Impact of COVID-19 on diabetes mellitus outcomes and care in sub-Saharan Africa: A scoping review.

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Abstract

Background

The COVID-19 pandemic impacted diabetes mellitus clinical outcomes and chronic care globally. However, little is known about its impact in low-resource settings such as sub-Saharan Africa. Hence, to address this, we systematically conducted a scoping review to explore the COVID-19 impact on diabetes outcomes and care in countries of sub-Saharan Africa.

Methods

We applied our search strategy to PubMed, Web of Science, CINAHL, African Index Medicus, Google Scholar, Cochrane Library, Scopus, Science Direct, ERIC and Embase to obtain relevant articles published from January 2020 to March 2023. Two independent reviewers were involved in the screening of retrieved articles. Data from eligible articles were extracted from quantitative, qualitative and mixed methods studies. Numerical data were summarised using descriptive statistics, while a thematic framework was used to categorise and identify themes for qualitative data.

Results

We found 42 of the retrieved 360 articles eligible, mainly from South Africa, Ethiopia and Ghana (73.4%). COVID-19 increased the risk of death (OR 1.30 – 9.0, 95% CI), hospitalisation (OR 3.30 – 3.73: 95% CI), and severity (OR: 1.30-4.05, 95% CI) in persons with diabetes mellitus. COVID-19 also increased the risk of developing diabetes mellitus in hospitalised cases. The pandemic, on the other hand, was associated with disruptions in patient self-management routine and diabetes mellitus care service delivery. Three major themes emerged, namely, (i) patient-related health management challenges, (ii) diabetes mellitus care service delivery challenges, and (iii) reorganisation of diabetes mellitus care delivery.

Conclusion

COVID-19 increased mortality and morbidity among people living with diabetes mellitus. In addition, the COVID-19 pandemic worsened diabetes mellitus care management. Sub-Saharan African countries should, therefore, institute appropriate policy considerations for persons with diabetes mellitus during widespread emergencies.

Introduction

Global evidence suggests that the coronavirus disease 2019 (COVID-19) resulted in a worldwide surge in mortality, morbidity, and disability, which predominantly occurred among older adults and individuals with chronic disease conditions [1,2]. COVID-19 has been reported to worsen diabetes mellitus (DM) clinical outcomes in particular, and DM care in general generally [3–8]. However, very little in this context is known in low- and middle-income countries, particularly in sub-Saharan Africa (SSA).

While SSA is estimated to be host to 24 million of the estimated 537 million people with DM globally, the region records the highest rate of DM-related premature mortality [9]. Furthermore, SSA is predicted to experience the highest rate of rise in DM prevalence than any other region by 2040, depicting the magnitude of a growing threat [9]. DM is an under-researched area in SSA, which may underlie the limited understanding of the scale of the COVID-19 impact on persons living with DM (PLWD) and related vulnerabilities within the region. To address this gap, we carried out a scoping review to assimilate knowledge in this area that supports evidence-based policy consideration and stimulates future research in this field in SSA.

We, therefore systematically conducted a scoping review of published qualitative, quantitative and mixed methods literature to explore the COVID-19 impact on DM outcomes and care in SSA. Our scoping review aimed to: (i) identify and characterise impact of COVID-19 infection on clinical outcomes of DM; (ii) describe DM care aspects that were impacted by the COVID-19 pandemic; and (iii) identify existing gaps in knowledge and research.

Methods

Study design

We report our scoping review in line with the Preferred Reporting Items for Systematic Reviews and Meta-analyses extension for Scoping Reviews (PRISMA-ScR) (S1 PRISMA-ScR Checklist). The initial protocol for this scoping review is reposited with Open Science Framework [https://doi.org/10.17605/OSF.IO/9JCKF].

Data sources and search strategy

We searched ten electronic databases, i.e., PubMed, Web of Science, Cumulative Index to Nursing and Allied Health Literature (CINAHL), African Index Medicus, Google Scholar, Cochrane Library, Scopus, Science Direct, Education Resource Information Centre (ERIC) and Embase. We defined our search strategy guided by the SPIDER (Sample population, Phenomenon of Interest, Design, Evaluation and Research type) framework as outlined by Cooke et al. [10] to identify relevant literature from qualitative and mixed methods studies. Additionally, to capture relevant literature from quantitative studies, we enriched our search strategy by incorporating appropriate elements of the PICO (Population, Intervention, Comparison and Outcome) framework [11]. The detailed search strategy applied to all citation databases with their respective search strings is provided as supplementary material (S2 Search strategy). A search across all databases was initially conducted in May 2022 and later updated using the same search strategy in March 2023 to include any relevant records published between the two periods. This also opened up possibilities for including studies with data on various 'waves' of COVID-19 infection and emerging interventions as the pandemic progressed. All retrieved records were merged into a single MS® Excel file for subsequent removal of duplicate records and screening.

Selection criteria

The retrieved records were screened for eligibility through two stages, i.e., an initial review of article title and abstract and a subsequent full-text review of articles to be considered in final inclusion. An initial screening for the title and abstract was independently conducted by WS and AMG and reviewed by SB, who also resolved any disagreements in screening decisions. The same approach was applied for full-text screening. We defined agreement as a matching decision independently held by the reviewers involved in the screening process.

The inclusion criteria were (i) articles from any country listed under SSA by the World Bank in 2021 [12], (ii) articles focusing on or concerning DM and COVID-19, (ii) peer-reviewed articles and reports and (iv) published from 01 January 2020 – 22 March 2023. The exclusion criteria were (i) no full-text availability, (ii) articles not published in the English language, (iii) non-human studies, (iv) reviews, (v) articles with irrelevant scope, (vi) duplicate articles, and (vii) articles published as multicountry studies involving countries outside SSA but without disaggregation of country-specific data (Fig 1).

