defined as > 70% of experts agreeing/strongly agreeing or disagreeing/strongly disagreeing with a statement in round 2. This level of agreement has been used in previous studies.[138,139] Stability of consensus was considered to have been reached if the between round group responses varied by ≤ 10%.

CHAPTER THREE — PREVALENCE AND FACTORS ASSOCIATED WITH GLYCAEMIC CONTROL AMONG PATIENTS WITH TYPE 2 DIABETES IN SUB-SAHARAN AFRICA

3.1 Introduction

This chapter presents the results of the systematic review of the prevalence and factors of glycaemic control in patients with type 2 diabetes in sub-Saharan Africa. Prevalence was estimated using a meta-analysis of 52 studies, and glycaemic control factors are grouped into six categories. The effect and intensity of the relationship with glycaemia are presented for each factor.

3.2 Research paper 2: Glycaemic control among type 2 diabetes patients in sub-Saharan Africa from 2012 to 2022: a systematic review and meta-analysis

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Glycaemic control among type 2 diabetes patients in sub-Saharan Africa from 2012 to 2022: a systematic review and meta-analysis

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Abstract

Background: There is an increased burden of diabetes globally including in sub-Saharan Africa. The literature shows that glycaemic control among type 2 diabetes patients is poor in most countries in sub-Saharan Africa. Understanding the factors influencing glycaemic control in this region is therefore important to develop interventions to optimize glycaemic control. We carried out a systematic review to determine the prevalence and factors associated with glycaemic control in sub-Saharan Africa to inform the development of a glycaemic control framework in the Democratic Republic of the Congo.

Methods: We searched five databases (African Index Medicus, Africa-Wide Information, Global Health, PubMed, and Web of Science) using the following search terms: type-2 diabetes, glycaemic control, and sub-Saharan Africa. Only peer-reviewed articles from January 2012 to May 2022 were eligible for this review. Two reviewers, independently, selected articles, assessed their methodological quality using Joanna Briggs checklists, and extracted data. A meta-analysis was performed to estimate the prevalence of glycaemic control. Factors associated with glycaemic control were presented as a narrative synthesis due to heterogeneity as assessed by the I^2.

Results: A total of 74 studies, involving 21,133 participants were included in the review. The pooled prevalence of good glycaemic control was 30% (95% CI:27.6–32.9). The glycaemic control prevalence ranged from 10–60%. Younger and older age, gender, lower income, absence of health insurance, low level of education, place of residence, family history of diabetes, longer duration of diabetes, pill burden, treatment regimen, side effects, use of statins or antihypertensives, alcohol consumption, smoking, presence of comorbidities/complications, and poor management were associated with poor glycaemic control. On the other hand, positive perceived family support, adequate coping strategies, high diabetes health literacy, dietary adherence, exercise practice, attendance to follow-up, and medication adherence were associated with good glycaemic control.

Conclusion: Suboptimal glycaemic control is pervasive among patients with type-2 diabetes in sub-Saharan Africa and poses a significant public health challenge. While urgent interventions are required to optimize glycaemic control in this region, these should consider sociodemographic, lifestyle, clinical, and treatment-related factors. This systematic review and meta-analysis protocol is registered in PROSPERO under CRD 42021237941.

Keywords: Systematic review, Meta-analysis, Prevalence, Factors, Glycaemic control, Type 2 diabetes, Sub-Saharan Africa

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Background

The prevalence of type 2 diabetes mellitus has been increasing worldwide, with low and middle-income countries bearing the brunt of this growth in terms of morbidity, mortality, and economic costs [1, 2]. As such, Africa has been experiencing the greatest increase of all the World Health Organization (WHO) regions. The epidemiological transition due to the adoption of the Western lifestyle and urbanization, among other things, has played a major role in the progression of diabetes [3]. The growing burden of diabetes has been a barrier to the wellness of families and the effectiveness of the health system.

One of the main goals of diabetes mellitus management is to achieve glycaemic control to delay or prevent the onset of diabetes complications. Worldwide, only approximately 50% of patients achieve glycaemic control [4] and in sub-Saharan Africa (SSA), glycaemic control rates are generally poor. In sub-Saharan Africa, the proper management of diabetes faces numerous challenges including inadequate resources, coexisting traditional health priorities, ill-preparedness for chronic disease management and low health insurance coverage [5].

Glycaemic control represents an emergency to alleviate the burden of the disease in sub-Saharan Africa [6]. The design and implementation of effective glycaemic control strategies require accurate knowledge of the factors underlying glycaemic control to enable the identification of effective interventions. The factors associated with poor glycaemic control are numerous and vary in importance depending on the population [7, 8]. Empirical evidence suggests that higher socioeconomic status, greater dietary knowledge, and higher self-efficacy and empowerment improve glycaemic control [9]. Factors driving poor glycaemic control include patients, diabetes disease, treatment, health system, and physician-related factors [8, 10]. However, there is a paucity of literature on factors that influence glycaemic control in the sub-Saharan region. Therefore, this systematic review aims to determine the prevalence and factors associated with glycaemic control among type 2 diabetes patients in sub-Saharan Africa. The review will comprise all articles on glycaemic control among patients with type 2 diabetes from January 2012 to May 2022 to have enough studies to have a broad view of the phenomenon.

Methods

The protocol of this systematic review and meta-analysis was registered on PROSPERO with reference CRD 41021237941. The Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) guidelines were used to report the entire process of this systematic review [11].

Eligibility criteria

Eligible studies were those that reported glycaemic control in persons with type 2 diabetes mellitus in sub-Saharan Africa. Only peer-reviewed articles were eligible to ensure the inclusion of valid research and avoid falsified data. Data from January 2012 to May 2022 without language restrictions were included. As we planned to estimate the prevalence and identify factors associated with glycaemic control, the following types of study designs were considered: randomized controlled trials, quasi-experimental trials, cohort studies, case–control studies, and cross-sectional studies. Only studies that reported a multivariate analysis were included in the systematic review.

Information sources

The search was conducted in five databases: African Index Medicus, Africa-Wide Information, Global Health, PubMed, and Web of Science. In addition, the reference lists of the selected articles were reviewed for any other eligible articles. The last search date was 02 May 2022.

Search strategy

The search term domains were "Type 2 diabetes mellitus", "glycaemic control", and "sub-Saharan Africa". Additional file 1: Table S1 presents the search strategy at the level of the five databases.

Selection process

Two investigators (JPF and JMF) independently reviewed the studies using the eligibility criteria and selected studies for inclusion in the review. The first investigator (JPF) reviewed all articles, and the second investigator (JMF) randomly assessed 10% of the selected articles. Differences in selection were assessed by consensus. The software used for the selection and recording of decisions was EndNote 20.

Data extraction

Data from eligible studies were captured using a Microsoft Excel file. The first investigator (JPF) performed data extraction on all the articles and the second investigator (JMF) randomly assessed 10% of the extracted information. Any differences of opinion between individual judgments were resolved through consensus. For the metaanalysis of the proportions of glycaemic control, we contacted eight authors for missing information and clarification. One provided us with its study dataset, and another showed us how to access the information needed to calculate the glycaemic control.

Study variables

Main outcomes

Reported glycaemic control: pooled prevalence of samples reported to have glycaemic control.

Exposure: reported independent risk factors for glycaemic control.

Data items

The following information was extracted from the studies: the last name of the first author, study type, publication year, country, study population, total sample size, glycaemic level assessment method, glycaemic control definition, number or proportion of persons with good glycaemic control, factors associated with glycaemic control, and measure of association for glycaemic control.

Study risk of bias assessment

The assessment of the methodological quality of the selected studies was performed by two reviewers (JPF and JMF) using the Joanna Briggs Institute Critical Appraisal Tools [12]; any differences of opinion between the two reviewers were resolved by consensus. The Joanna Briggs Institute Critical Appraisal Tools were used to classify each selected study as good, moderate, or poor regarding the risk of bias. The percentage of "Yes" votes was equal to or less than 50%, 51–80%, and more than 80% for poor, moderate, or good quality respectively [13]. The assessment of an item was marked "Yes" if the description met the criteria set for the assessment, otherwise, the assessment was "No". If the description was insufficient, the assessment was "Unknown".

Synthesis methods

To estimate the overall prevalence of glycaemic control, we carried out a meta-analysis with the random-effects model of the proportions of good glycaemic control. The statistical software used was Stata 17.0 [14]. The data needed for analysis are summarized in Additional file 3: Table S3. Only 51 studies were eligible for the estimation of the prevalence of glycaemic control as randomized control trials, quasi-experimental and case–control studies were excluded. We observed high heterogeneity of the studies as shown by the I^2 [15], and therefore reported the pooled prevalence estimate and the glycaemic control patterns in sub-Saharan Africa. Forest plots were used to visually display the results of individual studies and the syntheses. We explored heterogeneity by performing subgroups analysis of the prevalence by region of sub-Saharan Africa (Eastern, Western, Central, Southern), study type (case–control, cohort, cross-sectional, quasi-experimental, randomized control trial), and method (glycosylated haemoglobin, glycaemia) used to assess the control.

To assess the factors driving glycaemic control, due to the heterogeneity of the studies, we performed a narrative synthesis of reported factors. Each reported factor is presented with the studies in which it was assessed, and the measure of association —and its 95% confidence interval—with glycaemic control found in each study is reported. The factors were categorized into six groups: sociodemographic, lifestyle, clinical, treatment modalities, adherence, and interventions.

Results

Study selection

We retrieved 6656 publications from the information sources. A total of 105 publications were removed due to duplication. Of the remaining 6551 articles, 6425 were excluded after the titles and abstracts were reviewed, and 126 were retained for full-text evaluation based on the inclusion criteria. Of the 126, eighty-three articles were excluded after full-text review and 43 articles were retained. An additional search of the reference lists of selected articles yielded 2623 publications. We selected 53 publications for full-text evaluation according to the selection criteria. Of these, 22 were excluded because they did not meet inclusion criteria, and 31 articles were retained. The total number of included studies was 74 articles by both search strategies. The selection process is summarized in the PRISMA flow diagram (Fig. 1). The characteristics of the excluded studies and the reason(s) for exclusion are summarized in Additional file 2: Table S2.

General characteristics of the included studies

A total of 74 studies reporting on 21,133 patients with type 2 diabetes were included in the review. The studies were conducted in 16 sub-Saharan African countries, with Ethiopia (n = 26, 35.1%) being the most represented, followed by South Africa (n = 11, 14.9%) and Nigeria (n = 10, 13.5%). The majority of the studies (n = 51, 68.9%) were conducted in the last five years (2017-2022). Of the 74 studies selected, 55 (74.3%) were cross-sectional studies, ten (13.5%) were randomized controlled studies, four (5.4%) were quasi-experimental studies, three (4.1%) were case–control studies, and two (2.7%) were cohort studies. The general characteristics of the included studies are presented in Table 1.

Assessment of risk of bias

Of the 74 studies selected for the review, only 14 (18.9%) were assessed as being of good quality, 54 (73.0%) were

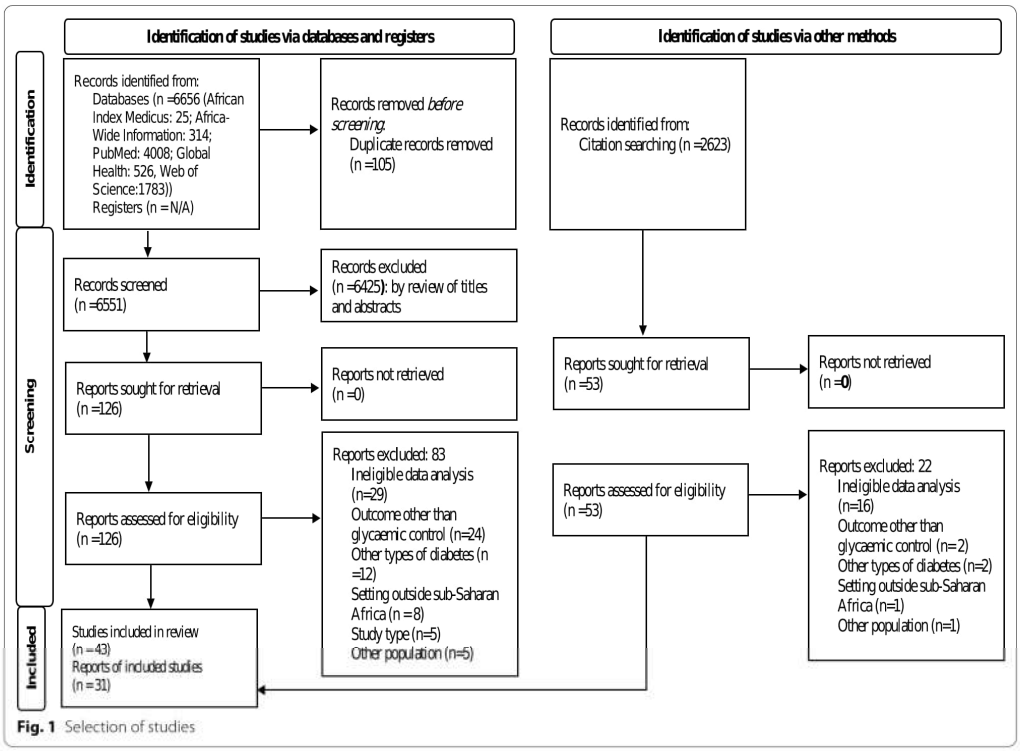

Fig. 1 Selection of studies

of moderate quality, and six (8.1%) were of poor quality. Additional file 4: Tables S4, Additional file 5: Table S5, Additional file 6: Table S6, Additional file 7: Table S7, Additional file 8: Table S8, Additional file 9 detail the assessment of study methodological quality. Of the 55 cross-sectional studies, only four (7.3%) were able to formally identify confounding factors, while ten (1 8.2%) reported the method used to address confounding factors. In the four quasi-experimental studies, one study (25.0%) did not measure the outcomes consistently or in a reproducible way. In two of the ten randomized controlled trials (20.0%), participants and treatment providers were not blinded to treatment allocation nor were the staff members assessing outcomes blinded to treatment allocation. Moreover, for one of these two studies, the treatment groups were not similar at baseline. For two of the three case–control studies, confounding factors were not identified, and for one study, cases and controls were mismatched.

Assessment of glycaemic control

Glycaemic control was assessed by glycosylated haemoglobin in 43(58.1%) studies, fasting blood glucose in 25 (33.8%) studies and a combination of both methods in 6(8.1%) studies. The cut-off points for good glycaemic control varied across studies and were: HbA1c < 7%, HbA1c ≤ 7%, HbA1c < 8%, HbA1c < 53 mmol/mol, FBG: 70–130 mg/dL, FBG < 126 mg/dL, FBG ≤ 126 mg/dL, FBG: 70–130 mg/dL, FBG < 154 mg/dL, FBS ≤ 130 mg/dl, FPG: 100–130 mg/dL, FBG: 4–7 mmol/L, FBG ≤ 130 mg/dL or 7. 2 mmol/L.

Prevalence of glycaemic control

The estimated pooled prevalence of good glycaemic control in sub-Saharan Africa was 30.3% (95% CI: 27.6–32.9). The analysis showed considerable heterogeneity (I^2: 93.9%, $p < 0.001$), and glycaemic control prevalence ranged from 10 to 60% (Fig. 2). The subgroup analysis by region showed that most of the studies in the Central

Table 1 General characteristics of included studies

First author last name	Study setting	Study type	Publication year	Study population	Sample size	Glycaemic level assessment method
Achila [16]	Eritrea	Cross-sectional	2020	Type 2 diabetes; 20–88 years	309	HbA1c
Adejumo [17]	Nigeria	Cross-sectional	2012	Type 2 diabetes with normal renal function; ≥ 18 years	144	HbA1c
Adeniyi [18]	South Africa	Cross-sectional	2016	Type 2 diabetes; ≥ 30 years at diagnostic of diabetes	327	HbA1c
Afolabi [19]	Nigeria	Cross-sectional	2018	Type 2 diabetes; 40–80 years	80	HbA1c
Akabwai [20]	Uganda	Cross-sectional	2016	Type 2 diabetes; ≥ 18 years	280	HbA1c
Akpalu [21]	Ghana	Cross-sectional	2018	Type 2 diabetes; 30–65 years	400	HbA1c
Anioke [22]	Nigeria	Cross-sectional	2019	Type 2 diabetes; ≥ 30 years	140	HbA1c
Anyanwu [23]	Nigeria	Randomized controlled trial	2016	Type 2 diabetes with poor glycemic control and vitamin D deficiency; 35–65 years	42	HbA1c
Assah [24]	Cameroon	Randomized controlled trial	2015	Type 2 diabetes	192	HbA1c
Ayele [25]	Ethiopia	Cross-sectional	2019	Type 2 diabetes; > 18 years	275	FBG
Belay [26]	Ethiopia	Cross-sectional	2017	Type 2 diabetes; 18–80 years	188	FPG
BeLue [27]	Senegal	Cross-sectional	2016	Type 2 diabetes	106	HbA1c
Biadgo [28]	Ethiopia	Cross-sectional	2018	Type 2 diabetes	159	FBS
Biru [29]	Ethiopia	Cross-sectional	2017	Type 2 diabetes; ≥ 18 years	322	FBG
Blum [30]	DR Congo	Cross-sectional	2019	Type 2 diabetes; ≥ 18 years	319	HbA1c
Botchway [31]	Ghana	Cross-sectional	2021	Type 2 diabetes; ≥ 18 years	254	HbA1c
Camara [32]	Cameroon and Guinea	Cross-sectional	2015	Type 2 diabetes; ≥ 16 years	1267	HbA1c
Dagnew [33]	Ethiopia	Comparative Cross-sectional	2017	Type 2 diabetes and healthy relatives; ≥ 30 years	210	FBG
Demoz [34]	Ethiopia	Cross-sectional	2019	Type 2 diabetes; ≥ 18 years	357	HbA1c and FBG
Doglikuu [35]	Ghana	Cross-sectional	2021	Type 2 diabetes; ≥ 18 years	530	HbA1c
Eticha [36]	Ethiopia	Cross-sectional	2016	Type 2 diabetes; ≥ 18 years	384	HbA1c
Ezema [37]	Nigeria	Randomized trial	2014	Type 2 diabetes; 40–55 years	54	FBG
Fayehun [38]	Nigeria	Randomized trial	2018	Type 2 diabetes; 33–64 years	46	HbA1c
Fekadu [39]	Ethiopia	Cross-sectional	2019	Type 2 diabetes; 18–86 years	228	Mean of FBG records from the last three clinic visits
Fseha [40]	Ethiopia	Cross-sectional	2017	Type 2 diabetes; 22–60 years	200	Three-month average FBG

Table 1 (continued)

First author last name	Study setting	Study type	Publication year	Study population	Sample size	Glycaemic level assessment method
Gathu [41]	Kenya	Randomized controlled trial	2018	Sub-optimally controlled type 2 diabetes; 18–65 years	140	HbA1c
Gebremedhin [42]	Ethiopia	Cross-sectional	2019	Type 2 diabetes; ≥ 18 years	267	FBG
Hailu [43]	Ethiopia	Controlled before-and-after study	2018	Type 2 diabetes; > 30 years	220	HbA1c
Id [44]	Ethiopia	Cross-sectional	2021	Type 2 diabetes; > 18 years	394	FBS
Inih [45]	Nigeria	Cross-sectional	2018	Type 2 diabetes; men	150	HbA1c
Kalain [46]	South Africa	Cross-sectional	2020	Type 2 diabetes; ≥ 18 years	200	HbA1c
Kamuhabwa [47]	Tanzania	Cross-sectional	2014	Type 2 diabetes; ≥ 18 years	469	FBG
Kassahun [48]	Ethiopia	Cross-sectional	2016	Type 2 diabetes; ≥ 18 years	309	Mean of at least four months FBG readings
Kefale [49]	Ethiopia	Cross-sectional	2019	Type 2 diabetes; ≥ 18 years	169	mean of at least three-month FBG measurements
Khoza [50]	South Africa	Case–control	2018	Type 2 diabetes; > 30 years	320	HbA1c and glucose
Kimando [51]	Kenya	Cross-sectional	2017	Type 2 diabetes without overt complications; ≥ 30 years	385	HbA1c
Maharaj [52]	Nigeria	Randomized controlled trial	2016	Non-insulin dependent type 2 diabetes; 30–58 years	90	HbA1c, FPG
Mamo [53]	Ethiopia	Case–control	2019	Type 2 diabetes with poor glycemic control (cases) and without good glycemic control (controls); > 18 years	410	FBG
Mash [54]	South Africa	Quasi-experimental study	2014	Type 2 diabetes; > 18 years	1570	HbA1c
Mash [55]	South Africa	Pragmatic Randomized controlled trial	2016	Type 2 diabetes	600	HbA1c
Mashele [56]	South Africa	Cross-sectional	2019	Type 2 diabetes; 35–74 years	176	HbA1c
Mayet [57]	South Africa	Descriptive retrospective study	2012	Poorly controlled insulin-requiring type 2 diabetes	131	HbA1c
Mobula [58]	Ghana	Cross-sectional	2018	Hypertensive and Type 2 diabetes; ≥ 18 years	1226	HbA1c
Mohamed [59]	Sudan	Case–control	2013	Type 2 diabetes and non-diabetic controls	457	HbA1c
Mohammed [60]	Ethiopia	Cross-sectional	2020	Type 2 diabetes	307	FBG
Mphwanthe [61]	Malawi	Cross-sectional	2020	Type 2 diabetes; ≥ 25 years	428	HbA1c
Mphwanthe [62]	Malawi	Cross-sectional	2020	Type 2 diabetes	428	HbA1c
Muchiri [63]	South Africa	Randomized controlled trial	2016	Type 2 diabetes; 40–70 years	82	HbA1c
Mwavua [64]	Kenya	Cross-sectional	2016	Type 2 diabetes; ≥ 18 years	200	HbA1c

Table 1 (continued)

First author last name	Study setting	Study type	Publication year	Study population	Sample size	Glycaemic level assessment method
Mwita [65]	Botswana	Cross-sectional	2019	Type 2 diabetes; ≥ 18 years	500	HbA1c
Noor [66]	Sudan	Cross-sectional	2017	Type 2 diabetes	387	HbA1c
Omar [67]	Sudan	Cross-sectional	2018	Type 2 diabetes; ≥ 18 years	339	HbA1c
Osuji [68]	Nigeria	Cross-sectional	2018	Type 2 diabetes; ≥ 18 years	316	HbA1c
Otieno [69]	Kenya	Cross-sectional	2017	Type 2 diabetes; ≥ 30 years	220	HbA1c
Oyewole [70]	Nigeria	Cross-sectional	2019	Type 2 diabetes; ≥ 21 years	162	FBG and HbA1c
Rambiritch [71]	South Africa	A 12-week, prospective, single-center, open-label, dose-escalation study	2014	Poorly controlled type 2 diabetes requiring oral antidiabetic medications; > 20 years	22	FBG
Ramkisson [72]	South Africa	Cross-sectional	2016	Type 2 diabetes; ≥ 18 years	401	HbA1c
Rwegerera [73]	Botswana	Cross-sectional	2019	Type 2 diabetes	368	HbA1c
Sarfo-Kantanka [74]	Ghana	Case–control	2017	Type 2 diabetes; 40–80 years	612	FBG and HbA1c
Shimels [75]	Ethiopia	Cross-sectional	2018	Type 2 diabetes; ≥ 18 years	361	FPG
Siddiqui [76]	South Africa	Prospective observational study	2018	Type 2 diabetes; 18–65 years	95	HbA1c
Tefera [77]	Ethiopia	Cross-sectional	2020	Type 2 diabetes; ≥ 18 years	400	FPG
Tekalegn [78]	Ethiopia	Cross-sectional	2018	Type 2 diabetes; ≥ 15 years	412	FBG
Teklay [79]	Ethiopia	Cross-sectional	2013	Type 2 diabetes; ≥ 18 years	267	Mean of the last four FBG readings
Thuita [80]	Kenya	Cross-sectional	2019	Type 2 diabetes; 20–79 years	153	HbA1c
Thuita [81]	Kenya	Randomized controlled trial	2020	Type 2 diabetes; 20–79 years	153	HbA1C and FBG
Tsobgny-Tsague [82]	Cameroon	Randomized controlled trial	2018	Type 2 diabetes with poor glycaemic control and moderate to severe chronic periodontitis	34	HbA1c
Woldu [83]	Ethiopia	Cross-sectional	2014	Type 2 diabetes	102	FBG
Yan [84]	Mozambique	Randomized controlled trial	2014	Type 2 diabetes; 40–70 years	41	HbA1c
Yigazu [85]	Ethiopia	Cross-sectional	2017	Type 2 diabetes; 18–80 years	174	average FBG
Yimam [86]	Ethiopia	Cross-sectional	2020	Type 2 diabetes with hypertension; ≥ 18 years	300	Mean FBG level over three months Consecutive measurements
Yosef [87]	Ethiopia	Cross-sectional	2021	Type 2 diabetes	245	Mean FBG over three consecutive visits
Abera [88]	Ethiopia	Cross-sectional	2022	Type 2 diabetes	325	HbA1c
Abebe [89]	Ethiopia	Prospective observational study	2022	Type 2 diabetes	138	Mean FBG level over three months consecutive measurements

HbA1c Haemoglobin A1c, *FBG* Fasting blood glucose, *FBS* Fasting blood sugar, *FPG* Fasting plasma glucose

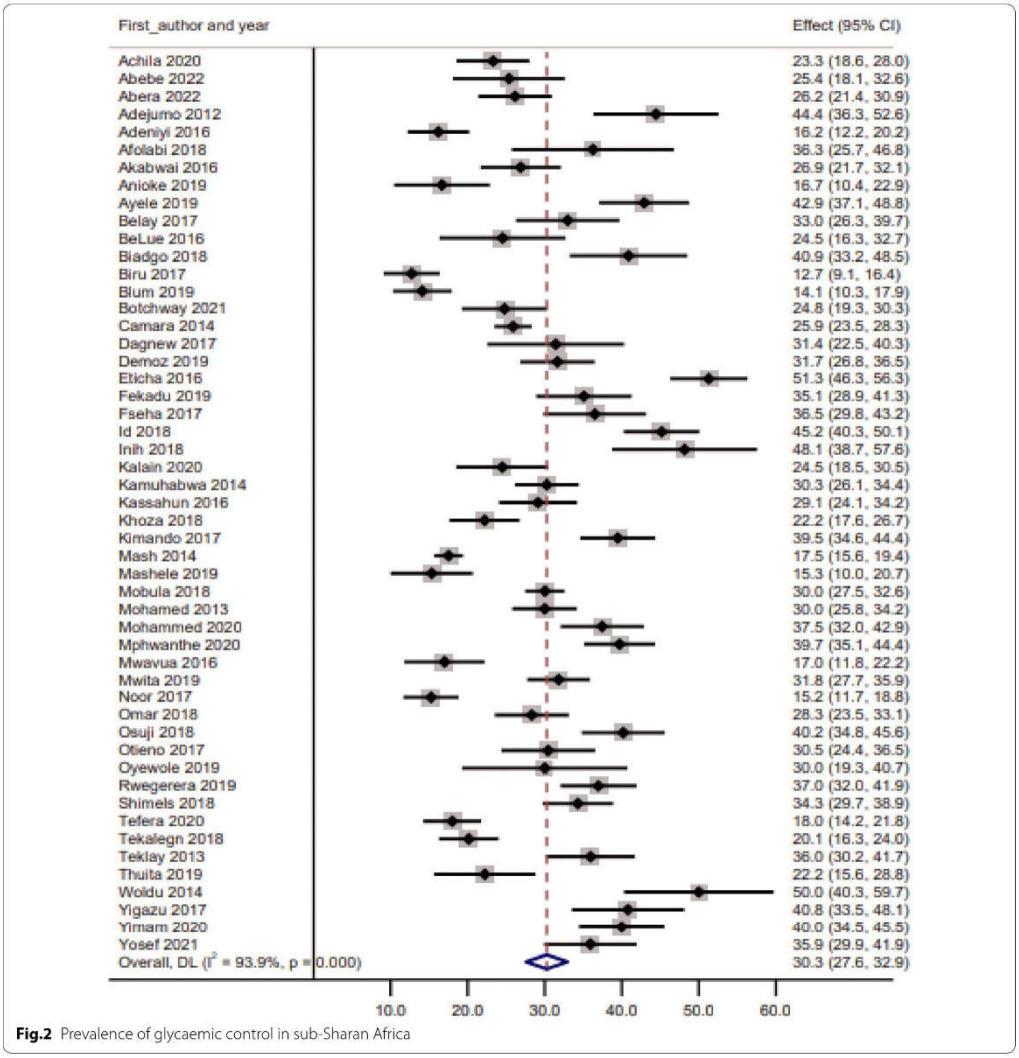

Fig.2 Prevalence of glycaemic control in sub-Sharan Africa

(n = 5, 83.3%) and the Southern (n = 5, 62.5%) regions had a prevalence of glycaemic control of < 30% while most of the studies in the Eastern region had a prevalence of glycaemic control > 30% (Fig. 3).

Factors associated with glycaemic control

The reported sociodemographic, lifestyle, clinical, adherence, treatment factors, and reported glycaemic control optimization interventions factors are summarized in Tables 2, 3, 4, 5, 6, 7.

Sociodemographic characteristics

Table 2 presents the sociodemographic factors with respect to their relationship with glycaemic control. Five studies assessed the relationship between increasing age and glycaemic control [27, 31, 34, 58, 61], two

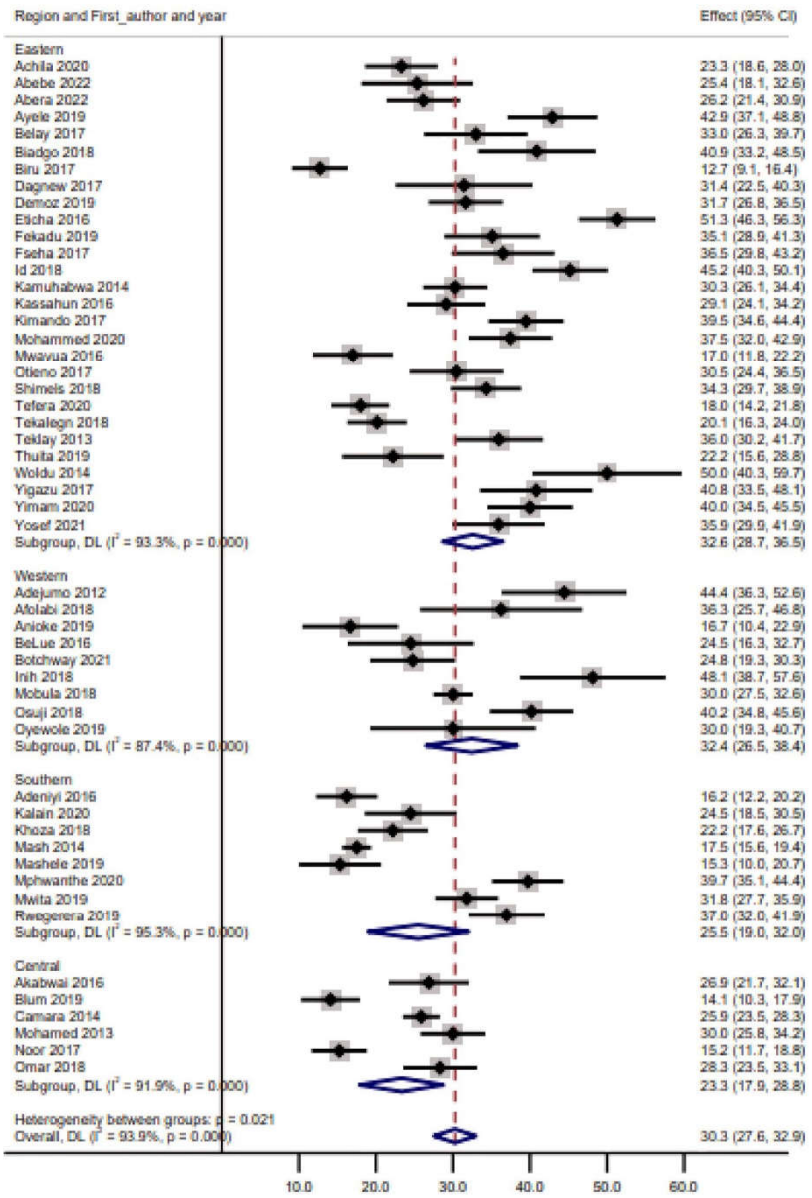

Fig.3 Prevalence of glycaemic control by sub-Saharan Africa regions

Table 2 Sociodemographic factors and glycaemic control in sub-Saharan Africa

First author name	Year	Study design	Study setting	Study population	Sample size	Measurement of glycemic control	Definition of glycaemic control	Generic factor	Specific factors	Measure of association	Point estimate	Lower bound	Upper bound	Association with glycemic control
BeLue [27]	2016	Cross-sectional	Senegal	Type 2 diabetes	106	HbA1c	Glycemic control (HbA1c < 7%)	Age	Increasing age	ß coefficient	− 0.06	− 0.08	− 0.04	No significant association between age and glycaemic control
Botchway [31]	2021	Cross-sectional	Ghana	Type 2 diabetes; ≥ 18 years	254	HbA1c	No threshold			ß coefficient	− 0.05	− 0.07	− 0.03	Significant negative association between age ard HbA1c
Demoz [34]	2019	Cross-sectional	Ethiopia	Type 2 diabetes; ≥ 18 years	357	FEG	Adequate control (average fasting blood glucose 70–130 mg/dL or HbA1c < 7%); poor control (average fasting blood glucose > 130 or < 70 mg/dL or HbA1c > 7%)			Odds Ratio	1.57	1.11	2.31	Age was not a predictor significantly associated with poor glycaemic control
Mobula [58]	2018	Cross-sectional	Ghana	Hypertensive and Type 2 diabetes; ≥ 18 years	1226	HbA1c	Poor control (HBA1c ≥ 7%)			Odds Ratio	0.97	0.96	0.98	Increasing age had significant association with good glycaemic control
Mphwanthe [61]	2020	Cross-sectional	Malawi	Type 2 diabetes; ≥ 25 years	428	HbA1c	Poor control (HbA1c ≥ 8%)			ß coefficient	− 0.065	− 0.80	− 0.050	Increasing age in years showed a negative significant association with HbA1c
Anioke [22]	2019	Cross-sectional	Nigeria	Type 2 diabetes; ≥ 30 years	140	HbA1c	Good control (HbA1c < 7%); poor control (HbA1c ≥ 7%)		Age ≥ 65 years	Odds Ratio	5.00	1.19	20.96	Being an elderly was five times more likely to show poor glycaemia than non-elderly
Osuji [68]	2018	Cross-sectional	Nigeria	Type 2 diabetes; ≥ 18 years	316	HbA1c	Good (HbA1c < 7%); poor (HbA1c ≥ 7%)			Odds Ratio	0.538	0.111	2.607	No significant association between glycaemic control and age group ≥ 65 years
											0.375	0.075	1.875	No significant association between glycaemic control and age group 45–64 yrs

Table 2 (continued)

First author name	Year	Study design	Study setting	Study population	Sample size	Measurement of glycemic control	Definition of glycaemic control	Generic factor	Specific factors	Measure of association	Point estimate	Lower bound	Upper bound	Association with glycemic control
Otieno [69]	2017	Cross-sectional	Kenya	Type 2 diabetes; ≥ 30 years	220	HbA1c	Good control (HbA1c ≤ 7%); poor/suboptimal (HbA1c > 7%)			Odds Ratio	0.9	0.3	3.6	No influence of age ≥ 65 years in determining glycaemic control in patients with depression
											1.5	0.6	3.6	No influence of age ≥ 65 years in determining glycaemic control in patients without depression
Biru [29]	2017	Cross-sectional	Ethiopia	Type 2 diabetes; ≥ 18 years	322	FBG	Good control (FBG ≤ 110 mg/dL)		41–50 years	Odds Ratio	2.82	0.62	12.74	Age 41–50 years was not associated significantly associated with glycaemic control
									51–60 years		3.22	0.76	13.70	Age 51–60 years was not associated significantly associated with glycaemic control
									61–70 years		8.32	1.76	39.35	Age 61–70 years was associated with good glycaemic control
									≥ 71 years		31.30	4.07	240.90	Age ≥ 71 years was associated with good glycaemic control
Woldu [83]	2014	Cross-sectional	Ethiopia	Type 2 diabetes	102	FBG	Poor glycaemic control (FBG level of > 126 mg/dl)		41–50 years	Odds Ratio	0.01	0.000	1.1144	Being in the age group 41–50 years was significantly associated with poor glycaemic control
									51–60 years		0.01	0.000	0.749	Being in the age group 51–60 years was significantly associated with poor glycaemic control

Table 2 (continued)

First author name	Year	Study design	Study setting	Study population	Sample size	Measurement of glycemic control	Definition of glycaemic control	Generic factor	Specific factors	Measure of association	Point estimate	Lower bound	Upper bound	Association with glycemic control
									61–70 years		0.01	0.000	0.395	Being in the age group 61–70 years was significantly associated with poor glycaemic control
									≥ 71 years		0.1	0.002	5.794	Being in the age group > 71 years was significantly associated with poor glycaemic control
Camara [32]	2014	Cross-sectional	Cameroon and Guinea	Type 2 diabetes mellitus; ≥ 16 years	1267	HbA1c	Good control (HbA1C < 7.0% or < 53 mmol/mol)		Age < 65 years	Odds Ratio	1.39	1.19	20.96	Age of less than 65 years was signifcantly asscciated with poor glycaemic control
Eticha [36]	2016	Cross-sectional	Ethiopia	Type 2 diabetes; ≥ 18 years	384	HbA1c	Good control (HbA1c < 7%); poor control (HbA1c ≥ 7%)		< 50 years	Odds Ratio	3.0	1.2	7.4	Age of less than 50 years was significantly associated with poor glycaemic control
									50–59 years		4.7	2.0	11.0	Age between 50 and 59 years was significantly associated with poor glycaemic control
Fekadu [39]	2019	Cross-sectional	Ethiopia	Type 2 diabetes; 18–86 years	228	FEG	Good control (FBG: 70–130 mg/dL); poor control (< 70 mg/dL and > 130 mg/dL)		< 21 years	Odds Ratio	1.32	0.09	38.04	No significant association between age < 21 years and glycaemic control
									21–40 years		1.21	0.03	1.49	No significant association between age 21–40 years and glycaemic control
									41–60 years		2.01	0.04	0.06	Significant association between age 41–60 years and poor glycaemic control

Table 2 (continued)

First author name	Year	Study design	Study setting	Study population	Sample size	Measurement of glycemic control	Definition of glycaemic control	Generic factor	Specific factors	Measure of association	Point estimate	Lower bound	Upper bound	Association with glycemic control
Kimando [51]	2017	Cross-sectional	Kenya	Type 2 diabetes without overt complications; ≥ 30 years	385	HbA1c	Sub-optimal control (HbA1c > 7.0%)		> 50 years	Odds Ratio	0.8	0.4	1.5	Being aged more than 50 years was not significantly associated with poor glycaemic control
Mwita [65]	2019	Cross-sectional	Botswana	Type 2 diabetes; ≥ 18 years	500	HbA1c	Optimal glycaemic (HbA1c < 7%)		≤ 50 years	Odds Ratio	5.79	1.08	31.14	Age equal or less than 50 years was significantly associated with optimal glycaemic control
Rwegerera [73]	2019	Cross-sectional	Botswana	Type 2 diabetes	368	HbA1c	desirable (< 7%); suboptimal (7–9%); poor (≥ 9%)		36–50 years	Odds Ratio	2.03	0.3	13.69	This age group was not significantly associated with glycaemic control
									51–65 years		4.32	0.63	29.8	This age group was not associated with desirable glycaemic control but significantly associated with suboptimal glycaemic control
									≥ 66 years		11.7	1.4	97.69	This age group was also significantly associated with both desirable and suboptimal glycaemic control
Shimels [75]	2018	Cross-sectional	Ethiopia	Type 2 diabetes; ≥ 18 years	361	FPG	glycemic control (FPG: 100–130 mg/dl)		46–60 years	Odds Ratio	0.66	0.37	1.18	No significant association betweer age of 46–60 years with glycaemic control
									> 60 years		0.74	0.36	1.52	No significant association betweer age of more than 60 years with glycaemic control
Tefera [77]	2020	Cross-sectional	Ethiopia	Type 2 diabetes; ≥ 18 years	400	FPG	Controlled (FPG:80–130 mg/dl)		< 40 years	Odds Ratio	6.23	1.99	9.11	Being of age less than 40 years was significantly associated with reaching glycaemic target

Table 2 (continued)

First author name	Year	Study design	Study setting	Study population	Sample size	Measurement of glycemic control	Definition of glycaemic control	Generic factor	Specific factors	Measure of association	Point estimate	Lower bound	Upper bound	Association with glycemic control
									40–60 years		2.52	0.47	3.61	No significant association has been found with 40–60 years age group age
Tekalegn [78]	2018	Cross-sectional	Ethiopia	Type 2 diabetes; ≥ 15 years	422	FBG	Good control (average FBG:70–130 mg/dL); poor control (average FBG > 130 or < 70 mg/dL)		40–49 years	Odds Ratio	2.14	0.74	6.2	No significant association between gycaemic control and age group 40–49 years
									50–59 years		2.46	0.91	6.63	No significant association between glycaemia control and age group 50–59 years
									≥ 60 years		1.02	0.37	2.78	No significant association between glycaemic control and age ≥ 60 years
Yimam [86]	2020	Cross-sectional	Ethiopia	Type 2 diabetes with hypertension; ≥ 18 years	300	FBG	Good control (mean FBG:80–130 mg/dl); poor control (FBG < 80 mg/dl or > 130 mg/dl)		41–60 years	Odds Ratio	3.05	1.20	7.77	Age 41–60 years was significantly associated with poor glycaemic control
									> 60 years		2.62	1.01	6.80	Age more than 60 years was significantly associated with poor glycaemic control
Abera [88]	2022	Cross-sectional	Ethiopia	Type 2 diabetes	325	HbA1c	Good control (HbA1c < 7%); poor control (HbA1c ≥ 7%)		18–44 years	Odds Ratio	1.63	0.66	4.18	Significant association between age groups of 45–54 years and ≥ 65 years and poor glycaemic control
									45–54 years		2.46	1.28	6.01	
									≥ 65 years		1.97	1.3	5.97	

Table 2 (continued)

First author name	Year	Study design	Study setting	Study population	Sample size	Measurement of glycemic control	Definition of glycaemic control	Generic factor	Specific factors	Measure of association	Point estimate	Lower bound	Upper bound	Association with glycemic control
Abebe [89]	2022	Cross-sectional	Ethiopia	Type 2 diabetes; > 18 years	138	FBG	Good control (mean FBG:80–130 mg/dl); poor control (FBG < 80 mg/dl or > 130 mg/dl)		≥ 60 years	Odds Ratio	0.4	0.16	1.008	No significant relationship between age ≥ 60 years and glycaemic control
Adeniyi [18]	2016	Cross-sectional	South Africa	Type 2 diabetes; ≥ 30 years at diagnostic of DM	327	HbA1c	Good control (HbA1c ≤ 7%); poor control (HbA1c > 7%); moderately poor (HbA1c = 7–8.9%); critically poor (HbA1c ≥ 9%)	Gender	Female gender	Odds Ratio	3.4	1.5	7.7	Female gender was a significant determinant of uncontrolled diabetes
Demoz [34]	2021	Cross-sectional	Ethiopia	Type 2 diabetes; ≥ 18 years	357	HbA1c and FBG	Adequate control (average fasting blood glucose 70–130 mg/dL or HbA1c < 7%); poor control (average fasting blood glucose > 130 or < 70 mg/dL or HbA1c > 7%)			Odds Ratio	1.59	1.20	2.38	Being Female was significantly associated with poor glycaemic control
Biru [29]	2017	Cross-sectional	Ethiopia	Type 2 diabetes; ≥ 18 years	322	FBG	Good control (FBG ≤ 110 mg/dL)			Odds Ratio	3.47	1.22	9.91	Female gender was significanty asscciated with good glycaemic control
Kimando [51]	2017	Cross-sectional	Kenya	Type 2 diabetes without overt complications; ≥ 30 years	385	HbA1c	Sub-optimal control (HbA1c > 7.0%)			Odds Ratio	1.1	0.7	1.6	No significant association betweer Female gender and glycaemic control
Mphwanthe [61]	2020	Cross-sectional	Malawi	Type 2 diabetes; ≥ 25 years	428	HbA1c	Poor control (HbA1c ≥ 8%)			ß coefficient	− 0.197	− 0.492	0.098	Female gender has no significant correlation with glycaemic control
Mwavua [64]	2016	Cross-sectional	Kenya	Type 2 diabetes; ≥ 18 years	200	HbA1c	Good control (HbA1c < 7%); poor control (HbA1c ≥ 7%)			Odds Ratio	1.0	0.4	2.4	Female gender had no significant correlation with glycaemic control
Mwita [65]	2019	Cross-sectional	Botswana	Type 2 diabetes; ≥ 18 years	500	HbA1c	Optimal glycaemic (HbA1c < 7%)			Odds Ratio	0.42	0.14	1.25	Female gender had no correlation with glycaemic control

Table 2 (continued)

First author name	Year	Study design	Study setting	Study population	Sample size	Measurement of glycemic control	Definition of glycaemic control	Generic factor	Specific factors	Measure of association	Point estimate	Lower bound	Upper bound	Association with glycemic control
Rwegerera [73]	2019	Cross-sectional	Bot-swana	Type 2 diabetes	368	HbA1c	desirable (< 7%); suboptimal (7–9%); poor (≥ 9%)			Odds Ratio	1.91	1.09	3.36	Female gender was significantly associated with good glycaemic control
BeLue [27]	2016	Cross-sectional	Senegal	Type 2 diabetes	106	HbA1c	Glycemic control (HbA1c < 7%)		Male gender	ß coefficient	1.5	0.86	2.14	Male gender was significantly positive association with poor glycaemic control
Shimels [75]	2018	Cross-sectional	Ethiopia	Type 2 diabetes; ≥ 18 years	361	FPG	Glycemic control (FPG: 100–130 mg/dl)			Odds Ratio	0.26	0.13	0.53	Male gender was significantly associated with good glycaemic control
Mobula [58]	2018	Cross-sectional	Ghana	hypertensive and Type 2 diabetes; ≥ 18 years	1226	HbA1c	Poor control (HBA1c ≥ 7%)			Odds Ratio	0.66	0.49	0.88	Male gender was significantly associated with good glycaemic control
Botchway [31]	2021	Cross-sectional	Ghana	Type 2 diabetes; ≥ 18 years	254	HbA1c	No threshold			ß coefficient	'− 0.30	− 0.68	− 0.08	Male gender had no significant correlation with glycaemic control
Fekadu [39]	2019	Cross-sectional	Ethiopia	Type 2 diabetes; 18–86 years	228	FBG	Good control (FBG: 70–130 mg/dL); poor control (< 70 mg/dL and > 130 mg/dL)			Odds Ratio	0.32	1.63	20.19	Male gender had no significant association with glycaemic control
Id [44]	2021	Cross-sectional	Ethiopia	Type 2 diabetes;, > 18 years	394	FES	Good blood glucose control (< 154 mg/dl); poor blood glucose control (≥ 154 mg/dl)			Odds Ratio	1.41	0.89	2.2	Male sex had nc significant association with glycaemic control
Noor [66]	2017	Cross-sectional	Sudan	Type 2 diabetes	387	HbA1c	Controlled < 7% Uncontrolled > 7%			Odds Ratio	1.250	0.491	3.179	Male sex had nc significant association with glycaemic control
Tefera [77]	2020	Cross-sectional	Ethiopia	Type 2 diabetes; ≥ 18 years	400	FPG	Controlled (FPG:80–130 mg/dl)			Odds Ratio	1.71	0.87	3.37	Male gender had no association with glycaemic control
Woldu [83]	2014	Cross-sectional	Ethiopia	Type 2 diabetes	102	FBG	Poor glycaemic control (FBG level of > 126 mg/dl)			Odds Ratio	0.3	0.051	1.718	No association between male gender and glycaemic control

Table 2 (continued)

First author name	Year	Study design	Study setting	Study population	Sample size	Measurement of glycemic control	Definition of glycaemic control	Generic factor	Specific factors	Measure of association	Point estimate	Lower bound	Upper bound	Association with glycemic control
Yigazu [85]	2017	Cross-sectional	Ethiopia	Type 2 diabetes; 18–80 years	174	FBG	Controlled (average FBG: 80–130 mg/dL); Uncontrolled (average FBG > 130 or < 70 mg/dL)			Odds Ratio	1.58	0.79	3.15	No association between male gender and glycaemic control
Yosef [87]	2021	Cross-sectional	Ethiopia	Type 2 diabetes; ≥ 18 years	245	FBG	Good control (FBG:70–130 mg/dL)			Odds Ratio	2.28	1.24	4.21	Male gender was associated with poor glycaemic control
Adeniyi [18]	2016	Cross-sectional	South Africa	Type 2 diabetes; ≥ 30 years at diagnostic of diabetes	327	HbA1c	Good control (HbA1c ≤ 7%); poor control (HbA1c > 7%); moderately poor (HbA1c = 7–8.9%); critically poor (HbA1c ≥ 9%)	Income	Individual monthly income	Odds Ratio	2.9	1.3	6.5	Lower monthly income was associated with poor glycaemic control
Ayele [25]	2019	Cross-sectional	Ethiopia	Type 2 diabetes; > 18 years	275	FBG	Good control (FBG level between 70 and 130 mg/dL); poor control (FBG greater than 130 or less than 70 mg/dL)			Odds Ratio	1.724	0.719	4.131	No association found between monthly income in ETB ≥ 2500 and glycaemic control
											0.755	0.271	2.102	No association found between monthly income in ETB 1500–2500 and glycaemic control
Yosef [87]	2021	Cross-sectional	Ethiopia	Type 2 diabetes; ≥ 18 years	245	FBG	Good control (FBG:70–130 mg/dL)			Odds Ratio	2.14	1.17	3.91	Significant association betweer a monthly income of less than 136 american dollars and poor glycaemic control
Mphwanthe [61]	2020	Cross-sectional	Malawi	Type 2 diabetes; ≥ 25 years	428	HbA1c	Poor control (HbA1c ≥ 8%)		Household Income	ß coefficient	0.087	− 0.157	0.331	No association found between household income level (≥ 30,000.34 MWK) and glycaemic control

Table 2 (continued)

First author name	Year	Study design	Study setting	Study population	Sample size	Measurement of glycemic control	Definition of glycaemic control	Generic factor	Specific factors	Measure of association	Point estimate	Lower bound	Upper bound	Association with glycemic control
BeLue [27]	2016	Cross-sectional	Senegal	Type 2 diabetes	106	HbA1c	Glycemic control (HbA1c < 7%)	Marital status	Unmarried	ß coefficient	− 0.108	− 0.778	0.562	Being unmarried had no significant correlation with glycaemic control
Demoz [34]	2019	Cross-sectional	Ethiopia	Type 2 diabetes; ≥ 18 years	357	HbA1c and FBG	Adequate control (average fasting blood glucose 70–130 mg/dL or HbA1c < 7%); poor control (average fasting blood glucose > 130 or < 70 mg/dL or HbA1c > 7%)			Odds Ratio	0.93	0.81	1.35	No significant association between glycaemic control and being never married
Ayele [25]	2019	Case–control	Ethiopia	Type 2 diabetes with poor glycemic control (cases) and without good glycemic control (controls); > 18 years	410	FBG	Good control (average fasting blood glucose of 80–130 mg/dL); poor control (average fasting blood glucose of > 130 mg/dL)		Single/ divorced /widowed	Odds Ratio	1.80	0.68	4.72	Being single/ divorced/widowed had no significant relationship with glycaemic control
Mashele [56]	2019	Cross-sectional	South Africa	Type 2 diabetes; 35–74 years	176	HbA1c	Optimal control (HbA1c < 7%); poor control (HbA1c ≥ 7%)		Marital status	Odds Ratio	1.006	0.962	1.051	Marital status had no significant relationship with glycaemic control
Mphwanthe [61]	2020	Cross-sectional	Malawi	Type 2 diabetes; ≥ 25 years	428	HbA1c	Poor control (HbA1c ≥ 8%)		Married	ß coefficient	− 0.119	− 0.427	0.189	Being married had no significant correlation with glycaemic control
Kimando [51]	2017	Cross-sectional	Kenya	Type 2 diabetes without overt complications; ≥ 30 years	385	HbA1c	Sub-optimal control (HbA1c > 7.0%)		Separated	Odds Ratio	1.4	0.1	15.3	No significant relationship between glycaemic control and being separated
									Unmarried		1.8	0.7	4.8	No significant relationship between glycaemic control and being single or unmarried

Table 2 (continued)

First author name	Year	Study design	Study setting	Study population	Sample size	Measurement of glycemic control	Definition of glycaemic control	Generic factor	Specific factors	Measure of association	Point estimate	Lower bound	Upper bound	Association with glycemic control
									Widowed		1.1	0.7	1.7	No significant relationship between glycaemic control and being a widowed
Rwegerera [73]	2019	Cross-sectional	Bot-swana	Type 2 diabetes	368	HbA1c	desirable (< 7%); suboptimal (7–9%); poor (≥ 9%)		Single/ Sepa-rated /Widowed	Odds Ratio	1.41	0.69	2.89	Being single/sepa-rated/widowed had no significant relationship with glycaemic control
Ayele [25]	2019	Cross-sectional	Ethiopia	Type 2 diabe-tes; > 18 years	275	FBG	Good control (FBG level between 70 and 130 mg/dL); Poor control (FBG greater than 130 or less than 70 mg/dL)	Place of residence	Rural	Odds Ratio	1.403	0.442	4.454	No significant association found between rural residency and glycaemic control
Ayele [25]	2019	Case–control	Ethiopia	Type 2 diabetes with poor glycemic control (cases) and without good glycemic control (con-trols); > 18 years	410	FBG	Good control (average fasting blood glucose of 80–130 mg/dL); poor control (average fasting blood glucose of > 130 mg/dL)			Odds Ratio	0.66	0.24	1.85	Rural residency had no significant association with glycaemic control
Woldu [83]	2014	Cross-sectional	Ethiopia	Type 2 diabetes	102	FBG	Poor control (FBG level of > 126 mg/dl)			Odds Ratio	0.5	0.106	1.986	Residing in rural area had no sig-nificant association with glycaemic control
Kefale [49]	2019	Cross-sectional	Ethiopia	Type 2 diabe-tes; ≥ 18 years	169	FBS	Glycemic control (FBS ≤ 130 mg/dl in all these most three recent measurements)		Urban	Odds Ratio	2.5	1.1	5.7	Urban residency was significantly associated with poor glycaemic control
Tefera [77]	2020	Cross-sectional	Ethiopia	Type 2 diabe-tes; ≥ 18 years	400	FFG	Controlled (FPG:80–130 mg/dl)			Odds Ratio	0.72	0.27	1.93	Residing in urban area was not signif-icantly associated with glycaemic control

Table 2 (continued)

First author name	Year	Study design	Study setting	Study population	Sample size	Measurement of glycemic control	Definition of glycaemic control	Generic factor	Specific factors	Measure of association	Point estimate	Lower bound	Upper bound	Association with glycemic control
Mobula [58]	2018	Cross-sectional	Ghana	hypertensive and Type 2 diabetes; ≥ 18 years	1226	HbA1c	Poor control (HBA1c ≥ 7%)		Urban	Odds Ratio	1.09	0.74	1.60	Residing in urban area had no significant relationship with glycaemic control
									Semi-urban		0.88	0.57	1.38	Residing in semi-urban area had no significant relationship with glycaemic control
Mphwanthe [61]	2020	Cross-sectional	Malawi	Type 2 diabetes; ≥ 25 years	428	HbA1c	Poor control (HbA1c ≥ 8%)		Semi-urban	ß coefficient	− 0.172	− 0.446	0.102	Residing in semi-urban area had no significant relationship with glycaemic control
Ayele [25]	2019	Cross-sectional	Ethiopia	Type 2 diabetes; > 18 years	275	FBG	Good control (FBG level between 70 and 130 mg/dL); Poor control (FBG greater than 130 or less than 70 mg/dL)	Employment	Farmer	Odds Ratio	0.279	0.098	0.797	Being farmer was inversely associated with good glycaemic control
									Unemployed		1.268	0.354	4.549	No significant association was found between glycaemic control with unemployed
									NGO employed		4.059	0.775	21.253	No significant association was found between glycaemic control with NGO employed
									Merchant		0.322	0.102	1.107	No significant association was found between glycaemic ccontrol with merchant
BeLue [25]	2016	Cross-sectional	Senegal	Type 2 diabetes	106	HbA1c	Glycemic control (HbA1c < 7%)		Employed	ß coefficient	0.07	0.01	0.13	No significant association found between being employed and glycaemic control

Table 2 (continued)

First author name	Year	Study design	Study setting	Study population	Sample size	Measurement of glycemic control	Definition of glycaemic control	Generic factor	Specific factors	Measure of association	Point estimate	Lower bound	Upper bound	Association with glycemic control
Kassahun [48]	2016	Cross-sectional	Ethiopia	Type 2 diabetes; ≥ 18 years	309	FBG	Poor control (mean FBG > 130 mg/dl)		Farmer	Odds Ratio	2.47	1.13	5.39	Being farmer has been found significantly associated with poor glycaemic control
									Employed		2.65	0.96	7.24	Significant association between poor glycaemic control with employed
									Merchant		2.69	0.86	8.37	No significant association between glycaemic control with merchant
									Daily labor		2.22	0.80	6.11	No significant association between glycaemic control with daily labor
Kimando [51]	2017	Cross-sectional	Kenya	Type 2 diabetes without overt complications; ≥ 30 years	385	HbA1c	Sub-optimal control (HbA1c > 7.0%)		Employed	Odds Ratio	0.9	0.4	2.3	No significant association between glycaemic control and being employed
									Self-employed		0.9	0.5	1.4	No significant association between glycaemic control and being self-employed
									Retired		0.9	0.5	1.6	No significant association between glycaemic control and being retired
BeLue [27]	2016	Cross-sectional	Senegal	Type 2 diabetes	106	HbA1c	Glycemic control (HbA1c < 7%)	Education level	No formal education	ß coefficient	0.11	− 0.44	0.66	Being of no education class was not significantly associated with glycaemic control
Biru [29]	2017	Cross-sectional	Ethiopia	Type 2 diabetes; ≥ 18 years	322	FEG	Good control (FBG ≤ 110 mg/dL)		Primary level	Odds Ratio	13.66	2.94	63.55	Being of primary level of education was significantly associated with good glycaemic control

Table 2 (continued)

First author name	Year	Study design	Study setting	Study population	Sample size	Measurement of glycemic control	Definition of glycaemic control	Generic factor	Specific factors	Measure of association	Point estimate	Lower bound	Upper bound	Association with glycemic control
									Secondary level		20.09	3.80	106.14	Being of secondary level of education was significantly associated with good glycaemic control
									Higher education		20.72	3.78	113.51	Being of higher education was associated with good glycaemic level
Botchway [31]	2021	Cross-sectional	Ghana	Type 2 diabetes; ≥ 18 years	254	HbA1c	No threshold		Junior secondary level	ß coefficient	− 0.21	− 0.62	0.20	No significant association between glycaemic control and having completed junior secondary school
									Senior secondary level or higher education		0.33	− 0.14	0.80	No significant association between glycaemic control and having completed senior secondary school or higher education
Demoz [34]	2019	Cross-sectional	Ethiopia	Type 2 diabetes; ≥ 18 years	357	HbA1c and FBG	Adequate control (average fasting blood glucose 70–130 mg/dL or HbA1c < 7%); poor control (average fasting blood glucose > 130 or < 70 mg/dL or HbA1c > 7%)		No formal education	Odds Ratio	1.59	0.37	1.09	No significant association between glycaemic control and no formal education
									Primary level		2.10	0.75	1.77	No significant association between glycaemic control and having primary level of education
									Secondary level		1.11	0.55	1.31	No significant association between glycaemic control with secondary level of education

Table 2 (continued)

First author name	Year	Study design	Study setting	Study population	Sample size	Measurement of glycemic control	Definition of glycaemic control	Generic factor	Specific factors	Measure of association	Point estimate	Lower bound	Upper bound	Association with glycemic control
Fekadu [39]	2019	Cross-sectional	Ethiopia	Type 2 diabetes; 18–86 years	228	FBG	Good control (FBG: 70–130 mg/dL); poor control (< 70 mg/dL and > 130 mg/dL)		Unable to read and write/illiterate	Odds Ratio	3.12	1.52	8.50	Being unable to read and write/illiterate was significantly associated with poor glycaemic control
									No formal education		2.28	2.14	32.60	Having informal education was significantly associated with poor glycaemic control
									Primary level		1.03	0.64	2.14	Being of primary education was significantly associated with poor glycaemic control
									Secondary level		1.04	0.26	17.48	Being of secondary level of education was not significantly associated with poor glycaemic control
Fseha [40]	2017	Cross-sectional	Ethiopia	Type 2 diabetes; 22–60 years	200	FBS	Good (FBS 70–130 mg/dl), poor (FBS > 130 mg/dl)		Formal education	Odds Ratio	1.054	0.492	2.261	Having had formal education was not significantly associated with glycaemic control
Kassahun [48]	2016	Cross-sectional	Ethiopia	Type 2 diabetes; ≥ 18 years	309	FBG	Poor control (mean FBG > 130 mg/dl)		Illiterate	Odds Ratio	3.45	1.01	11.91	Being illiterate has been found significantly associated with poor glycaemic control
									Able to read and write		0.81	0.20	3.26	No significant association between glycaemic control and being able to read and write
									Primary level		2.45	0.85	7.03	No significant association between glycaemic control and having reached 1–8 years of education

Table 2 (continued)

First author name	Year	Study design	Study setting	Study population	Sample size	Measurement of glycemic control	Definition of glycaemic control	Generic factor	Specific factors	Measure of association	Point estimate	Lower bound	Upper bound	Association with glycemic control
									Secondary level		1.97	0.69	5.55	No significant association betweer glycaemic control and having reachd 9–12 years of eductaion
Kimando [51]	2017	Cross-sectional	Kenya	Type 2 diabetes without overt complications; ≥ 30 years	385	HbA1c	Sub-optimal control (HbA1c > 7.0%)		No education	Odds Ratio	1.0	0.5	1.9	No significant association betweer glycaemic control and being illiterate
									Secondary level		1.0	0.5	2.0	No significant association betweer glycaemic control and having a secondary level of education
									Tertiairy level		0.9	0.3	2.8	No significant association betweer glycaemic control and being of tertiary level
Mashele [56]	2019	Cross-sectional	South Africa	Type 2 diabetes; 35–74 years	176	HbA1c	Optimal control (HbA1c < 7%); poor control (HbA1c ≥ 7%)		Level of education	Odds Ratio	1.014	0.985	1.045	The level of education had no signrificant relationship with glycaemic control
Mphwanthe [61]	2020	Cross-sectional	Malawi	Type 2 diabetes; ≥ 25 years	428	HbA1c	Poor control (HbA1c ≥ 8%)		Secondary level and above	ß coefficient	− 0.300	− 0.576	− 0.024	Being of secondary and above level of education had no significant association with glycaemic control
Mwavua [64]	2016	Cross-sectional	Kenya	Type 2 diabetes; ≥ 18 years	200	HbA1c	Good control (HbA1c < 7%); poor control (HbA1c ≥ 7%)		primary level and above	Odds Ratio	0.8	0.3	1.8	Having highest level of education below primary had no significant relationship with glycaemic control
Omar [65]	2018	Cross-sectional	Sudan	Type 2 diabetes; ≥ 18 years	339	HbA1c	Good control (HbA1c < 7%); poor control (HbA1c ≥ 7%)		Less or equal to secondary level	Odds Ratio	1.35	0.76	2.242	Being of an education less or equal to secondary level had no significant association with glycaemic control

Table 2 (continued)

First author name	Year	Study design	Study setting	Study population	Sample size	Measurement of glycemic control	Definition of glycaemic control	Generic factor	Specific factors	Measure of association	Point estimate	Lower bound	Upper bound	Association with glycemic control
Rwegerera [73]	2019	Cross-sectional	Botswana	Type 2 diabetes	368	HbA1c	desirable (< 7%); suboptimal (7–9%); poor (≥ 9%)		Primary to secondary completed	Odds Ratio	1.44	0.44	4.74	No singificant relationship between having completed primary to secondary school and glycaemic control
									College/University/Postgraduate completed		1.14	0.42	3.1	No singificant relationship between having completed College/University/Postgraduate ard glycaemic control
Tefera [77]	2020	Cross-sectional	Ethiopia	Type 2 diabetes; ≥ 18 years	400	FPG	Controlled (FPG:80–130 mg/dl)		Elementary school	Odds Ratio	0.20	0.02	1.65	No significant association between glycaemic control and having reached elementary school
									High school		0.20	0.02	1.63	No significant association between glycaemic control and having reached high school
									Higher education		0.45	0.05	3.86	No significant association between glycaemic control and having reached higher institution
									Able to read and write		0.12	0.01	1.05	No significant association between glycaemic control and being able to read and write
Yosef [87]	2021	Cross-sectional	Ethiopia	Type 2 diabetes; ≥ 18 years	245	FBG	Good control (FBG:70–130 mg/dL)		No formal education		3.12	1.53	6.35	Significant association between no formal education and poor glycaemic control

Table 2 (continued)

First author name	Year	Study design	Study setting	Study population	Sample size	Measurement of glycemic control	Definition of glycaemic control	Generic factor	Specific factors	Measure of association	Point estimate	Lower bound	Upper bound	Association with glycemic control
BeLue [27]	2016	Cross-sectional	Senegal	Type 2 diabetes	106	HbA1c	Glycemic control (HbA1c < 7%)	Unsatisfied household situation	Unsatisfied household situation	ß coefficient	− 0.701	-1.266	− 0.146	Having Unsatisfied household situation had no significant association with glycaemic control
Kamuhabwa [47]	2014	Cross-sectional	Tanzania	Type 2 diabetes; ≥ 18 years	469	FBG	Good control (FBG ≤ 130 mg/dL or 7.2 mmol/L): poor control (FBG > 130 mg/dL or 7.2 mmol/L)	Health insurance	Absence of health insurance	Odds Ratio	1.861	1.044	3.318	Absence of health insurance was significantly associated with poor glycaemic control
Mobula [58]	2018	Cross-sectional	Ghana	Hypertensive and Type 2 diabetes; ≥ 18 years	1226	HbA1c	Poor control (HBA1c ≥ 7%)			Odds Ratio	1.41	1.09	1.82	The absence of health insurance was significantly associated with poor glycaemic control
Ayele [25]	2019	Cross-sectional	Ethiopia	Type 2 diabetes; > 18 years	275	FBG	Good control (FBG level between 70 and 130 mg/dL); poor control (FBG greater than 130 or less than 70 mg/dL)	Distance from home to the health structure	Distance less than 100 km	Odds Ratio	13.195	3.193	54.517	Residing from less than 100 km from the hospital was significantly associated with glycaemic control
Mphwanthe [61]	2020	Cross-sectional	Malawi	Type 2 diabetes; ≥ 25 years	428	HbA1c	Poor control (HbA1c ≥ 8%)		Distance ≥ 5 kilometers	ß coefficient	− 0.167	− 0.428	0.094	Residing at a distance to the hospital ≥ 5 km was not significantly associated with glycaemic control
Fseha [40]	2017	Cross-sectional	Ethiopia	Type 2 diabetes; 22–60 years	200	FBS	Good (FBS 70–130 mg/dl), poor (FBS > 130 mg/dl)	Wealth status	Medium	Odds Ratio	2.335	0.933	5.844	Medium wealth status had no significant association with glycaemic control
									Rich		0.679	0.313	1.471	Rich Wealth status had no significa'nt association with glycaemic control

Table 2 (continued)

First author name	Year	Study design	Study setting	Study population	Sample size	Measurement of glycemic control	Definition of glycaemic control	Generic factor	Specific factors	Measure of association	Point estimate	Lower bound	Upper bound	Association with glycemic control
Camara [32]	2014	Cross-sectional	Cameroon and Guinea	Type 2 diabetes mellitus; ≥ 16 years	1267	HbA1c	Good control (HbA1C < 7.0% or < 53 mmol/mol)	Country of residence	Guinea	Odds Ratio	2.62	1.90	3.61	Residing in Guinea was significantly associated with poor glycaemic control
Osuji [68]	2018	Cross-sectional	Nigeria	Type 2 diabetes; ≥ 18 years	316	HbA1c	Good (HbA1c < 7%); poor (HbA1c ≥ 7%)	Family support	Perceived family support	Odds Ratio	112.51	46.638	271.440	Perceived family support was significantly associated with good glycaemic control
Botchway [31]	2021	Cross-sectional	Ghana	Type 2 diabetes; ≥ 18 years	254	HbA1c	No threshold	Religion	Frequency participating in religious activities	ß coefficient	− 0.22	− 0.32	− 0.12	Frequency of participating in religious activities had a significant association with good glycaemic control
Botchway [31]	2021	Cross-sectional	Ghana	Type 2 diabetes; ≥ 18 years	254	HbA1c	No threshold	Social support	Social support	ß coefficient	0.25	0.08	0.42	Social support had no significany association with glycaemic control
Botchway [31]	2021	Cross-sectional	Ghana	Type 2 diabetes; ≥ 18 years	254	HbA1c	No threshold	Alternative care	Frequency seeking traditional medicine practitioners	ß coefficient	1.40	0.92	1.88	The frequency of seeking Traditional Medicine practitioners had a significant association with poor glycaemic control

