# Diabetes in the Cape Town Metropole – a secondary analysis of the diabetes cascade database 2015 - 2020

by

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# Declaration

## Declaration

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# Abstract

Background: Diabetes is the leading cause of death in women in South Africa and one in four South Africans over the age of 45-years have diabetes. The Western Cape (WC) Provincial Health Data Centre has integrated data from multiple sources into a diabetes cascade database. The Director responsible for chronic disease management asked for an analysis of the database.

Aim: The aim of the study was to describe the demographics, comorbidities and outcomes of care for patients with diabetes treated at primary care facilities in the WC between 2015 – 2020.

Methods: This was a secondary analysis of data from the diabetes cascade database. Data was imported into the Statistical package for Social Sciences for analysis.

Results: The database included 116726 patients with a mean age of 61.4 years and 63.8% were female. The mean age at death was 66.0 years. Ninety-eight percent of people lived in the Cape Town Metropole. Co-morbidities included hypertension (69.5%), mental health disorders (16.2%), HIV (6.4%) and previous TB (8.2%). Sixty-three percent of the study population had at least one previous hospital admission and 20.2% of all admissions were attributed to cardiovascular diseases. Coronavirus related admissions were the third highest reason for admission over a 10-year period. Up to 70% of the people were not receiving an annual HbA1c test. The mean value for the last HBA1c taken was 9.0%. Three-quarters (75.5%) of patients had poor glycaemic control (HbA1c >7%) and a third (33.7%) were very poorly controlled (HbA1c≥10%). Glycaemic control was significantly different between sub-districts in Cape Town as well as rural areas. Renal disease was prevalent in 25.5%.

Conclusion: Diabetes is extremely poorly controlled in the province and diabetic related morbidity and mortality are high. There is poor compliance with guidelines for HbA1c and eGFR measurement. At least 7% of diabetic patients are being admitted for diabetic-related complications annually. This is a clear call to action on the care for people with diabetes in the WC.

# Introduction

Sub-Saharan Africa is challenged by an increase in both communicable (e.g. HIV/AIDS, tuberculosis, malaria) and non-communicable diseases (e.g. hypertension, diabetes).[1,2] The rising prevalence of diabetes has been deemed an international crisis with up to 9.3% of the world's adult population afflicted by the disease.[3] Diabetes also accounts for 11.3 % of all deaths in the adult population globally, with 46% of these in working-age adults less than 60 years old. Once considered to be a disease of the affluent, diabetes is becoming increasingly common in low- and middle-income countries. The African population is thought to have a lower prevalence of diabetes at 3.9%, but strained health services result in an estimated 60% of patients remaining undiagnosed.[3] Nevertheless, urbanised populations in Africa have prevalence rates of diabetes more comparable to the rest of the world, between 3 – 10%.[1]

South Africa is one of four countries on the African continent with a higher prevalence of diabetes, of approximately 12.7 – 15.3% in adults .[3,4] Diabetes accounts for high morbidity and mortality and is the second overall leading cause of death and the first cause of death for women.[5] The South African National Health and Nutrition Examination Survey has highlighted the potential of an even higher burden of disease.[6] It is estimated that 45% of the South African population remain unscreened for diabetes and although the public sector has an estimated population of 3.1 million people with T2DM only 240,000 of those currently receive care for the disease.[7] Of great concern, therefore, are the number of patients that remain undiagnosed.[8,9]

The Society for Endocrinology, Metabolism and Diabetes South Africa and the South African National Department of Health (NDOH) provide guidelines for the treatment of diabetes in order to control the disease and prevent microvascular and macrovascular complications.[10,11] Some preventable complications of diabetes include renal disease, retinopathy, peripheral neuropathy, as well as increased cardiovascular risk for myocardial infarct and stroke.[5]

Glycated haemoglobin $A_{1C}$ (HbA1c) is the 'gold standard' test for measuring glucose control in the diabetic patient. The target HbA1c should ideally be < 7.0% in most people, but between 7.1 – 8.5% is acceptable in elderly or frail patients and those with multiple co-morbidities. An ideal HbA1c of < 6.5 is recommended in younger or newly diagnosed patients in good general health as this translates to the lowest risk for complications. Other means of monitoring glucose control include random blood glucose measurements, but unless these results are taken over time, they should not be relied upon to make valid decisions about the control of diabetes.[12] Oral anti-diabetic medication is the mainstay of treatment in the state sector in most patients with Type II disease, but insulin may be needed in patients with HbA1c > 10%.[10,13] Other targets include blood pressure below 140/80 mmHg, total

cholesterol less than 4.5 mmol/L, an estimated glomerular filtration rate (eGFR) above 50ml/min and a body mass index (BMI) below 25kg/m.[2,10] The Western Cape's (WC) Practical Approach to Care Kit (PACK) guideline provides additional parameters for the management and monitoring of diabetic patients in the district health services.[13] These include 3-monthly follow up for uncontrolled patients, 6-monthly routine follow up for those well controlled, and annual investigations such as retinal and foot screening, cholesterol and CVD monitoring. Patients should be offered human immunodeficiency virus (HIV) testing and family planning at every visit.[13] Ideally HbA1c should be measured every year in patients with HbA1c $\leq$ 8%, or every 3 months if > 8% according to PACK guidelines[13]. The eGFR should be measured at diagnosis of diabetes and then annually. Chronic kidney disease is diagnosed if eGFR is <60ml/min, or if urine albumin excretion exceeds ≥30 mg/g for more than 3 months, or both.[10,13,14]

According to Stats SA, diabetes is the leading cause of non-communicable deaths in adults over 45-years in the WC.[5] The Metro Health Services have prioritized the need to improve the quality of care for people with diabetes, since a 2005 audit found deficiencies in the quality of care.[15] Until recently, the Western Cape Department of Health (WCDOH) performed annual audits to measure the quality of care, using an integrated audit tool for non-communicable diseases .[b,16] These audits are guided by the national and provincial guidelines provided in the state sector, namely the Standard Treatment Guidelines, PACK and the DOH Essential Medicines List. [b,13,11] These audits were performed on random systematically sampled files from most of the facilities within each district.