Data extraction and management

Data variables of interest from the selected articles were extracted and charted in the extraction form. The data extraction form was developed by WS and reviewed by AMG, SB, and SM. It was then tested with two randomly selected articles from each set of quantitative, qualitative, and mixed methods studies for appropriateness. Appropriate revisions were made and continuously refined and updated throughout the data extraction process. Data extraction and charting were conducted by WS and independently reviewed by AMG and SB during the extraction and charting phase.

Data synthesis

We used an inductive thematic approach to synthesise and collate findings of qualitative and mixed-methods studies and open-ended results of quantitative studies.

We used SPSS® version 27.0 (IBM Corp, Armonk: New York) to summarise findings from quantitative studies as mean (SD), range (minimum and maximum), proportions and frequencies, where appropriate. Due to the variability in methodological designs of interventions and outcome measures across studies, a meta-analysis was not performed.

Results

Selection and characteristics of included studies

A total of 360 unique records were retrieved from database searches, 42 of which were eligible for final inclusion (Fig 1). Inter-reviewer reliability analysis using the Cohen's kappa showed substantial agreement between reviewers at title and abstract screening (k=0.626, $p<0.01$), and moderate agreement at full-text screening (k=0.545, $p<0.01$). The detailed description of information of the included studies is shown in Table 1.

The included studies were all observational but dominated by cross-sectional design (69%), with sample sizes ranging from 18 [13] to 3,460,932 [14]. The studies were predominantly retrospective (66.7%) and published between 2021 and 2022 (85.7%). The majority originated in South Africa (40.5%) and were mainly hospital-based (83.3%) and employed quantitative methods (90.4%). The extracted data variables were, DM prevalence among COVID-19 cases, outcomes of DM related to COVID-19 and their predictors, patient-related health management aspects, DM care service delivery aspects, and organisation of DM care related to the pandemic.

130 Table 1: extraction of data from included studies.

Study	Study design	Location and period (study timeline)	Sample	Phenomenon studied/intervention	Evaluation / outcome	Key findings
Mash RJ, et al. [15]	Observational cross-sectional study	rural & urban district hospitals, South Africa March 2020 - June 2020 (Retrospective)	1,376 patients admitted with COVID-19	▪ Prevalence of comorbidities ▪ Predictors of mortality and length of hospitalisation	▪ Proportion ▪ Odds ratio	▪ 1. 25.2% had diabetes (20.3% among rural) ▪ Type 2 diabetes (AOR 1.84, 1.24 - 2.73, 95%CI) was independently associated with a higher risk of death. ▪ 73.2% (n=272) had uncontrolled diabetes (HbA1c>8%), 78.6% from rural hospitals
Dave JA, et al. [16]	Observational cohort	rural & urban district hospitals, western Cape, South Africa March 2020 - July 2020 (Retrospective)	9,305 persons with diabetes diagnosed with COVID-19	▪ Prevalence of new-onset diabetes ▪ Predictors of hospitalization and death	▪ Proportion ▪ Odds ratio	▪ 11.3% of the diabetes cases were newly diagnosed during the COVID-19 episode. ▪ Diabetes had a high risk for COVID-19 hospital admission (OR:3.73, 95%CI 3.53,3.94) and mortality (OR:3.01,95%CI: 2.76,3.28) ▪ Insulin use was associated with increased risk for hospitalisation (OR:1.39, 95% CI:1.24,1.57) and mortality (OR:1.49, 95% CI:1.27,1.74) ▪ Metformin was associated with reduced risk for hospitalisation (OR 0.662, 95% CI:0.55,0.71) and mortality (OR 0.77, 95% CI:0.64;0.92) ▪ Being male increased risk of COVID-

						19 hospitalisation (OR 1.41, 95%CI: 1.29,1.54) and mortality (OR 1.70, 95%CI: 1.51, 1.92) ▪ Age per 5-year interval was associated with increased risk of COVID-19 hospitalisation (OR 1.15, 95%CI: 1.13,1.17) and mortality (OR 1.33, 95%CI: 1.30,1.37)
Van Hoving DJ, et al. [17]	Observational Cohort	Rural and urban hospitals in South Africa April 2020 - June 2020 (Retrospective)	261 hospitalised patients admitted for COVID-19 investigation	▪ Prevalence of comorbidities ▪ Proportion of deaths among persons with diabetes	▪ Proportion	▪ Diabetes (19.2%) was among the common comorbidities in the admitted patients. ▪ 37.5% of deaths occurred in persons with diabetes
Ratshikhopha E. et al. [18]	Observational cross-sectional study	Urban hospitals, South Africa March 2020 - December 2021 (Retrospective)	10,149 health workers	▪ Prevalence of comorbidities ▪ Predictors of COVID-19 severity	▪ Proportion ▪ Odds ratio	▪ 27.6% of COVID-19 cases had diabetes. ▪ comorbid diabetes (aOR: 1.3, 95%CI 1.2-1.5) was associated with a higher risk for disease severity.
Claassen N, et al. [19]	Observational cross-sectional study	Urban hospital in Cape Town, South Africa April 2020 - August 2020	568 admitted patients with confirmed SARS-CoV2	▪ characteristics of survivors and deceased COVID-19 hospitalised patients ▪ predictors of death	▪ Proportion ▪ Odds ratio	▪ 51% of deaths occurred in patients with diabetes. ▪ Diabetes was associated with a higher risk of death (OR 2.7, 95% CI: 1.8 - 3.9) ▪ 19% of deaths in patients with diabetes were new onset
Abraha HE, et al. [20]	Observational cohort	rural and urban hospitals in Northern Ethiopia May 2020 -	2,617 RT-PCR positive COVID-19 admitted patients	▪ Characteristics of COVID-19 cases ▪ Predictors of mortality	▪ Proportion ▪ Relative risk	▪ 3.1% of all cases and 18.4% of severe cases had comorbid diabetes. ▪ Diabetes was associated with higher in-hospital mortality among COVID-19 patients (uRR: 7.73, 95% CI:

		October 2020 (Retrospective)				2.58-23.12
Kaswa R, et al. [21]	Observational cross-sectional study	Rural hospital, Eastern Cape South Africa March 2020 - July 2020 (Retrospective)	242 Hospitalised adult (>=18years) with laboratory-confirmed COVID-19	▪ Characteristics of clinical outcomes	▪ Proportion of comorbidity	▪ Diabetes occurred in 36.8% of the cases ▪ Diabetes was the commonest comorbidity associated with higher mortality
Mbarga NF, et al. [22]	Observational cohort	Urban hospitals in Cameroon April 2020 - July 2020 (Prospective)	313 Patients admitted with suspected or confirmed COVID-19	▪ Clinical characteristics of cases ▪ Predictors of COVID-19 severity	▪ Proportion ▪ Odds ratio	▪ 5.8% of cases had diabetes ▪ Diabetes was associated with increased COVID-19 severity (OR: 4.05, 95% CI 1.12,14.15; *p=0.01*)
Kwaghe VG, et al. [23]	Observational cross-sectional study	Urban hospital in Abuja, Nigeria March 2020 June 2020 (Retrospective)	200 admitted COVID-19 patients	▪ Characteristics of cases	▪ Proportion	▪ 18.5% of the cases had diabetes
Leulseged TW, et al. [24]	Observational case-control	Urban hospital in Ethiopia June 2020 - September 2020 (Retrospective)	COVID-19 admitted patients Case =49 (death) Controls = 98 (recovered)	▪ Predictors of clinical outcomes	▪ Proportion ▪ Odds ratio	▪ Having diabetes was associated with higher death outcomes than those with no diabetes (53.3% vs 46.7%, *p=0.001*) ▪ Diabetes patients exhibited higher odds of dying compared to those with no diabetes (AOR:3.26, 95% CI:1.35,7.87), *p=<0.01*.

Brey Z, et al. [25]	Observational cross-sectional study	Urban community setting in Cape Town, South Africa (Retrospective)	2,500 community health workers	▪ Home delivery of medication for chronic disease patients	▪ Effectiveness ▪ Challenges and threats	▪ 46.2% of the delivery target was achieved ▪ The intervention was affected by incomplete, outdated and missing patient records and failure to reach registered phone contacts. ▪ Perceived opportunities were improved relationships of community health workers with linkage facilities and improved risk factor tracking. ▪ Perceived threats were stigma associated with home delivery
Abate HK, et al. [26]	Observational cross-sectional study	Rural and urban hospitals in Ethiopia August 2020 - September 2020 (Prospective)	576 adult type 2 diabetes patients	▪ Predictors of adherence to exercise recommendations	▪ Proportion ▪ Odds ratio	▪ 26.4% only adhered to physical exercise recommendations. ▪ Rural residence was associated with higher odds of adherence to physical exercise recommendations (AOR: 1.95, 95% CI: 1.16,3.27, $p<0.05$) ▪ Being female was associated with higher odds of physical exercise adherence (AOR: 1.86, 95%CI, 1.27-2.72, $p<0.01$)
Bepouka BI, et al. [27]	Observational cohort	Urban hospital in Kinshasa, Democratic Republic of Congo March 2020 - June 2020 (Retrospective)	141 hospitalised patients with RT-PCR confirmed COVID-19	▪ Characteristics of cases ▪ Predictors of survival and mortality	▪ Proportion ▪ Survival rate	▪ 17% of COVID-19 hospitalised patients had diabetes. ▪ Patients with diabetes had reduced COVID-19 survival, $p=0.015$

Boulle, et al. [14]	Observational cohort	Rural and urban hospitals in West Cape Province, South Africa March 2020 - June 2020 (Retrospective)	3,460,932 patients with PCR-confirmed COVID-19	▪ Predictors of COVID-19 death	▪ Hazard ratio	▪ Diabetes was associated with COVID-19 death with the risk of death increasing with higher HbA1c values: <7% (HR 1.44, 95% CI: 1.06-1.96, *p=0.02*), 7%<9% (HR 1.81, CI:1.39-2.35, *p<0.001*), ≥9% (HR 1.60, CI: 1.27-2.0, *p<0.001*) all vs those without diabetes.
Poaty H, et al. [28]	Observational cross-sectional study	Urban hospital in The Congo March 2020 - August 2020 (Retrospective)	30 patients with pre-existing diabetes infected with SARS-CoV-2	▪ Characteristics of COVID-19 death	▪ Proportion	▪ Diabetes patients with COVID-19 had a mortality rate of 36.7%
Ikram AS & Pillay S. [29]	Observational cohort	Urban hospital in KwaZulu Natal, South Africa June 2020 - September 2020 (Retrospective)	236 hospitalised patients >13years with laboratory-confirmed SARS-CoV 2 infection	▪ Predictors of mortality	▪ Proportion ▪ Odds ratio	▪ 50% of those admitted with hyperglycaemia having no history of diabetes died ▪ 26.6% of those living with diabetes (pre-existing or newly diagnosed) died. ▪ patients presenting with admission hyperglycaemia had higher odds of death (OR:4.24, 95%CI:1.12-16) ▪ Patients with diabetes had higher odds of dying compared to those with diabetes (OR: 1.97, 95% CI:0.99-3.89)
Leulseged TW, et al. [30]	Observational cross-sectional study	Urban hospital in Ethiopia June 2020 - August 2020	686 patients admitted with RT-PCR confirmed diagnosis of	▪ Characteristics of cases ▪ Predictors of COVID-19 severity	▪ Proportion ▪ Odds ratio	▪ 16.6% of cases had diabetes. ▪ Diabetes had higher odds of COVID-19 severity than those who had no diabetes (AOR: 3.93, 95% CI:

		(Prospective)	COVID-19			1.96,7.85) ▪ 29.9% of the severe cases had diabetes
Leulseged TW., et al. [31]	Observational cohort	Rural and urban hospitals in Ethiopia July 2020 - September 2020 (Prospective)	1,345 patients admitted with RT-PCR confirmed COVID-19	▪ Characteristics of cases ▪ Predictors of recovery	▪ Proportion ▪ Odds ratio	▪ 13.7% of cases had diabetes. ▪ Diabetes had a higher median duration of recovery (15 days) than those with no diabetes. ▪ Having diabetes was associated with 45.1% (p=0.005) lower odds of achieving clinical recovery compared to those without diabetes (AOR=0.549, 95% CI:0.337,0.894; p=<0.05).
Adjei P, et al. [32]	Observational cross-sectional study	Urban hospital in Accra, Ghana April 2020 - June 2020 (Retrospective)	50 hospital-admitted COVID-19 diagnosed patients	▪ Clinical characteristics	▪ Proportion	▪ 42% of cases had diabetes. ▪ 90.5% of those with complications had diabetes. ▪ 23.8% of those with diabetes died
van der Westhuizen JN, et al. [33]	Observational cross-sectional study	Rural hospital in Western Cape Province, South Africa June 2020 August 2020 (Retrospective)	1,447 patients admitted with confirmed COVID-19 and pre-existing or newly diagnosed diabetes	▪ Characteristics of cases ▪ Predictors of death	▪ Proportion ▪ Odds ratio	▪ 86.5% had HbA1c >7%, median (IQR): 10% (8-12%). ▪ Being male (OR=2.05, 95%CI=1.07,3.93) and on insulin (OR=2.25, 95% CI=1.05,4.85) was associated with higher odds of death
Delobelle AP, et al. [34]	Observational cross-sectional study	Urban primary settings in South Africa	Facility workers = 09 Community-	▪ Appraisal of care and management	▪ Impact	▪ Cancellation of routine non-communicable disease clinic services and chronic patient 'clubs'

		October 2020 - November 2020 (Prospective)	based workers = 11 Patient with type 2 diabetes and other NCD = 08			▪ Reduced availability of healthcare workforce ▪ Introduction of clinic booking for clinics that improved clinic congestion. ▪ Home delivery of medication using community health workers was adopted to decongest health facilities. ▪ Improved performance of community health workforce ▪ Patient stigma associated with patient home visits and deliveries. ▪ General increase in workload among the health workforce. ▪ General decrease in the number of NCD patients visiting the facility compared with prior to COVID-19 period. ▪ Higher proportion of patients with uncontrolled diabetes.
Crankson S, et al. [35]	Observational cross-sectional study	Urban hospital in Ghana March 2020 - August 2021 (Retrospective)	2,334 PCR confirmed COVID-19 patients	▪ Characteristics of cases ▪ Predictors of long COVID and hospitalisation	▪ Proportion ▪ Correlation	▪ Comorbid diabetes occurred in 2% of patients ▪ Long COVID occurred in 4.3% of persons with diabetes ▪ Diabetes was associated with longer LOS (B=1.37, 95% CI=0.99-1.88, p <0.05)
Ephraim RKD, et al. [36]	Observational cross-sectional study	Rural and urban hospitals in Cape Coast, Ghana	157 diabetes patients aged 20 years and	▪ Characteristics of cases	▪ Proportion	▪ 57.3% of patients had known complications including retinopathy (36.3%) ▪ Family, friends and close relatives

		June 2020 - September 2020 (Prospective)	over			were the popular form of social support (79.6%) for diabetes patients, followed by diabetes teams (61.2%) fellow patients with diabetes (61.2%), social media (56.7%) and work/school mates (52.9%) ▪ Reduced frequency of meals was reported in 42% of the patients
Habineza JC, et al. [37]	Observational cross-sectional study	Rural and urban communities in Rwanda June 2020 - September 2020 (Prospective)	52 young adults with type 1 diabetes	▪ Pandemic experiences and challenges ▪ Coping mechanisms	▪ Proportion ▪ Experiences	▪ 80.8% reported a drop in family income; 57.7% reported a reduction in meal frequency; 43.1% reported reduced physical activity ▪ Hypoglycaemia was the major acute complication (87.5%) ▪ Access to diabetes management supplies during the COVID-19 pandemic did not significantly differ from pre-COVID-19. ▪ 81.8% increase in patients accessing healthcare by foot.
Baguma S, et al. [38]	Observational cohort	Urban Hospital in Northern Uganda March 2020 - October 2021 (Retrospective)	664 hospitalised patients with confirmed COVID-19	▪ Characteristics of cases ▪ Predictors of mortality	▪ Proportion ▪ Odds ratio	▪ 34.4% of deaths occurred in patients with diabetes. ▪ Diabetes was associated with higher odds of death compared to those who had no diabetes (AOR=9.014, 95% CI=1.726 - 47.067)
Iroungou BA, et al. [39]	Observational cross-sectional study	Urban hospital in Lebreville, Gabon March 2020 - June 2020	837 COVID-19 hospitalised patients	▪ Characteristics of severe COVID-19	▪ Proportion	▪ 16.1% patients with a history of diabetes had severe COVID-19

		(Retrospective)				
Awucha NE, et al. [40]	Observational cross-sectional study	Rural and urban community settings in Nigeria May 2020 - June 2020 (Prospective)	374 persons aged 15 years and older	▪ Impact on essential medicine access	▪ Proportion	▪ 28.1% had a known history of diabetes ▪ The proportion of patients with difficulty in accessing essential medicines during the COVID-19 pandemic was significantly higher than before the pandemic (29.6% vs 5.6%, p<0.001) ▪ 52.2% decrease in hospital visits for medicines
Kaswa RP. & Meel B. [41]	Observational cross-sectional study	Urban hospital in Eastern Cape, South Africa July 2020 - January 2021 (Retrospective)	100 patients who died of COVID-19	▪ Characteristics of COVID-19 deaths	▪ Proportion	▪ 37% of patients had diabetes
Usui R, Kanamori S, Aomori M. & Watabe S. [42]	Observational cross-sectional study	Rural and urban hospitals in Cote d'Ivoire March 2020 - July 2020 (Retrospective)	67 COVID-19 infected persons	▪ Comorbidities associated with COVID-19 deaths	▪ Proportion	▪ 45% of COVID-19 deaths occurred in patients with diabetes
Tagoe ET, Nonvignon J, van Der Meer R,	Observational cross-sectional study	Rural and urban hospitals in Ghana November 2020 - February 2021	18 healthcare professionals and health facility administrato	▪ COVID-19 impact on diabetes service delivery	▪ Impact	Themes: ▪ high medicine and service costs and medicine shortages (disruption in supply chain, rationing, increased pricing of medicines)