HbA1c Haemoglobin A1c, *FBG* Fasting blood glucose, *FBS* Fasting blood sugar, *FPG* Fasting plasma glucose, *MWK* Malawian Kwanza Rates (1 MWK = 0.00122305 USD), *ETB* Ethiopian Birr Rates (1 ETB = 0.0211419 USD)

Table 3 Lifestyle factors and glycaemic control in sub-Saharan Africa

First author name	Year	Study design	Study setting	Study population	Sample size	Measurement of glycemic control	Definition of glycaemic control	Generic factor	Specific factors	Measure of association	Point estimate	Lower bound	Upper bound	Association with glycemic control
Abera [88]	2022	Cross-sectional	Ethiopia	Type 2 diabetes	325	HbA1c	Good control (HbA1c < 7%); poor control (HbA1c ≥ 7%)	Dietary adherence	Poor dietary adherence	Odds Ratio	1.97	1.28	3.52	Poor dietary adherence was significantly associated with poor glycaemic control
Achila [17]	2020	Cross-sectional	Eritrea	Type 2 diabetes; 20–88 years	309	HbA1c	Poor control (HbA1c ≥ 7%)		Good dietary adherence	Odds Ratio	2.4	0.84	6.86	Following diet as prescribed is not significably associated with glycaemic control
Biru [29]	2017	Cross-sectional	Ethiopia	Type 2 diabetes; ≥ 18 years	322	FBG	Good control (FBG ≤ 110 mg/dL)			Odds Ratio	3.27	1.23	8.67	Good dietary adherence was found significantly associated with gooc glycaemic control
Eticha [36]	2016	Cross-sectional	Ethiopia	Type 2 diabetes; ≥ 18 years	384	HbA1c	Good control (HbA1c < 7%); poor control (HbA1c ≥ 7%)			Odds Ratio	0.3	0.1	0.5	Following recommended diet was significably associated with gooc glycaemic control
Fseha [40]	2017	Cross-sectional	Ethiopia	Type 2 diabetes; 22–60 years	200	FBS	Good (FBS 70–130 mg/dl), Poor (FBS > 130 mg/dl)			Odds Ratio	2.529	1.267	5.046	Taking meal appropriately was significantly associated with gooc glycaemic control

Table 3 (continued)

First author name	Year	Study design	Study setting	Study population	Sample size	Measurement of glycemic control	Definition of glycaemic control	Generic factor	Specific factors	Measure of association	Point estimate	Lower bound	Upper bound	Association with glycemic control
Mohammed [60]	2020	Cross-sectional	Ethiopia	Type 2 diabetes	307	FBG	Good control (average of last three FBG results between 70 mg/dL and 130 mg/dL)			Odds Ratio	3.56	1.75	8.23	Dietary adherence was found significantly associated with good glycemic control
Shimels [75]	2018	Cross-sectional	Ethiopia	Type 2 diabetes; ≥ 18 years	361	FPG	glycemic control (FPG: 100–130 mg/dl)			Odds Ratio	1.63	0.96	2.75	Good dietary adherence was found not significantly associated with glycaemic control
Demoz [34]	2019	Cross-sectional	Ethiopia	Type 2 diabetes; ≥ 18 years	357	HbA1c and FBG	Adequate control (average fasting blood glucose 70–130 mg/dL or HbA1c < 7%); Poor control (average fasting blood glucose > 130 or < 70 mg/dL or HbA1c > 7%)		Poor dietary adherence	Odds Ratio	3.44	0.71	1.55	Poor adherence to dietary plan was not significantly associated with glycaemic control
Doglikuu [35]	2021	Cross-sectional	Ghana	Type 2 diabetes; ≥ 18 years	530	HbA1C	Low, moderate, and high		Low adherence to diabetics' feeding recommendation	Odds Ratio	2.56	1.44	4.56	Low adherence to diabetics' feeding recommendation was associated significantly with poor glycaemic control

Table 3 (continued)

First author name	Year	Study design	Study setting	Study population	Sample size	Measurement of glycemic control	Definition of glycaemic control	Generic factor	Specific factors	Measure of association	Point estimate	Lower bound	Upper bound	Association with glycemic control
									Low adherence to fruit and vegetables		2.71	1.48	4.99	Low adherence to fruit and vegetables was associated significantly with poor glycaemic control
									Low adherence to whole grain, beans, starchy-fruits and plantain		3.29	1.81	6.02	Low adherence to whole grain, beans, starchy-fruits and plantain was associated significantly with poor glycaemic control
									Low adherence to foods prepared with walnut, canola, sunflower, cotton seed and fish oils		2.62	1.49	4.58	Low adherence to foods prepared with walnut, canola, sunflower, cotton seed and fish oils was associated significantly with poor glycaemic control

Table 3 (continued)

First author name	Year	Study design	Study setting	Study population	Sample size	Measurement of glycemic control	Definition of glycaemic control	Generic factor	Specific factors	Measure of association	Point estimate	Lower bound	Upper bound	Association with glycemic control
Fekadu [39]	2019	Cross-sectional	Ethiopia	Type 2 diabetes; 18–86 years	228	FBG	Good control (FBG: 70–130 mg/dL); poor control (< 70 mg/dL and > 130 mg/dL)		Inadequate dietary adherence	Odds Ratio	1.82	0.31	2.15	Following an healthful eating plan for 0–3 days is not significantly associated with glycaemic control
Kefale [49]	2019	Cross-sectional	Ethiopia	Type 2 diabetes; ≥ 18 years	169	FBS	Glycemic control (FBS ≤ 130 mg/dl)		No adherence to diet	Odds Ratio	0.8	1.267	5.046	No adherence to diet was found not significantly associated with glycaemic control
Mphwanthe [62]	2020	Cross-sectional	Malawi	Type 2 diabetes	428	HbA1c	Poor control (HbA1c ≥ 8%)		Number of meals	Odds Ratio	2.680	1.145	4.970	Number of meals was significantly associated with good glycaemic control
									Carbohydrates (CHO) percentage per day		1.167	1.107	1.231	CHO % of energy/day was found significantly associated with good glycaemic control
									Preventive diet score		1.015	0.730	1.412	Preventive diet score was not associated with glycaemic control

Table 3 (continued)

First author name	Year	Study design	Study setting	Study population	Sample size	Measurement of glycemic control	Definition of glycaemic control	Generic factor	Specific factors	Measure of association	Point estimate	Lower bound	Upper bound	Association with glycemic control
									Fat percentage of energy per day		1.063	0.968	1.168	Fat % of energy/day was not associated with glycaemic control
									Polyunsaturated fat (PUFA) (g/day)		1.113	0.828	1.496	PUFA (g/day) was not associated with glycaemic control
									Amount of fruit and vegetables (g/day)		0.432	0.165	1.132	Amount of fruit and vegetables (g/day) was not associated with glycaemic control
									Followed diet recommendation		0.996	0.532	1.865	Followed diet recommendation was found not significantly associated with glycaemic control
Omar [67]	2018	Cross-sectional	Sudan	Type 2 diabetes; ≥ 18 years	339	HbA1c	Good control (HbA1c < 7%); Poor control (HbA1c ≥ 7%)		Adding sugar to food	Odds Ratio	1.73	1.07	2.80	Adding sugar to food was found significantly associated with poor glycemic control

Table 3 (continued)

First author name	Year	Study design	Study setting	Study population	Sample size	Measurement of glycemic control	Definition of glycaemic control	Generic factor	Specific factors	Measure of association	Point estimate	Lower bound	Upper bound	Association with glycemic control
Abera [88]	2022	Cross-sectional	Ethiopia	Type 2 diabetes	325	HbA1c	Good control (HbA1c < 7%); Poor control (HbA1c ≥ 7%)		diet adherence of 0–3 days per week	Odds Ratio	1.97	1.28	3.52	Diet adherence of 0–3 days per week is associated with poor glycaemic control
Adeniyi [18]	2016	Cross-sectional	South Africa	Type 2 diabetes; ≥ 30 years at diagnostic of diabetes	327	HbA1c	Good control (HbA1c ≤ 7%); poor control (HbA1c > 7%); moderately poor (HbA1c = 7–8.9%); critically poor (HbA1c ≥ 9%)	Physical activity	Sedentary habits	Odds Ratio	21	7.2	61.3	Sedentary habits was found significantly associated with poor glycaemic control
Biru [29]	2017	Cross-sectional	Ethiopia	Type 2 diabetes; ≥ 18 years	322	FBG	Good control (FBG ≤ 110 mg/dL)		Practice of exercise	Odds Ratio	3.37	1.39	8.20	Adherence to exercice was associated with gooc glycaemic control
Demoz [34]	2019	Cross-sectional	Ethiopia	Type 2 diabetes; ≥ 18 years	357	HbA1c and FBG	Adequate control (average fasting blood glucose 70–130 mg/dL or HbA1c < 7%); Poor control (average fasting blcod glucose > 130 or < 70 mg/dL or HbA1c > 7%)			Odds Ratio	2.92	0.78	1.10	Exercising was found not significantly associated with glycaemic control
Eticha [36]	2016	Cross-sectional	Ethiopia	Type 2 diabetes; ≥ 18 years	384	HbA1c	Good control (HbA1c < 7%); poor control (HbA1c ≥ 7%)			Odds Ratio	0.1	0.1	0.2	Participating in physical exercise was found to be significantly associated with gooc glycaemic control

Table 3 (continued)

First author name	Year	Study design	Study setting	Study population	Sample size	Measurement of glycemic control	Definition of glycaemic control	Generic factor	Specific factors	Measure of association	Point estimate	Lower bound	Upper bound	Association with glycemic control
Shimels [75]	2018	Cross-sectional	Ethiopia	Type 2 diabetes; ≥ 18 years	361	FPG	Glycemic control (FPG: 100–130 mg/dl)			Odds Ratio	1.00	0.47	2.13	Being active was found not significantly associated with glycaemic control
Kefale [49]	2019	Cross-sectional	Ethiopia	Type 2 diabetes; ≥ 18 years	169	FBS	Glycemic control (FBS ≤ 130 mg/dl in all these most three recent measurements)			Odds Ratio	1.2	0.5	2.6	Exercising regularly was not significantly associated with glycaemic control
Fekadu [39]	2019	Cross-sectional	Ethiopia	Type 2 diabetes; 18–86 years	228	FBG	Good control (FBG: 70–130 mg/dL); poor control (< 70 mg/dL and > 130 mg/dL)		Inadequate physical activity	Odds Ratio	3.19	1.05	19.84	Doing exercise planned 0–3 days was significantly associated with poor glycaemic control (p:0.019)
Mamo [53]	2019	Case–control	Ethiopia	Type 2 diabetes with poor glycemic control (cases) and without good glycemic control (controls); > 18 years	410	FBG	Good control (average fasting blood glucose of 80–130 mg/dL); poor control (average fasting blood glucose of > 130 mg/dL)			Odds Ratio	4.79	1.70	13.53	Inadequate physical activity was significantly associated with poor glycaemic control
Fseha [40]	2017	Cross-sectional	Ethiopia	Type 2 diabetes; 22–60 years	200	FBS	Good (FBS 70–130 mg/dl), Poor (FBS > 130 mg/dl)		Moderate physical activity	Odds Ratio	2.927	1.335	6.420	Moderate physical exercise was found to be significantly associated with gooc glycaemic control

Table 3 (continued)

First author name	Year	Study design	Study setting	Study population	Sample size	Measurement of glycemic control	Definition of glycaemic control	Generic factor	Specific factors	Measure of association	Point estimate	Lower bound	Upper bound	Association with glycemic control
Mphwanthe [62]	2020	Cross-sectional	Malawi	Type 2 diabetes; ≥ 25 years	428	HbA1c	Poor control (HbA1c ≥ 8%)		Physical activity level	ß coefficient	− 0.143	− 0.186	− 0.100	Physical activity level was significantly correlated with gooc glycaemic control (p:0.001)
BeLue [128]	2016	Cross-sectional	Senegal	Type 2 diabetes	106	HbA1c	Glycemic control (HbA1c < 7%)	Smoking	Not smoking	ß coefficient	− 0.25	-1.25	0.75	Being a no smoker was not found significantly associated with glycaemic control
Fekadu [39]	2019	Cross-sectional	Ethiopia	Type 2 diabetes; 18–86 years	228	FBG	Good control (FBG: 70–130 mg/dL); poor control (< 70 mg/dL and > 130 mg/dL)		Smoking	Odds Ratio	4.51	0.00	0.50	Smoking was found significantly associated with poor glycaemic control (p:0.022)
Woldu [83]	2014	Cross-sectional	Ethiopia	Type 2 diabetes	102	FBG	Poor control (FBG level of > 126 mg/dl)			Odds Ratio	2.7	0.264	27.102	Smoking was not significantly associated with glycaemic control
Fekadu [39]	2019	Cross-sectional	Ethiopia	Type 2 diabetes; 18–86 years	228	FBG	Good control (FBG: 70–130 mg/dL); poor control (< 70 mg/dL and > 130 mg/dL)	Alcohol consumption	Acohol consumption	Odds Ratio	1.44	1.24	19.02	Alcohol consumption was not significantly associated with glycaemic control (p:0.177)

Table 3 (continued)

First author name	Year	Study design	Study setting	Study population	Sample size	Measurement of glycemic control	Definition of glycaemic control	Generic factor	Specific factors	Measure of association	Point estimate	Lower bound	Upper bound	Association with glycemic control
Biru [29]	2017	Cross-sectional	Ethiopia	Type 2 diabetes; ≥ 18 years	322	FBG	Good control (FBG ≤ 110 mg/dL)		History of alcohol consumption	Odds Ratio	0.15	0.03	0.65	The fact to ever had drunk alcohol was found significantly associated with poor glycaemic control
Kefale [49]	2019	Cross-sectional	Ethiopia	Type 2 diabetes; ≥ 18 years	169	FBS	Glycemic control (FBS ≤ 130 mg/dl)	Use of illicit substance	Use of illicit substance	Odds Ratio	0.5	0.2	1.2	Previous use of substarce was not significantly associated with glycaemic control

HbA1c Haemoglobin A1c, *FBG* Fasting blood glucose, *FBS* Fasting blood sugar, *FPG* Fasting plasma glucose

Table 4 Clinical factors and glycaemic control in sub-Saharan Africa

First author name	Year	Study design	Study setting	Study population	Sample size	Measurement of glycaemic control	Definition of glycaemic control	Generic factor	Specific factors	Measure of association	Point estimate	Lower bound	Upper bound	Association with glycemic control
Thuita [80]	2019	Cross-sectional	Kenya	Type 2 diabetes; 20–79 years	153	HbA1c	Good control (HbA1c < 7%); poor control (HbA1c > 7%)	Past history of diabetes	Existence of family history of diabetes	ß coefficient	0.119	0.066	0.874	A family history of diabetes was significantly associated with poor glycaemic control (p:0.017)
Adeniyi [18]	2016	Cross-sectional	South Africa	Type 2 diabetes; ≥ 30 years at diagnostic of DM	327	HbA1c	Good control (HbA1c ≤ 7%); poor control (HbA1c > 7%); moderately poor (HbA1c = 7–8.9%); critically poor (HbA1c ≥ 9%)	Duration of diabetes	Longer duration	Odds Ratio	35.8	4.4	294.2	Longer duration of type 2 diabetes was significantly associated with poor glycaemic control
BeLue [27]	2016	Cross-sectional	Senegal	Type 2 diabetes	106	HbA1c	Glycemic control (HbA1c < 7%)			ß coefficient	0.14	0.09	0.19	Longer duration of diabetes was significantly associated with poor glycaemic control (p < 0.05)
Botchway [31]	2021	Cross-sectional	Ghana	Type 2 diabetes; ≥ 18 years	254	HbA1c	No threshold			ß coefficient	0.04	0.02	0.06	The duration of diabetes was not significantly associated with glycaemic control
Mashele [56]	2019	Cross-sectional	South Africa	Type 2 diabetes; ≥5–74 years	176	HbA1c	Optimal control (HbA1c < 7%); poor control (HbA1c ≥ 7%)			Odds Ratio	1.011	1.37	2.624	Duration of diabetes was not significantly associated with glycaemic control (p:0.497)
Mobula [58]	2018	Cross-sectional	Ghana	hypertensive and Type 2 diabetes; ≥ 18 years	1226	HbA1c	Poor control (HBA1c ≥ 7%)			Odds Ratio	1.04	1.02	1.06	Duration of diabetes was significantly associated with poor glycaemic control (p:0.0005)
Mphwanthe [61]	2020	Cross-sectional	Malawi	Type 2 diabetes; ≥ 25 years	428	HbA1c	HbA1c clinically elevated ≥ 8%			ß coefficient	0.091	0.061	0.121	Duration of diabetes (p: .003) was significantly associated with poor glycaemic control (p: .003)

Table 4 (continued)

First author name	Year	Study design	Study setting	Study population	Sample size	Measurement of glycemic control	Definition of glycaemic control	Generic factor	Specific factors	Measure of association	Point estimate	Lower bound	Upper bound	Association with glycemic control
Omar [67]	2018	Cross-sectional	Sudan	Type 2 diabetes; ≥ 18 years	339	HbA1c	Good control (HbA1c < 7%); Poor control (HbA1c ≥ 7%)			Odds Ratio	1.04	0.99	1.10	Duration of diabetes, years was not significantly associated with glycaemic control
Mwita [65]	2019	Cross-sectional	Botswana	Type 2 diabetes; ≥ 18 years	500	HbA1c	Optimal glycaemic (HbA1c < 7%)			Odds Ratio	0.98	0.92	1.03	Diabetes duration,years was not significantly associated with glycaemic control
Belay [26]	2017	Cross-sectional	Ethiopia	Type 2 diabetes; 18–80 years	188	FPG	Good:FPG < 130 mg/dL; poor: FPG ≥ 130 mg/dL		Duration 5–10 years	Odds Ratio	2.6	1.12	6.01	Duration of diabetes 5–10 yrs was found significantly associated with poor glycaemic control
									Duration > 10 years		3.4	1.3	9.0	Duration of diabetes > 10 yrs was found significantly associated with poor glycaemic control
Camara [32]	2014	Cross-sectional	Cameroon and Guinea	Type 2 diabetes mellitus; ≥ 16 years	1267	HbA1c	Good control (HbA1C < 7.0% or < 53 mmol/mol)		Duration ≥ 3 years	Odds Ratio	2.36	1.74	3.20	Duration of diabetes of more or equal to 3 yrs was significantly associated with poor glycaemic control
Eticha [36]	2016	Cross-sectional	Ethiopia	Type 2 diabetes; ≥ 18 years	384	HbA1c	Good control (HbA1c < 7%); poor control (HbA1c ≥ 7%)		Duration ≥ 7 years	Odds Ratio	0.8	0.4	1.6	Duration of diabetes of more or equal to 7 yrs was not significantly associated with glycaemic control
Fseha [40]	2017	Cross-sectional	Ethiopia	Type 2 diabetes; 22–60 years	200	FBS	Good (FBS 70–130 mg/dl), Poor (FBS > 130 mg/dl)			Odds Ratio	0.460	0.216	1.987	Duration of diabetes of more or equal to 7 yrs was not significantly associated with glycaemic control

Table 4 (continued)

First author name	Year	Study design	Study setting	Study population	Sample size	Measurement of glycemic control	Definition of glycaemic control	Generic factor	Specific factors	Measure of association	Point estimate	Lower bound	Upper bound	Association with glycemic control
Kefale [49]	2019	Case–control	Ethiopia	Type 2 diabetes; ≥ 18 years	169	FBS	Glycemic control (FBS ≤ 130 mg/dl)		Duration ≥ 5 years	Odds Ratio	1.9	0.7	5.5	Diabetes duration of more or equal to 5 years was not significantly associated with glycaemic control
Kimando [51]	2017	Cross-sectional	Kenya	Type 2 diabetes without overt complications; ≥ 30 years	385	HbA1c	Sub-optimal control (HbA1c > 7.0%)		Duration > 5 years	Odds Ratio	1.1	0.7	1.6	Duration of diabetes of more than 5 years was not significantly associated with glycaemic control
Mamo [53]	2019	Case–control	Ethiopia	Type 2 diabetes with poor glycemic control (cases) and without good glycemic control (controls); > 18 years	410	FBG	Good control (average fasting blood glucose of 80–130 mg/dL); poor control (average fasting blood glucose of > 130 mg/dL)		Duration > 7 years	Odds Ratio	3.08	1.33	7.16	Duration of diabetes of more than 7 years was not significantly associated with glycaemic control
Mwavua [64]	2016	Cross-sectional	Kenya	Type 2 diabetes; ≥ 18 years	200	HbA1c	Good control (HbA1c < 7%); poor control (HbA1c ≥ 7%)		Duration ≤ 10 years	Odds Ratio	0.5	0.2	1.3	Diabetes duration less or equal to 10 years was not significantly associated with glycaemic control
Noor [66]	2017	Cross-sectional	Sudan	Type 2 diabetes	387	HbA1c	Controlled < 7% Uncontrolled > 7%		Duration ≥ 5 years	Odds Ratio	0.505	0.223	1.145	Diabetes duration of 5 years or more was not significantly associated with glycaemic control
Otieno [69]	2017	Cross-sectional	Kenya	Type 2 diabetes; ≥ 30 years	220	HbA1c	Good control (HbA1c ≤ 7%); poor/suboptimal (HbA1c > 7%)		Duration 5–10 years	Odds Ratio	2.5	0.4	14.4	In patients with comorbid depression, duration of diabetes 5–10 years was not significantly associated with glycemic control

Table 4 (continued)

First author name	Year	Study design	Study setting	Study population	Sample size	Measurement of glycemic control	Definition of glycaemic control	Generic factor	Specific factors	Measure of association	Point estimate	Lower bound	Upper bound	Association with glycemic control
									Duration > 10 years		1.3	0.3	5.3	In patients with comorbid depression, duration of diabetes > 10 years was not significantly associated with glycemic control
									Duration 5–10 years		1.0	0.4	2.1	In patients without depression, duration of diabetes 5–10 years was not significantly associated with glycemic control
									Duration > 10 years		1.9	0.8	4.6	In patients without depression, duration of diabetes > 10 years was not significantly associated with glycemic control
Rwegerera [73]	2019	Cross-sectional	Botswana	Type 2 diabetes	368	HbA1c	desirable (< 7%); suboptimal (7–9%); poor (≥ 9%)		5–10 years	Odds Ratio	0.34	0.13	0.86	Having a duration of diabetes of 5–10 yrs was associated with poor glycaemic control
									>10 years		0.42	0.15	1.15	Having a duration of diabetes of more than 10 yrs was not associated with glycaemic control
Tefera [77]	2020	Cross-sectional	Ethiopia	Type 2 diabetes; ≥ 18 years	400	FPG	Controlled (FPG:80–130 mg/dl)		Duration 5–10 years	Odds Ratio	1.95	0.87	4.40	Duration of diabetes 5–10 years was found not significantly associated with glycaemic control
									Duration > 10 years		2.86	0.99	8.23	Duration of diabetes > 10 years was found not significantly associated with glycaemic control

Table 4 (continued)

First author name	Year	Study design	Study setting	Study population	Sample size	Measurement of glycemic control	Definition of glycaemic control	Generic factor	Specific factors	Measure of association	Point estimate	Lower bound	Upper bound	Association with glycemic control
Tekalegn [78]	2018	Cross-sectional	Ethiopia	Type 2 diabetes; ≥ 15 years	422	FBG	Good control (average FBG:70–130 mg/dL); poor control (average FBG > 130 or < 70 mg/dL)		Duration 5–10 years	Odds Ratio	2.72	1.16	6.32	Duration of diabetes from 5 to 10 years was significantly associated with poor glycaemic control
									Duration > 10 years		1.7	0.8	3.7	Duration of diabetes > 10 years was not significantly associated with glycaemic control
Abera [88]	2022	Cross-sectional	Ethiopia	Type 2 diabetes	325	HbA1c	Good control (HbA1c < 7%); Poor control (HbA1c ≥ 7%)		Duration > 10 years	Odds Ratio	3.15	2.22	6.54	Significant association between diabetes duration of more than 10 years and poor glycaemic control
Abebe [89]	2022	Cross-sectional	Ethiopia	Type 2 diabetes; > 18 years	138	FBG	Controlled (FPG:80–130 mg/dl)		≥ 10 years	Odds Ratio	2.6	0.85	8.23	No significant relationship between duration of 10 years and more, and glycaemic control
									5–10 years		0.5	0.17	1.53	No significant relationship between duration of 5–10 years ard glycaemic control
Fekadu [39]	2019	Cross-sectional	Ethiopia	Type 2 diabetes; 18–86 years	228	FBG	Good control (FBG: 70–130 mg/dL); poor control (< 70 mg/dL and > 130 mg/dL)	Duration of treatment	Treatment > 10 years	Odds Ratio	3.94	1.51	27.83	Longer duration of diabetes treatment > 10 years was significantly associated with poor glycaemic control (p:0.012)
									Treatment 5–10 years		1.19	1.06	26.24	Duration of treatment of 5–10 years was not associated with glycaemic control (p:0.642)
Rwegerera [73]	2019	Cross-sectional	Botswana	Type 2 diabetes	368	HbA1c	desirable (< 7%); suboptimal (7–9%); poor (≥ 9%)		Treatment < 3 years	Odds Ratio	1.54	0.68	3.45	Being on treatment at block 6 Clinic few than 3 yrs was not associated with glycaemic control

Table 4 (continued)

First author name	Year	Study design	Study setting	Study population	Sample size	Measurement of glycemic control	Definition of glycaemic control	Generic factor	Specific factors	Measure of association	Point estimate	Lower bound	Upper bound	Association with glycemic control
Shimels [75]	2018	Cross-sectional	Ethiopia	Type 2 diabetes; ≥ 18 years	361	FPG	Good control (FPG: 100–130 mg/dl)		Treatment ≥ 11 years	Odds Ratio	0.83	0.37	1.83	Treatment duration ≥ 11 yrs was not significantly associated with glycaemic control
									Treatment 6–10 years		0.82	0.43	1.56	Treatment duration 6–10 yrs was not significantly associated with glycaemic control
Yigazu [85]	2017	Cross-sectional	Ethiopia	Type 2 diabetes; 18–80 years	174	FBG	Controlled (average FBG: 80–130 mg/dL); Uncontrolled (average FBG > 130 or < 70 mg/dL)		Treatment < 5 years	Odds Ratio	2.03	0.85	4.84	Duration of treatment < 5 years was not significantly associated with glycaemic control
Mphwanthe [61]	2020	Cross-sectional	Malawi	Type 2 diabetes; ≥ 25 years	428	HbA1c	Poor control (HbA1c ≥ 8%)	Self-report of glycaemic control	Fluctuating/unstable blood glucose levels	ß coefficient	1.760	1.479	2.041	Always having fluctuating/unstable blood glucose levels (p: < .001) was significantly associated with poor glycaemic control (p: < .00˙)
Mphwanthe [61]	2020	Cross-sectional	Malawi	Type 2 diabetes; ≥ 25 years	428	HbA1c	Poor control (HbA1c ≥ 8%)		No improvement of blood glucose levels from diagnosis	ß coefficient	0.968	0.621	1.307	Having blood glucose levels not improved from diagnosis was significantly associated with poor glycaemic control (p:0.004)
Mamo [53]	2019	Case–control	Ethiopia	Type 2 diabetes with poor glycemic control (cases) and without good glycemic control (controls); > 18 years	410	FBG	Good control (average fasting blood glucose of 80–130 mg/dL); poor control (average fasting blood glucose of > 130 mg/dL)	Presence of comorbidities	Presence of comorbidities	Odds Ratio	2.56	1.10	5.96	The presence of comorbidity was significantly associated with poor glycaemic control
Shimels [75]	2018	Cross-sectional	Ethiopia	Type 2 diabetes; ≥ 18 years	361	FPG	Glycemic control (FPG: 100–130 mg/dl)			Odds Ratio	0.16	0.09	0.27	The presence of comorbidity was significantly associated with poor glycaemic control

Table 4 (continued)

First author name	Year	Study design	Study setting	Study population	Sample size	Measurement of glycemic control	Definition of glycaemic control	Generic factor	Specific factors	Measure of association	Point estimate	Lower bound	Upper bound	Association with glycemic control
Tefera [77]	2010	Cross-sectional	Ethiopia	Type 2 diabetes; ≥ 18 years	400	FPG	Controlled (FPG:8C–130 mg/dl)			Odds Ratio	0.33	0.15	0.73	The presence of morbidity was significantly associated with poor glycaemic control
Yosef [87]	2021	Cross-sectional	Ethiopia	Type 2 diabetes; ≥ 18 years	245	FBG	Good control (FBG:70–130 mg/dL)			Odds Ratio	1.61	0.8	3.22	The presence of comorbidity was significantly associated with poor glycaemic control
Botchway [31]	2021	Cross-sectional	Ghana	Type 2 diabetes; ≥ 18 years	254	HbA1c	No threshold	Number of comorbidities	Number of comorbidities	ß coefficient	0.15	− 0.13	0.43	The number of type 2 diabetes comorbidities was not significantly associated with glycaemic control
Otieno [69]	2017	Cross-sectional	Kenya	Type 2 diabetes; ≥ 30 years	220	HbA1c	Good control (HbA1c ≤ 7%); poor/suboptimal (HbA1c > 7%)		Having 1 comorbidity in comorbid depression	Odds Ratio	1.6	0.2	15.1	In patients with depression, having 1 comorbidity was not significantly associated with glycaemic control
									Having 2 or more in comorbid depression		1.4	0.4	5.7	In patients with depression, having 2 or more comorbidities was not significantly associated with glycaemic control
									Having 1 comorbidity in patients without depression		1.1	0.3	4.1	In patients without depression, having 1 comorbidity was not significantly associated with glycaemic control
									Having 2 or more in patients without depression		5.2	0.6	43.1	In patients wihtout depression, having 2 or more comorbidities was not significantly associated with glycaemic control

Table 4 (continued)

First author name	Year	Study design	Study setting	Study population	Sample size	Measurement of glycemic control	Definition of glycaemic control	Generic factor	Specific factors	Measure of association	Point estimate	Lower bound	Upper bound	Association with glycemic control
Achila [17]	2020	Cross-sectional	Eritrea	Type 2 diabetes; 20–88 years	309	HbA1c	Poor control (HbA1c ≥ 7%)	Hyper-tension	Absence of hyper-tension	Odds Ratio	1.94	1.06	3.56	The absence of hypertension was significantly associated with poor glycaemic control
BeLue [27]	2016	Cross-sectional	Senegal	Type 2 diabetes	106	HbA1c	Glycemic control (HbA1c < 7%)			ß coefficient	0.76	− 0.18	1.7	The absence of hypertension was not significantly with glycaemic control
Eticha [36]	2016	Cross-sectional	Ethiopia	Type 2 diabe-tes; ≥ 18 years	384	HbA1c	Good control (HbA1c < 7%); poor control (HbA1c ≥ 7%)		Presence of hyper-tension	Odds Ratio	2.2	1.1	4.4	The presence of hypertension was associated significantly with poor glycaemic control
Mobula [58]	2018	Cross-sectional	Ghana	hypertensive and Type 2 diabe-tes; ≥ 18 years	1226	HbA1c	Poor control (HBA1c ≥ 7%)			Odds Ratio	0.69	0.50	0.95	Dual diagnosis of diabetes and hypertension was significantly associated with good glycaemic control
Demoz [34]	2019	Cross-sectional	Ethiopia	Type 2 diabe-tes; ≥ 18 years	357	HbA1c and FBG	Adequate control (average fasting blood glucose 70–130 mg/dL or HbA1c < 7%); Poor control (average fasting blood glucose > 130 or < 70 mg/dL or HbA1c > 7%)		Uncontrolled blood pressure	Odds Ratio	4.51	0.89	1.94	Uncontrolled BP was not found significantly associated with glycaemic control
Rwegerera [73]	2019	Cross-sectional	Ethiopia	Type 2 diabetes	368	HbA1c	Desirable (< 7%); suboptimal (7–9%); poor (≥ 9%)			Odds Ratio	1.04	0.67	1.59	Uncontrolled BP was not found significantly associated with glycaemic control
Anioke [22]	2019	Cross-sectional	Nigeria	Type 2 diabe-tes; ≥ 30 years	140	HbA1c	Good control (HbA1c < 7%); poor control (HbA1c ≥ 7%)		High systolic blood pressure	Odds Ratio	1.01	0.98	1.05	High systolic blood pressure was not significantly associated with glycaemic control

Table 4 (continued)

First author name	Year	Study design	Study setting	Study population	Sample size	Measurement of glycemic control	Definition of glycaemic control	Generic factor	Specific factors	Measure of association	Point estimate	Lower bound	Upper bound	Association with glycemic control
Mwita [65]	2019	Cross-sectional	Botswana	Type 2 diabetes; ≥ 18 years	500	HbA1c	Optimal glycaemic (HbA1c < 7%)		Optimal hypertension	Odds Ratio	1.61	0.63	4.13	Optimal hypertension control was not significantly associated with glycaemic control
Adeniyi [18]	2016	Cross-sectional	South Africa	Type 2 diabetes; ≥ 30 years at diagnostic of diabetes	327	HbA1c	Good control (HbA1c ≤ 7%); poor control (HbA1c > 7%); moderately poor (HbA1c = 7–8.9%); critically poor (HbA1c ≥ 9%)	Dyslipidemia	Elevated LDL	Odds Ratio	10.3	4.4	23.8	Elevated low-density lipoprotein cholesterol was significantly associated with poor glycaemic control
Demoz [34]	2019	Cross-sectional	Ethiopia	Type 2 diabetes; ≥ 18 years	357	HbA1c and FBG	Adequate control (average fasting blood glucose 70–130 mg/dL or HbA1c < 7%); Poor control (average fasting blood glucose > 130 or < 70 mg/dL or HbA1c > 7%)		Poor lipid control	Odds Ratio	2.13	0.57	1.34	Poor lipid control was not significantly associated with glycaemic control
Eticha [36]	2016	Cross-sectional	Ethiopia	Type 2 diabetes; ≥ 18 years	384	HbA1c	Good control (HbA1c < 7%); poor control (HbA1c ≥ 7%)		Presence of dyslipidemia	Odds Ratio	1.5	0.8	2.8	Presence of dyslipidemia was not significantly associated with glycaemic control
Mamo [53]	2019	Case–control	Ethiopia	Type 2 diabetes with poor glycemic control (cases) and without good glycemic control (controls); > 18 years	410	FBG	Good control (average fasting blood glucose of 80–130 mg/dL); poor control (average fasting blood glucose of > 130 mg/dL)		High Total Cholesterol	Odds Ratio	3.62	1.46	8.97	Total cholesterol ≥ 200 mg/dl was significantly associated with poor glycaemic control
Mwita [65]	2019	Cross-sectional	Botswana	Type 2 diabetes; ≥ 18 years	500	HbA1c	Optimal glycaemic (HbA1c < 7%)		Optimal LDL-C control	Odds Ratio	2.20	0.64	7.57	Optimal LDL-C-control was not significantly associated with glycaemic control
Noor [66]	2017	Cross-sectional	Sudan	Type 2 diabetes	387	HbA1c	Controlled < 7% Uncontrolled > 7%		Elevated Triglycerides	Odds Ratio	0.879	0.353	2.188	TG level > 150 was not significantly associated with glycaemic control

Table 4 (continued)

First author name	Year	Study design	Study setting	Study population	Sample size	Measurement of glycemic control	Definition of glycaemic control	Generic factor	Specific factors	Measure of association	Point estimate	Lower bound	Upper bound	Association with glycemic control
Woldu [83]	2014	Cross-sectional	Ethiopia	Type 2 diabetes	102	FBG	Poor control (FBG level of > 126 mg/dl)		Hyperlipidemia	Odds Ratio	5	1.145	20.462	Hyperlipidemia was significantly associated with poor glycaemic control
Abebe [89]	2022	Cross-sectional	Ethiopia	Type diabetes, > 18 years	138	FBG	Good control (mean FBG:80–130 mg/dl); poor control (FBG < 80 mg/dl or > 130 mg/dl)	Body mass index	Obesity	Odds Ratio	4.1	1.2	14.11	Significant association between being obesity and poor glycaemic control
									Overweight	Odds Ratio	1.7	0.49	6.32	No significant association between being overweight and poor glycaemic control
Adeniyi [18]	2016	Cross-sectional	South Africa	Type 2 diabetes; ≥ 30 years at diagnostic of diabetes	327	HbA1c	Good control (HbA1c ≤ 7%); poor control (HbA1c > 7%); moderately poor (HbA1c = 7–8.9%); critically poor (HbA1c ≥ 9%)		Overweight/obesity	Odds Ratio	22.3	1.9	261.2	Overweight/obesity was significantly associated with poor glycaemic control
BeLue [27]	2016	Cross-sectional	Senegal	Type 2 diabetes	106	HbA1c	Glycemic control (HbA1c < 7%)		BMI	ß coefficient	− 0.10	− 0.17	− 0.03	BMI was not significantly associated with glycaemic control
Demoz [34]	2019	Cross-sectional	Ethiopia	Type 2 diabetes; ≥ 18 years	357	HbA1c and FBG	Adequate control (average fasting blood glucose 70–130 mg/dL or HbA1c < 7%); Poor control (average fasting blood glucose > 130 or < 70 mg/dL or HbA1c > 7%)		Obesity	Odds Ratio	1.68	1.01	2.55	Obesity was singificantly associated with poor glycaemic control
									Overweight		3.51	1.82	4.01	Being overweight was not significantly associated with glycaemic control

Table 4 (continued)

First author name	Year	Study design	Study setting	Study population	Sample size	Measurement of glycemic control	Definition of glycaemic control	Generic factor	Specific factors	Measure of association	Point estimate	Lower bound	Upper bound	Association with glycemic control
Eticha [35]	2016	Cross-sectional	Ethiopia	Type 2 diabetes; ≥ 18 years	384	HbA1c	Good control (HbA1c < 7%); poor control (HbA1c ≥ 7%)		Normal BMI	Odds Ratio	0.3	0.1	1.8	Having a normal BMI was not significantly associated with glycaemic control
									Overweight		0.8	0.1	4.6	Being overweight was not significantly associated with glycaemic control
Kamuhabwa [47]	2014	Cross-sectional	Tanzania	Type 2 diabetes; ≥ 18 years	469	FBG	Good control (FBG ≤ 130 mg/dL or 7.2 mmol/L); poor control (FBG > 130 mg/dL or 7.2 mmol/L)		Obesity	Odds Ratio	2.347	1.274	4.324	Being obese was significantly associated with poor glycaemic control
									Normal BMI		2.234	1.278	3.904	Having a normal BMI was significantly associated with poor glycaemic control
Mphwanthe [61]	2020	Cross-sectional	Malawi	Type 2 diabetes; ≥ 25 years	428	HbA1c	HbA1c clinically elevated ≥ 8%		Underweight	ß coefficient	2.330	1.645	3.015	Underweight status was significantly associated with poor glycaemic control (p: .001)
									Overweight/obesity		− 0.143	− 0.419	0.133	Overweight/obese status was not significantly associated with glycaemic control (p: .605)
Otieno [69]	2017	Cross-sectional	Kenya	Type 2 diabetes; ≥ 30 years	220	HbA1c	Good control (HbA1c ≤ 7%); poor/suboptimal (HbA1c > 7%)		Overweight/obesity in patients with depression	Odds Ratio	1.7	0.4	6.5	In patients with depression, being overweight/obese (AOR:1.7 (0.4–6.5)) was not significantly associated with glycaemic control

Table 4 (continued)

First author name	Year	Study design	Study setting	Study population	Sample size	Measurement of glycemic control	Definition of glycaemic control	Generic factor	Specific factors	Measure of association	Point estimate	Lower bound	Upper bound	Association with glycemic control
									Overweight/ obesity in patients without depression		2.0	1.0	4.0	In patients without depression, being overweight/obese was significantly associated with poor glycaemic control
Rwegerera [73]	2019	Cross-sectional	Botswana	Type 2 diabetes	368	HbA1c	Desirable (< 7%); suboptimal (7–9%;; poor (≥ 9%)		Overweight/ Obese	Odds Ratio	1.38	0.53	3.59	Being overweight/ obese was not significantly associated with glycaemic control
Yosef [87]	2021	Cross-sectional	Ethiopia	Type 2 diabetes; ≥ 18 years	245	FBG	Good control (FBG:70–130 mg/dL)		Overweight	Odds Ratio	2.6	1.32	5.1	Being overweight was not significantly associated with poor glycaemic control
									Obese	Odds Ratio	3.44	1.44	8.21	Being obese was not significantly associated with poor glycaemic control
Achila [17]	2020	Cross-sectional	Eritrea	Type 2 diabetes; 20–88 years	309	HbA1c	Poor control (HbA1c ≥ 7%)	WHR/WC	Abnormal WHR	Odds Ratio	3.01	1.15	7.92	Abnormal WHR was associated significantly with poor glycaemic control
Anioke [22]	2019	Cross-sectional	Nigeria	Type 2 diabetes; ≥ 30 years	140	HbA1c	Good control (HbA1c < 7%); poor control (HbA1c ≥ 7%)		Low WHR	Odds Ratio	2.65	0.42	16.88	Low WHR was not significantly associated with glycaemic control
									Medium WHR		1.82	0.47	6.98	Medium WHR was not significantly associated with glycaemic control
BeLue [27]	2016	Cross-sectional	Senegal	Type 2 diabetes	106	HbA1c	Glycemic control (HbA1c < 7%)		Waist circumference	ß coefficient	0.04	0.03	0.05	Waist circumference was not significantly associated with glycaemic control
Blum [30]	2019	Cross-sectional	D R Congo	Type 2 diabetes; ≥ 18 years	319	HbA1c	Poor control (HbA1c ≥ 9%)		Abdominal obesity	Odds Ratio	0.61	0.33	1.12	Abdominal obesity was not significantly associated with glycaemic control

Table 4 (continued)

First author name	Year	Study design	Study setting	Study population	Sample size	Measurement of glycemic control	Definition of glycaemic control	Generic factor	Specific factors	Measure of association	Point estimate	Lower bound	Upper bound	Association with glycemic control
Mamo [53]	2019	Case–control	Ethiopia	Type 2 diabetes with poor glycemic control (cases) and without good glycemic control (controls); > 18 years	410	FBG	Good control (average fasting blood glucose of 80–130 mg/dL); poor control (average fasting blood glucose of > 130 mg/dL)		High WHR	Odds Ratio	3.52	1.23	10.11	Waist to hip ratio of 0.9 or greater for male and 0.85 or greater for female was significantly associated with poor glycaemic control
Mashele [56]	2019	Cross-sectional	South Africa	Type 2 diabetes; 35–74 years	176	HbA1c	Optimal control (HbA1c < 7%); poor control (HbA1c ≥ 7%)		Increased WC	Odds Ratio	1.089	1.030	1.151	Increased waist circumference was significantly associated with poor glycaemic control
Adejumo [17]	2012	cross-sectional	Nigeria	type 2 diabetes with normal renal function; ≥ 18 years	72	HbA1c	good control (HbA1c ≤ 7.5%); poor control (HbA1c > 7.5%)	Other comorbidities	Incidence of anaemia	Odds Ration	10.8	1.28	91.20	Incidence of aneamia was significantly associated with poor glycemic Control (p < 0.05)
Afolabi [19]	2018	cross-sectional	Nigeria	type 2 diabetes; 40–80 years	80	HbA1c	Good control (< 7%); poor control (≥ 7%)		Presence of Non Alcoholic Fatty Liver Disease	Odds Ratio	3.473	1.017	11.864	Non alcoholic Fatty Liver Disease was sgnificantly associated with poor glycaemic control (p:0.047)
Akabwai [20]	2016	Cross-sectional	Uganda	Type 2 diabetes; ≥ 18 years	280	HbA1c	Good control (< 7%); poor control (≥ 7%)		Presence of vitamin B12 deficiency	Odds Ratio	3.29	1.44	7.51	Presence of vitamin B12 deficiency was significantly associated with poor glycaemic control (p: 0.005))
Akpalu [21]	2018	Cross-sectional	Ghana	Type 2 diabetes; 30–65 years	400	HbA1c	Good control (HbA1c < 7%)		Presence of depression	Odds Ratio	1.04	0.85	2.29	Presence of depression was not significantly associated with glycaemic control
Biadgo [28]	2018	Cross-sectional	Ethiopia	Type 2 diabetes	159	FBS	Adequate control (FBS ≤ 130 mg/dl); poor control (FBS > 130 mg/dl)		Metabolic syndrome	Odds Ratio	2.53	1.01	6.32	Metabolic syndrome (IDF criteria) was significantly associated with poor glycaemic control

Table 4 (continued)

First author name	Year	Study design	Study setting	Study population	Sample size	Measurement of glycemic control	Definition of glycaemic control	Generic factor	Specific factors	Measure of association	Point estimate	Lower bound	Upper bound	Association with glycemic control
Dagnew [33]	2017	Comparative Cross-sectional	Ethiopia	Type 2 diabetes and healthy relatives; ≥ 30 years	210	FBG	FBG < 126 mg/dl versus FBG ≥ 126 mg/dl		Presence of cognitive impairment	Odds Ratio	4.43	1.14	17.18	Poor glycaemic control was significantly associated with the presence of cognitive impairment
Kalain [46]	2015	Cross-sectional	South Africa	Type 2 diabetes; ≥ 18 years	200	HbA1c	Good control (HbA1c < 7%)		Presence of Congestive Cardiac Failure (CCF)	Odds Ratio	3.172564			Presence of CCF was associated with glycaemic control (p:0.035); 95% CI not provided
Khoza [50]	2018	Case control	South Africa	Type 2 diabetes; > 30 years	320	HbA1c and glucose	No threshold		HIV infection	β coefficient	0.040			HIV-positive was significantly associated with poor glycaemic control (p:0.01); 95% CI not provided
										Odds Ratio	4.29	1	18.32	HIV-negative status was not associated with glycaemic control
Sarfo-Kantanka [74]	2017	Case–control	Ghana	Type 2 diabetes; 40–80 years	302	FBG and HbA1c	No threshold		Thyroid autoimmunity	Odds Ratio	1.46	1.23	1.73	Poor glycaemic control (p < 0.0001) was significantly associated with thyroid autoimmunity (p < 0.0001)
Woldu [83]	2014	Cross-sectional	Ethiopia	Type 2 diabetes	102	FBG	Poor control (FBG level of > 126 mg/dl)		Presence of dyspesia	Odds Ratio	4	0.026	6.000	Presence of dyspepsia was not significantly associated with glycaemic control
Demoz [34]	2019	Cross-sectional	Ethiopia	Type 2 diabetes; ≥ 18 years	357	HbA1c and FBG	Adequate control (average fasting blood glucose 70–130 mg/dL or HbA1c < 7%); Poor control (average fasting blood glucose > 130 or < 70 mg/dL or HbA1c > 7%)	Complications	Presence of complications	Odds Ratio	2.0	0.69	1.06	Presence of complications was not associated with glycaemic control

Table 4 (continued)

First author name	Year	Study design	Study setting	Study population	Sample size	Measurement of glycemic control	Definition of glycaemic control	Generic factor	Specific factors	Measure of association	Point estimate	Lower bound	Upper bound	Association with glycemic control
Rwegerera [73]	2019	Cross-setc-tional	Ethiopia	Type 2 diabetes	368	HbA1c	desirable (< 7%); suboptimal (7–9%); poor (≥ 9%)			Odds Ratio	0.76	0.44	1.3	Absence of complication was not associated with glycaemic control
Tefera [77]	2020	Cross-sectional	Ethiopia	Type 2 diabe-tes; ≥ 18 years	400	FPG	Controlled (FPG:8C–130 mg/dl)			Odds Ratio	0.77	0.26	2.34	Presence of complications was not significantly associated with glycaemic control
Eticha [36]	2016	Cross-sectional	Ethiopia	Type 2 diabe-tes; ≥ 18 years	384	HbA1c	Good control (HbA1c < 7%); poor control (HbA1c ≥ 7%)		Presence of renal disease	Odds Ratio	0.9	0.4	2.2	Presence of renal disease was not significantly associated with glycaemic control
Eticha [36]	2016	Cross-sectional	Ethiopia	Type 2 diabe-tes; ≥ 18 years	384	HbA1c	Good control (HbA1c < 7%); poor control (HbA1c ≥ 7%)		Presence of DKA	Odds Ratio	2.6	0.9	7.1	Presence of DKA was not signifi-cantly associated with glycaemic control
Woldu [83]	2014	Cross-sectional	Ethiopia	Type 2 diabetes	102	FBG	Poor control (FBG level of > 126 mg/dl)			Odds Ratio	0.6	0.015	22.402	Presence of DKA was not signifi-cantly associated with glycaemic control
Eticha [36]	2016	Cross-sectional	Ethiopia	Type 2 diabe-tes; ≥ 18 years	384	HbA1c	Good control (HbA1c < 7%); poor control (HbA1c ≥ 7%)		Presence of peripheral neu-ropathy	Odds Ratio	1.1	0.5	2.2	Presence of periph-eral neuropathy was not signifi-cantly associated with glycaemic control
Woldu [83]	2014	Cross-sectional	Ethiopia	Type 2 diabetes	102	FBG	Poor control (FBG level of > 126 mg/dl)			Odds Ratio	579	1`6.8	2870	Presence of periph-eral neuropathy was significanty associated with poor glycaemic control
Mohamed [59]	2013	Case–control	Sudan	Type 2 diabetes and non-diabetic controls	457	HbA1c	Well-controlled (HbA1c < 8%); poorly controlled (HbA1c > 8%)		High levels of mobility index	Odds Ratio	2.60	1.21	5.55	Poor glycaemic control was signifi-cantly associated with high levels of mobility index

Table 4 (continued)

First author name	Year	Study design	Study setting	Study population	Sample size	Measurement of glycemic control	Definition of glycaemic control	Generic factor	Specific factors	Measure of association	Point estimate	Lower bound	Upper bound	Association with glycemic control
Gebremedhin [42]	2019	Cross-sectional	Ethiopia	Type 2 diabetes; ≥ 18 years	267	FBG	No threshold	Examination findings	Health related quality of life	ß coefficient	− 0.08	− 0.12	− 0.04	Overall health related quality of life was inversely associated and FBG (p < 0.001)
Oyewole [70]	2019	Cross-sectional	Nigeria	Type 2 diabetes; ≥ 21 years	162	HbA1c and FBG	No threshold		Global disability burden	ß coefficient	0.061	0.057	0.067	Disability burden was significantly associated with poor glycaemic control (p: 0.001)
Ramkisson [72]	2016	Cross-sectional	South Africa	Type 2 diabetes; ≥ 18 years	401	HbA1c	No threshold		Diabetes related distress	Odds Ratio	1.04	1.00	1.09	Diabetes related distress was not significantly associated with glycaemic control
Achila [17]	2020	Cross-sectional	Eritrea	Type 2 diabetes; 20–88 years	309	HbA1c	Poor control (HbA1c ≥ 7%)	Laboratory findings	estimated Glomerular Filtration Rate (eGFR)	Odds Ratio	0.99	0.98	1	A unit reduction in eGFR was also associated with HbA1c ≥ 7% (p:0:031))
Mwita [65]	2019	Cross-sectional	Botswana	Type 2 diabetes; ≥ 18 years	500	HbA1c	Optimal glycaemic (HbA1c < 7%)			Odds Ratio	1.00	0.99	1.02	No significant association between eGFR and glycaemic control (p: 0.412)
Inih [45]	2018	Cross-sectional	Nigeria	Type 2 diabetes; men	164	HbA1c	Poor control (HbA1c > 7%)		Hypogonadism	Odds Ratio	3.85	0.13	0.55	Poor glycaemic control was significantly associated with hypogonadism (p < 0.001)
									Low sperm count		0.118	− 5.85	5.61	No significant association between low sperm count with HbA1c (p:0.97)

HbA1c Haemoglobin A1c, *FBG* Fasting blood glucose, *FBS* Fasting blood sugar, *FPG* Fasting plasma glucose

Table 5 Adherence to treatment plans and glycaemic control in sub-Saharan Africa

First author name	Year	Study design	Study setting	Study population	Sample size	Measurement of glycemic control	Definition of glycemic control	Generic factor	Specific factors	Measure of association	Point estimate	Lower bound	Upper bound	Association with glycemic control
Yigazu [85]	2017	Cross-sectional	Ethiopia	Type 2 diabetes; 18–80 years	174	FBG	Controlled (average FBG: 80–130 mg/dL); Uncontrolled (average FBG > 130 or < 70 mg/dL)	Adherence to follow-up	Adherence to regular follow-up	Odds Ratio	2.42	1.08	5.44	Adherence to regular follow-up was associated with good glycaemic control
Kefale [49]	2019	Case–control	Ethiopia	Type 2 diabetes; ≥ 18 years	169	FBS	glycemic control (FBS ≤ 130 mg/dl in all these most three recent measurements)		Having regular diabetic care follow up of every > 1 month	Odds Ratio	0.4	0.2	0.9	Having regular diabetic care follow up of every > 1 month was negatively associated with poor glycaemic control
Abebe [89]	2022	Cross-sectional	Ethiopia	Type 2 diabetes; > 18 years	138	FBG	Good control (mean FBG:80–130 mg/dl); poor control (FBG < 80 mg/dl or > 130 mg/dl)	Adherence to treatment	Drug adherence	Odds Ratio	3.08	1.22	7.08	Absence of drug adherence was significantly associated with poor glycaemic control
Demoz [34]	2019	Cross-sectional	Ethiopia	Type 2 diabetes; ≥ 18 years	357	HbA1c and FBG	Adequate control (average fasting blood glucose 70–130 mg/dL or HbA1c < 7%); Poor control (average fasting blood glucose > 130 or < 70 mg/dL or HbA1c > 7%)		Low medication adherence	Odds Ratio	5.10	1.18	6.55	Low adherence was significanty associated with poor glycaemic control
Kamuhabwa [47]	2014	Cross-sectional	Tanzania	Type 2 diabetes; ≥ 18 years	469	FBG	Good control (FBG ≤ 130 mg/dL or 7.2 mmol/L); poor control (FBG > 130 mg/dL or 7.2 mmol/L)		Low medication adherence	Odds Ratio	2.084	1.069	4.060	Low medication adherence was significantly associated with poor glycaemic control

Table 5 (continued)

First author name	Year	Study design	Study setting	Study population	Sample size	Measurement of glycemic control	Definition of glycemic control	Generic factor	Specific factors	Measure of association	Point estimate	Lower bound	Upper bound	Association with glycemic control
Kassahun [48]	2016	Cross-sectional	Ethiopia	Type 2 diabetes; ≥ 18 years	309	FBG	Poor control (mean FBG > 130 mg/dl)		Low medication adherence	Odds Ratio	5.08	2.02	12.79	Low adherence was significantly associated with poor glycaemic control
									Medium medication adherence		3.49	1.72	7.09	Medium adherence was significantly associated with poor glycaemic control
Yimam [86]	2020	Cross-sectional	Ethiopia	Type 2 diabetes with hypertension; ≥ 18 years	300	FBG	Good control (mean FBG:80–130 mg/dl); poor control (FBG < 80 mg/dl or > 130 mg/dl)		Low medication adherence	Odds Ratio	4.26	1.70	10.65	Low adherence to treatment was significantly associated with poor glycaemic control
									Medium medication adherence		2.43	0.97	6.07	Medium adherence to medication was not associated with glycaemic control
Mamo [53]	2019	Case–control	Ethiopia	Type 2 diabetes with poor glycemic control (cases) and without good glycemic control (controls); > 18 years	410	FBG	Good control (average fasting blood glucose of 80–130 mg/dL); poor control (average fasting blood glucose of > 130 mg/dL)		No adherence to medication	Odds Ratio	0.67	0.26	1.69	No adherence to antidiabetic medication was not associated with glycaemic control
Fseha [40]	2017	Cross-sectional	Ethiopia	Type 2 diabetes; 22–60 years	200	FBS	Good (FBS 70–130 mg/dl), Poor (FBS > 130 mg/dl)		Good medication adherence	Odds Ratio	2.033	1.025	4.034	Medical adherence was associated with good glycaemic control (p:0.001)
Shimels [75]	2018	Cross-sectional	Ethiopia	Type 2 diabetes; ≥ 18 years	361	FPG	glycemic control (FPG: 100–130 mg/dl)		Good medication adherence	Odds Ratio	1.38	0.62	3.09	Good medical adherence was not associated with glycaemic control

Table 5 (continued)

First author name	Year	Study design	Study setting	Study population	Sample size	Measurement of glycemic control	Definition of glycemic control	Generic factor	Specific factors	Measure of association	Point estimate	Lower bound	Upper bound	Association with glycemic control
Tefera [77]	2020	Cross-sectional	Ethiopia	Type 2 diabetes; ≥ 18 years	400	FPG	Controlled (FPG:80–130 mg/dl)		Good medication adherence	Odds Ratio	1.61	1.04	4.79	Good adherence level was significantly associated with good glycaemic control
									Intermediate adherence		0.19	0.06	0.59	Intermediate adherence wes not associated with glycaemic control
Teklay [79]	2013	Cross-sectional	Ethiopia	Type 2 diabetes;≥ 18 years	267	FBG	Controlled (average FBG: 70–130 mg/dl), Uncontrolled (average FBG > 130 mg/dl)		Good medication adherence		1.469	0.732	2.949	Poor glycaemic control was not associated with adherence to treatment (p:0.280)
Id [44]	2021	Cross-sectional	Ethiopia	Type 2 diabetes; > 18 years	394	FBS	Good blood glucose control (< 154 mg/dl); Poor blood glucose control (≥ 154 mg/dl)	Practice of recommendations	Poor level of practice	Odds Ratio	1.693	1.126	2.545	Poor level of practice was significantly associated with poor glycaemic control

Table 6 Treatment modalities and glycaemic control in sub-Saharan Africa

First author name	Year	Study design	Study setting	Study population	Sample size	Measurement of glycemic control	Definition of glycemic control	Generic factor	Specific factors	Measure of association	Point estimate	Lower bound	Upper bound	Association with glycemic control
Mobula [58]	2018	Cross-sectional	Ghana	Hypertensive and Type 2 diabetes; ≥ 18 years	1226	HbA1c	Poor control (HBA1c ≥ 7%)	Number of diabetes medicine	Number of diabetes medicines	Odds Ratio	1.73	1.45	2.07	number of diabetes medicines was associated with poor glycaemic control
Biru [29]	2017	Cross-sectional	Ethiopia	Type 2 diabetes; ≥ 18 years	322	FBG	Good control (FBG ≤ 110 mg/dL)		2	Odds Ratio	1.30	0.26	6.54	Being on 2 antidiabetes medications was not associated with glycaemic control
									3		1.26	0.22	7.33	Being on 3 antidiabetes medications was not associated with glycaemic control
									4		1.56	0.29	8.32	Being on 4 antidiabetes medications was not associated with glycaemic control
									5		3.16	0.59	16.96	Being on 5 antidiabetes medications was not associated with glycaemic control
									≥ 5		1.18	0.19	7.14	Being on ≥ 5 antidiabetes medications was not associated with glycaemic control

Table 6 (continued)

First author name	Year	Study design	Study setting	Study population	Sample size	Measurement of glycemic control	Definition of glycemic control	Generic factor	Specific factors	Measure of association	Point estimate	Lower bound	Upper bound	Association with glycemic control
Rwegerera [73]	2019	Cross-sectional	Ethiopia	Type 2 diabetes	368	HbA1c	Desirable (< 7%); sub-optimal (7–9%); poor (≥ 9%)		2 Oral hypoglycemic agents	Odds Ratio	0.47	0.18	1.2	Being on two oral hypoglycemic agents was not associated with glycaemic control
Kefale [49]	2019	Case–control	Ethiopia	Type 2 diabetes; ≥ 18 years	169	FBS	Good control (FBS ≤ 130 mg/dl)		Addition of a second antidiabetic medication	Odds Ratio	2.9	1.3	6.2	Addition of a second antidiabetic medication was associated with poor glycaemic control
Kamuhabwa [47]	2014	Cross-sectional	Tanzania	Type 2 diabetes; ≥ 18 years	469	FBG	Good control (FBG ≤ 130 mg/dL or 7.2 mmol/L); poor control (FBG > 130 mg/dL or 7.2 mmol/L)	Type of diabetes regimen	Combinaison therapy of Oral Hypoglycemic Agents (OHA)	Odds Ratio	2.528	1.475	4.531	Being on combinaison therapy of Oral Hypoglycemic Agents was associated with poor glycaemic control

Table 6 (continued)

First author name	Year	Study design	Study setting	Study population	Sample size	Measurement of glycemic control	Definition of glycemic control	Generic factor	Specific factors	Measure of association	Point estimate	Lower bound	Upper bound	Association with glycemic control
Kassahun [48]	2016	Cross-sectional	Ethiopia	Type 2 diabetes; ≥ 18 years	309	FBG	Poor control (mean FBG > 130 mg/dl)		Insulin and oral medication	Odds Ratio	4.59	1.05	20.14	Taking Insulin and oral medication was significantly associated with poor glycaemic control
									Insulin alone		1.77	0.60	5.19	Use of insuline alone was not significantly associated with glycaemic control

Table 6 (continued)

First author name	Year	Study design	Study setting	Study population	Sample size	Measurement of glycemic control	Definition of glycemic control	Generic factor	Specific factors	Measure of association	Point estimate	Lower bound	Upper bound	Association with glycemic control
Mamo [53]	2019	Case–control	Ethiopia	Type 2 diabetes with poor glycemic control (cases) and without good glycemic control (controls); > 18 years	410	FBG	Good control (average fasting blood glucose of 80–130 mg/dL); poor control (average fasting blood glucose of > 130 mg/dL)		Insulin	Odds Ratio	4.48	1.52	13.16	Being on insulin was significantly associated with poor glycaemic control
									Metformin plus Glibenclamide		9.22	2.90	29.35	Being on metformin plus Glibenclamide was significantly associated with poor glycaemic control
									Glibenclamide alone		3.57	0.18	68.66	Being on glibenclamide alone was not significantly associated with glycaemic control
									Metformin plus Insulin		3.73	0.87	16.05	Being on metformin plus insulin was not significantly associated with glycaemic control

Table 6 (continued)

First author name	Year	Study design	Study setting	Study population	Sample size	Measurement of glycemic control	Definition of glycemic control	Generic factor	Specific factors	Measure of association	Point estimate	Lower bound	Upper bound	Association with glycemic control
Mwita [65]	2019	Cross-sectional	Botswana	Type 2 diabetes; ≥ 18 years	500	HbA1c	Optimal glycaemic (HbA1c < 7%)		Insulin plus OHA	Odds Ratio	0.34	0.07	1.70	Use of insulin plus OHA was not significantly associated with glycaemic control
									OHA alone		0.90	0.46	1.74	Use of OHA alone was not significantly associated with glycaemic control
Id [44]	2021	Cross-sectional	Ethiopia	Type 2 diabetes; > 18 years	394	FBS	Good blood glucose control (< 154 mg/dl); poor blood glucose control (≥ 154 mg/dl)		Insulin plus Oral Anti-diabetic Drugs (OAD)	Odds Ratio	2.177	1.104	4.294	Being on Insulin plus OAD was significantly associated with poor glycaemic control
									Insuline alone		0.87	0.54	1.37	Being treated with Insulin alone was not significantly associated with glycaemic control

Table 6 (continued)

First author name	Year	Study design	Study setting	Study population	Sample size	Measurement of glycemic control	Definition of glycemic control	Generic factor	Specific factors	Measure of association	Point estimate	Lower bound	Upper bound	Association with glycemic control
Otieno [69]	2017	Cross-sectional	Kenya	Type 2 diabetes; ≥ 30 years	220	HbA1c	Good control (HbA1c ≤ 7%); poor/sub-optimal (HbA1c > 7%)		Insuline alone or combined with OADs	Odds Ratio	20.0	2.4	167.4	For the patients with comorbid depression, being on insulin therapy alone or combinec with OADs was associated with poor glycaemic control
									Insulin alone or combined with OADs		1.9	0.9	3.7	For the patients without depression, being on insulin therapy alone or combinec with OADs was not associated with poor glycaemic control
Rwegerera [73]	2019	Cross-sectional	Ethiopia	Type 2 diabetes	368	HbA1c	Desirable (< 7%); sub-optimal (7–9%); poor (≥ 9%)		Diet/ Oral hypoglycemic agents	Odds Ratio	6.41	2.28	18	Being on diet/oral hypoglycemic agents was significantly associated with good glycaemic control

Table 6 (continued)

First author name	Year	Study design	Study setting	Study population	Sample size	Measurement of glycemic control	Definition of glycemic control	Generic factor	Specific factors	Measure of association	Point estimate	Lower bound	Upper bound	Association with glycemic control
Shimels [75]	2018	Cross-sectional	Ethiopia	Type 2 diabetes; ≥ 18 years	361	FPG	Good control (FPG: 100–130 mg/dl)		Insulin plus oral combinaison therapy	Odds Ratio	0.33	0.14	0.77	Being on insulin plus oral combination therapy was significantly associated with good glycaemic control
									Oral combinaison therapy		0.37	0.18	0.76	Being on oral combination therapy was significantly associated with good glycaemic control
Tekalegn [78]	2018	Cross-sectional	Ethiopia	Type 2 diabetes; ≥ 15 years	422	FBG	Good control (average FBG:70–130 mg/dL); poor control (average FBG > 130 or < 70 mg/dL)		Insulin alone	Odds Ratio	3.01	1.5	5.99	Being on insulin was significantly associated with poor glycaemic control
									Insuline and OADs		1.2	0.24	6.27	Being on insulin and OHA was not associated with glycaemic control
									Diet only		2.9	0.86	9.9	Being on diet only was not associated with glycaemic control

Table 6 (continued)

First author name	Year	Study design	Study setting	Study population	Sample size	Measurement of glycemic control	Definition of glycemic control	Generic factor	Specific factors	Measure of association	Point estimate	Lower bound	Upper bound	Association with glycemic control
Abera [88]	2022	Cross-sectional	Ethiopia	Type 2 diabetes	325	HbA1c	Poor control (HBA1c ≥ 7%)		Insulin	Odds Ratio	3.07	2.1	6.12	Significan: association between being on insulin and poor glycaemi control
									OHA& Insulin		2.36	0.82	5.97	
									Diet/ exercise		0.91	0.52	3.53	
Yimam [86]	2020	Cross-sectional	Ethiopia	Type 2 diabetes with hypertension; ≥ 18 years	300	FBG	Good control (mean FBG:80–130 mg/dl); poor control (FBG < 80 mg/dl or > 130 mg/dl)	Side-effects	Presence of Drug Related Problems	Odds Ratio	2.29	1.20	4.39	Having drug related problems was found significantly associated with poor glycaemic control
Khoza [50]	2018	Case–control	South Africa	Type 2 diabetes; > 30 years	320	HbA1c and glucose	No threshold	Treatment for comorbid conditions	Use of statins	ß coefficient	0.030			The use of statins was significantly correlated with higher HbA1c level (p:0.002); 95% CI not provided
Khoza [50]	2018	Case–control	South Africa	Type 2 diabetes; > 30 years	320	HbA1c and glucose	No threshold		Use of Anti-HT	ß coefficient	0.069			The use of anti hypertensive treatment was significantly correlated with glucose level (p:0.0006); 95% CI not provided

Table 6 (continued)

First author name	Year	Study design	Study setting	Study population	Sample size	Measurement of glycemic control	Definition of glycemic control	Generic factor	Specific factors	Measure of association	Point estimate	Lower bound	Upper bound	Association with glycemic control
Anyanwu [23]	2016	Randomized controlled trial	Nigeria	Type 2 diabetes with poor glycemic control and vitamin D deficiency; 35–65 years	42	HbA1c	No threshold		Effect of Vitamin D supplementation	Mean difference	− 0.66	− 2.66	1.34	No significant drop in the mean HbA1c level in the treatment group after 12 weeks of Vitamin D3 supplementation compared to the placebo group
Tsobgny-Tsague [82]	2018	Randomized controlled trial	Cameroon	Type 2 diabetes with poor glycaemic control and moderate to severe chronic periodontitis	34	HbA1c	No threshold		Non-surgical periodontal treatment	Mean difference	3.0	0.6	5.4	Significan: reduction in HbA1c in the treatment group at 3 months
Adeniyi [18]	2016	Cross-sectional	South Africa	Type 2 diabetes; ≥ 30 years at diagnostic of DM	327	HbA1c	Good control (HbA1c ≤ 7%); poor control (HbA1c > 7%); moderately poor (HbA1c = 7–8.9%); critically poor (HbA1c ≥ 9%)	Information on diabetes	Source of diabetes information	Odds Ratio	3.2	1.4	7.0	Diabetes information from non-health workers was significantly associated with poor glycaemic control
Tefera [77]	2020	Cross-sectional	Ethiopia	Type 2 diabetes; ≥ 18 years	400	FPG	Controlled (FPG:80–130 mg/dl)		Diabetes health literacy	Odds Ratio	1.85	1.09	3.40	Patients with high diabetes literacy were 1.85 times more likely to achieve glycemic targets than lower diabetic literacy patients

Table 6 (continued)

First author name	Year	Study design	Study setting	Study population	Sample size	Measurement of glycemic control	Definition of glycemic control	Generic factor	Specific factors	Measure of association	Point estimate	Lower bound	Upper bound	Association with glycemic control
Yosef [87]	2021	Cross-sectional	Ethiopia	Type 2 diabetes; ≥ 18 years	245	FBG	Good control(FBG:70–130 mg/dL)		Diabetes Health education at Health Institution	Odds Ratio	1.21	0.67	2.18	Absence of Diabetes Health education at Health Institution was not associated with glycaemic control
Id [44]	2021	Cross-sectional	Ethiopia	Type 2 diabetes; > 18 years	394	FBS	Good blood glucose control (< 154 mg/dl); Poor blood glucose control (≥ 154 mg/dl)	Pharmacist advice	No clarity of pharmacist's advice	Odds Ratio	1.857	1.100	3.132	No Clarity of Pharmacist's advice about drug was significantly associated with poor glycaemic control
Abera [88]	2022	Cross-sectional	Ethiopia	Type 2 diabetes	325	HbA1c	Poor control (HBA1c ≥ 7%)	Definition of glycaemic goal	Failure to set glycaemic goal	Odds Ratio	3.42	2.17	5.97	Failure to set glycaemic goal was significantly associated with poor glycaemic control

Table 7 Glycaemic optimization interventions and glycaemic control in sub-Saharan Africa

First author name	Year	Study design	Study setting	Study population	Sample size	Measurement of glycemic control	Definition of glycemic control	Generic factor	Specific factors	Measure of association	Point estimate	Lower bound	Upper bound	Association with glycemic control
Mash [55]	2014	Pragmatic randomized controlled trial	South Africa	Type 2 diabetes	422	HbA1c	No threshold	Educational intervention	Effectiveness of group education	Mean difference	0.01	− 0.2	0.28	No significant difference between the intervention and control groups in reduction of HbA1c level by 1%
Thuita [81]	2020	Randomized controlled trail	Kenya	Type 2 diabetes; 20–79 years	153	HbA1C and FBG	Good control (HbA1c < 7%); poor control (HbA1c > 7%)		Effect of a nutrition education programme on the Metabolic syndrome in type 2 diabetes patients	Odds Ratio	2.04	0.84	4.92	No significant difference in the prevalence of high HbA1c between groups at six months post intervention (Nutrition ecucation group versus Control)
											2.08	0.85	5.09	No significant difference in the prevalence of high HbA1c between groups at six months post intervention (Nutrition education peer to peer support group (NEP) versus Control)
Gathu [41]	2018	Randomized controlled trial	Kenya	Sub-optimally controlled Type 2 diabetes; 18–65 years	140	HbA1c	No threshold		Diabetes self-management education	Mean difference	0.37	− 0.45	1.19	No significant difference in the primary outcome (HbA1c) between the two groups

Table 7 (continued)

First author name	Year	Study design	Study setting	Study population	Sample size	Measurement of glycemic control	Definition of glycemic control	Generic factor	Specific factors	Measure of association	Point estimate	Lower bound	Upper bound	Association with glycemic control
Muchiri [63]	2016	Randomized controlled trial	South Africa	type 2 diabetes; 40–70 years	82	HbA1c	No threshold		Effect of a participant-customised nutrition education programme	Mean difference	− 0.64	− 0.19	1.15	No significant difference between the intervention and control groups for HbA1c at 6 months (p = 0·13)
											− 0.63	− 0.26	1.5	No significant difference between the intervention and control groups for HbA1c at 12 months (p:0.16)
Hailu [43]	2018	Controlled before-and-after study	Ethiopia	Type 2 diabetes mellitus; > 30 years	220	FBS	No threshold		Nurse-led diabetes self-management education	Mean difference	27	17	37	Significant difference in the intervention group compared to the control group at 9 months

Table 7 (continued)

First author name	Year	Study design	Study setting	Study population	Sample size	Measurement of glycemic control	Definition of glycemic control	Generic factor	Specific factors	Measure of association	Point estimate	Lower bound	Upper bound	Association with glycemic control
Fseha [40]	2017	Cross-sectional	Ethiopia	Type 2 diabetes; 22–60 years	200	FBS	Good (FBS 70–130 mg/dl), Poor (FBS > 130 mg/dl)	Self-management of diabetes	Home glucose monitoring	Odds Ratio	1.697	0.852	3.353	Home glucose monitoring was not associated with glycaemic control
Fseha [40]	2020	Cross-sectional	Malawi	Type 2 diabetes; ≥ 25 years	428	HbA1c	Poor control (HbA1c clinically elevated ≥ 8%)		Additional blood glucose monitoring	ß coefficient	− 0.359	− 0.609	− 0.149	Additional blood glucose monitoring at private clinic/home/diabetes peer groups was not associated with glycaemic control
Mwavua [64]	2016	Cross-sectional	Kenya	Type 2 diabetes; ≥ 18 years	200	HbA1c	Good control (HbA1c < 7%); poor control (HbA1c ≥ 7%)		Monthly self-monitoring	Odds ratio	2.6	0.6	10.7	Monthly self-monitoring was not significantly associated with glycaemic control
									Absence of self-monitoring	Odds Ratio	3.3	0.8	12.6	Absence of self-monitoring was not associated with glycaemic control

Table 7 (continued)

First author name	Year	Study design	Study setting	Study population	Sample size	Measurement of glycemic control	Definition of glycemic control	Generic factor	Specific factors	Measure of association	Point estimate	Lower bound	Upper bound	Association with glycemic control
Maharaj [52]	2016	randomized controlled trial	Nigeria	Non-insulin dependent type 2 diabetes; 30–58 years	90	HbA1c	No threshold	Exercise programs	Effect of rebound exercise	Mean difference	0.904	0.832	0.985	Significant improvements at 9 weeks post-intervention in mean HbA1c in the exercise group
Yan [84]	2014	Randomized controlled trial	Mozambique	Type 2 diabetes; 40–70 years	41	HbA1c	No threshold		Effect of Aerobic Training	Mean difference	− 1.0	− 1.3	− 0.7	Significant reduction of plasma glucose at 120 min (Glu 120) following glucose loac in the exercise group after training
Siddiqui [76]	2018	Quasi-experimental study	South Africa	Type 2 diabetes; 18–65 years	95	HbA1C	No threshold		Level of physical activity measured with a pedometer	Mean difference	− 1.0420	− 1.2225	− 0.86	Change in HbA1c over the three-month period was significant in the intervention group
Fayehun [38]	2018	Randomized trial	Nigeria	Type 2 diabetes; 33–64 years	46	HbA1c	No threshold		Physical activity with a 10,000 steps each day	Mean difference	− 0.74	− 1.32	− 0.02	Endline HbA1c was lower in the intervention group than in the control group
Ezema [37]	2014	Randomized trial	Nigeria	Type 2 diabetes; 40–55 years	54	FBS	No threshold		Aerobic exercise training (V02 max)	Pearson product moment correlation test	− 0.252			Significant effect of the exercise training program on FBS (p:0.001); 95% CI not provided

Table 7 (continued)

First author name	Year	Study design	Study setting	Study population	Sample size	Measurement of glycemic control	Definition of glycemic control	Generic factor	Specific factors	Measure of association	Point estimate	Lower bound	Upper bound	Association with glycemic control
Mayet [57]	2012	Quasi-experimental study	South Africa	Type 2 diabetes	600	HbA1c	No threshold	Medical intervention	Insulin therapy initiation	Paired t-test				Mean HbA1c at insulin initiation was 10.29% (± 2.42), and 10.63% (± 1.93) after adjustment of insulin dose (p-value > 0.05)
Rambiritch [71]	2014	A 12-week, prospective, single-center, open-label, dose-escalation study	South Africa	Poorly controlled type 2 diabetes requiring oral antidibetic medications; > 20 years	22	FBG	No threshold		Dose escalation of Glibenclamide	Analysis of variance	19.61			Significant decrease in percentage of glucose from dose zero to 2.5 mg ($P \leq 0.001$); no significant decrease for the 2.5–5 mg, 5–10 mg, and 10–20 mg doses. 95% CI provided
Assah [24]	2015	Non-randomized controlled trial	Cameroon	Type 2 diabetes	192	HbA1c	No threshold	Multi level peer support	Effectiveness of a community-based multilevel peer support intervention	Mean difference	− 1.7	− 2.2	− 1.3	Significant reduction in HbA1c in the intervention group compared with controls
Mash [54]	2016	Quasi-experimental study	South Africa	Type 2 diabetes; > 18 years	600	HbA1c	No threshold	Laboratory testing	Introducing point-of-care (POC) testing for HbA1c	Mean difference	0.00	-1.5	1.5	No significant difference in Mean difference in HbA1c result (%) at 18 months in the intervention group

found that it was negatively associated with glycosylated haemoglobin [31, 61], and one found that it was associated with good glycaemic control [57]. Older age was associated with poor glycaemic control in twelve studies [22, 29, 32, 36, 39, 65, 68, 69, 73, 77, 83, 86]. Eight studies assessed the relationship between the female gender and glycaemic control [18, 29, 34, 51, 61, 64, 65, 73], two studies found that the female gender was significantly associated with poor glycaemic control [18, 34], and one study linked it to good glycaemic control [28]. Male gender with respect to glycaemic control was assessed by eleven studies [27, 31, 39, 44, 58, 66, 75, 77, 83, 85, 87]; two studies associated it with good glycaemic control [58, 75], while two studies linked it to poor glycaemic control [27, 87]. Fifteen studies assessed the relationship between educational level and glycaemic control; in one study, primary, secondary, or tertiary education levels were associated with good glycaemic control [28]. A lack of formal education and a low level of education were associated with poor glycaemic control in three studies [39, 48, 87]. In respectively two studies, low monthly income [18, 87], absence of health insurance [47, 58], and being a farmer [25, 48] were associated with poor glycaemic control. In respectively one study, living in urban areas [49], and a high frequency of seeking traditional medicine practitioners [30] were associated with poor glycaemic control. Residing less than 100 kms from a health facility [25], residing in Guinea compared to residing in Cameroon [32], self-reporting a positive perception of family support [68], and the frequency of participating in religious activities [31] were associated with good glycaemic control in respectively one study.