Whilst these audits have been helpful in improving some of the clinical processes in the management of diabetes, analysis of the impact of these audits has highlighted some limitations, including that the audits are performed internally per facility with no external validation and the possibility of reporting bias.[16] Another problem of these audits, in terms of assessing clinical outcomes, is the small sample size of only 10 folders per facility, which means the results are not valid at the level of the facility.[16] It is also suggested that a different methodology is also needed to assess clinical outcomes such as amputations and strokes.[16]

Despite these limitations, these audits have highlighted that diabetes is poorly controlled in the province.[a] Serial HbA1c measurements were poorly adhered to according to the 2018 audit, with only 36-38% of patients having a documented value within the file at the time of audit.[10] Of those, 30% chieved HbA1c targets of $\leq$8%, 36% had an HbA1c over 10% and only 40% were prescribed insulin.[a]

[a] Western Cape Department of Health. Primary Health Care Integrated Audit Report 2018 for Non-Communicable Chronic Disease. Unpublished. 2018.
[b] Western Cape Department of Health. Primary Health Care Integrated Audit Report 2015 for Non-Communicable Chronic Disease. Unpublished. 2015.

Poorly managed diabetic patients put strain on primary, secondary and tertiary levels of health care and the complications impact negatively on the quality of life of many South Africans.

The WC Provincial Health Data Centre (PHDC) collects health data on all diabetic patients. Data is aligned from different sources such as the National Health Laboratory Service (NHLS), primary care facilities, and hospital discharge summaries, using a unique patient identifier. This database uses the collection of diabetic medication from facilities and the laboratory tests from the NHLS as a proxy for diagnosis of diabetes. The dataset does not specifically discriminate between type 1and type 2 diabetes. It is thought that this database could provide more comprehensive information regarding patient demographics, control of the disease and prevalence of comorbidities and complications of diabetes if it was analysed in more depth. The data collected by the PHDC is now made available for clinicians using the Single Patient Viewer, which collates all data on a single patient into one report. The Diabetes Alliance, an alliance of South African organisations interested in diabetes and the National Department of Health, see the need for a national register of people with diabetes and believe that the database developed in the Western Cape may be a model of how to do this in other provinces [personal communication].[17]

An analysis of this database could provide new and more accurate knowledge on the real situation for people with diabetes in the WC. Information about the demographics, the prevalence of comorbidities such as hypertension, HIV and tuberculosis (TB), as well as the quality of glycaemic control can be very useful to guide future service delivery. Outcomes such as the patients' HbA1c, eGFR and hospital admissions can be analysed. The data can describe how well primary care facilities are adhering to the PACK and DOH guidelines for the routine monitoring of diabetic care. The data is also likely to provide information regarding differences in performance between district and sub-districts. The WCDOH, therefore, requested that the university assist with an analysis of the existing database to help them plan future service delivery. No previous audits of health service delivery and clinical outcomes in South Africa have been able to analyse a database of this size and most published studies focus on only one or two facilities and a few hundred patients.[18,19,20,21]

# Aim and objectives

The overall aim of the study was to describe the demographics, outcomes of care, co-morbidities and complications of patients with diabetes treated at primary care facilities in the Western Cape Province from January 2015 to December 2020. Specific objectives included the following:

1. Describe the demographic characteristics of diabetic patients
2. Describe comorbidity amongst diabetic patients
3. Describe the outcomes of care for diabetic patients (death, HbA1c and eGFR)
4. Describe the reasons for admission to hospital
5. Evaluate associations between the demographics, comorbidities and outcomes of care
6. Identify districts and substructures with the best and worst glycaemic control

# Methods

## Study design

This was a secondary analysis of data obtained from the PHDC for people with diabetes from 2015 to 2020. The database contained information about every patient with evidence of diabetes that attended a primary care facility in the Western Cape.

## Setting

The Western Cape is subdivided into six health districts: Cape Town Metropole , West Coast, Cape Winelands, Overberg, Garden Route, and Central Karoo.[22]The Cape Metropole health district consists of eight sub-districts (Western, Eastern, Southern, Northern, Klipfontein, Mitchells Plain, Tygerberg and Khayelitsha), which are further grouped into four substructures (Khayelitsha-Eastern, Northern-Tygerberg, Southern-Western and Klipfontein-Mitchells Plain).

It is estimated 6 610 920 people reside in the Western Cape, 63.4% in the Cape Town Metropole and 36.6% in rural districts.[22] The Cape Metro population is estimated at 4 194 178 people and consists of 152 primary care clinics and 8 district hospitals. The City of Cape Town (COCT) also has 102 primary care facilities (mostly clinics and satellites) and no district hospitals.[22,23]

The database for this study had data only for patients diagnosed with diabetes who visited a WCDOH or COCT primary care facility. In primary care, patients are managed by nurse practitioners and primary care doctors according to the PACK guidelines. Stable or well controlled patients may be seen every 6-months and in between obtain pre-packaged medication from alternative pick-up points, support groups or home delivery. Unstable or uncontrolled patients are seen more regularly at the primary care facility, usually every 3-months and collect their medication monthly. In 2020 the

coronavirus pandemic disrupted services for people with diabetes and only people with emergencies or very uncontrolled patients were seen at primary care facilities.