Megiddo I, & Godman B. [13]		(Prospective)	rs			▪ poor patient information management (substandard anthropometric procedures, increase in records with missing data, misplacement of patient record files) ▪ few trained healthcare providers (COVID-19 treatment prioritisation, patient rejection of referrals, high patient load) ▪ low healthcare provider motivation (unsupportive management) ▪ service organisation challenges (extended patient reviews, clinic overcrowding, increased clinic waiting times) ▪ national health policy-related concerns (policy restrictions could not allow flexibility in planning and cost sharing)
Sikhosana LM, Jassat W & Makatini Z. [43]	Observational cross-sectional study	Rural and urban hospitals in Gauteng, South Africa March 2020 - March 2021 (Retrospective)	1,861 SARS CoV 2 admitted patients	▪ characteristics of cases	▪ Proportion	▪ 21.6% of cases had diabetes
Elijah MI, et al. [44]	Observational cohort	Rural and urban hospitals in Kenya March 2020 - April 2021 (Retrospective)	1,792 admitted COVID-19 patients	▪ Predictors of hospitalisation and survival ▪ Prevalence of diabetes comorbidity	▪ Proportion ▪ Odds ratio	▪ 5.4% cases had diabetes ▪ Diabetes was a significant predictor of ICU admissions (aOR: 3.30, 95%CI: 1.94 - 560, p<0.0001) ▪ Diabetes was significantly associated with less survival probability compared to those without diabetes

						(p<0.0001)
Hardy OY, et al. [45]	Observational cross-sectional study	Urban hospital in Ghana March 2020 - October 2020 (Retrospective)	175 adult patients hospitalised with COVID-19	▪ Prevalence of comorbid diabetes ▪ Predictors of hospitalisation	▪ Proportion ▪ Correlation	▪ 36.6% patients had type 2 diabetes ▪ No significant difference in COVID-19 severity and duration of hospitalisation between patients with diabetes and those without
Huluka KD, et al. [46]	Observational cross-sectional study	Urban hospital in Addis Ababa, Ethiopia March 2020 - September 2020 (Retrospective)	463 SARS CoV-2 positive patients aged ≥18	▪ Clinical characteristics of cases	▪ Proportion	▪ 20.7% of cases had diabetes. ▪ 33.1 % of those who experienced severe COVID-19 had diabetes. ▪ 35.8% of COVID-19 deaths had diabetes
Nyasulu SP, et al. [47]	Observational cross-sectional study	Urban hospital in South Africa March 2020 - November 2020 (Prospective)	413 ICU admitted COVID-19 patients aged ≥18	▪ Characteristics of cases and outcomes	▪ Proportion	▪ 51% of patients had comorbid diabetes. ▪ 66% of patients with comorbid diabetes died
Solanki G, et al. [48]	Observational cross-sectional study	Rural and urban communities in South Africa March 2020 - June 2021 (Retrospective)	188,292 private health insurance patients who tested positive for COVID-19	▪ Risk of hospitalisation	▪ Odds ratio	▪ Diabetes was associated with high risk for hospitalisation (OR 3.6; 95% CI 3.27 - 3.94)
Diarra M, et al. [49]	Observational cross-sectional study	Rural and urban hospitals in Senegal	67,608 patients	▪ Clinical characteristics ▪ Predictors of mortality	▪ Proportion ▪ Relative risk	▪ 38.2% of cases had diabetes ▪ Relative risk for COVID-19 mortality was high in persons with comorbid diabetes (aRR=1.31, 95%CI=0.77-

		March 2020 - October 2020 (Prospective)				2.23, *p<0.001*)
Tolossa T, et al. [50]	Observational cohort	Urban hospital western Ethiopia September 2020 - June 2021 (Retrospective)	304 severe COVID-19 hospital-admitted patients	▪ Clinical characteristics ▪ Predictors of onset diabetes	▪ Proportion ▪ Hazard ratio	▪ Incidence of diabetes among patients was 14.5%. ▪ Overall diabetes incidence rate at the end of follow-up (34 days) was 13.7/1,000 person day's observation (95% CI 10.2, 18.4) ▪ Median occurrence of diabetes was 11 days (95% CI: 7, 13) ▪ Risk of developing diabetes increased for the first 20 days and was constant thereafter (Kaplan-Meier survival estimate) ▪ Predictors of Diabetes included older age >41 years (AHR = 2.54, 95% CI: 1.15, 5.57, compared to <25years, p=0.02), residing in urban settings (AHR = 2.49, 95% CI: 1.12, 5.52, compared to rural, p=0.02), being admitted within 48 hours of clinical manifestation compared to >48hours (0.49, 95% CI: 0.23,0.96 ref.≤48hrs, p=0.04)
David JN, et al. [51]	Observational cross-sectional study	Rural community in South Africa September 2020 - December 2020 (Prospective)	544 type 2 diabetes patients attending routine care	▪ Home delivery of medicines	▪ Impact of home delivery	▪ overall, HDM resulted in 0.46% reduction in HbA1c compared to non-HDM (p<0.01) ▪ Patients perceived HDM as timesaving. ▪ Patients perceived HDM as reducing exposure to coronavirus infection