Lifestyle factors

The lifestyle factors assessed were dietary adherence, the practice of exercise, smoking, and alcohol consumption (Table 3). Good dietary adherence was associated with good glycaemic control in five studies [29, 36, 40, 61, 86] while low adherence to dietary recommendations was associated with poor glycaemic control in two studies [35, 67]. Exercise was associated with good glycaemic control in two studies [29, 36]. The inadequate practice of exercise was associated with poor glycaemic control in two studies [39, 53]. In respectively one study, smoking [39], and alcohol consumption [29] were associated with poor glycaemic control.

Clinical factors

The clinical factors—history of diabetes and comorbidities—with respect to glycaemic control are summarized in Table 4. A family history of diabetes was significantly associated with poor glycaemic control in one study [80]. A long duration of diabetes was associated with poor glycaemic control in seven studies [18, 26, 27, 32, 58, 61]. As a corollary, treatment of > 10 years was associated with poor glycaemic in one study [38]. In one study, patients who always had fluctuating/unstable blood glucose levels or had blood glucose levels not improved from diagnosis were prone to poor glycaemic control [60].

Four studies found that the presence of comorbidities was associated with poor glycaemic control [53, 75, 77, 87]. The presence of hypertension led to poor glycaemic control in one study [16]. Dyslipidaemia was associated with poor glycaemic control in three studies [18, 53, 82]. Concerning body mass index (BMI), all categories, such as being underweight [60], having a normal BMI [46], or being overweight/obese [18, 34, 87] have been significantly associated with poor glycaemic control. Central obesity was associated with poor glycaemic control in four studies [16, 30, 52, 56]. In respectively one study, the presence of anaemia [17], non-alcoholic fatty liver disease [19], vitamin B12 deficiency [20], metabolic syndrome [28], cognitive impairment [32], congestive cardiac failure [46], HIV infection [46], thyroid autoimmunity [74], and hypogonadism [45] had a significant association with poor glycaemic control. The presence of peripheral neuropathy [83] or a high-level tooth mobility index [59] was associated with poor glycaemic control. Overall health-related quality of life was inversely associated with FBG [42]. The global disability burden was significantly associated with poor glycaemic control [70]. A unit reduction in the estimated glomerular filtration rate (eGFR) was also associated with HbA1c ≥ 7% [16].

Adherence to treatment plans

Adherence modalities, as represented by adherence to scheduled appointments or medication adherence, are presented in Table 5. Regular attendance at scheduled appointments was associated with good glycaemic control in two studies [49, 85]. Good medication adherence was associated with good glycaemic control in two studies [40, 77], while two other studies showed no association [75, 78]. Low medication adherence had a significant association with poor glycaemic control in three studies [33, 48, 86]. Medium medication adherence was associated with poor glycaemic control in one study [48].

Treatment modalities

The findings on the treatment modalities with respect to glycaemic control are summarized in Table 6. The pill burden was associated with poor glycaemic control in one study. Combination therapy with oral hypoglycaemic agents (OHA) was associated with poor glycaemic control in two studies [48, 53] while it was linked to good glycaemic control in one study [75]. Insulin plus OHA was associated with poor glycaemic control in three

studies [44, 48, 69], while it was linked to good glycaemic control in one study [75]. The use of insulin alone was associated with poor glycaemic control in two studies [53, 78]. The presence of drug-related problems was associated with poor glycaemic control as shown in one study [86]. Rwegerera et al. found that being on diet and OHA was associated with suboptimal glycaemic control [73]. A South African study found that the use of statin and antihypertensives was associated with higher glycaemic levels [50]. Non-surgical periodontal management was associated with good glycaemic control after three months in one study [82]. Diabetes information from non-health workers was significantly associated with poor glycaemic control [18], while having a high diabetes health literacy [77] was significantly associated with good glycaemic control. In one study, the absence of clarity in pharmacists' advice was associated with poor glycaemic control [44].

Reported glycaemic control optimization interventions

The interventions retrieved from the included studies are presented along with their effect on glycaemic control in Table 7. Only one study [43] out of five reported an educational program associated with good glycaemic control. None of the self-management programs was associated with glycaemic control as found in three studies [40, 61, 62]. All exercise programs were associated with improved glycaemic control as found in four studies [37, 38, 52, 76, 84]. Adding a second OHA was associated with poor glycaemic control in one study [49]. The effectiveness of a community-based multilevel peer support intervention was associated with a significant reduction in glycosylated haemoglobin in the intervention group in one study [24].

Discussion

We sought to determine the prevalence and factors associated with glycaemic control in sub-Saharan Africa (SSA) in the past 10 years (2012–2022). Our review shows that poor glycaemic control is common in SSA with only 10–60% of patients having optimal glycaemic control. In addition, glycaemic control was associated with sociodemographic factors (younger and older age, gender, lower income, absence of health insurance, low level of education, place of residence, family support, coping strategies), lifestyle (dietary adherence, practice of exercise, smoking, alcohol consumption), clinical factors (family history of diabetes, longer duration of diabetes, presence of comorbidities/complications), adherence (adhering to follow-up appointments and medication), treatment modalities (pill burden, treatment regimen, use of statins or anti-hypertensives, drug-related problems, diabetes information from non-health workers, high diabetes health literacy, absence of clarity in pharmacists' advice, failure to set glycaemic goals), and reported glycaemic control optimization interventions.

The assessment of glycaemic control was variable in the studies included in our review; in only 43 (58.1%) studies, glycosylated haemoglobin was used. This renders it difficult to estimate the real extent of glycaemic control, compare the results and, even in daily clinical practice, manage patients [90]. Nevertheless, our estimated prevalence of good glycaemic control in SSA is similar to the prevalence found by a meta-analysis in Ethiopia in which only one-third of patients were adequately controlled [90] and in a study in Central, East and West Africa with approximately 29% of good glycaemic control [91]. The prevalence of poor glycaemic control in sub-Saharan Africa is far lower than that found in eight European countries by The Panorama study (62.6%) [10], and in the United States of America by Fang and colleagues (55.3%) in 2015–2018 [92]. The poor glycaemic control in sub-Saharan Africa is the result of poor quality of diabetes care due, in turn, to a weak disease management framework and fragmented health systems [93]. Changes are required in the organization of healthcare systems in sub-Saharan African countries for better management of non-communicable diseases in general, with effective implementation of diabetes care into primary care [4, 93].

Several studies have reported significant associations between sociodemographic factors and glycaemic control. Advancing in age was negatively associated with poor glycaemic control, indicating the vulnerability of young patients as found by several studies [93]. Young patients are confronted with many barriers to effective self-management. Older age was associated with poor glycaemic control in our review, corroborating the findings of several studies and explained by insulin resistance and the presence of comorbidities [8, 90, 95]. Although both genders were linked to poor and good glycaemic control in our review, it is recognized that women are traditionally prone to poor glycaemic control [96]. Women with type 2 diabetes in sub-Saharan Africa have a greater risk of death due to poor access to care [97]. Thus, young, and older patients along with women represented vulnerable categories, in terms of propensity to poor glycaemic control and issues of accessing care. Caution must be taken when managing diabetes in sub-Saharan Africa to ease access to care and provide adequate responses to the needs of these categories.

Poor socioeconomic conditions (low income, poor education) have been associated with poor glycaemic control due to poor access to adequate care and poor health-seeking behaviors [18, 48, 87, 98, 99]. Increasing universal health coverage could address these problems and lead to better outcomes [100]. Factors such as food

insecurity and depression have been identified as mediators in the relationship between poor living conditions and glycaemic control [98]. Family support and adequate coping strategies such as participation in religious activities were beneficial for glycaemic control and could act through these mediating factors. Management interventions to optimize glycaemic control for patients with type 2 diabetes with poor socioeconomic conditions should consider these interconnected factors.

A long distance from home to the healthcare facility has been associated with poor glycaemic control while having less distance was found to be beneficial in many studies, as the latter favors access, adherence and monitoring of care [101, 102]. However, for the nearness of health facilities to have a meaningful impact, these facilities must have adequate equipment, and trained personnel for diabetes care [32].

As expected, adherence to dietary recommendations and physical exercise have been associated with good glycaemic control [103, 104]. In our review smoking was associated with poor glycaemic control. The literature shows that smoking has a confusing relationship with poor glycaemic control [104]. Indeed, if smoking was related to poor glycaemic control due to reduced effectiveness of insulin, quitting smoking has also been linked to poorer glycaemic control [106, 107]. Nevertheless, smoking cessation is one goal of diabetes care. One study in our review linked patients who ever drunk alcohol regularly to poor glycaemic control [29], and the author did not provide details on the quantity used and the term. The literature showed that drinking moderately in the short or medium-term did not affect glycaemic control [108]. Current guidelines support moderate alcohol consumption as excessive chronic alcohol consumption or acute intoxication that adversely has detrimental effects on all organs and affects mortality and morbidity [109, 110]. In sub-Saharan Africa, careful recommendations on alcohol use need to be developed for patients with type 2 diabetes as alcohol might represent a concurrent source of expenses of the few resources available. The real nature of alcoholic beverages found in sub-Saharan Africa is not accurately known.

Several studies confirmed our findings concerning clinical factors with respect to glycaemic control. With a longer duration of diabetes, there is a deterioration of the function of the pancreas due to failure in beta cells, and the emergence of disease-related complications, which in turn can have effects on glycaemic control [8, 111]. The presence of comorbidities/complications poses a problem with respect to pill burden, adherence to treatment and cost, or as an intricate mechanism linked to beta-cell impairment or aggravation of insulin resistance [8, 94, 112–117]. In sub-Saharan Africa, there is a high proportion of undiagnosed diabetes mellitus, and the diagnosis is often delayed. At diagnosis, many patients will present with complications or comorbidities, thus complicating the management and the attainment of glycaemic targets [118]. Strategies to improve the diagnosis of diabetes mellitus must be considered by policy makers in sub-Saharan Africa for a reduction in diabetes-related complications and mortality [118].

Good medication adherence was associated with good glycaemic control. This finding is in line with that found in several studies [111, 119, 120], particularly that good adherence improves glycaemic control, leads to fewer emergency department visits, decreases hospitalizations, and lowers medical costs [121]. In sub-Saharan Africa, medication adherence is confronted by the issues of access and affordability of drugs [122]. The organization of a regular and reliable system for the supply of medicines at affordable prices, even in remote areas is essential to improve diabetes care.

Oral hypoglycaemic agents (OHAs), either insulin only or combined with the former, were associated with poor glycaemic control in our review. In the included studies, the matters surrounding medication use, such as adherence, reason for prescribing one agent or a combination, were not reported. The use of statins and some antihypertensive agents (thiazide diuretics and non-selective beta-blockers) are linked to comorbidities, with hypertension being the most frequent [123] and having been linked in several studies with high levels of glycosylated haemoglobin [124–126]. Since many patients have comorbidities, present late and may need these adjunct treatments, these findings have implications for the management of patients with type 2 diabetes in sub-Saharan Africa. They call for the judicious use of these agents and adherence of healthcare professionals to evidence-based diabetes care in SSA.

Concerning the reported interventions, all the exercise programs, and one educational program for self-management were associated with good glycaemic control. Nevertheless, the full integration of exercise into routine healthcare in Africa is challenged by poor knowledge and attitudes of patients and healthcare providers [127]. In the same way, self-management of diabetes is poor in Africa as it faces numerous barriers [128, 129]. Peer-support interventions have been increasingly recognized worldwide, but one may note that the transferability of interventions across different cultures might be difficult [24]. Research is needed to identify effective interventions to optimize glycaemic control in the context of sub-Saharan Africa.

To the best of our knowledge, this systematic review is the first to provide a prevalence estimate of glycaemic control and an overview of factors associated with glycaemic control in patients with type 2 diabetes in SSA. The review only considered studies in which multivariate analysis was performed in the data analysis and therefore excluded factors without an uncertain link to glycaemic control. The findings of this systematic review are also as good as the quality of the studies included, more so that most (70.2%) were of moderate quality. Most of the studies were observational and one cannot ascertain causality between factors identified and glycaemic control. Glycaemic control was assessed using different methods across the studies, with only 58.1% of the included studies using the recommended glycosylated haemoglobin. There were also different thresholds for glycaemic control through studies even if the same glycaemic control assessment was used. These variations in assessment standards have the potential for errors in estimates and misclassifications.

Beyond these limitations, this systematic review is, to our knowledge, the first to provide a broad view of the extent and multifactorial drivers of glycaemic control among patients with type 2 diabetes in SSA. The review highlights the need for changes in the organization of the healthcare systems in sub-Saharan Africa while ensuring effective funding. Health providers must be trained, and health facilities equipped for adequate diabetes care. The screening of diabetes mellitus must be improved as well as access to care for vulnerable patients. While this review highlights the need for multipronged interventions to improve glycaemic control and diabetes care in this region, further studies are needed to assess their feasibility, effectiveness, affordability and acceptability.

Conclusion

Suboptimal glycaemic control is pervasive among patients with type-2 diabetes in sub-Saharan Africa and poses a significant public health challenge. While urgent interventions are required to optimize glycaemic control in this region, these should consider sociodemographic, lifestyle, clinical, and treatment-related factors.

Abbreviations

BMI: Body mass index; EGFR: Estimated Glomerular Filtration Rate; FBG: Fasting blood glucose; FBS: Fasting blood sugar; FPG: Fasting plasma glucose; Ghb: : Glycosylated haemoglobin; GLUT2: Glucose transporter 2; HbA1c: Haemoglobin A1c; JMF: Joel Msafiri Francis; JPF: Jean-Pierre FINA; LDL-C: Low-Density Lipoprotein-Cholesterol; Mh: : MesH term; Niddm: : Non insulin dependent diabetes mellitus; OBO: Olufemi Babatunde Omole; OHA: Oral Hypoglycaemic Agents; PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-analyses; SSA: Sub-Saharan Africa; T2d: Type 2 diabetes mellitus; Tw: Text word; WHO: World Health Organization.

Supplementary Information

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Additional file 1: Table S1. Search strategy in the included databases. A description of the strategy used for the literature search.

Additional file 2: Table S2. General characteristics of excluded studies and reason for exclusion. A description of the excluded studies and the reason for their exclusion.

Additional file 3: Table S3. Data for metanalysis of proportions of glycaemic control in included studies. Data extracted for metaanalysis in the individual studies.

Additional file 4: Table S4. Assessment of methodological quality for included cross-sectional studies. Assessment of the risk of bias for cross-sectional studies with the Joanna Briggs checklist.

Additional file 5: Table S5. Assessment of methodological quality of quasi-experimental studies. Assessment of the risk of bias for quasi-experimental studies with the Joanna Briggs checklist.

Additional file 6: Table S6. Assessment of methodological quality for included randomized controlled trials. Assessment of the risk of bias for randomized controlled trials

Additional file 7: Table S7. Assessment of methodological quality of case–control studies. The cross-sectional studies assessed with the Joanna Briggs checklist.

Additional file 8: Table S8. Assessment of methodological quality of cohort study. Assessment of the risk of bias for cohort study through the Joanna Briggs checklist.

Additional file 9. List of references of excluded studies. The list of excluded references

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Author contributions

JPF conceived the study, conducted the literature search, selected the studies, assessed the methodological quality of the studies, synthesized the findings, and wrote the first draft of the manuscript. OBO participated in the conceptualization, analysis, synthesis of data and review of the manuscript. JMF participated in the conceptualization, selection of the studies, assessment of the methodological quality of the studies, data synthesis, and reviewed the manuscript. All authors read and approved the final manuscript.

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Availability of data and materials

The dataset(s) supporting the conclusions of this article is(are) included within the article and in the supplementary files. The protocol can be accessed from request to the corresponding author.

Declarations

Ethics approval and consent to participate

Not applicable

Consent for publication
Not applicable.

Competing interests
The authors declare that they have no competing interests.

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CHAPTER FOUR — FACTORS ASSOCIATED WITH POOR GLYCAEMIC CONTROL IN KINSHASA, DEMOCRATIC REPUBLIC OF THE CONGO

4.1 Introduction

This chapter presents the factors associated with poor glycaemic control in Kinshasa. These were explored in a concurrent parallel mixed methods cross-sectional analytic design. The chapter presents the two papers written for this study. The first paper reports on the qualitative component of the study, and the second paper on the quantitative component. The research papers related to the two components have been published (Appendices 3 and 4).

4.2 Research paper 3: Perspectives for glycaemic control in type 2 diabetes in Kinshasa, Democratic Republic of the Congo

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Abstract

Glycaemic control is a significant problem in diabetes care in sub-Saharan Africa. In the Democratic Republic of the Congo, perspectives associated with glycaemic control are not fully known as previous studies rarely explored patients' perspectives and lived experiences. This qualitative study described the perspectives regarding glycaemic control among persons with type 2 diabetes in Kinshasa, Democratic Republic of the Congo. A total of 23 participants were purposively selected in seven health centres in Kinshasa. In-depth interviews were used for data collection. The study used deductive, constructionist, and thematic analyses. Data analyses were performed using the MAXQDA 2022. Themes were organized and integrated using social cognitive theory. Five themes emerged as perspectives for glycaemic control in Kinshasa: financial constraints, limited support, difficulties with lifestyle changes, understanding of the illness, and ability to adapt to what is required when caring for the illness. Participants expressed that they were unable to move towards better glycaemic control due to financial constraints, limited support, and difficulty in changing their lifestyle. Their understanding of diabetes also constituted a barrier. Our results showed that patients' lack of sufficient resources for diabetes care is a major determinant of glycaemic control. It is critically important to integrate a consistent and reliable funding system for the care of people living with diabetes. Persons with diabetes must be empowered through the provision of sufficient knowledge and support — technical, emotional or financial — from healthcare providers and relatives in order to successfully adapt to the requirements of diabetes care.

Contribution to Health Promotion

- Glycaemia control is a multifactorial problem requiring greater investment in health by society and equity in the allocation of resources.
- Better preparation and fundamental changes of the healthcare system is essential to meet the challenges of chronic diseases.
- Patients must be encouraged and equipped with the necessary skills for effective self-care.

Keywords: glycaemic control, perspectives, type 2 diabetes, qualitative study, sub-Saharan Africa

BACKGROUND

About 537 million adults (20-79 years) are living with diabetes worldwide, and this number is expected to rise to 643 million by 2030. Of these, over three in four adults with diabetes will live in low- and middle-income countries (LMICs) (IDF, 2022). In Africa, diabetes was responsible for 416,000 deaths in 2021 and 54% of people living with diabetes are undiagnosed (IDF, 2022).

The World Health Organization (WHO) targets adopted by the 75th World Health Assembly in 2022 stated that 80% of people diagnosed must have good control of glycaemia (WHO, 2022), but worldwide, glycaemic control remains a challenge for all stakeholders engaged in the care of diabetes (Giugliano et al., 2018).

In sub-Saharan Africa, studies have shown high rates of poor glycaemic control in several settings (Sobngwi et al., 2012; Gebreyohannes et al., 2019), and a recent meta-analysis showed that fewer than a third of patients in sub-Saharan were controlled (Fina Lubaki, Omole and Francis, 2022). Poor glycaemic control exposes patients to diabetes related complications that in turn will require more financial means to take care of. The situation is worse in a context characterized by high levels of poverty and resource constraints.

In a recent systematic review, younger and older age, gender, lower income, absence of health insurance, low level of education, place of residence, family history of diabetes, longer duration of diabetes, pill burden, treatment regimen, side effects, use of statins or antihypertensives, alcohol consumption, smoking, presence of comorbidities/complications, and poor management were associated with poor glycaemic control. On the other hand, positive perceived family support, adequate coping strategies, high diabetes health literacy, dietary adherence, exercise practice, attendance to follow-up, and medication adherence were associated with good glycaemic control (Fina Lubaki, Omole and Francis, 2022).

In sub-Saharan Africa, few studies have been conducted to assess the patients' perspectives for glycaemic control leading to a gap in knowledge (Adeniyi et al., 2015; Gathu et al., 2018). In the Democratic Republic of the Congo (DRC), diabetes affects an estimated 1,908,900 adults, representing a prevalence of 4.8% (IDF, 2022). The country is a low-income country with one in six individuals living in extreme poverty. In Kinshasa, less than 10% of the population have employment and only a few are covered by health insurance (World Bank, 2021). In this setting, persons with diabetes and their families spend a large portion of their incomes to meet the costs

of diabetes care, resulting in a large proportion not meeting glycaemic targets. Failure to meet glycaemic targets exposes persons with diabetes to complications of diabetes with the subsequent increased cost of care.

The challenges encountered by persons with type 2 diabetes in following their treatment require exploration, with the aim of improving treatment and, by extension, glycaemic control. However, most studies on glycaemic control in the DRC have excluded the perspectives of persons with diabetes in the complex process of diabetes care (Longo-Mbenzaet al., 2011; Sagastume et al., 2022). The reasons for poor glycaemic control have not been fully explored in Kinshasa as the perspectives of persons with diabetes and their lived experiences of glycaemic control have rarely been assessed. This knowledge gap has clinical and public health policy implications in that interventions may be constructed outside of patients' contexts and therefore less acceptable to patients and less scalable. Understanding the patients' perspectives and experiences would be beneficial for the management of patients with diabetes (Zimmermann et al., 2018). This study aimed to describe the perspectives among persons with type 2 diabetes of the barriers and facilitators for glycaemic control. The results will contribute to building an intervention package for persons with type 2 diabetes in Kinshasa, DRC.

METHODS

Study design

This qualitative study formed part of a large project dealing with glycaemic control in Kinshasa (Fina Lubaki, Omole and Francis, 2022). A preprint of this study has been published (Fina Lunaki, Omole and Francis, 2023). The study is reported according to the consolidated criteria for reporting qualitative research (COREQ) (Tong, Sainsbury and Craig, 2007).

Study setting

This study was conducted in seven health centres in the city of Kinshasa, the capital of the DRC. Kinshasa has an estimated population of about 15 million and spreads over an area of 9,965 km^2 (World Bank, 2021). The seven health centres were Bondeko, 2eme Rue, Mokengeli, Saint Ambroise, Saint-Pierre, Etonga, and Kikimi. These health centres are part of the Kinshasa Primary Healthcare Network comprising hospitals and health centres mainly from the Catholic Church and Salvation Army (Kapongo et al., 2015; Sagastume et al., 2022). These health centres, distributed in the 24 health districts of Kinshasa, have integrated diabetes care in the primary care level. Persons with diabetes were managed by generalists trained in diabetes care who visited them once monthly. Between visits, some persons with diabetes could return to the

health centres for blood glucose monitoring and advice from the nurses. For this study, the seven health centres were purposively selected to ensure the diversity of patients in terms of socioeconomic, illness duration, and experiential contexts. These were the facilities where patients who were likely to openly share their perspectives were identified and they also provided a conductive environment for the interviews to be held.

Study population, sample size and sampling

The study population comprised patients with type 2 diabetes mellitus attending the seven selected healthcare facilities in Kinshasa, DRC. The inclusion criteria were age ≥ 18 years, being diagnosed with type 2 diabetes, and being on treatment for at least six months. Pregnant women, those with difficulty communicating due to mental disability, and patients with diabetes emergencies were excluded.

Consecutive and purposefully selected information-rich persons with type 2 diabetes were recruited from the seven facilities to satisfy the need for diversity in sex, duration of diagnosis/illness, socioeconomic strata treatment categories, and levels of glycaemic control (Vasileiou et al., 2018). Health facilities teams who were well acquainted with the patients helped in their recruitment. After each interview, data were analysed in order to identify codes. In subsequent interviews, the search for a new aspect, dimension, or nuance of the codes was performed. Recruitment continued until data saturation. Data saturation was reached when no new element of the codes was identified (Hennink and Kaiser., 2022). It was planned to recruit 20 persons living with type 2 diabetes but ended up recruiting 23 individuals. None of the patients approached refused to participate or were excluded.

Data collection

Before the interviews, the Principal Investigator provided the study information summarized on a leaflet to potential study participants and obtained their written informed consent. A copy of the leaflet and of the signed consent form (to participate in the study and for the audio recording) was provided to the participant. The one-on-one interviews were then conducted by the principal investigator in a quiet room where the confidentiality of the participant's statements was guaranteed. The interviews were guided by an interview schedule (S1 appendix) and were conducted in French or Lingala depending on the preferences of the participants. All interviews were audio recorded and lasted at most 45 minutes. As the interviews were conducted during the COVID-19 pandemic, there was strict observation of the COVID-19 rules.

Data management and analysis

The recorded interviews were transcribed verbatim and then translated into English by a language expert. The principal researcher, who is fluent in French and Lingala, verified the translation and transcription by listening to the audios while reading the transcripts. Data coding and thematic analysis were performed using MAXQDA 2022 (Verbi Software, 2021). The analysis went through the six steps described by Braun and Clarke (2006) - familiarization with the data, generating initial codes, searching for themes, reviewing potential themes, defining and naming the themes, and producing the report. The coding was performed independently by the principal researcher (JPF) and one supervisor (OBO) in selected interviews without any pre-conceptualized theoretical framework. Outlying challenges were sought out, and an explanatory model that best explains the inter-relatedness of themes, and the experiences of patients on their glycaemic control, was developed.

Theoretical framework

Glycaemic control is a multifactorial issue (Fekadu et al., 2019). Factors that have been previously reported to influence glycaemic control are related to the persons with diabetes, their relatives, the health system, and community/society (Zimmermann et al. 2018; Fekadu et al., 2019; Fina Lubaki, Omole and Francis, 2022; Sagastume et al., 2022). Our explanatory model is aligned to the social cognitive model which recognises that for persons with diabetes, it is inconceivable to change a behaviour without considering the environment (Thojampa and Sarnkhaowkhom, 2019). Social cognitive theory is a learning theory developed by Albert Bandura, which provides a framework for understanding how people shape or are shaped by the environment (Thojampa and Sarnkhaowkhom, 2019; Sebastian et al., 2021). This theory posits that a particular behaviour (such as effectively becoming adherent to treatment behaviours for maintaining good glycaemic control) is a product of interactions between personal, cognitive and contextual/environmental factors (Thojampa and Sarnkhaowkhom, 2019; Sebastian et al., 2021).

Ethical approval and consent to participate

This study was conducted after the approval from the ethics committee of the Protestant University of Congo (reference number: CEUPC 0067; Date: 05/02/2021) and the Human Research Ethics Committee (Medical) of the University of the Witwatersrand (reference number: M210308; Date: 26/08/2021). It was conducted according to the ethical guidelines of the Declaration of Helsinki. Informed consent was obtained from each participant. Data

collection was done with strict adherence to local COVID-19 regulations. The participants were not paid for their participation in the study but were reimbursed for their transport to the healthcare facilities.

Consent for publication

Informed consent was obtained from each participant.

RESULTS

General characteristics of included participants

Twenty-three participants were interviewed. The general characteristics of the included participants are summarized in Table 1.

Table 1. General characteristics of included participants, N=23

	Categories	**n (%)**
Age (years)	<40	11 (47.83)
	40-64	9 (39.13)
	≥65	3 (13.04)
Sex	Female	14 (60.87)
	Male	9 (39.13)
Control of glycaemia	Poor	11 (47.83)
	Good	12 (52.17)
Duration of diabetes	Median (IQR), years	5 (1.5-10)
Treatment regimen	Insulin	5 (21.74)
	Insulin plus Oral hypoglycaemic agents	7 (30.43)
	Oral hypoglycaemic agents	11 (47.83)

Themes identified for glycaemic control

The analysis of the data gathered provided a group of five themes as perspectives for glycaemic control for persons living with type 2 diabetes in Kinshasa. These themes are financial constraints, limited support, difficulties with lifestyle changes, understanding of the illness, and ability to adapt to what is required for caring of the illness. Each theme comprises of sub-themes, which in turn contain initial codes (Table 2).

Table 2. Themes and sub-themes emerged as perspectives for glycaemic control in Kinshasa, Democratic Republic of the Congo

Theme	**Sub-themes**
Financial constraints	Unreliable financing
	Missing visits due to lack of visit fees
	Insufficient number of tests for blood glucose
	Irregular meals
	Lack of money for medication
Limited support	Fear of the reaction from others
	Inaccessibility of doctors between visits
Difficulties with lifestyle changes	Difficulty due to physical and health condition or work schedule
	Time needed to adopt the changes
	Confusing information on what to eat
Understanding of the illness	Diabetes has a mystic origin
	Need for signs of increased blood glucose to take drugs
Ability to adapt for what is required and motivations	Acquisition of skills
	Recognition of signs of increased blood glucose
	Encouragements from carers and relatives

Theme 1: Financial constraints

Diabetes is a chronic disease always requiring that the person with the disease follows the treatment, follows the appropriate diet, regularly monitors his blood glucose, and engages in follow-up scheduled visits. Financial constraints impacted on the capacity of the persons with diabetes to adequately follow these requirements.

A large proportion of the persons living with diabetes were not covered by health insurance and thus used out-of-pocket payments. They relied on their own resources, which were often limited. Most received help from their family members, but this was sometimes irregular and unreliable. With this manner of purchasing care, which was unreliable most of the time, persons with diabetes complied inadequately with the treatment. The lack of adherence led to poor glycaemic control.

Patients with diabetes regretted that they were not receiving the same support as patients suffering from HIV/AIDS or tuberculosis.

‘Sometimes, my family members help me with money when they have it.' (P15, Male, 35 years)
'Only one of my sons helps me financially. He doesn't work and struggles to find money. The other family members don't look after me.' (P2, Female, 60 years)

In our setting, the persons with diabetes are received at clinics once monthly; during these visits, they receive education on a subject relating to their illness, have their blood glucose tested, and are received by the doctor. Coming to scheduled visits also had indirect costs such as transport and the time patients must spend in the health centre as it was not unusual that they waited for hours before seeing the doctor.

'Sometimes, I do not have money for the transport as I'm living in Maluku and must come here for appointments.' (P21, Male, 41 years)
'The visits take too long. We spend about five hours for a visit. There are many patients coming here.' (P2, Female, 60 years)

Many participants reported that they would take their medicines as prescribed provided the medicines were available. Indeed, many participants reported that they encountered difficulties in adhering to their treatment as they must first find money to buy drugs. Some participants are not regularly taking their treatments or personally change their regimen to allow their medicine stock to last longer.

'After that I’m prescribed medicines by the doctor, I try to get the money as quickly as possible to buy these. Usually after three days, I can buy the medications.' (P14, Female, 32 years)
'Due to economic reasons, sometimes I don't have to take the medicine exactly as prescribed to avoid a lot of expenses.' (P10, Female, 40 years)

The financial constraints also limited their ability to perform blood glucose monitoring as they did not have money, or the strips, for those who had the glucometers.

'The test for glycaemia is not free and is done for a fee. I only do it when I can pay. Otherwise, I don't do it.' (P2, Female, 60 years)

Persons with diabetes receiving insulin need to have a regular meal when taking their drugs. Many participants reported that they only took the medicines when they were sure that they would have something to eat to avoid the side-effects of the medications.

> *'I would take the treatment only when I find something to eat.'* (P20, Male, 46 years)
> *'Yes, sometimes if I don't have enough food, I reduce the dose a little and then I want to go back to my usual routine.*' (P21, Male, 41 years)

Theme 2: Limited support

Participants expressed that diabetes brings emotional and financial upsets in the persons with diabetes, for which external support is essential. Family members were the main people that provided some emotional support to participants. For persons of advanced age, a number were supported financially by their relatives to meet the cost of diabetes care. The family also contributed with respect to diet. Some participants pointed out the roles of their relatives in reminding them to take their medicines. Other family members even helped in administering the medicines to the patients.

> *'My father wants me to follow the treatment correctly. He advises me a lot. And sometimes he brings me the medicine when I have to take it. He always tells me that with the treatment, I will be better.'* (P19, Male, 41 years)
> *'My third son got married to a girl who did medical science, she is the one who helps me with injections all the days. Every morning and every evening before going to sleep.'* (P11, Male, 80 years)

The participants reported that the people around them no longer thought of them as they used to once, they knew they had diabetes. It is important to note that the general population did not know much about diabetes due to a lack of awareness or education on the subject. One participant even said that they were seen as condemned. As a result, they did not open to anyone about their illness and only told those who were very close to them. One female participant expressed that while looking for a marriage, it would be difficult for her to be accepted if the partner knew that she was suffering from diabetes. Participants reported that, in some situations, the need to follow the requirements of diabetes care put them in an uncomfortable position.

> *'People feel sorry for you as if it is the end of your life because diabetes has no cure.'* (P22, Male, 37 years)

'I feel embarrassed when I go to a party, and I only have water, and people wonder why I just have water and no other drinks.' (P9, Female, 51 years)

'Yes, I'm thinking that diabetes is a real barrier to my wellness. I'm thinking that if I found a man who wants to marry me if I tell him that I have diabetes, he will leave me. Perhaps I will not tell the truth. But this will be difficult with the treatment that I have to follow.' (P12, Female, 40 years)

It is important to note that during the monthly interviews, the waiting list was usually very long. The doctor is faced with the problem of not having enough time to devote to each person. The encounter rarely covered personal matters of living with the illness.

Moreover, apart from the monthly visit to the health center, many participants expressed that they were not able to contact the doctor or nurse before the next meeting. For most of the time, they went to receive their daily insulin doses (those who were not able to do it by themselves) or to test their glycaemia. Apart from this, when they had some problem in between appointments and they wanted the doctor's advice, they were told to wait for the next visit. Thus, when needed, they were unable to adapt their regimens. They then continued to follow the prescribed doses until the next scheduled appointment.

'I cannot change (my treatment) until I come back here, I'm treated with insulin.' (P14, Female, 32 years)

Theme 3: Difficulties with lifestyle changes

Many barriers to regular physical activity were reported among participants. One participant reported that due to her age, it would be difficult to engage in exercise. Some participants reported constraints of time as they must be at work. Their work was time-consuming and did not allow exercise. Many finished work late and after that had to face lengthy traffic jams to arrive home. Participants found it difficult to follow the diet. At the beginning of their disease, participants found it difficult to adapt to the requirements; after time many succeeded to adapt to new meals.

'It is very difficult for me because of my age. When the opportunity arises, I take a short walk in the corridors of the house. When I get tired, I give up.' (P5, Female, 64 years)

'I don't know how to follow these recommendations properly because of my work rhythm. In the service, my schedule alternates between days on call and days off. I don't know how to combine these shifts with my diet and exercise.' (P4, Female, 55 years)

One participant stated that there was no accurate information about what patients must eat. Sometimes, the advice was confusing - some foods had been prescribed by certain health providers while others were prohibiting these foods.

'The advice we have from health providers is somewhat confusing. Sometimes, there is no precision on what we must eat.' (P13, Male, 67 years)

Theme 4: Understanding of the illness

Some participants thought that their diabetes could be due to a "spell" or had explanations other than that offered by medical science, resulting in these participants experimenting with alternative medicines. However, some of these participants returned to their clinic prescriptions when they noticed that the alternative treatments did not work for them:

'My family members think that diabetes in our family is a mysterious disease. There must be someone behind it.' (P16, Male, 40 years)
'They took me to a healer. I was mixing traditional treatment with pharmaceuticals. At one point, I even gave up pharmaceuticals. But when the traditional treatment didn't work, I came back to continue the treatment.' (P17, Female, 35 years)

On the other hand, several participants recognized that when they feel better, they tend to abandon or have a period of slackening their treatment:

'I respect the treatment because I know that my health depends on it, despite some slackening.' (P22, Male, 37 years)
'I take my treatment regularly. But sometimes I neglect the treatment when I feel well.' (P23, Female, 39 years)

Theme 5: Ability to adapt to what is required to care for the illness

Participants expressed their ability to adapt to the changes required to attain good glycaemic control. This ability was conveyed by the acquisition of the technical skills to administer drugs

daily and/or to monitor their glycaemia. With time it became easier to resolve issues emerging with the care. The ability to adapt to the change was also supported by the ability of the patient to know when they experienced signs of increased blood glucose and needed to take appropriate action.

> *'I really care about taking the treatment for this disease. I have gained some experience about resolving the issues.' (*P15, Male, 55 years*)*
> *'I have no problem using the glucometer.'* (P18, Female, 22 years)
> *'When the glycaemia is high, you will know it by your body.'* (P12, Female, 40 years)

The participants reported that in the process of adapting to what their illness requires, they were helped by the positive messages conveyed by their surroundings and healthcare providers.

> *'The health providers said that diabetes will not end, but they make us understand that diabetes is a disease like the others and that it requires to follow the recommendations for treatment, diet and exercise.'* (P9, Female, 51 years)

DISCUSSION

This study was designed to describe perspectives from persons living with type 2 diabetes for glycaemic control in Kinshasa, DRC. Five themes were identified: financial constraints, limited support, difficulties with lifestyle changes, understanding the illness, and ability to adapt to what is required to take care of the illness. Participants expressed that they were unable to move towards better glycaemic control due to financial constraints, limited support, and difficulty in changing their lifestyle. Their understanding of diabetes also constituted a barrier.

Diabetes is a chronic disease requiring lifelong, multidimensional care, as well as more reliable and sufficient funding. A lack of resources was undermining many aspects of care for the study participants, making them unable to access care and ensure self-care. Many persons with diabetes currently relied on out-of-pocket payments that put them in a vicious circle where a lack of money restricted access to care and led to complications that then increased the cost of care. Out-of-pocket payments are leading to poverty and efforts must be made to progressively suppress these (Tsega, Getaneh and Taddesse, 2021).

An adequate system of funding is necessary to ensure that persons with diabetes benefit from their care; this is seldom possible in a setting marked by poverty (Mayer et al., 2016; Adeniyi

et al., 2016; Okoronkwo et al., 2016; Adisa, Olajide and Fakeye, 2017). At the societal level, it is essential that the Government invests more in healthcare, as it is not sustainable to rely on foreign donors, which is proving to be unstable and unpredictable (Nyamugira et al., 2022). The current contribution of the Democratic Republic of Congo to healthcare is low and far from the 15% of Gross Domestic Product desired for African countries (Traoré, 2021). A social protection system needs to be developed to guarantee access to diabetes care for the most disadvantaged (Jackson et al., 2016; Stephani, Opoku and Beran, 2018). The funding for this system could come from taxes. In resource constrained settings, the allocation of resources must favour primary healthcare services where most of the population receives care. At the community level, the population must be encouraged to develop community-based health insurance (Artignan and Bellanger, 2021).

It is also important to develop mechanisms to reduce the cost of diabetes care for patients. The Government could support flat pricing for consultations and develop public-private partnerships with the pharmaceutical sector to promote the production of affordable generic medicines to reduce the cost of medication. Similarly, it is also important to act to reduce indirect costs such as that of transport to the health structures with adequate diabetes care coverage. A study in South Africa showed that transport costs comprised over 50% of total healthcare costs (Mutyambizi et al., 2019). Furthermore, the equitable geographic distribution of healthcare services with competency in diabetes care or the assignment of staff trained in diabetes management could be of geat help to the population.

Participants expressed that family members were their sole source of social and treatment support. Social support is linked with better health outcomes including glycaemic control (Strom and Egede, 2012; Osuji et al., 2018). Nevertheless, this support could be less effective due to the population's lack of knowledge about the origins of diabetes, which could lead to inadequate health-seeking behaviours and interfere with the access to appropriate care. There is thus a need to educate the public about diabetes, especially the closest family members, so that they can better support people with the disease.

Similarly, participants expressed concern about the reactions of others in their surroundings if they got to know about the participants illness or if participants do not behave themselves as others. This behaviour could reflect the participants' concern about maintaining a good image in the eyes of others and their fear of being stigmatized. Diabetes could lead to a negative body image (dissatisfaction of body or body parts, preoccupation with appearance, and engaging in

behaviors such as frequent mirror checking, self-weighing, or avoidance of public situations) through disease specific factors, side effects of medication, restriction of foods, adverse comments on the disease, and independent factors (media representation) that could lead, probably through psychological factors, to poor glycaemic control (Shaban, 2010; Hosseini and Padhy, 2023). Diabetes treatment must incorporate a psychological aspect to deal with diabetes and independent factors that cause patients to become susceptible to a negative body image.

Beyond the monthly visit, patients were seldom able to access doctors when they needed to discuss their treatment in between appointments. The limited doctor-patient communication may lead to clinical inertia (O'Connor et al.,2005). Clinical inertia is defined as lack of treatment intensification in a patient not at evidence-based goals for care and is a recognized reason for failure to achieve glycaemic targets (O'Connor et al.,2005; Andreozzi et al.,2020). Improving diabetes care also requires enhancing the practices of healthcare providers to enable them to develop a better approach to the management of chronic patients (Nang et al., 2019). In the context of the present study, where there is a chronic shortage of doctors, it may be unrealistic to expect doctors to always be available for all categories of patients with diabetes. Rather, nurses who were in constant contact with patients should be capacitated with the skills to solve the most common problems these patients present with.

Type 2 diabetes is a lifestyle disease and lifestyle modifications are the cornerstone of its management (Bekele et al., 2020). Studies have shown that lifestyle interventions are generally more effective than standard care when there is an association with weight loss (García-Molina et al.,2020). A systematic review of lifestyle interventions on patients with type 2 diabetes suggested a focus on diet and physical activity as these had a significant effect on blood glucose and weight loss (Zhang et al., 2023). In our setting, it is important to consider tailored interventions that consider people's medical conditions and economic situations. Moreover, it is critical to advocate for the integration of workplace physical activity (To et al., 2013). Interestingly, the practice of exercise is also recommended for those who do manual labor. This is because manual work causes a significant degree of stress to muscles, bones and joints. These stresses can be eliminated by strength and resistance exercises (Sundstrup et al.,2016).

Participants also stated that the resurgence of the symptoms of hyperglycaemia prompted them to take their treatment. As stated earlier, there was a trend for some patients to abandon or neglect the treatment when they feel better. The reasons for this could include: non-tolerance of side effects, lack of the means to afford the medications, and misunderstanding of the chronic

nature of diabetes. This implies that healthcare providers need to strengthen health education such that patients understand the benefit(s) of maintaining good glycaemic control and that there is no benefit to wait for symptoms before being adherent to their treatments.

As participants conceived diabetes as a real threat to their lives, there is a need to provide sufficient and reliable information to help them develop a good understanding of the diabetes disease. If there is a misunderstanding, persons with diabetes could change to ineffective alternative treatments, some of which make false promises of a cure for diabetes. It is therefore crucial that healthcare providers assess their clients' stage of change and motivate them to adopt the necessary lifestyle behavioural changes required for optimal diabetes care.

The participants expressed their ability to perform the required changes for good glycaemic control. Persons with diabetes are required to continuously resolve the issues related to living with diabetes and adopt the best solutions for their illness and its treatment. Care for people with diabetes must also seek to highlight the difficulties of adaptation to help patients resolve them (Kalra, Jena and Yeravdekar, 2018). Studies have shown that interventions for patient empowerment may improve glycaemia and blood pressure in persons with diabetes (Hood et al., 2018; Mogueo et al., 2020). In our setting, this aspect of care has not received the required attention and needs to be considered when developing strategies for improving diabetes care in Kinshasa.

Figure 1 presents an integrated explanatory model for glycaemic control among persons living with type 2 diabetes in Kinshasa, Democratic Republic of Congo using the social cognitive theory. The five themes identified in our study are displayed in relation to the six modules of social cognitive theory (Thojampa and Sarnkhaowkhom, 2019). The six main domains of social cognitive theory are: reciprocal determinism, behavioural capacity, observational learning, self-efficacy, expectations, and reinforcements.

Behavioural capacity refers to the patient's ability to change a specific behaviour through the acquisition of essential knowledge and practices (Joseph et al., 2017; Thojampa and Sarnkhaowkhom, 2019). This capacity was translated in theme 5 in which our participants expressed that they were confident of their ability to reach their glycaemic targets because they were able to acquire the necessary skills required for their treatment: self-injection of insulin, using glucometers, and recognising the signs of hypoglycaemia (Theme 5). These achievements

improved their self-efficacy in being able to do what is required for glycaemic control (Joseph et al., 2017; Thojampa and Sarnkhaowkhom, 2019).

Self-efficacy refers to a person living with diabetes having the confidence that they can achieve good glycaemic control. Self-efficacy has been found to be a significant predictor of improved self-care among persons with diabetes who have poor health literacy; a feature of many persons with diabetes in our study setting (Reisi et al., 2021). However, our results showed that participants were encountering many financial constraints in the care of their illness thus resulting in poor self-efficacy to achieve good glycaemic control (Theme 1).

Reinforcements refer to internal or external responses to a given behaviour with a positive or negative impact on the continuity of the behaviour (Thojampa and Sarnkhaowkhom, 2019). Our results showed that participants lived in an unfavourable social context with limited social support (Theme 2) and were exposed to poor glycaemic control by the way they were understanding their illness (Theme 3) and the difficulties they had with changes in lifestyle (Theme 4). These elements had a negative impact on glycaemic control. Social support is one of the main domains of social cognitive theory and enhancing it in diabetes self-management could help persons with diabetes improve their glycaemic control, achieve self-management goals, and facilitate coping with the disease (Thojampa and Sarnkhaowkhom, 2019).

Overall, this study is one of few studies in sub-Saharan Africa to investigate the perspectives of persons living with type 2 diabetes on glycaemic control and has clinical, public health and policy implications for improving glycaemic control in Kinshasa, the Democratic Republic of the Congo, and similar settings. The study highlighted many difficulties faced by patients in seeking diabetes treatment, both financial and related to the care they received from healthcare facilities. The patient approach should aim for a patient-centred approach in order to detect the challenges experienced by patients and to strengthen the skills of patients in order to help them adapt to all the demands brought on by living with diabetes. Changes are also desired in the health system to ensure that patients have quality access to care. These changes need to involve training less qualified health workers to cover many aspects of care in a setting where there is a scarcity of qualified healthcare workers. From a public health perspective, given the growing importance of diabetes in our community, its chronic nature and the high cost of its management, to ease the access to diabetes care requires substantial reliable funding, which calls for greater investment by the State in the care of the population in general, and chronic diseases in particular.

The qualitative design has potential interviewer, selection, and translation biases. However, the reflexivity of the principal researcher during interviews and analysis, the prior training in qualitative design, and the oversight of an experienced qualitative researcher, ensured the adoption of a neutral and non-judgmental attitude and limited the potential for biases. The participants' statements could have been altered during translation from Lingala or French to English; however, the translation performed by the language expert was verified by the principal investigator by referring to the audio recordings. The findings of the study were submitted for peer review and member checking to enhance their credibility. A detailed description of the data and the context from which they originated ensured the transferability, and external audits conducted by the study supervisors, who are senior researchers, and one external expert on qualitative research, ensured dependability.

In the future, engaging qualitative methods to understand the socio-cultural context underlying the persons with diabetes knowledge, attitudes, beliefs, perceptions and behaviours around diabetes will be of great help to improve the care of persons with diabetes.

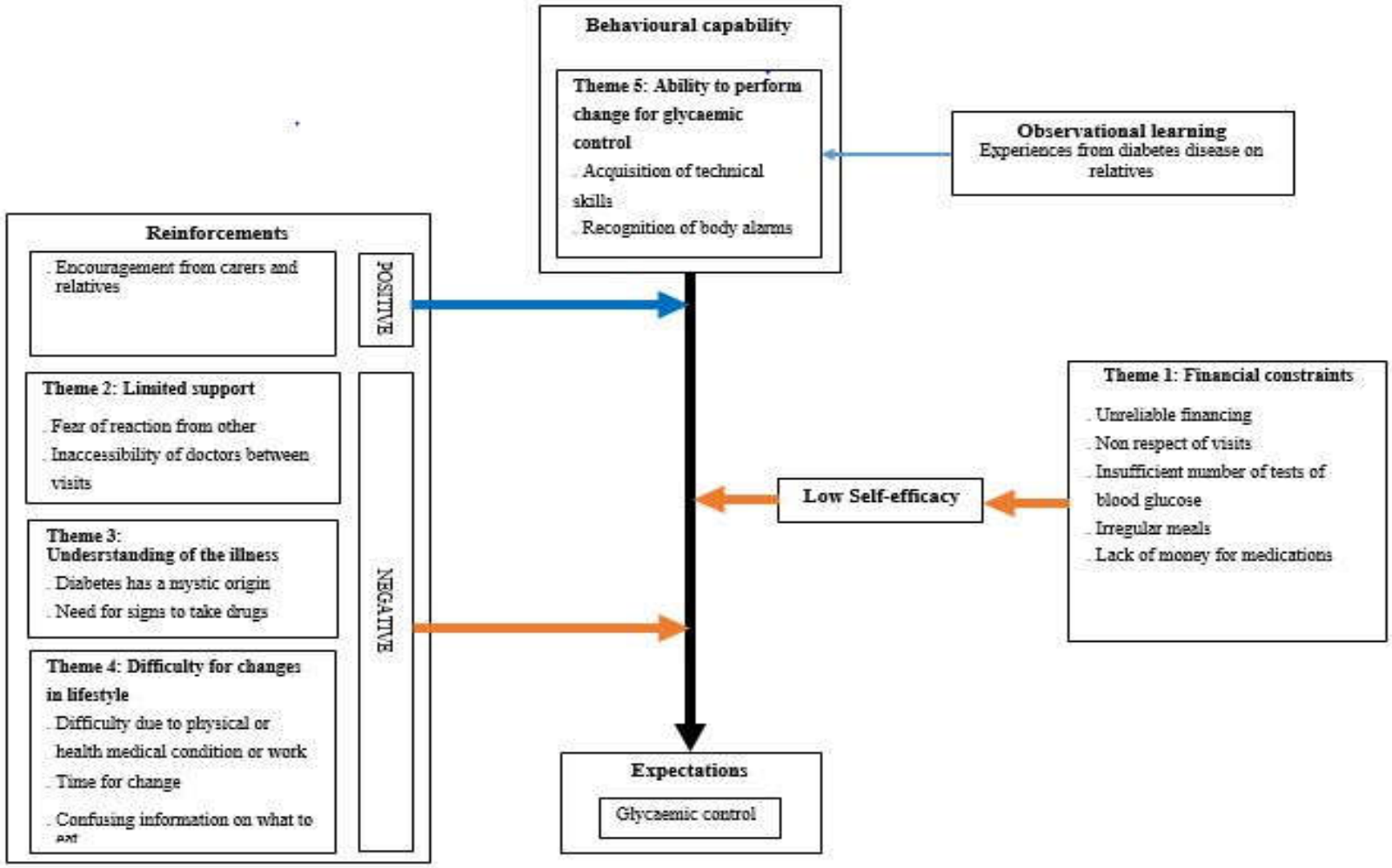

Figure 1 Explanatory model for glycaemic control among patients with type 2 diabetes in Kinshasa, Democratic Republic of the Congo, based on the social cognitive theory. Blue arrows means a positive influence while maroon arrows indicate a negative influence.

CONCLUSION

The results showed that a lack of adequate funding is a major determinant of glycaemic control. It is crucial to integrate a consistent and reliable funding system for the care of people living with diabetes through primarily more investment of the government in healthcare in general and noncommunicable diseases, including diabetes in particular. Persons with diabetes must be empowered to successfully adapt to the requirements of diabetes care through a better approach from healthcare providers which will help in identifying the challenges faced by patients and discussing how these problems could be resolved. In addition, developing family centered care is essential, taking into account the role of family in the process of care for patients.

Declaration of interest

The author(s) declare(s) that they have no competing interests.

Authors' contributions

JPF conceived the study, conducted the interviews, contributed to the translation of the transcripts to English, performed the analysis, and wrote the first draft of the manuscript. JMF contributed to the conceptualization and operationalisation of the study and reviewed the manuscript. OBO contributed to the conceptualisation and operationalisation of the study, the analysis, and reviewed the manuscript. All the authors agreed with the final draft of the manuscript.

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4.3 Research paper 4: Poor glycaemic control: prevalence, factors and implications for the care of patients with type 2 diabetes in Kinshasa, Democratic Republic of the Congo: a cross-sectional study

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ABSTRACT

Background

Diabetes is a significant problem in sub-Saharan Africa and glycaemic control poses a health challenge among patients living with type 2 diabetes. There are limited data on glycaemic control in Kinshasa, Democratic Republic of the Congo. This study assessed the prevalence and factors associated with glycaemic control to inform potential interventions to improve glycaemic control in Kinshasa.

Methods

This was a cross-sectional study conducted between November 2021–September 2022 among patients recruited from 20 randomly selected facilities in Kinshasa. Participants were asked to complete a structured questionnaire and to provide two millilitres of blood for an Hb1AC assay. Poor glycaemic control was defined as HbA1c ≥ 7%. Univariate and multivariable logistic regressions were performed to identify factors associated with poor glycaemic control.

Results

A total of 620 participants were recruited for this study. Study participants had a mean age of 60.21±12.44 years with the majority being female (66.0%; n=409), unemployed (67.8%; n=419), having an income below the poverty line (76.4%; n=473), and without health insurance (92.1%; n=571). Only a slight less than one-third of the participants (32.4%; n=201) had good knowledge of diabetes. Two-thirds of the participants (67.6%; n=420) had poor glycaemic control. More than half the participants were on insulin monotherapy (53.9%; n=334). No sociodemographic, and lifestyle characteristics were associated with poor glycaemic control. Participants on monotherapy with insulin (AOR: 1.72 (95%CI:1.17-2.55)) had increased odds of poor glycaemic control compared to participants on oral hypoglycaemic drugs. In contrast, participants having uncontrolled blood pressure (AOR: 0.60 (95%CI:0.39-0.92)) were less likely to have poor glycaemic control compared to participants having controlled blood pressure.

Conclusions

Poor glycaemic control is prevalent among patients with type 2 diabetes in Kinshasa, DRC. A high proportion of the participants were on monotherapy with insulin and being on insulin alone was associated with poor glycaemic control. Having uncontrolled blood pressure were less likely associated with poor glycaemic control. Our findings stressed the need for better management of diabetes through elaboration and adherence to clear management guidelines for type 2 diabetes in primary care settings.

Keywords: Diabetes Mellitus, Type 2; Factors; Glycaemic control; Cross-sectional study

Background

Worldwide, the prevalence of diabetes is 10.5% for adults aged 20 to 79 years [1]. In sub-Saharan Africa, one in 22 adults have diabetes [1] while in the Democratic Republic of the Congo (DRC), the prevalence of diabetes is estimated to be 5.8% for adults aged 20 to 79 years [2], with higher proportions of persons living with diabetes found in urban areas and the western part of the country [3,4]. Type 2 diabetes is increasing worldwide [1] – it is expected that the greatest increase in diabetes prevalence will take place in low- and middle-income countries [5]. On the African continent, type 2 diabetes is progressing rapidly due to modifiable risk factors, such as obesity and urbanisation [5]. In sub-Saharan Africa (SSA), diabetes care faces numerous challenges including the lack of organisation in the health system, insufficient financing for diabetes care, a high proportion of undiagnosed diabetes, and limited information on diabetes complications, and genetics [6-8]. All these challenges render the health system unable to meet the needs of patients with diabetes with a greater impact on morbidity and mortality [2,7].

Glycaemic control is the cornerstone of diabetes management, as it delays the onset of complications, reduces the cost of care and improves patients' quality of life. Nevertheless, the control of diabetes remains a challenge worldwide, with only about 50% of the patients controlled [9]. In SSA, it is estimated that less than one-third of patients with type 2 diabetes achieve target glycaemic levels [10,11]. In the DRC, few studies have assessed the prevalence of glycaemic control among patients with diabetes [12,13] ; the most recent study on the matter was done near Kinshasa and estimated the prevalence of good glycaemic control as 14% [12].

Worldwide, empirical evidence showed that higher socio-economic status, greater dietary knowledge, higher self-efficacy and empowerment improve glycaemic control among patients with diabetes [14]. This emphasizes the need to implement self-management initiatives, that incorporate dietary knowledge, to empower patients with diabetes in their own care [14]. In SSA, younger and older age, gender, lower income, absence of health insurance, low level of education, place of residence, family history of diabetes, longer duration of diabetes, pill burden, treatment regimen, side effects, use of statins or antihypertensives, alcohol consumption, smoking, presence of comorbidities/complications, and poor management were associated with poor glycaemic control. On the other hand, positive perceived family support, adequate coping strategies, high diabetes health literacy, dietary adherence, exercise practice, attendance to follow-up, and medication adherence were associated with good glycaemic

control [11]. In Kinshasa, DRC, two studies described factors related to glycaemic control and found that persons with diabetes older than 40 years of age had higher odds of achieving good glycaemic control than those younger [13] ; abdominal obesity and having a body mass index (BMI) > 25 Kg/m^2 were associated with poor glycaemic control [12].

Thus, there is a scarcity of data on poor glycaemic control in Kinshasa, DRC. In anticipation of the development of the intervention package for improving glycaemic control in Kinshasa, a more comprehensive understanding of the issue is essential. To expand the knowledge base on blood glucose control factors, a mixed-method cross-sectional study was designed. In this article, the results of the quantitative phase are presented. The aim of this study was to describe the factors associated with poor glycaemic control in Kinshasa, DRC. In a secondary purpose, the prevalence of poor glycaemic control was also determined.

Methods

This cross-sectional study was a component of a bigger research project on glycaemic control among patients with type 2 diabetes in Kinshasa, DRC, for which the study protocol was previously published [15].

Study design

This was a cross-sectional study of patients recruited from 20 randomly selected health facilities in Kinshasa, DRC.

Study setting

Our study was multisite within Kinshasa, a city of about 15 million inhabitants spread over an area of 9,965 km^2 [16]. The study was conducted in health facilities belonging to the Catholic Church and the Salvation Army. With a total of 66 health facilities (one referral hospital and 65 health centres) distributed across 24 health districts, these organisations own most of the facilities that have integrated diabetes care in primary care in Kinshasa.

Study population

The study population consisted of patients with type 2 diabetes attending health centres that offer diabetes care in the Kinshasa Primary Care Network, with about 7,326 patients registered in 2020. The inclusion criteria were age ≥ 18 years, receiving diabetes treatment for at least six months and consenting to the study. The exclusion criteria were pregnancy and having difficulty communicating due to mental disability.

Sample size estimation

The estimated minimum sample size was computed using Epi info version 7.2.2.2. Assuming that the prevalence of poor glycaemic control was 68% [17], at a 95% confidence level and a

power of 80%, 59,2% of patients who had a diabetes duration ≤ 7 years (unexposed) presented with poor glycaemic control, and 74,4% of those who had a diabetes duration > 7 years (exposed) presented with poor glycaemic control [18]. The unexposed to exposed ratio is 0.47 [18]. The minimum estimated sample size was 368. Adjusting for a design effect of 1.5, the calculated sample size of 552 was determined. To account for an estimated 10% non-response rate, the minimum required sample size was 614 patients, rounded up to 620 patients.

Sampling of participants

Participant selection was a two-stage process. The first stage was the random selection of 20 out of 48 healthcare facilities. As the healthcare facilities have an unequal number of patients, the participants were selected by probability proportional to the patient population size. The second stage consisted of the selection of the participants; 31 patients were selected from each selected healthcare facility using systematic sampling. The research assistant took the record of the first patient on a clinic day to assess eligibility and subsequently took the record of every third patient for questionnaire administration. If the first patient or the third patient selected in the next step was not eligible, the research assistant selected the next patient(s) until an eligible patient was obtained, then continued with the selection of each third patient. This process ensured that each patient had the same probability of selection or self-weighting.