### Study population

The database included all individuals with a diagnosis of diabetes residing in the Western Cape Province utilizing primary care facilities run by the WCDOH or COCT. All people (≥ 18 years) with a diagnosis of diabetes were included and there was no sampling of the database. The entire database for the province was provided by the PHDC for the period selected. The database did not discriminate between type 1 and type 2 diabetes.

### Data analysis

The data was provided in an Excel spreadsheet. The data was checked using the filter tool in Excel and any obvious errors or duplications removed. Categorical data was numerically coded prior to analysis. Each hospital admission had a primary diagnosis recorded using the International Classification of Diseases version 10 (ICD-10). The ICD-10 codes were too detailed and too numerous for useful analysis and were re-coded into the parent codes with decimal places removed (A00-Z99) using Python Pandas software. Each of these codes was then given a numerical code for analysis in the Statistical Package for Social Sciences (SPSS) version 27.

Categorical variables were summarized using frequencies and percentages. Normally distributed numerical variables were analysed using means and standard deviations. All data was normally distributed.

Associations between dependent numerical variables (usually HbA1c) and independent binary variables were assessed using the independent samples t-test. The associations with independent nominal variables were assessed using analysis of variance and post hoc tests used the Bonferonni method for nominal independent variables.

## Ethics approval

Ethical approval was granted by the Stellenbosch University's Health Research Ethics Committee (Reference No: S20/01/002) prior to commencement of the study and it was conducted in line with the principles outlined in the Declaration of Helsinki.[24] Permission was also granted by the WCDOH and City of Cape Town Health Department.

# Results

## Demographic and clinical characteristics

The database included 116 726 people living with diabetes who had a mean age of 61.4 years (SD 13.8). The majority of people with diabetes were aged between 40-79 years (see Table 1 and Figure 1). The mean age of females was 62.0 years (SD 13.7) compared to 60.6 years for males (SD 13.3), with a mean difference of 1.5 years (95% CI 1.3 - 1.7; p<0.001). Overall, 63.8% were female and 36.1% were male. Amongst those that had died (10.0% of the database), the mean age at death was 66.0 years (SD 12.1) and 86.0% of these patients were between the ages of 50-79 years. Overall, 98.6% of people in the database lived in the Cape Town metropole. The data provided by the PHDC was from the whole province, but the frequencies of patients with diabetes living outside of the Metropole were disproportionately and unexpectedly low, and not likely representative of people in the rural areas. We combined all non-metro results into a 'rural' category as there were insufficient comparable numbers to analyse per rural district.

Hypertension was a comorbidity in 69.5% and mental health disorders in 16.2% of the study population (Table 1). Overall, 6.4% had HIV and 88.5% of them were on antiretroviral treatment. However, the HIV status was unknown in 75.3% of the study population. The lifetime prevalence of TB was 8.2% and in 62.2% of these cases TB occurred after the diagnosis of diabetes was made. Of the subjects with HIV, 28.4% had TB at some point. Overall, the prevalence of TB infection was higher in the HIV infected group (52.0%) compared to the HIV negative (12.9%) and HIV unknown (5.3%) groups.

*Table 1: Demographic and clinical characteristics*

| Variables | n (%) |
|---|---|
| **Gender** | **N=116611** |
| Female | 74431 (63.8) |
| Male | 42180 (36.1) |
| **Age group** | **N=116725** |
| 18 – 19 years | 105 (0.1) |
| 20 – 29 years | 1418 (1.2) |
| 30 – 39 years | 5825 (5.0) |
| 40 – 49 years | 14137 (12.1) |
| 50 – 59 years | 27793 (23.9) |
| 60 – 69 years | 34378 (29.6) |
| 70 – 79 years | 22280 (19.2) |
| 80 – 89 years | 8822 (7.6) |
| ≥ 90 years | 1580 (1.4) |
| **Age group at death** | **N=11681** |
| 18 – 19 years | 3 (0.0) |
| 20 – 29 years | 61 (0.5) |
| 30 – 39 years | 220 (1.9) |

| | |
|---|---|
| 40 – 49 years | 679 (5.8) |
| 50 – 59 years | 2311 (32.0) |
| 60 – 69 years | 3735 (27.0) |
| 70 – 79 years | 3153 (27.0) |
| 80 – 89 years | 1353 (11.6) |
| ≥ 90 years | 166 (1.4) |
| **Substructure** | **N=115408** |
| Khayelitsha-Eastern | 25108 (21.8) |
| Northern-Tygerberg | 31551 (27.3) |
| Southern-Western | 27004 (23.4) |
| Klipfontein-Mitchells Plain | 30108 (26.1) |
| Rural Health Services | 1637 (1.4) |
| **Sub-district** | **N=115408** |
| Eastern | 12783(11.1) |
| Khayelitsha | 12325 (10.7) |
| Northern | 6285 (5.4) |
| Tygerberg | 25266 (21.9) |
| Southern | 15468 (13.4) |
| Western | 11536 (10.0) |
| Klipfontein | 14318 (12.4) |
| Mitchells Plain | 15790 (13.7) |
| Rural | 1637 (1.4) |
| **Co-morbidities** | **N=116726** |
| Hypertension | 81070 (69.5) |
| HIV positive total | 7507 (6.4) |
| HIV positive on ART | 6642 (5.7) |
| HIV status unknown | 87846 (75.3) |
| Ever had TB | 9519 (8.2) |
| HIV and previous TB | 2135 (1.9) |
| Mental health disorder | 18887 (16.2) |

