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Glycaemic, blood pressure and low-density lipoprotein-cholesterol control among patients with diabetes mellitus in a specialised clinic in Botswana

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Abstract

Objective: Control of glycaemic, hypertension and low-density lipoprotein-cholesterol (LDL-C) among type 2 diabetes mellitus (T2DM) patients is vital for the prevention of cardiovascular diseases (CVD). This study aimed to determine the prevalence of optimal glycaemic, hypertension, and LDL-C control among ambulant patients with type 2 diabetes mellitus in Botswana. Also, the research aimed at assessing factors associated with optimal glycaemic, hypertension and LDL-C therapeutic goals.

Design: A cross-sectional study.

Setting: A specialised public outpatient clinic in Gaborone, Botswana.

Participants: 500 T2DM patients on treatment for 3 or more months between August 2017 and February 2018.

Primary outcome measure: the prevalence of optimal glycaemic (HbA1c <7 %), hypertension (blood pressure <140/90mmHg) and LDL-C (<1.8mmol/L) control.

Results: The proportions of patients meeting optimal targets were 32.3% for glycaemic, 54.2% for hypertension, and 20.4% for LDL-C. Optimal glycaemic control was positively associated with age ≥ 50 years (AOR 5.79; 95% CI 1.08 to 31.14) but was inversely associated with an increase in diabetes duration (AOR 0.91; 95%CI 0.85 – 0.98). Patients on angiotensin converting inhibitors (ACEIs) had lower odds of optimal hypertension control (AOR 0.35; 95% CI 0.14 – 0.85) than those without ACEIs. Being female (AOR 0.21; 95% CI 0.08 – 0.58) was inversely associated with an optimal LDL-C control.

Conclusion: T2DM in Gaborone, Botswana, presented with poor control of recommended glycaemic, hypertension and LDL-C control. These finds calls for urgent individual and health systems interventions to address key determinants of the recommended therapeutic targets among patients with diabetes in this setting.

Keywords: Glycemic, hypertension, LDL, Diabetes Mellitus, Botswana

Strengths and limitations of this study

- The study provides data on the three critical therapeutic targets in patients with diabetes in a specialised public clinic in Botswana.
- We explored factors associated with glycaemic, hypertension and LDL-C control.
- The study was limited to one public clinic and may not be generalised to other facilities in the country. However, the findings can be used as a basis for future studies and efforts to improve diabetes care in Botswana and different settings in Africa.
- The cross-sectional design limited the assessment of the temporal relationship between factors associated with poor control of glycaemic, LDL-C and hypertension.

Introduction

Diabetes mellitus and related cardiovascular complications are growing public health concerns worldwide [1 2]. There are approximately 16 million people with diabetes in Africa, and this number is projected to increase to 41 million by 2045 due to rapid urbanisation, lifestyles changes and nutrition transition in the continent [1]. This increase in prevalence and incidence of diabetes is attributable to type 2 diabetes, which is associated with multiple co-morbidities such as obesity and hypertension requiring chronic care and catastrophic health expenditure [1]. Diabetes and associated comorbidities are known to increase patients risk to the development of cardiovascular diseases (CVD), which are responsible for about 70% of diabetes-related deaths[3]. The risk to the development of CVD is higher in people with suboptimal glycaemic, hypertension and LDL-C control [3 4]. A reduction of HbA1c to control targets along with optimal hypertension control and the use of statins to lower LDL-C levels have been shown to improve long-term outcomes including reducing mortality among patients with diabetes [5-8]. Achieving these targets remains a challenge in most settings, especially in settings with limited access to standard diabetes care[9-13]. Only a minority of patients with diabetes in Africa achieve optimal therapeutic targets, leaving the majority of patients at high risk of diabetes-related complications [12]. This is a public health concern because the current total health expenditure in most sub-Saharan Africa countries remains far below the 15% recommended in the Abuja declaration and the rising cost of managing diabetes complications will further make the health system goals unattainable[1 14]. Thus, this study aimed to evaluate the current prevalence of glycaemic, hypertension, and LDL-C control among ambulant patients with type 2 diabetes mellitus in Botswana to provide future guidance. The study also assessed for factors associated with attainment of glycaemic, blood pressure and LDL-C therapeutic patients in these patients.

Methods

Study design and participants

We conducted a cross-sectional study of outpatients with established type 2 diabetes attending a specialised public diabetes clinic in Gaborone, Botswana between August 2017 and February 2018. The clinic has been operational since 2011 as a referral centre for health facilities in Gaborone and nearby towns. Patients were eligible to participate in the study if they were aged ≥ 18 years and had received care from the clinic for at least three months. Systematic random sampling was used to select ten patients from a list of about 80 patients who attended the clinic every day. We picked the first patient from the first eight people in the queue. Then every eighth individual was approached until the daily target of 10 patients was reached. Participants provided informed consent before enrolment. The study was granted the ethical approval by the Ministry of Health (HPDME: 13/18/1 VOL XI) and Princess Marina Hospital (PMH 5/79,317-1-2017) Institutional Review Boards.

Data collection and procedures

Patient information was collected using an interviewer-administered questionnaire and through reviews of medical charts and electronic records. The information included: demography (age, gender, occupation, marital status, and education), diabetes duration, history of hypertension, and medications for diabetes, hypertension and lipid disorders. We performed anthropometry (weight, height, waist and hip circumferences) and blood pressure measurements at enrolment. We conducted three blood pressure measurements after 10 minutes of rest, and the mean of the three measurements was recorded[15]. Moreover, we documented a blood pressure reading from each patient's prior visit. Patients' serum creatinine, LDL-C and HbA1c, and urine dipstick for proteinuria results over the past six months were abstracted from electronic medical records.

Definitions of the key outcomes and exposure variables

We calculated diabetes duration as the date of enrolment into the study minus the date of diabetes diagnosis. A patient was considered hypertensive by self-reported hypertension and the use of blood pressure-lowering medications or has sustained blood pressure ≥140/90 mmHg during the previous visit and at enrolment [16-18]. Optimal glycaemic control was defined as HbA1c < 7% [16 18]. For patients who were on lipid-lowering medications, optimal LDL-C control was LDL cholesterol level <1.8mmol/L[16]. We calculated patients' eGFR by the Modification of Diet in Renal Disease (MDRD) formula, and an eGFR <60.0 mL/min/1.73m^2 defined Chronic Kidney Disease (CKD)[2 19 20]. Body mass index (BMI) was calculated as weight in kilograms divided by the square of height in meters. We considered underweight as BMI < 18.5 kg/m2, normal weight as BMI of 18.5 –24.9 kg/m^2, overweight as BMI of 25.0 –29.9 kg/m^2, and obesity as BMI ≥ 30 kg/m^2 [21]. Waist-hip ratio (WHR) was calculated as waist circumference (WC) in centimetres divided by hip circumference (HC) in centimetres, and WHR ≥ 0.85 for women and ≥ 0.90 for men were classified as high [21].

Statistical analysis

Analyses were performed using Stata, Version 14 (Stata Corp, College Station, TX). We used percentages to summarise categorical variables. Means and standard deviation (SD) or medians and interquartile range (IQR) were used to summarise continuous variables. Pearson's $\chi 2$ or Fisher's exact tests were used to assessing statistical differences by gender for the categorical variables, while the Student's t-test or the Mann-Whitney U test were used for the continuous ones. Bivariate logistic regression was used to explore factors associated with each primary outcome - glycaemic, hypertension and LDL-C control. We further performed three multivariate logistic regression models for each of the three outcomes. The independent variables selected for multivariate models were those displaying a p-value < 0.2 at the univariate analysis level in addition to those considered clinically meaningful (age and gender). We described results as

crude odds ratio (OR), adjusted odds ratio (AOR), and their corresponding 95% confidence intervals (95% CI). A 2-tailed p-value < 0.05 was considered statistically significant.

Results

We included 500 patients with type 2 diabetes in the study, of which 330 (66%) were females. The mean (SD) age was 58.9 (12.2) years and 78.2%) were aged > 50 years. The median (IQR) diabetes duration was 6 (2 – 13) years. There were a high percentage of patients with hypertension (80.8%), overweight (31.1%) and obesity (50.2%). Table 1 summarises the patients' characteristics by gender. Female patients tended to be older (60.8 vs 55.4 years, p<0.001, obese (56.7% vs 37.1%, p<0.001), have higher WHR (95.2% vs 55.9%), be hypertensive (86.1% vs 70.6%, p <0.001), and have a higher mean total cholesterol (4.5mmol/L vs 4.3mmol/L, p =0.030 and LDL-C (2.9mmol/L vs 2.6mmol/L, p=0.006) than male patients. Urine dipstick was positive for protein in 10.2% of patients, mostly males (15.9% vs 7.3%, P = 0.003).

[Table 1: Clinical and socio-demographic characteristics of patients with type 2 diabetes at a specialised Diabetes clinic in Gaborone (N= 500)]

Optimal glycaemic control

The mean (SD) HbA1c was 8.4 (2.4) % overall, 8.6 (2.7) % for female and 8.0 (1.6) % for male patients (p=0.199) [Table 1]. The proportion of the patients receiving oral hypoglycaemic agents alone was 54.2%; 30% were treated with oral hypoglycaemic agents combined with insulin; 13.6% insulin alone and 2.2% were on a diet alone. Of all the 218 patients on insulin, 184 (84.4%) were on premix insulin. Of all the 421 patients on oral hypoglycaemic agents, 411(97.6%) patients were on metformin, and 194 (46.1%) patients were on a sulphonylurea. Compared to patients on other anti-diabetic medications, those on insulin injections were more likely to be males. We noted optimal glycaemic control in 159 (32.3%) patients, whose mean (SD) HbA1c was 6.1 (0.6) %. Age over 50 years was associated with optimal glycaemic control (AOR 5.79; 95%CI 1.08 – 31.14). On the other hand, an increase in diabetes duration was associated with lower odds of optimal glycaemic control (AOR 0.91; 95%CI 0.85 – 0.98). There was no association between gender, anthropometry, diabetes medications or education on the prevalence of optimal glycaemic control [Table 2].

[Table 2: Factors associated with optimal glycaemic control among patients with type 2 diabetes at a specialised diabetes clinic in Gaborone (N= 500)]

Optimal hypertension control

There were 404 (80.8%) hypertensive patients [Table 1]. Age ≥ 50 years (AOR 4.954; 95%CI 2.811– 8.732), increased WHR (AOR 3.874; 95%CI 1.723–8.709), eGFR (AOR 0.982; 95% 0.975 – 0.989), and a long diabetes duration (AOR= 1.068, 95%CI: 1.019– 1.119) were associated with hypertension. Seventeen (4.2%) hypertensive patients did not receive any antihypertensive medication. Of the 389 patients who received antihypertensive medicines, 219 (56.3%) received calcium channel blockers, 189 (48.6%) were treated with thiazides diuretics, 183(47.0%) with angiotensin-converting enzyme inhibitors (ACE inhibitors), and 74(19.0%) with angiotensin receptor blockers (ARBs). The proportions of patients receiving β- and α-blockers were 22.4% and 5.4% respectively.

Of the 389 patients who received antihypertensive medicines, optimal hypertension control was noted in 211 (54.2%) patients. Patients on ACE inhibitors had lower odds of optimal hypertension control, compared to those who were not treated by ACE inhibitors (AOR 0.35; 95% CI 0.14 – 0.85). There was no association between gender, anthropometry, or education on the prevalence of optimal hypertension control [Table 3].

[Table 3: Factors associated with optimal hypertension control among patients with type 2 diabetes at a specialised diabetes clinic in Gaborone (N= 500)]

Optimal LDL-C control

A total of 225 (45%) patients were receiving lipid-lowering drugs, mostly (96.4%) atorvastatin. Of these, 147 (65.3%) patients had LDL-C measurements available. Only 30 (20.4%) achieved the optimal LDL-C control target. Females were less likely to achieve optimal LDL-C control as compared to males, (AOR 0.211; 95% CI 0.077 – 0.578). There was no association of age, anthropometry, or education on the prevalence of optimal LDL-C control [Table 4].

[Table 4: Factors associated with optimal LDL-C control among patients with type 2 diabetes at a specialised diabetes clinic in Gaborone (N= 500)]

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Discussion

This outpatient cross-sectional study showed a low proportion of patients with optimal control of glycaemic, hypertension, and LDL-C among Type 2 patients attending a diabetes clinic in Botswana. In the multivariate analysis, duration of diabetes and age above 50 years were significantly associated with the presence of an optimal glycaemic control. Being on ACEIs was inversely related to optimal

hypertension control compared to those who were not using ACEIs. Females were less likely to attain optimal LDL-C control than males.

Only 32.3% of our participants achieved optimal glycaemic control. Similar findings have also been seen among patients with diabetes in Africa. [10 12 22 23]. The proportion of patients with optimal glycaemic control in specialised diabetes care centers across six sub-Saharan African countries was reported to be 29% [12], despite using a lower cut-off value of 6.5%. Similarly, only 7-20% of patients have been said to have attained optimal glycaemic control (HbA1c level < 7%) in South African diabetic clinics[11 23]. Suboptimal glycaemic is, therefore, a big concern not only in Botswana but also in other African countries. In most of the findings, the majority of the patients have HbA1c > 8%, well above the recommended target (<7%) required to avoid the development of microvascular and macrovascular complications[11 12]. This could explain the four and tenfold prevalence of sight-threatening diabetic retinopathy and proliferative retinopathy found in African populations compared to European prevalence is [24]. Despite this poor glycaemic control level, few of our patients were on insulin suggesting clinical inertia in response to low glycaemic control[25]. Similar to other studies in Sub-Saharan Africa, the likelihood of attaining optimal glycaemic control decreased as the duration of diabetes increased[26]. There is evidence of a progressive loss of beta-cell function with increasing diabetes duration [6]. Insulin production progressively declines over time, leading to sub-optimal glycaemic control unless higher dosages or additional agents are initiated [6]. Comparable to reports from other studies, our older patients were more likely to achieve optimal glycaemic control than young ones[27 28]. It is possible that young patients are less likely to be compliant with medication and lifestyle modification as compared to their older counterparts. However, we need to research this further before making any concrete statements and instigating pertinent quality improvement programmes.