Data collection

The data collection process lasted from November 2021 to September 2022. For each participant, the research team performed physical and anthropometric measurements. These measurements were taken once by trained staff members on the same portable equipment at all the health facilities. The questionnaire consisted of pre-existing standardised tools translated from English into French and Lingala (S2Appenix and S3 Appendix). The questionnaire was pre-tested before data collection, no changes were necessary on the tools used in the study. At the end of the data collection, a blood sample was taken from the participant. The questionnaire was administered using REDCap (Research Electronic Data Capture) on a tablet or smartphone [19]. The information about the diabetes disease was verified with information in the patient's medical records, if available.

Variables of the study

Outcome

The main outcome variable was poor glycaemic control, defined as HbA1c ≥ 7% [20], and obtained from the blood sample assayed at the School of Medicine laboratory at the Protestant University of Congo in Kinshasa. The assay was performed using an automated Genuis WP 21B with the antibody-based immunoassay method of Cypress Diagnostics [21].

Exposures

The possible determinants for glycaemic control considered in this study were sociodemographic parameters (age, sex, marital status, educational attainment, occupation, income, use of health insurance, access to food, and distance from place of residence to health centre), lifestyle parameters (smoking, and problematic alcohol consumption), clinical parameters (duration of diabetes, height, weight, body mass index, and waist circumference), presence of comorbidities (hypertension, hyperlipidemia, obesity, cataracts, diabetic retinopathy, impaired renal function, erectile dysfunction, blood pressure, treatment, and duration of treatment), and psychological parameters (adherence to treatment, depression, diabetes distress, social support, self-management, and knowledge).

Measurement tools, operational definitions, and references for the exposures

Sociodemographic parameters

A distance from the participant's place of residence to the health centre of < five kilometres or < one hour was considered as nearby, while > five kilometres or > one hour was considered as distant. A daily income < 3800 Congolese Francs (< US$1.9) was set as the threshold for poverty [22].

The food security status was assessed with the Household Food Insecurity Scale (HFIAS), a nine-item measurement tool. It reported the experience of the past four weeks [23]. The HFIAS has showed a good internal consistency (Cronbach's alpha of 0.76 and 0.73 in two rounds) in an Ethiopian study and the authors concluded that the tool was simple, and suggested an adaptation of questions and wording, as well as additional examples before the application could be used [24]. Our sample data displayed a good internal consistency (Cronbach's alpha: 0.96).

The HFIAS categorises households into four levels of food access: food secure, mild food insecure, moderately food insecure, and severely food insecure [25]. A food secure household experiences none of the food insecurity conditions, or just experiences worry, but rarely. A mildly food insecure household worries about not having enough food sometimes or often, and/or is unable to eat preferred foods, and/or eats a more monotonous diet than desired and/or

some foods considered undesirable, but only rarely; but it does not cut back on quantity nor experience any of three most severe conditions (running out of food, going to bed hungry, or going a whole day and night without eating). A moderately food insecure household sacrifices quality more frequently, by eating a monotonous diet or undesirable foods sometimes or often, and/or has started to cut back on quantity by reducing the size of meals or number of meals, rarely or sometimes; but it does not experience any of the three most severe conditions. A severely food insecure household has graduated to cutting back on meal size or number of meals often, and/or experiences any of the three most severe conditions (running out of food, going to bed hungry, or going a whole day and night without eating), even as infrequently as rarely; any household that experiences one of these three conditions even once in the last four weeks (30 days) is considered severely food insecure [25].

Clinical parameters

For physical measurements, trained staff members measured clinical parameters (height, weight, waist circumference, and blood pressure) using validated equipment. The height of the participant was measured with a stadiometer on which the participant stands bare feet with his or her back against the vertical scale, feet parallel to each other, toes pointing forward and the soles of the feet flat on the floor. The measurement was read on the vertical scale to the nearest centimetre. The weight was assessed using a SECA scale 260 with the participant wearing light clothing, in bare feet, minus outer clothing, no heavy jewellery, and empty pockets. The weight was expressed in kilograms. The waist circumference was measured with the patient standing upright with feet slightly apart and arms hanging loosely on each side. A tape was placed just above the hip bones to measure the middle and was taken just after the participant breathed out, to the nearest centimetre [26]. The blood pressure was measured seated using an EDAN automatic sphygmomanometer (EDAN Instruments) three times separated by 5 minutes interval. The mean was calculated based on the three readings.

The BMI was calculated as weight (Kg)/height (squared meters) and was categorised as follows: underweight/overweight (BMI < 25 Kg/m^2), and overweight/obese (BMI ≥ 25 Kg/m^2) [27]. For the waist circumference, normal values were defined according to sex: men < 102 centimetres; and women < 88 centimetres [28]. Controlled blood pressure was defined as a systolic blood pressure level < 130 mm Hg and a diastolic blood pressure level < 80 mm Hg [29].

The duration of diabetes was separated into three categories: less than 5 years, 5 to 10 years, and 10 years or more. The duration of the treatment had two categories: less than 7 years, and 7 years or more. There were three options for treatment regimens: insulin alone, oral hypoglycaemic drugs, and mixed treatment (insulin plus oral hypoglycaemic drugs).

Psychological parameters

The knowledge of diabetes was assessed with the Simplified Diabetes Knowledge Scale, a true/false response format of the Revised Diabetes Knowledge Scale of the Michigan Diabetes Research Center [30,31]. It contained 20 items with three related to insulin users. It has an internal reliability of 0.71, an item correlation of 0.26–0.58, and corrected item-total correlation of > 0.2 for all items, except for items 7, 8, and 20 [30]. Our sample data demonstrated a similar Cronbach's alpha at 0.74. The Simplified Diabetes Knowledge Scale was used as a continuous score. For the analysis, the score was categorised into three categories, namely low (< 7), acceptable (7–10), and good (≥ 11).

The treatment adherence was assessed by using the four-item Morisky Green Levine (MGL) test [32]. The four-item MGL test has an alpha reliability of 0.61. Our data showed a similar Cronbach's alpha value of 0.64. The scale is a yes/no scale with 'yes' coded as 1, and 'no' as 0. The MGL test divides patients into adherence categories: high, medium, and low with 0, 1–2, and 3–4 points, respectively.

Social support was assessed by applying the Multidimensional Scale for Perceived Social Support (MSPSS) [33]. The MSPSS is a brief self-report questionnaire that contains 12 items rated on a five-point Likert-type scale. The MSPSS assessed three subscales of social support: family, friends, and significant others. The internal consistency of the total scale was 0.87: the subscales were 0.84 (friends), 0.85 (family), and 0.74 (significant others) [33]. The data sample showed a similar Cronbach's alpha value of 0.89. For the MSPSS, the mean scores were calculated as follows: Significant Others Subscale - sum across items 1, 2, 5 and 10, divided by 4; Family Subscale - sum across items 3, 4, 8 and 11, divided by 4; and Friends Subscale - sum across items 6, 7, 9 and 12, divided by 4. The total scale was calculated as the sum across all 12 items, divided by 12. Any mean scale score ranging from 1–2.9 could be considered low support, a score of 3–5 as moderate support, and a score from 5.1–7 as high support.

A screening for depression was performed with the Patient Health Questionnaire-9 (PHQ-9) [34]. The PHQ-9 is the nine-point depression module of the full PHQ and is a screening tool and measure of depression severity. The Cronbach's alpha was 0.89 in a primary healthcare study [35]. Our sample demonstrated a Cronbach's alpha of 0.77, less than that of the previous study but acceptable. Depression screening with PHQ-9 determined the following categories: moderate depression (12–14), moderately severe depression (15–19), and severe depression (20–27) [34].

The diabetes distress score was measured using the Diabetes Distress Scale (DDS) [36], a 17-item scale that captures four critical dimensions of distress: emotional burden (five items), regimen distress (five items), interpersonal distress (three items), and physician distress (four items). The internal consistency expressed by Cronbach's α was 0.93 for the total score, 0.88 for emotional burden, 0.88 for physician-related distress, 0.88 for regimen-related distress, and 0.88 for interpersonal-related distress scales [36]. Our sample showed a Cronbach's alpha value of 0.94. For the DDS and its subscales, a mean item score of 2.0–2.9 are considered 'moderate distress,' while a mean item score > 3.0 is considered 'high distress'.

The diabetes self-management was described with the use of the Diabetes Self-Management Questionnaire (DSMQ), a 16-item questionnaire comprising four subscales: dietary control (four items), glucose management (five items), physical activity (three items), and physician contact (three items). Low adherence was defined as a score of dietary control < 4, a score of glucose management < 5, a score of physical activity < 3, and a score of physician contact < 3 [37]. The overall internal consistency (Cronbach's alpha) was good (0.84) and consistencies of the subscales were acceptable (glucose management [0.77]; dietary control [0.77]; physical activity [0.76]; and physician contact [0.60]) [37]. Our sample showed an acceptable Cronbach's alpha of 0.76.

Lifestyle parameters

For lifestyle parameters, substance use was investigated. Alcohol use was measured with the Alcohol Use Disorders Identification Test-Concise (AUDIT-C), where a score ≥ 4 (in men) or ≥ 3 (in women) represents health-risk consumption [38]. The internal consistency of AUDIT-C was 0.75, and its test-retest reliability was 0.93 [39]. Our sample demonstrated a Cronbach's alpha value of 0.64. The history of smoking was obtained from the participants and focused only on current smoking.

Data analysis

All the analyses were performed using survey data analysis with STATA 17 [40] to account for the study design characteristics. We expressed age as median with interquartile range (IQR), as it was not normally distributed. The other variables were analysed as categorical variables and expressed as frequency (n) and percentage (%). Bivariate analysis was performed to compare uncontrolled versus controlled participants in terms of glycosylated haemoglobin using the Chi-square/Fisher exact test for categorical variables. We further performed a multivariable logistic regression to assess factors associated with glycaemic control. Age, sex, duration of treatment, and food security were included in the regression model a priori. Other variables with a p-value < 0.2 in the univariate analysis were also included in the model. A p-value of < 0.05 was considered statistically significant.

Results

A total of 620 participants were included in the study out of a total of 627 invited, accounting for a non-response rate of 1.1%. The participants had a mean age of 60.21±12.44 years and the majority were female (66.0%; n=409). In our sample, men differed significantly from women by marital status (p=0.013), occupation (p=0.037), income (p=0.037), distance from home to the healthcare facility (p=0.023), and health insurance (p=0.100). Table 1 summarises the sociodemographic characteristics of the participants.

The participants had a mean Body Mass Index (BMI) of 23.60±5.21 Kg/m2, a mean waist circumference of 89.95±13.49 centimetres, a mean duration of diabetes disease of 83.17±75.18 months, and a mean treatment duration of 82.17±75.02 months. Fewer than two-thirds of the participants (64.7%; n=401) presented a complication or a comorbidity. The most common complications or comorbidities were hypertension (53.9%; n=215), diabetic retinopathy (15.8%; n=63), erectile dysfunction (14.04%; n=56), and cataracts (3.5%; n=14). Slightly more than half the participants (53.9%; n=334) were on insulin alone followed by Oral Hypoglycaemic Agents (OHA) (38.2%; n=237) and Mixed-treatment (Insulin-OHA) (7.9%; n=49).

Prevalence of glycaemic control and participants' characteristics

About two-thirds of the participants (67.8%; n=420) had poor glycaemic control. There was no statistically significant difference between participants with good glycaemic control and those having poor glycaemic control in terms of sociodemographic characteristics (Table 2).

Table 1 Sociodemographic characteristics of participants with type 2 diabetes in Kinshasa, n=620 (2021-2022)

	All N (%), Nt=620	**Male N (%), Nm=409**	**Female N (%), Nf=211**	**p**
Age (years)				0.481
18-39	39 (6.3)	22 (5.4)	17 (8.1)	
40-64	342 (55.2)	231 (56.5)	111 (52.2)	
≥ 65	239 (38.5)	156 (38.1)	83 (39.3)	
Marital status				0.013*
Single	199 (32.1)	150 (36.7)	49 (23.2)	
Married	393 (63.4)	242 (59.2)	151 (71.6)	
Other	28 (4.5)	17 (4.2)	11 (5.2)	
Educational level				0.157
No formal education	77 (12.4)	50 (12.2)	27 (12.8)	
Primary school	199 (32.1)	140 (34.2)	59 (28.0)	
Secondary school	269 (43.4)	178 (43.5)	91 (43.1)	
Tertiary	75 (12.1)	41 (10.0)	34 (16.1)	
Occupation				0.037*
Employed	132 (21.3)	72 (17.6)	60 (28.4)	
Unemployed	419 (67.6)	295 (72.1)	124 (58.8)	
Other	69 (11.1)	42 (10.3)	27 (12.8)	
Income				0.037*
< 1.99 US $/day	473 (76.3)	329 (80.4)	144 (68.2)	
≥ 1.99 US $/day	147 (23.7)	80 (19.6)	67 (31.8)	
Access to food				0.687
Food security	247 (39.8)	163 (39.9)	84 (39.8)	
Mildly Food Insecure Access	71 (11.5)	51 (12.5)	20 (9.5)	
Moderately Food Insecure Access	111 (17.9)	72 (17.6)	39 (18.5)	
Severely Food Insecure Access	191 (30.8)	123 (30.1)	68 (32.2)	
Health insurance				0.100*
Insured	49(7.9)	27 (6.6)	22 (10.4)	
Without health insurance	571 (92.1)	382 (93.4)	189 (89.6)	
Distance to a health facility				0.023*
Nearby	451 (72.7)	285 (69.7)	166 (78.7)	
Distant	169 (27.3)	124 (30.3)	45 (21.3)	

Legend:Nt: total number of participants, Nm: number of male participants, Nf: number of female participants, *statistically significant; primary: 1-7 years; secondary: 8-12 years; tertiary: > 13 years; food secure household: no food insecurity; mildly food insecure household: worries about not having enough food sometimes or often, and/or is unable to eat preferred foods, and/or eats a more monotonous diet than desired and/or some foods considered undesirable, but only rarely; moderately food insecure household sacrifices quality more frequently, by eating a monotonous diet or undesirable foods sometimes or often, and/or has started to cut back on quantity by reducing the size of meals or number of meals, rarely or sometimes; severely food insecure household has graduated to cutting back on meal size or number of meals often, and/or experiences any of the three most severe conditions (running out of food, going to bed hungry, or going a whole day and night without eating), even as infrequently as rarely; nearby: participant's place of residence to the health centre of < five kilometres or < one hour; distant: > five kilometres or > one hour

Table 2 Sociodemographic characteristics presented by glycaemic control in participants with type 2 diabetes in Kinshasa, n=620 (2021-2022)

	All participants (n, %), Nt=620	Good glycaemic control (n, %(95%CI)), Ng=200	Poor glycaemic control (n, %(95%CI)), Np=420	p
Age (years)				0.479
18-39	39 (6.3)	9 (22.8 (10.7-42.2))	30 (77.2 (57.8-89.3))	
40-64	342 (55.2)	112 (32.7 (26.7-39.4))	230 (67.3 (60.6-73.3))	
≥ 65	239 (38.5)	79 (33.0 (24.8-42.2))	160 (67.0 (57.6-75.2))	
Sex				0.989
Male	211 (34.0)	68 (32.2 (24.6-40.8))	143 (67.8 (59.2-75.4))	
Female	409 (66.0)	132 (32.2 (25.3-40.0))	277 (67.8 (60.0-74.7))	
Marital status				0.413
Single	199 (32.1)	68 (34.3 (25.7-43.9))	131 (65.7 (56.1-74.3))	
Married	393 (63.4)	126 (31.3 (25.4-39.3))	267 (65.7 (60.7-74.6))	
Other	28 (4.5)	6 (21.3 (9.7-40.6))	22 (78.7 (59.4-90.3))	
Educational status				0.781
No formal	77 (12.4)	28 (36.4 (18.2-59.7))	49 (63.6 (40.3-81.8))	
Primary school	199 (3.2)	64 (32.1 (24.6-40.6))	135 (67.9 (59.4-75.4))	
Secondary school	269 (43.4)	87 (32.3 (25.9-39.4))	182 (67.7 (60.6-74.1))	
University	75 (12.1)	21 (27.9 (19.5-38.3))	54 (72.1 (61.7-80.5))	
Occupation				0.518
Employed	132 (21.3)	45 (34.1 (27.2-41.9))	87 (65.9 (58.1-72.8))	
Unemployed	419 (67.6)	130 (30.9 (24.1-38.8))	289 (69.1(61.2-75.9))	
Other	69 (11.1)	25 (36.3 (25.6-48.6))	44 (63.7 (51.4-74.4))	
Income				0.342
Below poverty line	473 (76.3)	149 (31.4 (25.1-38.5))	324 (68.6 (61.5-74.9))	

Above the poverty line	147 (23.7)	51 (34.7 (27.8-42.4))	96 (65.3 (57.6-72.2))	
Access to food				0.192
Food secure	249 (40.2)	69 (27.6 (19.7-37.3))	180 (72.4 (62.7-80.3))	
Mildly Food Insecure	71 (11.5)	28 (36.5 (24.2-50.9))	49 (63.5 (49.1-75.8))	
Moderately Food Insecure	107 (17.3)	43 (40.2 (31.5-49.6))	64 (59.8 (50.4-68.5))	
Severely Food Insecure	187 (30.2)	60 (31.9 (24.0-41.1))	127 (68.1 (58.9-76.0))	
Health insurance				0.782
Insured	49 (7.9)	17 (34.5 (20.2-52.2))	32 (65.5 (47.8-79.8))	
Uninsured	571 (92.1)	183 (32.0 (25.8-39.0))	388 (68.0 (61.0-74.2))	
Distance to a health facility				0.644
Nearby	451(72.7)	148 (32.8 (25.8-40.6))	303 (67.2 (59.4-74.2))	
Distant	189 (27.3)	52 (30.7 (23.7-38.7))	117(69.3 (61.3-76.3))	

Legend: Nt: total number of participants, Ng: number of participants with good glycaemic control, Np: number of participants with poor glycaemic control, primary: 1-7 years; secondary: 8-12 years; tertiarty: > 13 years; food secure household: no food insecurity; mildlyfood insecure household: worries about not having enough food sometimes or often, and/or is unable to eat preferred foods, and/or eats a more monotonous diet than desired and/or some foods considered undesirable, but only rarely; moderately food insecure household sacrifices quality more frequently, by eating a monotonous diet or undesirable foods sometimes or often, and/or has started to cut back on quantity by reducing the size of meals or number of meals, rarely or sometimes; severely food insecure household has graduated to cutting back on meal size or number of meals often, and/or experiences any of the three most severe conditions (running out of food, going to bed hungry, or going a whole day and night without eating), even as infrequently as rarely; poverty line: 1.99 US $ distant: nearby: participant's place of residence to the health centre of < five kilometres or < one hour; distant: > five kilometres or > one hour

However, participants with good glycaemic control differed significantly from those with poor glycaemic control in terms of BMI (p=0.005), control of blood pressure (p=0.009), and treatment regimens (p=0.002) (Table 3).

Perceived support from significant others (p=0.006), perceived family support (p=0.020), treatment regimen distress (p=0.033), and adherence to physical activity (p=0.019) were significantly different between participants with good glycaemic control and those having poor glycaemic control (Table 4).

Determinants of poor glycaemic control

Participants on monotherapy with insulin (AOR: 1.72 (95%CI:1.17-2.55)) had increased odds of poor glycaemic control compared to participants on oral hypoglycaemic drugs (Table 5). In contrast, participants uncontrolled blood pressure (AOR: 0.60 (95%CI:0.39-0.92)) were less likely to have poor glycaemic control compared to participants having controlled blood pressure (Table 5).

Table 3 Lifestyle and clinical characteristics and glycaemic control among participants with type 2 diabetes in Kinshasa

	All participants (n, %), Nt=620	**Good glycaemic control (n, %(95% CI)), Ng=200**	**Poor glycaemic control (n, %(95% CI)), Np=420**	**p**
Smoking				0.268
No	616 (99.4)	200 (32.4 (26.5-38.9))	416 (67.6 (61.1-73.5))	
Yes	4 (0.6)	0 (0.0 (0.0))	4 (100.0 (0.0))	
Alcohol disorder				0.566
No disorder	611 (98.6)	198 (32.4 (26.5-38.8))	413 (67.6 (61.2-73.5))	
Health risk consumption	9 (1.4)	2 (22.1 (4.0-66.2))	7 (77.9 (33.8-96.0))	
Duration of diabetes (years)				0.549
0-5	267 (43.1)	84 (31.3 (23.0-41.0))	183 (68.7 (59.0-77.0))	
5-10	217 (35.0)	76 (35.1 (26.5-44.8))	141 (64.9 (55.2-73.5))	
≥ 10	136 (21.9)	40 (29.3 (22.2-37.5))	96 (70.7 (62.5-77.8))	
Body mass index				0.005*
Underweight/normal	412 (66.5)	116 (28.2 (21.4-36.0))	296 (71.8 (64.0-78.6))	
Overweight/obesity	208 (33.5)	84 (40.4 (33.5-47.7))	124 (59.6 (52.3-66.5))	
Waist circumference				0.082
Abnormal	243 (39.2)	93 (38.2 (29.8-47.3))	150 (61.8 (52.7-70.2))	
Normal	377 (60.8)	107 (28.3 (21.5-36.3))	270 (71.7 (63.7-78.5))	
Presence of comorbidities				0.266
Yes	401 (64.7)	136 (33.9 (27.6-40.7))	265 (66.1 (59.3-72.4))	
No	219 (35.3)	64 (29.2 (21.6-38.1))	155 (70.8 (61.9-78.4))	
Hypertension				0.145
Yes	405 (65.3)	121 (29.9(23.0-37.7))	284 (70.1(62.3-77.0))	
No	215 (34.7)	79 (36.7(29.6-44.5))	136 (63.3(55.5-70.4))	
Blood pressure				0.008*
Controlled	411 (66.3)	115 (280 (21.5-35.5))	296 (72.0 (64.5-78.5))	
Uncontrolled	209 (33.7)	85 (40.7 (33.4-48.4))	124 (59.3 (51.6-66.6))	
Treatment				0.002*

Insulin	334 (53.9)	87 (26.0 (20.7-32.1))	247 (74.0 (67.9-79.3))	
OHA	237 (38.2)	98 (41.3 (31.6-51.7))	139 (58.7 (48.3-68.4))	
Mixed	49 (7.9)	15 (30.7 (21.1-42.3))	34 (69.3 (57.7-78.9))	
Duration of treatment				0.229
< 7 years	387 (62.4)	132 (34.1 (27.3-41.6))	255 (65.9 (58.4-72.7))	
≥ 7 years	233 (37.6)	68 (29.1 (21.9-37.4))	165 (70.9 (62.6-78.1))	

Legend: : Nt: total number of participants, Ng: number of participants with good glycaemic control, Np: number of participants with poor glycaemic control, *: statistically significant; CI: Confidence Interval; Body mass Index: underweight/normal (Body mass index <25.0 Kg/m2), overweight/obesity (Body mass index≥25 Kg/m2); waist circumference: normal (men <102 centimetres; and women <88 centimetres), abnormal: (men ≥102 centimetres; and women ≥88 centimetres); blood pressure: controlled (systolic blood pressure level < 130 mmHg and a diastolic blood pressure level < 80 mmHg), uncontrolled (systolic blood pressure level equal or more than of 130 mmHg and/or a diastolic blood pressure level of equal or more than 80 mmHg)

Table 4 Psychological characteristics and glycaemic control among participants with type 2 diabetes in Kinshasa (n=620)

	All participants (n, %), Nt=620%)	**Good glycaemic control (n, %(95% CI)), Ng=200**	**Poor glycaemic control (n, %(95% CI)), Np=420**	**p**
Adherence to treatment				
High	351 (55.6)	110 (31.3 (23.4-40.3))	241 (68.7 (59.7-76.6))	0.427
Moderate	217 (35.0)	76 (35.0 (29.2-41.4))	141 (65.0 (58.6-70.8))	
Low	52 (8.4)	14 (26.8 (17.0-39.7))	38 (73.2 (60.3-83.0))	
Depression				
Without depression	612 (98.7)	198 (32.3 (26.5-38.7))	414 (67.6 (61.3-73.5))	0.535
Moderate depression	6 (.9)	1 (16.7 (2.6-60.0))	5 (83.3 (40.0-95.4))	
Moderately severe depression	2 (0.3)	1 (50.1 (4.6-95.4))	1 (49.9 (4.6-95.4))	
Multidimensional perceived social support				
Total score				0.299
Low support	139 (22.4)	40 (28.8 (20.6-38.6))	99 (71.2 (61.4-79.4))	
Moderate support	460 (74.2)	150 (32.5 (25.6-40.4))	310 (67.5 (59.6-74.4))	
High support	21 (3.4)	10 (47.4 (27.8-67.8))	11 (52.6 (32.2-72.2))	
Significant others				0.006*
Low support	182 (29.4)	49 (26.9 (19.3-36.1))	133 (73.1 (63.9-80.7))	
Moderate support	325 (52.4)	98 (30.2 (23.2-38.2))	227 (69.8 (61.8-76.8))	
High support	113 (18.2)	53 (46.7 (38.1-55.6))	60 (53.3 (44.4-61.9))	
Family				0.020*
Low support	140 (22.6)	44 (31.5 (24.7-39.3))	96 (68.5 (60.7-75.3))	
Moderate support	386 (62.3)	111 (28.7 (21.4-37.2))	275 (71.3 (62.8-78.6))	
High support	94 (15.2)	45 (47.8 (36.3-59.5))	49 (52.2 (40.5-63.7))	
Friends				0.463
Low support	282 (45.5)	100 (35.3 (27.1-44.5))	182 (64.7 (55.5-72.9))	
Moderate support	321 (51.8)	95 (29.6 (20.7-40.4))	226 (70.4 (59.6-79.3))	
High support	17 (2.7)	5 (29.4 (17.1-45.6))	12 (70.6 (54.4-82.9))	
Diabetes distress				
Total score				0.113
No distress	268 (43.2)	105 (39.0 (31.8-46.8))	163 (61.0 (53.2-68.2))	
Moderate distress	138 (22.3)	37 (26.8 (19.5-35.5))	101 (73.2 (64.5-80.5))	
High distress	214 (3.5)	58 (27.2 (16.9-40.6))	156 (72.8 (59.4-83.1))	
Emotional				0.375

No distress	395 (63.7)	135 (34.1 (27.9-40.9))	260 (65.9 (59.1-72.1))	
High distress	225 (36.3)	65 (28.9 (19.8-40.2))	160 (71.1 (59.8-80.2))	
Regimen				0.033*
No distress	256 (41.3)	102 (39.7 (32.1-47.9))	154 (60.3 (52.1-67.9))	
Moderate distress	144 (23.2)	31 (21.5 (14.7-30.3))	113 (78.5 (69.7-85.3))	
High distress	220 (35.5)	67 (30.5 (20.7-42.5))	153 (69.5 (57.5-79.3))	
Interpersonal				0.293
No distress	247 (39.8)	91 (36.7 (29.1-45.1))	156 (63.3 (54.9-70.9))	
Moderate distress	130 (21.0)	37 (28.4 (22.3-35.4))	93 (71.6 (64.6-77.7))	
High distress	243 (39.2)	72 (29.6 (19.9-41.6))	169 (70.4 (58.4-80.1))	
Physician				0.134
No distress	278 (44.8)	106 (38.0 (30.8-45.8))	172 (62.0 (54.2-69.2))	
Moderate distress	129 (20.8)	40 (30.9 (25.7-36.6))	89 (69.1 (63.4-74.3))	
High distress	213 (34.4)	54 (25.5 (15.3-39.2))	159 (74.5 (60.8-84.7))	
Self-management				
Total score				0.748
Good adherence	595 (96.0)	193 (32.4 (26.2-39.3))	402 (67.6 (60.7-73.8))	
Poor adherence	25 (4.0)	7 (28.3 (11.2-55.3))	18 (71.7 (44.7-88.8))	
Dietary control				0.386
Good adherence	526 (84.8)	174 (33.0 (26.0-40.8))	352 (67.0 (59.2-74.0))	
Poor adherence	94 (15.2)	26 (27.7 (19.8-37.2))	68 (72.3 (62.8-80.2))	
Glucose management				0.511
Good adherence	552 (89.0)	181 (32.7 (26.5-39.6))	371 (67.3 (60.4-73.5))	
Poor adherence	68 (11.0)	19 (28.0 (16.4-43.4))	49 (72.0 (56.6-83.6))	
Physician contact				0.304
Good adherence	552 (89.0)	183 (33.1 (26.3-40.6))	369 (66.9 (59.4-73.7))	
Poor adherence	68 (11.0)	17 (25.1 (15.1-38.7))	51 (74.9 (61.3-84.9))	
Physical activity				0.019*

Good adherence	385 (62.1)	110 (28.5 (22.7-35.2))	275 (71.5 (64.8-77.3))	
Poor adherence	235 (37.9)	90 (38.2 (30.5-46.6))	145 (61.8 (53.4-69.5))	
Knowledge on diabetes				0.097
Low	174 (28.1)	62 (35.6 (27.6-44.6))	112 (64.4 (55.4-72.4))	
Acceptable	245 (39.5)	68 (27.7 (20.9-35.7))	177 (72.3 (64.3-79.1))	
Good	201 (32.4)	70 (34.7 (28.5-41.5))	131 (65.3 (58.5-71.5))	

Legend: Nt: total number of participants, Ng: number of participants with good glycaemic control, Np: number of participants with poor glycaemic control, *statistically significant at $p < 0.05$; CI: Confidence Interval; Knowledge level with Simplified knowledge test: low (< 7), acceptable (7–10), good (≥ 11); adherence level with Morisky Levine Test: high (0), medium (1-2), low (3–4); social support score with Multidimensional Scale for Perceived Social Support: low (1–2.9), moderate (3–5), high (5.1–7); depression score with Patient Health Questionnaire-9: moderate depression (12–14), moderately severe depression (15–19), severe depression (20–27) ; diabetes distress score (all scales): no distress (< 2.0), moderate distress (2.0–2.9), high distress (> 3.0); diabetes self-management score (all scales) : poor adherence (dietary control < 4, glucose management < 5, physical activity < 3, physician contact < 3), good adherence (dietary control ≥ 4, glucose management ≥ 5, physical activity ≥ 3, physician contact ≥ 3); alcohol use score with the Alcohol Use Disorders Identification Test-Concise: health risk-consumption: ≥ 4 (in men) or ≥ 3 (in women)

Table 5 Factors associated with poor glycaemic control among patients with type 2 diabetes in Kinshasa, 2021-2022

	Univariate analysis		Multivariate analysis	
	p	**COR (95%CI)**	**AOR (95%CI)**	p
Age (years)				
18-39		1	1	
40-64	0.276	0.61 (0.24-1.54)	0.72 (0.30 -1.70)	0.430
≥ 65	0.271	0.60 (0.23-1.54)	0.79 (0.34-1.82)	0.565
Sex				
Male		1	1	
Female	0.989	1.00 (0.64-1.55)	0.99 (0.65-1.50)	0.959
Access to food				
Food secure		1	1	
Mildly Food Insecure	0.199	0.66 (0.35-1.27)	0.82 (0.44-1.54)	0.525
Moderately Food Insecure	0.008	0.57 (0.38-0.85)	0.80 (0.41-1.59)	0.514
Severely Food Insecure	0.468	0.81 (0.45-1.46)	0.67 (0.38-1.19)	0.161
Body mass index (Kg/m^2)				
<25		1	1	
≥ 25	0.022	0.58 (0.37-0.91)	0.83 (0.58-1.20)	0.305
Waist circumference				
Normal		1	1	
Abnormal	0.084	0.64 (0.38-1.07)	0.88 (0.53-1.45)	0.603
Blood pressure				
Controlled		1		
Uncontrolled	0.009	0.57 (0.38-0.85)	0.60 (0.39-0.92)	0.021*
Duration of treatment (years)				
< 7		1	1	
≥ 7	0.229	1.26 (0.85-1.87)	0.74 (0.51-1.09)	0.124
Treatment regimen				
OHA		1	1	
Insulin	0.003	2.00 (1.31-3.05)	1.72 (1.17-2.55)	0.009*
Mixed	0.144	1.59 (0.84-2.99)	1.56 (0.73-3.33)	0.233
Significant other support				
Low support		1	1	
Moderate support	0.465	0.85 (0.54-1.34)	0.82 (0.52-1.29)	0.382
High support	0.002	0.42 (0.25-0.71)	0.65 (0.36-1.16)	0.135
Family support				
Low support		1	1	
Moderate support	0.586	1.14 (0.69-1.91)	1.18 (0.63-2.21)	0.585
High support	0.015	0.50 (0.29-0.86)	0.69 (0.34-1.40)	0.287
Diabetes distress				
No distress		1	1	
Moderate distress	0.017	1.75 (1.12-2.73)	1.45 (0.88-2.29)	0.134
High distress	0.009	1.72 (0.83-3.54)	0.95 (0.40-2.16)	0.899

Physical activity				
Poor adherence		1	1	
Good adherence	0.019	1.55 (1.08-2.22)	1.09 (0.74-1.61)	0.639
Knowledge on diabetes				
Low		1	1	
Acceptable	0.004	1.45 (1.14-1.83)	1.11 (0.80-1.54)	0.506
Good	0.846	1.04 (0.68-1.59)	0.64 (0.41-1.00)	0.050

Legend: *statistically significant; COR: Crude Odds Ratio; AOR: Adjusted Odds Ratio; food secure household: no food insecurity; mildly food insecure household: worries about not having enough food sometimes or often, and/or is unable to eat preferred foods, and/or eats a more monotonous diet than desired and/or some foods considered undesirable, but only rarely; moderately food insecure household sacrifices quality more frequently, by eating a monotonous diet or undesirable foods sometimes or often, and/or has started to cut back on quantity by reducing the size of meals or number of meals, rarely or sometimes; severely food insecure household has graduated to cutting back on meal size or number of meals often, and/or experiences any of the three most severe conditions (running out of food, going to bed hungry or going a whole day and night without eating): significant other support and family support: low (1–2.9), moderate (3–5), high (5.1–7); diabetes distress score: no distress (<2.0), moderate distress (2.0–2.9), high distress (>3.0); Knowledge level with Simplified knowledge test: low (<7), acceptable (7–10), good (≥11); Body mass Index: underweight/normal (Body mass index <25.0 Kg/m2), overweight/obesity (Body mass index≥25 Kg/m2); waist circumference: normal (men <102 centimetres; and women <88 centimetres), abnormal: (men ≥102 centimetres; and women ≥88 centimetres); blood pressure: controlled (systolic blood pressure level < 130 mmHg and a diastolic blood pressure level < 80 mmHg), uncontrolled (systolic blood pressure level equal or more than of 130 mmHg and/or a diastolic blood pressure level of equal or more than 80 mmHg); OHA: Oral Hypoglycaemic Agent

Discussion

This study was designed to assess the extent of poor glycaemic control and describe its associated factors among patients living with type 2 diabetes in Kinshasa. The study found that poor glycaemic control is very prevalent and no sociodemographic or lifestyle characteristics were associated with glycaemic control. More than half of the participants were on insulin monotherapy (53.9%; n=334). Participants on monotherapy with insulin had increased odds of poor glycaemic control compared to participants on oral hypoglycaemic drugs. In contrast, participants who had uncontrolled blood pressure were less likely to have poor glycaemic control compared to participants having controlled blood pressure.

That more than two-thirds of the study participants were found to have poor glycaemic control corroborates the findings of previous studies on glycaemic control in SSA [10,11]. Furthermore, this study found a lower prevalence of poor glycaemic control than that found by Blum et al in the nearby rural province of Kwilu in the DRC. In rural areas of the DRC, there are fewer centres that offer care to patients with diabetes, and the access to medicines as well as the range of medications are limited. Health system planners must work to ensure equitable geographical distribution of diabetes care centres, and a regular and extensive supply of diabetes medications.

Glycaemic control in our study was poorer than that found in European or North American studies [41,42], and indicated poor diabetes care in Kinshasa. The results are similar to that in SSA in general, is due to multifactorial reasons including lack of adequate funding for non-communicable diseases, lack of evidence-based national guidelines directed at diabetes, lack of availability of medications and other supplies, and inequity between the public and private sector diabetes care [7,8]. Self-management is key to glycaemic control but has been reported to be poor in SSA and represents a threat to the health of individuals and capacity of the health system [43]. An effective preparation of the health care systems to face the diabetes burden is important and should include effective financing, training of healthcare providers, and provision of the required materials and medicines [7,44].

No sociodemographic and lifestyle characteristics were associated with poor glycaemic control similar to the findings of the study of Blum et al [12], in the nearby province of Bandundu, DRC. The income assessed in our study was the individual's income and did consider the contribution of relatives, which was sometimes substantial. In addition, most persons living with diabetes in our study were not paid employees and, those in the informal sector of the

economy may not accurately determine their income. Overall, the general financial state of the patients was not good and interventions that enhance affordability and access to diabetes care are warranted in Kinshasa. Such may include the implementation of universal health coverage [45] as advocate for by the WHO for improved access and health outcomes, particularly among the financially vulnerable groups such as the elderly, women, children and non-insured Sagastume et al [13] also found that younger persons with diabetes needed to give attention to achieving glycaemic targets and need to be targeted during clinic visits for treatment dherence check and if necessary, health education/counselling and intensification of treatments, as the for social protection through the universal health coverage.

Our study found that slighty more than half the participants were on monotherapy with insulin. This finding agrees with the study by Sagastume et al in a retrospective analysis of the database of the Kinshasa Primary Healthcare Network that found 56.6% of patients on insulin [13]. These findings are far higher than the use of insulin elsewhere for patients with type 2 diabetes (7.58% in a study in a primary care setting in the Netherlands) [46] or in most other African countries [47]. While this could be a symptom of poor access to newer oral hypoglycaemic agents when tighter control is needed [48]. The propensity of clinicians to use insulin might also reflect the lack of appropriate guidelines or poor clinicians' adherence to evidence-based clinical guidelines. There is also no system of safeguarding or regulating medical prescriptions, especially as these are mostly provided in private clinics. Clear management guidelines must therefore be developed for the rational use of available medicines. The technical supervision of health facilities by the national programme is critical to ensuring the proper management of diabetes in accordance with published evidence-based standards.

In this study, participants on monotherapy with insulin were 1.72 times more likely to have poor glycaemic control than those on oral hypoglycaemic drugs. Studies have shown that only around a quarter of persons with diabetes on insulin could achieve glycaemic targets because they might be erroneously taking an insufficient daily dose and incorrectly titrating insulin [49]. One may also therefore hypothesize that as most of the persons with diabetes were unemployed and not covered by health insurance, they were unable to adequately follow the prescribed regimen, considering that most participants were of low socioeconomic status and may lack money to pay for their medicines or food. Psychological resistance to insulin therapy is prevalent in our setting according to the study by Rita et al [50], and could also be another explanation for poor glycaemic control among persons with type 2 diabetes who despite the need to intensify treatment, are reluctant to initiate insulin therapy. In the Diabetes Attitudes,

Wishes and Needs second study (DAWN), participants reported having low confidence in the efficacy of insulin, with 26.9% of them abstaining from insulin because they thought insulin therapy is unfeasible or impracticable to manage their diabetes [51]. When patients show elements of reluctance, healthcare providers need to ensure that psychological resistance to initiating insulin is adequately addressed, and that patients with diabetes are educated to understand the breath of management and the necessity of escalation when a step fails to achieve glycaemic control.

In this study sample, participants with uncontrolled blood pressure were 40.0% less likely to have poor glycaemic control. This association is unusual in the medical literature and counterintuitive. Indeed, controlling blood pressure is one of the goals of managing type 2 diabetes as elevated blood pressure exacerbates both micro-and macrovascular complications of diabetes [52]. Mobula et al [53], in a Ghanaian study, also found that systolic blood pressure was significantly higher among persons with diabetes having adequate glycaemic control compared to the group with poor glycaemic control. As discussed by Mobula et al [53], among persons with diabetes having good glycaemic control, it can be that there was a significantly higher proportion of patients with dual diagnosis—hypertension and diabetes. This association is most likely related to the burden of treatment associated with having diabetes and hypertension co_morbidity. Since diabetes is the more burdensome of the two, it is likely that it attracts more attention for both patients and healthcare providers. Also, the asymptomatic nature of hypertension may make patients think it is less consequential. The lower prioritization of its treatment in patients with co-morbid diabetes may therefore explain the reduced likelihood of poor glycaemic control. Since co-morbid uncontrolled hypertension in a patient with diabetes tremendously increases the risk of adverse outcomes, it is important to ensure that both blood pressure and glycaemia control are considered equally important [54].

Strengths and limitations of the study

This study estimated the extent of poor glycaemic control among type 2 diabetes patients in Kinshasa. Also, it broadly assessed the psychological scales related to glycaemic control in SSA to promote an understanding of the management of patients with diabetes. Because of the cross-sectional nature of the study, it is not possible to ascertain a causal relationship between poor glycaemic control and the determinants. Other potential biases include selection bias as only patients who attended the diabetic clinics during the period of the study could be included in the study; recall bias as for some responses, the participants might refer to their history with the possibility of having lost memory or omitted details for some events; interviewer bias since the

data collectors could have influenced the participants by how they asked questions or reacted to the answers; and social desirability bias as participants could have given answers that made them look good to the respondents and did not talk about their true experiences [55]. These biases were minimised by ensuring effective training of the data collectors to ensure that the aim and objectives of the study were clearly stated to the participants, and that questions were asked in a non-judgemental way. Notwithstanding the limitations, this study provides an understanding of important factors that influence poor glycaemic control in Kinshasa, DRC and which when addressed, have the potential to improve glycaemic control in Kinshasa, DRC, or similar settings, particularly in SSA.

Conclusion

Poor glycaemic control is prevalent among patients with type 2 diabetes in Kinshasa, DRC and a large proportion of the study participants were on monotherapy with insulin and being on insulin alone was associated with poor glycaemic control. Having uncontrolled blood pressure were less likely associated with poor glycaemic control. Our findings stressed the need for better management of diabetes through elaboration and adherence to clear management guidelines for type 2 diabetes in primary care settings.

List of abbreviations

AOR: Adjusted Odds Ratio, BMI: Body mass index, CEUPC: Ethics Committee of the Protestant University of the Congo, COR: Crude Odds Ratio, DAWN: Diabetes Attitudes, Wishes and Needs second study, DRC: Democratic Republic of the Congo, IQR: Inter Quartile Range, RedCap: Research Electronic Data Capture, SSA: Sub-Saharan Africa, STATA: Statistics and data.

Declarations

Ethics approval

The researchers declared that they complied with the conditions under which this study obtained approval from the ethics committees of the Protestant University of Congo (reference number: CEUPC 0067; Date: 05/02/2021) and Human Research Ethics Committee (Medical) of the University of the Witwatersrand (reference number: M210308; Date: 26/08/2021). The study was conducted according to the ethical guidelines of the Declaration of Helsinki. Permission was obtained from the Kinshasa Primary HealthCare Network to conduct the study. Informed consent was obtained from each participant. Data collection was conducted in strict adherence to local COVID-19 regulations.

Consent for publication

Informed consent was obtained from each participant.

Availability of data and materials

All data generated or analysed during this study are included in this published article and its supplementary information files.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

JPF, OBO, and JMF designed the study. JPF contributed to acquisition of funding and data. JPF oversaw the research process. JPF and JMF performed the data processing and quality control. JPF conducted the statistical analyses, drafted the manuscript, and is the guarantor of this work. JPF, OBO, and JMF interpreted the data. All authors edited and critically reviewed the manuscript for intellectual content and approved the final version.

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CHAPTER FIVE — PERSPECTIVES FROM PERSONS WITH TYPE 2 DIABETES AND HEALTH PROVIDERS TO IMPROVING GLYCAEMIC CONTROL IN KINSHASA, DEMOCRATIC REPUBLIC OF THE CONGO

5.1 Introduction

Using the findings from previous sub-studies, a qualitative study was conducted in Kinshasa to explore the patients' and healthcare providers' perspectives on improving glycaemia control. This chapter presents the themes identified and and their integration using the WHO Innovative Care for Chronic Conditions Framework.

5.2 Research paper 5: Perspectives of healthcare providers and persons with type 2 diabetes mellitus on improving glycaemic control in Kinshasa, Democratic Republic of the Congo: a qualitative study

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Abstract

Background

Despite advances in the therapeutic management of type 2 diabetes, glycaemic control remains suboptimal in sub-Saharan Africa, including in the Democratic Republic of the Congo (DRC). Defining interventions to improve glycaemic control requires an accurate knowledge of local factors that relate to poor glycaemic control including the views and perspectives of key stakeholders such as healthcare providers and persons with diabetes. Qualitative studies exploring these perspectives are lacking in the DRC. The aim of this study was to explore the perspectives of persons with type 2 diabetes and healthcare providers on ways to improve glycaemic control in the DRC.

Methods

This qualitative study utilized one-on-one in-depth interviews conducted on 26 purposefully sampled participants - 10 persons with type 2 diabetes and 16 healthcare providers in Kinshasa, DRC. The study used deductive, constructionist, and thematic analyses. Themes were organized and integrated using the World Health Organization Innovative Care for Chronic Diseases Framework.

Results

From the healthcare providers statements regarding improving glycaemic control, three themes were identified: strengthening the healthcare system, supporting persons with diabetes/population, and adopting supportive health policies. From the persons with diabetes perspectives three themes were also identified: need for support for caring of the illness, need for enhanced knowledge about diabetes, and the need for better communication with healthcare providers. The improvement of glycaemic control requires action from the persons with diabetes and their families, healthcare organisations, the community, and the policy environment. The persons with diabetes should be empowered for self-management through a patient-provider relationship that is patient-centred. The care offered to persons with diabetes should be evidence-based and provided by multidisciplinary healthcare teams in well-equipped healthcare facilities. At the community level, efforts should focus on improving people's knowledge of diabetes and providing more support to persons with diabetes. At the policy level, primary prevention of diabetes and effective healthcare financing should be assured.

Conclusion

This study found that the improvement of glycaemic control for persons with type 2 diabetes in Kinshasa, DRC, requires multidimensional strategies that include persons with diabetes, family and community level interventions; structural and processes of care interventions in the health system; and health policy level interventions. To be efficient, these interventions need to be

integrated into existing platforms of healthcare services delivery, particularly the chronic diseases management framework.

Keywords: perspectives, glycaemic control, type 2 diabetes, qualitative study

Background

Type 2 diabetes is the most common form of diabetes, and its prevalence is expected to rise because of ageing, economic development, and increasing urbanisation leading to more sedentarily lifestyles and greater consumption of unhealthy foods linked to obesity [1]. Africa as a region is experiencing the greatest increase in the number of cases of diabetes worldwide and also has the highest prevalence of undiagnosed diabetes [2,3]. In the Democratic Republic of the Congo (DRC), the prevalence of diabetes will also increase, with urban areas most affected [1].

One of the goals in diabetes management is the control of blood sugar, which avoids or reduces the risk of diabetic complications. When complications occur, these impose additional costs to persons with diabetes and reduce their quality of life [4,5]. Many advances have been made on the therapeutic level including the development of evidence-based guidelines and the addition of new anti-diabetic medications. However, the results in terms of glycaemic control are not clear. On the global level, only half the patients with diabetes were controlled [6]. In sub-Saharan Africa, blood sugar control rates were very low [7]. And, in the DRC, recent studies in type 2 patients showed control rates ranging from 14 to 30% [8].

Studies into interventions for blood glucose control in diabetics require a clear knowledge of the factors related to poor glycaemic control. These factors are multiple and vary depending on the context [9-11]. Patients and healthcare providers' perspectives have been found to be essential for building an adequate and responsive healthcare system for diabetes care [12]. In sub-Saharan Africa, few studies have explored the lived experiences of patients on glycaemic control [13], and similarly, there are few studies assessing the perspectives and experiences of key players, patients and healthcare providers on improving glycaemic control.

The health system in the DRC directs most of its attention towards infectous diseases. Despite the emerging importance of noncommunicable diseases, the DRC lacks a comprehensive policy for their management and prevention. For example, since 2012, there has been no update of the standards for diabetes care [14]. An understanding of the current context of diabetes care is essential for drafting a management plan that will contribute to an improvement of glycaemic control. This need could be addressed by exploring the perspectives of patients and healthcare providers on ways to improve glycaemic control. Therefore, the aim of this study was to explore

the perspectives of patients and healthcare providers on ways to improve glycaemic control in the DRC.

Methods

Study design

This was a qualitative study that explored the perspectives of patients with type 2 diabetes mellitus and health providers regarding the ways to improve glycaemic control in Kinshasa, DRC. This study was part of a larger project on developing a framework for improving glycaemic control among patients with type 2 diabetes in Kinshasa, DRC [15]. The preceding phases of the project included: factors driving glycaemic control in sub-Saharan Africa: a systematic review and meta-analysis, and a mixed-method cross-sectional study on factors associated with poor glycaemic control in Kinshasa, DRC. The current study is reported according to the consolidated criteria for reporting qualitative research (COREQ) [16].

Theoretical framework

The literature has shown multiple perspectives from patients and providers about improving glycaemic control [17]. The inter-relatedness of these perspectives could best be explored using the World Health Organization (WHO) Innovative care for chronic conditions framework [18]. This framework was developed by the WHO to adapt the use of the Chronic Care Model [19] in low- and middle-income countries. It recognizes three levels of care (micro, meso, and macro) and incorporates six principles: evidence-based decision making, population focus, prevention focus, quality focus, integration, flexibility, and adaptability. The themes identified from this study resulted from deductive, constructionist, and thematic analysis processes of data collection and analysis [20].

Study setting

Kinshasa, the capital of the Democratic Republic of the Congo, had 16,315,534 inhabitants in 2023 [21]. The DRC is a low-income country located in Central Africa. A large majority of the population live below the poverty line and experience food insecurity [22]. At the time of the study, resources were scarce and only 4% of the national government budget was devoted to health [23]. Patients and households contributed more than 70% of health expenditure as universal health coverage was not fully implemented, leaving most people uninsured.

The management of diabetes in Kinshasa was largely provided by a structure called the Kinshasa Primary Healthcare Network that combined health structures of the Catholic Church

and the Salvation Army. In addition, a few other State and private clinics also cared for patients with diabetes. The diabetic clinics in these structures were managed by nurses and once monthly, a doctor came to visit the patients with diabetes. In Kinshasa, the pharmaceutical sector was largely dominated by private entrepreneurs who import the drugs; the distribution of drugs was also controlled by private merchants. Drug delivery was not reliable and the storage of products, such as insulin, was of a poor standard.

Study population and sample

We recruited health providers and patients with type 2 diabetes in Kinshasa Primary Healthcare Network, in both the state/public and private healthcare facilities. Patients and healthcare providers aged ≥ 18 years were invited to participate.

Patients were purposively selected ensuring that both controlled and uncontrolled patients, the diversity of sociodemographic characteristics, and the duration of the disease were taken into account. Patients selected were those who have been followed for at least six months for diabetes and caution was taken to select those who were willing to discuss their views on improving blood glucose control. Health facilities' teams who knew the patients helped in their selection; these patients were then invited to come to the healthcare facilities for interviews.

With regard to selecting healthcare providers, preference was given to providers with much experience of diabetes. Male and female providers were selected as well as doctors and nurses. The participants were excluded if they had difficulty communicating due to mental disability or refused to give consent. Health managers in charge of the health structures helped in selecting the health providers to include in the study.

For each category of participants, patients or healthcare providers, we stopped recruitment when data saturation was reached [24]. Each interview was analysed, and codes identified. In subsequent interviews, any new aspects, dimensions, or nuances of that code were identified, until no novelty emerged [24]. Selection of the participants took place from 21 October 2022 to 31 March 2023.

Data collection

The data collection was conducted through one-on-one in-depth interviews. The interviews were guided by an interview schedule (S4 appendix). At the respective facilities, the principal investigator interviewed the participants in a quiet room where the confidentiality of the

participants' statements was guaranteed. All interviews were audio recorded and lasted about 40-50 minutes. Each interview was analysed, and codes identified. Data collection was carried out in strict observance of the COVID-19 infection prevention regulations in the DRC.

Data management and analysis

The recorded interviews were transcribed verbatim and then translated into English by a language expert based in Kinshasa. The principal researcher who is fluent in French and Lingala verified the translation and transcription by listening to the audio recordings while reading the transcripts. The coding was performed independently by the principal researcher (JPF) and one supervisor (OBO) in selected interviews without any pre-conceptualized theoretical framework. The analysis was performed using the MAXQDA 2022 software [25]. The analysis included the six steps described by Braun and Clarke [26] - familiarization with the data, generating initial codes, searching for themes, reviewing potential themes, defining and naming the themes, and producing the report. Two experts in diabetology assisted in reviewing and conceptualizing the findings of the study. Outlying perspectives were sought out, and an explanatory model that best explains the inter-relatedness of themes was developed.

Results

A total of 26 participants were included in the study - 10 patients with type 2 diabetes and 16 healthcare providers. None of the participants invited for inclusion in the study refused or was excluded. Table 1 summarizes the participants' characteristics.

Table 1 Sociodemographic characteristics of the participants in Kinshasa, n= 26 (2023)

	N (%)
Patients	
Age (years)	
< 40	1 (3.8)
40-65	7 (26.9)
≥ 65	2 (7.7)
Sex	
Male	4 (15.4)
Female	6 (23.1)
Occupation	
Employed	5 (19.2)
Unemployed	5 (19.2)
Duration of diabetes (years)	
< 5	1 (3.8)
5-10	3 (11.5)
≥ 10	6 (23.1)
Health providers	
Age (years)	
< 40	5 (19.2)
40-65	6 (23.1)
≥ 65	2 (7.7)
Sex	
Male	9 (34.6)
Female	7 (26.9)
Category	
Doctors	
Specialists	6 (23.1)
Generalists	5 (19.2)
Nurses	4 (15.4)
Nutritionist	1 (3.8)
Number of years of experience with diabetes (years)	
< 5	1 (3.8)
5-10	7 (26.9)
≥ 10	8 (30.8)

A total of three major themes were identified from the healthcare providers statements for improving blood glucose control for type 2 diabetes patients in Kinshasa. Three themes were also identified from the declarations of the persons with diabetes (Table 2).

Table 2 Themes identified for improving glycaemic control, Kinshasa, Democratic Republic of the Congo, 2022-2023

	Theme	**Sub-themes**
Healthcare providers	Strengthening the healthcare system for diabetes care	Defining a management protocol
		Training of healthcare providers
		Providing basic materials
		Organising a reliable drug delivery system
		Promoting self-management
	Supporting patients/population	Community sensitization about diabetes
		Involving families as support system to patients
	Adopting supportive policies	Fight against poverty to address socioeconomic disparities
		Effective financing of the healthcare system
		Support activities for prevention of diabetes
		Multidisciplinary approach
Persons with diabetes	Need for support for caring of the illness	Diabetes leading to poverty
		Could they be treated as those with HIV without having to pay?
		Need for support for better adherence
	Need for knowledge on diabetes	Lack of knowledge on diabetes
		Knowledge as a means to better support and adequate behaviours from persons with diabetes' relatives
	Need for a better approach from healthcare provider	Better person with diabetes-healthcare provider communication
		Support to patient centred care

Healthcare providers perspectives

Theme 1: Strengthening the healthcare system

This first theme summarized the necessary actions to be taken in the health system and comprised four sub-themes: defining a management protocol, training of healthcare providers, providing basic materials, organising a reliable drug delivery system, promoting self-management, and individualized care.

Defining a management protocol

The evolution of disease management requires knowledge updates, which are essential for patient support. The participants recommended that there should be an updated management protocol and continuing professional development for healthcare providers engaged in diabetes care. At present, the different healthcare facilities were managing patients with diabetes according to their own rules. Isolated healthcare providers were not guided by any official guideline:

"Many of our staff care for diabetes based on training they received since five to six years ago. There is a need to re-train so that they can improve the way they are taking care of diabetes." (Generalist, Male, 5 years of experience)

"There is no normative document to guide the management of diabetes. It would be desirable to have them to guide the management and that even if a doctor is isolated, he can be guided in the way to treat the diabetic patient" (Nurse, Male, 11 years of experience)

Training of healthcare providers

When patients presented themselves to the health centre, the healthcare provider needed to have been trained to manage the patient effectively. Participants reported that an early diagnosis is of benefit for the patient and their glycaemic control:

"It (the health facility) must have a well-trained provider to carry out the diagnostic process and even offer opportunistic screening aimed at high-risk groups (Diabetologist, Male, 12 years of experience)

Only a small proportion of the personnel had training on how to manage diabetes. The participants recommended that health providers in contact with the population in primary healthcare facilities must receive training on diabetes care. Moreover, as the number of specialists on diabetes was limited and insufficient for the demand of care, participants recommended task shifting to help cover the demand of care.

Diabetes mellitus is a disease with a bad reputation among the public. A participant expressed that in many instances, a patient's denial is a common reaction to receiving a diagnosis of diabetes. This lack of understanding of diabetes may constitute a barrier for appropriate care. Participants suggested an approach of progressively engaging with the patients to promote an understanding of diabetes and its management:

"In most cases, the first time you tell the patient about the diagnosis of diabetes, they will reject it; He (the patient) will seek to provide you with another explanation for his complaints. He will tell you that he has taken too much sugar lately or that he is under

stress or that he has eaten beans. If you insist on convincing him that it's really diabetes, he's going to be gone forever. It must be done differently, with tact. (Diabetologist, Male, 12 years of experience)

Providing healthcare facilities with basic materials

The participants expressed that many health facilities lacked the necessary equipment to confirm the diagnosis of and monitor diabetes. Some health centres in rural areas only had urine strips for glucosuria. Once the diagnosis was made and the patient might be followed up, many health centres only based their follow-up on fasting blood sugar. They could not offer the battery of tests necessary for follow-up. The glycosylated haemoglobin was not available nor the tests for screening the complications. The participants recommended that health centres be equipped with the necessary point of care tests and materials for the diagnosis and follow-up of the patients.

A participant suggested that equipping facilities should take account of the level of care and clinical responsibility:

"At the health centre level, there is no need to do a lot of tests, blood glucose levels can be enough. When we multiply the examinations at the health centre, it creates an additional cost for patients. In the follow-up of patients, those who are not controlled are referred to the secondary level and those with complications or comorbidities should be managed at the tertiary level." (Diabetologist, Male, 14 years of experience)

Organising a reliable drug delivery system

Type 2 Diabetes is a chronic condition requiring the adoption of life-long medications. If non-therapeutic measures are prioritised, drugs would need to be added at some point and must be taken for a long time, if not for life. The lack of an organised drug delivery system also raised the problem of the quality of the drugs available in the setting. Apart from insulin, glibenclamide and metformin, the other more recently developed oral hypoglycaemic agents (α-glucosidase inhibitors, thiazolinediones, and meglitinides) were not available in many primary care settings. These new agents could present more options for dealing with glycaemic control before initiating treatment with insulin.

In addition, patients lacked facilities to store medications effectively e.g., a fridge for insulin. The participants recommended the organisation of a reliable drug delivery system, and that with the partnership of the private sector, this may help make medicines of acceptable quality available and affordable:

> *"What I can recommend is that drug products be available in our community." (Nurse, Male, 14 years of experience)*

It is crucial that the storage condition standards of the medications be maintained throughout the system of distribution to ensure that good quality drugs are sold to persons with diabetes as drug quality influences treatment efficacy and safety.

> *"The system must ensure that the medicines, mainly insulin, are stored according to the requirements. What we are seeing is that insulin is kept out of the fridge in many pharmacies." (Nurse, Female, 25 years of experience)*

Promoting self-management

Type 2 diabetes is a lifestyle disease and successful care requires that patients engage in lifestyle modifications. Moreover, they must adhere to the drug treatment and acquire the technical skills required for successful implementation of the drug treatment and lifestyle modification. The participants expressed they experienced many barriers in their life with diabetes and recommended that patients be empowered for self-management:

> *"In the training, it is said that diabetics cannot make the parade in the hospital because he must know how to take care of himself. We do everything to teach them how to take care of themselves, so that they can check their blood sugar with their device and follow their treatment properly." (Nurse, Female, 9 years with diabetes)*

One participant stressed that for good glycaemic control, this communication has to be extended to all significant persons related to the patient as they can interfere or influence the management and outcomes. He also suggested that regular home visits be performed to gain a deeper understanding of the patient's social context:

"If they had (the) financial means, we would also do home visits and arrive where the patients live with their families, since these are elements that we do not know. These elements can help us in finding solutions to the challenges raised in the care of these patients." (Generalist, Male, 15 years of experience)

As the patients were experiencing different challenges, the participants recommended their approach to patients with diabetes be individualized to respond to the needs relevant to each patient. Considering patients' socio-economic levels, the healthcare providers identified two categories of patients. Firstly, patients who were poor and could not consistently afford the cost of care (purchase of medicines, carrying out follow-up examinations, recommended diet, and lifestyle changes). Secondly, those who worked and were covered by insurance but had difficulties adhering to lifestyle modifications: hygiene-dietary measures, lack of time for physical exercise, and eating very late. Participants reported there was no suitable canteen or gymnasium at the workplace. When considering the age, the young were reluctant to adopt the requirements of the treatments, while the older people were limited by comorbid conditions.

Theme 2: Supporting the patients and the population

This theme described the actions for supporting the patients with diabetes to cope and succeed in reaching good glycaemic control. These actions related to the society, the health providers, and the community.

Community sensitization about diabetes

One participant expressed that for a person to seek care for diabetes, he must be informed about diabetes mellitus. Patients had many questions about the origin of the disease, especially at the beginning of the disease. When all these concerns were not well addressed, they might abandon treatment and move on to other alternatives:

"Patients who do not receive good information about their disease will orientate themselves to alternative medicine." (Diabetologist, Male, 12 years of experience*)*

The participants noted that there were many negative influences in the surroundings of patients with diabetes. For example, there were messages broadcast on radio and television by people claiming that they could cure the disease. These messages motivated patients to seek alternative treatments. There was a need for accurate information for the patients:

"It is also crucial to fight against those charlatans coming with illusions saying that they can cure diabetes and spreading messages through mass media." (Nurse, Female, 25 years of experience)

Involving families as a support system to patients

Several participants reported that it was important to involve families in the care of their family members. The family was in many instances the sole source of support for the patients. The family provided emotional and financial support. They found that this was of importance not only to the extent that families could help to lighten the burden of care, but that families could also encourage patients to follow their treatments:

"To improve blood sugar control, it is important to involve family members, because they are the ones who surround him more closely, help him to heal himself or to overcome difficulties." (Nurse, Female, 17 years of experience)

However, the proportion of aid received was not the same for everyone. It varied according to the person's rank in the family. The proportion of assistance received from family members also depended on their assets.

"My experience is that when the parents have diabetes, their elderly children respond favourably to our call and act to find a way to support their parents; when the sick person is a brother or a sister, assistance (support) is more difficult to get from their relatives." (Family physician, Male, 5 years of experience)

Theme 3: Adopting supportive policies

This theme described supportive policies required in the healthcare setting to facilitate the move to better glycaemic control.

Fight against poverty to address socioeconomic disparities

The lack of resources influenced many, if not all, aspects of diabetes care. From the organisation of care in the health system to the capacity of patients to adhere adequately to the treatment

prescribed by healthcare providers, through to the motivation of healthcare providers to be engaged in this activity.

One participant suggested that patients should be empowered in terms of financial capacity:

> *"Nothing could be done properly if the issue of poverty is not resolved." (Nurse, Female, 25 years of experience)*

> *"Patients do not know how to follow their treatments well if they are food insecure. Government action should also aim at improving." (Diabetologist, Male, 14 years of experience)*

Effective financing of diabetes care

Participants expressed that the Government had key roles to play in improving diabetes care and consequently, glycaemic control. One of these roles is ensuring that the health system was strengthened through the provision of sufficient funds to guarantee that all the activities dedicated to fight diabetes be realized.

Participants noticed a lack of distributive justice and called for equity in the distribution of health resources particularly in diabetes care:

> *"The Government must revise its lists of health priorities; diabetes might (should) be put at the same levels as malaria, tuberculosis and HIV/AIDS." (Generalist, Male, 5 years of experience).*

Support activities for the prevention of diabetes

Healthy lifestyle choices counted much in the prevention of diabetes. In Kinshasa, there was a tendency for inhabitants to drink sweetened beverages and eat fast-foods that were mainly cholesterol-rich foods. The consumption of these products was supported by widespread advertising on the streets, radio, and television. The Government should be involved in promoting the primary prevention of diabetes by discouraging the consumption of unhealthy diets or regulating their production:

"It is important to regulate the manufacture and consumption of sugar-sweetened beverages." (Diabetologist, Male, 14 years of experience)

Multidisciplinary approach

There was a need for a multidisciplinary approach to the management of diabetes in Kinshasa. The care of diabetes disease necessitates the involvement of many qualified healthcare providers to manage its complications in an effective manner. Bringing together all qualified specialised staff? in the current organisation of care could be difficult to implement as already, patients have difficulty affording the cost of care offered to them. One way to overcome this is for the highly qualified specialists—endocrinologist, nutritionist, psychologist, counsellors, and podologists—to define clear guidelines on how to approach the patients attending primary healthcare facilities and to teach these strategies to lower-level healthcare providers. Creating a multidisciplinary approach with tasks that complement each other would be a major step forward in primary healthcare in Kinshasa.

Persons with diabetes perspectives

Theme 1: Need for support for caring for the illness

For patients who were mostly uninsured or had low incomes, affording medication was a real hurdle. Drugs were expensive and not easily available because there was no reliable drug distribution system. Patients had to rely on private merchants who usually import diabetes medicines and determined their prices without any control. Diabetes care took up a large part of their revenue and sometimes was beyond their income.

"In current situation without health insurance, if they have not a good source of revenue, patients with diabetes are condemned to poverty and poor health outcomes." (Patient, Male, 20 years of diabetes)

Participants noticed a lack of distributive justice and called for equity in the distribution of health resources particularly in diabetes care. Many were asking themselves why they had to pay for their treatment while those suffering from malaria and HIV/AIDS were not paying.

"Why are we not treated freely as the other who had HIV/AIDS? We have no money. We are suffering for an illness that has no end" (Patient, Female, 10 years with diabetes)

One participant reported that even for him who was covered by a health mutual fund for the care of his illness, there was a limit on what he could use for a month. Many times, the insulin he was receiving could not be used until the next scheduled appointment. This made it difficult to adhere to what was prescribed.

Adhering to what is prescribed was identified by the participants as one way to succeed on diabetes treatment.

"Yes, if you do not respect what is prescribed, you will have complications." (Patient, Female, 15 years with diabetes)

Participants also explained how they used what was within their reach (technology) to help with adherence to treatment. One participant explained using the phone alarm to remember the times when he was taking medication:

"I try to take the medication as prescribed. I use my phone alarm to remind me of medication times." (Patient, Female, 7 years with diabetes)

Theme 2: Need for enhanced knowledge about diabetes

Most of the participants stated that they had little information about diabetes before they developed the disease. Their encounter with the healthcare teams helped them gain some information on the diabetes disease and its treatment. However, the people with whom they lived in their households still had beliefs that sometimes contrasted with what is prescribed by the healthcare teams. The fact that the persons with diabetes relatives had misunderstanding or erroneous beliefs could prompt the relatives to adopt behaviours that could interfere with the support they normally must provide for the persons with diabetes. Participants reported instances where they had been led to resort to fetishes or devotion to free themselves from diabetes. Sometimes, family members showed a lack of understanding when faced with the patients with diabetes'choice of new lifestyle. Family members may not support them even though their need is real.

The participants expressed their concern that in mass broadcasting channels, there was no message on diabetes while messages about other diseases such as malaria and HIV were common. The participants recommended that the population must be informed about diabetes:

> "I think we need a campaign to raise awareness or educate the population. The lack of information contributed to the deaths of many people." (Patient, Male, 20 years with diabetes)

Theme 3: Need for a better approach from healthcare providers

Diabetes is a disease for which the care requires active participation from the person with diabetes. The healthcare provider has the role to empower the person with diabetes. The healthcare provider must accurately understand the challenges faced by the person with diabetes in order to know how to manage the disease effectively.

To adequately identify the health needs and the context in which diabetes was experienced, participants recommended that healthcare providers develop good communication with their patients:

> *"If I have to recommend something to improve the care I'm receiving, this will be for the healthcare provider to develop good communication with their patients so as to let them understand what is going on with their disease and help them engage in the care." (Patient, Female, 5 years with diabetes)*

One participant stated that before she changed healthcare providers, she did not understand the real threat posed by diabetes and how necessary it was to manage the disease. The current healthcare provider tried to help her understand the results of lab exams, discuss what was better to achieve in terms of the glycaemia, and what was the side effects she could encounter. This showed the patient what was expected of them in the diabetes treatment.

> *"If I did not change the healthcare provider, I would probably be in jeopardy. I was not understanding what diabetes represented and what is required for its care."*
> (Patient, Female, 5 years with diabetes)

An important issue in this process was education for behavioural change. While many patients felt condemned when they received the diagnosis of diabetes, they appreciated the healthcare providers support which allowed them to develop a positive mindset towards their illness.