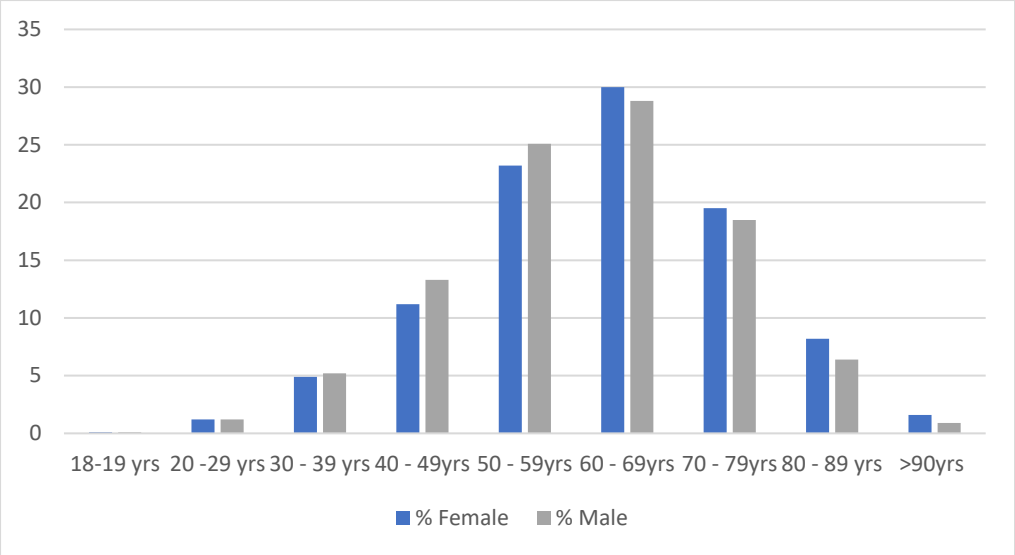

*Figure 1: Age categories by gender (N=116226)*

## Process of care

Table 2 shows the last time people were seen at a facility, were admitted to hospital, or had an HbA1c or eGFR investigation, between 2015 and 2020. Of those last seen between 2015 and 2020 less than half were seen in the last 2-years (45.6%). Interestingly, the partial data from 2021 (data was extracted in first quarter) showed that 53.1% of the database had been seen in 2021. Out of the whole database 63.3% had at least one previous hospital admission. The data available reflects the date of last admission and not all admissions to hospital. More than two-thirds of the documented admissions (65.2%) were between 2015 and 2020 (Table 2) and on average 6.9% of the database were admitted every year. The average length of admission was 5.3 days (SD 10.4).

A record of an HbA1c having ever been done was available for 93.0% of the study population, whilst 79.1% had an HbA1c done between 2015 -2020. The mean value for the last HBA1c taken was 9.0% (SD 2.5). Only 60.4% of the database had an HbA1c done over the last 2-year period in 2019/2020. An eGFR was recorded for 96.1% of the study population and 57.1% had an eGFR in the last two years.

*Table 2: Proportion of patients seen at primary care facilities, admitted to hospital and receiving investigations (HbA1c and eGFR) between 2015 -2020*

| Variables | n (%) |
|---|---|
| **Last seen at PHC facility** | **N = 54731** |
| Last seen in the last year (2020) | 15752 (28.8) |
| Last seen in the last 2 years (2019-2020) | 24930 (45.6) |
| Last seen in last 3 years (2018 – 2020) | 34658 (63.4) |
| Last seen in last 4 years (2017 – 2020) | 43173 (79.0) |
| Last seen in last 5 years (2016 – 2020) | 50087 (91.6) |
| Last seen in last 6 years (2015 – 2020) | 54731 (100.0) |
| **Admitted to hospital** | **N = 48143** |
| Admitted in the last year (2020) | 10694 (22.2) |
| Admitted in the last 2 years (2019-2020) | 20003 (41.5) |
| Admitted in last 3 years (2018 – 2020) | 28732 (59.6) |
| Admitted in last 4 years (2017 – 2020) | 36319 (75.4) |
| Admitted in last 5 years (2016 – 2020) | 42778 (88.8) |
| Admitted in last 6 years (2015 – 2020) | 48143 (100.0) |
| **HbA1c done** | **N = 92335** |
| HbA1c in the last year (2020) | 28224 (30.6) |
| HbA1c in the last 2 years (2019-2020) | 55698 (60.4) |
| HbA1c in last 3 years (2018 – 2020) | 70983 (77.0) |
| HbA1c in last 4 years (2017 – 2020) | 81305(88,2) |
| HbA1c in last 5 years (2016 – 2020) | 87888 (95.3) |
| HbA1c in last 6 years (2015 – 2020) | 92335(100.0) |
| **eGFR done** | **N = 96995** |
| eGFR in the last year (2020) | 26901 (27.7) |

| | |
|---|---|
| eGFR in the last 2 years (2019-2020) | 55376 (57.1) |
| eGFR in last 3 years (2018 – 2020) | 72832 (75.1) |
| eGFR in last 4 years (2017 – 2020) | 84622 (87.3) |
| eGFR in last 5 years (2016 – 2020) | 92085 (95.0) |
| eGFR in last 6 years (2015 – 2020) | 96995 (100.0) |

Table 3 presents the most common ICD-10 codes for the last admissions where an ICD 10 code was recorded. The commonest reasons for admission were cataracts, complications of type 2 diabetes and coronavirus infectious disease 2019 (COVID-19). The top 25 diagnoses reflected the known complications and comorbidities of diabetes such as heart failure, hypertension, ischaemic heart disease and stroke. Amongst pregnant women, caesarean deliveries were more common than uncomplicated deliveries.