We also found a high prevalence (80.8%) of hypertension among patients attending our specialised diabetes clinic. A decade ago, the prevalence of hypertension among patients with diabetes in this setting was 61.2% [29]. Our findings may suggest an increasing burden of hypertension as seen globally, but also a reflection of the improvement in the screening and diagnosis of hypertension over the past few years[30]. We are aware that comparable high frequencies of hypertension have been reported in other African studies [12]. Consistent with previous studies, patients with hypertension were older, more obese, and had declining GFR and longer diabetes duration[10 31]. Thiazide diuretics; calcium channel blockers and ACE inhibitors were the three most used anti-hypertensive agents. This finding is in line with previous studies and guidelines recommendations suggesting that thiazide diuretics and calcium channels blockers are more effective than other anti-hypertensives in the black population [16 17 31]. Optimal hypertension control was observed in only 54.2% of the patients on anti-hypertensives, suggesting a need for efforts to improve identification and control of hypertension. This low rate is a concern given the increased mortality if

hypertension is not controlled[5]. Having said this, the proportion of patients with optimal hypertension control in our population was superior to several studies in Africa, notwithstanding, the variation of the definitions of optimal hypertension control across these studies [10 12 13 31 32]. In the present study, the use of ACE inhibitors was inversely associated with optimal hypertension control. Although ACEIs are indicated for patients with diabetes and proteinuria, they are associated with a clinically significant lesser reduction in both systolic and diastolic blood pressure in blacks. This could partly explain suboptimal hypertension control among our majority black patients. There appeared to be no influence of gender on hypertension control similar to other studies[33], which is encouraging as a recent systematic review found that males in low and middles income countries(LMICs) were more likely to be non-adherent to their medications [34 35].

Less than half of the patients (45%) were on lipid-lowering drugs, mostly statins. This is not surprising as the use of lipid-lowering drugs in Africa has been reported in as low as 3 – 13% of patients with diabetes due to the limited access to these drugs as well as lack of facilities for monitoring lipid profile while on treatment [12 35 36]. It is, however, a concern as the reduced use of statins will increase mortality rates in patients with diabetes[7]. In some countries, the issue of co-payments limits the prescription of expensive medications like statins[37]. Medicines are provided free of charge in Botswana; consequently, concerns with medication adherence due to co-payments should not be a problem[37 38]. Although the lack of co-payments has led to the more excellent use of statins in Botswana than in other African countries, we would expect the rate of statin prescriptions to mirror the high rates seen in Western countries[39]. Education and adherence to guidelines will possibly improve the prescription and use of statins by the majority of patients with diabetes according to treatment guidelines[16 18]. Even when statins were used, an undesirably small proportion of our patients achieved guideline-recommended LDL-C target level. Sub-optimal LDL-C control rates have also been reported across different settings, even in developed countries [8 12 40 41]. This is disappointing as achieving LDL-C reduction is said to be associated with the highest cardiovascular risk reduction than hypertension and HbA1c reduction[8]. Inadequate patients' adherence and possibly clinicians' under-dosage of statin for fear of potential side effects are some of the factors that possibly explain sub-optimal LDL-C control in our patients[8]. Besides, clinicians may be unaware of the current LDL-C as well as those of HbA1c and hypertension therapeutic goals[16 18]. Irrespective of the reason, there is an urgent need to instigate measures to meet guideline- recommended therapeutic, and we have started to address this in our clinics. As reported in other studies, women were less likely than men to achieve optimal LDL-C control[40]. Although the reason for this gender difference is not apparent, this information is significant for clinicians to pay attention to the management of women with diabetes in Botswana and other African countries.

Conclusion

In conclusion, there was a high prevalence of suboptimal attainment of recommended glycaemic, hypertension and LDL-C targets for patients with diabetes in the study settings. These findings call for urgent individual and health systems interventions to address the factors associated with sub-optimal control of the cardiovascular risk factors among patients with type 2 diabetes. This will be the subject of future initiatives and research in our clinic given the growing prevalence of patients with type 2 diabetes in Botswana.

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Competing Interests statement

Dr. Mwita has nothing to disclose.

Dr. Msafiri has nothing to disclose.

Dr. Omech has nothing to disclose.

Dr. Botsile has nothing to disclose.

Dr. Oyewo has nothing to disclose.

Dr. Godman has nothing to disclose.

Dr. Tshikuka has nothing to disclose.

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Author contributions

J.C.M was involved in the conception of the study, data analysis, drafting and revising the manuscript. B.O was involved in the conception of the study and critical revision of the manuscript. A.O, M.M participated in the conception of the study, data collection and critical revision of the manuscript. J.M.F participated in data analysis and manuscript review. E.B performed data entry and management, and critical revision of the manuscript. O.J.M, B.G, and J.G.T were involved in interpretation of the data and manuscript revision. All the authors granted a final approval of the version to be published; and agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Data sharing statement

The dataset analysed during the current study is available from the corresponding author on reasonable request, through the Princess Marina Hospital and Ministry of Health of Botswana ethical approval.

References

1. International Diabetes Federation. IDF Diabetes Atlas, 8th edition. 2017. http://www.diabetesatlas.org (accessed July 24, 2018).
2. World Health Organization. Global report on diabetes. 2016. http://apps.who.int/iris/bitstream/handle/10665/204871/9789241565257_eng.pdf;jsessionid=7534319F5DD126A2E538996187D64045?sequence=1 (accessed August 2, 2018).
3. Low Wang CC, Hess CN, Hiatt WR, et al. Clinical Update: Cardiovascular Disease in Diabetes Mellitus: Atherosclerotic Cardiovascular Disease and Heart Failure in Type 2 Diabetes Mellitus - Mechanisms, Management, and Clinical Considerations. *Circulation* 2016;133(24):2459-502. doi: https://doi.org/10.1161/CIRCULATIONAHA.116.022194 [published Online First: 2016/06/15]
4. Marks JB, Raskin P. Cardiovascular risk in diabetes: a brief review. *Journal of diabetes and its complications* 2000;14(2):108-15. doi: https://doi.org/10.1016/S1056-8727(00)00065-9 [published Online First: 2000/08/26]
5. U.K Prospective Diabetes Study Group. Tight blood pressure control and risk of macrovascular and microvascular complications in type 2 diabetes: UKPDS 38. *BMJ (Clinical research ed)* 1998;317(7160):703-13. doi: https://doi.org/10.1136/bmj.317.7160.703 [published Online First: 1998/09/11]
6. U.K. Prospective Diabetes Study Group. Overview of 6 years' therapy of type II diabetes: a progressive disease: UKPDS 16. *Diabetes* 1995;44(11):1249-58. doi: https://doi.org/10.2337/diab.44.11.1249 [published Online First: 1995/11/01]
7. Collins R, Armitage J, Parish S, et al. MRC/BHF Heart Protection Study of cholesterol-lowering with simvastatin in 5963 people with diabetes: a randomised placebo-controlled trial. *Lancet (London, England)* 2003;361(9374):2005-16. doi: https://doi.org/10.1016/S0140-6736(03)13636-7 [published Online First: 2003/06/20]
8. Wan EYF, Fung CSC, Yu EYT, et al. Effect of Multifactorial Treatment Targets and Relative Importance of Hemoglobin A1c, Blood Pressure, and Low-Density Lipoprotein-Cholesterol on Cardiovascular Diseases in Chinese Primary Care Patients With Type 2 Diabetes Mellitus: A Population-Based Retrospective Cohort Study. *Journal of the American Heart Association* 2017;6(8):e006400. doi: https://doi.org/10.1161/JAHA.117.006400
9. Saydah SH, Fradkin J, Cowie CC. Poor control of risk factors for vascular disease among adults with previously diagnosed diabetes. *JAMA* 2004;291(3):335-42. doi: https://doi.org/10.1001/jama.291.3.335 [published Online First: 2004/01/22]
10. Mwita JC, Mugusi F, Lwakatare J, et al. Hypertension control and other cardiovascular risk factors among diabetic patients at Muhimbili National Hospital, Tanzania. *East African journal of public health* 2012;9(2):70-73.
11. Klisiewicz A, Raal F. Sub-optimal management of type 2 diabetes mellitus–a local audit. *Journal of Endocrinology, Metabolism and Diabetes of South Africa* 2009;14(1)
12. Sobngwi E, Ndour-Mbaye M, Boateng KA, et al. Type 2 diabetes control and complications in specialised diabetes care centres of six sub-Saharan African countries: the Diabcare Africa study. *Diabetes research and clinical practice* 2012;95(1):30-36. doi: https://doi.org/10.1016/j.diabres.2011.10.018 [published Online First: 2011/11/11]
13. Kibirige D, Atuhe D, Sebunya R, et al. Suboptimal glycaemic and blood pressure control and screening for diabetic complications in adult ambulatory diabetic patients in

Uganda: a retrospective study from a developing country. *Journal of Diabetes & Metabolic Disorders* 2014;13(1):40.

14. World Health Organization. The Abuja declaration: ten years on. 2011. 2016. http://www.who.int/healthsystems/publications/abuja_report_aug_2011.pdf?ua=1 (accessed August 25, 2018).
15. Chobanian AV, Bakris GL, Black HR, et al. The Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure: the JNC 7 report. *JAMA* 2003;289(19):2560-72. doi: https://doi.org/10.1001/jama.289.19.2560 [published Online First: 2003/05/16]
16. SEMDSA Type 2 Diabetes Guidelines Expert Committee. SEMDSA 2017 guidelines for the management of type 2 diabetes mellitus. *J Endocr Metab Diabetes S Afr* 2017;22(1 Suppl 1):S1-S196.
17. James PA, Oparil S, Carter BL, et al. 2014 evidence-based guideline for the management of high blood pressure in adults: Report from the panel members appointed to the eighth joint national committee (JNC 8). *JAMA* 2014;311(5):507-20. doi: https://doi.org/10.1001/jama.2013.284427 [published Online First: 2013/12/20]
18. American Diabetes Association. Standards of Medical Care in Diabetes-2017 Abridged for Primary Care Providers. *Clinical diabetes : a publication of the American Diabetes Association* 2017;35(1):5-26. doi: https://doi.org/10.2337/cd16-0067 [published Online First: 2017/02/02]
19. Work Group and Evidence Review Team Membership. K/DOQI clinical practice guidelines for chronic kidney disease: evaluation, classification, and stratification. *American journal of kidney diseases : the official journal of the National Kidney Foundation* 2002;39(2 Suppl 1):S1-266. doi: https://doi.org/10.1016/S0272-6386(02)70084-X [published Online First: 2002/03/21]
20. Levey AS, Greene T, Schluchter MD, et al. Glomerular filtration rate measurements in clinical trials. Modification of Diet in Renal Disease Study Group and the Diabetes Control and Complications Trial Research Group. *Journal of the American Society of Nephrology : JASN* 1993;4(5):1159-71. [published Online First: 1993/11/01]
21. World Health Organization. Waist circumference and waist-hip ratio: report of a WHO expert consultation, Geneva, 8-11 December 2008. 2011. http://www.who.int/iris/handle/10665/44583 (accessed 27/08/2018).
22. Adeniyi OV, Yogeswaran P, Longo-Mbenza B, et al. Cross-sectional study of patients with type 2 diabetes in OR Tambo district, South Africa. *BMJ Open* 2016;6(7):e010875. doi: http://dx.doi.org/10.1136/bmjopen-2015-010875 [published Online First: 2016/07/31]
23. Erasmus RT, Blanco Blanco E, Okesina AB, et al. Assessment of glycaemic control in stable type 2 black South African diabetics attending a peri-urban clinic. *Postgrad Med J* 1999;75(888):603-6. doi: http://dx.doi.org/10.1136/pgmj.75.888.603 [published Online First: 2000/01/06]
24. Burgess PI, Allain TJ, García-Fiñana M, et al. High prevalence in Malawi of sight-threatening retinopathy and visual impairment caused by diabetes: identification of population-specific targets for intervention. *Diabetic Medicine* 2014;31(12):1643-50. doi: http://dx.doi.org/10.1111/dme.12492
25. Shah BR, Hux JE, Laupacis A, et al. Clinical inertia in response to inadequate glycemic control: do specialists differ from primary care physicians? *Diabetes Care*

2005;28(3):600-6. doi: http://dx.doi.org/10.2337/diacare.28.3.600 [published Online First: 2005/03/01]
26. Camara A, Balde NM, Sobngwi-Tambekou J, et al. Poor glycemic control in type 2 diabetes in the South of the Sahara: the issue of limited access to an HbA1c test. *Diabetes Res Clin Pract* 2015;108(1):187-92. doi: https://doi.org/10.1016/j.diabres.2014.08.025 [published Online First: 2015/02/24]
27. El-Kebbi IM, Cook CB, Ziemer DC, et al. Association of younger age with poor glycemic control and obesity in urban African Americans with type 2 diabetes. *Arch Intern Med* 2003;163(1):69-75. doi: https://doi.org/10.1001/archinte.163.1.69 [published Online First: 2003/01/14]
28. Fox KM, Gerber Pharmd RA, Bolinder B, et al. Prevalence of inadequate glycemic control among patients with type 2 diabetes in the United Kingdom general practice research database: A series of retrospective analyses of data from 1998 through 2002. *Clin Ther* 2006;28(3):388-95. doi: https://doi.org/10.1016/j.clinthera.2006.03.005 [published Online First: 2006/06/06]
29. Mengesha AY. Hypertension and related risk factors in type 2 diabetes mellitus (DM) patients in Gaborone City Council (GCC) clinics, Gaborone, Botswana. *African health sciences* 2008;7(4)
30. Forouzanfar MH, Liu P, Roth GA, et al. Global Burden of Hypertension and Systolic Blood Pressure of at Least 110 to 115 mm Hg, 1990-2015. *JAMA* 2017;317(2):165-82. doi: https://doi.org/10.1001/jama.2016.19043 [published Online First: 2017/01/18]
31. Choukem SP, Kengne AP, Dehayem YM, et al. Hypertension in people with diabetes in sub-Saharan Africa: revealing the hidden face of the iceberg. *Diabetes Res Clin Pract* 2007;77(2):293-9. doi: http://dx.doi.org/10.1016/j.diabres.2006.11.007 [published Online First: 2006/12/23]
32. Adeniyi OV, Yogeswaran P, Longo-Mbenza B, et al. Uncontrolled Hypertension and Its Determinants in Patients with Concomitant Type 2 Diabetes Mellitus (T2DM) in Rural South Africa. *PLoS One* 2016;11(3):e0150033. doi: http://dx.doi.org/10.1371/journal.pone.0150033 [published Online First: 2016/03/02]
33. Nashilongo MM, Singu B, Kalemeera F, et al. Assessing Adherence to Antihypertensive Therapy in Primary Health Care in Namibia: Findings and Implications. *Cardiovascular drugs and therapy* 2017;31(5-6):565-78. doi: https://doi.org/10.1007/s10557-017-6756-8. [published Online First: 2017/10/17]
34. Nielsen JO, Shrestha AD, Neupane D, et al. Non-adherence to anti-hypertensive medication in low- and middle-income countries: a systematic review and meta-analysis of 92443 subjects. *Journal of human hypertension* 2017;31(1):14-21. doi: https://doi.org/10.1038/jhh.2016.31 [published Online First: 2016/06/17]
35. Gudina EK, Amade ST, Tesfamichael FA, et al. Assessment of quality of care given to diabetic patients at Jimma University Specialised Hospital diabetes follow-up clinic, Jimma, Ethiopia. *BMC Endocr Disord* 2011;11:19. doi: http://dx.doi.org/10.1186/1472-6823-11-19 [published Online First: 2011/12/22]
36. Uloko AE, Ofoegbu EN, Chinenye S, et al. Profile of Nigerians with diabetes mellitus - Diabcare Nigeria study group (2008): Results of a multicenter study. *Indian J Endocrinol Metab* 2012;16(4):558-64. doi: http://dx.doi.org/10.4103/2230-8210.98011 [published Online First: 2012/07/28]