Discussion

This study aimed to describe the perspectives of healthcare providers and patients with type 2 diabetes on improving glycaemic control in Kinshasa, DRC. Three themes were identified from the analysis of the healthcare providers' statements: strengthening the healthcare system, supporting patients and their communities, and adopting supportive healthcare policies. Three themes were identified from the persons with diabetes perspectives: need for support for caring of the illness, need for enhanced knowledge about diabetes, and need for a better approach from healthcare providers .

Glycaemic control could not be achieved without strengthening the healthcare system and this includes ensuring that the evidence-based care of diabetes is managed by trained staff working in well-equipped healthcare structures and where the supplies are adequately organized [27]. An assessment of the Kinshasa Healthcare Network in relation to diabetes care found that the capacities, knowledge, and practice of type 2 diabetes care was poor [28]. Our study findings align with these authors' recommendations that the capacity of health facilities should be improved by providing the necessary equipment, training of healthcare providers, and implementing task shifting to other employee categories where there is a scarcity of medical doctors in primary healthcare facilities.

To achieve these changes in the healthcare system, better healthcare financing is required, mainly from the Government to invest more in the healthcare financing and including exploring public-private partnerships [29]. In Kinshasa, DRC, the private sector represents a major actor in the health sector, both in pharmaceuticals and in the provision of care. Nevertheless, apart from some waivers in the importation of health products, the private sector was not benefitting from any subsidies. Providing better quality diabetes care that is in line with standards will require a greater financial investment in healthcare services, which could be reflected in lowering the overall cost of care for patients. Already, our study found that the costs for diabetes care is a real barrier to accessing and adequately follow-up of the treatment. This could be partly addressed by the Government, through a public-private partnership with the pharmaceutical sector, to reduce costs by producing generic formulations, and thus help create an affordable

and reliable drug delivery system [29]. A study in Nigeria found that the integration of generic medicines into routine care as an element of a partnership with the pharmaceutical private sector helped reduce the burden of medications [30].

Considering their emerging importance in the health of the population, there is a need to advocate to the Government and society for a shift in the prioritisation of health issues, and incorporating noncommunicable diseases including diabetes. Such an advocacy requires accurate data about the burden of diabetes in the country. The Ministry of Health must thus empower the national diabetes programme to pilot and monitor the epidemiology and management of diabetes in the country. The national programme must also lead the development of a diabetes management programme for the country in collaboration with all the stakeholders in the management of diabetes.

Diabetes care is costly and costs per person are much higher than in the general population [31]. There is a need to reduce the financial burden of diabetes among persons with diabetes in our setting. Participants reported difficulty affording the costs of medications and monitoring of the treatment. In Kinshasa, most patients are uninsured and rely on out-of-pocket payments, resulting in significant risk for poor treatment adherence and glycaemic control [32]. To this end, a systematic review on the influence of health system on type 2 diabetes recommended reducing or even eliminating out-of-pocket payments [33]. In the light of the WHO recommendations, the government of the DRC must explore extending health insurance to those who are socioeconomically vulnerable by implementing universal health coverage [34]. For sustainability, there is a need to improve the financial capacity of the population through educational and socioeconomic programmes aimed at developing the knowledge and skills base of the population, as well as wealth creation and redistribution that fights endemic poverty.

A healthy lifestyle such as low calorie and fat diets, regular exercise, moderate alcohol consumption, and smoking cessation, reduce the risk of developing type 2 diabetes [35-37] and should be emphasised by public health programmes. Lifestyle programmes must be integrated and consider available and affordable foods and regulation of sugar sweetened beverages in the DRC, feasible exercise and physical activity plans in the community and workplace, as well as health policies that regulate alcohol and tobacco marketing, use and misuse [38-40]. At the population level, different strategies via diverse channels (media, labelling and information, economic incentives, schools, and workplaces) could be used to promote a healthy lifestyle [41]. For the media, sustained, focused media and educational campaigns for increasing the

consumption of healthy foods or reducing the consumption of specific less healthy foods and beverages, and tobacco could be used. The labelling and information used by mandated nutrition facts panels or campaigns encouraging physical exercise in public places could be useful. The economic incentives through tax strategies to increase the prices of less healthy foods and beverages, and tobacco products, or in contrast, to subsidise strategies to lower the prices of more healthy foods and beverages. At schools, multi component interventions focused on improving both diet and physical activity, include specialised educational curricula. At the workplace, this includes comprehensive worksite wellness programmes with nutrition, physical activity, and tobacco cessation/prevention.

Self-care behaviours — adopting a healthy diet, exercising regularly, and getting plenty of sleep — are correlated with improved glycaemic control [42], however, many barriers to self-management in patients with type 2 diabetes were reported by study participants. In our study, healthcare providers reported that patients are of low educational level and that this interferes with their understanding of the health education messages shared with them. Indeed, as reported by Al-Rasheedi [43], educational level showed mixed results in relation to glycaemic control. Educational programmes on diet, exercise and follow-up appointments were of greater benefit in glycaemic control than other aspects of care. Abdulah and colleagues [44] also found in a double-arm post-test intervention study that patients benefitted from three two-hour educational sessions on dietary habits and physical activity designed according to the Health Belief Model; showing improvements in positive physical activity, dietary and biochemical indicators [44]. Group health education for patients with type 2 diabetes on knowledge, diet, and exercise also improved glycaemic control compared to the usual care [45]. However, whether these intervention modalities would be beneficial in Kinshasa, DRC, is unknown. Implementation studies are needed to explore the feasibility, suitability and utility of these interventions in diabetes self-management in Kinshasa, DRC.

Our study also found that patients with diabetes were the targets of misleading messages about diabetes and its treatment through the mass media which promised to cure the disease. There is therefore a need to regulate the advertisement of healthcare services, particularly by alternative healthcare practitioners in Kinshasa [46]. Patients with type 2 diabetes are vulnerable and promises that are not evidenced-based shared by these practitioners have the potential to deter patients from adhering to or even default their medical treatment, with serious consequences. The promotion of evidence-based health information by community-based diabetes advocacy groups can assist patients with diabetes not to accept false messages and prevent the untoward

consequences of default of treatment [47]. Furthermore, community-level organizations including community health workers should be used for health education and campaigns, and to connect patients and their households to the continuum of diabetes care provided within healthcare facilities [41].

In this study, the family was reported by many participants as the sole source of emotional and financial support [48]. This needs to be recognised by healthcare providers as a strength and used to formulate a family-oriented management approach for diabetes, especially as this approach improves relatives' understanding of the diseases, reduces their stress, anxiety and depression, and increases their satisfaction and relationship with healthcare providers [49]. Several studies have shown that family support is associated with better glycaemic control [50,51]. The family represents the place where the illness experience begins and is handled with the support of significant people [52]. However, for this involvement to be helpful, family members must not be obstructive in their behaviours: planning unhealthy meals, tempting patients to eat unhealthy foods, or questioning the need for medications, nag or argue with patients to 'support' adherence only to undermine patients' self-efficacy and create family conflict [53].

Since improving blood glucose control in patients with type 2 diabetes requires an improvement in the healthcare system, it would be wise to think, as recommended by the WHO [54], in a broader context of better preparedness of the health system not only for diabetes but for other non-communicable and communicable diseases. Figure 1 presents the explanatory model based on the WHO ICCC that integrates the themes identified from the participants' perspectives in our study [18]. The micro level comprises the patients and their families, the meso level the health system organisation and the community, and the macro level the policy environment.

At the micro level, a strong healthcare provider-patient relationship facilitates communication in a patient-centred way and encourages self-management, improving patients' positive experience of their own disease and its care.

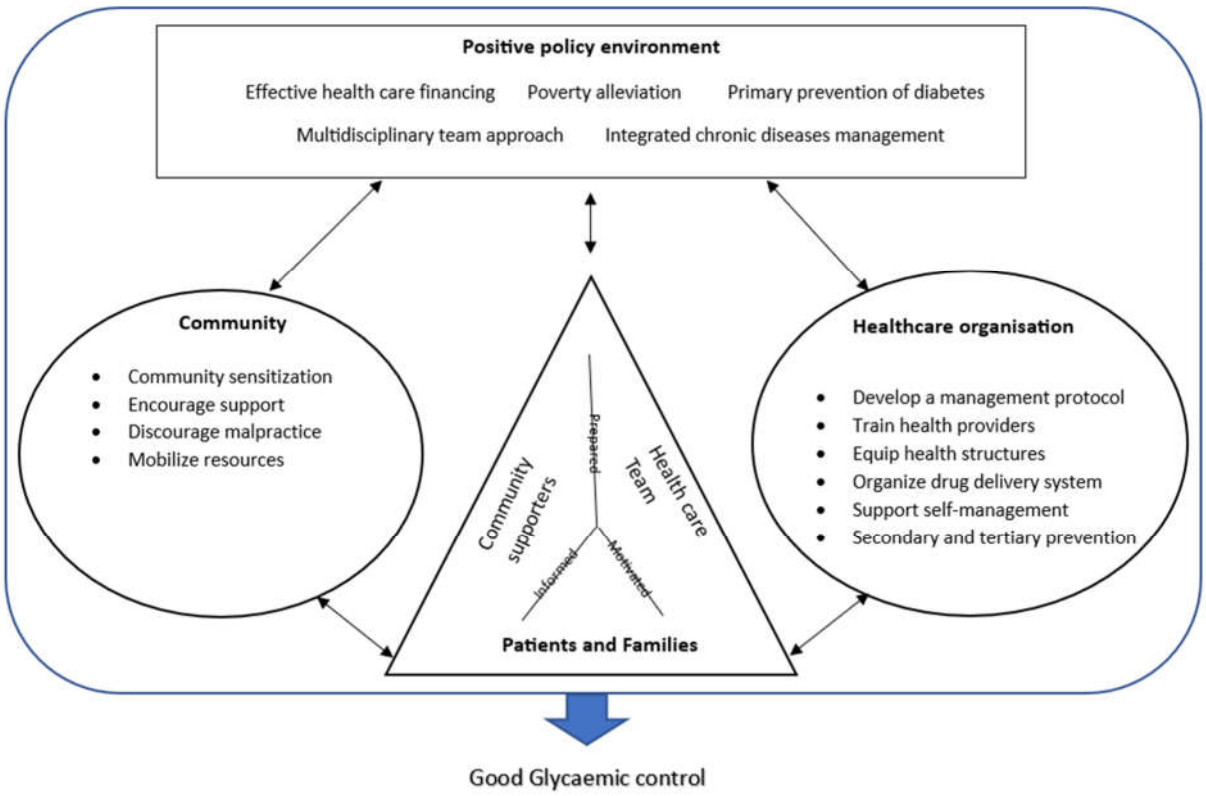

Figure 1 Explanatory model: Improving glycaemic control among patients with type 2 diabetes. Adapted from the WHO Innovative care model for chronic diseases (WHO, 2002)

At the meso level, diabetes care needs to be evidence-based and provided by trained healthcare providers within healthcare facilities that are well-equipped and supported by a reliable drug delivery system. In the community, mass, group and individual education on diabetes improve patients' and relatives' knowledge of diabetes and ensures positive support is provided to the patients by their families and relatives. At the macro level, appropriate measures should be taken to ensure primary prevention of diabetes, fight poverty and promote food security, regulation of healthcare advertising for "truthful" health messaging, public healthcare financing that promotes universal coverage, and a multidisciplinary team approach to diabetes care. All these actions when implemented in an integrated way have the potential to improve glycaemic control among patients with type 2 diabetes in Kinshasa, DRC.

To our knowledge, this was the first qualitative study to explore the perspectives of both patients with type 2 diabetes and healthcare providers on improving glycaemic control in sub-Saharan Africa. The findings are an appeal for changes in health policy, diabetes clinical practice, health systems organization and future research in diabetes in this setting, particularly in the DRC. From the perspective of health policy, this study recommends consistent and reliable financing of diabetes care through primarily great involvement of the government. The diabetes clinical practice needs to be evidence-based and ensured by trained healthcare providers. The healthcare

system needs better preparation for the care of diabetes. Furthermore, the credibility of the study findings was enhanced by the multi-source triangulation, with patients from different socioeconomic backgrounds and healthcare providers with various levels of expertise in diabetes care. The use of two experts in diabetology to review and conceptualize the findings of the study added more value to the interpretation.

Nevertheless, there is potential for information and interpretation biases, as social desirability on the part of some participants and researcher's preconceptions, could have influenced participants' responses and the data analysis, respectively. These were addressed by prior training of the interviewer in qualitative methods to ensure that the interviewer adopted a neutral attitude during the interviews and was aware of his own preconceptions, preventing them from influencing him during the data analysis. Also, creating a free and non-judgmental interview environment enabled participants to give their perspectives, unhindered. Although a selection bias could have resulted from the purposive sampling, health professionals in the different care facilities were the ones that identified the patients most likely to share their experiences. Triangulation of findings with other investigators, an external review by two experts and audits of the data and research processes by the research supervisors, all enhanced the credibility of the study findings. While the study findings cannot be generalized (due to the qualitative design), the findings are transferable, and therefore useful in informing the development of programmatic frameworks and interventions aimed at improving glycaemic control among patients with type 2 diabetes in the DRC, sub-Saharan Africa and similar settings.

Conclusions

This study found that the improvement of glycaemic control for patients with type 2 diabetes in Kinshasa, DRC, requires multidimensional strategies that include patient, family and community level interventions; structural and processes of care interventions in the health system; and health policy level interventions. To be efficient, these interventions need to be integrated into existing platforms of healthcare services delivery, particularly the chronic diseases management framework.

List of abbreviations

COREQ: Consolidated criteria for reporting qualitative research, DRC: Democratic Republic of the Congo, HIV/AIDS: Human Immunodeficiency Virus/Acquired Immunodeficiency Syndrom, JPF: Jean-Pierre Fina, OBO: Olufemi Babatunde Omole, WHO: The World Health Organization

Declarations/Acknowledgements

Ethics approval

This study was conducted after approval from the ethics committee of the Protestant University of Congo (reference number: CEUPC 0067; Date: 05/02/2021) and the Human Research Ethics Committee (Medical) of the University of the Witwatersrand (reference number: M210308; Date: 26/08/2021). The study was conducted according to the ethical guidelines of the Declaration of Helsinki. Permission was obtained from the Kinshasa Primary HealthCare Network to conduct the study. An informed consent was obtained from each participant.

Consent for publication

Informed consent was obtained from each participant.

Availability of data and materials

The transcripts of our study can be provided upon reasonable request to the corresponding author.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

JPF conceived the study, conducted the interviews, contributed to the translation of the transcripts to English, performed the analysis, and wrote the first draft of the manuscript. JMF contributed to the conceptualization and operationalization of the study and reviewed the manuscript. OBO contributed to the conceptualisation and operationalization of the study, analysis, and reviewed the manuscript. All the authors agreed with the final draft of the manuscript.

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CHAPTER SIX — CONSENSUS ON INTERVENTIONS TO IMPROVE GLYCAEMIC CONTROL IN KINSHASA, DEMOCRATIC REPUBLIC OF THE CONGO

6.1 Introduction

In this chapter, we present the results of the Delphi study, which focused on the search for a consensus on interventions likely to improve glycaemic control and brought together a number of experts with an interest in diabetes management in Kinshasa. The researcher paper has been published (Appendix 5).

6.2 Research paper 6: Consensus on potential interventions for improving glycaemic control among patients with type 2 diabetes in Kinshasa, Democratic Republic of the Congo: a Delphi study

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Abstract

Background

Poor glycaemic control is a multifactorial and complex problem with dire clinical and economic implications. In the Democratic Republic of the Congo, recent studies have shown alarming poor control rates. There is no policy framework to guide corrective actions.

Objectives

To build a consensus on interventions to improve glycaemic control among patients with type 2 diabetes in Kinshasa, Democratic Republic of the Congo.

Methods

This was a two-round electronic Delphi study involving 31 local and five international experts. The experts rated proposed interventions from previous studies on glycaemic control in sub-Saharan Africa and Kinshasa on a 4-Likert scale questionnaire. In addition, the experts were asked to suggest other recommendations useful for the purpose. The mode, mean, and standard deviation of each statement were calculated for each round.

Results

Participants reached consensus in six domains that included 39 statements on how to improve glycaemic control in Kinshasa: strengthening the health system, enhancing the awareness of diabetes, alleviating the financial burden of diabetes, enhancing the adoption of lifestyle modifications, reducing the proportion of undiagnosed diabetes, and empowering healthcare providers. Strengthening the healthcare system for better care promotes better organization and provision of services for diabetes care. Enhancing the awareness of diabetes among the population/patients stresses the need to develop and share information about diabetes through the most appreciated channels by the population. Alleviating the financial burden of diabetes targets for the long-term the need for universal health coverage, and meanwhile, encouraging the development of community-based health insurance. It also includes the search for a reduction in costs of diabetes medicines and materials through public-private partnerships. Enhancing the adoption of lifestyle modifications in our setting passes through the provision of accurate information on the content of lifestyle changes, and developing realistic exercise and dietary plans. Reducing the proportion of undiagnosed patients with diabetes needs to increase the detection of diabetes by targeting high risk groups at the level of primary care settings.

Conclusions

Improved glycaemic control needs to be considered within the broader framework of managing noncommunicable diseases in a more integrated, coordinated and better financed healthcare system. Further studies are needed to operationalize the interventions identified for successful implementation.

BACKGROUND

The prevalence of diabetes mellitus is increasing worldwide, with the number of affected adults almost having quadrupled between 1985 and 2014 [1]. The African region has the greatest predicted increase in the number of people with diabetes of all International Diabetes Federation (IDF) regions – an expected increase of 129% to 55 million people by 2045 [2]. In the Democratic Republic of Congo (DRC), the trend of increasing prevalence of diabetes is clear, but better organization of health data is needed to assess the true extent of the problem. The latest estimates from the IDF showed a 5.8% prevalence of diabetes among adults [3] with disparities between urban and rural areas, as well as between the western and eastern parts of the country [4,5].

One of the major difficulties in the management of diabetes is achieving glycaemic control, which is essential for the prevention of complications and thus for the preservation of the quality of life of patients [6]. Complications of diabetes result in increased costs of care for patients, society, and the health care system [7].

Controlling blood sugar levels is a complex phenomenon primarily due to the numerous factors that determine it. A literature review was performed to develop a conceptual model based on the Chronic Care Model [8]. The factors were grouped into the following categories: policy, healthcare system, community, as well as patients and their families [9-12]. Knowledge of the factors acting in a given environment is essential to determine the interventions needed to remedy the situation [13].

The complexity of glycaemic control is also because there are many interventions identified to improve glycaemic control. The main reference on the management of hyperglycaemia in type 2 patients is continually updated, and is managed by the American Diabetes Association (ADA) and the European Association for the Study of Diabetes (EASD); it has advocated therapeutic education, hygienic and dietary measures, and patient-centred care, in particular taking into account patients' preferences in the provision of care [14,15]. In 2019, a team of diabetes experts from sub-Saharan Africa, considering the difficulties encountered in managing diabetes in Africa, and in particular the cost and availability of medicines, proposed an algorithm for initiating and intensifying diabetes treatment in sub-Saharan Africa [15]. In the DRC, the latest Ministry of Health standards for diabetes treatment were issued in 2012 and have not been updated [16].

Worldwide, only half of patients with type 2 diabetes achieve good glycaemic control [17]. In Africa, poor control is common, and, in the DRC, recent studies have shown similar worrying results with only 16 to 32% of the patients with type 2 diabetes having controlled glycaemia [18]. In our setting the need for better diabetes care and management of hyperglycaemia is crucial, however, there is no framework for improving glycaemic control in Kinshasa, DRC. We conducted a series of studies to determine the magnitude and drivers of poor glycaemic control to inform a potential framework to address the poor glycaemic control in Kinshasa, DRC. At the end of this process, one may ask what the potential interventions for improving glycaemic control in Kinshasa, DRC. The aim of this study was to solicit the views of experts in the field and based on the conducted studies findings to develop a recommended framework to optimize glycaemic control in the DRC.

METHODS

Study design

In a situation where there is insufficient, conflicting, or an overload of information, consensus methods provide another means of synthetizing information [19]. Consensus strategies create structured environments allowing the experts to be given the best available information on an issue and to provide more justifiable and credible solutions [19]. Two consensus methods are commonly used in health services research, the Delphi process and the nominal group technique [20]. The Delphi process is commonly used to develop guidelines by healthcare professionals [20]. Thus, the Delphi consensus method is the best approach to develop a policy framework considering the multitude of factors associated with blood glucose control, the number of possible interventions, some with contrasting results, and the socio-economic and cultural peculiarities of Kinshasa, DRC [20].

This was a two round, electronic, and anonymous Delphi study seeking policy consensus from important stakeholders in diabetes management in Kinshasa to develop a package of interventions for improving glycaemic control. The Delphi study is part of a larger project aimed at developing a framework for improving glycaemic control for patients with type 2 diabetes in Kinshasa, DRC, the protocol of which has been published [8]. Previously in the project, factors associated with glycaemic control in sub-Saharan Africa were determined in a meta-analysis [10]. Additionally, the factors associated with poor glycaemic control in

Kinshasa, DRC, were determined in a cross-sectional study and substantiated with findings from qualitative studies of the perspectives of patients and healthcare providers on the factors that affect glycaemic control and proposed interventions in Kinshasa. Informed by these studies, experts were brought together to define a package of interventions to improve glycaemic control among type 2 patients in the DRC through consensus. The process of the Delphi study is summarized in figure 1. This Delphi study is reported according to the Guidance on Conducting and Reporting Delphi Studies (CREDES) [21].

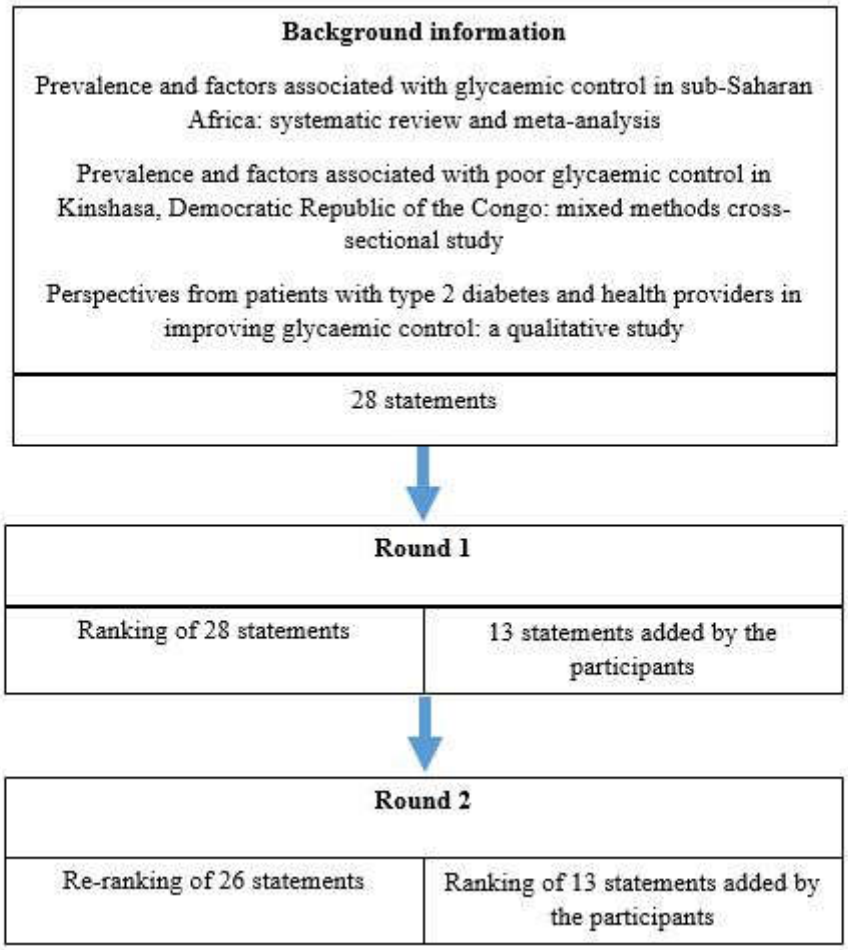

Figure 1. Description of the Delphi study process

Context

The proposed interventions are for patients with type 2 diabetes in Kinshasa, the capital city of the DRC. The country is a low-income country with a population of 95,894,118 inhabitants [22]. In 2019, the country spent 4% of its Gross Domestic Product on health expenditure [23]. In 2022, about 64% of the population were living on less than 2.15 $US a day [22]. Most of the

population are not covered by health insurance and must rely on out-of-pocket payments. Kinshasa has a population of approximately 15 million within an area of 9,965 square kilometres [24]. In recent years, the population of Kinshasa is growing fast due to a rural exodus resulting from the destruction of economic infrastructure in the surrounding provinces. The care for diabetes patients is mainly organized via the Kinshasa Primary Care Network uniting mainly health structures belonging to the Catholic Church and the Salvation Army [25]. The other facilities organizing diabetes care are privately owned and some State health structures. The problem in this context is that there is no real integration or control of activities, with each player trying to find their own way with whatever resources it can muster. The national diabetes programme is not yet effective on the ground. Therefore, despite the growing importance of diabetes, there are no data showing the real burden of diabetes on the population and society.

Subjects

The Delphi study included representatives of stakeholders in diabetes management in Kinshasa, DRC. Two approaches were used to select the experts. The first was to contact the heads of institutions involved in diabetes and request them to nominate representatives for the Delphi study. In the second approach, individuals known for their expertise in diabetes were contacted. We selected six health services managers, eight healthcare providers, seven representatives from universities, nine members of the staff of the National Programme against Diabetes, and six people from Non-Government Organizations working on diabetes in Kinshasa and in Africa. The healthcare providers were persons qualified in the clinical practice of medicine, namely five doctors or three nurses, and taking care of diabetes; managers were individuals in charge of a healthcare structure (hospital or health centre) or a group of healthcare structures organizing diabetes care; representatives of universities were diabetologists or internal medicine specialists; NGO partners were all the persons within organizations participating in the management of diabetes by providing financial or technical support; representatives from the Ministry of Health were individuals working in the National Programme of diabetes. The participants were purposively selected by the research team — principal researcher and supervisors — based on their interest in the subject and expertise in diabetes control. Contact was made with the structures organizing or providing support for diabetes care to ensure that participants were experts in the area; known experts in diabetes management were contacted directly through e-mail, telephone and WhatsApp.

All the participants had an age ≥ 18 years; experts were local and international experts with preference given to those who currently or previously worked in the DRC, and those with known expertise in diabetes. The exclusion criteria was conflict of interest in study participation.

Thirty-six participants were included in the first round of the Delphi from a total of 62 experts invited, representing a response rate of 58.1%. In the second round of the 36 participants who took part in the first round, two dropped out, and the response rate was of 94.4%.

Data collection

E-mail was used to send an information document describing the purpose and objectives of the study to eligible people. They were requested to agree electronically to participate in the study. Once they accepted to participate in the study, a second e-mail informed them of the results of previous sub-studies of this project.

This Delphi study included two rounds. In the first round, each stakeholder was asked to use the 4-point Likert scale to indicate by how much they agreed or disagreed with the statements. The statements were constructed based on the findings of previous studies in sub-Saharan Africa and Kinshasa on factors associated with glycaemic control and perspectives for improving glycaemic control. The questionnaire also comprised open questions for the participants to suggest additional interventions for improving glycaemic control or to comment on the proposed interventions. The questionnaire was designed on Redcap 13.4.13 [26] and shared with the participants through e-mail and WhatsApp. The questions were constructed using a 4-point Likert scale (‘strongly agree’, ‘agree’, ‘disagree’, and ‘strongly disagree’).

The participants’ responses in the first round were used to perform an initial assessment of the extent to which they agreed with the recommendations. At the end of the first round, the researcher summarized the rankings from the participants and their motivations and used these for the second round. Only the recommendations that were strongly agreed to and those suggested by the participants were used in the second round. The reliability of the survey tool used in the second round was assessed using the Cronbach’s alpha coefficient; the result was 0.97 indicating high internal consistency.

In the second round, the experts were asked to re-rank the statements after reconsidering their opinions or judgements considering other group members' responses and again to motivate their choice or suggest other interventions. No new themes were identified by the participants. For most participants, the positions or responses did not vary substantially from those expressed in the first round. Their ratings consisted of assessing each intervention again according to a 4-point Likert scale ('strongly agree', 'agree', 'disagree', and 'strongly disagree'). At the end of the second round, the researchers sorted a list ranking the remaining interventions along with minority opinions achieving consensus. Expert contributions were anonymous. The process of the Delphi study is summarized in figure 1.

Data analysis

For each round and for all proposed interventions, the frequencies of all responses of the 4-Likert were summarized to determine the mode. The means and standard deviations were used to describe group responses to each statement. For each statement, the overall interpretation used was: 4.00-3.00: strongly agree; 2.99-2.00: agree; 1.99-1.00: disagree; 1.00-0.99: strongly disagree [27, 28]. At the end of a round, only recommendations with an average score above 3.00 should be considered for the next round. Between rounds, the data were analysed to identify convergence and change of experts' opinions or judgements. Consensus was defined as > 70% of experts agreeing/strongly agreeing or disagreeing/strongly disagreeing with a statement in round 2. This level of agreement has been used in previous studies [29, 30]. Stability of consensus was considered to have been reached if the between round group responses varied by ≤ 10%.

RESULTS

Table 1 presents the characteristics of the participants.

Table 1. Characteristics of the participants of the Delphi study, n=36

	Categories	**Number**	**Percentage (%)**
Age (years)			
	< 40	14	38.9
	40-65	20	55.5
	≥ 65	2	5.5
Sex			
	Male	28	77.8
	Female	8	22.2
Role			
	Clinician	8	22.2
	Manager	6	16.7
	National Programme Against Diabetes	9	25.0
	University	7	19.4
	Non-Government Organization	6	16.7
Background			
	Physician	26	72.2
	Nurse	3	8.3
	Economist	4	11.1
	Pharmacist	1	2.8
	Political Scientist	1	2.8
	Lawyer	1	2.8
Expertise (years)			
	< 10	16	44.4
	10-19	13	36.1
	≥ 20	7	19.4
Location			
	National	31	86.1
	International	5	13.9

Five domains of statements were identified for improving glycaemic control. Table 2 presents a summary of grouped statements by domain from the Delphi study.

Table 2. Summary of grouped statements by domain

	Number of statements in each domain		Proportion of statements where consensus was reached	
	Round 1	Round 2	Round 1	Round 2
Strengthening the healthcare system for better diabetes care	14	17	13	17
Enhancing the awareness of diabetes among the population/patients	3	5	3	5
Alleviating the financial burden of diabetes	4	9	4	9
Enhancing the adoption of lifestyle modifications in our setting	4	5	3	5
Reducing the proportion of undiagnosed patients with diabetes	3	3	3	3
Total	28	39	26	39

From the 28 initial statements, the participants agreed on 26 statements (92.9%) and two were excluded (7.1%). For the second round, these 26 statements were added to 13 additional recommendations suggest by the participants in the first round; a total of 39 statements were submitted to the experts and all reached consensus.

Table 3 describes in detail the assessment of each statement throughout the two rounds of the Delphi study. In the first round, "creating food banks" and "implementing gatekeeping on prescriptions to improve adherence to evidence-based guidelines" reached 55.9% and 69.7%, respectively, and were excluded. The participants also suggested 13 additional recommendations that were added to the second round of the Delphi study. All the statements reached the consensus (100%). The stability of the consensus was assessed for 26 of 39 statements (%); only one of the 26 statements had varied by more than 10%.

DISCUSSION

This Delphi study aimed to build a policy consensus on recommendations for improving glycaemic control in Kinshasa, DRC. The study identified five domains containing 39 statements: strengthening the healthcare system for better diabetes care, enhancing the awareness of diabetes among the population/patients, alleviating the financial burden of diabetes, enhancing the adoption of lifestyle modifications in our setting, reducing the proportion of undiagnosed patients with diabetes, and helping healthcare providers to act for improving glycaemic control.

Strengthening the healthcare system for better diabetes care

Improving glycaemic control among patients with type 2 diabetes cannot be realised without strengthening of the health system. The WHO framework characterized a well-functioning health system as one that puts together trained and motivated health workers, a well-maintained infrastructure, a reliable supply of medicines and technologies, backed by adequate funding, strong health plans, and evidence-based policies [31]. These elements have been identified in the recommendations made by the experts during the current Delphi study. Concerning healthcare providers, the recommendations of this Delphi study highlighted the benefits of establishing multidisciplinary care teams for better diabetes care at the primary health care level. Such multidisciplinary teams have been linked to better outcomes including good

glycaemic control among patients with type 2 diabetes [32]. In this multidisciplinary team, task shifting should be strongly considered considering the shortage of qualified and specialized healthcare providers in Kinshasa. Interventions led by nurses and pharmacists in Low- and Middle-Income Countries (LMICS) with relatively low physician density are effective in the management of diabetes [33]. In a realistic and cost-effective manner, improving diabetes care must be considered in the broader framework of managing noncommunicable diseases at the primary healthcare level [34, 35]. For these changes to occur, diabetes and more noncommunicable diseases should be treated as important by policymakers. The Ministry of Health through the National Programme against Diabetes should provide data that translates the burden of diabetes and advocates for prioritization.

The Government should engage with itself to provide more funding for the health sector to better prepare the health system to face noncommunicable diseases. The Ministry of Health should also ensure the development of clear guidelines for the management of diabetes, which consider the specificities of diabetes in our setting. The Ministry of Health and the National Programme against Diabetes should also ensure that healthcare staff are trained, motivated and assigned to diabetes management centres to provide the full package required for the care of patients with diabetes.

Table 3. Analysis of the responses to statements throughout the Delphi process

Domains	**Strategies**	**First round statistics (n=36)**				**Second round statistics (n=34)**				**Stability (%)**
		Responses (%)		**Mean*** **	**Standard deviation**	**Responses (%)**		**Mean*** **	**Standard deviation**	
		Agreed/ strongly agreed	Disagree/ strongly disagree			Agreed/ strongly agreed	Disagree/ strongly disagree			
Strengthening the healthcare system for better diabetes care	Set up a diabetes primary care team: multidisciplinary/training/task shifting	100.0	0.0	3.7	0.4	97.1	2.9	3.6	0.6	2.9
	Equip the health structures with basic equipment	100.0	0.0	3.7	0.4	97.1	2.9	3.8	0.6	2.9
	Set up an effective drug delivery system	94.1	5.9	3.5	0.6	100.0	0.0	3.6	0.7	5.9
	Develop a diabetes management protocol	91.7	8.3	3.6	0.6	97.1	2.9	3.7	0.6	5.4
	Augment geographical access to care	100	0.0	3.6	0.5	94.1	5.9	3.6	0.7	5.9
	Reduce waiting time for access to care	97.1	2.9	3.5	0.6	91.2	8.8	3.3	0.7	5.9
	Technical supervision	94.3	5.7	3.5	0.6	94.1	5.9	3.5	0.7	0.2
	Adopt glycosylated haemoglobin for glycaemic control	91.2	8.8	3.3	0.6	94.1	5.9	3.4	0.7	2.9
	Implement "gatekeeping" on prescriptions to improve adherence to evidence-based guidelines*	69.7	30.3	2.9	0.7					
	Strengthen the National Diabetes Control Programme**					97.1	2.9	3.7	0.6	
	Develop individual care for patients	94.2	5.8	3.5	0.6	97.1	2.9	3.5	0.7	2.9
	Adhering to evidence-based clinical guidelines	100.0	0.0	3.6	0.5	94.1	5.9	3.4	0.7	5.9
	Better approach to patients promoting patient-centered care	100.0	0.0	3.5	0.5	97.1	2.9	3.4	0.7	2.9
	Support self-management of the patients	85.7	14.3	3.3	0.8	91.2	8.8	3.5	0.7	5.5
	Identify patients at risk of poor glycaemic control	100.0	0.0	3.7	0.4	94.1	5.9	3.5	0.7	5.9

	Educate the family and communicate the objectives of the family with the patient's consent**					97.1	2.9	3.6	0.7	
	Identify patients with poor glycaemic profile **					94.1	5.9	3.5	0.8	
	Send text messages to remind patients to take their medicines or to respond to follow-up visit**					85.3	14.7	3.3	0.8	
Enhancing the awareness of diabetes among the population/patients	Develop radio/TV spots on diabetes	100.0	0.0	3.7	0.5	94.1	5.9	3.5	0.7	5.9
	Distribute information leaflets on diabetes	77.1	22.9	3.1	0.8	88.2	11.8	3.3	0.8	11.1
	Send text/videos through social media	97.2	2.9	3.5	0.6	91.2	8.8	3.3	0.8	6.0
	Community-based awareness activities in churches, schools, and open spaces (markets) **					97.1	2.9	3.7	0.6	
	Train and involve community health workers in the sensitization of the population**					97.1	2.9	3.7	0.6	
Alleviating the financial burden of diabetes	Implement universal health coverage	100.0	0.0	3.7	0.5	97.1	2.9	3.7	0.6	2.9
	Promoting health insurance	88.2	11.8	3.5	0.7	97.1	2.9	3.5	0.7	8.9
	Encourage the creation of health mutuals	97.1	2.9	3.6	0.5	97.1	2.9	3.6	0.7	0.0
	Encourage family involvement and support	85.3	14.7	3.2	0.8	94.1	5.9	3.6	0.7	8.8
	Partner with pharmaceutical industry to avail good quality generic drugs at affordable cost**					94.1	5.9	3.5	0.8	
	Improve the standard of living of the Congolese population by granting an acceptable minimum wage to the lowest paid workers so that they are able to contribute to or support the mutual insurance system**					94.1	5.9	3.6	0.7	
	Promote flat-rate pricing for disease episodes or even monthly patient care at the centre or hospital. **					97.1	2.9	3.5	0.7	
	Exempt imported equipment for diabetes care (insulin, strips, syringes) from excise and import duties to reduce costs**					94.1	5.9	3.6	0.7	

	Allocation of a significant budget for chronic diseases**					97.1	2.9	3.5	0.7	
Enhancing the adoption of lifestyle modifications in our setting	Develop a suitable exercise plan for patients considering their occupations	91.4	8.6	3.5	0.7	94.1	5.9	3.4	0.7	0.0
	Encourage realistic dietary plans that considers affordability	97.1	2.9	3.8	0.5	97.1	2.9	3.6	0.6	0.0
	Create food banks*	55.9	44.1	2.7	0.8					
	Providing accurate information on recommended diet and exercise	97.1	2.9	3.6	0.5	97.1	2.9	3.7	0.6	0.0
	Promote primary prevention using policies that target marketing and sales of of tobacco, alcohol, sweetened beverages, and fast foods**					82.2	17.8	3.3	0.8	
	Open gymnasiums and encourage healthy and balanced eating**					88.2	11.8	3.2	0.7	
Reducing the proportion of undiagnosed patients with diabetes	Implement opportunistic screening at primary care level	94.4	5.6	3.7	0.6	97.1	2.9	3.7	0.6	2.7
	Promote cases finding among in high-risk population e.g. patients' families	88.2	11.8	3.2	0.6	88.2	11.8	3.3	0.8	0.0
	Mass screening during diabetes international day	88.6	11.4	3.3	0.8	94.1	5.9	3.5	0.7	5.5

Legend: * Strategy excluded after the first round; ** strategy added after the first round; *** Scale range: for each statement, the overall interpretation is: 4.00-3.00 : strongly agree ; 2.99-2.00 : agree ; 1.99-1.00 : disagree ; 1.00-0.99 : strongly disagree

Healthcare providers must be trained on these guidelines and formative supervision and oversight by more qualified healthcare providers of the activities should help to improve the quality of care. In the training of healthcare providers, care must be taken to consider the development of a patient-centered approach [36], and to ensure prevention of poor glycaemic control by identifying high-risk patients.

Strengthening of the healthcare system should also include enabling a bidirectional referral pathway that allows for escalated/more complex care at highly specialized level (for patients who are uncontrolled at PHC) and de-escalated care to PHC level for follow up when such patients become stabilized [37].

Funding is critical in implementing the changes required in the structure and processes of care for better diabetes management. There is a need to ensure, as outlined in the Global Diabetes Compact, that everyone with diabetes should have access to equitable, comprehensive, affordable, and quality treatment and care [38]. The government has just started the process of universal health coverage, but diabetes is not yet covered due to negative financial constraints. Extending universal health coverage to diabetes will allow vulnerable and disadvantaged individuals access to equitable care [39].

Alleviating the financial burden of diabetes

Empirical evidence shows that better socioeconomic conditions are associated with improved glycaemic control [40]. The Government should ensure that the war against poverty is effective as it could allow persons with diabetes to have their purchasing power grow in order to face the cost of diabetes. The Government should also provide social protection to vulnerable categories of persons with diabetes through the extension of universal health coverage to noncommunicable diseases. One way to reduce the burden of diabetes is to help persons with diabetes access affordable medications. A partnership with the pharmaceutical sector, which is mainly private, could help with this. The government could reduce taxes on medications and supplies for the care of diabetes and other non-communicable diseases, with a view to lowering their market cost.

In the quest to reduce the cost of health care, the integration of a regulation of prescriptions could be beneficial as it has been dismantled in other settings [41]. The panel of experts did not opt for this recommendation by a very narrow margin of consensus. The lack of health insurance may have been a reason for rejecting this measure. Nevertheless, technical supervision may have as one of its objectives the monitoring of prescriptions. The panel also rejected the creation of food banks on the grounds that the healthcare system is suffering from budgetary constraints and that these banks could require far too much financial resources to organise.

At the healthcare system level, integrating the Package of Essential Noncommunicable (PEN) disease interventions-Plus could be a cost-effective approach [35]. The DRC has not yet incorporated this model. There is a need to move towards the implementation of PEN and PEN-Plus in our setting. In the long term, the population must be financially empowered to face the costs of diabetes care by prepaid payments — health insurance or health mutual. Out-of-pocket payment for health care currently represents a significant barrier to healthcare access in Kinshasa and could lead to impoverishment [42].

At the level of the relatives, family are sometimes the sole source of support for the patients. The healthcare providers must be encouraged to develop a family-oriented care approach for patients to increase the involvement of the patients' relatives in their care [43]. Family support has been linked to better health outcomes [43] and it is thus important to develop a family orientated care approach to ensure that relatives understand the diabetes disease in order to ensure their support to the sufferer.

Enhancing the awareness of diabetes

Raising the awareness of the population will contribute to positive health seeking behaviours [44]. Participants pointed out that people in the community do not read much; unsurprisingly as most are not highly educated and are more attracted to plays on television. The national programme against diabetes should organize awareness campaigns for these diseases. As part of this campaign, the messages can be effectively communicated via the plays that are popular with the public. Community-based campaigns in public spaces, churches, and schools were seen as an appropriate approach in our environment.

Enhancing the adoption of lifestyle modifications

Lifestyle interventions have been found to be effective for glycaemic control in low-and middle-income countries [45]. For persons living with diabetes in our setting, the critical point is to integrate these changes in their daily activities. Advocating for the integration of the practice of exercise in the workplace will be of great value. There are five main types of workplace exercise: preparatory workplace exercise (exercise before their work shift), compensatory workplace exercise (break exercise or active break), relaxing workplace exercise (exercise at the end of the work shift), corrective workplace exercise (to correct posture and restore any muscle or joint imbalances), and maintenance workplace exercise (to avoid or prevent degenerative disorders [46]. Policies that target the marketing and sale of tobacco, alcohol, sweetened beverages, and fast foods could also be applied to control their use by the public. As far as diet is concerned, it is essential to define appropriate diets that considersome patients' low incomes. Further, operational research is needed to determine the best interventions for enabling lifestyle change, considering the patient's condition and purchasing power.

Reducing the proportion of undiagnosed diabetes

Incorporating opportunistic screening of diabetes by targeting high-risk individuals could ease the management of diabetes at the point of diagnosis and delay the occurrence of complications. Opportunistic screening is a cost-effective way to screen for diabetes [47]. The healthcare facilities and their teams should be prepared and equipped to offer these activities.

Strengths and limitations of the study

This was the first study in Kinshasa, DRC, that tried to build consensus on how to improve glycaemic control using a Delphi panel of experts [48]. This Delphi study was supported by a rich background of information from the findings of previous studies that identified the factors of glycaemic control in sub-Saharan Africa and Kinshasa and the perspectives from patients with type 2 diabetes and healthcare providers in improving glycaemic control.

The weakness of the study was that Delphi studies do not allow live discussions that could have increased the depth of engagement and potentially given rise to more ideas on the issue. The consensus concerned a specific situation and therefore, may not be generalizable [49]. The high

proportion of participants with medical backgrounds could have introduced a bias in the findings of this Delphi study.

Conclusions

The study found that participants had a high level of consensus on how to improve glycaemic control among patients with type 2 diabetes in Kinshasa with most statements converging around five domains that focused on the need for a more integrated, coordinated and adequately financed healthcare system for better diabetes care. All these statements were expressed within a broader framework of managing noncommunicable diseases. Further studies are needed to operationalize the interventions identified to determine their scalability, effectiveness, efficiency and acceptability.

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Author Contributions

JPFL conceived the study, conducted the process, analysed the findings; JMF and OBO contributed to the conception of the study and the analyses of the findings. All the authors agreed with the manuscript.

Disclosure statement

None of the authors have any competing interest.

Ethics and consent

The study was conducted after the approval from the Ethics committee of the Protestant University of Congo (reference number: CEUPC 0067; Date: 05/02/2021) and Human Research Ethics Committee (Medical) of the University of the Witwatersrand (reference number: M210308; Date: 26/08/2021). An informed consent was sought from the participants.

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None.

Paper context

Achieving good glycaemic control is a global challenge. The challenge is particularly acute in sub-Saharan Africa due to multiple barriers. This study identified a number of interventions for improving glycaemic control in a particular context, which may be relevant in similar settings.

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CHAPTER SEVEN — SUMMARY, DISCUSSIONS AND CONCLUSIONS

7.1 Summary and Discussion of the Main Findings

This PhD study aimed to produce an intervention package to improve glycaemic control among patiens with type 2 diabetes in Kinshasa, Democratic Republic fo the Congo (DRC). The achievement of this aim was realized by the description of factors associated with glycaemic control in sub-Saharan Africa and in Kinshasa and the perspectives from healthcare providers and patients with type 2 diabetes on ways to improve glycaemic control in Kinshasa. Finally, based on these findings, a Delphi study reuniting stakeholders in diabetes management came up with interventions suitable for our setting.

It is important to recall that for a secondary purpose, this study was able to estimate the prevalence of good glycemic control among patients with type 2 diabetes in sub-Saharan Africa and Kinshasa, which was very low, prevailing for only less than a third of participants in both cases.

7.2.1 Factors of glycaemic control

In sub-Saharan Africa, our systematic review of publications from 2012-2022 on glycaemic control among persons with type 2 diabetes found that younger and older age, gender, lower income, absence of health insurance, low level of education, place of residence, family history of diabetes, longer duration of diabetes, pill burden, treatment regimen, side effects, use of statins or antihypertensives, alcohol consumption, smoking, presence of comorbidities/complications, and poor management were associated with poor glycaemic control. On the other hand, positive perceived family support, adequate coping strategies, high diabetes health literacy, dietary adherence, exercise practice, attendance at follow-up visits, and medication adherence were associated with good glycaemic control. The findings of this study were corroborated by those of other studies,[36,48,140] and call for equitable care within the framework of universal health coverage and improved living conditions for the population.[141,142]

The mixed cross-sectional study provided a reasonably broad understanding of poor blood glucose control in Kinshasa, Democratic Republic of Congo. Most of the participants were on monotherapy with insulin and participants on monotherapy with insulin (AOR: 1.72

(95%CI:1.17-2.55)) had increased odds of poor glycaemic control compared to participants on oral hypoglycaemic drugs. In contrast, participants having uncontrolled blood pressure (AOR: 0.60 (95%CI:0.39-0.92)) were less likely to have poor glycaemic control compared to participants having controlled blood pressure. The predominance of participants on monotherapy with insulin questions the alignment of healthcare providers on management protocols for type 2 diabetes. In many instances these protocols recommend adding insulin as the last resort when lifestyle and oral drugs are not sufficient. This finding highlights the need for training of healthcare providers on clearly defined management protocols. Patients need to be empowered by the provision of education on diabetes in the perspective of effective self-management.

Five themes emerged as explanatory for glycaemic control in the qualitative phase: financial constraints, limited support, difficulties with lifestyle changes, understanding of the illness, and ability to adapt to what is required for caring for the illness. Participants stated that they were unable to move towards better glycaemic control due to financial constraints, limited support, and difficulty in changing their lifestyle. Their understanding of diabetes also constituted a barrier. The qualitative study furthered our understanding of poor glycaemic control in Kinshasa; and it confirmed the element of poor management previously described in the quantitative phase. The care was poorly organized with long queues and was non-individualized. Our findings highlighted the importance of scarce patient resources and the lack of patient health coverage that undermined almost all aspects of care. Participants reported that the lack of money did not allow them to access care, or to adhere to drug prescriptions.

The findings of this study were corroborated by those of previous studies. [48,81,140] The literature highlights the importance of eliminating out-of-pocket payments and integrating patient-centred care.[143]

7.1.2 Perspectives from healthcare providers and patients with diabetes on ways to improve glycaemic control

The study collected feedback from patients with type 2 diabetes and healthcare professionals on improving blood sugar control. From the healthcare providers statements regarding improving glycaemic control, three themes were identified: strengthening the healthcare system, supporting persons with diabetes/population, and adopting supportive health policies. From the persons with diabetes perspectives three themes were also identified: need for support

for caring of the illness, need for enhanced knowledge about diabetes, and the need for better communication with healthcare providers..

Improving diabetes care cannot be achieved without improving the health system as a whole, which requires greater public involvement. Family members and communities must be provided with the necessary information about diabetes to enable them to support their sick siblings. At a higher level, laws or measures need to be passed to support diabetes management. The question of financing is critical and must be addressed to find appropriate solutions.

7.1.3 Intervention package

Five strategies comprising a total of 39 interventions have been retained in the intervention package for improving glycaemic control for persons living with type 2 diabetes in Kinshasa, DRC (Figure 7.1).

Strengthening the healthcare system is a sine qua none condition for improving glycaemic control.[144] The Government should get involved by seeking to mobilise and better allocate resources to the healthcare system, taking into account the impact of non-communicable diseases on morbidity and mortality, as part of a cost-benefit approach. The Ministry of Health should support this approach by documenting the real impact of non-communicable diseases, including diabetes, in our environment. The National Diabetes Control Programme should work to define an updated diabetes management protocol. It should ensure that healthcare staff are trained to form a multidisciplinary team to bring to patients the full package recommended for diabetes care.[145,146] Healthcare staff should develop a patient-centred approach to ensure that patients adhere fully to established care programmes.[147] In this approach, the healthcare provider must develop good communication with the person with diabetes and build a trustful relationship with him. Through this relationship, he must identify and respect persons with diabetes values, preferences and expressed needs. He must provide information and require the participation of the person with diabetes in all the decisions pertaining to his/her health. He must provide emotional support and alleviation of fear and anxiety where required, and involve family and friends where needed.[148] Patient-centered approach has been linked to improved health outcomes, including in diabetes care.[149,150]

Reducing the financial burden of diabetes is also important for society, the healthcare system, as well as patients and their families. The Government should ensure that the fight against

poverty, universal health coverage, and the establishment of partnerships with third parties, particularly the private sector and international organisations, are strengthened. An effort should be made to abandon the out-of-pocket payments that are so prevalent in our setting.[143]

Lifestyle modification is the cornerstone of the management of type 2 diabetes. Advocacy for the integration of physical exercise during work is particularly important in our environment. Similarly, the development of diets that are accessible to patients whatever their income level. In the interests of public health, the government should regulate the advertising and marketing of sugary drinks, alcohol, tobacco, and fast food.

The lack of knowledge about diabetes is a real barrier for patients with diabetes. This lack of knowledge is also the case for the patients'families and the population in general, and it could lead to unsupportive behaviours towards patients. As the family is, in many instances, the sole support of the persons with diabetes, healthcare providers are encouraged to develop a family oriented care to ease the understanding of the disease and encourage the support for the sufferers.[151] The programme must ensure that the population benefits from health education that includes diabetes and non-communicable diseases. The population's preferred channels must be used to spread these messages.

Given the high proportion of undiagnosed diabetes in sub-Saharan Africa, and the management difficulties associated with diagnosis, the approach to diabetes must include the search for early diagnosis. Health workers should be equipped to carry out opportunistic screening.

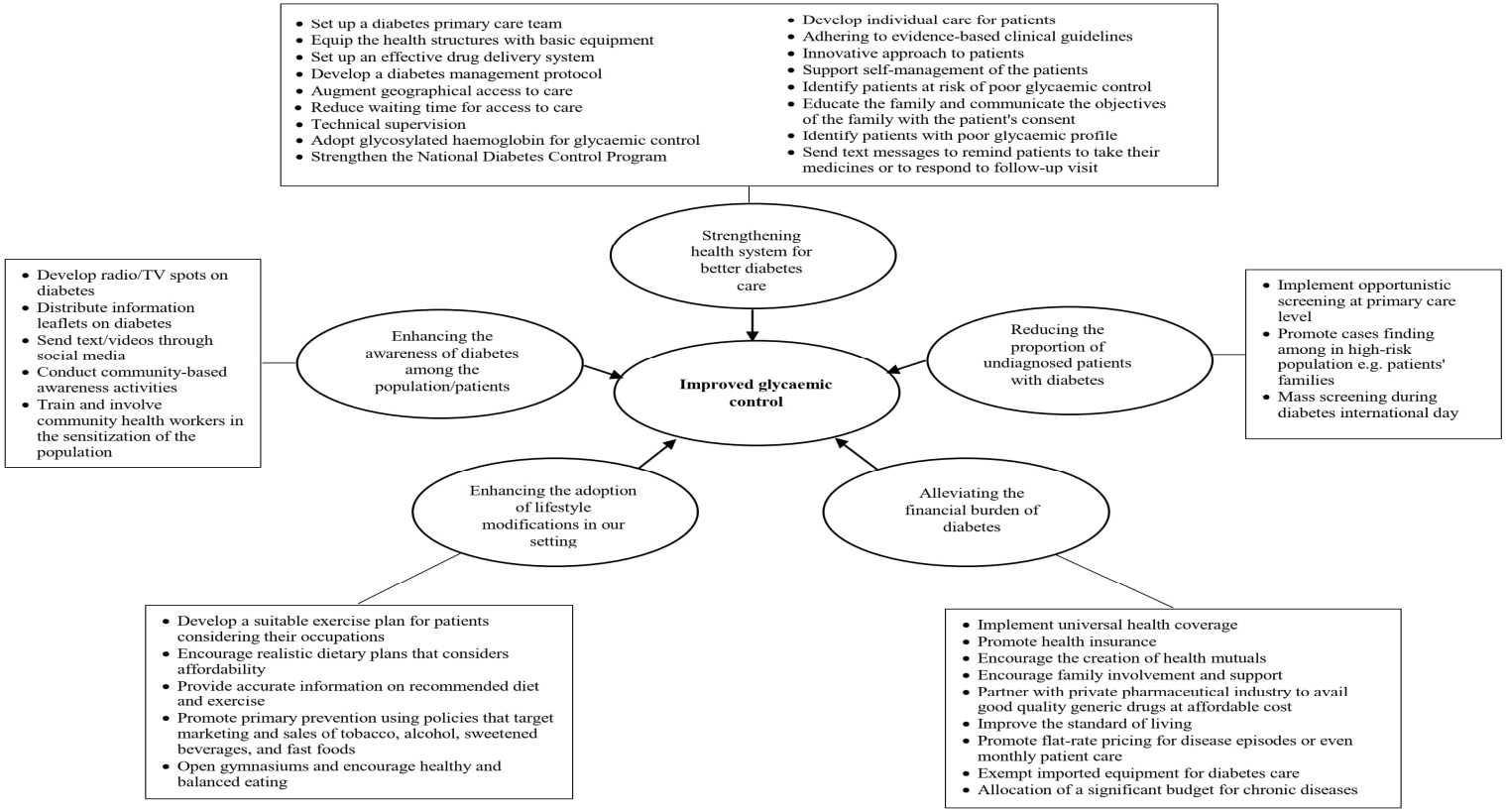

Figure 7.1 Intervention package to improve glycaemic control for persons with type 2 diabetes in Kinshasa, Democratic Republic of the Congo

7.2 Thesis Strengths

7.2.1 Background rich in information on blood sugar control factors

This study was intended to reach a consensus on a package of interventions to improve blood glucose control for patients with type 2 diabetes in Kinshasa, DRC. Building this consensus could not have been achieved without accurate knowledge of the factors associated with blood glucose control. The first strength of this study was that it was able to gather a rich background of information on blood glucose control factors both in Africa south of the Sahara and in Kinshasa, DRC.

To our knowledge, this project was the first to conduct a systematic review and meta-analysis of the prevalence and factors associated with glycaemic control for the entire sub-Saharan Africa. It was also the first, to our knowledge, to assess patients' and healthcare professionals' perspectives on improving glycaemic control. Finally, to our knowledge, it was also the first to organise a Delphi study to come up with a consensus on potential interventions for glycaemic control in Kinshasa.

The mixed methods design of the study on poor glycaemic control in Kinshasa, Democratic Republic of Congo, allowed a complete picture of the phenomenon in the setting.

7.2.2. Reliable instrument for evaluating interventions to improve glycaemic control

The final instrument for evaluating interventions to improve glycaemic control in the Delphi study resulted from the rich information from previous studies in this project and the interactions between experts. The instrument showed excellent reliability according to Cronbach's alpha coefficient.

7.2.3 Study design

In the quantitative phase of the mixed methods cross-sectional study, using glycosylated haemoglobin to assess blood glucose control was also a strength. Using a selection proportional to the size of the patients enrolled in the different health centres also strengthened the study by allowing a better representation of the population in the selected sample.

In the qualitative components of this study, the in-depth interviews allowed a better understanding of both the experiences of patients with diabetes concerning glycaemic control on the one hand and the prospects for improving blood glucose in Kinshasa.

7.3 Limitations

This study has estimated the prevalence of good glycaemic control among patients with type 2 diabetes in sub-Saharan Africa. This estimate suffered not only from the diversity of the biochemical methods used to assess glycaemic control but also from the different cut-off points used in the studies to define glycaemic control. Harmonisation of the methods used to assess glycaemic control is desirable to better evaluate and compare data from different sites.

The study included qualitative components, notably in the cross-sectional mixed methodology study and exploring prospects for improving blood glucose. These studies have inherent limitations concerning the generalisation of data. Nevertheless, our data may be transferred to environments similar to ours.

The Delphi study brought together experts on a problem arising in a well-defined environment with its own unique conditions. The recommendations adopted cannot be generalised. Nevertheless, these interventions could be transferable in similar settings.

7.4 Future Work

This thesis resulted in consensus on the interventions to improve glycaemic control for patients with type 2 diabetes in Kinshasa, DRC. The next step is the implementation of the intervention package. This implementation requires the involvement of several actors — with a crucial role to be played by the National Diabetes Control programme and the Government.

7.5 Conclusions

Poor glycaemic control is prevalent among patients with type 2 diabetes in sub-Saharan Africa and Kinshasa in the Democratic Republic of Congo. About three-quarters of participants were unable to achieve glycaemic control.

In sub-Saharan Africa, the factors associated with glycaemic control are multiple, and interventions are numerous but require better evaluation. In Kinshasa, the factors identified

stressed the lack of resources for patients to access care and adhere to therapeutic protocols and lifestyle modifications as prescribed. Patients received little support from family members or the community. In addition, the majority were not covered by health insurance and might rely on direct out-of-pocket payments. They did not have much knowledge about diabetes and showed poor self-management.

Improving blood glucose control for providers and patients required strengthening the health care system, better support for patients and the public, and taking essential steps to help control diabetes and achieve better glycaemic control.

Five areas of intervention were identified for improving glycaemic control: strengthening the health system, improving knowledge about diabetes, reducing the financial burden of diabetes, reducing the proportion of undiagnosed diabetes, and strengthening the adoption of lifestyle change measures.

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Appendices

Appendix 1. Research paper 1

PLOS ONE

STUDY PROTOCOL

Protocol: Developing a framework to improve glycaemic control among patients with type 2 diabetes mellitus in Kinshasa, Democratic Republic of the Congo

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Data Availability Statement: This research protocol reports no data. It describes the plan for a

Abstract

In Kinshasa, Democratic Republic of the Congo (DRC), between 68–86% of patients with type 2 diabetes present with poor glycaemic control leading to increased risk of complications and high cost of care. Identifying the factors driving glycaemic control is essential for better management. There is lack of data on factors associated with poor glycaemic control and targeted interventions in the DRC. This study aims to determine the factors associated with type 2 diabetes control and develop an appropriate intervention package in Kinshasa. The study will comprise of three sub-studies as follows: the first sub-study being a concurrent parallel mixed-methods cross-sectional study to determine factors driving poor glycaemic control among patients in Kinshasa. A total of 614 patients will be invited to participate in a cross-sectional study and respond to standardized questionnaires. A minimum of 20 purposively selected patients will participate in the qualitative study that will involve in-depth interviews about their perspectives on glycaemic control. In the quantitative study, multivariable logistic regression will be performed to determine factors associated with glycaemic control, after identifying the confounding factors. In the qualitative study, thematic analysis will be performed. Findings of the quantitative and qualitative studies on factors that are associated with glycaemic control will be triangulated. And allow to conduct the second sub-study, a qualitative inquiry with a minimum of 20 healthcare providers and 20 patients, selected purposively, to explore their perspectives about potential interventions to improve glycaemic control. At the last, the findings of both sub-studies will be subjected to an anonymous electronic three-round process Delphi study involving 25 stakeholders on the intervention package to develop a framework to optimise glycaemic control in Kinshasa. The implementation of the intervention package will occur after the completion of this study with expected substantial impact on the patients, healthcare providers, and health system.

PhD research protocol with three sub-studies to be completed successively over four years. For these studies, the modalities to access data underlying the results will be indicated at the time of publication. We will favour public access at the Publisher's site.

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Competing interests: The authors have declared that no competing interests exist.

Introduction

Non-communicable diseases (NCD) are responsible for more than 70% of deaths worldwide, and more than three-quarters of these occur in low- and middle-income countries [1]. Diabetes is one of the major non-communicable diseases. Globally, from 1980 to 2014, the prevalence of diabetes has almost quadrupled [2], and in 2019, it was the cause of 4.2 million deaths and the reason for approximately $760 billion in global health expenditure [3]. Diabetes requires many adjustments in the lives of patients to achieve control which can reduce or even delay the onset of complications [4]. Patients are required to eat healthy, exercise, stop smoking, manage stress, drastically limit alcohol consumption, follow the scheduled visits, adhere to treatment, and participate actively in the treatment process [5]. Worldwide, diabetes control remains a major challenge for people living with the disease with, the proportion of patients with type 2 diabetes achieving glycaemic control being around 50% [6]. In Sub-Saharan Africa, poor glycaemic control rates are higher [7]. Knowledge of the determinants of poor glycaemic control is essential for planning interventions to ensure adequate management [7, 8]. Nevertheless, the reasons for poor glycaemic control in type 2 diabetic patients are complex and can involve factors related to the patient (sociodemographic, economic, biologic, and psychologic factors), caregiver (therapeutic inertia, poor training), the healthcare system (preparation for chronic care model, few resources, organization), and society (culture and environment) [9, 10]. In addition, it should be noted that the presence and importance of these factors vary through locations [7, 10].

This study will be conducted in the Democratic Republic of the Congo (DRC). In 2020, the International Diabetes Federation estimated the prevalence of diabetes in the DRC to be approximately 4.8% [11], with about 92% being type 2 diabetes [12]. The guidelines from the Ministry of Health in the Democratic Republic of the Congo defined glycaemic control as a level of glycosylated haemoglobin < 7.0% [12]. The rate of glycaemic control among diabetic patients is extremely low with–local studies finding that control was not achieved in 68% to 86% of patients [13, 14]. This is within a context of socioeconomic deprivation, where patients must pay from their own pockets and without a good integration of diabetes care in the health system [15]. The burden of diabetes is a real hindrance to the wellness of both patients and their families, and the effectiveness of the health system oriented towards other priorities with limited resources [13], and the burden is greater when glycaemic control is not achieved, and complications arise. It is imperative that all the stakeholders in diabetes management agree to move towards the goal of better glycaemic control [8, 13]. Data on glycaemic control in the DRC are very scarce [12] and the factors associated with glycaemic control are not fully known, and no framework exists to improve control among patients with type 2 diabetes mellitus. Few studies have attempted to analyse factors related to poor glycaemic control among patients with type 2 diabetes and have been conducted in single health facilities. In Kinshasa, Longo-Mbenza et al. found, in a cross-sectional survey in one clinic in Kinshasa, that factors associated with poor control in diabetes were Type 1 diabetes, diabetes duration ≥ 4 years, female gender, underweight, diabetic retinopathy, diabetic nephropathy, elevated total cholesterol and higher levels of HDL-cholesterol [13]. In the latest study to date, Blum et al., in a cross-sectional survey in a centre for the follow-up of diabetic patients in a rural area, were unable to identify any socio-economic factor underlying the very low proportion of glycaemic control [14]. Very little attention was paid to identifying the lived experiences and perspectives of diabetic patients, leading to a gap in knowledge that could have helped the understanding and response to the poor glycaemic control in our setting [16]. Our approach to determine the factors that explain poor glycaemic control will consist of a concurrent parallel mixed methods cross sectional analytic study, which will include assessment of psychological and behavioural

aspects, often neglected in the previous studies, but also of food insecurity, which is an increasingly important factor in the control of diabetes [17]. The identification of the interventions to improve glycaemic control will comprise of two components. The first component is to identify patients and healthcare provider's perspectives on ways to improve glycaemic control. The patients and healthcare providers' perspectives have been found essential to build an adequate system of care for diabetes [18]. These perspectives are variable according to settings and may be different from patients to healthcare providers [19, 20]. In the DRC, to the best of our knowledge, there have been no studies devoted to identifying patients and/or perspectives on the control of type 2 diabetes. Consequently, we have designed a descriptive study on the perspectives of patients and healthcare providers on ways to improve glycaemic control in the DRC. The second component of identifying the interventions will be to search for a consensus from all the stakeholders involved in the management of diabetes in the country and in international level. In Kinshasa, a recent study in Kinshasa Primary HealthCare Network found that the practice of type 2 diabetes care was poor [21]. In the DRC, very few interventions are specifically directed towards glycaemic control [12]. Models for chronic care applied to diabetes recognise the importance of restructuring health systems with greater empowerment of patients, involvement of their families and the communities in the care, need for resources and necessary changes in policies [22, 23]. As highlighted in the conceptual model resumed in the Fig 1, innovative interventions that consider the specificities and context of care for patients with diabetes are essential. The development of this consensus will advance with the identification of factors associated with control of type 2 diabetes in the DRC, and the perspectives of patients and healthcare providers on ways to improve glycaemic control.

Materials and methods

The study has obtained ethical clearance from the Ethics Committee of the Protestant University of the Congo (Comité d'éthique de l'Université Protestante au Congo, reference number: CEUPC 0067; Date: 05/02/2021) and the Human Research Ethics Committee (Medical) of the University of the Witwatersrand (reference number: M210308; Date: 26/08/2021). This study protocol is registered on Open Science Framework (OSF) since May 1, 2021, with number: osf.io/6fvt4. It will comprise, in addition to a systematic review and meta-analysis on glycaemia control in sub-Saharan Africa (PROSPERO CRD 42021237941), the following three sub-studies: a concurrent parallel mixed methods cross-sectional analytic study on factors for glycaemic control among patients with type 2 diabetes in Kinshasa, a qualitative descriptive study of perspectives from patients and healthcare providers on ways to improve glycaemic control, and a Delphi study to develop an intervention package for glycaemic control. The two first sub-studies will gather the elements for the conceptualisation and choice of interventions in the ultimate phase, the Delphi study. The research plan is summarized in the Fig 2. The cross-sectional study will be reported according to the Strengthening the reporting of observational studies in epidemiology (STROBE) guidelines [24], and the qualitative components of this study will be reported according to Consolidated criteria for reporting qualitative research (COREQ) guidelines [25].

Sub study 1

This study will be of a concurrent parallel mixed methods cross sectional analytic design to identify drivers of poor glycaemic control among patients with type 2 diabetes mellitus. The key outcome in this study is glycaemic control, which is defined as controlled if the HbA1c is $< 7\%$ and uncontrolled if the HbA1c is $\geq 7\%$ [12].