Sane HA, et al. [52]	Observational cross-sectional study	Urban hospitals in Addis Ababa, Ethiopia September 2020 - September 2021 (Retrospective)	244 COVID-19-admitted patients with diagnosed diabetes	▪ Prevalence of new-onset diabetes ▪ Predictors of new-onset diabetes	▪ Proportion ▪ Odds ratio	▪ 31.1% of COVID-19 patients had onset Diabetes (95% CI: 25.4, 37.4) ▪ Males were more likely to develop new onset diabetes than females (aOR=2.9, 95%CI:1.2,7.1, p=0.018)
Jassat W, et al. [53]	Observational cross-sectional study	Rural and urban hospital in South Africa November 2020 - June 2021 (Prospective)	3,217 COVID-19 hospitalised patients	▪ Prevalence of diabetes	▪ Proportion	▪ 26.6% had self-reported diabetes ▪ 7.3% of diabetes case were new diagnoses
Mengist B, Animut Z & Tolossa T. [54]	Observational cohort	Rural and urban hospitals in Northwest Ethiopia March 2020 - March 2021 (Retrospective)	552 COVID-19 hospitalised patients	▪ Prevalence of diabetes ▪ Predictors of mortality	▪ Proportion ▪ Hazard ratio	▪ 4% of patients had comorbid diabetes. ▪ patients with diabetes had 8 times higher hazard mortality than those without diabetes (AHR: 8.1, 95% Ci:2.9, 22.4, *p<0.001*)

Prevalence and incidence of DM among COVID-19 cases

As shown in Table 2, comorbidity of DM and COVID-19 was very prevalent, with up to 51% pre-existing cases reported, and a mean (SD) figure of 23% (±13.8). Prevalence as high as 31.1% was also reported for new-onset DM among COVID-19 hospitalised cases, and a high incidence rate of 37/1,000 person days [50].

Table 2: Studies reporting on different COVID-19 outcome variables.

Outcome variable	Range or value	Study reference
Comorbidity of DM and COVID-19		
Incidence of DM in COVID-19 cases (per 1,000-person day's observation)	13.7	[50]
Prevalence of new-onset DM among COVID-19 cases	7.3% - 31.1%	[16,50,52,53]
Prevalence of DM among COVID-19 cases*	2.0% - 51.0%	[15–18,20–23,30–32,35,38,40,43,45–47,49,53–56]
COVID-19-related outcomes in DM patients		
Proportion of DM deaths attributed to COVID-19	5.3% - 66%	[17,19,24,28,29,32,33,42,46,47]
*DM risk for COVID-19 mortality (odds ratio, 95% CI)***	1.30 – 9.0	[14–16,19,20,24,38,49,54]
Proportion of DM hospitalisation attributed to COVID-19***	17%	[27]
*DM risk for COVID-19 hospitalisation (odds ratio, 95% CI)***	3.30 - 3.73	[16,35,48]
Proportion of DM-related COVID-19 severity	16.1% - 33.1%	[20,30,39,46]
*DM risk for COVID-19 severity (odds ratio, 95% CI)***	1.30 - 4.05	[18,22,30]
Duration of hospitalisation of DM patients with COVID-19	4.7 - 15.0 days	[22,31]
Proportion of PLWD experiencing COVID-19 complications	4.3% - 90.5%	[32,35]
Predictors of COVID-19-related clinical outcomes in DM		
Predictors of COVID-19 mortality in PLWD (odds ratio, 95% CI)		
Age (per 5-year ageing interval)	1.13 - 1.37	[16]
Gender (Male)	1.50 - 2.04	[16,18,33]
Medication (Insulin)	1.49 - 2.25	[16,33]
Glycaemic control (HbA1c≥7%)	1.39 - 1.60	[14]
Predictors of COVID-19 hospitalisation in PLWD (odds ratio, 95% CI)		
Age (per 5-year ageing interval)	1.13 - 1.17	[16]
Gender (Male)	1.29 - 1.54	[16]
Medication (Insulin)	1.24 - 1.57	[16]
Predictors of new-onset DM in COVID-19 patients (odds ratio, 95% CI)		
Age (>41years)	1.15 - 5.57	[50]

Gender (Male)	1.2 - 7.1	[52]
Residence (Urban)	1.12 - 5.52	[50]

*(mean=23% ±13.8%); ** compared to those with no diabetes; *** figure reported from single studies without confidence interval; HbA1c: Glycated Haemoglobin; CI: confidence interval

COVID-19-related outcomes of DM and their predictors

As shown in Table 2, mortality, hospitalisation, severity, and complications were the major outcomes related to COVID-19 in DM. The proportions of COVID-19-attributed mortality [17,19,24,28,29,32,33,42,46,47], hospitalisation [27], and severity [20,30,39,46] for PLWD were noticeable to high across the studies. The major predictors of COVID-19-related mortality and hospitalisation in PLWD were age, gender, DM treatment, and glycaemic control. For every 5-year age interval , being male, insulin treatment and HbA1c ≥7.0% were independently associated with higher odds for both COVID-19-related mortality [14,16,18,33] and hospitalisation [16]. On the other hand, new-onset DM, defined as DM diagnosed in hospitalised COVID-19 patients with prior normoglycaemia, was associated with age over 41 years, male gender and urban residence [50,52].

Impact of the COVID-19 pandemic on DM care

Using an inductive thematic approach, we constructed three major themes from qualitative, mixed methods studies and open-ended quantitative results. The findings were thematically categorised as patient-related health management challenges, DM care service delivery challenges, and reorganisation of DM care delivery (S3 Themes). Table 3 presents a summary of studies that reported on each theme category.

Table 3: Studies reporting COVID-19 pandemic's impact on various aspects of DM care management.