*Table 3: Top 25 diagnoses for all admissions with ICD 10 codes on the database (N = 40699)*

| ICD 10 Code | Description | n (%) |
|---|---|---|
| H26, H25 | Cataract | 2460 (6.0) |
| E11 | Type 2 diabetes mellitus | 1941 (4.8) |
| U07 | COVID-19 | 1729 (4.2) |
| E10 | Type 1 diabetes mellitus | 1524 (3.7) |
| I50 | Heart failure | 1393 (3.4) |
| O82 | Encounter for caesarean delivery without indication | 1131 (2.8) |
| I10 | Essential (primary) hypertension | 1089 (2.7) |
| R73 | Angina pectoris | 890 (2.2) |
| I64 | Stroke | 889 (2.2) |
| O80 | Encounter for full-term uncomplicated delivery | 866 (2.1) |
| I21 | Acute myocardial infarction | 791 (1.9) |
| I63 | Cerebral infarction | 682 (1.7) |
| E16 | Other disorders of pancreatic internal secretion – including hypoglycaemia | 625 (1.5) |
| I73 | Other peripheral vascular diseases | 624 (1.5) |
| N39 | Other disorders of urinary system | 595 (1.5) |
| R10 | Abdominal and pelvic pain | 578 (1.4) |
| L02 | Cutaneous abscess, furuncle and carbuncle | 532 (1.3) |
| J18 | Pneumonia, unspecified organism | 530 (1.3) |
| L03 | Cellulitis and acute lymphangitis | 529 (1.3) |
| J44 | Other chronic obstructive pulmonary disease | 526 (1.3) |
| K29 | Gastritis and duodenitis | 494 (1.2) |
| I25 | Chronic ischemic heart disease | 474 (1.2) |
| O24 | Diabetes mellitus in pregnancy, childbirth, and the puerperium | 428 (1.1) |
| A41 | Other septicaemia | 389 (1.0) |
| N18 | Chronic kidney disease | 386 (0.9) |

Table 4 further describes the last admissions in terms of ICD-10 categories. Although 4390 (9.7%) of the diagnoses were missing a category, 20.2% of all admissions were attributed to cardiovascular

diseases. Within the next commonest ICD-10 category (endocrine, nutrition and metabolic disorders), ketoacidosis and hypoglycaemia were the most common specific problems.

*Table 4: Proportion of admissions by diagnostic category (N = 40699)*

| | ICD Category | n (%) |
|---|---|---|
| 1 | Diseases of the circulatory system | 8239 (20.2) |
| 2 | Endocrine, nutrition and metabolic diseases | 4609 (11.3) |
| 3 | Diseases of the eye and adnexa | 3153 (7.7) |
| 4 | Diseases of the digestive system | 3107 (7.6) |
| 5 | Pregnancy, childbirth and the puerperium | 2947 (7.2) |
| 6 | Diseases of the genitourinary system | 2270 (6.8) |
| 7 | Diseases of the respiratory system | 2701 (6.6) |
| 8 | Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified | 2499 (6.1) |
| 9 | Injury, poisoning and certain other consequences of external causes | 1628 (4.0) |
| 10 | Certain infectious and parasitic diseases | 1589 (3.9) |
| 11 | Diseases of the skin and subcutaneous tissue | 1448 (3.6) |
| 12 | Neoplasms | 1267 (3.1) |
| 13 | Mental and behavioural disorders | 1240 (3.0) |
| 14 | Diseases of the musculoskeletal system and connective tissue | 1048 (2.6) |
| 15 | Diseases of the nervous system | 1012 (2.5) |
| 16 | Factors influencing health status and contact with health services | 804 (2.0) |
| 17 | Diseases of the blood and blood-forming organs and certain disorders involving the immune mechanism | 301 (0.7) |
| 18 | Diseases of the ear and mastoid process | 135 (0.3) |
| 19 | External causes of morbidity and mortality | 51 (0.1) |
| 20 | Other | 651 (1.6) |

## Outcomes of care

Table 6 presents the results for glycaemic control and kidney function. The HbA1c results are presented according to the PACK guidelines, which are used to guide clinical decisions in the Western Cape, as well as according to national guidelines, which are more aligned with international standards.[11,13] According to the national guidelines 75.5% of the database were uncontrolled and 33.7% had an HbA1c of ≥10 %. . The proportion of elderly that were uncontrolled was slightly better at 57.3%. Renal disease was present in 25.5% of those people who had eGFR's recorded (eGFR < 60ml/min).[14]