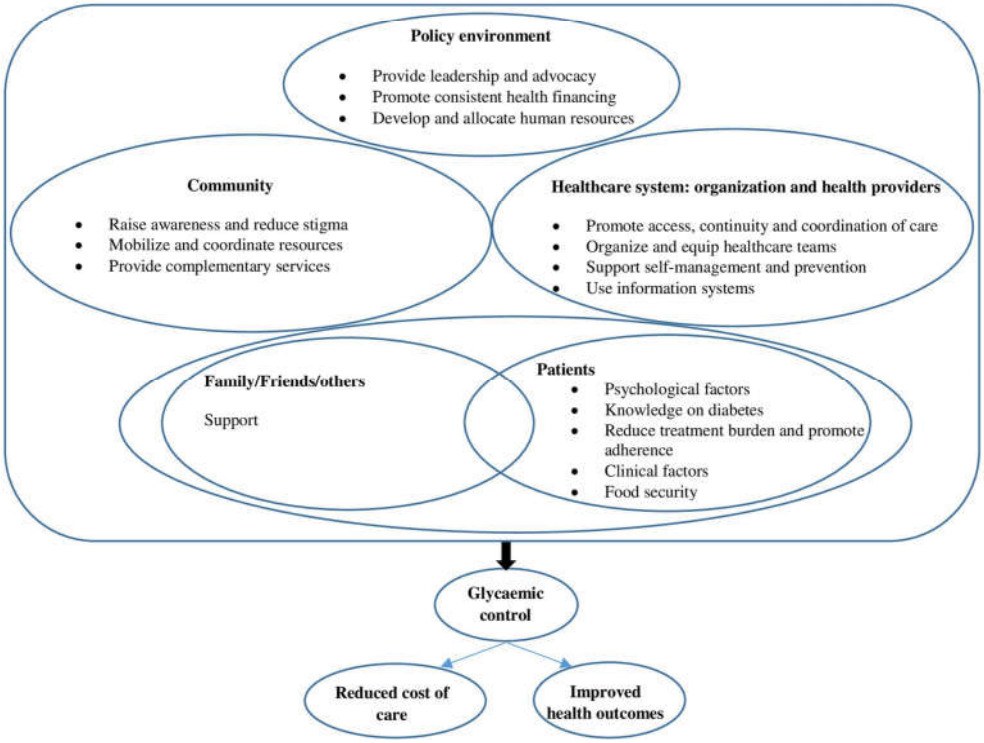

Fig 1. Conceptual model for glycaemic control among patients with type 2 diabetes mellitus in Kinshasa, DRC.

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Study setting. This study will be multicentric within the city of Kinshasa, the capital of the DRC, which has an estimated total population of about 15 million inhabitants spread over an area of 9,965 km^2 [26]. The study will be conducted in the health facilities belonging to the Catholic Church and the Salvation Army. With a total of 66 health facilities (1 referral hospital and 65 health centres) distributed across 24 health districts, these organizations own most of the facilities that have integrated diabetes care in primary care. These healthcare facilities have registered 9170 patients in 2020. The health centres serve as the first point of contact for the patients; these are mainly managed by nurses who ensure routine care and refer patients with problems to the doctor. In the referral hospital in general and in a minority of health centres, outpatient diabetes care is managed by doctors assisted by nurses.

Qualitative phase. This will be a qualitative exploratory study on the lived experiences and perspectives of type 2 diabetic patients on factors driving poor glycaemic control.

Study population, sample size and sampling. The study population will comprise of patients with type 2 diabetes mellitus followed in the 20 healthcare facilities selected for the study in Kinshasa. These healthcare facilities will be the same selected for the quantitative phase of this sub-study; these will be selected from the total of 66 healthcare through sampling proportional to number of diabetic patients followed. The inclusion criteria will be age $\geq$18 years and being

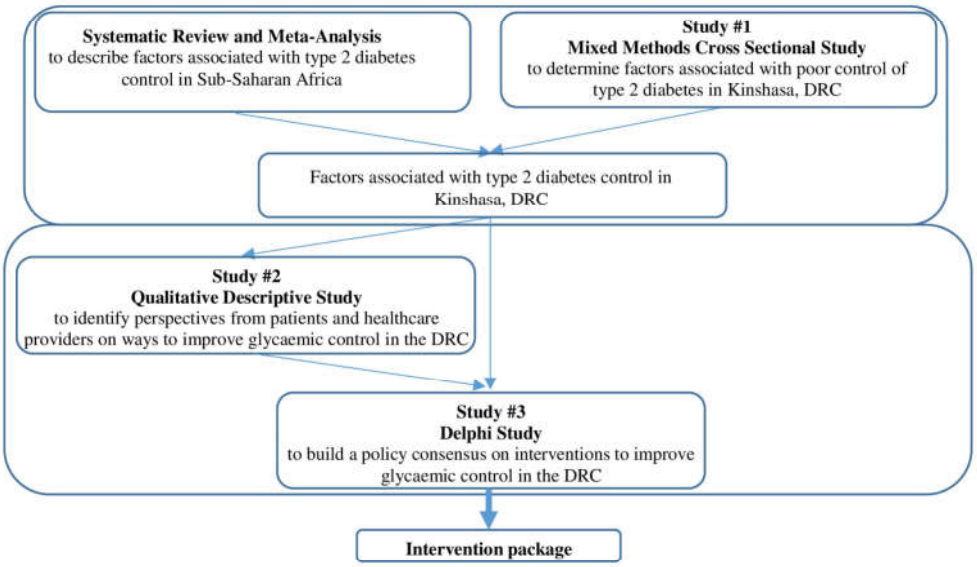

Fig 2. Research plan.

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on drug therapy for at least six months; the exclusion criteria will be: pregnancy, difficulty communicating due to mental disability, and refusal to give consent.

Previous studies have recommended 20 interviews to be adequate to reach thematic saturation when using thematic analysis, defined as the point at which no new concepts emerge from subsequent interviews [27]. Nevertheless, heterogeneity of participants and the complexity of the glycaemic control in diabetes will be considered in purposively recruiting patients e.g., ensuring diversities in sex, duration of illness, socioeconomic strata, treatment categories, good and poor glycaemic control, are represented. While expecting to recruit a minimum of 20 patients, data saturation will determine the ultimate sample size.

We plan to purposively select patients with type 2 diabetes with both good and poor glycaemic control, based on their propensity to report their experiences. Health facilities' teams who know the patients will help in selecting them; these patients will then be invited for interviews in the healthcare where they receive diabetes care.

Data collection. Prior to the commencement of sub study 1, the Principal Investigator will recruit the research assistants (four medical doctors) and train them on study procedures, research ethics and will ensure all have undertaken the online research ethics course. Research assistants will be responsible for administrative tasks and recruiting participants. Prior to the interviews, the Principal Investigator will provide study information summarized on a leaflet to potential study participants and obtain written informed consent. A copy of the leaflet and that of the signed consent form (to participate in the study and for audio recording) will be given to the participant. In the respective facilities selected for the study, the interviews will be conducted by the Principal Investigator in a quiet room where the confidentiality of the participants' statements will be guaranteed. The interviews will be guided by an interview schedule (S1 Appendix). The interviews will be conducted in French or in Lingala depending on the

preferences of the participants. All interviews will be audio recorded. A maximum of three patients are expected to be interviewed per day for three times a week. It is envisaged that data collection for the qualitative study will be completed in about 3 weeks. Each in-depth interview will take approximately at most 45 minutes. At the end of the interview, a sample of 2 millilitres of veinous blood will be drawn from patients for glycosylated haemoglobin assay. We will report on the distribution of poor versus good glycaemic controlled patients in the sample. Data collection will be held in strict respect of rules edited for the prevention of the COVID-19 infection in the country and implemented in the selected health facility.

Data management and analysis. The recorded interviews will be transcribed verbatim and then translated into English language by a language expert for analysis. Data coding and thematic analysis will be performed using the MAXQDA version 20. Similar themes would be coalesced into major themes, and similar major themes, if necessary, will be aggregated into categories. Outlying lived experiences will be sought out for and explanatory model that best explain the inter-relatedness of themes and categories, and the experiences of patients on their own glycaemic control.

Credibility, transferability, dependability, and confirmability. The credibility of the study will be enhanced by peer debriefing and member checking; thick description of data will ensure transferability; external audits conducted by the supervisors and one external expert on qualitative research will ensure dependability, and the confirmability will be ensured by external audits and audit trial [28]. Triangulation of findings between the principal investigator and the supervisors will enhance credibility.

Bias. The biases that may interfere with the data are as follows: selection, interviewer, and social desirability biases. The Principal Investigator will ensure that a comfortable environment has been provided for the interviews and ensure confidentiality to participants to minimize the potential biases.

Quantitative phase. This will be a cross-sectional analytic study among patients with type 2 diabetes mellitus attending at the health centres and hospitals for type 2 diabetes mellitus in Kinshasa, DRC.

Study population and setting. The study will be conducted in selected healthcare facilities organizing diabetes care in Kinshasa. The total number of patients registered in these healthcare structures is 9170. The inclusion criteria will be age $\geq$18 years, and on drug therapy for at least six months; the exclusion criteria will be: pregnancy, difficulty communicating due to mental disability, and refusal to give consent.

Sample size estimation for the cross-sectional study. The estimated minimum sample size has been computed by Epi info version 7.2.2.2 assuming that the prevalence of poor glycaemic control is 68% [13], and a 95% confidence level, a power value of 80%, that among patients who have been on diabetes treatment for $\leq$ 7 years (Unexposed), 59,2% present with poor glycaemic control and those who have been on treatment for > 7 years (Exposed), 74,4% present with poor glycaemic control, and a ratio (Unexposed: Exposed) of 0.47 [29]. The minimum estimated sample size is 368. Adjusting for a design effect of 1.5, the calculated sample size of 552 was determined. At the last, to account for 10% non-response rate, the minimum required sample size is 614 patients.

Sampling and recruitment of participants. As the healthcare facilities have unequal number of patients, we will select the participants through probability proportional to the patient population size. Through this strategy, we plan to randomly select 20 health facilities and in each selected health facility, a minimum of 31 patients will be randomly selected. This process will ensure that as result, a sample where each patient has the same overall probability of selection or self-weighting.

Practically, for the selection of the participants, at each selected health facility, the research assistant will recruit eligible (age ≥18 years, on treatment ≥ 6 months) type 2 diabetic patients attending the clinic at the respective clinic day. The research assistant will pick the file of the first patient on a clinic day to assess for eligibility and thereafter will pick every 3rd patient's file for the subsequent three patients for the administration of questionnaire in a particular day. In a situation where the first patient is ineligible or the 3rd picked patient in the subsequent stage is ineligible, the research assistant will pick the next patient/s until he/she obtains an eligible patient and then continue with every 3rd patient selection. If a patient refuses to participate, the research assistant will pick the next patient on the list and thereafter, pick every 3rd patient on the list. The process will continue until the number of patients is reached. We intend to recruit about 4 patients per each of the five data collectors a day three times a week for a maximum of 11 weeks until the minimum sample size is attained.

Data collection. The research team (principal investigator and research assistants) will provide study information to each potential study participant and then obtain a written informed consent. Data collection will be held in strict respect of rules edited for the prevention of the COVID-19 infection in the country and implemented in the selected health facility.

The administration of the questionnaire. Once a patient is declared eligible and gave consent for the study, the research team will proceed to assess physical and anthropometric measurements. Then, the data collectors will administer the questionnaires. The administration of the questionnaire will last approximately up to 60 minutes. At the end of the data collection, a blood sample is taken from the participant. The research team (principal investigator and research assistants) will administer the questionnaire to the study participants using an electronic questionnaire prepared in REDCap on a Tablet/Smartphone. The questionnaire will be administered in French or in Lingala depending on the preferences of the participants. The information that will be sought from the participants will be the followings: patient factors (sociodemographic factors (age, gender, ethnic group, marital status, occupation, household income, education level, number of people with diabetes in the household, social support), psychological factors (self-care management, diabetes distress, depression), knowledge on diabetes, lifestyle (smoking, alcoholism, practice of exercise)); degree of food insecurity (food security, low food security, very low food insecurity); clinical factors (physical measurements (weight, height, body mass index, waist circumference), characteristics of diabetic disease (family history, duration, number and reason for previous hospitalisations, co-morbidity (hypertension, depression, obesity. . .), treatment. . .); health system factors (existence of health insurance, distance from health centre). The information about the characteristics of diabetes disease will be verified in the patients' medical records, if available.

Measurements tools and operational definitions.

- Patients with type 2 diabetes will be those identified as such in the medical record.
- Glycaemic control or diabetes control will be defined according to the followings: adequate control—HbA1C <7.0%, poor control—HbA1C ≥7.0% [15, 30].
- A distance from participant's place of residence to the health centre of < 5 kilometres or < 1 hour will be considered as adequate while > 5 kilometres or more than 1 hour will be inadequate.—A daily income < $1.9 will be set as threshold for poverty [31].
- Alcohol use will be assessed with the Alcohol Use Disorders Identification Test (AUDIT-C) [32]; a score ≥ 4 (in men) or ≥3 (in women) represents health-risk consumption while a score ≥ 5 (in men) or ≥ 4 (in women) indicates alcohol dependence.

- Nicotine dependence among smokers will be assessed with the Fagerstrom Test for Nicotine Dependence (FTND) [33]; the interpretation of the score obtained is as follows: 1–2: low dependence, 3–4: low to moderate dependence, 5–7: moderate dependence, and ≥ 8: high dependence.
- Physical activity will be assessed by use of the Global Physical Activity Questionnaire (GPAQ). The GPAQ consists of 16 questions covering three domains as: activity at work, transport and leisure activities [34].
- Trained staff using validated devices will measure clinical parameters (height, weight, waist circumference and blood pressure). Relating to the BMI, patients will be categorized as underweight (BMI<18.5 Kg/m^2), normal weighted (18.5–24.99 Kg/m^2), overweighed (BMI≥25 Kg/m2), and obese: ≥30Kg/m2 [35]. For the waist circumference, normal values are defined according to gender as: men <102 centimetres; women < 88 centimetres [36]. Hypertension will be defined as a systolic blood pressure level of 140 mmHg or higher and/or a diastolic blood pressure level of 90 mmHg or higher [37].
- Food security status will be measured with the household food insecurity scale (HFIAS), a 9-item measurement tool. It reports the experience of past four weeks [38, 39]. The HFIAS categorises households into four levels of food access: food secure, mild food insecure, moderately food insecure and severely food insecure.
- Knowledge of diabetes will be assessed by the use of the simplified diabetes knowledge scale, a true/false response format of the Revised Diabetes Knowledge Scale of the Michigan Diabetes Research Center [40, 41]. It contains 20 items with three related to insulin users. The internal reliability of the Revised Diabetes Knowledge Scale is 0.71 versus 0.61 for the Simplified Diabetes Knowledge Scale; the item correlation with the total knowledge test score ranged from 0.23 to 0.45 for the Revised Diabetes Knowledge Scale versus 0.26–0.58 for the Simplified Diabetes Knowledge Scale. The corrected item-total correlations were >0.2 for the Revised Diabetes Knowledge Scale and the Simplified Diabetes Knowledge Scale [40]. The Simplified Diabetes Knowledge Scale is used as a continuous score; no cut-off point has been defined for knowledge.
- Adherence to treatment will be assessed by the Morisky Green Levine test (MGL test) [42]. The MGL test is a structured four-point measure of treatment adherence with an alpha reliability of 0.61. The MGL test divides patients into three categories of adherence: high, medium, and low.
- Social support will be assessed by the Multidimensional Scale for Perceived Social Support (MSPSS) [43]; the MSPSS is a brief self-report questionnaire that contains 12 items rated in a five-point Likert-type scale. The MSPSS assessed three sub-scales of the social support as: family, friends, and significant others; its internal consistency and test-retest reliability are excellent (Cronbach's alpha: 0.81 to 0.98 in non-clinical samples and 0.92–0.94 in clinical samples) [44]. For the Multidimensional Scale for perceived social support (MSPSS), the mean scores are calculated as: Significant Other Subscale—sum across items 1, 2, 5, & 10, and divided by 4. Family Subscale—sum across items 3, 4, 8, & 11, then divided by 4. Friends Subscale—sum across items 6, 7, 9, & 12, then divided by 4. Total Scale—sum across all 12 items and divided by 12. Any mean scale score ranging from 1 to 2.9 could be considered low support, a score of 3 to 5 as moderate support, and a score from 5.1 to 7 high support.
- Screening of depression will be done using the Patient Health Questionnaire-9 (PHQ-9) [45]. PHQ-9 is the 9-point depression module of the full PHQ and is a screening tool and

measure of depression severity. The Cronbach's alpha was 0.89 in a primary healthcare study [46]. Depression screening with PHQ-9 will determine the following categories: moderate depression (12–14), moderately severe depression (15–19), severe depression (20–27) [45].

- Diabetes distress will be assessed through the Diabetes Distress Scale (DDS) [47], a 17-item scale that captures four critical dimensions of distress: emotional burden (5 items), regimen distress (5 items), interpersonal distress (3 items) and physician distress (4 items). Associations have been found between DDS scores and behavioural management and biological variables when DDS scores are > 2.0 [48]. For the DDS, a mean item score 2.0–2.9 should be considered 'moderate distress,' while a mean item score > 3.0 'high distress'.
- Diabetes self-management will be assessed with the use of the Diabetes Self-Management Questionnaire (DSMQ), a 16-item questionnaire recognised to be a reliable and valid instrument that enables an efficient assessment of self-care behaviours associated with glycaemic control [49]. It comprises for subscales: dietary control (4 items), glucose management (5 items), physical activity (3 items), and physician contact (3 items).

Laboratory procedures. All patients will have 2 millilitres of venous blood taken by the researchers for determination of glycosylated haemoglobin. The glycosylated haemoglobin will be assayed using the same validated method at one central laboratory at the Didactic Health Centre of the School of medicine at the Protestant University of Congo at Kinshasa to avoid differences between laboratories [50].

Variables. Outcome: the main outcome variable will be the glycaemic control that will be assessed with HbA1c. Glycaemic control will be defined as HbA1c <7% [12, 26].

Exposures of interest: potential factors associated with glycaemic control as described above in the information sought from the participants and related to patients, society, and health system (S2 and S3 Appendices).

Data analysis. Statistical analysis will be performed using STATA 17. Quantitative variables normally distributed will be expressed as mean ± standard deviation; and non-normally distributed data as median with interquartile range (IQR). The categorical variables will be expressed as frequency (n) and percentage (%). Subsequently, we will perform the bivariate analysis to determine factors associated with glycaemic control using t -test or Mann-Whitney U for continuous variables and Chi square test/Fisher exact test for categorical variables. We will fit a multivariable logistic regression to assess factors associated with glycaemic control. Age, sex, duration on treatment, food security will be included in the regression model a priori. And other factors will be included in the model if they have a p-value of <0.20 in bivariate analysis. The p value of <0.05 will be considered the statistically significant.

Reliability, validity, and generalisability. Ensuring the reliability of the study will be using validated questionnaires for data collection and training of the research team. The findings will be generalisable to the DRC context but could be extended for use in similar settings in SSA.

Bias. The potential biases for this study are—selection (non- response of the eligible participants), recall, interpretation, and social desirability. We will minimize the biases by ensuring the research assistants are properly trained and the aim of the study is clearly explained to the participants.

Sub study 2

Using the findings from the sub study 1, we will carry out a qualitative study in the four clinics in Kinshasa to explore patients' and healthcare providers' perspectives on how to improve the control of glycaemia.

Study population and sample. Patients and healthcare providers aged ≥18 years will be invited to participate. Patients and healthcare providers will be chosen deliberately. Patients to be selected will be those who have been followed for at least six months for diabetes and who have mastered the model of care offered to patients with diabetes. Caution will be taken to select those who will be willing to discuss their views on improving blood glucose control. Attention will be paid to selecting male and female patients, from different socio-economic categories and ages, and independently of their status regarding glycaemic control (controlled and uncontrolled). About caregivers, preference will be given to selecting providers with long experience of diabetes. Male and female providers will be selected as well as doctors and nurses. The participants will be excluded if they present with difficulty communicating due to mental disability or, refuse to give consent.

For each category of participants, patients, or healthcare providers, as stated by many authors for adequate sample size, we expect to have 20 interviews but will continue to include participants until thematic saturation [27]. The total of expected participants is 40; twenty (20) patients and twenty (20) healthcare providers. Health managers in charge of the healthcare facilities will help in selecting the health providers to be included in the study. In turn, health facilities' teams who know the patients will help in selecting them; these patients will then be invited to come to the health facilities for interviews. The research team will ensure diversity of participants in terms of sex/ gender, duration of diabetes, treatment types, type of healthcare facility, etc. for patients and sex, years of professional experience, clinical category, type of facility, etc. for healthcare providers. A maximum of three participants are expected to be interviewed per day for three times a week. A maximum of five weeks will suffice to complete data collection.

Data collection. The data collection will be carried through in-depth interviews which will be audiotaped. Prior to the interviews, the Principal Investigator will provide study information to potential study participants and obtain written informed consent for both the interview and audio recording. The interviews will be guided by an interview schedule (S4 Appendix). This interview schedule will be updated based on the findings from the systematic review associated with this research and the sub-study 1 on factors driving glycaemic control. At the respective facilities, the principal investigator will interview the participants in a quiet room where the confidentiality of the participants' statements will be guaranteed. The interviews will be conducted in Lingala or French depending on the preferences of the participants. All interviews will be audio recorded. Data collection will be held in strict respect of rules edited for the prevention of the COVID-19 infection in the country and implemented in the selected health facility.

Data management and analysis. The recorded interviews will be transcribed verbatim and then translated into English language for analysis. Data coding and thematic analysis will be performed using the MAXQDA version 20. Identified themes that are similar would be coalesced into major themes, and similar major themes, if necessary, will be aggregated into categories. Outliers' perceptions will be sought out for. Attempts will be made to develop explanatory models that best explain the inter-relatedness of themes and categories, and the perceptions of patients and healthcare providers on interventions that can improve glycaemic control in type 2 patients.

Credibility, transferability, dependability, and confirmability. The credibility of the study will be enhanced by triangulation, peer debriefing and member checking; thick description of data will ensure transferability; external audits conducted by the supervisors and one external expert on qualitative research will ensure dependability, and the confirmability will be ensured by external audits and audit trial [28].

Bias. The biases that may interfere with the data are—selection (non-response of the eligible participants), interviewer, and social desirability biases.

Sub study 3

This will be a Delphi study, seeking policy consensus from important stakeholders in diabetes management in developing the package of interventions to improve glycaemic control based on the use of findings from the sub studies 1 and 2. A research team lead by the Principal Investigator and including one supervisor and a statistician will conduct data collection and initial analysis. Data interpretation will be done by the whole team of investigators.

Study site. The Delphi study will be anonymous electronic survey. The participants will respond on potential glycaemic control interventions in Kinshasa.

Study population and sample size. The Delphi study will include all representatives of stakeholders in diabetes management in Kinshasa, DRC. Twenty-five people will be involved–five clinicians from the health centres, five managers in diabetes care, five representatives from universities, five representatives from partners in diabetes management, and five representatives from the Ministry of health. The clinicians are persons qualified in clinical practice of medicine being doctors or nurses and taking care of diabetes; the managers are individuals who are in charge of a healthcare structure (hospital, health centre) or a group of healthcare structures organizing diabetes care; the representatives of universities will be diabetologists or internal medicine experts; partners are all the persons or organizations participating in the management of diabetes by providing financial or technical support; the representatives from the Ministry of health will be individuals working in the National Program of diabetes and the National Directorate against diseases. The participants will be purposively selected with caution to ensure motivation for the subject and expertise on diabetes control. Contacts will be made with the structures organizing or providing a support for diabetes care to have delegates as experts in the issue; known experts in the diabetes management will be contacted directly through emails.

Inclusion/Exclusion criteria. All the participants will have an age $\geq$18 years; the exclusion criteria being difficulty communicating due to mental disability, conflict of interest in study participation, and refusal to give consent. Experts will be local or international experts with preference given to those with current or past work in DRC.

Data collection. Participants will receive by e-mail a document on the purpose and objectives of the study. They will be asked to consent electronically to participate in the study. Once they accept to participate in the study, a second e-mail will inform them on the results of previous sub-studies of this study. This Delphi study will be a three rounds process. At the first round, each stakeholder will be approached to answer an open-ended questionnaire on interventions to improve diabetes control in patients with type 2 diabetes. The participants' responses at the first round will be used to identify items that will be used by the researchers to draw a well-structured questionnaire on interventions to improve glycaemic control. In the second round, experts will be subjected to the questionnaire built after the first round and asked individually to rank the interventions in terms of priority. Their ratings will consist of assessing each intervention according to a 4-point Likert scale ('strongly agree', 'agree', 'disagree', 'strongly disagree'). Additionally, they will be asked to motivate their ranking. At the end of the second round, the researcher will summarize the rankings from the experts and their motivations and feed back to the experts in the third round. In this third round, experts will be asked to re-rank after reconsidering their opinions or judgements in light of other group members' rankings or to specify the reasons for remaining outside the consensus. At the end of the third round, the researchers will sort out a list of remaining interventions and their

rankings along with minority opinions and interventions achieving consensus. The experts' contributions will be anonymous. Researcher team' correspondences with experts will be made in French and English while experts' contributions will be made in English or French depending on their preferences; feedback by the researcher will be in English and French.

Data analysis. The data from the first round will more consists of qualitative data; the qualitative data will be summarized using content analysis. In the subsequent rounds, for each round, medians will be used to describe group responses to each statement. And, between rounds, data will be analysed to identify convergence and change of experts' opinions or judgements. Consensus will be defined as > 70% of experts agreeing/strongly agreeing or disagreeing/strongly disagreeing with a statement in the Round 3. Stability of consensus will be considered as reached if the between round group responses vary by $\leq$10%.

Ethical considerations and declarations

The researchers declare that they will comply with the conditions under which this study has obtained approval from the ethics committees of the Protestant University of Congo and Human Research Ethics Committee (Medical) of the University of the Witwatersrand. Any departure from the protocol will need two Ethics Committees. The authorization has been obtained from the Kinshasa Primary HealthCare Network to conduct the study. A written consent will be sought from participants of each of the sub-studies of this research. Withdrawal from the study will have no impact on the care that patients receive or on the position that health care providers occupy within the health care structure. No interventions will be carried out on study participants. During this period of the pandemic, data will be collected in strict compliance with the rules laid down for the protection of individuals in health facilities, namely: wearing masks, social distancing, frequent hand washing and curfews. In this way, crowds will be avoided throughout the data collection process. The research data will be kept at the Protestant University of Congo for a period of 20 years after the end of the study. The participants will not be paid for their participation in the study. Nevertheless, the participants will be reimbursed for the transport to come to the healthcare structure in case they will be invited. If one of the scales used in this study suspects a medical condition for which a participant needs to be managed, s/he will be referred to the appropriate facilities for management.

The research assistants will be acknowledged for their support in the study. The authorship will be based on the fulfilment of all the four conditions listed in the International Committee of Medical Journal Editors uniform requirements for manuscripts submitted to BioMedical Journals [51].

Status and timeline of the study

The Table 1 presents the timeline of the study. None form of data collection has been conducted at this stage.

Discussion

Diabetes mellitus, like other NCDs, is growing in importance globally with substantial impact on mortality and a huge economic burden to societies [52, 53]. The progress of diabetes is dramatic in low-and-middle countries, like the DRC, because of the coexisting traditional health priorities, few resources, and the unpreparedness of the health system [8, 54, 55]. The control of glycaemia has shown to prevent or delay the occurrence of the complications [56]. Nevertheless, the control of glycaemia requires many adjustments for all the actors in the diabetes care for better achievements. In the DRC, recent studies have shown high rates of poor control among patients with type 2 diabetes. The burden of diabetes for the patients and the families is

Table 1. Timing of the activities of the study.

	2020				2021				2022				2023			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Protocol drafting and approval	■	■	■	■	■	■	■									
Sub study 1																
Data collection								■	■	■						
Data analysis									■	■						
Sub study 2																
Data collection										■	■	■				
Data analysis												■				
Sub study 3																
Data collection												■	■	■		
Data analysis													■	■		
Dissemination of the findings										■	■	■	■	■	■	■

Q1: first quarter, Q2: second quarter, Q3: third quarter, Q4: fourth quarter.

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multiplied when complications arise and represents a real obstacle for the wellness of patients and families, and the effectiveness of the health system [57]. As we stated earlier, it is time to act unless we let diabetes continue with its innumerable consequences. In this way, as factors for poor control of glycaemia vary according to settings, the identification of factors acting primer roles in Kinshasa is a pre-requisite if we want effective interventions [7]. From the few studies that have been conducted in the DRC, data on factors driving glycaemic control are scarce [13, 14, 58]. And there were not many efforts to look on how the patients explain by themselves poor glycaemic control that would contribute to the understanding of the phenomenon. Moreover, elements to build an adequate system of care for diabetes are unknown as we have not yet explored perspectives from patients and the healthcare providers on ways to improve glycaemic control.

This study will describe the factors associated with glycaemic control among patients with type 2 diabetes in Kinshasa, DRC. And further explore the perspectives from patients and healthcare providers on ways to improve the control of diabetes. The findings will inform the development of the targeted intervention package to improve glycaemic control in Kinshasa, DRC.

Findings of the planned studies should be interpreted in consideration of the following limitations: the cross-sectional design of the study will not allow to establish the causal inference for factors of poor glycaemic control. The qualitative nature of some components will not guarantee the generalisability of the findings to other settings not similar to Kinshasa, DRC.

Supporting information

S1 Appendix. Interview guide for patients with type 2 diabetes sub-study 1.
(DOCX)

S2 Appendix. Questionnaire for patients with type 2 diabetes sub-study 1.
(DOCX)

S3 Appendix. Laboratory sheet.
(DOCX)

S4 Appendix. Interview guide for patients and healthcare providers sub-study 2.
(DOCX)

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S1 Appendix: Interview guide for patients with type 2 diabetes sub-study 1.

STUDY TITLE: DEVELOPING A FRAMEWORK TO IMPROVE GLYCAEMIC CONTROL AMONG PATIENTS WITH TYPE 2 DIABETES MELLITUS IN KINSHASA, DEMOCRATIC REPUBLIC OF THE CONGO

S1 APPENDIX: INTERVIEW GUIDE FOR IN-DEPTH INTERVIEW

Topic I: Self-management of diabetes

What was your reaction when you were told you have diabetes?
What were you told about diabetes mellitus?
What were you told about self-management?
What are your feelings about self-management of diabetes?
Can you tell us what you typically eat?
What kind of effect you think diet has on your diabetes?
How do you monitor your glucose?
How do changes in your treatment are made?
Tell us about your exercise plan for a typical week
Why is the diabetes treatment important for you?
What are your therapeutic goals?
How do you describe your commitment to the treatment?
What changes did you have to make to your daily life?
What is your motivation to follow the treatment?
What are the complications that you have been told during education? How to avoid theses?

Topic II: Support from family/friends/others

Who are the most supportive persons since you have been told you have diabetes?
Can you describe the kind of support they offer?

Can you tell us how following diabetes treatment place you in uncomfortable position with your entourage?

Topic III: Community

What are the thoughts of the members of your community about diabetes?

What do you think are the consequences of these thoughts on your diabetes care?

Describe where you access your treatment for diabetes mellitus

Can you tell us how following the treatment puts you in difficulty in work? Waiting lists, number of appointments, distance from home to health center…

Topic IV: Healthcare system

4.1 Accessing diabetes treatment

Do you have any challenge regarding attending the facility for your treatment?

Describe the health facility you are attending for your diabetes mellitus

Tell us about your relation with the healthcare providers

4.2 Health insurance

Tell us how diabetes treatment interferes with your usual expenses

What are the competing priorities do you have to deal in following your treatment?

4.3 Communication with the health providers/health facility

Tell us more about your relation with the healthcare providers.

What are the challenges that make it difficult for you to respond to scheduled appointments or to follow treatment?

Describe a typical encounter with the healthcare provider during scheduled appointment

How the health facility where you are receiving diabetes care is organized?

Topic V:

Food security

Tell us about your experience on accessing food before and after being diagnosed with diabetes.

S2 Appendix: Questionnaire for patients with type 2 diabetes sub-study 1.

STUDY TITLE: DEVELOPING A FRAMEWORK TO IMPROVE GLYCAEMIC CONTROL AMONG PATIENTS WITH TYPE 2 DIABETES MELLITUS IN KINSHASA, DEMOCRATIC REPUBLIC OF THE CONGO

S2 APPENDIX: QUESTIONNAIRE

ID:…… **Province:……**

Place:…….. **Investigator number:……**

Date: / /

Sociodemographic characteristics

1 Age (years):……..

2 Sex:

1. Male
2. Female

3 Marital status: .....

1. Single
2. Free union
3. Married (monogamic)
4. Married (polygamic)
5. Divorced/ Separated
6. Widow

4 Ethnic group:……...

1.Kongo
2. Luba
3. Ngala
4. Swahili
5. Other……

5 Religion:……

1. Catholic
2. Protestant
3. Independent group
4. Jehovah witness
5. Kimbanguist
5. Muslim
6. Animist
7. Without religion
8. Other……

6 Highest general education qualification:

1.No formal education
2. Primary school
3. Secondary school
4. University

7 Occupation

1. Employed
2. Unemployed
3. Other

8 Monthly income (Congolese Francs):……..

9 Number of persons with diabetes in the household:…….

Health system characteristics

10 Distance from home to health center

1. < 5 Kilometers or < one hour to cover
2. ⩾ 5 kilometers or ⩾ one hour

11 Health insurance

1. No
2. Yes

11a If Yes, Specify …….

Diabetes disease and care characteristics

History

12 Duration of Diabetes: Months

13 Comorbidity/complications :

1. Hypertension
2. Hyperlipidemia
3. Obesity
4. Cataracts
5. Diabetic retinopathy
6. Impaired renal function
7. Erectile dysfunction
8. Other

13a If Other, Specify……

14 Hospitalizations in the last year :

1. No
2. Yes

14a If Yes, Specify below:

14a	**Number**	**Period**	Reason

Lifestyle

15 **Alcohol use/AUDIT-C**

Q1: How often did you have a drink containing alcohol in the past year?	
Answer	Points
Never	0
Monthly or less	1
Two to four times a month	2
Two to three times a week	3
Four or more times a week	4
Q2: How many drinks did you have on a typical day when you were drinking in the past year?	
Answer	Points
None, I do not drink	0
1 or 2	0
3 or 4	1
5 or 6	2
7 to 9	3
10 or more	4
Q3: How often did you have six or more drinks on one occasion in the past year?	
Answer	Points
Never	0
Less than monthly	1
Monthly	2
Weekly	3
Daily or almost daily	4
TOTAL	

16 Smoking

Do you currently smoke cigarettes?			
1. No			
2. Yes			
16a If Yes, respond to the questions below			
16a **Fagerstrom test for nicotine dependence**			
How soon after walking do you smoke your first cigarette?	Within 5 minutes	☐	3
	5-30 minutes	☐	2
	31-60 minutes	☐	1
Do you find it difficult to refrain from smoking in places where it is forbidden? e.g. Church , Library, etc.	Yes	☐	1
	No	☐	0
Which cigarette would you hate to give up?	The first in the morning	☐	1
	Any other	☐	0
How many cigarettes a day do you smoke?	10 or less	☐	0
	11-20	☐	1
	21-30	☐	2
	31 or more	☐	3
Do you smoke more frequently in the morning?	Yes	☐	1
	No	☐	0
Do you smoke even if you are sick in bed most of the day?	Yes	☐	1
	No	☐	2
Total score			

17	**Global physical activity questionnaire**		
Physical Activity			
Next I am going to ask you about the time you spend doing different types of physical activity in a typical week. Please answer these questions even if you do not consider yourself to be a physically active person. Think first about the time you spend doing work. Think of work as the things that you have to do such as paid or unpaid work, study/training, household chores, harvesting food/crops, fishing or hunting for food, seeking employment. *[Insert other examples if needed]*. In answering the following questions 'vigorous-intensity activities' are activities that require hard physical effort and cause large increases in breathing or heart rate, 'moderate-intensity activities' are activities that require moderate physical effort and cause small increases in breathing or heart rate.			
Questions		**Response**	**Code**
Activity at work			
1	Does your work involve vigorous-intensity activity that causes large increases in breathing or heart	Yes 1	P1

	rate like *[carrying or lifting heavy loads, digging or construction work*] for at least 10 minutes continuously? *[INSERT EXAMPLES] (USE SHOWCARD)*	No 2 *If No, go to P 4*	
2	In a typical week, on how many days do you do vigorous-intensity activities as part of your work?	Number of days ⌊_⌋	P2
3	How much time do you spend doing vigorous-intensity activities at work on a typical day?	Hours : minutes ⌊_⌋⌊_⌋ : ⌊_⌋⌊_⌋ hrs mins	P3 (a-b)
4	Does your work involve moderate-intensity activity that causes small increases in breathing or heart rate such as brisk walking *[or carrying light loads*] for at least 10 minutes continuously? *[INSERT EXAMPLES] (USE SHOWCARD)*	Yes 1 No 2 *If No, go to P 7*	P4
5	In a typical week, on how many days do you do moderate-intensity activities as part of your work?	Number of days ⌊_⌋	P5
6	How much time do you spend doing moderate-intensity activities at work on a typical day?	Hours : minutes ⌊_⌋⌊_⌋ : ⌊_⌋⌊_⌋ hrs mins	P6 (a-b)
Travel to and from places			
The next questions exclude the physical activities at work that you have already mentioned. Now I would like to ask you about the usual way you travel to and from places. For example to work, for shopping, to market, to place of worship. [insert other examples if needed]			
7	Do you walk or use a bicycle (*pedal cycle*) for at least 10 minutes continuously to get to and from places?	Yes 1 No 2 *If No, go to P 10*	P7
8	In a typical week, on how many days do you walk or bicycle for at least 10 minutes continuously to get to and from places?	Number of days ⌊_⌋	P8
9	How much time do you spend walking or bicycling for travel on a typical day?	Hours : minutes ⌊_⌋⌊_⌋ : ⌊_⌋⌊_⌋ hrs mins	P9 (a-b)
Recreational activities			
The next questions exclude the work and transport activities that you have already mentioned. Now I would like to ask you about sports, fitness and recreational activities (leisure), [insert relevant terms].			
10	Do you do any vigorous-intensity sports, fitness or recreational (*leisure*) activities that cause large increases in breathing or heart rate like [*running or football,]* for at least 10 minutes continuously? *[INSERT EXAMPLES] (USE SHOWCARD)*	Yes 1 No 2 *If No, go to P 13*	P10

11	In a typical week, on how many days do you do vigorous-intensity sports, fitness or recreational (*leisure*) activities?	Number of days ⌊__⌋	P11
12	How much time do you spend doing vigorous-intensity sports, fitness or recreational activities on a typical day?	Hours : minutes ⌊__⌋⌊__⌋ : ⌊__⌋⌊__⌋ hrs mins	P12 (a-b)
13	Do you do any moderate-intensity sports, fitness or recreational *(leisure)* activities that causes a small increase in breathing or heart rate such as brisk walking,(*cycling, swimming, volleyball*)for at least 10 minutes continuously? *[INSERT EXAMPLES] (USE SHOWCARD)*	Yes 1 No 2 *If No, go to P16*	P13
14	In a typical week, on how many days do you do moderate-intensity sports, fitness or recreational (*leisure*) activities?	Number of days ⌊__⌋	P14
15	How much time do you spend doing moderate-intensity sports, fitness or recreational (*leisure*) activities on a typical day?	Hours : minutes ⌊__⌋⌊__⌋ : ⌊__⌋⌊__⌋ hrs mins	P15 (a-b)
	Sedentary behaviour		
The following question is about sitting or reclining at work, at home, getting to and from places, or with friends including time spent [sitting at a desk, sitting with friends, travelling in car, bus, train, reading, playing cards or watching television], but do not include time spent sleeping. *[INSERT EXAMPLES] (USE SHOWCARD)*			
16	How much time do you usually spend sitting or reclining on a typical day?	Hours : minutes ⌊__⌋⌊__⌋ : ⌊__⌋⌊__⌋ hrs mins	P16 (a-b)
	GLOBAL PHYSICAL ACTIVITY SCORE		

Clinical parameters

18 Weight (Kg): ……

19 Height (centimeters): ……

20 BMI (Kg/m^2):……

21 Waist circumference: ……..cms

22 Blood pressure: …../…….mmHg

Treatment

Regimen

23a Insulin: Type:……..

23b Oral Antidiabetic Drugs:……..

1. Single:……
2. Mixed: ……..

23c Mixed Insulin-Oral Antidiabetic Drugs: …..
23d Other:…….
Total duration of treatment
23e Number of months:……

Patient health questionnaire-9 (PHQ-9)

Over the last 2 weeks, how often have you been bothered by any of the following problems?

		Not at all	Several days	More than half the days	Nearly every day
		0	1	2	3
1	Little interest or pleasure in doing things	0	1	2	3
2	Feeling down, depressed, or hopeless	0	1	2	3
3	Trouble failing or staying asleep, or sleeping too much	0	1	2	3
4	Feeling tired or having little energy	0	1	2	3
5	Poor appetite or overeating	0	1	2	3
6	Feeling bad about yourself-or that you are a failure or have let yourself or your family down	0	1	2	3
7	Trouble concentrating on things, such as reading the newspaper or watching television	0	1	2	3
8	Moving or speaking so slowly that other people could have noticed. Or the opposite-being so figety or restless that you have been moving around a lot more than usual	0	1	2	3
9	Thoughts that you would be better off dead, or of hurting yourself	0	1	2	3
		Add columns			
24		Total			

Diabetes distress study (DDS)

Living with diabetes can sometimes be tough. There may be many problems and hassles concerning diabetes and they can vary greatly in severity. Problems may range from minor hassles to major life difficulties. Listed below are 17 potential problem areas that people with diabetes may experience. Consider the degree to which each of the 17 items may have distressed or bothered you DURING THE PAST MONTH.

Please note that we are asking you to indicate the degree to which each item may be bothering you in your life, NOT whether the item is merely true for you. If you feel that a particular item is not a bother or a problem for you, we would circle "1". If it is very bothersome to you, we might circle "6".

	Not a problem	A slight problem	A moderate problem	Somewhat serious problem	A serious problem	A very serious problem
1. Feeling that diabetes is taking up too much of my mental and physical energy every day	1	2	3	4	5	6
2. Feeling that my doctor doesn't know enough about diabetes and diabetes care.	1	2	3	4	5	6
3. Not feeling confident in my day-to-day ability to manage diabetes.	1	2	3	4	5	6

4. Feeling angry, scared and/or depressed when I think about living with diabetes.	1	2	3	4	5	6
5. Feeling that my doctor doesn't give me clear enough directions on how to manage my diabetes.	1	2	3	4	5	6
6. Feeling that I am not testing my blood sugars frequently enough.	1	2	3	4	5	6
7. Feeling that I will end up with serious long-term complications, no matter what I do.	1	2	3	4	5	6
8. Feeling that I am often failing with my diabetes routine.	1	2	3	4	5	6
9. Feeling that friends or family are not supportive enough of self-care efforts (e.g. planning activities that conflict with my schedule, encouraging me to eat the "wrong" foods).	1	2	3	4	5	6
10. Feeling that diabetes controls my life.	1	2	3	4	5	6
11. Feeling that my doctor doesn't take my concerns seriously enough.	1	2	3	4	5	6
12. Feeling that I am not sticking closely enough to a good meal plan.	1	2	3	4	5	6
13. Feeling that friends or family don't appreciate how difficult living with diabetes can be.	1	2	3	4	5	6
14. Feeling overwhelmed by the demands of living with diabetes.	1	2	3	4	5	6
15. Feeling that I don't have a doctor who I can see regularly enough about my diabetes.	1	2	3	4	5	6
16. Not feeling motivated to keep up my diabetes self-management.	1	2	3	4	5	6
17. Feeling that friends or family don't give me the emotional support that I would like.	1	2	3	4	5	6

25	**25a**	Total score	
	25b	Emotional burden	
	25c	Physician burden	
	25d	Regimen burden	
	25e	Interpersonal burden	

Diabetes self-management questionnaire (DSMQ)

The following statements describe self-care activities related to your diabetes. Thinking about your self-care over the **last 8 weeks**, please specify the extent to which each statement applies to you. Note: If you monitor your glucose using continuous interstitial glucose monitoring (CGM), please refer to this where 'blood sugar checking' is requested.	applies to me very much	applies to me to a consider-able degree	applies to me to some degree	does not apply to me
1. I check my blood sugar levels with care and attention. ☐ *Blood sugar measurement is not required as a part of my treatment.*	☐3	☐2	☐1	☐0
2. The food I choose to eat makes it easy to achieve optimal blood sugar levels.	☐3	☐2	☐1	☐0
3. I keep all doctors' appointments recommended for my diabetes treatment.	☐3	☐2	☐1	☐0
4. I take my diabetes medication (e. g. insulin, tablets) as prescribed. ☐ *Diabetes medication/insulin is not required as a part of my treatment.*	☐3	☐2	☐1	☐0
5. Occasionally I eat lots of sweets or other foods rich in carbohydrates.	☐3	☐2	☐1	☐0
6. I record my blood sugar levels regularly (or analyse the value chart with my blood glucose meter). ☐ *Blood sugar measurement is not required as a part of my treatment.*	☐3	☐2	☐1	☐0
7. I tend to avoid diabetes-related doctors' appointments.	☐3	☐2	☐1	☐0
8. I do regular physical activity to achieve optimal blood sugar levels.	☐3	☐2	☐1	☐0
9. I strictly follow the dietary recommendations given by my doctor or diabetes specialist.	☐3	☐2	☐1	☐0
10. I do not check my blood sugar levels frequently enough as would be required for achieving good blood glucose control. ☐ *Blood sugar measurement is not required as a part of my treatment.*	☐3	☐2	☐1	☐0
11. I avoid physical activity, although it would improve my diabetes.	☐3	☐2	☐1	☐0
12. I tend to forget to take or skip my diabetes medication (e. g. insulin, tablets). ☐ *Diabetes medication/insulin is not required as a part of my treatment.*	☐3	☐2	☐1	☐0
13. Sometimes I have real 'food binges' (not triggered by hypoglycaemia).	☐3	☐2	☐1	☐0
14. Regarding my diabetes care, I should see my medical practitioner(s) more often.	☐3	☐2	☐1	☐0
15. I tend to skip planned physical activity.	☐3	☐2	☐1	☐0

16. My diabetes self-care is poor.			☐3	☐2	☐1	☐0
26	**26a**	Total score				
	26b	Dietary control				
	26c	Glucose management				
	26d	Physical activity				
	26e	Physician contact				

Household food insecurity access scale(HFIAS)

No	Question	Response Options	Code
1	In the past four weeks, did you worry that your household would not have enough food?	0 = No (skip to Q2) 1=Yes	….|___|
1.a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	….|___|
2.	In the past four weeks, were you or any household member not able to eat the kinds of foods you preferred because of a lack of resources?	0 = No (skip to Q3) 1=Yes	….|___|
2.a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	….|___|
3.	In the past four weeks, did you or any household member have to eat a limited variety of foods due to a lack of resources?	0 = No (skip to Q4) 1=Yes	….|___|
3.a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	….|___|
4.	In the past four weeks, did you or any household member have to eat some foods that you really did not want to eat because of a lack of resources to obtain other types of food?	0 = No (skip to Q5) 1=Yes	….|___|

4.a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	….|___|
5.	In the past four weeks, did you or any household member have to eat a smaller meal than you felt you needed because there was not enough food?	0 = No (skip to Q6) 1=Yes	….|___|
5.a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	….|___|
6.	In the past four weeks, did you or any other household member have to eat fewer meals in a day because there was not enough food?	0 = No (skip to Q7) 1=Yes	….|___|
6.a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	….|___|
7.	In the past four weeks, was there ever no food to eat of any kind in your household because of lack of resources to get food?	0 = No (skip to Q8) 1=Yes	….|___|
7.a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	….|___|
8.	In the past four weeks, did you or any household member go to sleep at night hungry because there was not enough food?	0 = No (skip to Q9) 1=Yes	….|___|
8.a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	….|___|
9.	In the past four weeks, did you or any household member go a whole day and night without eating anything because there was not enough food?	0 = No (questionnaire is finished) 1=Yes	….|___|
9.a	How often did this happen?	1 = Rarely (once or twice in the past four weeks)	….|___|

		2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	
27		HFIAS category	

Revised Michigan knowledge questionnaire

Here are 20 statements about diabetes, some are true statements and some are false. Please read each statement and then indicate whether you think it is true or false or you don't know.

1	The diabetes diet is a healthy diet for most people	TRUE / FALSE / DON'T KNOW
2	Glycosylated haemoglobin (HbA1c) is a test that measures your average blood glucose level in the past week.	TRUE / FALSE / DON'T KNOW
3	A pound of chicken has more carbohydrate in it than a pound of potatoes.	TRUE / FALSE / DON'T KNOW
4	Orange juice has more fat in it than low fat milk.	TRUE / FALSE / DON'T KNOW
5	Urine testing and blood testing are both equally as good for testing the level of blood glucose.	TRUE / FALSE / DON'T KNOW
6	Unsweetened fruit juice raises blood glucose levels.	TRUE / FALSE / DON'T KNOW
7	A can of diet soft drink can be used for treating low blood glucose levels.	TRUE / FALSE / DON'T KNOW
8	Using olive oil in cooking can help lower the cholesterol in your blood.	TRUE / FALSE / DON'T KNOW
9	Exercising regularly can help reduce high blood pressure.	TRUE / FALSE / DON'T KNOW
10	For a person in good control, exercising has no effect on blood sugar levels.	TRUE / FALSE / DON'T KNOW
11	Infection is likely to cause an increase in blood sugar levels.	TRUE / FALSE / DON'T KNOW
12	Wearing shoes a size bigger than usual helps prevent foot ulcers.	TRUE / FALSE / DON'T KNOW
13	Eating foods lower in fat decreases your risk for heart disease.	TRUE / FALSE / DON'T KNOW
14	Numbness and tingling may be symptoms of nerve disease.	TRUE / FALSE / DON'T KNOW
15	Lung problems are usually associated with having diabetes.	TRUE / FALSE / DON'T KNOW
16	When you are sick with the flu you should test for glucose more often.	TRUE / FALSE / DON'T KNOW
	SKIP TO QUESTION 19 IF YOU DON'T TAKE INSULIN	
17	High blood glucose levels may be caused by too much insulin.	TRUE / FALSE / DON'T KNOW
18	If you take your morning insulin but skip breakfast your blood glucose level will usually decrease.	TRUE / FALSE / DON'T KNOW
19	Having regular check-ups with your doctor can help spot the early signs of diabetes complications.	TRUE / FALSE / DON'T KNOW
20	Attending your diabetes appointments will stop you getting diabetes complications.	TRUE / FALSE / DON'T KNOW
28	TOTAL SCORE	

MULTIDIMENSIONAL SCALE OF PERCEIVED SOCIAL SUPPORT

Instructions: We are interested in how you feel about the following statements. We will read each statement; tell us how you feel about each statement.

"1" is for **Very Strongly Disagree**
"2" is for **Strongly Disagree**
"3" is for **Mildly Disagree**
"4" is for **Neutral**
"5" is for **Mildly Agree**
"6" is for **Strongly Agree**
"7" is for **Very Strongly Agree**

		Very Strongly Disagree	Strongly Disagree	Mildly Disagree	Neutral	Mildly Agree	Strongly Agree	Very Strongly Agree
1	There is a special person who is around when I am in need.	1	2	3	4	5	6	7
2	There is a special person with whom I can share joys and sorrows.	1	2	3	4	5	6	7
3	My family really tries to help me.	1	2	3	4	5	6	7
4	I get the emotional help & support I need from my family.	1	2	3	4	5	6	7
5	I have a special person who is a real source of comfort to me.	1	2	3	4	5	6	7
6	My friends really try to help me.	1	2	3	4	5	6	7
7	I can count on my friends when things go wrong.	1	2	3	4	5	6	7
8	I can talk about my problems with my family.	1	2	3	4	5	6	7
9	I have friends with whom I can share my joys and sorrows.	1	2	3	4	5	6	7
10	There is a special person in my life who cares about my feelings.	1	2	3	4	5	6	7
11	My family is willing to help me make decisions.	1	2	3	4	5	6	7
12	I can talk about my problems with my friends.	1	2	3	4	5	6	7
29			**29a**	Significant other				
			29b	Family				
			29c	Friends				
			29d	Total				

MORISKY GREEN LEVINE TEST		
	Yes	No
Do you ever forget to take your medicine?	○	○
Are you careless at times about taking your medicine?	○	○
When you feel better do you sometimes stop taking your medicine?	○	○
Sometimes you feel worse, when you take the medicine, do you stop taking it?	○	○
30	**MGL Category**	

THANK YOU FOR YOUR PARTICIPATION

S3 Appendix: Laboratory sheet

STUDY TITLE: DEVELOPING A FRAMEWORK TO IMPROVE GLYCAEMIC CONTROL AMONG PATIENTS WITH TYPE 2 DIABETES MELLITUS IN KINSHASA, DEMOCRATIC REPUBLIC OF THE CONGO

S3 APPENDIX: LABORATORY SHEET

ID:…… **Province:……**

Place:……..... **Investigator number:……**

Date: / /

Laboratory measurements

HbA1C: ……..%

S4 Appendix: Interview guide for patients and healthcare providers sub-study 2.

STUDY TITLE: DEVELOPING A FRAMEWORK TO IMPROVE GLYCAEMIC CONTROL AMONG PATIENTS WITH TYPE 2 DIABETES MELLITUS IN KINSHASA, DEMOCRATIC REPUBLIC OF THE CONGO

S4 APPENDIX: INTERVIEW GUIDE FOR IN-DEPTH INTERVIEW

FOR HEALTHCARE PROVIDERS

Topic I: Organisation and equipment for diabetes care

Can you describe the organization of your healthcare structure for diabetes (human resource, financement of care…)?

What are the failures of this organization in regard to diabetes care?

How do you think your structure must be organized for better care?

What equipment you need the most for diabetes care and follow-up?

What are the documents do you use for diabetes care (guidelines, protocols….)?

How is feasible the support from other categories of health providers in your practice?

Topic II: Support to self-management and prevention

What is your understanding of self-management of diabetes?

How do you practically approach your patients to support self-management? How are you encouraging patient involvement in the care (treatment…)?

How would your healthcare system be improved by transferring activities for diabetes treatment and follow-up to patients?

How are you organizing feedbacks to patients in regard to treatment follow-up?

What are the barriers have you identified to effectively support self-management of diabetes?

How are you determining therapeutic goals for patients?

How are you identifying high risk patients for poor glycaemic control? How do you approach these patients?

What are the most important skills you show to patients to avoid complications?

What are resources available for reaching therapeutic goals?

Tell us about your motivation in taking care of patients with type 2 diabetes

Topic III: Information systems

How is important for you to report your activities?

How is your organization organizing the referral?

How are you identifying patients with special needs or at risk?

How are you organized to remind patients about their follow up or care?

How to better report the impact of diabetes in the healthcare system?

Topic IV: Continuity and coordination of care

How do you collaborate with other caregivers of your patients?

What are the documents used for this purpose?

Who is acting as coordinator of care for your patients?

Topic V: Policy environment

What is your basic education? What is the training received to take care of patients with diabetes? How are organize continual professional development activities?

[redacted]

Topic VI: Closing the interview

Additional comments

Acknowledgements

FOR PATIENTS WITH DIABETES

Topic I: Self-management

How do you manage to maintain control of diabetes mellitus?

What resources do you think can be useful to deal with challenges in diabetes?

What kind of support from the healthcare providers you expect for better care?

Do you have any ideas as to changes in the management of diabetes mellitus?

How would you prevent complications?

Topic II: Healthcare system

Can you critically appraise the care you receive from your healthcare facility and indicate what are changes would you recommend?

How would you appreciate feedback from your healthcare givers?

Topic III: Policy environment

What would be your expectations for what the decision-makers can do for great impact on diabetes care?

How can your communication with the healthcare provider could be improved? How can your access to care (geographical, financial…) be improved?

Topic IV: Community

Tell us how living with diabetes has stigma attached to it

How to deal with stigmatization about patients with diabetes in communities?

Would you appreciate any complimentary service in the community you live in? If any, can you describe the type of service?

Topic V: Closing the interview

Additional comments

Acknowledgements



Appendix 2. Supplementary information for research paper 2

Additional file 1: Table S1. Search strategy in included databases

	Search strategy
African Index Medicus	tw:(tw:((tw:(glycemic control)) OR (tw:(glycaemic control)) OR (tw:(blood glucose control)) AND (tw:(type 2 diabetes)) OR (tw:(type ii diabetes mellitus)) OR (tw:(diabetes mellitus, type 2))) AND (year_cluster:[2011 to 2022]))
Africa-Wide Information	(glycaemic control OR glycemic control or hba1c OR ghb OR blood sugar OR blood glucose OR glycated haemoglobin OR haemoglobin a1c) AND (type 2 diabetes OR type 2 diabetes mellitus OR t2dm OR t2d OR niddm OR non-insulin dependent diabetes mellitus) AND Africa Limits: 2011-2022
Global Health	(glycaemic control OR glycemic control OR hba1c OR ghb OR blood sugar OR blood glucose OR glycated hemoglobin OR haemoglobin a1c) AND (type 2 diabetes OR type 2 diabetes mellitus OR t2dm OR t2d OR niddm OR non-insulin dependent diabetes mellitus) AND Africa Limits: January 2011-February 2022
PubMed	((((((((((((((((((((Type 2 diabetes mellitus [tw]) OR (Type II diabetes mellitus [tw])) OR (Non insulin dependent diabetes mellitus [tw])) OR (Ketosis resitant diabetes mellitus [tw])) OR (Type 2 diabetes [tw])) OR (Type II diabetes [tw])) OR (Type 2 diabetes mellitus [mh])) AND (Cause [tw])) OR (Etiology [tw])) OR (Determinant [tw])) OR (Factor [tw])) OR (Contributor [tw])) OR (Predictor [tw])) OR (Risk factor [tw])) OR (Risk factor [mh])) AND (Glycaemic control [tw])) OR (Blood glucose control [tw])) OR (Glycemic control [tw])) OR (Glycemic control [mh])) AND (sub Saharan africa [tw])) OR (Africa south of the sahara [tw])) OR (Africa south of the sahara [mh]) Filters applied: Clinical Trial, Observational Study, Randomized Controlled Trial, from 2011/1/1-2022/2/28, Female, Male, Adult: 19+ years.
Web of Science	**glycaemic OR glycemic OR blood OR glucose AND control AND type 2 diabetes OR non insulin dependent diabetes OR ketosis resistant diabetes OR type II diabetes AND africa south of the sahara OR sub saharan africa (All Fields) and 2022 or 2021 or 2020 or 2019 or 2018 or 2017 or 2016 or 2015 or 2014 or 2013 or 2012 or 2011 (Publication Years) and Articles (Document Types) and ETHIOPIA or UGANDA or KENYA or GHANA or TANZANIA or CAMEROON or MALAWI or SUDAN or ZAMBIA or ZIMBABWE or RWANDA or MOZAMBIQUE or DEM REP CONGO or BOTSWANA or BURKINA FASO or GAMBIA or BENIN or COTE IVOIRE or SENEGAL or MALI or REP CONGO or GABON or NAMIBIA or TOGO or NIGER or LIBERIA or ESWATINI or MADAGASCAR or GUINEA or LESOTHO or ANGOLA or ERITREA or BURUNDI or CHAD or GUINEA BISSAU or SWAZILAND or CENT AFR REPUBL or SOMALIA or SOUTH SUDAN or SOUTH AFRICA or NIGERIA (Countries/Regions) and Endocrinology Metabolism or Health Care Sciences Services (Web of Science Categories)**

Legend: tw: text word, DM: diabetes mellitus, t2d: type 2 diabetes mellitus, niddm: non insulin dependent diabetes mellitus, hba1c: haemoglobin glycosylated, ghb: glycosylated haemoglobin, mh: MesH term

Additional file 2: Table S2. General characteristics of excluded studies and reason for exclusion

First author last name	Study type	Publication year	Study setting	Study Population	Sample size	Reason for exclusion
Abubakar [1]	Retrospective case-control study	2014	Nigeria	Type 2 diabetes; 30-70 years; treatment failure with metformin and glibenclamide	520	Ineligible data analysis
Abutair [2]	Randomized controlled trial	2018	Palestine	Type 2 diabetes	40	Setting outside sub-Saharan Africa
Adeniyi [3]	Experimental study	2013	Nigeria	Type 2 diabetes	29	Another outcome: influence of gender on time for glycaemic improvement
Adisa [4]	Cross-sectional	2017	Nigeria	Hypertension, type 2 diabetes, and Type 2 diabetes comorbid with hypertension	450	Ineligible data analysis
Adisa [5]	Cross-sectional	2016	Nigeria	Type 2 diabetes; 51-70 years	176	Ineligible data analysis
Adisa [6]	Prospective cross-sectional and retrospective Review	2013	Nigeria	Type 2 diabetes	176	Ineligible data analysis
Aga [7]	Cross-sectional, correlational study	2020	USA	Adult patients with comorbid heart failure and Type 2 diabetes	180	Setting outside sub-Saharan Africa
Amendezo [8]	Randomized Controlled Trial	2017	Rwanda	Types 1 and 2 diabetes	223	Another type of diabetes included
Anakwue [9]	Cross-sectional	2019	Nigeria	Types 1 and 2 diabetes	84	Another type of diabetes included
Anetor [10]	Case-control	2016	Nigeria	Type 2 diabetes and healthy controls	65	Ineligible data analysis
Angamo [11]	Cross-sectional	2013	Ethiopia	Types 1 and 2 diabetes	284	Another type of diabetes included

Anyakudo [12]	Experimental controlled study	2014	Nigeria	Male Type 2 diabetes	20	Another outcome: postprandial glycemic index of food processing methods
Asfaw [13]	Cross-sectional	2014	Ethiopia	Type 2 diabetes	103	Ineligible data analysis
Awadalla [14]	Cross-sectional	2017	Sudan	Type 2 diabetes	424	Ineligible data analysis
Awadalla [15]	Cross-sectional	2018	Sudan	Type 2 diabetes; 20-75 years	188	Ineligible data analysis
Awodele [16]	Descriptive and prospective study	2015	Nigeria	Type 2 diabetes; 18 years	152	Another outcome: medication adherence
Azar [17]	Randomized, parallel, open-label, active-controlled trial	2016	Algeria, Israel, India, Lebanon, Malaysia, South Africa, and United Arab Emirates	Type 2 diabetes; 18-80 years	343	An international study with sites outside sub-Saharan Africa
Azenabor [18]	Cross-sectional	2011	Nigeria	Type 2 diabetes; 40-60 years	300	Ineligible data analysis
Azubike [19]	Cohort study	2013	Nigeria	Type 2 diabetes with diabetic nephropathy	22	Another outcome: progression glycaemia in diabetic nephropathy
Bello [20]	Cross-sectional	2019	Nigeria	Types 1 and 2 diabetes	175	Another type of diabetes included
Biadgo [21]	Cross-sectional	2016	Ethiopia	Type 2 diabetes and healthy controls	296	Ineligible data analysis
Botha [22]	Cohort study	2017	Scotland	Type 2 diabetes	23,208	Setting outside Sub-Saharan Africa
Bulbulia [23]	Retrospective cross sectional clinical audit	2020	South Africa	Type 2 diabetes on either insulin only therapy or insulin and metformin therapy; 30-88 years	321	Ineligible data analysis
Correia [24]	Audit	2020	Guinea-Bissau	Types 1 and 2 diabetes	63	Another type of diabetes included
Dalia [25]	Cross-sectional and case-control	2019	Sudan	Type 2 diabetes and healthy controls	120	Ineligible data analysis
Darko [26]	Nested case-control	2015	Ghana	Type 2 diabetes and	189	Another outcome: variations in the levels of InterLeukin-6 and

				controls; 25-70 years		Tumor Necrosis Factor-α in patients with type 2 diabetes
Danquah [27]	Cross-sectional	2012	Ghana	Type 2 diabetes	675	Another outcome: prevalence of diabetes
Diaf [28]		2015	Libya	Type 2 diabetes	238	Setting outside sub-Saharan Africa
Dickie [29]	Cohort study	2014	South Africa	Healthy women without diabetes	297	Study population other than patients with diabetes
Diouf [30]	Cross-sectional	2015	Senegal	Type 2 diabetes; ≥33 years	195	Ineligible data analysis
Diouf [31]	Retrospective study	2013	Senegal	Type 2 diabetes; 36-83 years	130	Ineligible data analysis
Distiller [32]	Cross-sectional	2016	South Africa	Types 1 and 2 diabetes	50	Another type of diabetes included; another outcome
Edo [33]	Randomized trial	2011	Nigeria	Type 2 diabetes	10	Another outcome: plasma glucose response
Elkhidir [34]	Case-control	2017	Sudan	Type 2 diabetes and healthy controls; 44-60 years	87	Ineligible data analysis
Essien [35]	Randomized controlled trial	2017	Nigeria	Types 1 and 2 diabetes	104	Another type of diabetes included
Ewenighi [36]	12-week diabetic management therapy	2013	Nigeria	Type 2 diabetes; ≥18 years	52	Another outcome: responses to glycemic control therapy according to age, gender, level of adiposity, and duration of diabetes
Ezenwaka [37]	Cross-sectional	2014	Nigeria	Type 2 diabetes; 40-84 years	89	Ineligible data analysis
Farmer [38]	Protocol study	2019	South Africa and Malawi	Type 2 diabetes		Study type: study protocol
Fondjo [39]	Cross-sectional	2018	Ghana	Type 2 diabetes, women; ≥25 years	192	Ineligible data analysis
Geneto [40]	Comparative Cross-sectional	2015	Ethiopia	Type 2 diabetes and healthy controls; 20-76 years	108	Ineligible data analysis
Gill [41]	Retrospective study	2012	South Africa	Type 2 diabetes	120	Another outcome: effect of the introduction of a standard monitoring protocol on the investigations performed on the metabolic control of type 2 diabetes
Hall [42]	Cross-sectional	2017	Cameroon	Type 2 diabetes	261	Ineligible data analysis

Idonije [43]	Case-control	2011	Nigeria	Type 2 diabetes	130	Another outcome: comparison of plasma glucose level, creatinine, and urea among diabetic and healthy patients
Iloh [44]	Descriptive study	2017	Nigeria	Type 2 diabetes; ≥18 years	120	Ineligible data analysis
Iloh [45]	Cross-sectional	2018	Nigeria	Type 2 diabetes	120	Ineligible data analysis
Iwuala [46]	Cross-sectional	2015	Nigeria	Type 2 diabetes	100	Ineligible data analysis
Jackson [47]	Cross-sectional	2021	Nigeria	Type 2 diabetes	226	Ineligible data analysis
Jemal [48]	Cross-sectional	2017	Ethiopia	Type 2 diabetes; ≥18 years	196	Ineligible data analysis
Karau [49]	Cross-sectional	2019	Kenya	Type 2 diabetes; >18 years	151	Ineligible data analysis
Leulseged [50]	Retrospective chart Review	2019	Ethiopia	Type 2 diabetes; >18 years	686	Another outcome: time to optimal glycaemic control and associated factors
Madela [51]	Cross-sectional	2020	South Africa	General Population	6481	Another outcome: screening general population for hypertension and diabetes
Makan [52]	prospective study	2013	South Africa	Type 2 diabetes	14	Study type: conference proceeding
Mashitisho [53]	Review	2016		Type 2 diabetes		Study type: a clinical review
Matheka [54]	Cross-sectional	2013	Kenya	Types 1 and 2 diabetes	198	Another type of diabetes included; another outcome: use and level of glycosylated haemoglobin (HbA1c)
Matshipi [55]	Longitudinal study	2017	South Africa	General Population	713	Other population
Mbwete [56]	Cross-sectional	2020	Tanzania	Type 2 diabetes and hypertension; >18 years	161	Ineligible data analysis
Mbouemboue [57]	Cross-sectional	2018	Cameroon	General Population	948	Other population; another outcome: prevalence of diabetes in a community setting
Mels [58]	Cohort study	2013	South Africa	General Population	409	Other Population
Mogre [59]	Psychometric evaluation of the summary of diabetes self-care activities	2019	Ghana	Type 2 diabetes	187	Another outcome: Psychometric evaluation of the summary of diabetes self-care activities
Mohamed [60]	Intervention study	2012	Egypt	Type 2 diabetes and normal subjects	16	Setting outside sub-Saharan Africa

Monanabela [61]	Retrospective, descriptive study	2019	South Africa	Type 2 diabetes	575	Another outcome: HbA1c and fasting plasma glucose results in guiding treatment changes
Motta [62]	Cohort study	2017	South Africa	Types 1 and 2 diabetes		Another type of diabetes included
Moustafa [63]	Randomized controlled trial	2019	Egypt	Type 2 diabetes		Setting outside sub-Saharan Africa
Muddu [64]	Cross-sectional	2018	Uganda	Types 1 and 2 diabetes	201	Another type of diabetes included
Mullugeta [65]	Cross-sectional	2012	Ethiopia	Type 2 diabetes	165	Ineligible data analysis
Munyogwa [66]	Cross-sectional	2020	Tanzania	Type 2 diabetes; ≥18 years	330	Ineligible data analysis
Musenge [67]	Cross-sectional	2016	Zambia	Types 1 and 2 diabetes	198	Another type of diabetes included
Neboh [68]		2012	Nigeria	Type 2 diabetes	130	Another outcome: comparison of type 2 diabetic patients and healthy individuals
Nduati [69]	Cross-sectional	2016	Kenya	Type 2 diabetes; ≥35 years	149	Ineligible data analysis
Ngala [70]	Case-control	2014	Ghana	Type 2 diabetes	200	Another outcome: effect on diabetes
Ng'ang'a [71]	study protocol	2020	Rwanda	Insulin-dependent Type 2 diabetes	82	Study type: study protocol
Nganou-Gnindjio [72]	Cross-sectional	2018	Cameroon	Type 2 diabetes; 43-62 years	54	Ineligible data analysis
Nielsen [73]	Comparative Cross-sectional	2015	Uganda	People living in diabetic households	90	Other Population
Nkoana [74]	Prospective observational study	2020	South Africa	Types 1 and 2 diabetes	96	Another outcome: relationship between self-monitored fasting blood glucose (FBG) levels and HbA1c values
Odume [75]	Descriptive Cross-sectional	2015	Nigeria	Type 2 diabetes;18-70 years	145	Ineligible data analysis
Ofori [76]	Cross-sectional	2019	Ghana	Type 2 diabetes and healthy controls	161	Ineligible data analysis
Okoro [77]	Cross-sectional	2019	Nigeria	Type 2 diabetes and healthy health workers (controls); 35-75 years	180	Ineligible data analysis
Olaniyan [78]	Descriptive study	2019	Nigeria	Type 2 diabetes; ≥18 years	189	Ineligible data analysis