Major theme	Sub-theme	Reference
Patient-related health management challenges	Self-management challenges	[15,33,36,37]
	Affordability challenges	[13,37]
	Health service accessibility challenges	[13,37,51]
DM care service delivery	Health workforce challenges	[13,34]

challenges	Healthcare infrastructure challenges	[13]
	Health information challenges	[25]
	Medicines and medical supplies	[13]
Re-organisation of DM care delivery	Patient-level reorganisation of care access	[25,34,51]
	Clinic-level reorganisation of management	[34]
	Community-level re-organisation of community health worker services	[25,34,51]

Patient-related health management challenges

The three sub-themes that emerged under patient-related health management challenges were, self-management challenges, affordability challenges, and health service accessibility challenges. Self-management challenges reported among PLWD during the COVID-19 pandemic include reduced daily meal frequency [36,37], inadequate physical activity [26,37], and worsening glycaemic control [15,33,34]. Affordability challenges were related to increased costs of medicines [13] and reduced individual or household income [37]. PLWD also experienced health service accessibility challenges reported as increased clinic waiting time [13] and limited transport means to healthcare facilities [16,51]. Type 1 DM-specific challenges were limited food access, reduced affordability of living costs and accessibility of DM care services [37].

DM care service delivery challenges

Four sub-themes emerged under DM care delivery challenges, namely, health workforce challenges [13,34], healthcare infrastructure challenges [13,34], health information management challenges [13,25], and medicines and medical supplies [13]. Health workforce challenges were characterised by health workers' hesitancy towards work and the limited number of available DM specialists. This resulted in fewer active health workers at health facilities that increased workload [13,34]. At the same time, inadequate healthcare infrastructure limited available physical clinic space due to overwhelming patient numbers

[13,34]. The COVID-19 pandemic was also characterised by poor management of health information and medical records attributed to the heavy workload of health workers and the fear of the risk of cross-infection while collecting patient data [13,25]. Additionally, the pandemic worsened shortages of medicine and medical supplies at health facilities [13].

Reorganisation of DM care delivery

Four sub-themes, as shown in Table 3, were categorised under the reorganisation of DM care delivery as a result of the pandemic, namely, patient-level reorganisation of care access [25,34,51], clinic-level reorganisation in management [34], and community-level reorganisation of community health worker services [25,34,51]. The reorganisation of DM care delivery was in response to the challenges patients and healthcare facilities faced in accessing and delivering DM care services. The interventions included delivery of patient medicines to their homes through their community health workers [25,34,51], which addressed the risk of infection and mitigated the health facility accessibility challenges faced by patients during lockdowns [34]. At clinic level, routine non-communicable disease 'walk-in' clinics were replaced with a clinic booking system to manage patient appointments and control clinic patient numbers [34]. At the community level, community health workers were empowered to monitor and follow up on patients with non-communicable diseases, including DM, aimed at reducing the workload of health facility staff [25,34,51].

Discussion

Our scoping review of 42 articles highlighted COVID-19's impact on DM outcomes and care in SSA. It also lays down existing gaps in knowledge and research. To the best of our knowledge, this is the first systematic scoping review in SSA to investigate outcomes of DM with COVID-19 and the pandemic's effect on DM care. Our results show an inequitable representation in DM research in countries of SSA, with research outputs mainly contributed by South Africa.

Overall, our scoping review shows that COVID-19 increased the risk of mortality and hospitalisation in PLWD, which were associated with older age, poor glycaemic control, insulin use and being male. These risk factors have also been reported in the US [57], China [58] and the UK [59]. We observed that PLWD had up to nine times higher risk of death, more than three times higher risk of hospitalisation and up to four times higher risk for severity due to COVID-19 compared to those without DM. Notably, similar findings but with varying levels of mortality and morbidity have been reported in China and the USA by Kumar et al. [60]. They revealed higher odds of COVID-19-related mortality (2.16, 95% CI: 1.74-2.65) and severity (2.75, 95% CI: 2.09-3.62) in PLWD than those without DM. COVID-19's impact on DM clinical outcomes in SSA is significant and consistent with reports from the World Health Organization that indicate COVID-19 is deadlier in PLWD in Africa due to the region's characteristic poor glycaemic control [61,62]. Additionally, COVID-19 was associated with an increased risk of developing new-onset DM, especially among hospitalised COVID cases over 41 years, males and urban residents. We observed a DM incident rate of 13.7/1,000 person-days (the equivalent of 5/1,000 person-years) and a prevalence of new-onset DM of up to 31% among COVID-19 cases in SSA. This rate is, however, considerably lower than what has been reported in the US (23-83/1,000 person-years) [63], England (37.2/1,000 person-years) [64] and China (13.5/1,000 person-years) [65]. Whereas the variation in diabetes incidence among COVID-19 patients in SSA may be due to underreporting, COVID-19's epidemiological threat to the growing burden of DM in SSA needs to be tracked.

As a pandemic, COVID-19 also impacted DM indirectly by causing disruptions in patient self-management routines and delivery of DM services in SSA. As our scoping review highlights, this impact manifested through challenges posed by instituted COVID-19 restrictions. For PLWD, we observe that this negatively affected their dietary intake and engagement in physical activity and limited their access to healthcare. The experience in SSA was however, in marked contrast with reports from India [66] and the UK [67], which showed no notable negative COVID-19 impact on access to essential services among PLWD. This stark variation may be explained by the different countries' approaches to containing COVID-19, which in most SSA countries mainly targeted geographical containment, closure of non-essential services and prohibition of gatherings [68]. These unprecedented approaches created blockades to accessibility and affordability of various services, including health and social services [69–71]. On other grounds, there was a considerable shortage of health workforce, physical infrastructure and severe shortages of DM medicine and medical supplies. Whereas we acknowledge the pre-existence of challenges in the health workforce, healthcare infrastructure and medical supplies in SSA before the COVID-19 pandemic, the magnitude might have worsened during the pandemic due to a shift in healthcare resource prioritisation toward COVID-19 [72][73][74][73,75].