*Table 6: Glycaemic control and kidney function*

| Variables | n (%) |
|---|---|
| **Glycaemic control according to provincial (PACK) targets** | |
| **HbA1c %** | **N = 108350** |
| ≤8 | 45877 (42.3) |
| >8 | 62473 (57.7) |
| **Glycaemic control according to national targets** | |
| **HbA1c %** | **N = 108330** |
| 0 – 6.4 | 16750 (15.5) |
| 6.5 – 6.9 | 9837 (9.1) |
| ≥7 | 81743 (75.5) |
| **Glycaemic control for elderly (>65yrs)** | |
| **HbA1c %** | **N = 43078** |
| 0 – 6.4 | 8634 (20.0) |
| 6.5 – 7.4 | 9753 (22.6) |
| ≥7.5 | 24691 (57.3) |
| **Kidney function** | |
| **eGFR (ml/min/1.73m)** | **N = 109955** |
| Normal/High ≥ 90 | 625 (0.6) |
| Mildly decreased 60-89 | 81280 (73.9) |
| Mild to moderately decreased 45-59 | 10739 (9.8) |
| Moderately to severely decreased 30-44 | 7255 (6.6) |
| Severely decreased 15-29 | 5374 (4.9) |
| Kidney failure (<15) | 4682 (4.3) |

Table 7 presents the relationships between demographic or clinical characteristics and glycaemic control. Men were significantly better controlled, although the absolute difference was small. Mean HbA1c significantly improved with age. There were significant differences in glycaemic control between substructures and sub-districts. Patients with hypertension and mental health disorders were significantly better controlled. Those with an unknown HIV status were significantly better controlled than those with a negative status (post hoc analysis). Those who developed TB after the diagnosis of diabetes had much worse glycaemic control.

*Table 7: HbA1c value by age, substructure, sub-district and comorbidity*

| Variables | Mean HbA1c (95% CI) | p-value |
|---|---|---|
| **Gender** | | |
| Male | 9.0 | |
| Female | 9.1 | |
| Mean difference | 0.11 (0.08-0.14) | <0.001 |
| **Age category** | | |
| 18 – 19 years | 11.04 (10.30– 11.80) | <0.001 |
| 20 – 29 years | 10.18 (10.0 – 10.36) | |
| 30 – 39 years | 9.55 (9.47 – 9.62) | |
| 40 – 49 years | 9.58 (9.54 – 9.63) | |

| | | |
|---|---|---|
| 50 – 59 years | 9.63 (9.50 – 9.65) | |
| 60 – 69 years | 9.08 (9.05- 9.10) | |
| 70 – 79 years | 8.42 (8.38 – 8.45) | |
| 80 – 89 years | 7.82 (7.78 – 7.86) | |
| ≥ 90 years | 7.40 (7.31 – 7.50) | |
| **Substructure** | | |
| Khayelitsha Eastern | 9.16 (9.13 - 9.19) | <0.001 |
| Northern Tygerberg | 8.91 (8.89 - 8.94) | |
| Southern Western | 8.80 (8.77 - 8.83) | |
| Klipfontein Mitchells Plain | 9.32 (8.80 - 9.06) | |
| Rural | 8.93 (8.0 - 9.05) | |
| **Sub-district** | | |
| Eastern | 8.94 (8.90 – 9.00) | <0.001 |
| Khayelitsha | 9.40 (9.35 – 9.45) | |
| Northern | 8.75 (8.69 – 8.82) | |
| Tygerberg | 8.95 (8.80 – 8.98) | |
| Southern | 8.72 (8.62 – 8.76) | |
| Western | 8.90 (8.86 – 8.95) | |
| Klipfontein | 9.16 (9.12 – 9.21) | |
| Mitchells Plain | 9.45 (9.41 – 9.50) | |
| Rural | 8.93 (8.80 – 9.05) | |
| **Hypertension** | | |
| With hypertension | 9.00 | |
| Without hypertension | 9.13 | |
| Mean difference | 0.13 (0.10-0.17) | <0.001 |
| **HIV status** | | |
| HIV positive not on ART | 9.23 (9.02 – 9.44) | <0.001 |
| HIV positive on ART | 9.09 (9.01 – 9.15) | |
| HIV negative | 9.11 (9.06 – 9.15) | |
| HIV Unknown | 9.01 (8.96 – 9.03) | |
| **TB infection** | | |
| TB after diagnosed DM | 10.26 | |
| TB before diagnosed DM | 8.97 | |
| Mean difference | 1.3 (1.23 – 1.36) | <0.001 |
| **Mental health disorders** | | |
| Mental health care user | 8.61 | |
| Non-mental health care user | 9.12 | |
| Mean difference | 0.52 (0.47 – 0.56) | <0.001 |

# Discussion

## Key findings

Three-quarters of people with diabetes in the Western Cape had poor glycaemic control (HbA1c >7%) and a third were very poorly controlled (HbA1c ≥10%). Almost every patient (99.4%) had abnormal renal function, with most being mild, but 9% had severe renal disease necessitating follow up in a higher level of care. Glycaemic control was significantly different between most sub-districts in Cape Town as well as rural areas. Improved glycaemic control was observed in patients with comorbid

hypertension, mental health disorders, unknown HIV status and those who had TB before the diagnosis of diabetes.

People with diabetes should be seen at least annually and more frequently if uncontrolled. However, only 46% of patients last seen between 2015 and 2020 were seen in the previous two years, although paradoxically 60% had an HbA1c test taken. Approximately 7% of people with diabetes were admitted to hospital annually. The reasons for admission were the predictable diabetic-related complications and diseases of the cardiovascular system were the commonest, with 20% of all admissions being related to this category. Diabetic ketoacidosis and hypoglycaemia were the most common direct complications of diabetes.