37. Simoens S, Sinnaeve PR. Patient co-payment and adherence to statins: a review and case studies. *Cardiovascular drugs and therapy* 2014;28(1):99-109. doi: http://dx.doi.org/10.1007/s10557-013-6497-2 [published Online First: 2013/10/24]
38. Mathes T, Jaschinski T, Pieper D. Adherence influencing factors - a systematic review of systematic reviews. *Archives of public health = Archives belges de sante publique* 2014;72(1):37. doi: http://dx.doi.org/10.1186/2049-3258-72-37 [published Online First: 2015/02/12]
39. Pokharel Y, Akeroyd JM, Ramsey DJ, et al. Statin Use and Its Facility-Level Variation in Patients With Diabetes: Insight From the Veterans Affairs National Database. *Clinical cardiology* 2016;39(4):185-91. doi: http://dx.doi.org/10.1002/clc.22503 [published Online First: 2016/04/10]
40. Pinchevsky Y, Shukla V, Butkow N, et al. The achievement of glycaemic, blood pressure and LDL cholesterol targets in patients with type 2 diabetes attending a South African tertiary hospital outpatient clinic. *Journal of Endocrinology, Metabolism and Diabetes of South Africa* 2015;20(2):81-86. doi: http://dx.doi.org/10.1080/16089677.2015.1056468
41. Pinchevsky Y, Butkow N, Chirwa T, et al. Glycaemic, blood pressure and cholesterol control in 25 629 diabetics. *Cardiovasc J Afr* 2015;26(4):188-92. doi: http://dx.doi.org/10.5830/cvja-2015-050 [published Online First: 2015/09/26]

Table 1: Clinical and socio-demographic characteristics of patients with type 2 diabetes at a specialised Diabetes clinic in Gaborone (N= 500)

Characteristics	All (N=500)	Males(n= 170)	Females(n= 330)	P value
Mean age (SD), years	58.9 ± 12.2	55.4 ± 12.6	60.8 ± 11.6	**<0.001**
Age <50 years n (%)	109(21.80)	57 (33.5)	52 (15.8)	**<0.001**
Age ≥ 50 years n (%)	391 (78.20)	113 (66.5)	278(84.2)	
Diabetes duration, median, IQR, years	6 (2 – 13)	6.5 (2 – 14)	6 (2.5 – 13)	**0.927**
HbA1c mean (SD), %	8.4 (2.4)	8.6 (2.7)	8.4 (2.4)	**0.199**
Diabetes treatment				
Diet alone n (%)	11(2.2)	3(1.8)	8 (2.4)	**0.001**
Insulin alone n (%)	68 (13.6)	38(22.3)	30 (9.1)	
OHA alone n (%)	271(54.2)	82(48.2)	189 (57.3)	
Insulin and OHA	150 (30.0)	47(27.7)	103(31.2)	
BMI, mean (SD) kg/m^2	30.5 ± 6.0	28.7 ± 5.2	31.4 ± 6.2	<0.001
Normal weight n (%)	93 (18.7)	46(27.1)	49 (14.9)	<0.001
Overweight n (%)	155(31.1)	61(36.3)	94 (28.5)	
Obese n (%)	250(50.2)	63 (37.1)	187(56.7)	
Marital status				
Living alone n (%)	266 (53.20)	55 (32.4)	211(63.9)	**<0.001**
Living with a partner n (%)	234(46.8)	115 (67.6)	119(36.01)	
Education status				<0.001
No formal education, n (%)	77(15.4)	26(15.3)	51 (15.5)	
Primary School, n (%)	229(45.8)	56 (32.9)	173 (52.4)	
Secondary school, n (%)	131(26.2)	55(32.4)	76 (23.0)	
College/University, n (%)	63(12.6)	33 (19.4)	30 (9.1)	
WC, mean (SD), cm	103.3 ±12.5	101.7 ± 11.9	104.0 ± 12.7	**0.049**
WHR	0.94 ± 0.10	0.97 ± 0.09	0.93 ± 0.10	**<0.001**
Low WHR n (%)	75 (44.1)	16(4.9)		**<0.001**
High WHR n (%)	95 (55.9)	314(95.2)		
CKD n (%)	54 (10.8)	24 (14.1)	30 (9.1)	**0.086**
eGFR, Median, IQR (ml/min/1.73m²)	112.5(84.3–138.1)	113.1(80.8 –139.5)	112.3(84.4 –137.9)	0.737
Total cholesterol mean (SD), mmol/L	4.4(1.1)	4.3(1.2)	4.5(1.1)	**0.030**
LDL-C mean (SD), mmol/L	2.8(1.0)	2.6(1.0)	2.9(1.0)	**0.006**
Macroproteinuria n (%)	51(10.20)	27 (15.9)	24(7.27)	**0.003**
Hypertension n (%)	404 (80.80)	120 (70.59)	284(86.06)	<0.001
Dyslipidaemia n (%)	358 (71.60)	114 (67.06)	244(73.94)	0.106

Legend: DM - Diabetes mellitus; WC- waist circumference; BMI- Body Mass Index; SD- standard deviation; IQR – interquartile range; eGFR- estimated glomerular filtration rate; LDL-C – Low-density lipoprotein; WHR – Waist-hip ratio, HbA1c- Haemoglobin A1c; CKD- Chronic kidney disease; OHA – oral hypoglycaemic agent

Table 2: Factors associated with optimal glycaemic control among patients with type 2 diabetes at a specialised diabetes clinic in Gaborone (N= 500)

Characteristic	Unadjusted OR(95% CI)	P value	Adjusted OR (95%CI)	P value
Age group				
> 50 years	1		1	
≤ 50 years	2.16(1.29 – 3.61)	**0.003**	5.79 (1.08 – 31.14)	**0.041**
Diabetes duration, years	0.97(0.95 –0.99)	**0.040**	0.909 (0 .85 – 0.98)	**0.011**
Diabetes treatment				
Insulin alone(yes)	0.80(0.45– 1.43)	0.450		
OHA alone(yes)	2.785 (1.862 –4.167)	**<0.001**	0.90 (0.46 – 1.74)	0.745
Insulin and OHA(yes)	0.185 (0.124 – 0.356)	**<0.001**	0.34 (0 .07 – 1.70)	0.188
BMI	0.99(0.96 – 1.02)	0.427		
Normal weight	1			
Overweight	1.10 (0.64– 1. 90)	0.721		
Obese	0. 83(0. 50 – 1.39)	0.476		
Gender				
Men	1			
Women	0.92(0.62 – 1.36)	0.663	0.42 (0.14 – 1.25)	0.120
Education status				
None	1	1		
Primary School	1.58(0.88 – 2.81)	0.124		
Secondary school	1.14 (0.60 – 2.16)	0.687		
College/University	1.00(0.47 – 2.13)	0.996		
Marital status				
Living alone	1			
Living with a partner	0.93 (0.64 – 1.36)	0.703		
WHR	0.92 (0.13 – 6.58)	0.937		
Low WHR	1			
High WHR	0.92(0.57 – 1.50	0.745		
Weight, kg	0.99 (0.98 – 1.01)	0.298		
eGFR, (ml/min/1.73m²)	1.00 (0.99 – 1.00)	0.074	1.00(0.99 – 1.01)	0.766
CKD (yes)	1.053 (0.578 – 1.920	0.866		
Macroproteinuria(yes)	1.16(0.63 – 2.14)	0.624		
Optimal hypertension control(yes)	2.53 (1.63 – 3.93)	<0.001	1.61(0.63 – 4.13)	0.322
Optimal LDL-C control(yes)	2.10 (0.90 – 4.88)	0.086	2.20 (0.64 – 7.57)	0.209

Legend: Legend: BMI- Body Mass Index; CKD- Chronic kidney disease; DM - Diabetes mellitus; eGFR- estimated glomerular filtration rate; IQR – interquartile range; LDL-C – Low-density lipoprotein; OHA – oral hypoglycaemic agent; SD- standard deviation; WHR – Waist-hip ratio.

Table 3: Factors associated with optimal hypertension control among patients with type 2 diabetes at a specialised diabetes clinic in Gaborone (N= 500)

Characteristic	Unadjusted OR (95% CI)	P value	Adjusted OR (95% CI)	P value
Age group				
< 50 years	1			
≥50 years	0.885(0.483 – 1.619)	0.691		
Diabetes duration, years	0.972 (0.947 – 0.997)	**0.023**	0 .975 (0.923 – 1.029)	0.352
Diabetes treatment				
Insulin alone(yes)	0.446 (0.243 – 0.819)	**0.009**	1.150 (0.304 – 4.435)	0.837
OHA alone(yes)	1.940 (1.295 – 2.908)	**0.001**	1.370 (0.512 – 3.661)	0.531
Insulin and OHA(yes)	0.588 (0.403 – 0.949)	**0.028**	1.15(0.304 – 4.374)	0.837
BMI, kg/m^2				
Normal weight	1			
Overweight	0.786 (0.422 – 1.465	0.449		
Obese	0.774(0.435 – 1.378	0.384		
Gender				
Men	1			
Women	1.425(0.915 – 2.219)	0.117	0.968 (0.359 – 2.608)	0.949
Marital				
Living alone	1			
Living with partner	0.675 (0.614 –1.371)	0.668		
Education status				
No formal education	1			
Primary School	1.028(0.578 – 1.827)	0.09		
Secondary school	1.078(0.556 – 2.091)	0.22		
College/University	0.887(0.410 – 1.919)	0.761		
WHR	1.293 (0 .139 – 11.997)	0.821		
Low WHR	1			
High WHR	1.177 (0.653 – 2.121)	0.589		
eGFR, (ml/min/1.73m²)	1.004 (0.999 – 0 1.009	0.139	1.004(0.994 – 1.015)	0.412
Serum Cholesterol	0.964 (0.804 – 1.156)	0.693		
Macroproteinuria	0.484(0.255 –0.921)	**0.027**	0.360(0.072 1.800) . .35961	0.213
Antihypertensive				
CCB(yes)	0.729(0.718 – 1.607)	0.729		
Thiazides(yes)	1.583(1.058 – 2.369)	**0.026**	1.444 (0.615 – 3.391)	0.399
ACEI(yes)	0.636 (0.425 – 0.952)	**0.028**	0.348 (0.142 – 0.849)	**0.020**
ARB(yes)	0.947(0.568 – 1.578)	0.834		
Alpha blocker(yes)	0.243(0.087 – 0.677)	**0.007**	0.756 (0.136 –4.195)	0.749
Beta blocker(yes)	0.702 (0.434 –1.135)	0.149	0.514(0.193 – 1.374)	0.184
Optimal Glycaemic control(yes)	2.531 (1.631 – 3.928)	**<0.001**	1.921 (0.706 –5.228)	0.201
Optimal LDL-C control(yes)	0.554 (0.225 – 1.363)	0.199	0.754 (0.245 – 2.320	0.623

Legend: ACEI – Angiotensin-converting enzyme inhibitors; ARB – Angiotensin Receptor Blockers; BMI- Body Mass Index; CCB- Calcium Channel Blockers; DM - Diabetes mellitus; eGFR- estimated glomerular filtration rate; HbA1c- Haemoglobin A1c; IQR – interquartile range; LDL-C – Low-density lipoprotein; OHA – oral hypoglycaemic agent; SD- standard deviation; WHR – Waist-hip ratio.

Table 4: Factors associated with optimal LDL-C control among patients with type 2 diabetes at a specialised diabetes clinic in Gaborone (N= 500)

Characteristic	Unadjusted OR (95% CI)	P value	Adjusted OR (95% CI)	P value
Age group				
<50 years	1			
≥ 50 years	0.559 (0.208 – 1.503)	0.249		
Diabetes duration, years	1.016(0. 968 – 1.064)	0.525		
Diabetes treatment				
Insulin alone(yes)	1.578 (0.559 – 4.458)	0.389		
OHA alone(yes)	0.95 (0.426 – 2.119)	0.9		
Insulin and OHA(yes)	0.825 (0.345 – 1.968)	0.664		
BMI	0.998 (0.933 –1.068)	0.951		
Normal weight	1			
Overweight	1.429 (0.344 – 5.940)	0.624		
Obese	1.269(0.329 – 4.889)	0.730		
Gender				
Men	1			
Women	0.2 (0.086 – 0.467)	**<0.001**	0.211 (0.077 – 0.578)	0.002
Education status				
No formal education	1	1		
Primary School	0.793 (0. 294 – 2.140)	0.647		
Secondary school	0.284 (0.068 – 1.198)	0.087		
College/University	0.786(0.199 – 3.106)	0.731		
Marital status				
Living alone	1			
Living with a partner	.986 (0.441– 2.204)	0.973		
HbA1c	1.001(0.850 – 0.198)	0.917		
Low WHR	1			
High WHR	0.307(0.105 – 0.891)	**0.030**	1.699(0.361 – 7.982)	0.502
Macroproteinuria	0.688 (0.144 – 3.286)	0.64		
eGFR, (ml/min/1.73m²)	0.999(0.991 – 1.008)	0.878		
CKD (yes)	1.8756(0 .727 – 4.833)	0.193		
Hypertension (yes)	1.125 (0.299 – 4.232)	0.862		

Legend: Legend: BMI- Body Mass Index; CKD- Chronic kidney disease; DM - Diabetes mellitus; eGFR- estimated glomerular filtration rate; IQR – interquartile range; LDL-C – Low-density lipoprotein; OHA – oral hypoglycaemic agent; SD- standard deviation; WHR–Waist-hip ratio

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	1
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	2
Objectives	3	State specific objectives, including any prespecified hypotheses	2
Methods			
Study design	4	Present key elements of study design early in the paper	2
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	2
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	2
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	2
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	2
Bias	9	Describe any efforts to address potential sources of bias	*2*
Study size	10	Explain how the study size was arrived at	2
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	3
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	3
		(*b*) Describe any methods used to examine subgroups and interactions	3
		(*c*) Explain how missing data were addressed	
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	
		(*e*) Describe any sensitivity analyses	
Results			3

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	3
		(b) Give reasons for non-participation at each stage	
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	4
		(b) Indicate number of participants with missing data for each variable of interest	
Outcome data	15*	Report numbers of outcome events or summary measures	4,5
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	4,5
		(*b*) Report category boundaries when continuous variables were categorized	4,5
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	
Discussion			
Key results	18	Summarise key results with reference to study objectives	5
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	1
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	8
Generalisability	21	Discuss the generalisability (external validity) of the study results	8
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	8

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Glycaemic, blood pressure and low-density lipoprotein-cholesterol control among patients with diabetes mellitus in a specialised clinic in Botswana: a cross-sectional study

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Glycaemic, blood pressure and low-density lipoprotein-cholesterol control among patients with diabetes mellitus in a specialised clinic in Botswana: a cross-sectional study

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Abstract

Objective: Control of glycaemic, hypertension and low-density lipoprotein-cholesterol (LDL-C) among type 2 diabetes mellitus (T2DM) patients is vital for the prevention of cardiovascular diseases (CVD). The current study was an audit of glycaemic, hypertension, and LDL-C control among ambulant patients with type 2 diabetes mellitus in Botswana. Also, the study aimed at assessing factors associated with attaining optimal glycaemic, hypertension and LDL-C therapeutic goals.