Omar [79]	Cross-sectional	2019	Sudan	Type 2 diabetes	600	Another outcome than glycaemic control
Osei-Yeboah [80]	Cross-sectional	2019	Ghana	Type 2 diabetes; 27-84 years	150	Ineligible data analysis
Osei-Yeboah [81]	Cross-sectional	2018	Ghana	Healthcare workers	112	Other Population
Osman [82]	Descriptive study	2013	Sudan	Types 1 and 2 diabetes	400	Another type of diabetes included
Owolabi [83]	Randomized controlled trial	2019	South Africa	Adult with uncontrolled diabetes; types 1 and 2 diabetes	216	Another outcome: Efficacy, acceptability, and feasibility of daily text-messaging in promoting glycaemic control and Other clinical outcomes; another type of diabetes included
Paruk [84]	Retrospective observational study	2017	South Africa	Type 2 diabetes		Another outcome: patterns of treatment and control
Pengpid [85]	Study protocol	2014	South Africa	General population	300	Study type: study protocol; other population
Philis-Tsimikas [86]	26-week, open-label trial	2013	Multicentre study	Type 2 diabetes uncontrolled on oral antidiabetic agents	458	Other Setting
Pillay [87]	Cross-sectional	2018	South Africa	Types 1 and 2 diabetes	744	Another type of diabetes included
Pinchevsky [88]	Descriptive Cross-sectional	2013	South Africa	Retrospective	666	Another outcome: identifying treatment gaps in the management of type 2 diabetes after implementation of guidelines
Pinchevsky [89]	Cross-sectional	2015	South Africa	Type 2 diabetes; ≥18 years	261	Ineligible data analysis
Pinchevsky [90]	Retrospective study	2016	South Africa	Type 2 diabetes; ≥18 years	261	Ineligible data analysis
Pinchevsky [91]	Cross-sectional	2017	South Africa	Type 2 diabetes; ≥18 years	519	Another outcome: treatment gaps in the management of type 2 diabetes
Pirie [92]	Cross-sectional	2014	South Africa	Type 2 diabetes	292	Another outcome: a predictor of diabetic retinopathy
Ramkisson [93]	Cross-sectional	2017	South Africa	Type 2 diabetes; ≥18 years	401	Ineligible data analysis
Rwegerera [94]	Cross-sectional	2021	Botswana	Type 2 diabetes with and without HIV infection	357	Ineligible data analysis
Sadik [95]	Quantitively exploratory descriptive	2017	Sudan	Type 2 diabetes with manifestations suggestive	140	Ineligible data analysis

	research study			of acute myocardial ischemia and healthy controls		
Shimels [96]	Cross-sectional	2021	Ethiopia	Diabetic hypertensive patients	409	Another outcome: adherence to medication, glycaemic control not assessed
Randeree [97]	Prospective, open-label, non-interventional, observational, 24-week study	2013	International study	Type 2 diabetes	2,026	Setting outside Sub-Saharan Africa
Segal [98]	Non-Randomized interventional study	2012	South Africa	Types 1 and 2 diabetes	77	Another type of diabetes included
Sobngwi [99]	Cross-sectional	2012	East Africa (Tanzania and Kenya), Central Africa (Cameroon) and West Africa (Ghana, Senegal, and Nigeria)	Type 2 diabetes	2352	Another outcome: factors of glycaemic control not assessed
Tayo [100]	Cross-sectional	2017	South Africa	Types 1 and 2 diabetes	97	Another type of diabetes included
Udoh [101]	Cross-sectional	2019	Nigeria	Type 2 diabetes; ≥40 years	208	Ineligible data analysis
Unung [102]	Case-control	2020	Nigeria	Type 2 diabetes with or without Diabetic retinopathy; non-diabetic normohypertensive control; 30-80 years	150	Ineligible data analysis
van den Berg [103]	Cross-sectional	2019	Lesotho	Type 2 diabetes	122	Another outcome: a descriptive study, factors of glycaemic control not assessed
Woyesa [104]	Cross-sectional	2017	Ethiopia	Type 2 diabetes mellitus;	319	Ineligible data analysis

				≥30-80 years		
Yameogo [105]	Cross-sectional	2012	Senegal	Type 2 diabetes; 40-85 years	318	Ineligible data analysis

Additional file 3: Table S3. Data for metaanalysis of proportions of glycaemic control in included studies

Study	n	N	study population	method	Country	Type	Region
Achila 2020	72	309	Adults with type 2 diabetes	hba1c	Eritrea	cross-sectional	Eastern
Abebe 2022	35	138	Adults with type 2 diabetes	fbg	Ethiopia	cross-sectional	Eastern
Abera 2022	85	325	Adults with type 2 diabetes	hba1c	Ethiopia	cross-sectional	Eastern
Adejumo 2012	64	144	Adults with type 2 diabetes and normal renal function	hba1c	Nigeria	cross-sectional	Western
Adeniyi 2016	53	327	≥ 30 years of age and type 2 diabetes	hba1c	South Africa	cross-sectional	Southern
Afolabi 2018	29	80	40-80 years of age and type 2 diabetes	hba1c	Nigeria	cross-sectional	Western
Akabwai 2016	75	279	Adults with type 2 diabetes	hba1c	Uganda	cross-sectional	Central
Anioke 2019	23	138	≥ 30 years of age and type 2 diabetes	hba1c	Nigeria	cross-sectional	Western
Ayele 2019	118	275	Adults with type 2 diabetes	fbg	Ethiopia	cross-sectional	Eastern
Belay 2017	62	188	Adults with type 2 diabetes	fbg	Ethiopia	cross-sectional	Eastern
BeLue 2016	26	106	Adults with type 2 diabetes	hba1c	Senegal	cross-sectional	Western
Biadgo 2018	65	159	Adults with type 2 diabetes	fbg	Ethiopia	cross-sectional	Eastern
Biru 2017	41	322	Adults with type 2 diabetes	fbg	Ethiopia	cross-sectional	Eastern
Blum 2019	45	319	Adults with type 2 diabetes	hba1c	DR Congo	cross-sectional	Central
Botchway 2021	58	234	Adults with type 2 diabetes	hba1c	Ghana	cross-sectional	Western
Camara 2014	328	1267	≥16 years type 2 diabetes	hba1c	Cameroon and Guinea	cross-sectional	Central
Dagnew 2017	33	105	≥30 years type 2 diabetes	fbg	Ethiopia	cross-sectional	Eastern
Demoz 2019	113	357	Adults with type 2 diabetes	hba1c	Ethiopia	cross-sectional	Eastern
Eticha 2016	197	384	Adults with type 2 diabetes	hba1c	Ethiopia	cross-sectional	Eastern
Fekadu 2019	80	228	adult type diabetes	fbg	Ethiopia	cross-sectional	Eastern
Fseha 2017	73	200	Adults with type 2 diabetes	fbg	Ethiopia	cross-sectional	Eastern
Id 2018	178	394	Adults with type 2 diabetes	fbg	Ethiopia	cross-sectional	Eastern
Inih 2018	52	108	adult males with type 2 diabetes	hba1c	Nigeria	cross-sectional	Western
Kalain 2020	49	200	Adults with type 2 diabetes	hba1c	South Africa	cross-sectional	Southern
Kamuhabwa 2014	142	469	Adults with type 2 diabetes	fbg	Tanzania	cross-sectional	Eastern

Kassahun 2016	90	309	Adults with type 2 diabetes	fbg	Ethiopia	cross-sectional	Eastern
Khoza 2018	71	320	>30 years age and type 2 diabetes	hba1c	South Africa	case-control	Southern
Kimando 2017	152	385	≥30 years age and type 2 diabetes	hba1c	Kenya	cross-sectional	Eastern
Mash 2014	275	1570	Adults with type 2 diabetes	hba1c	South Africa	Pragmatic randomized controlled trial	Southern
Mashele 2019	27	176	Adults with type 2 diabetes	hba1c	South Africa	cross-sectional	Southern
Mobula 2018	368	1226	Adults with type 2 diabetes	hba1c	Ghana	cross-sectional	Western
Mohamed 2013	137	457	Adults with type 2 diabetes, and non-diabetic controls	hba1c	Sudan	case-control	Central
Mohammed 2020	115	307	Adults with type 2 diabetes	fbg	Ethiopia	cross-sectional	Eastern
Mphwanthe 2020	170	428	≥25 years age and type 2 diabetes	hba1c	Malawi	cross-sectional	Southern
Mwavua 2016	34	200	Adults with type 2 diabetes	hba1c	Kenya	cross-sectional	Eastern
Mwita 2019	159	500	Adults with type 2 diabetes	hba1c	Botswana	cross-sectional	Southern
Noor 2017	59	387	Adults with type 2 diabetes	hba1c	Sudan	cross-sectional	Central
Omar 2018	96	339	Adults with type 2 diabetes	hba1c	Sudan	cross-sectional	Central
Osuji 2018	127	316	Adults with type 2 diabetes	hba1c	Nigeria	cross-sectional	Western
Otieno 2017	67	220	≥30 years age and type 2 diabetes	hba1c	Kenya	cross-sectional	Eastern
Oyewole 2019	21	70	≥21 years age and type 2 diabetes	fbg	Nigeria	cross-sectional	Western
Rwegerera 2019	136	368	Adults with type 2 diabetes	hba1c	Botswana	cross-sectional	Southern
Shimels 2018	142	414	Adults with type 2 diabetes	fbg	Ethiopia	cross-sectional	Eastern
Tefera 2020	72	400	Adults with type 2 diabetes	fbg	Ethiopia	cross-sectional	Eastern
Tekalegn 2018	83	412	≥15 years age and type 2 diabetes	fbg	Ethiopia	cross-sectional	Eastern
Teklay 2013	96	267	Adults with type 2 diabetes	fbg	Ethiopia	cross-sectional	Eastern
Thuita 2019	34	153	20-79 years age and type 2 diabetes	hba1c	Kenya	cross-sectional	Eastern
Woldu 2014	51	102	Adults with type 2 diabetes	fbg	Ethiopia	cross-sectional	Eastern
Yigazu 2017	71	174	Adults with type 2 diabetes	fbg	Ethiopia	cross-sectional	Eastern
Yimam 2020	120	300	Adults with type 2 diabetes	fbg	Ethiopia	cross-sectional	Eastern
Yosef 2021	88	245	Adults with type 2 diabetes	fbg	Ethiopia	cross-sectional	Eastern

Additional file 4: Table S4 Assessment of methodological quality for included cross-sectional studies

	First author surname	Year of publication	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Quality of study
1	Achila [16]	2020	Y	Y	N	Y	N	N	Y	Y	Moderate
2	Adejumo [17]	2012	Y	N	U	Y	N	N	U	Y	Poor
3	Adeniyi [18]	2016	Y	Y	Y	Y	N	Y	Y	Y	Good
4	Afolabi [19]	2018	Y	N	Y	Y	N	N	Y	Y	Moderate
5	Akabwai [20]	2016	Y	Y	Y	Y	N	N	Y	Y	Moderate
6	Akpalu [21]	2018	Y	N	Y	Y	Y	Y	Y	Y	Good
7	Anioke [22]	2019	Y	Y	Y	Y	Y	Y	Y	Y	Good
8	Ayele [25]	2019	Y	Y	Y	Y	N	N	Y	Y	Moderate
9	Belay [26]	2017	Y	Y	U	Y	N	Y	N	Y	Moderate
10	BeLue [27]	2016	Y	Y	Y	Y	N	N	Y	Y	Moderate
11	Biadgo B [28]	2018	Y	Y	Y	Y	N	N	N	Y	Moderate
12	Biru [29]	2017	Y	N	U	Y	N	N	U	Y	Poor
13	Blum [30]	2018	Y	Y	Y	Y	N	N	Y	Y	Moderate
14	Botchway [31]	2021	Y	Y	Y	Y	Y	Y	Y	Y	Good
15	Camara [32]	2015	Y	Y	U	Y	N	N	Y	Y	Moderate
16	Dagnew [33]	2017	Y	Y	Y	Y	N	N	N	Y	Moderate
17	Demoz [34]	2019	Y	Y	Y	Y	N	N	U	Y	Moderate
18	Doglikuu [35]	2021	N	Y	Y	Y	N	N	Y	Y	Moderate
19	Eticha [36]	2016	Y	Y	U	Y	N	N	U	Y	Poor
20	Fekadu [39]	2019	Y	Y	Y	Y	N	N	N	Y	Moderate
21	Fseha [40]	2017	Y	Y	Y	Y	N	N	N	Y	Moderate
22	Gebremedhin [42]	2019	Y	Y	Y	Y	N	N	N	Y	Moderate
23	Id [44]	2021	Y	Y	Y	Y	N	N	N	Y	Moderate
24	Inih [45]	2018	N	N	Y	Y	N	N	Y	Y	Poor
25	Kalain [46]	2020	Y	Y	U	Y	N	N	U	Y	Poor
26	Kamuhabwa [47]	2014	Y	Y	N	Y	N	Y	N	Y	Moderate
27	Kassahun [48]	2016	Y	Y	Y	Y	N	N	N	Y	Moderate
28	Kefale [49]	2019	Y	Y	Y	Y	N	N	N	Y	Moderate
29	Khoza [50]	2018	Y	Y	Y	Y	N	N	Y	Y	Moderate
30	Kimando [51]	2017	Y	Y	Y	Y	N	N	Y	Y	Moderate
31	Mashele [56]	2019	Y	Y	Y	Y	N	N	Y	Y	Moderate
32	Mobula [58]	2018	Y	Y	Y	Y	N	N	Y	Y	Moderate
33	Mohammed [60]	2020	Y	Y	Y	Y	N	N	N	Y	Moderate
34	Mphwanthe G[61]	2020	N	N	Y	Y	Y	Y	Y	Y	Moderate
35	Mphwantwe[62]	2020	Y	Y	Y	Y	N	N	Y	Y	Moderate
36	Mwavua [64]	2016	Y	Y	Y	Y	N	N	Y	Y	Moderate
37	Mwita [65]	2019	Y	Y	Y	Y	N	N	U	Y	Moderate
38	Noor [66]	2017	Y	Y	Y	Y	N	N	Y	Y	Moderate
39	Omar [67]	2018	Y	Y	Y	Y	N	N	U	Y	Moderate
40	Osuji [68]	2018	Y	Y	Y	Y	N	N	Y	Y	Moderate
41	Otieno [69]	2017	Y	Y	Y	Y	N	N	Y	Y	Moderate
42	Oyewole [70]	2019	N	Y	N	Y	N	N	Y	Y	Poor
43	Ramkisson [72]	2016	Y	N	N	Y	N	Y	Y	Y	Moderate

44	Rwegerera [73]	2019	Y	Y	N	Y	N	N	Y	Y	Moderate
45	Shimels [75]	2018	Y	Y	Y	Y	N	N	N	Y	Moderate
46	Tefera [77]	2020	Y	Y	Y	Y	N	N	N	Y	Moderate
47	Tekalegn [78]	2018	Y	Y	Y	Y	N	Y	N	Y	Moderate
48	Teklay [79]	2013	Y	Y	Y	Y	N	N	N	Y	Moderate
49	Thuita [80]	2019	Y	N	Y	Y	N	N	Y	Y	Moderate
50	Woldu [83]	2014	Y	Y	Y	Y	N	N	N	Y	Moderate
51	Yigazu [85]	2017	Y	Y	Y	Y	N	N	N	Y	Moderate
52	Yimam [86]	2020	Y	Y	Y	Y	N	N	N	Y	Moderate
53	Yosef [87]	2021	Y	Y	Y	Y	N	N	N	Y	Moderate
54	Abera [88]	2022	Y	Y	Y	Y	N	Y	Y	Y	Good
55	Abebe [89]	2022	Y	Y	Y	Y	N	N	N	Y	Moderate
All (%)			93	85	80	100	7	18	51	100	

Legend: Q1. Were the criteria for inclusion in the sample clearly defined? Q2. Were the study subjects and the setting described in detail? Q3. Was the exposure measured in a valid and reliable way? Q4. Were objective, standard criteria used for measurement of the condition? Q5. Were confounding factors identified? Q6. Were strategies to deal with confounding factors stated? Q7. Were the outcomes measured in a valid and reliable way? Q8. Was appropriate statistical analysis used? Y: Yes, N: No, U: Unknown.

Additional file 5: Table S5 Assessment of methodological quality of quasi-experimental studies

	First author surname	Year of publication	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Quality of study
1	Assah [24]	2015	Y	Y	Y	Y	Y	Y	N	U	Y	Moderate
2	Hailu [43]	2018	Y	Y	Y	Y	Y	Y	Y	Y	Y	Good
3	Mash [54]	2016	Y	Y	Y	Y	Y	Y	Y	Y	Y	Good
4	Rambiritch [71]	2014	Y	Y	Y	N	Y	Y	Y	N	Y	Moderate
All (%)			100	100	100	75	100	100	75	50	100	

Legend: Q1. Is it clear in the study what is the 'cause' and what is the 'effect' (i.e. there is no confusion about which variable comes first)? Q2. 2. Were the participants included in any comparisons similar? Q3. Were the participants included in any comparisons receiving similar treatment/care, other than the exposure or intervention of interest? Q4. Was there a control group? Q5. Were there multiple measurements of the outcome both pre- and post-intervention/exposure? Q6. Was follow-up complete and if not, were differences between groups in terms of their follow-up adequately described and analysed? Q7. Were the outcomes of participants included in any comparisons measured in the same way? Q8. Were outcomes measured in a reliable way? Q9. Was appropriate statistical analysis used? Y: Yes, N: No, U: Unknown.

Additional **file 6: Table S6.** Assessment of methodological quality for included randomized controlled trials

	First author surname	Year of publication	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Quality of study
1	Anyanwu [23]	2016	Y	U	Y	Y	N	N	Y	Y	Y	Y	Y	Y	Y	Moderate
2	Ezema [37]	2014	Y	U	Y	N	N	N	Y	Y	Y	Y	N	Y	Y	Moderate
3	Fayehun [38]	2018	Y	Y	Y	Y	Y	U	Y	Y	Y	Y	Y	Y	Y	Good
4	Gathu [41]	2018	Y	Y	Y	Y	Y	U	Y	Y	Y	Y	Y	Y	Y	Good
5	Maharaj [52]	2016	Y	U	Y	Y	Y	U	Y	Y	Y	Y	Y	Y	Y	Good
6	Mash [55]	2014	Y	Y	N	N	N	N	Y	Y	Y	Y	Y	Y	Y	Moderate
7	Muchiri [63]	2016	Y	Y	Y	N	Y	N	Y	Y	Y	Y	Y	Y	Y	Good
8	Thuita [81]	2020	Y	Y	Y	N	N	N	Y	Y	Y	Y	Y	Y	Y	Moderate
9	Tsobgny-Tsague [82]	2018	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Good
10	Yan [84]	2014	Y	N	N	N	N	N	N	Y	Y	Y	Y	Y	Y	Moderate
All (%)			100	60	80	50	50	10	90	100	100	100	90	100	100	

Legend: Q1. Was true randomization used for the assignment of participants to treatment groups? Q2. Was allocation to treatment groups concealed? Q3. Were treatment groups similar at the baseline? Q4. Were participants blind to treatment assignment? Q5. Were those delivering treatment blind to Treatment assignment? Q6. Were outcomes assessors blind to treatment assignment? Q7. Were treatment groups treated identically other than the intervention of interest? Q8. Was follow up complete and if not, were differences between groups in terms of their follow up adequately described and analysed? Q9. Were participants analysed in the groups to which they were randomized? Q10. Were outcomes measured in the same way for treatment groups? Q11. Were outcomes measured in a reliable way? Q12. Was appropriate statistical analysis used? Q13. Was the trial design appropriate, and any deviations from the standard RCT design (individual randomization, parallel groups) accounted for in the conduct and analysis of the trial? Y: Yes, N: No, U: Unknown.

Additional file 7: Table S7. Assessment of methodological quality of case-control studies

	First author surname	Year of publication	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Quality of study
1	Mamo [53]	2019	Y	N	Y	Y	Y	N	Y	N	Y	Y	Moderate
2	Mohamed [59]	2013	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Good
3	Sarfo-Kantanka [74]	2017	Y	Y	Y	Y	Y	N	Y	Y	N	Y	Good
All (%)			100	66.7	100	100	100	33.3	100	66.7	33.3	100	

Legend: Q1. Were the groups comparable other than the presence of disease in cases or the absence of disease in controls? Q2. Were cases and controls matched appropriately? Q3. Were the same criteria used for the identification of cases and controls? Q4. Was exposure measured in a standard, valid and reliable way? Q5. Was exposure measured in the same way for cases and controls? Q6. Were confounding factors identified? Q7. Were strategies to deal with confounding factors stated? Q8. Were outcomes assessed in a standard, valid and reliable way for cases and controls?

Additional file 8: Table S8. Assessment of methodological quality of cohort study

	First author surname	Year of publication	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Quality of study
1	Siddiqui [76]	2018	N	Y	Y	N	N	Y	Y	Y	N	N	Y	Moderate
2	Mayet [57]	2012	Y	Y	Y	N	N	N	Y	Y	Y	N	Y	Moderate
	All (%)		50	100	100	0	0	50	100	100	50	0	100	

Legend: Q1. Were the two groups similar and recruited from the same population? Q2. Were the exposures measured similarly to assign people to both exposed and unexposed groups? Q3. Was the exposure measured in a valid and reliable way? Q4. Were confounding factors identified? Q5. Were strategies to deal with confounding factors stated? Q6. Were the groups/participants free of the outcome at the start of the study (or at the moment of exposure)? Q7. Were the outcomes measured in a valid and reliable way? Q8. Was the follow-up time reported and sufficient to be long enough for outcomes to occur? Q9. Was follow-up complete, and if not, were the reasons to loss to follow-up described and explored? Q10. Were strategies to address incomplete follow-up utilized? Q11. Was appropriate statistical analysis used? Y: Yes, N: No.

Additional file 9: List of references of excluded studies

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Appendix 3. Research paper 3

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Perspectives for glycaemic control in type 2 diabetes in Kinshasa, Democratic Republic of the Congo

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Abstract

Glycaemic control is a significant problem in the Democratic Republic of the Congo (DRC), the perspectives associated with glycaemic control are not fully known as previous studies rarely explored patients' perspectives and lived experiences. This qualitative study described the perspectives regarding glycaemic control among persons with type 2 diabetes in Kinshasa, DRC. A total of 23 participants were purposively selected in seven health centres in Kinshasa. In-depth interviews were used for data collection. The study used a phenomenology approach, and deductive, constructionist and thematic analysis. Data analysis was performed using the MAXQDA 2022. Five themes were identified as perspectives for glycaemic control in Kinshasa: financial constraints, limited social and relational support, difficulties with lifestyle changes, beliefs and practices about diabetes and ability to adapt for caring for the illness. Themes were integrated using social cognitive theory. Participants expressed that they were unable to achieve better glycaemic control due to financial constraints, limited social and relational support and difficulty in changing their lifestyle. Their beliefs and practices about diabetes also constituted a barrier. Our results showed that lack of adequate funding is a major determinant of glycaemic control and therefore it is crucial to integrate a consistent and reliable funding system for care of people living with diabetes. Persons with diabetes must be empowered to successfully adapt to the requirements of diabetes care. In this process, support for people living with type 2 diabetes is also essential and should involve their families as well as healthcare providers.

Keywords: glycaemic control, perspectives, type 2 diabetes, qualitative study, sub-Saharan Africa

BACKGROUND

About 537 million adults (20–79 years) are living with diabetes worldwide, and this number is expected to rise to 643 million by 2030 (International Diabetes Federation., 2022a). Of these, over 3 in 4 adults with diabetes will live in low- and middle-income countries. In Africa, diabetes was responsible for 416 000 deaths in 2021 and 54% of people living with diabetes are undiagnosed (International Diabetes Federation., 2022a).

The World Health Organization (WHO) targets adopted by the 75th World Health Assembly in 2022 stated that 80% of people diagnosed must have good control of glycaemia (WHO, 2022), but worldwide, glycaemic control remains a challenge for all the stakeholders engaged in the care of diabetes (Giugliano *et al.*, 2018).

In sub-Saharan Africa, studies have shown high rates of poor glycaemic control among patients with type 2 diabetes in several settings. The DiabCare study conducted in six sub-Saharan countries—Cameroon, Ghana, Kenya, Nigeria, Senegal and Tanzania—found that only 29% of the participants reached a level of glycosylated haemoglobin below 6.5% (Sobngwi *et al.*, 2012). Asystematic review in Ethiopia found that only 33.2% (95% CI: 21.8–44.6) of the participants had good glycaemic control (Gebreyohannes *et al.*, 2019).

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Contribution to Health Promotion

- Glycaemia control is a multifactorial problem requiring greater investment in health by society and equity in the repartition of resources.
- Better preparation and fundamental changes in the healthcare system are essential to meet the challenges of chronic diseases.
- People living with diabetes must be encouraged and equipped with the necessary skills for effective self-care.

A metaanalysis of glycaemic control in sixteen sub-Saharan African countries showed that only 30.3% (95% CI: 27.6–32.9) of the participants had good glycaemic control (Fina Lubaki *et al.*, 2022A). Therefore, persons with diabetes are exposed to complications and increased costs of diabetes care in a context characterized by high levels of poverty and resource constraints. In a recent systematic review, the factors associated with poor glycaemic control included age, gender, lower income, absence of health insurance, low level of education, place of residence, family history of diabetes, longer duration of diabetes, high pill burden, treatment regimen, side effects, use of statins or antihypertensive medications, alcohol consumption, smoking, presence of comorbidities/complications and poor management (Fina Lubaki *et al.*, 2022A). Very few studies have been conducted to assess the patients' perspectives on glycaemic control leading to a gap in knowledge (Adeniyi *et al.*, 2015; Gathu *et al.*, 2018). In the Democratic Republic of Congo (DRC), diabetes affects an estimated 1 908 900 adults, representing a prevalence of 4.8% (International Diabetes Federation., 2022b). The country is a low-income country with one out of six individuals living in extreme poverty (World Bank, 2021). In Kinshasa, less than 10% of the population has employment and only a few are covered by health insurance (World Bank, 2021). In this setting, persons with diabetes and their families spend a large portion of their incomes to meet the costs of diabetes care, resulting in a large proportion not meeting glycaemic targets (Mottini *et al.*, 2003; Sagastume *et al.*, 2022). Failure to meet glycaemic targets on the other hand exposes persons with diabetes to complications of diabetes with the subsequent increased cost of care (Mottini *et al.*, 2003; Sagastume *et al.*, 2022). The challenges encountered by persons with type 2 diabetes in following their treatment deserve to be explored to improve treatment and, by extension, glycaemic control. However, most studies on glycaemic control in the DRC have excluded persons with diabetes' perspectives in the complex process of diabetes care (Longo-Mbenza *et al.*, 2011; Sagastume *et al.*, 2022). The reasons for poor glycaemic control have not been fully explored in Kinshasa as the perspectives of persons with diabetes and their lived experiences of glycaemic control have rarely been assessed. This knowledge gap has clinical and public health policy implications in that interventions may be constructed outside of patients' contexts and therefore less acceptable to patients and less scalable. Understanding the patients' perspectives and experiences would be beneficial for the management of patients with diabetes (Zimmermann *et al.*, 2018). This study aims to describe the perspectives on glycaemic control among persons with type 2 diabetes. The results will contribute to building an intervention package for persons with type 2 diabetes in Kinshasa, DRC.

METHODS

Study design

This study engaged a qualitative approach to explore the perspectives of persons with type 2 diabetes mellitus regarding diabetes treatment in Kinshasa, DRC. A total of 23 participants were included in the study and one-on-one in-depth interviews were used to collect data. This study is part of a large project dealing with glycaemic control in Kinshasa (Fina Lubaki *et al.*, 2022B). A preprint of this study has been published (Fina Lubaki *et al.*, 2023). The study is reported according to the consolidated criteria for reporting qualitative research (COREQ) (Tong *et al.*, 2007).

Study setting

This study was conducted in seven health centres in the city of Kinshasa, the capital of the DRC. Kinshasa has an estimated population of about 15 million and spreads over an area of 9965 km^2 (World Bank, 2021). The seven health centres were Bondeko, 2eme Rue, Mokengeli, Saint Ambroise, Saint-Pierre, Etonga and Kikimi. These health centres are part of the Kinshasa Primary Healthcare Network reuniting hospitals and health centres mainly from the Catholic Church and Salvation Army (Kapongo *et al.*, 2015; Sagastume *et al.*, 2022). These health centres are distributed in the 24 health districts in Kinshasa and integrated diabetes care. Persons with type 2 diabetes did not have access to specialists in diabetes care; they were managed by generalists trained in diabetes care who visited them once monthly. Between visits, some persons with diabetes could return to the health centres for blood glucose monitoring and advice from the nurses. For this study, the seven health centres were purposively selected to ensure the diversity of patients in terms of socioeconomic, illness duration and experiential contexts. These

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were the facilities where patients who were likely to expressively share their perspectives have been identified and also provided a conducive environment for the interviews to be held.

Study population, sample size and sampling

The study population comprised of persons with type 2 diabetes mellitus attending the seven selected healthcare facilities in Kinshasa, DRC. The inclusion criteria were age ≥18 years, being diagnosed with type 2 diabetes and being on treatment for at least 6 months. Pregnant women, those with difficulty communicating due to mental disability, and patients with diabetes emergencies were excluded.

Consecutive and purposefully selected information-rich persons with type 2 diabetes were recruited from the seven facilities to satisfy the need for diversity in sex, duration of diagnosis/illness, socioeconomic strata treatment categories and levels of glycaemic control (Vasileiou *et al.*, 2018). Health facilities' teams who were well acquainted with the patients helped in their recruitment. The role of the health facilities teams was to point out persons with diabetes susceptible to effectively discuss their perspectives on glycaemic control. The members of health facilities teams were not involved in contacting the persons with diabetes for the study. Only the interviewer was in charge of presenting the study to the participants and inviting them to enter the study. Recruitment continued until data saturation. Data saturation was reached when no new element of the codes was identified (Hennink and Kaiser, 2022). After each interview, data was analysed to identify codes. Then in subsequent interviews, a search for new aspects, dimensions, or nuances of the codes was performed until novel findings were uncommon. In total, we conducted 23 interviews of persons living with type 2 diabetes. None of the patients approached refused to participate or were excluded.

Data collection

The interviews were then conducted by the principal investigator in a quiet room where the confidentiality of the participant's statements was guaranteed. Only the study staff was involved in the organization of the interviews. The interviews were one-on-one in-depth interviews. The interview was facilitated by exploring the clarity of the participants' statements. The interviews were guided by an interview schedule (Supplementary File 1) and were conducted in French or Lingala depending on the preferences of the participants. All interviews were audio recorded and lasted at most 45 min. As the interviews were conducted during the COVID-19, there was a strict observation of the COVID-19 rules. The data collection took place from December 2021 to March 2022.

Data management and analysis

The recorded interviews were transcribed verbatim and then translated into English by a language expert. The principal researcher who is fluent in French and Lingala verified the translation and transcription by re-listening to the audio while reading the transcripts. Data coding and thematic analysis were performed using the MAXQDA 2022 (Verbi Software, 2021). The analysis went through the six steps described by Braun and Clarke (Braun and Clarke, 2006)—familiarization with the data, generating initial codes, searching for themes, reviewing potential themes, defining and naming the themes and producing the report.

In MAXQDA, the researcher uploaded the transcripts of the interviews. When he identified a code during the readings, he created it in the system and wrote a memo to describe its meaning. After that, all the words, parts of sentences, sentences or groups of sentences related to this code were associated with this particular code. One may note that a sentence a word, part of a sentence, a sentence, a group of sentences could be associated with more than one code. Then, the different codes identified were grouped into sub-themes and finally into themes. The coding was performed independently by the principal researcher (J.P.F.) and one supervisor (O.B.O.) in selected interviews without any pre-conceptualized theoretical framework. The integration of the themes identified was performed using social cognitive theory (Thojampa and Sarnkhaowkhom, 2019; Sebastian *et al.*, 2021).

Credibility, transferability, dependability and confirmability

The credibility of the study is a measure of the truth value of qualitative research, or whether the study's findings are correct and accurate (Guba, 1981). In our study, it was enhanced by peer debriefing and member checking. Two experts, one in diabetology and another in sociology assisted in conceptualizing the findings of the study. The findings were submitted to five participants to seek their agreement with identified themes (member checking). Triangulation of findings between the principal investigator and the supervisors enhanced credibility. Transferability measures whether, or to what extent, the study's results are applicable within other contexts or settings (Guba, 1981). It was ensured in this study by thick description or extensive description of the site, participants and the methods used during the study. Dependability is used to measure the consistency and reliability of the results (Guba, 1981). It is done by an exam of the methods used, the analysis and the interpretation of data. In this study; it is ensured by external audits conducted by the supervisors and one external expert on qualitative research.

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The confirmability is ensured when the research process is neutral and not influenced by the assumptions or biases of the researchers (Guba, 1981). In this study, this was ensured by audit trail.

Research team and reflexivity

The principal investigator is a male physician who conducted all the interviews. At the time of the study, he was working with the Protestant University of Congo as a senior lecturer and had experience conducting qualitative inquiries. For this study, he had no previous relationship with the participants. The information about the researcher was shared with the participants for research purposes only. The principal investigator was assisted by two supervisors in conceptualizing this research, analysing the data and reporting the findings.

Ethical considerations

The study was approved by the Ethics Committee of the Protestant University of Congo (reference number: CEUPC 0067; date: 5 February 2021) and Human Research Ethics Committee (Medical) of the University of the Witwatersrand (reference number: M210308; date: 26 August 2021) and conducted according to the ethical guidelines of the Declaration of Helsinki. Permission was obtained from the Kinshasa Primary HealthCare Network to conduct the study. Before the interviews, the principal investigator provided study information summarized on a leaflet to potential study participants and obtained written informed consent. A copy of the leaflet and the signed consent form (to participate in the study and for audio recording) was given to the participant. Data collection was done with strict adherence to local COVID-19 regulations. The participants were not paid for their participation in the study. Nevertheless, the participants were reimbursed for the transport to come to the healthcare facilities. An informed consent for the publication of the study results was obtained from each participant.

They received an equivalent of 5$ US for the transport to the health facility.

An informed consent for publication of the study results was obtained from each participant.

RESULTS

General characteristics of included participants

Twenty-three participants were interviewed. The majority of the participants were female (60.87%) and of the 40–64 years age group (56.84%). About half of the participants had good glycaemic control (52.17%). The median duration of diabetes was 5 (IQR: 1.5–10) years. The general characteristics of the included participants are summarized in the Supplementary File 2.

Themes identified for glycaemic control

The analysis of the data gathered provided a group of five themes as perspectives for glycaemic control for persons living with type 2 diabetes in Kinshasa. These themes are financial constraints, limited social and relational support, difficulties with lifestyle changes, beliefs about diabetes and the ability to adapt to what is required for caring for the illness. Each theme comprises sub-themes, which in turn contain initial codes (Table 1).

Theme 1: Financial constraints

Diabetes is a chronic disease requiring that at all times the person with the disease follows the treatment, takes the appropriate diet, regularly monitors his blood glucose and engages in follow-up scheduled visits. Financial constraints impact the capacity of the persons with diabetes to adequately follow these requirements.

A large proportion of the persons living with diabetes are not covered by health insurance and use out-of-pocket payments. They could only rely on their resources, which are often very limited. Most receive help from their family members, but this is sometimes irregular and unreliable. They regretted that they were not receiving the same support as patients suffering from HIV/AIDS or tuberculosis.

> Sometimes, my family members help me with money when they have it. (P15, Male, 35 years)
> Only one of my sons helps me financially. He doesn't work and struggles to find money. The other family members don't look after me. (P2, Female, 60 years)

Coming to scheduled visits also have indirect costs such as transport and the time they have to spend in the health centre. It is not unusual them had to wait for hours before seeing the doctor.

> Sometimes, I do not have money for the transport as I'm living in Maluku and must come here for appointments. (P21, Male, 41 years)
> The visits take too long. We spend about 5 hours for a visit. There are many patients coming here. (P2, Female, 60 years)

Many participants reported that they would take their medicines as prescribed provided the medicines are available. Indeed, many participants reported that they encountered difficulties in adhering to their treatment as they must first find money to buy drugs. Some participants are not regularly taking their treatments or personally change their regimen to allow their medicine stock to last longer.

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Table 1: Themes, sub-themes and codes identified as perspectives for glycaemic control in Kinshasa, Democratic Republic of the Congo

Theme	Sub-themes	Codes
Financial constraints	Unreliable financing	Scarcity of revenues
		Use of out-of-pockets payments
		Lack of health insurance
		Absence of support from the Government
		Irregular financial aid from family members
	Non respect of scheduled visits	Lack of money for visit fees
		Unable to afford indirect costs: transport....
	Insufficient number of tests for blood glucose	High cost needed for repeating the tests
		Fear to run out of strips
	Irregular meals	High cost of suitable meals for diabetes
		Self-adaptation of medications to avoid side effects
	Lack of money for medications	Stock run out of medications
		High cost of newer products
Limited social and relational support	Fear of the reaction from others	Sharing information about diabetes would result on altered relation with others
		Living differently is seldom accepted by others
	Inaccessibility of doctors between visits	Poor doctor–patient communication
		Limited number of trained personnel for treating diabetes
Difficulties with lifestyle changes	Difficulty due to physical and health condition or work schedule	Ageing and/or presence of Comorbidities or ageing limiting physical condition
		Workload letting few time or space for physical exercise
	Time needed to adopt the changes	Changes are difficult and need time
		Diabetes requires changes in many aspects of the life
	Confusing information on what to eat	Patients receiving sometimes contradictory advices from health providers
		Population beliefs on diet for diabetes
Beliefs and practices about diabetes	Diabetes has a mystic origin	Diabetes result from a bad sort
		Seeking traditional healers to cure diabetes
	Need for signs of increased blood glucose to take drugs	Presence of signs prompt to take medicines
		Absence of signs lead sometimes to neglect of treatment
Ability to adapt for what is required for caring the illness	Acquisition of skills	Persons with diabetes able to inject themselves
		Ability to use devices to follow-up glycaemia
		Persons with diabetes resolve difficulties related to the treatment of their illness
	Acquisition of knowledge about the disease	Ability to identify body alarms
		Knowing what the disease requires
	Encouragements from carers and relatives	Appreciated support from health workers
		Positive support from family members

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> Once I'm prescribed medicines by the doctor, I try to get the money as quickly as possible to buy these. Usually after three days, I can buy the medications. (P14, Female, 32 years)
> Due to economic reasons, sometimes I don't have to take the medicine exactly as prescribed to avoid a lot of expenses. (P10, Female, 40 years)

The financial constraints also limit their ability to perform blood glucose monitoring as they do not have money or the strips for those who have the glucometers.

> The test for glycaemia is not free and is done for a fee. I only do it when I can pay. Otherwise, I won't do it. (P2, Female, 60 years)
> Testing regularly costs very much. In the beginning, I used to test my glycaemia every day. This was very difficult to follow. The medical team advised me to reduce to one test per week. (P15, Male, 35 years)

The persons with diabetes receiving insulin need to have regular meals to accompany the taking of their drugs. Many participants reported that they only take the medicines when they are sure that they will have something to eat to avoid side effects of the medications.

> I would take the treatment only when I find something to eat. (P20, Male, 46 years)
> Yes, sometimes if I don't have enough food, I reduce the dose a little and then I want to go back to my usual routine. (P21, Male, 41 years)
> If food is available, then I take the medicine. If not, I don't take the medicine until the next day. When I have nothing to eat, I don't take the medicine. (P2, Female, 60 years)

Theme 2: Limited social and relational support

Participants expressed that diabetes brings emotional and financial upsets in persons with diabetes, for which external support is essential. The family members were the main people that provided some emotional support to participants. For persons advanced in age, a number were supported financially by their relatives to meet the cost of diabetes care. The family also contributed concerning diet. Some participants pointed out the roles of their relatives in reminding them to take their medicines. Other family members even helped in administering the medicines to the patients.

> My father wants me to follow the treatment correctly. He advises me a lot. And sometimes he brings me the medicine when I have to take it. He always tells me that with the treatment, I will be better. (P19, Male, 41 years)
> My third son got married to a girl who did medical science, she is the one who helps me with injections every days. Every morning and every evening before going to sleep. (P11, Male, 80 years)

If the closest family members were supportive of persons with diabetes, the participants reported that the people around them no longer thought of them as they used to once they knew they had diabetes. It is important to note that the general population does not know much about diabetes due to a lack of awareness or education on the subject. One participant even said that they were seen as condemned. As a result, they did not open up to anyone about their illness and only told those who were very close to them. One female participant expressed that while looking for a marriage, it would be difficult for her to be accepted if the partner knew that she was suffering from diabetes. Participants reported that, in some situations, the need to follow the requirements of diabetes care put them in an uncomfortable position.

> People feel sorry for you as if it is the end of your life because diabetes has no cure. (P22, Male, 37 years)
> I feel embarrassed when I go to a party, and I only have water, and people wonder why I just have water and no other drinks. (P9, Female, 51 years)
> Yes, I'm thinking that diabetes is a real barrier to my wellness. I'm thinking that if I find a man who wants to marry me if I tell him that I have diabetes, he will leave me. Perhaps I will not tell the truth. But this will be difficult with the treatment that I have to follow. (P12, Female, 40 years)

In our study settings, the persons with diabetes are received once monthly; during these visits, they receive an education on a subject relating to their illness, have their blood glucose tested and are received by the doctor. It is important to note that during the monthly interviews, the waiting list is usually very long. Usually, there is one doctor to visit all the patients registered in the health centre and scheduled for the visit. The doctor is faced with the problem of not having enough time to devote to each person. The encounter covers rarely personal matters of living with the illness.

Moreover, apart from the monthly visit to the health centre, many participants expressed that they could not contact the doctor or nurse before the next meeting. When needed they could not adapt their regimens. Not all the nurses are trained in diabetes and able to make required adjustments to the treatments. They continue

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to follow the prescribed doses until the next scheduled appointment.

> I cannot change (my treatment) until I come back here, I'm treated with insulin. (P14, Female, 32 years)

Theme 3: Difficulties with lifestyle changes

Many barriers to regular physical activity were reported among participants. One participant reported that relating to her age, it would be difficult to engage in exercise. Some participants reported constraints of time as they must be at work. Their work is time-consuming and does not allow for exercise. Many finish work late and after that have to face lengthy traffic jams to arrive at home. Participants find it difficult to follow the diet. At the beginning of their disease, the participants must adapt to the requirements; after time many succeeded in adopting new meals.

> It is very difficult for me because of my age. When the opportunity arises, I take a short walk in the corridors of the house. When I get tired, I give up. (P5, Female, 64 years)
> I don't know how to follow these recommendations properly because of my work rhythm. In the service, my schedule alternates between days on call and days off. I don't know how to combine these shifts with my diet and exercise. (P4, Female, 55 years)

One participant stated that there was no accurate information on what the patients must eat. Sometimes, the advice was confusing—Some ailments have been prescribed by certain health providers while others were prohibiting them.

> The advice we have from health providers is somewhat confusing. Sometimes, there is no precision on what we must eat. (P13, Male, 67 years)

Theme 4: Beliefs and practices about diabetes

Some participants perceived that their diabetes could be due to a 'spell' or had another explanation than that offered by medical science, resulting in these participants experimenting with alternative medicines. However, some of these participants returned to their clinic prescriptions when they noticed that these alternative treatments did not work for them:

> My family members think that diabetes in our family is a mysterious disease. There must be someone behind it. (P16, Male, 40 years)
> They took me to a healer. I was mixing traditional treatment with pharmaceuticals. At one point, I even gave up the pharmaceuticals. But when the traditional treatment didn't work, I came back to continue the treatment. (P17, Female, 35 years)

On the other hand, several participants recognized that when they feel well, they tend to abandon their treatment or to have a period of slackening:

> I respect the treatment because I know that my health depends on it, despite some slackening. (P22, Male, 37 years)
> I take my treatment regularly. But sometimes I neglect the treatment when I feel well. (P23, Female, 39 years)

Theme 5: Ability to adapt to what is required for caring for the illness

Participants expressed their ability to effect requires change to attain good glycaemic control. This ability is conveyed by the acquisition of the technical skills to administer drugs daily and/or to monitor their glycaemia. And as time passes, it is easier to resolve issues emerging with the care. The ability to perform the change is also supported by the ability of the patient to know when s/he is experiencing signs of increased blood glucose and needs to take appropriate actions.

> I care about taking the treatment for this disease. I have gained some experience in resolving the issues. (P15, Male, 55 years)
> I have no problem using the glucometer. (P18, Female, 22 years)
> When the glycaemia is high, you will know it by your body. (P12, Female, 40 years)

The participants reported that in the process of adapting to what their illness requires, they are helped by the positive messages conveyed by their surroundings and the healthcare providers.

> The health providers said that diabetes will not end, but they make us understand that diabetes is a disease like the others and that it requires following the recommendations for treatment, diet and exercise. (P9, Female, 51 years)

DISCUSSION

This study was designed to describe perspectives from persons living with type 2 diabetes for glycaemic control in Kinshasa, DRC. Five themes were identified: financial constraints, limited social and relational support, difficulties with lifestyle changes, beliefs and practices about diabetes and the ability to adapt to what is required for caring for the illness. Participants expressed they were unable to move towards better glycaemic control due to financial constraints, limited

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support and difficulty in changing their lifestyle. Their understanding of diabetes also constituted a barrier.

Diabetes is a chronic disease requiring lifelong and multidimensional care. Lack of resources was undermining many aspects of care for our participants and making them unable to access care and ensure self-care. An adequate system of funding is necessary to ensure that persons with diabetes benefit from their care, this is seldom possible in a setting marked by poverty (Adeniyi *et al.*, 2016; Mayer *et al.*, 2016; Okoronkwo *et al.*, 2016; Adisa *et al.*, 2017) necessitating an expanded social-support system for better health outcomes. The introduction of universal health coverage in Kinshasa will be of great benefit in ensuring equity of access to diabetes care (Jackson *et al.*, 2016; Stephani *et al.*, 2018). Many persons with diabetes currently rely on out-of-pockets payments that put them in a vicious circle where lack of money restricts care and leads to complications that will then require more money. Out-of-pocket payments are leading to poverty and efforts must be made to progressively suppress these (Tsega *et al.*, 2021). At the societal level and long term, it implies progressively empowering the people by a fight against poverty and engaging themselves with health mutuals. It is also important to act to reduce indirect costs such as for the transport to health structures with adequate diabetes care coverage. A study in South Africa showed that transport costs were contributing to over 50% of total healthcare costs (Mutyambizi *et al.*, 2019).

Participants expressed that family members were their sole source of social and treatment support. Social support is linked with better health outcomes including glycaemic control (Strom and Egede, 2012; Osuji *et al.*, 2018). The participants expressed concerns that reactions the others in their surroundings could manifest if they know about their illness or if they do not conduct themselves as the others. This behaviour could reflect the participants' concern about maintaining a good image in the eyes of others and their fear of being stigmatized. Body image-related distress can lead to suboptimal glycaemic control (Shaban, 2010). The fact that the origin of diabetes is not well known in the population leaves room for many interpretations. As a result, persons with diabetes could not receive enough support. There is a need to educate the general public about diabetes, especially the people who live with patients so that they can better support people with the disease. Beyond the monthly visit, patients were rarely able to access doctors when they needed to discuss their treatment in between appointments. The limited doctor–patient communication may aggravate the effects of clinical inertia which is a recognized reason for failure to achieve glycaemic targets (Andreozzi *et al.*, 2020). Improving diabetes care also requires enhancing the skills of healthcare providers to enable them to develop a better approach to the management of chronic patients (Nang *et al.*, 2019). In our context where there is a chronic shortage of doctors, it may be unrealistic to expect doctors to be always available for all categories of patients with diabetes. Rather, nurse clinicians who are in constant contact with patients should be capacitated skills-wise to solve most of the common problems these patients present with.

Type 2 diabetes is a lifestyle disease and lifestyle modifications are the cornerstone of its management (Bekele *et al.*, 2020). Studies have shown that lifestyle interventions are more effective than standard care mainly when there is an association with weight loss (García-Molina *et al.*, 2020). A systematic review of lifestyle interventions on patients with type 2 diabetes suggested focusing on diet and physical activity as these had a significant effect on blood glucose and weight loss (Zhang *et al.*, 2023). In our study settings, it is particularly important to consider tailored interventions respective to the people's medical conditions and economic situations. Moreover, it is crucial to advocate for the integration of workplace physical activity activities (To *et al.*, 2013).

The participants also expressed that the resurgence of the symptoms of hyperglycaemia prompted them to take their treatment. As stated earlier, there is a trend for some patients to abandon or neglect the treatment when they feel better. The resurgence of symptoms of hyperglycaemia needs to be considered as 'teachable moments' (Xiang, 2016) as they offer opportunities for strengthening health education such that patients understand the benefit(s) of maintaining good glycaemic control and that there is no benefit to wait for symptoms before being adherent to their treatments.

The beliefs of the participants—that diabetes is caused by human being's influence, particularly witchcraft—represent a real threat to their lives, there is a need to provide sufficient and reliable information to help them develop a good understanding of diabetes disease. These beliefs could push persons with diabetes to orient themselves to ineffective alternative treatments, more so, that some of these are false promises of cure for diabetes. It is therefore crucial that healthcare providers assess their clients' stage of change and motivate them to adopt the necessary lifestyle behavioural changes required for optimal diabetes care.

The participants expressed their ability to perform the required changes for good glycaemic control. Persons with diabetes are demanded to continuously resolve the issues related to living with diabetes and adopt the best solutions for their illness and its treatment. Care for people with diabetes must also seek to highlight the difficulties of adaptation to help patients resolve them (Kalra *et al.*, 2018). Studies showed that interventions for patient empowerment may improve

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glycaemia and blood pressure in persons with diabetes (Hood *et al.*, 2015; Mogueo *et al.*, 2020). In our study settings, this aspect of care has not received the required attention and needs to be considered when developing strategies for improving diabetes care in Kinshasa.

This study was based on a phenomenology approach which is premised on participants sharing their perspectives on glycaemic control (Rodriguez and Smith, 2018). Glycaemic control is a multifactorial issue (Fekadu *et al.*, 2019). Factors that have been reported in the literature to influence glycaemic control are related to the persons with diabetes, their relatives, the health system and the community/society (Zimmermann *et al.*, 2018; Fekadu *et al.*, 2019; Fina Lubaki *et al.*, 2022; Sagastume *et al.*, 2022).

Supplementary File 3 presents an integrated explanatory model for glycaemic control among persons living with type 2 diabetes in Kinshasa, DRC using the social cognitive theory. This theory posits that particular behaviour (such as effecting becoming adherent to treatment behaviours for maintaining good glycaemic control) is a product of interactions between personal, cognitive and contextual/environmental factors (Thojampa and Sarnkhaowkhom, 2019; Sebastian *et al.*, 2021). Put together, the five themes identified in our study are displayed about the six modules of social cognitive theory (Thojampa and Sarnkhaowkhom, 2019). Behavioural capacity refers to the patient's ability to change a specific behaviour through the acquisition of essential knowledge and practices (Joseph *et al.*, 2017; Thojampa and Sarnkhaowkhom, 2019). The participants in our study expressed that they have learned about diabetes through previous experiences of diabetes with their relatives or from self-experience. Also, some of them have acquired the technical skills required for diabetes treatment (Theme 5). These achievements improved their self-efficacy in being able to do what is required for good glycaemic control (Joseph *et al.*, 2017; Thojampa and Sarnkhaowkhom, 2019). Self-efficacy refers to a person living with diabetes confidence in achieving good glycaemic control. Our results noted that participants were encountering many financial constraints in the care of their illness thus resulting in poor self-efficacy to achieve good glycaemic control (Theme 1). Reinforcements refer to internal or external responses to a given behaviour with a positive or negative impact on the continuity of the behaviour (Thojampa and Sarnkhaowkhom, 2019). Our results showed that participants lived in an unfavourable social context with limited social support (Theme 2) and were exposed to poor glycaemic control by the way they understood their illness (Theme 3) and the difficulties they had with lifestyle changes (Theme 4). These elements have a negative impact on glycaemic control.

Our explanatory model is aligned with social cognitive model as it is recognized that for persons with diabetes, it is inconceivable to change a behaviour without considering the environment (Thojampa and Sarnkhaowkhom, 2019). Among the modules of social cognitive theory, self-efficacy is a significant predictor of improved self-care among persons with diabetes who have poor health literacy; a feature of many persons with diabetes in our study setting (Reisi *et al.*, 2021). Social support is one of the main domains of social cognitive theory and, enhancing it in diabetes self-management could help persons with diabetes improve their glycaemic control, achieve self-management goals and facilitate coping with the disease (Thojampa and Sarnkhaowkhom, 2019).

Overall, this study is one of few studies in sub-Saharan Africa to investigate the perspectives of persons living with type 2 diabetes on glycaemic control and has clinical, public health and policy implications for improving glycaemic control in Kinshasa, DRC, and similar settings. The qualitative design has potential interviewer, selection and translation biases. However, the reflexivity of the principal researcher during interviews and analysis, the prior training in qualitative design and the oversight of an experienced qualitative researcher, all ensured the adoption of a neutral and non-judgmental posture and limited the potential for biases. Furthermore, it is rightly inherent in qualitative studies to sample information-rich participants. The participants' statements could have been altered during translation from Lingala or French to English; nevertheless, the translation performed by the language expert was verified by the principal investigator by referring to the audio recordings. The findings of the study were submitted for peer review and member checking to enhance their credibility. A thick description of data and the context from which they emerged ensured the transferability, and external audits conducted by the supervisors, who are senior researchers, and one external expert on qualitative research ensured dependability.

In the future, engaging qualitative methods to understand the socio-cultural context underlying the persons with diabetes knowledge, attitudes, beliefs, perceptions and behaviours around diabetes will be of great help to improve the care of persons with diabetes.

CONCLUSION

Our results showed that lack of adequate funding is a major determinant of glycaemic control. It is crucial to integrate a consistent and reliable funding system for

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the care of people living with diabetes. Persons with diabetes must be empowered to successfully adapt to the requirements of diabetes care. In this process, support for people living with type 2 diabetes is also essential and should involve their families as well as healthcare providers.

SUPPLEMENTARY MATERIAL

Supplementary material is available at *Health Promotion International* online.

AUTHOR CONTRIBUTIONS

J.P.F. conceived the study, conducted the interviews, contributed to the translation of the transcripts to English, performed analysis, and wrote the first draft of the manuscript. J.M.F. contributed to the conceptualization and operationalisation of the study and reviewed the manuscript. O.B.O. contributed to the conceptualisation and operationalisation of the study, the analysis, and reviewed the manuscript. All the authors agreed with the final draft of the manuscript.

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CONFLICT OF INTEREST

J.M.F. holds the position of Deputy Editor in Chief for Health Promotion International and is involved neither in the review process nor in any decision-making on the manuscript.

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Poor glycaemic control: prevalence, factors and implications for the care of patients with type 2 diabetes in Kinshasa, Democratic Republic of the Congo: a cross-sectional study

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Introduction: Diabetes is a significant problem in sub-Saharan Africa and achieving glycaemic control poses a health challenge among patients living with type 2 diabetes. There are limited data on glycaemic control in Kinshasa, Democratic Republic of the Congo. This study assessed the prevalence and factors associated with glycaemic control to inform potential interventions to improve glycaemic control in Kinshasa.

Methods: This was a cross-sectional study conducted between November 2021–September 2022 among patients recruited from 20 randomly selected health facilities in Kinshasa. Participants were asked to complete a structured questionnaire and to provide two millilitres of blood for Hb1AC assay. Poor glycaemic control was defined as HbA1c ≥7%. Univariate and multivariable logistic regressions were performed to identify factors associated with poor glycaemic control.

Results: A total of 620 participants were recruited for this study. Study participants had a median age of 60 (IQR=53.5-69) years with the majority being female (66.1%), unemployed (67.8%), having income below the poverty line (76.4%), and without health insurance (92.1%). About two-thirds of the participants (420; 67.6%) had poor glycaemic control. Participants on monotherapy with insulin (AOR=1.64, 95%CI [1.10-2.45]) and those on a treatment duration ≥7 years (AOR=1.45, 95%CI [1.01-2.08]) were associated with increased odds of poor glycaemic control while being overweight (AOR= 0.47, 95%CI [0.26-0.85]) and those with uncontrolled blood pressure (AOR=0.65, 95% CI [0.48-0.90]) were protective for poor glycaemic control.

Conclusion: Poor glycaemic control is prevalent among patients with type 2 diabetes in Kinshasa, DRC. Being on insulin alone and a duration of diabetes

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treatment equal or more than 7 years predisposed to poor glycaemic control. By contrary, having uncontrolled blood pressure and being overweight had protective effect against poor glycaemic control. These links between uncontrolled blood pressure and overweight on the one hand, and glycaemic control on the other are unusual. These reflect, among other things, the specific characteristics of diabetes in sub Saharan Africa.

KEYWORDS

diabetes mellitus, type 2, factors, glycaemic control, cross-sectional study, sub-Sahara Africa

Introduction

Type 2 diabetes is increasing worldwide (1) – it is expected that the greatest increase in diabetes prevalence will take place in low- and middle-income countries (2). On the African Continent, type 2 diabetes is progressing rapidly due to modifiable risk factors, such as obesity and urbanisation (2).

In sub-Saharan Africa (SSA), diabetes care faces numerous challenges leading to unmet needs and a greater impact on morbidity and mortality (3, 4). In the Democratic Republic of the Congo (DRC), the prevalence of diabetes is estimated to be 5.8% for adults aged 20 to 79 years (4), with higher proportions of persons living with diabetes found in urban areas and the western part of the country (5, 6).

Good glycaemic control is the cornerstone of diabetes management, as it delays the onset of complications, reduces the cost of care and improves persons with diabetes quality of life. Nevertheless, the control of diabetes remains a challenge worldwide, with only about 50% of the person with diabetes controlled (7). In SSA, it is estimated that less than one-third of persons with type 2 diabetes achieve target glycaemic levels (8, 9). A recent systematic review of the studies on glycaemic control found: age, sex, poor socio-economic conditions, place of residence, positive family history of diabetes, longer duration of diabetes, treatment modalities and effects, alcohol consumption, smoking, presence of comorbidities or complications, and poor management were associated with poor glycaemic control (9). Contrarily, high diabetes health literacy, positive perception of family support, adequate coping strategies, dietary adherence, physical activity, adherence to follow–up appointments and medications, were associated with good glycaemic control (9).

Abbreviations: AOR, Adjusted Odds Ratio; BMI, Body mass index; CEUPC, Ethics Committee of the Protestant University of the Congo; COR, Crude Odds Ratio; DAWN, Diabetes Attitudes, Wishes and Needs second study; DRC, Democratic Republic of the Congo; IQR, Inter Quartile Range; OHA, Oral Hypoglycaemic Agents; RedCap, Research Electronic Data Capture; SSA, Sub-Saharan Africa; STATA, Statistics and data.

An accurate knowledge of factors driving glycaemic control in a particular setting is essential to developing an intervention package to improve glycaemic control. Multiple factors drive glycaemic control in SSA, differing across settings (8). In the DRC, the prevalence of poor glycaemic control among persons with type 2 diabetes was reported as high as 86% and 79.9% have been reported in the nearby province of Kwilu and Kinshasa, respectively (10, 11). In these studies, Sagastume et al. (11) found that persons with diabetes older than 40 years of age had higher odds of achieving good glycaemic control than those younger while Blum et al. (10) found that abdominal obesity and having a body mass index (BMI) > 25 Kg/m2 were associated with poor glycaemic control. The study by Blum et al. (10) was conducted in a single site while Sagastume et al. (11) proceeded to a retrospective analysis of Kinshasa Primary HealthCare Network. Thus very few studies have been devoted to the factors of glycaemic control in DRC leading to a very rudimentary data on the issue and poor understanding of glycaemic control. In anticipation of the building of an intervention package to deal with the issue in Kinshasa, and in an effort to expand knowledge about blood glucose control factors, we designed a mixed-method cross-sectional study. Studies with mixed methodology are appropriate to explore complex phenomena in a broad way. In this article, we present the results of the quantitative phase.

Materials and methods

Study design

This was a cross sectional study, a component of a bigger research project on glycaemic control among persons with type 2 diabetes in Kinshasa, DRC, for which the study protocol was previously published (12). Routinely, type 2 diabetes is defined by a bundle of epidemiological and clinical arguments: onset of diabetes at more than 40 years, history of diabetes in the family, presence of autoimmune pathology, association with metabolic syndrome: hypertension, upper BMI, dyslipidaemia, presence of ketone bodies and favourable response of treatment to oral hypoglycaemic agents (OHA).

Study setting

Our study was multisite within Kinshasa, a city of about 15 million inhabitants spread over an area of 9,965 km^2 (13). The participants were recruited from 20 randomly selected health facilities in Kinshasa, DRC. The study was conducted in the health facilities belonging to the Catholic Church and the Salvation Army. With a total of 66 health facilities (1 referral hospital and 65 health centres) distributed across 24 health districts, these organisations own most of the facilities that have integrated diabetes care in primary care in Kinshasa.

Study population

The study population consisted of persons with type 2 diabetes attending health centres that offer diabetes care in the Kinshasa Primary Care Network, with about 7326 persons with diabetes registered in 2020. The inclusion criteria were age ≥18 years, receiving diabetes treatment for at least six months and consenting to the study. The exclusion criteria were pregnancy, and having difficulty communicating due to mental disability.

Sample size estimation

The estimated minimum sample size was computed using Epi info version 7.2.2.2. Assuming that the prevalence of poor glycaemic control was 68% (14), a 95% confidence level and a power of 80%, 59,2% of persons with diabetes who had a diabetes duration ≤7 years (unexposed) presented with poor glycaemic control, and 74,4% of those who had a diabetes duration >7 years (exposed) presented with poor glycaemic control (15). The unexposed to exposed ratio is 0.47 (15). The minimum estimated sample size was 368. Adjusting for a design effect of 1.5, the calculated sample size of 552 was determined. To account for an estimated 10% non-response rate, the minimum required sample size was 614 persons with diabetes, rounded up to 620.

Sampling of participants

Participant selection was a two-stage process. The first stage was the random selection of 20 out of 48 healthcare facilities. As the healthcare facilities have an unequal number of persons with diabetes, the participants were selected by probability proportional to the patient population size. The second stage consisted of the selection of the participants; 31 patients were selected from each selected healthcare facility using systematic sampling. The research assistant was taking the record of the first patient on a clinic day to assess eligibility and subsequently was taking the record of every third patient for questionnaire administration. If the first patient was not eligible or if the third patient selected in the next step was not eligible, the research assistant selected the next patient(s) until an eligible patient was obtained, then continued with the selection of each third patient. This process ensured each patient had the same probability of selection.

Data collection

The data collection process lasted from November 2021–September 2022. For each participant, the research team performed physical and anthropometric measurements. These measurements were taken once by trained staff members on the same portable equipment at all the health facilities. The questionnaire consisted of pre-existing standardised tools translated from English into French and Lingala. The questionnaire was pre-tested before data collection, no changes were necessary on the tools for use in our study. At the end of the interview, 2 millilitres of venous blood was collected in a tube with EDTA from the participant. The tube was identified and put in a fridge at 2-8 °C—when the centre has a fridge—or directly in the isotherm box prepared. At the end of the visit, all the samples were transferred in the laboratory using the isotherm box. The questionnaire was administered using REDCap (Research Electronic Data Capture) on a tablet or smartphone (16). Information captured during the interview on the history of diabetes was verified with what is recorded in the medical records.

Variables of the study

Outcome

The main outcome variable was poor glycaemic control, defined as HbA1c ≥7% (17–19), and obtained from the blood sample assayed at the laboratory of the School of Medicine at the Protestant University of Congo in Kinshasa. The assay was performed using an automated Genuis WP 21B with antibody-based immunoassay method of Cypress Diagnostics (20).

Exposures

The possible determinants for glycaemic control considered in this study were sociodemographic parameters (age, sex, marital status, educational attainment, occupation, income, use of health insurance, access to food, distance from place of residence to health centre), lifestyle parameters (smoking, problematic alcohol consumption), clinical parameters (duration of diabetes, height, weight, body mass index, waist circumference, presence of comorbidities, blood pressure, treatment, duration of treatment), and psychological parameters (adherence to treatment, depression, diabetes distress, social support, self-management, knowledge). Supplementary file 1 detailed the exposures, their measurements, operational definitions, reliability, and references.

Data analysis

All the analyses were performed using survey data analysis with STATA 17 (21) to account for the study design characteristics. We expressed age as median with interquartile range (IQR), as it was not normally distributed. The other variables were analysed as categorical variables and expressed as frequency (n) and percentage (%). Bivariate analysis was performed to compare

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uncontrolled versus controlled participants in terms of glycosylated haemoglobin using the Chi-square/Fisher exact test for categorical variables. We further carried out multivariable logistic regression to assess factors associated with glycaemic control. Age, sex, duration of treatment, and food security were included in the regression model a priori. Other variables with a p-value <0.2 in univariate analysis were also included in the model. The p-value of <0.05 was considered statistically significant.

Results

A total of 620 participants were included in the study out of a total of 627 invited, accounting for a non-response rate of 1.1%. The participants had a mean age of 60.21 ± 12.44 years, a mean BMI of 23.60 ± 5.21 Kg/m^2, a mean waist circumference of 89.95 ± 13.49 centimetres, a mean duration of diabetes disease of 83.17 ± 75.18 months, and a mean duration of 82.17 ± 75.02 months. Table 1 summarises the sociodemographic, lifestyle and clinical characteristics of the participants. Fewer than two-thirds of the participants (64.68%) of the participants presented a complication or a comorbidity. The most common complications or comorbidities were hypertension (53.88%), diabetic retinopathy (15.79%), erectile dysfunction (14.04%), and cataract (3.51%). A slight more than half of the participants (53.87%) were on insulin alone while 38.23% and 7.9% of the participants on Oral Hypoglycaemic agents (OHA) and Mixed treatment (Insulin-OHA). The most common OHA were: Metformin (69.29%), Glibenclamide (15.04%), Gliclazide (11.04%), and Glimepiride (3.15%).

TABLE 1 Sociodemographic characteristics of participants with type 2 diabetes in Kinshasa, n=620 (2021-2022).

	N (%)
Age (years)	
18-39	39 (6.4)
40-64	342 (55.1)
≥ 65	239 (38.5)
Sex	
Male	211 (33.9)
Female	409 (66.1)
Marital status	
Single	199 (32.2)
Married	393 (63.3)
Other	28 (4.5)
Educational level	
No formal education	77 (12.5)
Primary school	199 (32.1)
Secondary school	269 (43.4)
Tertiary	75 (12.1)
Occupation	
Employed	132 (21.1)
Unemployed	419 (67.7)
Other	69 (11.2)
Income	
Below the poverty line	473 (76.4)
Above the poverty line	147 (23.6)
Access to food	
Food security	249 (40.0)
Mildly Food Insecure Access	77 (12.5)
Moderately Food Insecure Access	107 (17.3)
Severely Food Insecure Access	187 (30.2)
Health insurance	
Insured	49(7.9)
Without health insurance	571 (92.1)
Distance to a health facility	
Nearby	451 (72.6)
Distant	165 (27.4)

Prevalence of glycaemic control and participants' characteristics

About two-thirds of the participants (67.8%; n=420) had poor glycaemic control.

There was no statistically significant difference between controlled and uncontrolled participants in terms of sociodemographic characteristics (Table 2).

However, controlled participants differed significantly from uncontrolled participants in terms of BMI (p=0.005), control of blood pressure (p=0.027), and treatment regimens (p=0.002) (Table 2).

Perceived support from significant others (p=0.005), perceived family support (p=0.020), treatment regimen distress (p=0.029), and adherence to physical activity (p=0.017) were significantly different between controlled and uncontrolled participants (Table 3).

Determinants of glycaemic control

Being on monotherapy with insulin (AOR=1.64, 95%CI [1.10-2.45]) and having a treatment duration ≥7 years (AOR=1.45, 95%CI [1.01-2.08]) increased the odds of poor glycaemic control. On the other hand, being overweight (AOR= 0.47, 95%CI [0.26-0.85]) and having uncontrolled blood pressure (AOR=0.65, 95% CI [0.48-0.91]) decreased the odds of poor glycaemic control (Table 4). An

TABLE 2 Sociodemographic, lifestyle and clinical characteristics in relation with glycaemic control among participants with type 2 diabetes in Kinshasa, n=620 (2021-2022).