The majority of people were older adults in their sixties and almost two-thirds were female. Although this is a database for the whole province, only 1.4% came from the rural areas. Hypertension was the main recorded comorbidity, but mental health disorders were the second commonest in this database. The presence of mental health in the cascade is ascertained by the dispensing of any psycholeptic medication and ICD 10 coding for mental illness. Although HIV is highly prevalent in the population, only 6.4% of people with diabetes were diagnosed with HIV and the HIV status was largely unknown (75%).

## Discussion of key findings

The target HbA1c for the majority of the population was <7% to prevent the micro- and macro-vascular complications of diabetes.[10,11] Fewer elderly patients were poorly controlled when the age-adjusted HbA1c targets were taken into account and there was a tendency towards improved HbA1c values with increasing age The reason for this in our population is unclear, but is consistent with other studies from USA and Spain in which people with diabetes over 65-years of age had a trend towards lower HbA1c levels, but increased cardiovascular risk factors and complications of disease.[25,26] A possible explanation for this might be the survival bias phenomenon, whereby the more severe or complicated cases of diabetes are likely to die younger and so might be underrepresented in the aging population.[27] Health services in the Western Cape had adopted the PACK guidelines, which recommended that levels of HbA1c up to 8% were considered adequate control, and according to these guidelines only 58% of patients were uncontrolled and in need of more clinical intervention and more frequent monitoring.[13] Although glycaemic control significantly differed between substructures and sub-districts the absolute differences were not large and the reasons for these differences could not be ascertained. Mitchells Plain and Khayelitsha had the worst glycaemic control.

Up to 70% of the people were not receiving an annual HbA1c test. Previous clinical audit and feedback of a sample of people with diabetes at primary care facilities in the metropole had suggested slightly higher levels of testing, with 40% receiving an annual test. Well controlled patients should have an HbA1c annually and uncontrolled patients every 3-months. The lack of testing may influence the accuracy of the results for glycaemic control as many of the tests included in the analysis were not recent. In addition, the lack of testing means that people were not receiving feedback on their control, which might have motivated them to better adherence to treatment or lifestyle modification. However, providing more frequent point of care HbA1c testing has not been shown to improve glycaemic control in the local context, possibly due to clinical inertia.[28]

Levels of glycaemic control in the Western Cape were similar or better than other provinces in South Africa.[20,29] South Africa also fared the worst in a comparison of glycaemic control between four low-and-middle income countries.[30] High income countries also appear to be doing better with approximately 53% of people well controlled in USA and Europe.[31,32]

The 25.5% prevalence of renal disease in this population is comparable to the UK (25%) and USA (36%).[3] It is possible that this database underestimates the true prevalence renal disease in the study population as only creatinine and eGFR were used as indicators of abnormal renal function, and albuminuria that meets the criteria for chronic kidney disease was not recorded. [14] The prevalence of chronic kidney disease in patients with diabetes in Sub-Saharan Africa is about 35%, but might vary as much as 11 – 87.3%.[1,19,33] The high rates of kidney disease are congruent with poor control and would also imply similarly high rates of microvascular disease in the retina. Retinopathy was not reported in the database although the Metro Health Services do have a digital fundal camera service that could feed data into the cascade. Other studies have reported high rates of cataract and retinopathy in the same population.[34] There are substantial implications of these high rates of kidney disease for patients and health services. Dialysis services in the public sector are severely restricted and many people with severe disease will not be eligible and will be referred for palliative care. Previous studies have recommended a more aggressive approach to screening for microalbuminuria and intervening early when there is a possibility of reversing or slowing the loss of kidney function.[35]

The Western Cape has previously been identified as a province with one of the highest rates of comorbid hypertension and diabetes.[36,37] The national prevalence is closer to 43%, compared to 70% in this study.[36,37] The Western Cape province has a high prevalence of obesity and metabolic syndrome, especially in woman, which are important risk factors for both hypertension and

diabetes.[9,38] In Sub-Saharan Africa, hypertension and diabetes comorbidity falls within the range of 44% - 76%,[39] and similar prevalence rates have been observed in higher income countries.[40]

The HIV prevalence in our database was lower than the national average of about 12% amongst children and adults or 19% amongst the 15 – 49-year-old population, however three-quarters of the people in the dataset had an unknown HIV status.[41] We are unsure whether point-of-care HIV testing results were reliably fed into the database. Glycaemic control was significantly better in those with an unknown HIV status compared to those that were known to be HIV negative. The underlying reasons for this difference need further investigation. Other studies have suggested that HIV positive individuals might do better because of greater health awareness and lower levels of obesity, while others have suggested that diabetes may cause HIV to progress faster and lead to increased mortality. More studies are needed in South Africa that report diabetes according to HIV status.[4,42] A review of diabetes and HIV prevalence in the African context showed no statistically significant association yet between HIV infection or ART use and the prevalence of type 2 diabetes.[43]

The effects of the COVID-19 pandemic became apparent in this study as COVID related admissions in 2020-21 were the third highest reason for admission over a 10-year period. This reflects the high admission rate, mortality and morbidity of patients with diabetes contracting COVID-19 disease, which was observed in district hospitals in the Western Cape and abroad.[44,45] Even without COVID-19, people with diabetes are frequently admitted to hospital with complications and require a substantial commitment of health service resources. Interventions to improve glycaemic control will not only improve peoples' quality of life, but also reduce the strain on the health system.