Design: A cross-sectional study.

Setting: A specialised public diabetes clinic in Gaborone, Botswana.

Participants: Type 2 diabetes mellitus patients who had attended the clinic for ≥ three months between August 2017 and February 2018.

Primary outcome measure: The proportion of patients with optimal glycaemic (HbA1c <7 %), hypertension (blood pressure <140/90mmHg) and LDL-C (<1.8mmol/L) control.

Results: The proportions of patients meeting optimal targets were 32.3% for glycaemic, 54.2% for hypertension, and 20.4% for LDL-C. Optimal glycaemic control was positively associated with age ≥ 50 years (AOR 5.79; 95% CI 1.08 - 31.14) but was inversely associated with an increase in diabetes duration (AOR 0.91; 95%CI 0.85 - 0.98). Being on an angiotensin-converting-enzyme inhibitor (ACE inhibitor) was inversely associated with optimal hypertension control (AOR 0.35; 95% CI 0.14 - 0.85). Being female (AOR 0.24; 95% CI (0.09 - 0.59) was inversely associated with optimal LDL-C control.

Conclusion: Patients with Type 2 diabetes mellitus in Gaborone, Botswana, presented with suboptimal control of recommended glycaemic, hypertension and LDL-C targets. These findings call for urgent individual and health systems interventions to address key determinants of the recommended therapeutic targets among patients with diabetes in this setting.

Keywords: Glycaemic, hypertension, LDL-C, cholesterol, control Diabetes Mellitus, Botswana

Strengths and limitations of this study

- The first study to objectively assess the three critical therapeutic targets in patients with diabetes in Botswana.
- The study was done in one specialised public diabetes clinic and may not be generalised to other facilities in the country. The clinic is, however, a leading diabetes care facility in the country; hence the results may predict the status in other facilities.
- The cross-sectional design limited the assessment of the temporal relationship between factors associated with poor control of glycaemia, LDL-C and hypertension.
- Systematic random sampling and incomplete data in some participants may not have yielded a representative sample of our clinic enrollees.

Introduction

Diabetes mellitus and related cardiovascular complications are growing public health concerns worldwide [1 2]. There are approximately 16 million people with diabetes in Africa, and this number is projected to increase to 41 million by 2045 due to rapid urbanisation, lifestyles changes and nutrition transition in the continent [1]. This increase in prevalence and incidence of diabetes is attributable to type 2 diabetes, which is associated with multiple comorbidities such as obesity and hypertension requiring chronic care and catastrophic health expenditure[1]. Diabetes and associated comorbidities are known to increase patients' risk of developing cardiovascular diseases (CVD), which are responsible for approximately 70% of diabetes-related deaths[3]. The risk to the development of CVD is higher in people with suboptimal glycaemic, hypertension and LDL-C control [3 4]. A reduction of HbA1c to control targets along with optimal hypertension control and the use of statins to lower LDL-C levels have been shown to improve long-term outcomes including reducing mortality among patients with diabetes [5-8]. Achieving these targets remains a challenge in most settings, especially those with limited access to standard diabetes care[9-13]. Only a minority of patients with diabetes in Africa achieves optimal therapeutic targets, leaving the majority of patients at high risk of diabetes-related complications [12]. Suboptimal treatment to recommended targets is a public health concern because the current total health expenditure in most sub-Saharan African countries remains far below the 15% recommended in the Abuja declaration [14]. The rising cost of managing diabetes complications will further make health system goals unattainable[1]. Thus, this study was an audit of glycaemic, hypertension, and LDL-C control among ambulant patients with type 2 diabetes mellitus in Botswana. The study also assessed factors associated with attainment of glycaemic, blood pressure and LDL-C therapeutic targets in these patients.

Methods

Study design and participants

We conducted a cross-sectional study of outpatients with established type 2 diabetes attending a specialised public diabetes clinic in Gaborone, Botswana between August 2017 and February 2018. The clinic has been operational since 2011 as a referral centre for health facilities in Gaborone and nearby towns. Eligible patients were those aged ≥ 18 years and had received care from the clinic for at least three months. Systematic random sampling was used to select patients from a list of patients who attended the clinic every day. We randomly picked the first patient from the first eight people in the queue. Subsequently, every eighth individual was enrolled until either the daily target of 10 patients was reached or the clinic came to an end. As there was a daily variation of the number of clinic attendees, the number of our daily enrolments varied as well. Participants provided informed consent before enrolment. The Ministry of Health (HPDME: 13/18/1 VOL XI) and Princess Marina Hospital (PMH 5/79,317-1-2017) Institutional Review Boards granted ethical approval for the study.

Data collection and procedures

Patient information was collected using an interviewer-administered questionnaire and through reviews of medical charts and electronic records. The information included: demographic data (age, gender, occupation, marital status, and education), diabetes duration, history of hypertension, and medications for diabetes, hypertension and lipid disorders. We performed anthropometry (weight, height, waist and hip circumferences) and blood pressure measurements at enrolment. We conducted three blood pressure measurements after 10 minutes of rest, and the mean of the three measurements was recorded[15]. Moreover, we documented blood pressure readings from each patient's prior visit. Patients' serum creatinine, LDL-C and HbA1c, and urine dipstick for proteinuria results over the past six months were abstracted from the electronic medical records.

Definitions of the key outcomes and exposure variables

We calculated the diabetes duration as the date of enrolment into the study minus the date of diabetes diagnosis. A patient was considered hypertensive by self-reported hypertension and the use of blood pressure-lowering medications or had sustained blood pressure ≥140/90 mmHg during the previous visit and at enrolment [16-18]. Optimal glycaemic control was defined as HbA1c < 7% [16 18]. For patients who were on lipid-lowering medications, optimal LDL-C control was LDL cholesterol level <1.8mmol/L[16]. We calculated patients' eGFR by the Modification of Diet in Renal Disease (MDRD) formula, and an eGFR <60.0 mL/min/1.73m^2 defined Chronic Kidney Disease (CKD)[2 19 20]. Body mass index (BMI) was calculated as weight in kilograms divided by the square of height in meters. We considered underweight as BMI < 18.5 kg/m2, normal weight as BMI of 18.5 –24.9 kg/m^2, overweight as BMI of 25.0 –29.9 kg/m^2, and obesity as BMI ≥ 30 kg/m^2 [21]. Waist-hip ratio (WHR) was calculated as waist circumference (WC) in centimetres divided by hip circumference (HC) in centimetres and classified as high when WHR was ≥ 0.85 and ≥ 0.90 for women and men respectively[21].

Patient and Public Involvement

We did not directly involve patients in the design, recruitment to and conduct of the study. However, the development of the research question and outcome measures were informed by patients' priorities, experience, and preferences. These were realised during the regular diabetes support group meetings where the authors of this study interact with patients and their families. Investigators working at the clinic will discuss the study findings with colleagues and provide them with critical results for sharing with patients (study participants). In close collaboration with the patient support group, the investigation team will summarize the results in plain language for a large poster and place it in a waiting room.

Statistical analysis

We performed analyses using Stata, Version 14 (Stata Corp, College Station, TX). We used percentages to summarise categorical variables. Means and standard deviation (SD) or medians and interquartile range (IQR) were used to summarise continuous variables. Pearson's $\chi 2$ or Fisher's exact tests were used to assessing statistical differences by gender for the categorical variables, while the Student's t-test or the Mann-Whitney U test were used for the continuous ones. Bivariate logistic regression was used to explore factors associated with each primary outcome - glycaemic, hypertension and LDL-C control. We further performed three multivariate logistic regression models for each of the three outcomes. The independent variables selected for multivariate models were those displaying a p-value < 0.2 at the univariate analysis level in addition to those considered clinically meaningful (age and gender). We described results as crude odds ratio (OR), adjusted odds ratio (AOR), and their corresponding 95% confidence intervals (95% CI). We used the Hosmer-Lemeshow goodness-of-fit test to assess how well the data fit the model [22]. A 2-tailed p-value < 0.05 was considered statistically significant.

Results

The response rate was 97%, as only 17 (3.4%) of the approached participants declined participation because of time constraints We included 500 patients with type 2 diabetes in the study, of which 330 (66%) were females. The mean (SD) age was 58.9 (12.2) years, and 78.2% were aged > 50 years. The median (IQR) diabetes duration was 6 (2 - 13) years. There was a high percentage of patients with hypertension (80.8%), overweight (31.1%) and obesity (50.2%). Table 1 summarises the patients' characteristics by gender. Female patients tended to be older (60.8 vs 55.4 years, p < 0.001, obese (56.7% vs 37.1%, p < 0.001), have higher WHR (95.2% vs 55.9%), be hypertensive (86.1% vs 70.6%, p <0.001), and have a higher mean total cholesterol (4.5mmol/L vs 4.3mmol/L, p = 0.030) and LDL-C (2.9 mmol/L vs 2.6 mmol/L, p = 0.006) than male patients. Urine dipstick was positive for protein in 10.2% of patients, mostly males (15.9% vs 7.3%, p = 0.003).

[Table 1: Clinical and socio-demographic characteristics of patients with type 2 diabetes at a specialised Diabetes clinic in Gaborone (N= 500)]

Optimal glycaemic control

The mean (SD) HbA1c was 8.4 % (2.4) overall, 8.6% (2.7) for female and 8.0% (1.6) for male patients (p=0.199) [Table 1]. The proportion of the patients receiving oral hypoglycaemic agents alone was 54.2%; 30% were on oral hypoglycaemic agents combined with insulin; 13.6% on insulin alone and 2.2% were on a diet alone. Of the 218 patients on insulin, 184 (84.4%) were on premix insulin. Of the 421 patients on oral hypoglycaemic agents, 411(97.6%) patients were on metformin, and 194 (46.1%) patients were on a sulphonylurea. Compared to patients on other anti-diabetic medications, those on insulin injections were

more likely to be males. We noted optimal glycaemic control in 159 (32.3%) patients, whose mean) HbA1c was 6.1 %. Age over 50 years was associated with optimal glycaemic control (AOR 5.79; 95%CI 1.08 - 31.14). On the other hand, an increase in diabetes duration was inversely associated with optimal glycaemic control (AOR 0.91; 95%CI 0.85 - 0.98**).** There was no association between gender, anthropometry, diabetes medications or education on the level of glycaemic control [Table 2].

[Table 2: Factors associated with optimal glycaemic control among patients with type 2 diabetes at a specialised diabetes clinic in Gaborone (N= 500)]

Optimal hypertension control

There were 404 (80.8%) hypertensive patients [Table 1]. Age ≥ 50 years (AOR 4.95; 95%CI 2.81-8.73), increased WHR (AOR 3.87; 95%CI 1.72 - 8.71), eGFR (AOR 0.98; 95% CI 0.97 - 0.99), and a long diabetes duration (AOR= 1.07, 95% CI1.02 - 1.12) were associated with hypertension. Seventeen (4.2%) hypertensive patients did not receive any antihypertensive medication. Of the 389 patients who received antihypertensive medications, 219 (56.3%) received calcium channel blockers, 189 (48.6%) were treated with thiazides diuretics, 183(47.0%) with angiotensin-converting-enzyme inhibitors (ACE inhibitors), and 74(19.0%) with Angiotensin II receptor blockers (ARBs). The proportions of patients receiving β- and α-blockers were 22.4% and 5.4% respectively.

Of the 389 patients who received antihypertensive medicines, optimal hypertension control was noted in 211 (54.2%) patients. Patients on ACE inhibitors were less likely to attain optimal hypertension control compared to those who were not on ACE inhibitors (AOR 0.24; 95% CI (0.09 - 0.59). There was no association between gender, anthropometry, or education on the level of hypertension control [Table 3].

[Table 3: Factors associated with optimal hypertension control among patients with type 2 diabetes at a specialised diabetes clinic in Gaborone (N= 500)]

Optimal LDL-C control

A total of 225 (45%) patients were receiving lipid-lowering drugs, mostly (96.4%) atorvastatin. Of these, 147 (65.3%) patients had LDL-C measurements available. Only 30 (20.4%) achieved the optimal LDL-C control target. Females were less likely to achieve optimal LDL-C control as compared to males, (0.24; 95% CI (0.09 - 0.59). There was no association of age, anthropometry, or education on the level of LDL-C control [Table 4].

[Table 4: Factors associated with optimal LDL-C control among patients with type 2 diabetes at a specialised diabetes clinic in Gaborone (N= 500)]

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Discussion

This outpatient cross-sectional study showed a low proportion of patients with optimal control of glycaemic, hypertension, and LDL-C among Type 2 patients attending a diabetes clinic in Botswana. In the multivariate analysis, duration of diabetes and age above 50 years were significantly associated with optimal glycaemic control. Being on ACE inhibitors was inversely related to optimal hypertension control. Females were less likely to attain optimal LDL-C levels than males.