	All participants (n, %)	Good glycaemic control (n, %(95%CI))	Poor glycaemic control (n, %(95%CI))	p
Sociodemographic characteristics				
Age				0.479
18-39	39 (100.0)	9 (22.8 (10.7-42.2))	30 (77.2 (57.8-89.3))	
40-64	342 (100.0)	112 (32.7 (26.7-39.4))	230 (67.3 (60.6-73.3))	
≥ 65	239 (100.0)	79 (33.0 (24.8-42.2))	160 (67.0 (57.6-75.2))	
Sex				0.989
Male	211 (100.0)	68 (32.2 (24.6-40.8))	143 (67.8 (59.2-75.4))	
Female	409 (100.0)	132 (32.2 (25.3-40.0))	277 (67.8 (60.0-74.7))	
Marital status				0.413
Single	199 (100.0)	68 (34.3 (25.7-43.9))	131 (65.7 (56.1-74.3))	
Married	393 (100.0)	126 (31.3 (25.4-39.3))	267 (65.7 (60.7-74.6))	
Other	28 (100.0)	6 (21.3 (9.7-40.6))	22 (78.7 (59.4-90.3))	
Educational status				0.781
No formal	77 (100.0)	28 (36.4 (18.2-59.7))	49 (63.6 (40.3-81.8))	
Primary school	199 (100.0)	64 (32.1 (24.6-40.6))	135 (67.9 (59.4-75.4))	
Secondary school	269 (100.0)	87 (32.3 (25.9-39.4))	182 (67.7 (60.6-74.1))	
University	75 (100.0)	21 (27.9 (19.5-38.3))	54 (72.1 (61.7-80.5))	
Occupation				0.518
Employed	132 (100.0)	45 (34.1 (27.2-41.9))	87 (65.9 (58.1-72.8))	
Unemployed	419 (100.0)	130 (30.9 (24.1-38.8))	289 (69.1(61.2-75.9))	
Other	69 (100.0)	25 (36.3 (25.6-48.6))	44 (63.7 (51.4-74.4))	
Income				0.342
Below the poverty line	473 (100.0)	149 (31.4 (25.1-38.5))	324 (68.6 (61.5-74.9))	
Above the poverty line	147 (100.0)	51 (34.7 (27.8-42.4))	96 (65.3 (57.6-72.2))	
Access to food				0.192
Food secure	249 (100.0)	69 (27.6 (19.7-37.3))	180 (72.4 (62.7-80.3))	
Mildly Food Insecure	71 (100.0)	28 (36.5 (24.2-50.9))	49 (63.5 (49.1-75.8))	
Moderately Food Insecure	107 (100.0)	43 (40.2 (31.5-49.6))	64 (59.8 (50.4-68.5))	
Severely Food Insecure	187 (100.0)	60 (31.9 (24.0-41.1))	127 (68.1 (58.9-76.0))	
Health insurance				0.782
Insured	48 (100.0)	17 (34.5 (20.2-52.2))	32 (65.5 (47.8-79.8))	
Uninsured	571 (100.0)	183 (32.0 (25.8-39.0))	388 (68.0 (61.0-74.2))	
Distance to a health facility				0.644
Nearby	451(100.0)	148 (32.8 (25.8-40.6))	303 (67.2 (59.4-74.2))	
Distant	169 (100.0)	52 (30.7 (23.7-38.7))	117(69.3 (61.3-76.3))	
Lifestyle characteristics				
Smoking				0.268

(Continued)

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TABLE 2 Continued

	All participants (n, %)	Good glycaemic control (n, %(95%CI))	Poor glycaemic control (n, %(95%CI))	p
Sociodemographic characteristics				
No	616 (100.0)	200 (32.4 (26.5-38.9))	416 (67.6 (61.1-73.5))	
Yes	4 (100.0)	0 (0.0 (0.0))	4 (100.0 (0.0))	
Alcohol disorder				0.566
No disorder	611 (100.0)	198 (32.4 (26.5-38.8))	413 (67.6 (61.2-73.5))	
Health risk consumption	9 (100.0)	2 (22.1 (4.0-66.2))	7 (77.9 (33.8-96.0))	
Clinical characteristics				
Duration of diabetes				0.549
0-5 years	267 (100.0)	84 (31.3 (23.0-41.0))	183 (68.7 (59.0-77.0))	
5-10 years	217 (100.0)	76 (35.1 (26.5-44.8))	141 (64.9 (55.2-73.5))	
≥10 years	136 (100.0)	40 (29.3 (22.2-37.5))	96 (70.7 (62.5-77.8))	
Body mass index				0.005*
Underweight	65 (100.0)	14 (21.6 (13.4-33.0))	51 (78.4 (67.0-86.6))	
Normal	347 (100.0)	102 (29.3 (21.9-37.9))	245 (70.7 (62.1-78.1))	
Overweight	142 (100.0)	66 (46.6 (39.1-54.2))	76 (53.4 (45.8-60.9))	
Obesity	66 (100.0)	18 (27.3 (15.7-43.1))	48 (72.7 (56.9-84.3))	
Waist circumference				0.083
Abnormal	243 (100.0)	93 (38.2 (29.8-47.3))	150 (61.8 (52.7-70.2))	
Normal	377 (100.0)	107 (28.3 (21.5-36.3))	270 (71.7 (63.7-78.5))	
Presence of comorbidities				0.266
Yes	401 (100.0)	136 (33.9 (27.6-40.7))	265 (66.1 (59.3-72.4))	
No	218 (100.0)	64 (29.2 (21.6-38.1))	155 (70.8 (61.9-78.4))	
Blood pressure				0.027*
Controlled	400 (100.0)	117 (29.2 (22.9-36.4))	283 (70.8 (63.6-77.1))	
Uncontrolled	220 (100.0)	83 (37.7 (30.8-45.2))	137 (62.3 (54.8-69.2))	
Treatment				0.002*
Insulin	334 (100.0)	87 (26.0 (20.7 32.1))	247 (74.0 (67.9 79.3))	
Oral hypoglycaemic agents	237 (100.0)	98 (41.3 (31.6-51.7))	139 (58.7 (48.3-68.4))	
Mixed	49 (100.0)	15 (30.7 (21.1-42.3))	34 (69.3 (57.7-78.9))	
Duration of treatment				0.229
< 7 years	387 (100.0)	132 (34.1 (27.3-41.6))	255 (65.9 (58.4-72.7))	
≥ 7 years	233 (100.0)	68 (29.1 (21.9-37.4))	165 (70.9 (62.6-78.1))	

*p<0.05.

analysis of the relation between BMI and poor glycaemic control in two separated groups as non-insulin and insulin users found that only in non-insulin users, being overweight was protective against poor glycaemic control ((AOR: 0.28,95%CI [0.10-0.80],p:0.020) versus (AOR:0.55, 95%CI [0.25-1.17], p:0.115) for non-insulin users and insulin users respectively).

Discussion

This study was designed to assess the extent of poor glycaemic control among persons living with type 2 diabetes in Kinshasa, including its driving factors. The study found that poor glycaemic control is very prevalent (67.8%) and no sociodemographic or

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TABLE 3 Psychological characteristics and glycaemic control among participants with type 2 diabetes in Kinshasa (n=620).

	All participants (n, %)	Good glycaemic control (n, %(95%CI))	Poor glycaemic control (n, %(95%CI))	p
Adherence to treatment				
High	351 (100.0)	110 (31.3 (23.4-40.3))	241 (68.7 (59.7-76.6))	0.427
Moderate	217 (100.0)	76 (35.0 (29.2-41.4))	141 (65.0 (58.6-70.8))	
Low	52 (100.0)	14 (26.8 (17.0-39.7))	38 (73.2 (60.3-83.0))	
Depression				
Without depression	612 (100.0)	198 (32.3 (26.5-38.7))	414 (67.6 (61.3-73.5))	0.535
Moderate depression	6 (100.0)	1 (16.7 (2.6-60.0))	5 (83.3 (40.0-95.4))	
Moderately severe depression	2 (100.0)	1 (50.1 (4.6-95.4))	1 (49.9 (4.6-95.4))	
Multidimensional perceived social support				
Total score				0.299
Low support	139 (100.0)	40 (28.8 (20.6-38.6))	99 (71.2 (61.4-79.4))	
Moderate support	460 (100.0)	150 (32.5 (25.6-40.4))	310 (67.5 (59.6-74.4))	
High support	21 (100.0)	10 (47.4 (27.8-67.8))	11 (52.6 (32.2-72.2))	
Significant others				0.006*
Low support	182 (100.0)	49 (26.9 (19.3-36.1))	133 (73.1 (63.9-80.7))	
Moderate support	325 (100.0)	98 (30.2 (23.2-38.2))	227 (69.8 (61.8-76.8))	
High support	113 (100.0)	53 (46.7 (38.1-55.6))	60 (53.3 (44.4-61.9))	
Family				0.020*
Low support	140 (100.0)	44 (31.5 (24.7-39.3))	96 (68.5 (60.7-75.3))	
Moderate support	386 (100.0)	111 (28.7 (21.4-37.2))	275 (71.3 (62.8-78.6))	
High support	94 (100.0)	45 (47.8 (36.3-59.5))	49 (52.2 (40.5-63.7))	
Friends				0.463
Low support	282 (100.0)	100 (35.3 (27.1-44.5))	182 (64.7 (55.5-72.9))	
Moderate support	321 (100.0)	95 (29.6 (20.7-40.4))	226 (70.4 (59.6-79.3))	
High support	17 (100.0)	5 (29.4 (17.1-45.6))	12 (70.6 (54.4-82.9))	
Diabetes distress				
Total score				0.113
No distress	268 (100.0)	105 (39.0 (31.8-46.8))	163 (61.0 (53.2-68.2))	
Moderate distress	138 (100.0)	37 (26.8 (19.5-35.5))	101 (73.2 (64.5-80.5))	
High distress	214 (100.0)	58 (27.2 (16.9-40.6))	156 (72.8 (59.4-83.1))	
Emotional				0.375
No distress	395 (100.0)	135 (34.1 (27.9-40.9))	260 (65.9 (59.1-72.1))	
High distress	225 (100.0)	65 (28.9 (19.8-40.2))	160 (71.1 (59.8-80.2))	
Regimen				0.033*
No distress	256 (100.0)	102 (39.7 (32.1-47.9))	154 (60.3 (52.1-67.9))	
Moderate distress	144 (100.0)	31 (21.5 (14.7-30.3))	113 (78.5 (69.7-85.3))	
High distress	220 (100.0)	67 (30.5 (20.7-42.5))	153 (69.5 (57.5-79.3))	

(Continued)

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TABLE 3 Continued

	All participants (n, %)	Good glycaemic control (n, %(95%CI))	Poor glycaemic control (n, %(95%CI))	p
Interpersonal				0.293
No distress	247 (100.0)	91 (36.7 (29.1-45.1))	156 (63.3 (54.9-70.9))	
Moderate distress	130 (100.0)	37 (28.4 (22.3-35.4))	93 (71.6 (64.6-77.7))	
High distress	243 (100.0)	72 (29.6 (19.9-41.6))	169 (70.4 (58.4-80.1))	
Physician				0.134
No distress	278 (100.0)	106 (38.0 (30.8-45.8))	172 (62.0 (54.2-69.2))	
Moderate distress	129 (100.0)	40 (30.9 (25.7-36.6))	89 (69.1 (63.4-74.3))	
High distress	213 (100.0)	54 (25.5 (15.3-39.2))	159 (74.5 (60.8-84.7))	
Self-management				
Total score				0.748
Good adherence	595 (100.0)	193 (32.4 (26.2-39.3))	402 (67.6 (60.7-73.8))	
Poor adherence	25 (100.0)	7 (28.3 (11.2-55.3))	18 (71.7 (44.7-88.8))	
Dietary control				0.386
Good adherence	526 (100.0)	174 (33.0 (26.0-40.8))	352 (67.0 (59.2-74.0))	
Poor adherence	94 (100.0)	26 (27.7 (19.8-37.2))	68 (72.3 (62.8-80.2))	
Glucose management				0.511
Good adherence	552 (100.0)	181 (32.7 (26.5-39.6))	371 (67.3 (60.4-73.5))	
Poor adherence	68 (100.0)	19 (28.0 (16.4-43.4))	49 (72.0 (56.6-83.6))	
Physician contact				0.304
Good adherence	552 (100.0)	183 (33.1 (26.3-40.6))	369 (66.9 (59.4-73.7))	
Poor adherence	68 (100.0)	17 (25.1 (15.1-38.7))	51 (74.9 (61.3-84.9))	
Physical activity				0.019*
Good adherence	385 (100.0)	110 (28.5 (22.7-35.2))	275 (71.5 (64.8-77.3))	
Poor adherence	235 (100.0)	90 (38.2 (30.5-46.6))	145 (61.8 (53.4-69.5))	
Knowledge on diabetes				0.097
Low	174 (100.0)	62 (35.6 (27.6-44.6))	112 (64.4 (55.4-72.4))	
Acceptable	245 (100.0)	68 (27.7 (20.9-35.7))	177 (72.3 (64.3-79.1))	
Good	201 (100.0)	70 (34.7 (28.5-41.5))	131 (65.3 (58.5-71.5))	

*p<0.05.

lifestyle characteristics were associated with glycaemic control. While monotherapy with insulin and having a treatment duration ≥7 years increased the odds of poor glycaemic control, being overweight and having uncontrolled blood pressure reduced its odds.

That more than two-thirds of the study participants have poor glycaemic control corroborates the findings of other studies in SSA (8, 9). Furthermore, this study found a lower prevalence of poor glycaemic control than that found by Blum et al. in the nearby rural province of Kwilu in the DRC. In rural areas in the Democratic Republic of Congo, there are fewer centers that offer care to persons with diabetes, and the access to medicines and the range of foods are limited. Health system planners must work to ensure equitable geographical distribution of diabetes care centers, and regular and extensive supply of medications. Glycaemic control in our study was poorer than that found in the European or North American studies (22, 23), and indicated poor diabetes care in Kinshasa. Our result also translate the issues in SSA in general, where diabetes care faces multiple barriers, such as lack of funding for non-communicable diseases, lack of accurate guidelines directed to the specificities of diabetes in the population, lack of availability of medications and other supplies, and inequity between public and private sector diabetes care (3, 24). Moreover, self-management in SSA is poor and represents a threat to the health of individuals and capacity of the health system (25). An effective preparation of the health care systems to face diabetes burden is crucial and including

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TABLE 4 Results of survey logistic regression estimating the odds for poor glycaemic control in Kinshasa, 2021-2022.

	Univariate analysis		Multivariate analysis	
	p	COR (95%CI)	p	AOR (95%CI)
Age (years)				
18-39		1		1
40-64	0.276	0.61 (0.24-1.54)	0.652	0.81 (0.32 -2.08)
≥ 65	0.271	0.60 (0.23-1.54)	0.736	0.86 (0.35-2.13)
Sex				
Male		1		1
Female	0.989	1.00 (0.64-1.55)	0.494	1.16 (0.75-1.79)
Access to food				
Food secure		1		1
Mildly Food Insecure	0.199	0.66 (0.35-1.27)	0.079	0.59 (0.33-1.07)
Moderately Food Insecure	0.008	0.57 (0.38-0.85)	0.083	0.69 (0.46-1.05)
Severely Food Insecure	0.468	0.81 (0.45-1.46)	0.670	0.90 (0.53-1.51)
Body mass index				
Underweight		1		1
Normal	0.178	0.66 (0.36-1.22)	0.288	0.73 (0.41-1.32)
Overweight	0.000	0.32 (0.18-0.55)	0.015*	0.47 (0.26-0.85)
Obese	0.515	0.73 (0.28-1.94)	0.574	1.21 (0.60-2.48)
Waist circumference				
Normal		1		1
Abnormal	0.084	0.64 (0.38-1.07)	0.328	0.80 (0.51-1.26)
Blood pressure				
Controlled		1		
Uncontrolled	0.027	0.68 (0.84-0.95)	0.011*	0.65 (0.48-0.90)
Duration of treatment (years)				
< 7		1		1
≥ 7	0.229	1.26 (0.85-1.87)	0.043*	1.45 (1.01-2.08)
Treatment regimen				
OHA		1		1
Insulin	0.003	2.00 (1.31-3.05)	0.019*	1.10 (1.10-2.45)
Mixed	0.144	1.59 (0.84-2.99)	0.319	1.39 (0.71-2.74)
Significant other support				
Low support		1		1
Moderate support	0.465	0.85 (0.54-1.34)	0.244	0.78 (0.51-1.20)
High support	0.002	0.42 (0.25-0.71)	0.128	0.64 (0.36-1.15)
Family support				
Low support		1		1
Moderate support	0.586	1.14 (0.69-1.91)	0.533	1.22 (0.63-2.34)

(Continued)

TABLE 4 Continued

	Univariate analysis		Multivariate analysis	
	p	COR (95%CI)	p	AOR (95%CI)
High support	0.015	0.50 (0.29-0.86)	0.359	0.70 (0.31-1.55)
Diabetes distress				
No distress		1		1
Moderate distress	0.017	1.75 (1.12-2.73)	0.179	1.42 (0.84-2.39)
High distress	0.009	1.72 (0.83-3.54)	0.901	0.95 (0.42-2.23)
Physical activity				
Poor adherence		1		1
Good adherence	0.019	1.55 (1.08-2.22)	0.067	1.34 (0.98-1.80)
Knowledge on diabetes				
Low		1		1
Acceptable	0.004	1.45 (1.14-1.83)	0.054	0.69 (0.48-1.01)
Good	0.846	1.04 (0.68-1.59)	0.419	1.13 (0.83-1.52)

*p<0.05.

effective financing, training of the healthcare providers, and provision of required materials and medicines (3, 26).

In this study, participants on monotherapy with insulin were 1,64 times more likely to have poor glycaemic control than those on oral hypoglycaemic drugs. Studies have shown that only around one-fourth of persons with diabetes on insulin could achieve glycaemic targets because they might be erroneously taking an insufficient daily dose and incorrectly titrating insulin (27). One may also hypothesize that as most of the persons with diabetes were unemployed and not covered by health insurance, they could have been unable to adequately follow the prescribed regimen when they lack money to pay for their medicines or food. The psychological resistance to insulin, prevalent in our setting according to the study by Rita et al. (28), could also be another explanation for poor glycaemic control among persons with type 2 diabetes in our study. In the diabetes attitudes, wishes and needs second study (DAWN), participants reported low confidence in the efficacy of insulin, with 26.9% of participants abstaining from insulin because they thought insulin unfeasible or impracticable to manage their diabetes (29). Healthcare providers must ensure that psychological resistance to initiating insulin is adequately addressed, and effectively train the persons with diabetes to correctly follow their prescriptions.

Type 2 diabetes is a lifestyle disease, and all guidelines recommend that insulin therapy should accompany lifestyle modification and oral hypoglycaemic drugs. The propensity of clinicians to use insulin may reflect the lack of appropriate guidelines or poor clinicians' adherence to evidence-based clinical guidelines. There is also no system of safeguards to regulate medical prescriptions, especially since these are mostly provided in private pharmacies. Clear management guidelines must also be adapted for the use of available medicines and efforts must be made to offer new hypoglycaemic agents at affordable prices. The technical supervision of health facilities by the national programme is crucial to ensure the proper management of diabetes in accordance with standards.

In this study, the odds of overweight participants having poor glycaemic control were reduced by 53.0%. The sub-analysis also found that being overweight was protective only for non-insulin users. Our finding contrasted the well-known relationship between being overweight and suboptimal glycaemic control and poor glycaemic control (30). One may note that in our context, poor glycaemic patients are receiving, in most instances, insulin. Once they are better controlled, they are put on OHA. Thus, it is possible that current patients receiving OHA gained weight during a previous treatment with insulin phase and are beginning oral treatment with better glycaemic control. Blum et al. (10), in their study near Kinshasa, also found that BMI>25 Kg/m^2 and abdominal obesity were protective against poor glycaemic control. The authors stated that this finding could reflect the existence of special features of diabetes in SSA. Weight loss or the prevention of weight gain is an important goal in the management of type 2 diabetes or prediabetes (31). However, increasing weight could also arise in persons with diabetes due to the effect of antidiabetic medication on body weight. Apart from metformin and thiazolidinediones, other antidiabetic agents could lead to weight gain (32). In Kinshasa, insulin is largely used and there has been a limited range of affordable medications for persons with diabetes. Healthcare providers must furthermore ensure that the persons with diabetes are adequately managed to avoid adverse effects (32).

In the study sample, persons with diabetes having uncontrolled blood pressure reduced the odds of having poor glycaemic control by 35.0%. Mobula et al. (33), in a Ghanaian study, also found that systolic blood pressure was significantly higher among persons with diabetes having adequate glycaemic control compared to the group with poor glycaemic control. As discussed by Mobula et al. (33), among persons with diabetes having good glycaemic control, it can

be that there was a significantly higher proportion of patients with dual diagnosis—hypertension and diabetes. This observation can also be explained by the fact that health providers give more attention to persons with comorbidity or an increase in healthcare utilisation by the persons with comorbidity (34). Hypertension is frequently associated with diabetes (35), which indicates that more insight into adequate management of hypertension among persons with diabetes in our setting will be required (34).

This study found that a treatment duration ≥7 years increased the odds of poor glycaemic control by 1,45 times. Longer duration of treatment has been linked to poor glycaemic control in SSA (36). As diabetes is a progressive disease with deterioration in the function of the ßeta cells of the pancreas with time, more adjustments in the treatments are required in older persons with diabetes who would generally have had diabetes longer and are more likely to have comorbidities (37). Health providers must be informed of the progression of diabetes and be able to adjust the treatments for persons with diabetes accordingly.

Most of our participants (93.7%) were older than 40 years. This proportion aligns with the classic description of type 2 diabetes, in which the disease appears in individuals older than 40 years most of the time. Female persons with diabetes represented approximately two-thirds of the participants. A retrospective analysis of the Kinshasa Health Network database conducted by Sagastume et al. (11) also found the same-sex prevalence. This high prevalence of type 2 diabetes affects more women than men, due to the higher metabolic risk in the former (38). Furthermore, the health-seeking behaviour of women is better than in men (39). Most of the participants were unemployed, poor and without health insurance, which has been representative of the condition of the general population in Kinshasa. No sociodemographic and lifestyle characteristics were associated with poor glycaemic control. Our finding here has been corroborated by the study of Blum et al. (10), who also found no sociodemographic or lifestyle factors associated with poor glycaemic control in a cross-sectional survey in the nearby province of Bandundu in the DRC. However, we can discuss the efficiency of the assessment of certain characteristics such as income in our environment. The income assessed was the individual's income and did not take into account the contribution of relatives, which was sometimes substantial. And since most persons with diabetes were not paid employees, those in the informal or liberal sector could not accurately determine their income. In a retrospective study in Kinshasa, Sagastume et al. (11) found that younger persons with diabetes needed prioritised attention to reach glycaemic targets. Nevertheless, interventions for better glycaemic control have to prioritise vulnerable groups, such as younger and older age, women and non-insured persons with diabetes (9). Implementing universal coverage can increase access to care for the aforementioned groups (40).

Limitations of the study

This study estimated the extent of poor glycaemic control among persons with type 2 diabetes in Kinshasa. Because of the cross-sectional nature of the study, it is not possible to ascertain a causal relationship between poor glycaemic control and the determinants. Other potential biases include selection bias as only persons with diabetes who attended the diabetic clinics in the period of the study could be included in the study, recall bias as for some responses, the participants might refer to their history with the possibility to have lost memory or omitted details for some events, interviewer bias since the data collectors could have influenced the participants by how they asked questions or reacted to the answers, and social desirability bias since participants could have given answers that made them look good to respondents and did not talk about their true experiences (41). These biases were minimised by ensuring effective training of the data collectors to make certain that the aim and objectives of the study were clearly stated to the participants, and that questions were asked in a non-judgemental way.

Nonetheless, this study provides an understanding of important factors on which to focus for improved glycaemic control in Kinshasa, DRC or similar settings, particularly in sub-Saharan Africa.

Conclusion

Poor glycaemic control is prevalent among persons with type 2 diabetes in Kinshasa, DRC. Being on insulin alone and a duration of diabetes treatment equal or more than 7 years predisposed to poor glycaemic control. By contrary, having uncontrolled blood pressure and being overweight had protective effect against poor glycaemic control. These links between uncontrolled blood pressure and overweight on the one hand, and glycaemic control on the other are unusual. These reflect, among other things, the specific characteristics of diabetes in sub-Saharan Africa.

Availability of data and materials

All data generated or analysed during this study are included in this published article and its Supplementary Information Files.

Ethics approval

The researchers declared that they complied with the conditions under which this study obtained approval from the ethics committees of the Protestant University of Congo (reference number: CEUPC 0067; Date: 05/02/2021) and Human Research Ethics Committee (Medical) of the University of the Witwatersrand (reference number: M210308; Date: 26/08/2021). The study was conducted according to the ethical guidelines of the Declaration of Helsinki. Permission was obtained from the Kinshasa Primary HealthCare Network to conduct the study. Informed consent was obtained from each participant. Data collection was done in strict adherence to local COVID-19 regulations.

Data availability statement

The original contributions presented in the study are included in the article/Supplementary Materials, further inquiries can be directed to the corresponding author.

Ethics statement

The studies involving humans were approved by Ethics committee of the Protestant University of Congo (reference number: CEUPC 0067; Date: 05/02/2021) and Human Research Ethics Committee (Medical) of the University of the Witwatersrand (reference number: M210308; Date: 26/08/2021). The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

J-PL, OO, and JF designed the study. J-PL contributed to acquisition of funding and data. J-PL oversaw the research process. J-PL and JF performed the data processing and quality control. J-PL conducted the statistical analyses, drafted the manuscript, and is the guarantor of this work. J-PL, OO, and JF interpreted the data. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fcdhc.2023.1241882/full#supplementary-material

SUPPLEMENTARY FILE 2
xls — Study dataset. Anonymised database.

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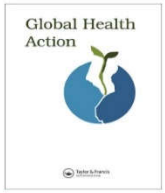
Appendix 5: Research paper 6



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RESEARCH ARTICLE

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Consensus on potential interventions for improving glycaemic control among patients with type 2 diabetes in Kinshasa, Democratic Republic of the Congo: a Delphi study

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ABSTRACT

Background: Poor glycaemic control is a multifactorial and complex problem with dire clinical and economic implications. In the Democratic Republic of the Congo, recent studies have shown alarming poor control rates. There is no policy framework to guide corrective actions.

Objectives: To build a consensus on interventions to improve glycaemic control among patients with type 2 diabetes in Kinshasa, Democratic Republic of the Congo.

Methods: This was a two-round electronic Delphi study involving 31 local and 5 international experts. The experts rated proposed interventions from previous studies on glycaemic control in sub-Saharan Africa and Kinshasa on a 4-Likert scale questionnaire. Additionally, the experts were asked to suggest other recommendations useful for the purpose. The mode, mean and standard deviation of each statement were calculated for each round.

Results: Participants reached consensus in five domains that included 39 statements on how to improve glycaemic control in Kinshasa: strengthening the health system, enhancing the awareness of diabetes, alleviating the financial burden of diabetes, enhancing the adoption of lifestyle modifications, and reducing the proportion of undiagnosed diabetes.

Conclusions: Improved glycaemic control needs to be considered within the broader framework of managing noncommunicable diseases in a more integrated, coordinated and better financed healthcare system. Further studies are needed to operationalise the interventions identified for successful implementation.

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Background

The prevalence of diabetes mellitus is increasing worldwide, with the number of affected adults almost having quadrupled between 1985 and 2014 [1]. The African region has the greatest predicted increase in the number of people with diabetes of all International Diabetes Federation (IDF) regions – expected increase of 129% to 55 million people by 2045 [2]. In the Democratic Republic of Congo (DRC), the trend of increasing prevalence of diabetes is clear, but better organisation of health data is needed to assess the true extent of the problem. The latest estimates from the IDF showed a 5.8% prevalence of diabetes among adults [3] with disparities between urban and rural areas, as well as between the western and eastern parts of the country [4,5].

One of the major problems in the management of diabetes is the difficulty to achieve glycaemic control, which is essential for the prevention of complications and thus for the preservation of the quality of life of patients [6]. Complications of diabetes result in increased costs of care for patients, society, and the health care system [7].

Controlling blood sugar levels is a complex phenomenon. Its complexity is primarily due to the existence of numerous factors that determine it. A literature review enabled us to develop a conceptual model based on the Chronic Care Model [8]. The factors were grouped into the following categories: policy, healthcare system, community, and patients and their families [9–12]. Knowledge of the factors acting in a given environment is essential to determine the interventions needed to remedy the situation [13].

The complexity of glycaemic control also lies in the fact that there are many interventions identified to improve glycaemic control. Among the consensuses on the management of hyperglycaemia in type 2 patients, the one continually updated and steered by the American Diabetes Association (ADA) and the European Association for the Study of Diabetes (EASD) remains the usual reference and has advocated therapeutic

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education, hygienic and dietary measures, and patient-centred care, in particular taking into account patients' preferences in the provision of care [14,15]. In 2019, a team of diabetes experts from sub-Saharan Africa, taking into account the difficulties encountered in managing diabetes in Africa, in particular the cost and availability of medicines, proposed an algorithm for initiating and intensifying diabetes treatment in sub-Saharan Africa [15]. In DRC, the latest Ministry of Health standards for diabetes treatment were issued in 2012 and have not been updated [16].

Still, worldwide, only half of patients with type 2 diabetes achieve good glycaemic control [17]. In Africa, poor control is common, and, in the DRC, recent studies have shown similar worrying results with only 16% to 32% of the patients with type 2 diabetes having controlled glycaemia [18].

In our setting, the need for better diabetes care and management of hyperglycaemia is still crucial. There is no framework for improving glycaemic control in Kinshasa, DRC. We conducted a series of studies to determine the magnitude and drivers of poor glycaemic control to inform a potential framework to address the poor glycaemic control in the Kinshasa DRC. So the Delphi work was to solicit the views of experts in the field based on the conducted studies' findings to come up with a recommended framework to optimise glycaemic control in DRC.

Methods

Study design

In situation where there is insufficient or conflicting or overload information, consensus methods provide another means of synthetising information [19]. Consensus strategies create structured environments allowing the experts to be given the best available information on an issue and to provide more justifiable and credible solutions [19]. Two consensus methods are commonly used in health services research, the Delphi process and the nominal group technique [20]. Delphi process is the one that is commonly used to develop guidelines by healthcare professionals [20]. Thus, the Delphi consensus method is the best approach to develop a policy framework considering the multitude of factors associated with blood glucose control, the number of possible interventions, some with contrasting results, and the socio-economic and cultural peculiarities of Kinshasa, DRC [20].

This was a two round, electronic, and anonymous Delphi study seeking policy consensus from important stakeholders in diabetes management in Kinshasa to develop a package of interventions for improving glycaemic control. The Delphi study is part of a larger project aimed at developing a framework for improving glycaemic control for patients with type 2 diabetes in Kinshasa, Democratic Republic of Congo, the protocol of which has been published [8]. Previously in the project, factors associated with glycaemic control in sub-Saharan Africa were determined in a meta-analysis [10]. Additionally, the factors associated with poor glycaemic control in Kinshasa, DRC were determined in a cross-sectional study and substantiated with findings from qualitative studies of the perspectives of patients and caregivers on the factors that affect glycaemic control and proposed interventions in Kinshasa. Informed by these studies, experts were brought together to define a package of interventions to improve glycaemic control among type 2 patients in the Democratic Republic of Congo through consensus. The process of the Delphi study is summarised in Figure 1. This Delphi study is reported according to the Guidance on Conducting and Reporting Delphi Studies (CREDES) [21].

Context

The proposed interventions are for patients with type 2 diabetes in Kinshasa, the capital city of the DRC. The country is a low-income country with a population of 95,894,118 inhabitants [22]. In 2019, the country spent 4% of its Gross Domestic Product in health expenditure [23]. In 2022, about 64% of the population were living with less than 2.15 $US a day [22]. Most of the population are not covered by health insurance and have to rely on out-of-pocket payments. Kinshasa has a population of approximately 15 million within an area of 9 965 square kilometres [24]. In recent years, the population of Kinshasa is growing fast due to a rural

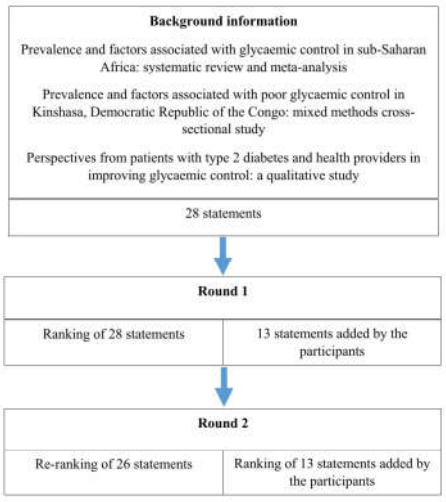

Figure 1. Description of the Delphi study process.

exodus resulting from the destruction of economic infrastructure of the surrounding provinces. The care for diabetes patients is mainly organised via the Kinshasa Primary Care Network uniting health structures belonging to the Catholic Church and the Salvation Army [25]. The other facilities organising diabetes care are privately owned and some State health structures. The problem in this context is that there is no real integration or control of activities, with each player trying to find its own way with whatever resources it can muster. The national diabetes programme is not yet really effective on the ground. Data on the impact of diabetes are not well organised.

Subjects

The Delphi study included representatives of stakeholders in diabetes management in Kinshasa, DRC. Two approaches were used to select the experts. The first was to contact the heads of institutions involved in diabetes and ask them to nominate representatives for the Delphi study. In the second approach, individuals known for their expertise in diabetes were contacted. We selected six health services managers, eight clinicians, seven representatives from universities, nine members of the staff of the National Program against Diabetes, and six people from non-government organisations working on diabetes in Kinshasa and in Africa. The clinicians were persons qualified in the clinical practice of medicine, namely five doctors or three nurses, and taking care of diabetes; managers were individuals in charge of a healthcare structure (hospital or health centre) or a group of healthcare structures organising diabetes care; representatives of universities were diabetologists or internal medicine specialists; NGO partners were all the persons within organisations participating in the management of diabetes by providing financial or technical support; representatives from the Ministry of Health were individuals working in the National Program of diabetes. The participants were purposively selected by the research team – principal researcher and supervisors – based on their interest in the subject and expertise in diabetes control. Contact was made with the structures organising or providing support for diabetes care to ensure that participants were experts in the issue; known experts in diabetes management were contacted directly through e-mail, telephone and WhatsApp.

All the participants had an age ≥18 years; experts were local and international experts with preference given to those who currently or previously worked in the DRC, and those with known expertise in diabetes. The exclusion criteria was conflict of interest in study participation.

Thirty-six participants were included in the first round of the Delphi from a total of 62 experts invited, representing a response rate of 58.1%. In the second round of the 36 participants who took part in the first round, two dropped out, and the response rate was of 94.4%.

Data collection

E-mail was used to send an information document describing the purpose and objectives of the study to eligible people. They were requested to agree electronically to participate in the study. Once they accepted to participate in the study, a second e-mail informed them of the results of previous sub-studies of this project.

This Delphi study included two rounds. In the first round, each stakeholder was asked to use a 4-point Likert scale to indicate by how much he/she agreed or disagreed with the statements constructed based on the findings of previous studies in sub-Saharan Africa and Kinshasa on factors associated with glycaemic control and perspectives for improving glycaemic control. The questionnaire also comprised open questions for the participants to suggest additional interventions for improving glycaemic control or to comment on the proposed interventions. The questionnaire was designed on Redcap 13.4.13 [26] and shared with the participants through e-mail and WhatsApp. The questions were constructed using a 4-point Likert scale ('strongly agree', 'agree', 'disagree', and 'strongly disagree').

The participants' responses in the first round were used to perform an initial assessment of the extent to which they agreed with the recommendations. At the end of the first round, the researcher summarised the rankings from the participants and their motivations and used these for the second round. Only the recommendations that were strongly agreed to by the participants and those suggested by the participants were used in the second round. The reliability of the survey tool used in the second round was assessed using the Cronbach's alpha coefficient; the result was 0.97 indicating high internal consistency.

In this second round, the experts were asked to re-rank the statements after reconsidering their opinions or judgements in light of other group members' responses and/or again to motivate their choice or suggest other interventions. No new themes were identified by the participants. For the majority of participants, the positions or responses did not vary substantially from those expressed in the first round. Their ratings consisted of assessing each intervention again according to a 4-point Likert scale ('strongly agree', 'agree', 'disagree', and 'strongly disagree'). At the end of the second round, the researchers sorted a list ranking the remaining interventions along with

minority opinions achieving consensus. Expert contributions were anonymous.

Data analysis

For each round and for all proposed interventions, the frequencies of all responses of the 4-Likert were summarised to determine the mode. The means and standard deviations were used to describe group responses to each statement. For each statement, the overall interpretation used was: 4.00–3.00: strongly agree; 2.99–2.00: agree; 1.99–1.00: disagree; 1.00–0.99: strongly disagree [27,28].

At the end of a round, only recommendations with an average score above 3.00 should be considered for the next round. Between rounds, the data were analysed to identify convergence and change of experts' opinions or judgements.

Consensus was defined as >70% of experts agreeing/strongly agreeing or disagreeing/strongly disagreeing with a statement in round 2. This level of agreement has been used in previous studies [29,30]. Stability of consensus was considered to have been reached if the between round group responses varied by ≤10%.

Table 1. Characteristics of the participants of the Delphi study, $n = 36$.

	Categories	Number	Percentage (%)
Age (years)			
	<40	14	38.9
	40–65	20	55.5
	≥65	2	5.5
Sex			
	Male	28	77.8
	Female	8	22.2
Role			
	Clinician	8	22.2
	Manager	6	16.7
	National Program Against Diabetes	9	25.0
	University	7	19.4
	Non-Government Organization	6	16.7
Background			
	Physician	26	72.2
	Nurse	3	8.3
	Economist	4	11.1
	Pharmacist	1	2.8
	Political Scientist	1	2.8
	Lawyer	1	2.8
Expertise (years)			
	<10	16	44.4
	10–19	13	36.1
	≥20	7	19.4
Location			
	National	31	86.1
	International	5	13.9

Results

Table 1 presents the characteristics of the participants.

Five domains of statements were identified for improving glycaemic control. Table 2 presents a summary of grouped statements by domain from the Delphi study.

From the 28 initial statements, the participants agreed on 26 statements (92.9%) and two were excluded (7.1%). For the second round, these 26 statements were added to 13 additional recommendations suggested by the participants in the first round, a total of 39 statements were submitted to the experts and all reached consensus.

Table 3 describes in detail the assessment of each statement throughout the two rounds of the Delphi study. In the first round, 'creating food banks' and 'implementing gatekeeping on prescriptions to improve adherence to evidence-based guidelines' reached 55.9% and 69.7%, respectively, and were excluded. The participants also suggested 13 additional recommendations that were added to the second round of the Delphi study. All the statements reached the consensus (100%). The stability of the consensus was assessed for 26 of 39 statements (%); only one of the 26 statements had varied by more than 10%.

Discussion

This Delphi study aimed to build a policy consensus on recommendations for improving glycaemic control in Kinshasa, DRC. The study identified five domains containing 39 statements: strengthening healthcare system for better diabetes care, enhancing the awareness of diabetes among the population/patients, alleviating the financial burden of diabetes, enhancing the adoption of lifestyle modifications in our setting, reducing the proportion of undiagnosed patients with diabetes, and helping healthcare providers to act for improving glycaemic control.

Table 2. Summary of grouped statements by domain.

	Number of statements in each domain		Proportion of statements where consensus was reached	
	Round 1	Round 2	Round 1	Round 2
Strengthening the healthcare system for better diabetes care	14	17	13	17
Enhancing the awareness of diabetes among the population/patients	3	5	3	5
Alleviating the financial burden of diabetes	4	9	4	9
Enhancing the adoption of lifestyle modifications in our setting	4	5	3	5
Reducing the proportion of undiagnosed patients with diabetes	3	3	3	3
Total	28	39	26	39

Table 3. Analysis of the responses to statements throughout the Delphi process.

		First round statistics ($n = 36$)				Second round statistics ($n = 34$)				
		Responses (%)				Responses (%)				
Domains	Strategies	Agreed/ strongly agreed	Disagree/ strongly disagree	Mean***	Standard deviation	Agreed/ strongly agreed	Disagree/ strongly disagree	Mean***	Standard deviation	Stability (%)
Strengthening the healthcare system for better diabetes care	Set up a diabetes primary care team	100.0	0.0	3.7	0.4	97.1	2.9	3.6	0.6	2.9
	Equip the health structures with basic equipment	100.0	0.0	3.7	0.4	97.1	2.9	3.8	0.6	2.9
	Set up an effective drug delivery system	94.1	5.9	3.5	0.6	100.0	0.0	3.6	0.7	5.9
	Develop a diabetes management protocol	91.7	8.3	3.6	0.6	97.1	2.9	3.7	0.6	5.4
	Augment geographical access to care	100	0.0	3.6	0.5	94.1	5.9	3.6	0.7	5.9
	Reduce waiting time for access to care	97.1	2.9	3.5	0.6	91.2	8.8	3.3	0.7	5.9
	Technical supervision	94.3	5.7	3.5	0.6	94.1	5.9	3.5	0.7	0.2
	Adopt glycosylated haemoglobin for glycaemic control	91.2	8.8	3.3	0.6	94.1	5.9	3.4	0.7	2.9
	Implement 'gatekeeping' on prescriptions to improve adherence to evidence-based guidelines*	69.7	30.3	2.9	0.7					
	Strengthen the National Diabetes Control Program**					97.1	2.9	3.7	0.6	
	Develop individual care for patients	94.2	5.8	3.5	0.6	97.1	2.9	3.5	0.7	2.9
	Adhering to evidence-based clinical guidelines	100.0	0.0	3.6	0.5	94.1	5.9	3.4	0.7	5.9
	Innovative approach to patients	100.0	0.0	3.5	0.5	97.1	2.9	3.4	0.7	2.9
	Support self-management of the patients	85.7	14.3	3.3	0.8	91.2	8.8	3.5	0.7	5.5
	Identify patients at risk of poor glycaemic control	100.0	0.0	3.7	0.4	94.1	5.9	3.5	0.7	5.9
	Educate the family and communicate the objectives of the family with the patient's consent**					97.1	2.9	3.6	0.7	
	Identify patients with poor glycaemic profile**					94.1	5.9	3.5	0.8	
	Send text messages to remind patients to take their medicines or to respond to follow-up visit**					85.3	14.7	3.3	0.8	
Enhancing the awareness of diabetes among the population/patients	Develop radio/TV spots on diabetes	100.0	0.0	3.7	0.5	94.1	5.9	3.5	0.7	5.9
	Distribute information leaflets on diabetes	77.1	22.9	3.1	0.8	88.2	11.8	3.3	0.8	11.1
	Send text/videos through social media	97.2	2.9	3.5	0.6	91.2	8.8	3.3	0.8	6.0
	Community-based awareness activities in churches, schools, and open spaces (markets)**					97.1	2.9	3.7	0.6	
	The train and involve community health workers in the sensitization of the population**					97.1	2.9	3.7	0.6	
Alleviating the financial burden of diabetes	Implement universal health coverage	100.0	0.0	3.7	0.5	97.1	2.9	3.7	0.6	2.9
	Promoting health insurance	88.2	11.8	3.5	0.7	97.1	2.9	3.5	0.7	8.9
	Encourage the creation of health mutuals	97.1	2.9	3.6	0.5	97.1	2.9	3.6	0.7	0.0
	Encourage family involvement and support	85.3	14.7	3.2	0.8	94.1	5.9	3.6	0.7	8.8
	Partner with pharmaceutical industry to avail good quality generic drugs at affordable cost**					94.1	5.9	3.5	0.8	
	Improve the standard of living of the Congolese population by granting an acceptable minimum wage to the lowest paid workers so that they are able to contribute to or support the mutual insurance system**					94.1	5.9	3.6	0.7	
	Promote flat-rate pricing for disease episodes or even monthly patient care at the center or hospital.**					97.1	2.9	3.5	0.7	
	Exempt imported equipment for diabetes care (insulin, strips, syringes …) from excise and import duties to reduce costs**					94.1	5.9	3.6	0.7	
	Allocation of a significant budget for chronic diseases**					97.1	2.9	3.5	0.7	
Enhancing the adoption of lifestyle modifications in our setting	Develop a suitable exercise plan for patients considering their occupations	91.4	8.6	3.5	0.7	94.1	5.9	3.4	0.7	0.0
	Encourage realistic dietary plans that considers affordability	97.1	2.9	3.8	0.5	97.1	2.9	3.6	0.6	0.0
	Create food banks*	55.9	44.1	2.7	0.8					
	Providing accurate information on recommended diet and exercise	97.1	2.9	3.6	0.5	97.1	2.9	3.7	0.6	0.0
	Promote primary prevention using policies that target marketing and sales of of tobacco, alcohol, sweetened beverages, and fast foods**					82.2	17.8	3.3	0.8	
	Open gymnasiums and encourage healthy and balanced eating**					88.2	11.8	3.2	0.7	
Reducing the proportion of undiagnosed patients with diabetes	Implement opportunistic screening at primary care level	94.4	5.6	3.7	0.6	97.1	2.9	3.7	0.6	2.7
	Promote cases finding among in high-risk population e.g. patients' families	88.2	11.8	3.2	0.6	88.2	11.8	3.3	0.8	0.0
	Mass screening during diabetes international day	88.6	11.4	3.3	0.8	94.1	5.9	3.5	0.7	5.5

Legend: *Strategy excluded after the first round; **strategy added after the first round; ***scale range: for each statement, the overall interpretation is: 4.00–3.00: strongly agree; 2.99–2.00: agree; 1.99–1.00: disagree; 1.00–0.99: strongly disagree.

Strengthening the healthcare system for better diabetes care

Improving glycaemic control among patients with type 2 diabetes cannot be realised without strengthening of the health system. The WHO framework characterised a well-functioning health system as one that puts together trained and motivated health workers, a well-maintained infrastructure, a reliable supply of medicines and technologies, backed by adequate funding, strong health plans, and evidence-based policies [31]. These elements have been identified in the recommendations made by the experts during the current Delphi study. Concerning healthcare providers, the recommendations of this Delphi study highlighted the benefits of establishing multidisciplinary care teams for better diabetes care at the primary health care level. Such multidisciplinary teams have been linked to better outcomes, including good glycaemic control among patients with type 2 diabetes [32]. In this multidisciplinary team, task shifting should be strongly considered considering the shortage of qualified and specialised healthcare providers in Kinshasa. Interventions led by nurses and pharmacists in Low- and Middle-Income Countries (LMICS) with relatively low physician density are effective in the management of diabetes [33]. In a realistic and cost-effective way, improving diabetes care has to be considered in the broader framework of managing noncommunicable diseases in the primary healthcare level [34,35]. For these changes to occur, diabetes and more noncommunicable diseases should be taken at their just value by the policy-makers. The Ministry of Health through the National Program against diabetes should provide data that translates the burden of diabetes and advocate for prioritisation.

The Government should engage itself to provide more funding to health to better prepare the health system to face noncommunicable diseases. The Ministry of health should also ensure the development of clear guidelines for the management of diabetes, which take into account the specificities of diabetes in our setting. The Ministry of Health and the National Program against Diabetes should also warrant that healthcare staff are trained, motivated and assigned to diabetes management centres to provide all the package required for the care for patients with diabetes.

Healthcare providers must be trained on this guideline and formative supervision and oversight by more qualified clinicians of the activities should help to improve the quality of care. In the training of the healthcare providers, caution must be taken to consider the development of a patient-centred approach [36], and to ensure prevention of poor glycaemic control by identifying high-risk patients.

Strengthening of the healthcare system should also include enabling a bidirectional referral pathway that allows for escalated/more complex care at highly specialised level (for patients who are uncontrolled at primary healthcare (PHC) and de-escalated care to PHC level for follow up when such patients become stabilised) [37].

Funding is critical in implementing the changes required in the structure and processes of care for better diabetes management [38]. There is a need to ensure, as outlined in the Global Diabetes Compact, that everyone with diabetes should have access to equitable, comprehensive, affordable, and quality treatment and care [39]. The government has just started the process of universal health coverage, but diabetes is not yet covered due to negative financial constraints. Extending universal health coverage to diabetes will allow vulnerable and disadvantaged individuals access to equitable care [40].

Alleviating financial burden of diabetes

Empiric evidence shows that better socioeconomic conditions are associated with improved glycaemic control [41]. The Government should ensure that the war against poverty is effective as it could allow persons with diabetes to have their purchasing power to grow in order to face the charges of diabetes. The Government should also provide social protection to vulnerable categories of persons with diabetes through the extension of universal health coverage to noncommunicable diseases. One way to reduce the burden of diabetes is also to help persons with diabetes access to affordable medications. A partnership with the pharmaceutical sector mainly private could help in this purpose. The government could reduce taxes on medications and supplies for the care of diabetes and other non-communicable diseases, with a view to lowering their cost on the market.

In the search for a reduction in the cost of health care, the integration of a regulation of prescriptions could be beneficial as it has been dismantled in other settings [42]. The panel of experts did not opt for this recommendation by a very narrow margin of consensus. The lack of health insurance may have been a reason for rejecting this measure. Nevertheless, technical supervision may have as one of its objectives the monitoring of prescriptions. They also rejected the creation of food banks on the grounds that the healthcare system is suffering from budgetary constraints and that these banks could require far too much financial resources to organise.

In the healthcare system level, integrating PEN-Plus could be a cost-effective approach [35]. The DRC has not yet incorporated this model. There is a need to move towards the implementation of PEN and PEN-Plus in our setting. In the long term, the population must be financially empowered to face the costs of diabetes care by prepaid payments – health insurance or health mutual. Out-of-pocket payment for health care currently represents a serious barrier to healthcare access in Kinshasa and could lead to impoverishment [43].

At the level of the relatives, one may note that family represent sometimes the sole source of support for the patients. The healthcare providers must be encouraged to develop a family-oriented care approach for patients to increase the involvement of the patients' relatives in their care [44]. Family support has been linked to better health outcomes [44]. They must develop a family orientated care to ensure that the relatives understand the diabetes disease to ease their support to the sufferer

Enhancing the awareness of diabetes

Raising the awareness of the population will also contribute to acceptable health seeking behaviours [45]. Participants pointed out that people in the community do not read much, unsurprisingly because most are not highly educated; they are more attracted to plays on television. The national programme against diabetes should organise awareness campaigns for these diseases. As part of this campaign, we need to take account of the need to get messages across via the plays that are popular with the public. Community-based campaigns in public spaces, churches, and schools have been seen as an appropriate approach in our environment.

Enhancing the adoption of lifestyle modifications

Lifestyle interventions have been found to be effective for glycaemic control in low- and middle-income countries [46]. For the persons living with diabetes in our setting, the critical point is to integrate these changes in the daily activities. Advocating for the integration of the practice of exercise in workplace will be of greater usefulness. Policies that target marketing and sales of tobacco, alcohol, sweetened beverages, and fast foods could also be applied to try to control their use by the public. As far as diet is concerned, it is essential to define appropriate diets that take account of patients' sometimes low incomes. Operational research is needed to determine the best interventions for lifestyle change, taking into account the patient's condition and purchasing power.

Reducing the proportion of undiagnosed diabetes

Incorporating opportunistic screening of diabetes by targeting high-risk individuals could ease the management of diabetes at the time of diagnosis and delay the occurrence of complications. Opportunistic screening is one of the cost effectiveness way to screen for diabetes [47]. The healthcare facilities and their teams should be prepared and equipped to offer these activities.

Strengths and limitations of the study

This is the first study in Kinshasa, Democratic Republic of the Congo that tried to build consensus on how to improve glycaemic control using a Delphi panel of experts [48]. This Delphi study was supported by a rich background of information from the findings of previous studies that identified the factors of glycaemic control in sub-Saharan Africa and Kinshasa and the perspectives from patients with type 2 diabetes and healthcare providers in improving glycaemic control.

The weakness of the study was that Delphi studies do not allow live discussions that could have increased the depth of engagement and potentially given rise to more ideas on the issue. The consensus concerned a specific situation and therefore may not be generalisable [49]. The high proportion of participants with medical background could have introduced a bias in the findings of this Delphi study.

Conclusions

The study found that participants had a high level of consensus on how to improve glycaemic control among patients with type 2 diabetes in Kinshasa with most statements converging around five domains that focused on the need for a more integrated, coordinated and adequately financed healthcare system for better diabetes care. All of these statements were expressed within a broader framework of managing noncommunicable diseases. Further studies are needed to operationalise the interventions identified to determine their scalability, effectiveness, efficiency and acceptability.

Acknowledgments

The authors would like to thank all the experts who gave their time to contribute to this reflection.

Author contributions

JP FL conceived the study, conducted the process, analysed the findings; JMF and OBO contributed to the conception of the study and the analyses of findings. All the authors agreed with the manuscript.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Ethics and consent

The study was conducted after the approval from the Ethics committee of the Protestant University of Congo (reference number: CEUPC 0067; Date: 05/02/2021) and Human Research Ethics Committee (Medical) of the University of the Witwatersrand (reference number:

M210308; Date: 26/08/2021). An informed consent was sought from the participants.

Funding information

The author(s) reported there is no funding associated with the work featured in this article.

Paper context

Achieving good glycaemic control is a global challenge. The challenge is particularly acute in sub-Saharan Africa due to multiple barriers. This study identified a number of interventions for improving glycaemic control in a particular context, but which may be relevant in similar settings.

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Joel Msafiri Francis http://orcid.org/0000-0003-1902-2683

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Appendix 6: Human research ethics committee (Medical) clearance certificate

UNIVERSITY OF THE WITWATERSRAND JOHANNESBURG

R14/40 Dr Jean-Pierre Fina Lubaki

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)

CLEARANCE CERTIFICATE NO. M210308

NAME: (Principal Investigator)	Dr Jean-Pierre Fina Lubaki
DEPARTMENT:	Family Medicine and Primary Care Kinshasa Primary Healthcare Network Democratic Republic of the Congo
PROJECT TITLE:	Developing a framework to improve glycaemic control among patients with type 2 diabetes mellitus in Kinshasa, Democratic Republic of the Congo
DATE CONSIDERED:	26/03/2021
DECISION:	Approved unconditionally
CONDITIONS:	
SUPERVISOR:	Dr Joel Mesfin Francis and Prof Olufemi Babatunde Omole
APPROVED BY:	Dr CB Penny, Chairperson, HREC (Medical)
DATE OF APPROVAL:	26/03/2021

This clearance certificate is valid for 5 years from date of approval. Extension may be applied for.

DECLARATION OF INVESTIGATORS

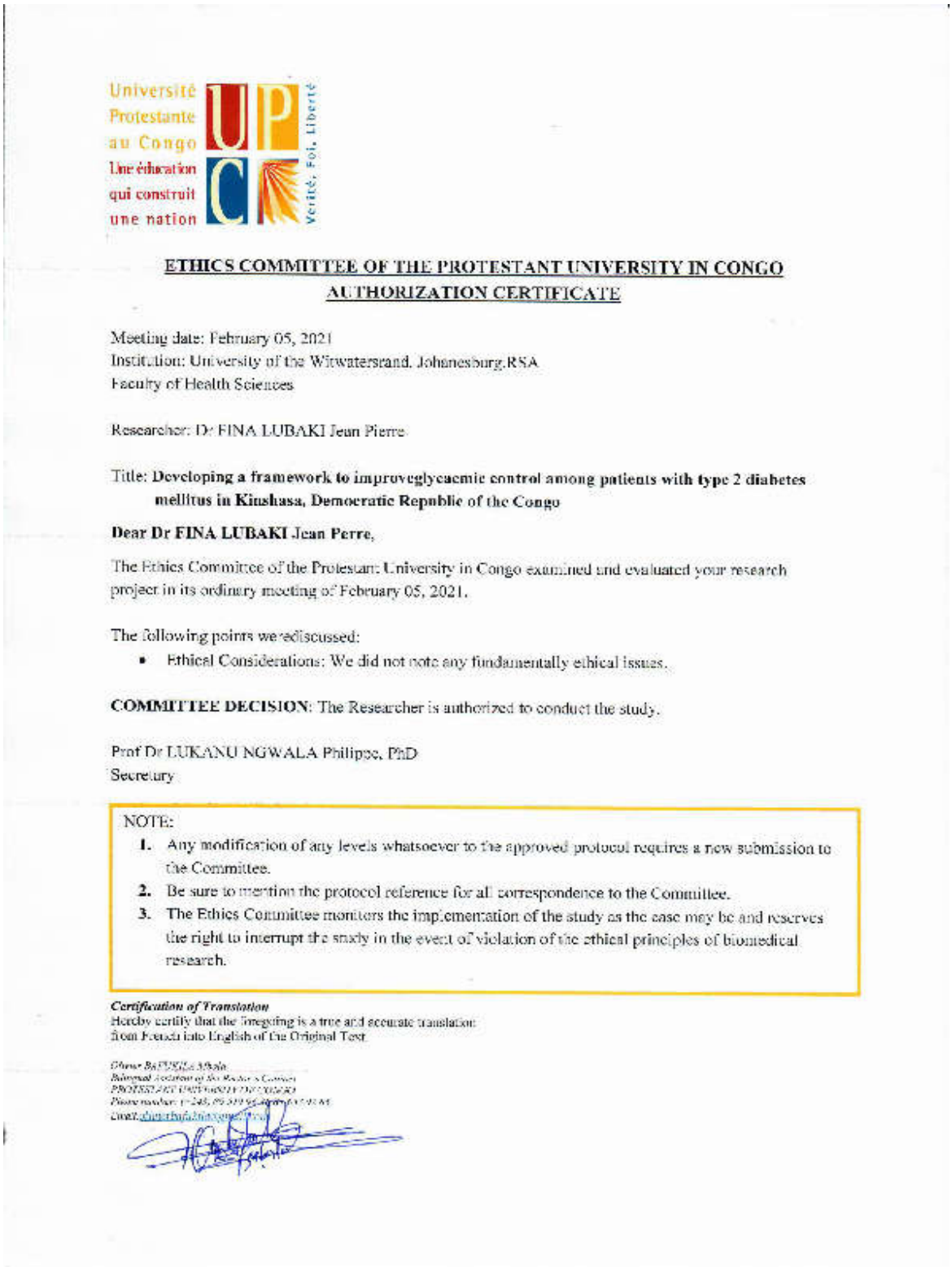
To be completed in duplicate and **ONE COPY** returned to the Research Office Secretary on the Third Floor, Faculty of Health Sciences, Phillip Tobias Building, 29 Princess of Wales Terrace, Parktown, 2193, University of the Witwatersrand. I/we fully understand the conditions under which I am/we are authorized to carry out the above-mentioned research and I/we undertake to ensure compliance with these conditions. Should any departure be contemplated, from the research protocol as approved, I/we undertake to resubmit the application to the Committee. **I agree to submit a yearly progress report.** The date for annual re-certification will be one year after the date of convened meeting where the study was initially reviewed. In this case, the study was initially reviewed in **March** and will therefore be due in the month of **March** each year. Unreported changes to the application may invalidate the clearance given by the HREC (Medical).

Principal Investigator Signature

03/04/2021
Date

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES

Appendix 7: Ethics committee of the Protestant University in Congo authorisation certificate



Université Protestante au Congo
Une éducation qui construit une nation
Vérité, Foi, Liberté

ETHICS COMMITTEE OF THE PROTESTANT UNIVERSITY IN CONGO
AUTHORIZATION CERTIFICATE

Meeting date: February 05, 2021
Institution: University of the Witwatersrand, Johannesburg,RSA
Faculty of Health Sciences

Researcher: Dr FINA LUBAKI Jean Pierre

Title: **Developing a framework to improveglycaemic control among patients with type 2 diabetes mellitus in Kinshasa, Democratic Republic of the Congo**

Dear Dr FINA LUBAKI Jean Perre,

The Ethics Committee of the Protestant University in Congo examined and evaluated your research project in its ordinary meeting of February 05, 2021.

The following points werediscussed:

- Ethical Considerations: We did not note any fundamentally ethical issues.

COMMITTEE DECISION: The Researcher is authorized to conduct the study.

Prof Dr LUKANU NGWALA Philippe, PhD
Secretary

NOTE:
1. Any modification of any levels whatsoever to the approved protocol requires a new submission to the Committee.
2. Be sure to mention the protocol reference for all correspondence to the Committee.
3. The Ethics Committee monitors the implementation of the study as the case may be and reserves the right to interrupt the study in the event of violation of the ethical principles of biomedical research.

Certification of Translation
Hereby certify that the foregoing is a true and accurate translation from French into English of the Original Text

Appendix 8: Permission to conduct the study in the Kinshasa Primary Healthcare Network

ARCHIDIOCESE DE KINSHASA
SERVICE MEDICAL-BDOM
Centre Social Elikya
13è Rue – BP 482
KINSHASA – LIMETE
Tél : 0998231693
bdomkinshasardc@yahoo.fr
Le Médecin Directeur

Kinshasa, le 14/01/2021

N° Réf : ..576.. /01 /2021/MD

Re : Permission to conduct resaecrh at Kinshasa Primary HealthCare Network

To Dr Jean-Pierre FINA LUBAKI

After having reviewed the research protocol of your study which title is "Developing a framework to improve glycaemic control among patients with type 2 diabetes in Kinshasa, Democratic Republic of the Congo" and considering the importance of the glycaemic control in our setting, we accept that this research be conducted in the network of our healthcare structures. We stress here that no form of data collection can be undertaken until the research has been approved by ethics committees as listed in the research protocol. We would be grateful to the researcher team to have the results this research once these will be published.

Regards,

Dr Joséphine NKOY BELILA
Médecin Directeur du BDOM

ARCHIDIOCESE DE KINSHASA
ASBL
BUREAU DES OEUVRES MEDICALES
13 ème RUE LIMETE B.P. 482

Appendix 9: Authorisation form the Salvation Army

SALVATION ARMY
William Booth, Founder

Medical service
B.P. 8636 Kinshasa
Colonel Ebeya n ° 23 / Gombe
Rep. Week From Congo
Phone: (+243) 15 14 50 06
kinshasa.medical@kin.salvationarmy.org

Brian PEDDLE
General
Lucien LAMARTINIERE
Territory Manager

INTERNSHIP / RESEARCH AUTHORIZATION

I, the undersigned **TUMU CLEMENTINE**

Hereby authorizes Sir. Madam. Miss **FINA LUBAKI**

To do the internship / The search for **the P.E.C of diabetes**

at the health center, Hospital Center, Dental / Maternity Clinic, at the Diabetic Clinic .....

....., from **April 1st, 021** to **April 30th, 021**

Done in Kinshasa, on February 2nd, 2021

for Technical coordination
TUMU Clémentine

DEVELOP A FRAMEWORK TO IMPROVE GLYCAEMIC CONTROL AMONG PATIENTS WITH TYPE 2 DIABETES MELLITUS IN KINSHASA, DEMOCRATIC REPUBLIC OF CONGO

Certification of Translation
Hereby certify that the foregoing is a true and accurate translation from French into English of the Original Text.

Divine BATUKISA Albert
Bilingual Assistant of the Master's Cohort
PROTESTANT UNIVERSITY OF CONGO
Phone number: (+243) 82 34638 38 81 853 92 85
Email: divine.batukisa@protestant.cg

Appenidx 10: Plagiarism declaration

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

FACULTY OF HEALTH SCIENCES

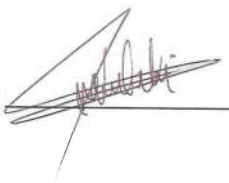
PLAGIARISM DECLARATION TO BE SIGNED BY ALL HIGHER DEGREE STUDENTS

SENATE PLAGIARISM POLICY: APPENDIX ONE

I JEAN-PIERRE FINJA LUBAKI (Student number: 2136297) am a student registered for the degree of PHD IN FAMILY MEDICINE in the academic year 2023.

I hereby declare the following:

- I am aware that plagiarism (the use of someone else's work without their permission and/or without acknowledging the original source) is wrong.
- I confirm that the work submitted for assessment for the above degree is my own unaided work except where I have explicitly indicated otherwise.
- I have followed the required conventions in referencing the thoughts and ideas of others.
- I understand that the University of the Witwatersrand may take disciplinary action against me if there is a belief that this is not my own unaided work or that I have failed to acknowledge the source of the ideas or words in my writing.
- I have included as an appendix a report from "Turnitin" (or other approved plagiarism detection) software indicating the level of plagiarism in my research document.

Signature:  Date: 20/07/2023

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Appendix 11: Letter to support similarity index

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

DEPARTMENT OF FAMILY MEDICINE AND PRIMARY CARE

15 November 2023

Chair: Faculty Graduate Studies Committee

FACULTY OF HEALTH SCIENCES

Dear Chairperson,

Re: Similarity Index of the PhD thesis by FINA LUBAKI Jean-Pierre (Student number: 2136297)

This letter serves to confirm that I have evaluated the **Similarity Index** of the above-named student PhD thesis that is being submitted for re-examination. I confirm that the similarity index is high due to published papers and pre-prints from his work including the PhD protocol. All his papers are published as journal articles or preprints.

Thank you so much for your consideration.

Yours faithfully,

Joel Francis

Joel Francis, MD, MS, PhD

Senior Researcher

Room 432, PVT Health Sciences Building, 29 Princess of Wales Road, Parktown 2193 South Africa,
T: 0117172159 E: Joel.Francis@wits.ac.za

Appendix 12: Turn-it-in report

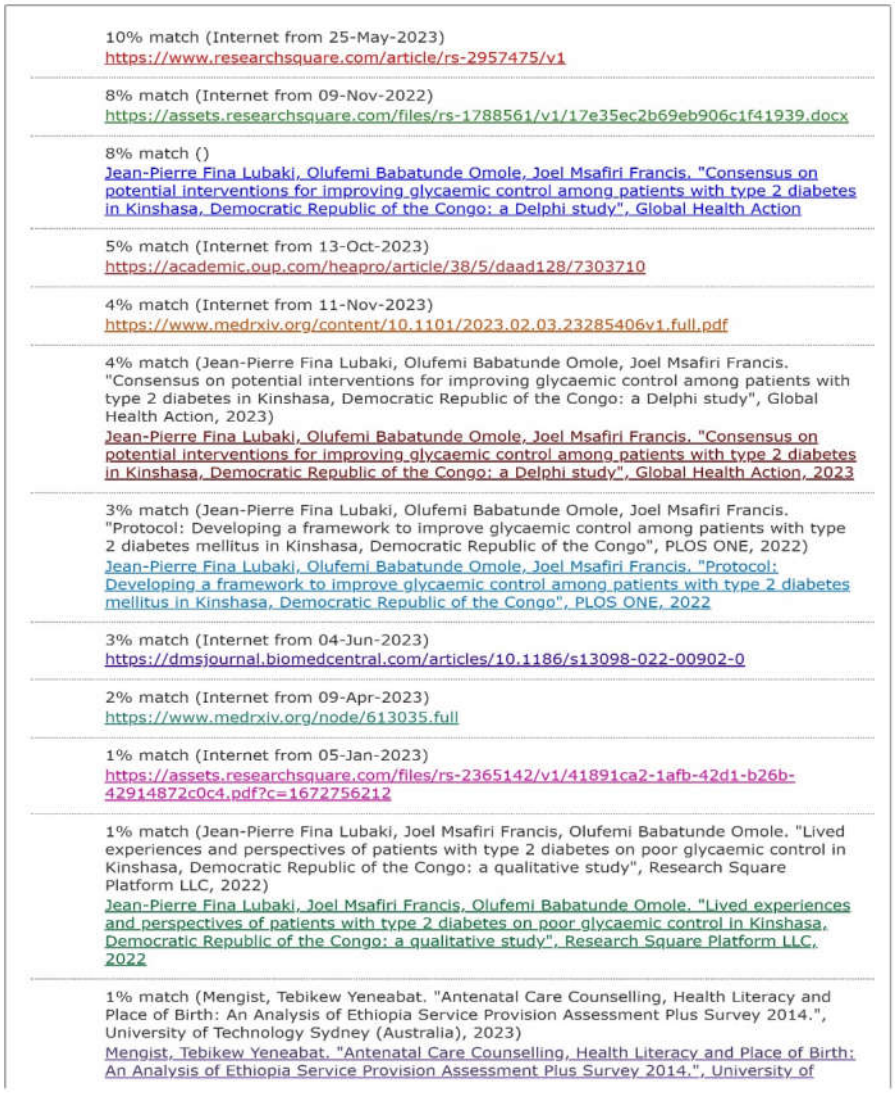


Turnitin Originality Report

Processed on: 15-Nov-2023 9:31 AM SAST
ID: 2228825320
Word Count: 63618
Submitted: 1

Fina Thesis 15 November 2023.docx
By Jean-pierre Fina Lubaki

Similarity Index	Similarity by Source	
57%	Internet Sources:	48%
	Publications:	52%
	Student Papers:	6%



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8% match ()
Jean-Pierre Fina Lubaki, Olufemi Babatunde Omole, Joel Msafiri Francis. "Consensus on potential interventions for improving glycaemic control among patients with type 2 diabetes in Kinshasa, Democratic Republic of the Congo: a Delphi study", Global Health Action

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