We had a much higher proportion of female patients with diabetes in our dataset and a recently published systematic review found that the prevalence of diabetes might be as high as 16.8% in females and 12.4% in males in South Africa, whereas the rest of the world tends to see a more even distribution, with a slightly higher prevalence in men (9.6% vs 9.0%).[3,4] In South Africa the risk factors for diabetes (metabolic syndrome) are much higher in women than men and this may partly account for the differences.[46,47] Even so the dataset appeared to have a missing group of men when compared to the ratio found in the review. It is possible that employed men struggle to access care in the public sector due to inconvenient opening times.[48]

## Strengths and limitations

One of the strengths of this study was the size and power of the database. We were able to quantify differences to a high level of precision although not all these differences were clinically significant. The database did not discriminate between type 1 or type 2 diabetes. However, type 2 diabetes is the

most common aetiological type, 90 - 95% of people with diabetes in South Africa and worldwide, and thus this study mostly describes the characteristics and outcomes of people with type 2 diabetes.[3,10] Although type 1 diabetes can be diagnosed at any age, the vast majority are diagnosed in childhood and before 25 years of age.[10,39] By only including study subjects 18-years and older, we also excluded a number of people with type 1 diabetes. The proportion of female patients with gestational diabetes in this database is also unknown, but 1.1% of all the admissions were for diabetes during the puerperal period.

The database is unique in South Africa, as it collates routinely collected data on people with diabetes from multiple sources and links the data with a unique patient identifier. The data, however, is dependent on what is collected electronically by other systems, such as in the laboratories and hospitals. It is therefore somewhat opportunistic rather than intentional in design and information about some important indicators is not available, such as blood pressure control or retinal screening. This is because there is no electronic medical record as yet in the public sector and not all data sources feed into the provincial data centre. The researchers had difficulty in obtaining the database from the PHDC, and not all variables requested were made available.

The accuracy of data was dependent on the source and data was often dependent on clerical staff to enter into the system at hospitals and clinics. This may account, for example, for the discrepancy between the proportion seen in the last year and the proportion having an HbA1c test. In order to have an HbA1c or eGFR laboratory test done one would have to be seen at a facility and this implies that the laboratory data may be more accurate than the clerical data.

The ICD-10 codes required recoding into broader subgroups of diseases, and the decimal places were left out of the analysis as this level of detail was not required and unmanageable. This narrowed the more than 40000 admission codes to approximately 1000 different codes.

We originally proposed to answer the aim and objectives in relation to people with diabetes in the Cape Town Metropole, but wider access was granted by the PHDC to include study subjects in the Western Cape Province. However, when we analysed the database, it became apparent that the frequencies of patients with diabetes living outside of the Metropole were disproportionately and unexpectedly low. We then combined all non-metro results into a ‘rural’ category as there were insufficient comparable numbers to analyse per rural district. It is probable data was missing for patients living outside of the Metro and that rural health services were not entering data into the database.

## Implications and recommendations

This study highlights that the scale of the problem and the level of poor control, with high rates of hospital admissions for complications, should make this a priority for the health services. Diabetes has recently become a leading cause of mortality in South Africa and is now the leading cause of death for women.[5] There is therefore a clear clarion call to action on diabetes that should harness the same focus and energy as has been seen for the HIV and TB epidemics.

One of the key areas that needs attention is patient education and counselling. This is because even with the best adherence to medication, without lifestyle modification and commitment to self-management, medication alone is unlikely to be enough. Numerous projects around the country are modelling potential interventions, such as group empowerment and training for diabetes, brief behaviour change counselling, and support for initiation of insulin.[49,50,51] However, few have gone to scale or received significant resources to implement them more widely.

One of the key challenges to the health services is how to offer high quality primary care to enormous numbers of people with chronic conditions while operating with limited resources. The potential of ward-based outreach teams and community health workers to assist with this has also been recognised in policy on primary health care re-engineering and integrated health services.[52] Community health workers may be able to support self-management in the community for people with relatively stable or controlled diabetes.[53] In addition, they may be able to address some of the underlying risk factors through individual and community level interventions. The picture that emerges is more community-based services for people with stable conditions, reserving facility-based services for people that are uncontrolled. The implementation of these ideas within a community-orientated primary care framework is yet to be fully realised.

This kind of diabetes database is a major step forward from the scarcity of information previously available and once the system was established requires less effort than the annual clinical audit and feedback conducted by clinical staff. Clinicians are now able to pull reports on their primary care facilities from the data centre whenever they want. Ultimately, however, we will need a more intentionally designed system and an electronic medical record, as anticipated in the implementation of national health insurance.[54]

# Conclusion

People with diabetes who attend public sector primary care facilities in the Western Cape are mostly female and between 50-69 years of age. Comorbidity with hypertension and mental health disorders were common. Three-quarters of people had poor glycaemic control and a third were very poorly controlled. At least a quarter of the diabetic population had renal disease, necessitating follow up in a

higher level of care. Glycaemic control was significantly different between most sub-districts in Cape Town as well as rural areas. Improved glycaemic control was observed in patients with comorbid hypertension, mental health disorders, unknown HIV status and in those who had TB before the diagnosis of diabetes. The commonest reasons for admission were cataracts, COVID-19 and complications of diabetes such as ketoacidosis and hypoglycaemia. Approximately 7% of people with diabetes were admitted to hospital annually and most were admitted for the predictable complications of diabetes. These findings are a clarion call to the health services to address the problem of diabetes with the same energy as has been seen for the HIV and TB epidemics.

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