Only 32.3% of our participants achieved optimal glycaemic control. Similarly, low levels of glycaemic control have also been seen among patients with diabetes in Africa [10 12 23 24]. The proportion of patients with optimal glycaemic control (HbA1c < 6.5%) in specialised diabetes care centres across six sub-Saharan African countries was reported to be 29% [12]. Similarly, only 7-20% of patients attained optimal glycaemic control (HbA1c level < 7%) in South African diabetic clinics[11 24].

Consequently, suboptimal glycaemic levels are an apparent concern not only in Botswana but also in other African countries. In most studies, the majority of the patients have HbA1c > 8%, well above the recommended target (<7%) required to avoid the development of microvascular and macrovascular complications[11 12]. This suboptimal glycaemic control could explain the four and tenfold prevalence of sight-threatening diabetic retinopathy and proliferative retinopathy respectively found among African populations compared to their European counterparts [25]. Despite poor glycaemic control level, only a few of our patients were on insulin, suggesting clinical inertia of our clinicians in response to low glycaemic control[26]. We will be investigating this further given concerns with the lack of glycaemic control in our patients. Similar to other studies in Sub-Saharan Africa, the likelihood of attaining optimal glycaemic control decreased as the duration of diabetes increased[27]. There is evidence of a progressive loss of beta-cell function with increasing diabetes duration [6]. Insulin production progressively declines over time, leading to suboptimal glycaemic control unless higher dosages or additional agents are initiated [6]. Comparable to reports from other studies, older patients in our study were more likely to achieve optimal glycaemic control than young ones[28 29]. It is possible that young patients are less likely to be compliant with medication and lifestyle modification as compared to their older counterparts. However, again we need to research this further before making any concrete statements and instigating pertinent quality improvement programmes.

We also found a high prevalence (80.8%) of hypertension among patients attending our specialised diabetes clinic. A decade ago, the prevalence of hypertension among patients with diabetes in this setting was 61.2% [30]. Our findings may suggest an increasing burden of hypertension as seen globally, but also a reflection of

the improvement in the screening and diagnosis of hypertension over the past few years[31]. We are aware of the comparable high frequencies of hypertension in other African studies [12]. Consistent with previous studies, patients with hypertension were older, more obese, and had declining GFR and longer diabetes duration[10 32]. Thiazide diuretics, calcium channel blockers and ACE inhibitors were the three most prescribed antihypertensive agents. This finding is in line with the available evidence recommending thiazide diuretics and calcium channels blockers as the most effective antihypertensives in the black population [16 17 32]. Optimal hypertension control was observed in only 54.2% of the patients on antihypertensives, suggesting an urgent need for initiatives to improve the identification and control of hypertension. This low control level is a concern given the increased mortality if hypertension is not controlled[5]. Having said this, the proportion of patients with optimal hypertension control in our population was superior to several studies in Africa, notwithstanding the variation of the definitions of optimal hypertension control across these studies [10 12 13 32 33]. However, there is no room for complacency. In the present study, the use of ACE inhibitors was inversely associated with optimal hypertension control. Although ACE inhibitors are indicated for patients with diabetes and proteinuria, they have a clinically significant lesser reduction in both systolic and diastolic blood pressure in the black population. This could partly explain suboptimal hypertension control among predominantly black patients in our study. There appeared to be no influence of gender on hypertension control similar to other studies[34], which is encouraging as a recent systematic review found that males in low and middles income countries(LMICs) are more likely to be non-adherent to their medications [35 36].

Less than half of the patients (45%) were on lipid-lowering drugs, mostly statins. This is not surprising as the prescription of lipid-lowering medications in Africa is as low as 3 - 13% in patients with diabetes due to the limited access to these drugs as well as lack of facilities for monitoring lipid profiles while patients are on treatment [12 36 37]. It is, however, a concern as the reduced use of statins will increase mortality rates in patients with diabetes[7]. In some countries, the issue of co-payments limits the prescription of expensive medications like statins[38]. However, this is not an issue in Botswana where medications are provided free of charge to patients. Although the lack of co-payments might have led to a higher prescription of statins in Botswana than in other African countries, we would expect the rate of statin prescriptions to mirror the high rates seen in Western countries[39]. Education and adherence to guidelines will possibly improve the prescription and use of statins among the majority of patients with diabetes according to treatment guidelines[16 18]. Even when statins were used, an undesirably small proportion of our patients achieved guideline-recommended LDL-C target level. Suboptimal LDL-C control rates are also frequent across different settings, even in developed countries [8 12 40 41]. This is disappointing as achieving LDL-C reduction is associated with the highest cardiovascular risk reduction than hypertension and HbA1c reduction[8]. Inadequate patients' adherence and possibly clinicians' under-dosage of statin for fear of potential side

effects are some of the factors that possibly explain suboptimal LDL-C control in our patients[8]. Besides, clinicians may be unaware of the current LDL-C as well as those of HbA1c and hypertension therapeutic goals[16 18]. Irrespective of the reason, there is an urgent need to instigate measures to meet guideline-recommended therapeutic goals, and we have started to address this in our clinic. As reported in other studies, women were less likely than men to achieve optimal LDL-C control[40]. Although the reason for this gender difference is not apparent, this information is significant for clinicians to pay attention to the management of women with diabetes in Botswana and other African countries.

Conclusion

In conclusion, there was suboptimal glycaemic, hypertension and LDL-C control among patients with diabetes in our setting. These findings call for urgent individual and health systems interventions to address the factors associated with suboptimal control of the cardiovascular risk factors among patients with type 2 diabetes. This will be the subject of future initiatives and research in our clinic given the growing prevalence of patients with type 2 diabetes in Botswana.

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Competing Interests statement

Dr Mwita has nothing to disclose.

Dr Msafiri has nothing to disclose.

Dr Omech has nothing to disclose.

Dr Botsile has nothing to disclose.

Dr Oyewo has nothing to disclose.

Dr Godman has nothing to disclose.

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Author contributions

JCM was involved in the conception of the study, data analysis, drafting and revising the manuscript. BO was involved in the design of the study and critical revision of the manuscript. AO, MM participated in the design of the study, data collection and critical revision of the manuscript. JMF participated in data analysis and manuscript review. EB performed data entry and management, and critical revision of the manuscript. OJM, BG, and JGT were involved in the interpretation of the data and manuscript revision. All the authors

granted final approval of the version to be published; and agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Data sharing statement

The dataset analysed during the current study is available from the corresponding author on reasonable request, through the Princess Marina Hospital and Ministry of Health of Botswana ethical approval.

References

1. International Diabetes Federation. IDF Diabetes Atlas, 8th edition. 2017. http://www.diabetesatlas.org (accessed July 24, 2018).
2. World Health Organization. Global report on diabetes. 2016. http://apps.who.int/iris/bitstream/handle/10665/204871/9789241565257_eng.pdf;jsessionid=7534319F5DD126A2E538996187D64045?sequence=1 (accessed August 2, 2018).
3. Low Wang CC, Hess CN, Hiatt WR, et al. Clinical Update: Cardiovascular Disease in Diabetes Mellitus: Atherosclerotic Cardiovascular Disease and Heart Failure in Type 2 Diabetes Mellitus - Mechanisms, Management, and Clinical Considerations. *Circulation* 2016;133(24):2459-502. doi: https://doi.org/10.1161/CIRCULATIONAHA.116.022194 [published Online First: 2016/06/15]
4. Marks JB, Raskin P. Cardiovascular risk in diabetes: a brief review. *Journal of diabetes and its complications* 2000;14(2):108-15. doi: https://doi.org/10.1016/S1056-8727(00)00065-9 [published Online First: 2000/08/26]
5. U.K Prospective Diabetes Study Group. Tight blood pressure control and risk of macrovascular and microvascular complications in type 2 diabetes: UKPDS 38. *BMJ (Clinical research ed)* 1998;317(7160):703-13. doi: https://doi.org/10.1136/bmj.317.7160.703 [published Online First: 1998/09/11]
6. U.K. Prospective Diabetes Study Group. Overview of 6 years' therapy of type II diabetes: a progressive disease: UKPDS 16. *Diabetes* 1995;44(11):1249-58. doi: https://doi.org/10.2337/diab.44.11.1249 [published Online First: 1995/11/01]
7. Collins R, Armitage J, Parish S, et al. MRC/BHF Heart Protection Study of cholesterol-lowering with simvastatin in 5963 people with diabetes: a randomised placebo-controlled trial. *Lancet (London, England)* 2003;361(9374):2005-16. [published Online First: 2003/06/20]
8. Wan EYF, Fung CSC, Yu EYT, et al. Effect of Multifactorial Treatment Targets and Relative Importance of Hemoglobin A1c, Blood Pressure, and Low-Density Lipoprotein-Cholesterol on Cardiovascular Diseases in Chinese Primary Care Patients With Type 2 Diabetes Mellitus: A Population-Based Retrospective Cohort Study. *Journal of the American Heart Association* 2017;6(8):e006400. doi: https://doi.org/10.1161/JAHA.117.006400
9. Saydah SH, Fradkin J, Cowie CC. Poor control of risk factors for vascular disease among adults with previously diagnosed diabetes. *Jama* 2004;291(3):335-42. doi: https://doi.org/10.1001/jama.291.3.335 [published Online First: 2004/01/22]

10. Mwita JC, Mugusi F, Lwakatare J, et al. Hypertension control and other cardiovascular risk factors among diabetic patients at Muhimbili National Hospital, Tanzania. *East African journal of public health* 2012;9(2):70-73.
11. Klisiewicz A, Raal F. Sub-optimal management of type 2 diabetes mellitus–a local audit. *Journal of Endocrinology, Metabolism and Diabetes of South Africa* 2009;14(1)
12. Sobngwi E, Ndour-Mbaye M, Boateng KA, et al. Type 2 diabetes control and complications in specialised diabetes care centres of six sub-Saharan African countries: the Diabcare Africa study. *Diabetes research and clinical practice* 2012;95(1):30-36. doi: https://doi.org/10.1016/j.diabres.2011.10.018 [published Online First: 2011/11/11]
13. Kibirige D, Atuhe D, Sebunya R, et al. Suboptimal glycaemic and blood pressure control and screening for diabetic complications in adult ambulatory diabetic patients in Uganda: a retrospective study from a developing country. *Journal of Diabetes & Metabolic Disorders* 2014;13(1):40.
14. World Health Organization. The Abuja declaration: ten years on. 2011. 2016. http://www.who.int/healthsystems/publications/abuja_report_aug_2011.pdf?ua=1 (accessed August 25, 2018).
15. Chobanian AV, Bakris GL, Black HR, et al. The Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure: the JNC 7 report. *Jama* 2003;289(19):2560-72. doi: https://doi.org/10.1001/jama.289.19.2560 [published Online First: 2003/05/16]
16. SEMDSA Type 2 Diabetes Guidelines Expert Committee. SEMDSA 2017 guidelines for the management of type 2 diabetes mellitus. *J Endocr Metab Diabetes S Afr* 2017;22(1 Suppl 1):S1-S196.
17. James PA, Oparil S, Carter BL, et al. 2014 evidence-based guideline for the management of high blood pressure in adults: Report from the panel members appointed to the eighth joint national committee (JNC 8). *Jama* 2014;311(5):507-20. doi: https://doi.org/10.1001/jama.2013.284427 [published Online First: 2013/12/20]
18. American Diabetes Association. Standards of Medical Care in Diabetes-2017 Abridged for Primary Care Providers. *Clinical diabetes: a publication of the American Diabetes Association* 2017;35(1):5-26. doi: https://doi.org/10.2337/cd16-0067 [published Online First: 2017/02/02]
19. Work Group and Evidence Review Team Membership. K/DOQI clinical practice guidelines for chronic kidney disease: evaluation, classification, and stratification. *American journal of kidney diseases: the official journal of the National Kidney Foundation* 2002;39(2 Suppl 1):S1-266. doi: https://doi.org/10.1016/S0272-6386(02)70084-X [published Online First: 2002/03/21]
20. Levey AS, Greene T, Schluchter MD, et al. Glomerular filtration rate measurements in clinical trials. Modification of Diet in Renal Disease Study Group and the Diabetes Control and Complications Trial Research Group. *Journal of the American Society of Nephrology: JASN* 1993;4(5):1159-71. [published Online First: 1993/11/01]
21. World Health Organization. Waist circumference and waist-hip ratio: report of a WHO expert consultation, Geneva, 8-11 December 2008. 2011. http://www.who.int/iris/handle/10665/44583 (accessed 27/08/2018).
22. Hosmer DW, Hosmer T, Le Cessie S, et al. A comparison of goodness-of-fit tests for the logistic regression model. *Statistics in medicine* 1997;16(9):965-80. [published Online First: 1997/05/15]