Interestingly, we also observed from our scoping review that the pandemic presented some opportunities for DM care innovation. For instance, the delivery of medicine to patient homes implemented in South Africa reportedly reduced the risk of COVID-19 infection among PLWD, mitigated DM care access challenges and ensured continued chronic patient follow-up [40]. Home delivery of medicine has also been reported to improve treatment adherence among chronic disease patients in Rwanda, which shows its feasibility in other SSA countries [76]. The pandemic, as demonstrated in South Africa, has also evidenced the value of integrating chronic non-communicable disease prevention and care in the services of community health workers. Additionally, clinic booking systems introduced to replace walk-in clinics in public health centres were found to mitigate clinic overcrowding, reduce clinic waiting time, and provide better doctor-to-patient time. These changes in the reorganisation of healthcare service delivery proved vital in addressing many challenges posed by the COVID-19 pandemic and offer lessons to policy and practice in future planning.

Gaps in knowledge and research

In our scoping review, we note various gaps in knowledge that can inform subsequent research. Firstly, there is a gap in the published literature on the use of guidelines for managing COVID-19 and DM in SSA countries, which would help evaluate their appropriateness for future similar occurrences. Secondly, the studies in our scoping review did not report on vaccine uptake or how the different 'waves' of COVID-19 infection influenced COVID-19 outcomes among PLWD. This would provide an understanding of the outcomes of PLWD across evolving pandemic dynamics and health system interventions. Exploiting research opportunities to address such gaps in knowledge can provide further and comprehensive understanding to shape appropriate post-pandemic DM care approaches and health system preparedness in addressing chronic care vulnerabilities during possible future pandemics.

Limitations

While this scoping review provides reliable information by scoping various research types and sources, there are some limitations. Firstly, our scoping review only included articles published in English. This may have limited studies published from non-English speaking countries within SSA; therefore, some relevant studies may have been missed. However, considering what was retrieved from most SSA countries, we predict this number to be likely minimal. Secondly, the included studies were dominated by three countries, which may limit the generalisation of findings to SSA. Thirdly, the studies were mainly conducted in the initial phase of the pandemic in 2020, indicating that changes experienced after that may render some findings unrepresentative of the post-2020 dynamics including the impact of emerging COVID-19 variants. Moreover, the limited disaggregation of data by studies in our scoping review, especially age, gender and type of DM, limited the drawing of specific conclusions and analyses. Finally, we only included peer-reviewed literature, which may have excluded some valuable literature sources such as manuscripts, institutional reports and archives.

Nevertheless, this scoping review provided critical information and insights on how COVID-19 impacted PLWD and healthcare systems in SSA.

Conclusions

COVID-19 increased mortality and morbidity among PLWD and the occurrence of DM. In addition, the pandemic worsened DM self-care and DM service delivery generally. Therefore, further research in SSA is needed to understand the disease syndemism of pandemics such as COVID-19 and DM to inform future management strategies and policy considerations.

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Supporting information

S1 PRISMA-ScR Checklist

S2 Search strategy

S3 Themes

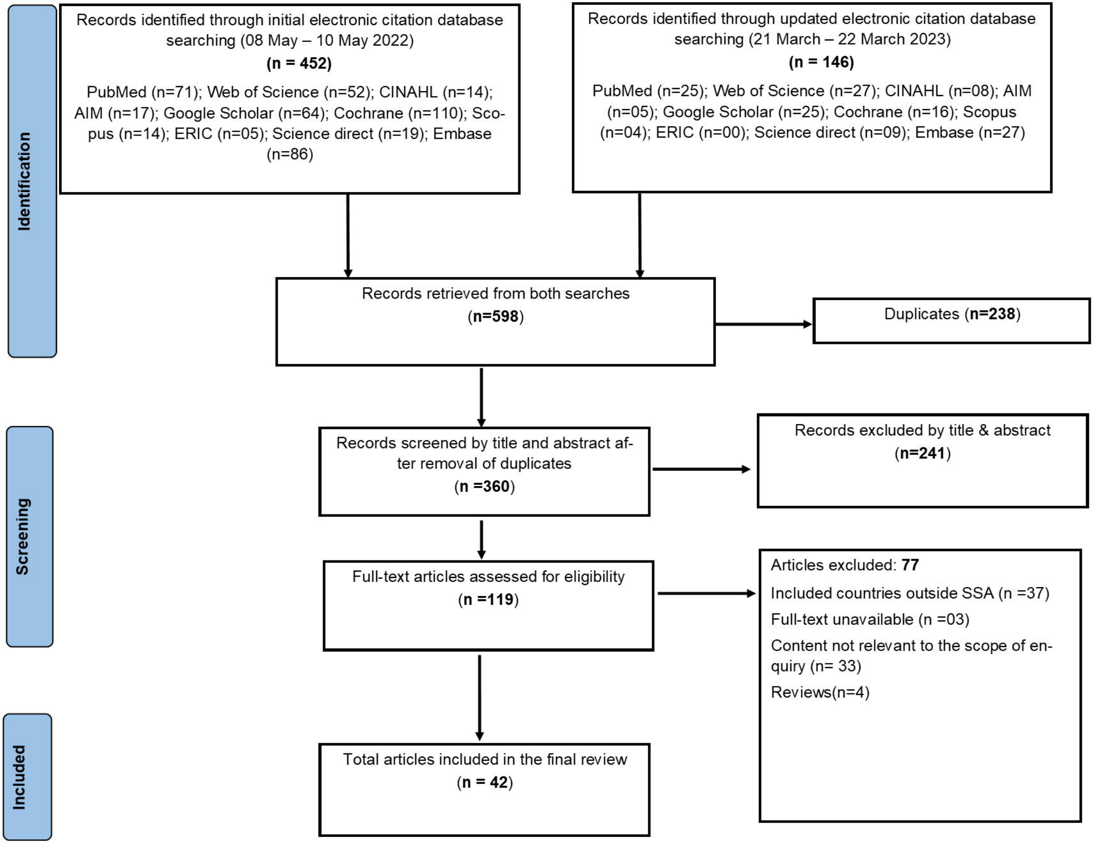

Fig. 1: PRISMA-ScR diagram reporting outcomes of the systematic scoping review process.