23. Adeniyi OV, Yogeswaran P, Longo-Mbenza B, et al. Cross-sectional study of patients with type 2 diabetes in OR Tambo district, South Africa. *BMJ open* 2016;6(7):e010875. doi: http://dx.doi.org/10.1136/bmjopen-2015-010875 [published Online First: 2016/07/31]
24. Erasmus RT, Blanco Blanco E, Okesina AB, et al. Assessment of glycaemic control in stable type 2 black South African diabetics attending a peri-urban clinic. *Postgraduate medical journal* 1999;75(888):603-6. doi: http://dx.doi.org/10.1136/pgmj.75.888.603 [published Online First: 2000/01/06]
25. Burgess PI, Allain TJ, García-Fiñana M, et al. High prevalence in Malawi of sight-threatening retinopathy and visual impairment caused by diabetes: identification of population-specific targets for intervention. *Diabetic Medicine* 2014;31(12):1643-50. doi: http://dx.doi.org/10.1111/dme.12492
26. Shah BR, Hux JE, Laupacis A, et al. Clinical inertia in response to inadequate glycemic control: do specialists differ from primary care physicians? *Diabetes care* 2005;28(3):600-6. doi: http://dx.doi.org/10.2337/diacare.28.3.600 [published Online First: 2005/03/01]
27. Camara A, Balde NM, Sobngwi-Tambekou J, et al. Poor glycemic control in type 2 diabetes in the South of the Sahara: the issue of limited access to an HbA1c test. *Diabetes Res Clin Pract* 2015;108(1):187-92. doi: https://doi.org/10.1016/j.diabres.2014.08.025 [published Online First: 2015/02/24]
28. El-Kebbi IM, Cook CB, Ziemer DC, et al. Association of younger age with poor glycemic control and obesity in urban African Americans with type 2 diabetes. *Archives of internal medicine* 2003;163(1):69-75. doi: https://doi.org/10.1001/archinte.163.1.69 [published Online First: 2003/01/14]
29. Fox KM, Gerber Pharmd RA, Bolinder B, et al. Prevalence of inadequate glycemic control among patients with type 2 diabetes in the United Kingdom general practice research database: A series of retrospective analyses of data from 1998 through 2002. *Clinical therapeutics* 2006;28(3):388-95. doi: https://doi.org/10.1016/j.clinthera.2006.03.005 [published Online First: 2006/06/06]
30. Mengesha AY. Hypertension and related risk factors in type 2 diabetes mellitus (DM) patients in Gaborone City Council (GCC) clinics, Gaborone, Botswana. *African health sciences* 2008;7(4)
31. Forouzanfar MH, Liu P, Roth GA, et al. Global Burden of Hypertension and Systolic Blood Pressure of at Least 110 to 115 mm Hg, 1990-2015. *Jama* 2017;317(2):165-82. doi: https://doi.org/10.1001/jama.2016.19043 [published Online First: 2017/01/18]
32. Choukem SP, Kengne AP, Dehayem YM, et al. Hypertension in people with diabetes in sub-Saharan Africa: revealing the hidden face of the iceberg. *Diabetes Res Clin Pract* 2007;77(2):293-9. doi: http://dx.doi.org/10.1016/j.diabres.2006.11.007 [published Online First: 2006/12/23]
33. Adeniyi OV, Yogeswaran P, Longo-Mbenza B, et al. Uncontrolled Hypertension and Its Determinants in Patients with Concomitant Type 2 Diabetes Mellitus (T2DM) in Rural South Africa. *PloS one* 2016;11(3):e0150033. doi: http://dx.doi.org/10.1371/journal.pone.0150033 [published Online First: 2016/03/02]
34. Nashilongo MM, Singu B, Kalemeera F, et al. Assessing Adherence to Antihypertensive Therapy in Primary Health Care in Namibia: Findings and Implications. *Cardiovascular drugs and therapy* 2017;31(5-6):565-78. doi: https://doi.org/10.1007/s10557-017-6756-8. [published Online First: 2017/10/17]

35. Nielsen JO, Shrestha AD, Neupane D, et al. Non-adherence to anti-hypertensive medication in low- and middle-income countries: a systematic review and meta-analysis of 92443 subjects. *Journal of human hypertension* 2017;31(1):14-21. doi: https://doi.org/10.1038/jhh.2016.31 [published Online First: 2016/06/17]
36. Gudina EK, Amade ST, Tesfamichael FA, et al. Assessment of quality of care given to diabetic patients at Jimma University Specialized Hospital diabetes follow-up clinic, Jimma, Ethiopia. *BMC endocrine disorders* 2011;11:19. doi: http://dx.doi.org/10.1186/1472-6823-11-19 [published Online First: 2011/12/22]
37. Uloko AE, Ofoegbu EN, Chinenye S, et al. Profile of Nigerians with diabetes mellitus - Diabcare Nigeria study group (2008): Results of a multicenter study. *Indian journal of endocrinology and metabolism* 2012;16(4):558-64. doi: 10.4103/2230-8210.98011 [published Online First: 2012/07/28]
38. Simoens S, Sinnaeve PR. Patient co-payment and adherence to statins: a review and case studies. *Cardiovascular drugs and therapy* 2014;28(1):99-109. doi: http://dx.doi.org/10.1007/s10557-013-6497-2 [published Online First: 2013/10/24]
39. Pokharel Y, Akeroyd JM, Ramsey DJ, et al. Statin Use and Its Facility-Level Variation in Patients With Diabetes: Insight From the Veterans Affairs National Database. *Clinical cardiology* 2016;39(4):185-91. doi: http://dx.doi.org/10.1002/clc.22503 [published Online First: 2016/04/10]
40. Pinchevsky Y, Shukla V, Butkow N, et al. The achievement of glycaemic, blood pressure and LDL cholesterol targets in patients with type 2 diabetes attending a South African tertiary hospital outpatient clinic. *Journal of Endocrinology, Metabolism and Diabetes of South Africa* 2015;20(2):81-86. doi: http://dx.doi.org/10.1080/16089677.2015.1056468
41. Pinchevsky Y, Butkow N, Chirwa T, et al. Glycaemic, blood pressure and cholesterol control in 25 629 diabetics. *Cardiovascular journal of Africa* 2015;26(4):188-92. doi: http://dx.doi.org/10.5830/cvja-2015-050 [published Online First: 2015/09/26]

Table 1: Clinical and socio-demographic characteristics of patients with type 2 diabetes at a specialised Diabetes clinic in Gaborone (N= 500)

Characteristics	All (N=500)	Males (n= 170)	Females (n= 330)	p-value
Mean age (SD), years	58.9 (12.2)	55.4 (12.6)	60.8(11.6)	**<0.001**
Age <50 years n (%)	109(21.80)	57 (33.5)	52 (15.8)	**<0.001**
Age ≥ 50 years n (%)	391 (78.20)	113 (66.5)	278(84.2)	
Diabetes duration, median, IQR,years	6 (2 - 13)	6.5 (2 - 14)	6 (2.5 - 13)	0.927
HbA1c mean (SD), %	8.4 (2.4)	8.6 (2.7)	8.4 (2.4)	0.199
Diabetes treatment				
Diet alone n (%)	11(2.2)	3(1.8)	8 (2.4)	**0.001**
Insulin alone n (%)	68 (13.6)	38(22.3)	30 (9.1)	
OHA alone n (%)	271(54.2)	82(48.2)	189 (57.3)	
Insulin and OHA	150 (30.0)	47(27.7)	103(31.2)	
BMI, mean (SD) kg/m^2	30.5(6.0)	28.7(5.2)	31.4(6.2	**<0.001**
Normal weight n (%)	93 (18.7)	46(27.1)	49 (14.9)	**<0.001**
Overweight n (%)	155(31.1)	61(36.3)	94 (28.5)	
Obese n (%)	250(50.2)	63 (37.1)	187(56.7)	
Marital status				
Living alone n (%)	266 (53.20)	55 (32.4)	211(63.9)	**<0.001**
Living with a partner n (%)	234(46.8)	115 (67.6)	119(36.01)	
Education status				
No formal education, n (%)	77(15.4)	26(15.3)	51 (15.5)	**<0.001**
Primary School, n (%)	229(45.8)	56 (32.9)	173 (52.4)	
Secondary school, n (%)	131(26.2)	55(32.4)	76 (23.0)	
College/University, n (%)	63(12.6)	33 (19.4)	30 (9.1)	
WC, mean (SD), cm	103.3(12.5)	101.7 (11.9)	104.0 (12.7)	**0.049**
WHR	0.94(0.10)	0.97(0.09)	0.93(0.10)	**<0.001**
Low WHR n (%)	75 (44.1)	16(4.9)		**<0.001**
High WHR n (%)	95 (55.9)	314(95.2)		
CKD n (%)	54 (10.8)	24 (14.1)	30 (9.1)	**0.086**
eGFR, Median, IQR (ml/min/1.73m^2)	112.5(84.3-138.1)	113.1(80.8 -139.5)	112.3(84.4 - 137.9)	0.737
Cholesterol, mean (SD), mmol/L	4.4(1.1)	4.3(1.2)	4.5(1.1)	**0.030**
LDL-C mean (SD), mmol/L	2.8(1.0)	2.6(1.0)	2.9(1.0)	**0.006**
Macroproteinuria n (%)	51(10.20)	27 (15.9)	24(7.27)	**0.003**
Hypertension n (%)	404 (80.80)	120 (70.59)	284(86.06)	**<0.001**
Dyslipidaemia n (%)	358 (71.60)	114 (67.06)	244(73.94)	0.106

Legend: DM - Diabetes mellitus; WC- waist circumference; BMI- Body Mass Index; SD- standard deviation; IQR – interquartile range; eGFR- estimated glomerular filtration rate; LDL-C – Low-density lipoprotein; WHR – Waist-hip ratio, HbA1c- Haemoglobin A1c; CKD- Chronic kidney disease; OHA – oral hypoglycaemic agent

Table 2: Factors associated with optimal glycaemic control among patients with type 2 diabetes at a specialised diabetes clinic in Gaborone (N= 500)

Characteristic	Unadjusted OR (95% CI)	p-value	Adjusted OR (95%CI)	p-value
Age group				
> 50 years	1			
≤ 50 years	2.16(1.29 - 3.61)	**0.003**	5.79 (1.08 - 31.14)	**0.041**
Diabetes duration, years	0.97(0.95 - 0.99)	**0.040**	0.91 (0 .85 - 0.98)	**0.011**
Use of Insulin alone				
No	1			
Yes	0.80(0.45- 1.43)	0.590		
Use of OHA alone				
No	1			
Yes	2.785 (1.862 - 4.167)	**<0.001**	0.90 (0.46 - 1.74)	0.745
Use of Insulin plus OHA				
No	1			
Yes	0.185 (0.124 - 0.356)	**<0.001**	0.34 (0 .07 - 1.70)	0.188
BMI	0.99(0.96 - 1.02)	0.427	–	–
Normal weight	1	–	–	–
Overweight	1.10 (0.64 - 1. 90)	0.721	–	–
Obese	0. 83(0. 50 - 1.39)	0.476	–	–
Gender			–	–
Men	1	–	–	–
Women	0.92(0.62 - 1.36)	0.663	0.42 (0.14 - 1.25)	0.120
Education status				
None	1	1	–	–
Primary School	1.58(0.88 - 2.81)	0.124	–	–
Secondary school	1.14 (0.60 - 2.16)	0.687	–	–
College/University	1.00(0.47 - 2.13)	0.996	–	–
Marital status				
Living alone	1	–	–	–
Living with a partner	0.93 (0.64 - 1.36)	0.703	–	–
WHR	0.92 (0.13 - 6.58)	0.937		–
Low WHR	1	–	–	–
High WHR	0.92(0.57 - 1.50	0.745	–	–
Weight, kg	0.99 (0.98 - 1.01)	0.298		–
eGFR, (ml/min/1.73m²)	1.00 (0.99 - 1.00)	0.074	1.00(0.99 - 1.01)	0.766
CKD				
No	1			
Yes	1.053 (0.578 - 1.920	0.866	–	–
Macroproteinuria				
No	1		–	
Yes	1.16(0.63 - 2.14)	0.624	–	–
Optimal hypertension control				
No	1		–	
Yes	2.53 (1.63 - 3.93)	**<0.001**	1.61(0.63 - 4.13)	0.322
Optimal LDL-C control				
No	1			
Yes	2.10 (0.90 - 4.88)	0.086	2.20 (0.64 - 7.57)	0.209

Legend: Legend: BMI- Body Mass Index; CKD- Chronic kidney disease; DM - Diabetes mellitus; eGFR- estimated glomerular filtration rate; IQR – interquartile range; LDL-C – Low-density lipoprotein; OHA – oral hypoglycaemic agent; SD- standard deviation; WHR – Waist-hip ratio.

Table 3: Factors associated with optimal hypertension control among patients with type 2 diabetes at a specialised diabetes clinic in Gaborone (N= 500)

Characteristic	Unadjusted OR (95% CI)	p-value	Adjusted OR (95% CI)	p-value
Age group				
< 50 years	1	–	–	–
≥50 years	0.89(0.48 - 1.62)	0.691	–	–
Diabetes duration, years	0.97(0.94 - 0.99)	**0.023**	0 .98 (0.92 - 1.03)	0.352
Use of Insulin alone				
No	1	–	–	–
Yes	0.45 (0.24 - 0.82)	**0.009**	1.15 (0.30 - 4.44)	0.837
Use of OHA alone				
No		–	–	–
Yes	1.94 (1.30 - 2.91)	**0.001**	1.37 (0.51 - 3.66)	0.531
Use of Insulin plus OHA				
No	1	–	–	–
Yes	0.59 (0.40 - 0.95)	**0.028***	–	–
BMI, kg/m^2	0.98 (0.94 - 1.01)	0.149	0.93(0.86 - 1.01)	
Normal weight	1		–	–
Overweight	0.79 (0.42 - 1.47	0.449	–	–
Obese	0.77(0.44 -1.38	0.384	–	–
Gender				
Men	1	–	–	–
Women	1.43(0.92 - 2.22)	0.117	0.97 (0.36 - 2.61)	0.949
Marital				
Living alone	1	–	–	–
Living with a partner	0.68 (0.61 - 1.37)	0.67	–	–
Education status				
No formal education	1		–	–
Primary School	1.03(0.58 - 1.83)	0.09	–	–
Secondary school	1.08(0.56 - 2.09)	0.22	–	–
College/University	0.89(0.41 - 1.92)	0.761	–	–
WHR	1.29 (0 .14 - 12.00)	0.821		–
Low WHR	1			
High WHR	1.18 (0.65 - 2.12)	0.589		
eGFR, (ml/min/1.73m^2)	1.00 (1.00 - 1.01	0.139	1.00(0.99 -1.02)	0.412
Serum Cholesterol	0.964 (0.80 - 1.16)	0.693	–	–
Macroproteinuria				
No	1	–	–	–
Yes	0.48(0.26 - 0.92)	**0.027**	0.36(0.07 - 1.80)	0.213
Use of CCB				
No	1	–	–	–
Yes	0.73(0.72 - 1.61)	0.729	–	–
Use of Thiazides				
No	1	–	–	–
Yes	1.58(1.06 - 2.37)	**0.026**	1.44(0.62 - 3.39)	0.399
Use of ACE INHIBITORS				
No	1	**-**	–	–
Yes	0.64 (0.43 - 0.95)	**0.028**	0.35(0.14 - 0.85)	**0.020**
Use of ARB				
No	1	–	–	–

Yes	0.95(0.57 - 1.58)	0.834	–	–
Alpha blocker				
No	1	–	–	–
Yes	0.24(0.09 - 0.68)	**0.007**	0.76 (0.14 - 4.20)	0.749
Beta-blocker				
No	1	–	–	–
Yes	0.70 (0.43 -1.14)	0.149	0.51(0.19 - 1.37)	0.184
Optimal Glycaemic control				
No	1	–	–	–
Yes	2.53 (1.63- 3.93)	**<0.001**	1.92 (0.71 - 5.23)	0.201
Optimal LDL-C control				
No	1	–	–	–
Yes	0.55 (0.23 - 1.36)	0.199	0.75 (0.25 - 2.32	0.623

Legend: * omitted because of collinearity. ACE INHIBITORS – angiotensin-converting-enzyme inhibitor; ARB – Angiotensin II receptor blocker; BMI- Body Mass Index; CCB- Calcium Channel Blockers; DM - Diabetes mellitus; eGFR- estimated glomerular filtration rate; HbA1c- Haemoglobin A1c; IQR – interquartile range; LDL-C – Low-density lipoprotein; OHA – oral hypoglycaemic agent; SD- standard deviation; WHR – Waist-hip ratio.

Table 4: Factors associated with optimal LDL-C control among patients with type 2 diabetes at a specialised diabetes clinic in Gaborone (N= 500)

Characteristic	Unadjusted OR (95% CI)	p-value	Adjusted OR (95% CI)	p-value
Age group				
<50 years	1		–	–
≥ 50 years	0.56 (0.21 - 1.50)	0.249	–	–
Diabetes duration, years	1.02(0. 97 - 1.06)	0.525		–
Use of Insulin alone				
No	1	–	–	–
Yes	1.58 (0.56 - 4.46)	0.389	–	–
Use of OHA alone				
No	1	–	–	–
Yes	0.95 (0.43 - 2.12)	0.900	–	–
Use of Insulin plus OHA				
No	1	–	–	–
Yes	0.83 (0.35 - 1.97)	0.664	–	–
BMI	1.00 (0.93 -1.07)	0.951		–
Normal weight	1	–	–	–
Overweight	1.43 (0.34 - 5.94)	0.624	–	–
Obese	1.27(0.33 - 4.89)	0.730	–	–
Gender				
Men	1		–	–
Women	0.2 (0.09 - 0.47)	**<0.001**	0.24(0.09- 0.59)	**0.002**
Education status				
No formal education	1	1	–	–
Primary School	0.79 (0. 29 - 2.14)	0.647	–	–
Secondary school	0.28 (0.07 - 1.20)	0.087	–	–
College/University	0.79(0.20 - 3.11)	0.731	–	–
Marital status				
Living alone	1	–	–	–
Living with a partner	0.99 (0.44 - 2.20)	0.973	–	–
HbA1c	1.00 (0.85 - 0.20)	0.917		–
WHR	7.59(0.19 - 303.60)	0.281	–	–
Low WHR	1			
High WHR	0.31(0.11 – 0.89)	**0.030**	0.64(0.20 - 2.10	0.463
Macroproteinuria				
No		–	–	–
Yes	0.69 (0.14 - 3.27)	0.64	–	–
eGFR, (ml/min/1.73m²)	1.00(0.99 - 1.01)	0.878	–	–
CKD				
No	1	–	–	–
Yes	1.88(0 .73 - 4.83)	0.193	1.67 (0.61 - 4.58)	0.321
Hypertension				
No		–	–	–
Yes	1.13 (0.30 - 4.23)	0.86	–	–

Legend: Legend: BMI- Body Mass Index; CKD- Chronic kidney disease; DM - Diabetes mellitus; eGFR- estimated glomerular filtration rate; IQR – interquartile range; LDL-C – Low-density lipoprotein; OHA – oral hypoglycaemic agent; SD- standard deviation; WHR–Waist-hip ratio

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	1
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	2
Objectives	3	State specific objectives, including any prespecified hypotheses	2
Methods			
Study design	4	Present key elements of study design early in the paper	2
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	2
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	2
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	2
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	2
Bias	9	Describe any efforts to address potential sources of bias	*2*
Study size	10	Explain how the study size was arrived at	2
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	3
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	3
		(*b*) Describe any methods used to examine subgroups and interactions	3
		(*c*) Explain how missing data were addressed	
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	
		(*e*) Describe any sensitivity analyses	
Results			3

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	3
		(b) Give reasons for non-participation at each stage	
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	4
		(b) Indicate number of participants with missing data for each variable of interest	
Outcome data	15*	Report numbers of outcome events or summary measures	4,5
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	4,5
		(*b*) Report category boundaries when continuous variables were categorized	4,5
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	
Discussion			
Key results	18	Summarise key results with reference to study objectives	5
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	1
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	8
Generalisability	21	Discuss the generalisability (external validity) of the study results	8
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	8

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Glycaemic, blood pressure and low-density lipoprotein-cholesterol control among patients with diabetes mellitus in a specialised clinic in Botswana: a cross-sectional study

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Glycaemic, blood pressure and low-density lipoprotein-cholesterol control among patients with diabetes mellitus in a specialised clinic in Botswana: a cross-sectional study

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Abstract

Objective: Control of glycaemic, hypertension and low-density lipoprotein-cholesterol (LDL-C) among type 2 diabetes mellitus (T2DM) patients is vital for the prevention of cardiovascular diseases (CVD). The current study was an audit of glycaemic, hypertension, and LDL-C control among ambulant patients with type 2 diabetes mellitus in Botswana. Also, the study aimed at assessing factors associated with attaining optimal glycaemic, hypertension and LDL-C therapeutic goals.

Design: A cross-sectional study.

Setting: A specialised public diabetes clinic in Gaborone, Botswana.

Participants: Type 2 diabetes mellitus patients who had attended the clinic for ≥ three months between August 2017 and February 2018.

Primary outcome measure: The proportion of patients with optimal glycaemic (HbA1c <7 %), hypertension (blood pressure <140/90mmHg) and LDL-C (<1.8mmol/L) control.

Results: The proportions of patients meeting optimal targets were 32.3% for glycaemic, 54.2% for hypertension, and 20.4% for LDL-C. Optimal glycaemic control was positively associated with age ≥ 50 years (AOR 5.79; 95% CI 1.08 - 31.14) but was inversely associated with an increase in diabetes duration (AOR 0.91; 95%CI 0.85 - 0.98). Being on an angiotensin-converting-enzyme inhibitor (ACE inhibitor) was inversely associated with optimal hypertension control (AOR 0.35; 95% CI 0.14 - 0.85). Being female (AOR 0.24; 95% CI (0.09 - 0.59) was inversely associated with optimal LDL-C control.

Conclusion: Patients with Type 2 diabetes mellitus in Gaborone, Botswana, presented with suboptimal control of recommended glycaemic, hypertension and LDL-C targets. These findings call for urgent individual and health systems interventions to address key determinants of the recommended therapeutic targets among patients with diabetes in this setting.

Keywords: Glycaemic, hypertension, LDL-C, cholesterol, control Diabetes Mellitus, Botswana

Strengths and limitations of this study

- The first study to objectively assess the three critical therapeutic targets in patients with diabetes in Botswana.
- The study was undertaken in one specialised public diabetes clinic and the findings may not be generalised to other facilities in the country..
- The cross-sectional design limited the assessment of the temporal relationship between factors associated with poor control of glycaemia, LDL-C and hypertension.
- Systematic random sampling and incomplete data in some participants may not have yielded a representative sample of our clinic enrolees.

Introduction

Diabetes mellitus and related cardiovascular complications are growing public health concerns worldwide [1 2]. There are approximately 16 million people with diabetes in Africa, and this number is projected to increase to 41 million by 2045 due to rapid urbanisation, lifestyles changes and nutrition transition in the continent [1]. This increase in prevalence and incidence of diabetes is attributable to type 2 diabetes, which is associated with multiple comorbidities such as obesity and hypertension requiring chronic care and catastrophic health expenditure[1]. Diabetes and associated comorbidities are known to increase patients' risk of developing cardiovascular diseases (CVD), which are responsible for approximately 70% of diabetes-related deaths[3 4]. The risk to the development of CVD is higher in people with suboptimal glycaemic, hypertension and LDL-C control [3 5]. A reduction of HbA1c to control targets along with optimal hypertension control and the use of statins to lower LDL-C levels have been shown to improve long-term outcomes including reducing mortality among patients with diabetes [6-9]. Achieving these targets remains a challenge in most settings, especially those with limited access to standard diabetes care [10-16]. Only a minority of patients with diabetes in Africa achieves optimal therapeutic targets, leaving the majority of patients at high risk of diabetes-related complications [13 15]. Suboptimal treatment to recommended targets is a public health concern because the current total health expenditure in most sub-Saharan African countries remains far below the 15% recommended in the Abuja declaration [17]. The rising cost of managing diabetes complications will further make health system goals unattainable[1]. Thus, this study was an audit of glycaemic, hypertension, and LDL-C control among ambulant patients with type 2 diabetes mellitus in Botswana. The study also assessed factors associated with the attainment of glycaemic, blood pressure and LDL-C therapeutic targets in these patients.

Methods

Study design and participants

We conducted a cross-sectional study of outpatients with established type 2 diabetes attending a specialised public diabetes clinic in Gaborone, Botswana between August 2017 and February 2018. The clinic has been operational since 2011 as a referral centre for health facilities in Gaborone and nearby towns. Eligible patients were those aged ≥ 18 years and had received care from the clinic for at least three months. We needed a sample size of 500 to produce a two-sided 95% confidence interval with a width equal to 3.86% based on the assumptions of approximately 26.2 % glycaemic control among patients with type 2 diabetes in Botswana[16]. Systematic random sampling was used to select patients from a list of patients who attended the clinic every day. In a recruitment day, we randomly picked the first patient from the list of the first eight clinic attendees. Subsequently, we enrolled every eighth individual until either the daily target of 10 patients was reached or the clinic came to an end. As there was a daily variation of

the number of clinic attendees, the number of our daily enrolments varied as well. Participants provided informed consent before enrolment. The Ministry of Health (HPDME: 13/18/1 VOL XI) and Princess Marina Hospital (PMH 5/79,317-1-2017) Institutional Review Boards granted ethical approval for the study.

Data collection and procedures

Patient information was collected using an interviewer-administered questionnaire and through reviews of medical charts and electronic records. The information included: demographic data (age, gender, occupation, marital status, and education), diabetes duration, history of hypertension, and medications for diabetes, hypertension and lipid disorders. We performed anthropometry (weight, height, waist and hip circumferences) and blood pressure measurements at enrolment. We conducted three blood pressure measurements after 10 minutes of rest, and the mean of the three measurements was recorded[18]. Moreover, we documented blood pressure readings from each patient's previous visit. Patients' serum creatinine, LDL-C and HbA1c, and urine dipstick for proteinuria results over the past six months were abstracted from the electronic medical records.

Definitions of the key outcomes and exposure variables

We calculated the diabetes duration as the date of enrolment into the study minus the date of a diabetes diagnosis. A patient was considered hypertensive by self-reported hypertension and the use of blood pressure-lowering medications or had sustained blood pressure ≥140/90 mmHg during the previous visit and at enrolment [19-21]. Optimal glycaemic control was defined as HbA1c < 7% [19 21]. For patients who were on lipid-lowering medications, optimal LDL-C control was LDL cholesterol level <1.8mmol/L[19]. We calculated patients' eGFR by the Modification of Diet in Renal Disease (MDRD) formula, and an eGFR <60.0 mL/min/1.73m^2 defined Chronic Kidney Disease (CKD)[2] [22] [23]. Body mass index (BMI) was calculated as weight in kilograms divided by the square of height in meters. We considered underweight as BMI < 18.5 kg/m2, normal weight as BMI of 18.5-24.9 kg/m^2, overweight as BMI of 25. -29.9 kg/m^2, and obesity as BMI ≥ 30 kg/m^2 [24]. Waist-hip ratio (WHR) was calculated as waist circumference (WC) in centimetres divided by hip circumference (HC) in centimetres and classified as high when WHR was ≥ 0.85 and ≥ 0.90 for women and men respectively[24].

Patient and Public Involvement

We did not directly involve patients in the design, recruitment to and conduct of the study. However, the development of the research question and outcome measures were informed by patients' priorities, experience, and preferences. These were realised during the regular diabetes support group meetings where the authors of this study interact with patients and their families. Investigators working at the clinic will

discuss the study findings with colleagues and provide them with critical results for sharing with patients (study participants). In close collaboration with the patient support group, the investigation team will summarise the results in plain language for a large poster and place it in a waiting room.

Statistical analysis

We performed analyses using Stata, Version 14 (Stata Corp, College Station, TX). We used percentages to summarise categorical variables. Means and standard deviation (SD) or medians and interquartile range (IQR) were used to summarise continuous variables. Pearson's $\chi 2$ or Fisher's exact tests were used to assessing statistical differences by gender for the categorical variables, while the Student's t-test or the Mann-Whitney U test were used for the continuous ones. Bivariate logistic regression was used to explore factors associated with each primary outcome - glycaemic, hypertension and LDL-C control. We further performed three multivariate logistic regression models for each of the three outcomes. The independent variables selected for multivariate models were those displaying a p-value < 0.2 at the univariate analysis level in addition to those considered clinically meaningful (age and gender). We described results as crude odds ratio (OR), adjusted odds ratio (AOR), and their corresponding 95% confidence intervals (95% CI). We used the Hosmer-Lemeshow goodness-of-fit test to assess how well the data fit the model [25]. A 2-tailed p-value < 0.05 was considered statistically significant.

Results

The response rate was 97%, as only 17 (3.4%) of the approached participants declined participation because of time constraints. We included 500 patients with type 2 diabetes in the study, of which 330 (66%) were females. The mean (SD) age was 58.9 (12.2) years, and 78.2% were aged > 50 years. The median (IQR) diabetes duration was 6 (2 - 13) years. There was a high percentage of patients with hypertension (80.8%), overweight (31.1%) and obesity (50.2%). Table 1 summarises the patients' characteristics by gender. Female patients tended to be older (60.8 vs 55.4 years, p < 0.001, obese (56.7% vs 37.1%, p < 0.001), have higher WHR (95.2% vs 55.9%), be hypertensive (86.1% vs 70.6%, p <0.001), and have a higher mean total cholesterol (4.5mmol/L vs 4.3mmol/L, p = 0.030) and LDL-C (2.9 mmol/L vs 2.6 mmol/L, p = 0.006) than male patients. Urine dipstick was positive for protein in 10.2% of patients, mostly males (15.9% vs 7.3%, p = 0.003).

[Table 1: Clinical and socio-demographic characteristics of patients with type 2 diabetes at a specialised Diabetes clinic in Gaborone (N= 500)]

Optimal glycaemic control

The mean (SD) HbA1c was 8.4 % (2.4) overall, 8.6% (2.7) for female and 8.0% (1.6) for male patients (p=0.199) [Table 1]. The proportion of the patients receiving oral hypoglycaemic agents alone was 54.2%; 30% were on oral hypoglycaemic agents combined with insulin; 13.6% on insulin alone and 2.2% were on a diet alone. Of the 218 patients on insulin, 184 (84.4%) were on premix insulin. Of the 421 patients on oral hypoglycaemic agents, 411(97.6%) patients were on metformin, and 194 (46.1%) patients were on a sulphonylurea. Compared to patients on other anti-diabetic medications, those on insulin injections were more likely to be males. We noted optimal glycaemic control in 159 (32.3%) patients, whose mean) HbA1c was 6.1 %. Age over 50 years was associated with optimal glycaemic control (AOR 5.79; 95%CI 1.08 - 31.14). On the other hand, an increase in diabetes duration was inversely associated with optimal glycaemic control (AOR 0.91; 95%CI 0.85 - 0.98**).** There was no association between gender, anthropometry, diabetes medications or education on the level of glycaemic control [Table 2].

[Table 2: Factors associated with optimal glycaemic control among patients with type 2 diabetes at a specialised diabetes clinic in Gaborone (N= 500)]

Optimal hypertension control

There were 404 (80.8%) hypertensive patients [Table 1]. Age ≥ 50 years (AOR 4.95; 95%CI 2.81-8.73), increased WHR (AOR 3.87; 95%CI 1.72 - 8.71), eGFR (AOR 0.98; 95% CI 0.97 - 0.99), and a long diabetes duration (AOR= 1.07, 95% CI1.02 - 1.12) were associated with hypertension. Seventeen (4.2%) hypertensive patients did not receive any antihypertensive medication. Of the 389 patients who received antihypertensive medications, 219 (56.3%) received calcium channel blockers, 189 (48.6%) were treated with thiazides diuretics, 183(47.0%) with angiotensin-converting-enzyme inhibitors (ACE inhibitors), and 74(19.0%) with Angiotensin II receptor blockers (ARBs). The proportions of patients receiving β- and α-blockers were 22.4% and 5.4% respectively.

Of the 389 patients who received antihypertensive medicines, optimal hypertension control was noted in 211 (54.2%) patients. Patients on ACE inhibitors were less likely to attain optimal hypertension control compared to those who were not on ACE inhibitors (AOR 0.24; 95% CI (0.09 - 0.59). There was no association between gender, anthropometry, or education on the level of hypertension control [Table 3].

[Table 3: Factors associated with optimal hypertension control among patients with type 2 diabetes at a specialised diabetes clinic in Gaborone (N= 500)]

Optimal LDL-C control

A total of 225 (45%) patients were receiving lipid-lowering drugs, mostly (96.4%) atorvastatin. Of these, 147 (65.3%) patients had LDL-C measurements available. Only 30 (20.4%) achieved the optimal LDL-C control target. Females were less likely to achieve optimal LDL-C control as compared to males, (0.24; 95% CI (0.09 - 0.59). There was no association of age, anthropometry, or education on the level of LDL-C control [Table 4].

[Table 4: Factors associated with optimal LDL-C control among patients with type 2 diabetes at a specialised diabetes clinic in Gaborone (N= 500)]

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Discussion

This outpatient cross-sectional study showed a low proportion of patients with optimal control of glycaemic, hypertension, and LDL-C among Type 2 patients attending a diabetes clinic in Botswana. In the multivariate analysis, duration of diabetes and age above 50 years were significantly associated with optimal glycaemic control. Being on ACE inhibitors was inversely related to optimal hypertension control. Females were less likely to attain optimal LDL-C levels than males.

Only 32.3% of our participants achieved optimal glycaemic control. Similarly, low levels of glycaemic control have also been seen among patients with diabetes in Africa [11 13 26 27]. The proportion of patients with optimal glycaemic control (HbA1c < 6.5%) in specialised diabetes care centres across six sub-Saharan African countries was reported to be 29% [13]. Similarly, only 7-31% of patients attained optimal glycaemic control (HbA1c level < 7%) in other settings in Africa[12 14 27]. Consequently, suboptimal glycaemic levels are an apparent concern not only in Botswana but also in other African countries. In most studies, the majority of the patients have HbA1c > 8%, well above the recommended target (<7%) required to avoid the development of microvascular and macrovascular complications[12 13]. This suboptimal glycaemic control could explain the four and tenfold prevalence of sight-threatening diabetic retinopathy and proliferative retinopathy respectively found among African populations compared to their European counterparts [28]. Despite poor glycaemic control level, only a few of our patients were on insulin, suggesting clinical inertia of our clinicians in response to low glycaemic control[29]. We will be investigating this further given concerns with the lack of glycaemic control in our patients. Similar to other studies in Sub-Saharan Africa, the likelihood of attaining optimal glycaemic control decreased as the duration of diabetes increased[30]. There is evidence of a progressive loss of beta-cell function with increasing diabetes duration [7]. Insulin production progressively declines over time, leading to suboptimal glycaemic control unless higher dosages or additional agents are initiated [7]. Comparable to reports from other studies, older patients in our study were more likely to achieve optimal glycaemic control than young ones[31 32]. It is possible that young patients are less likely to be compliant with medication and lifestyle modification as

compared to their older counterparts. However, again we need to research this further before making any concrete statements and instigating pertinent quality improvement programmes.

We also found a high prevalence (80.8%) of hypertension among patients attending our specialised diabetes clinic. A decade ago, the prevalence of hypertension among patients with diabetes in this setting was 61.2% [33]. Our findings may suggest an increasing burden of hypertension as seen globally, but also a reflection of the improvement in the screening and diagnosis of hypertension over the past few years[34]. We are aware of the comparable high frequencies of hypertension in other African studies [13]. Consistent with previous studies, patients with hypertension were older, more obese, and had declining GFR and longer diabetes duration[11 35]. Thiazide diuretics, calcium channel blockers and ACE inhibitors were the three most prescribed antihypertensive agents. This finding is in line with the available evidence recommending thiazide diuretics and calcium channels blockers as the most effective antihypertensives in the black population [19 20 35]. Optimal hypertension control was observed in only 54.2% of the patients on antihypertensives, suggesting an urgent need for initiatives to improve the identification and control of hypertension. This low control level is a concern given the increased mortality if hypertension is not controlled[6]. Having said this, the proportion of patients with optimal hypertension control in our population was superior to several studies in Africa, notwithstanding the variation of the definitions of optimal hypertension control across these studies [11-14 35-37].The proportion of type 2 diabetes with optimal hypertension in Africa is often below 35%[11 12 37].

However, there is no room for complacency. In the present study, the use of ACE inhibitors was inversely associated with optimal hypertension control. Although ACE inhibitors are indicated for patients with diabetes and proteinuria, they have a clinically significant lesser reduction in both systolic and diastolic blood pressure in the black population. This could partly explain suboptimal hypertension control among predominantly black patients in our study. There appeared to be no influence of gender on hypertension control similar to other studies[38], which is encouraging as a recent systematic review found that males in low and middles income countries(LMICs) are more likely to be non-adherent to their medications [39 40].

Less than half of the patients (45%) were on lipid-lowering drugs, mostly statins. This is not surprising as the prescription of lipid-lowering medications in Africa is as low as 3 - 13% in patients with diabetes due to the limited access to these drugs as well as lack of facilities for monitoring lipid profiles while patients are on treatment , regular medication stock outs, and insufficient health professionals [13 40 41]. It is, however, a concern as the reduced use of statins will increase mortality rates in patients with diabetes[8]. In some countries, the issue of co-payments limits the prescription of expensive medications like statins[42]. However, this is not an issue in Botswana where medications are provided free of charge to patients. Although the lack of co-payments might have led to a higher prescription of statins in Botswana than in other African countries, we would expect the rate of statin prescriptions to mirror the high rates seen in Western

countries[43]. Education and adherence to guidelines will possibly improve the prescription and use of statins among the majority of patients with diabetes according to treatment guidelines[19 21]. Even when statins were used, an undesirably small proportion of our patients achieved guideline-recommended LDL-C target level. Suboptimal LDL-C control rates are also frequent across different settings, even in developed countries [9 13 15 44]. This is disappointing as achieving LDL-C reduction is associated with the highest cardiovascular risk reduction than hypertension and HbA1c reduction[9]. Inadequate patients' adherence and possibly clinicians' under-dosage of statin for fear of potential side effects are some of the factors that possibly explain suboptimal LDL-C control in our patients[9]. Besides, clinicians may be unaware of the current LDL-C as well as those of HbA1c and hypertension therapeutic goals[19 21]. Irrespective of the reason, there is an urgent need to instigate measures to meet guideline-recommended therapeutic goals, and we have started to address this in our clinic. As reported in other studies, women were less likely than men to achieve optimal LDL-C control[44]. Although the reason for this gender difference is not apparent, this information is significant for clinicians to pay attention to the management of women with diabetes in Botswana and other African countries.

To the best of our knowledge this first study to objectively assess the three critical therapeutic targets in patients with diabetes in one of the few specialised diabetes clinics in Botswana. However, our findings should be interpreted considering several limitations. First, the study was limited to one specialised public diabetes clinic, and the findings may not be generalised to other public and private facilities in the country. Nevertheless, being the leading specialised diabetes clinics in the country, our findings likely represent the 'best' quality of diabetes care in Botswana. Consequently, highlighted concerns are likely to be higher in non-specialist healthcare facilities treating patients with type 2 diabetes in Botswana. Second, the study was cross-sectional in design and therefore unable to establish a temporal relationship between the factors associated with poor control of glycaemia, LDL-C and hypertension. Third, the results may be subject to selection bias because of incomplete data in some participants. Another potential risk of selection bias is the fact that the study enrolled only those patients available at the clinic during the study period. As such, patients unable to attend the clinic or those whose appointments did not coincide with the study period did participate. Despite these limitations, we believe our findings are robust to help improve the care of patients with type 2 diabetes in Botswana.

In conclusion, there was suboptimal glycaemic, hypertension and LDL-C control among patients with diabetes in our setting. These findings call for urgent individual and health systems interventions to address the factors associated with suboptimal control of the cardiovascular risk factors among patients with type 2 diabetes in Botswana. This will be the subject of future initiatives and research in our clinic given the growing prevalence of patients with type 2 diabetes in Botswana.

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Competing Interests statement

None disclosed

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Author contributions

JCM was involved in the conception of the study, data analysis, drafting and revising the manuscript. BO was involved in the design of the study and critical revision of the manuscript. AO, MM participated in the design of the study, data collection and critical revision of the manuscript. JMF participated in data analysis and manuscript review. EB performed data entry and management, and critical revision of the manuscript. OJM, BG, and JGT were involved in the interpretation of the data and manuscript revision. All the authors granted final approval of the version to be published; and agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Data sharing statement

The dataset analysed during the current study is available from the corresponding author on reasonable request, through the Princess Marina Hospital and Ministry of Health of Botswana ethical approval.

References

1. International Diabetes Federation. IDF Diabetes Atlas, 8th edition. 2017. http://www.diabetesatlas.org (accessed July 24, 2018).
2. World Health Organization. Global report on diabetes. 2016. http://apps.who.int/iris/bitstream/handle/10665/204871/9789241565257_eng.pdf;jsessionid=7534319F5DD126A2E538996187D64045?sequence=1 (accessed August 2, 2018).
3. Low Wang CC, Hess CN, Hiatt WR, et al. Clinical Update: Cardiovascular Disease in Diabetes Mellitus: Atherosclerotic Cardiovascular Disease and Heart Failure in Type 2 Diabetes Mellitus - Mechanisms, Management, and Clinical Considerations. *Circulation* 2016;133(24):2459-502. doi: https://doi.org/10.1161/CIRCULATIONAHA.116.022194 [published Online First: 2016/06/15]
4. Mwita JC, Magafu M, Omech B, et al. Undiagnosed and diagnosed diabetes mellitus among hospitalised acute heart failure patients in Botswana. *SAGE open medicine* 2017;5:2050312117731473. doi: https://doi.org/10.1177/2050312117731473 [published Online First: 2017/09/22]

5. Marks JB, Raskin P. Cardiovascular risk in diabetes: a brief review. *Journal of diabetes and its complications* 2000;14(2):108-15. doi: https://doi.org/10.1016/S1056-8727(00)00065-9 [published Online First: 2000/08/26]
6. U.K Prospective Diabetes Study Group. Tight blood pressure control and risk of macrovascular and microvascular complications in type 2 diabetes: UKPDS 38. *BMJ (Clinical research ed)* 1998;317(7160):703-13. doi: https://doi.org/10.1136/bmj.317.7160.703 [published Online First: 1998/09/11]
7. U.K. Prospective Diabetes Study Group. Overview of 6 years' therapy of type II diabetes: a progressive disease: UKPDS 16. *Diabetes* 1995;44(11):1249-58. doi: https://doi.org/10.2337/diab.44.11.1249 [published Online First: 1995/11/01]
8. Collins R, Armitage J, Parish S, et al. MRC/BHF Heart Protection Study of cholesterol-lowering with simvastatin in 5963 people with diabetes: a randomised placebo-controlled trial. *Lancet (London, England)* 2003;361(9374):2005-16. doi: https://doi.org/10.1016/S0140-6736(03)13636-7 [published Online First: 2003/06/20]
9. Wan EYF, Fung CSC, Yu EYT, et al. Effect of Multifactorial Treatment Targets and Relative Importance of Hemoglobin A1c, Blood Pressure, and Low-Density Lipoprotein-Cholesterol on Cardiovascular Diseases in Chinese Primary Care Patients With Type 2 Diabetes Mellitus: A Population-Based Retrospective Cohort Study. *Journal of the American Heart Association* 2017;6(8):e006400. doi: https://doi.org/10.1161/JAHA.117.006400
10. Saydah SH, Fradkin J, Cowie CC. Poor control of risk factors for vascular disease among adults with previously diagnosed diabetes. *Jama* 2004;291(3):335-42. doi: https://doi.org/10.1001/jama.291.3.335 [published Online First: 2004/01/22]
11. Mwita JC, Mugusi F, Lwakatare J, et al. Hypertension control and other cardiovascular risk factors among diabetic patients at Muhimbili National Hospital, Tanzania. *East Afr J Public Health* 2012;9(2):70-3. [published Online First: 2012/11/13]
12. Klisiewicz A, Raal F. Sub-optimal management of type 2 diabetes mellitus–a local audit. *Journal of Endocrinology, Metabolism and Diabetes of South Africa* 2009;14(1):13-16. doi: https://doi.org/10.1080/22201009.2009.10872186
13. Sobngwi E, Ndour-Mbaye M, Boateng KA, et al. Type 2 diabetes control and complications in specialised diabetes care centres of six sub-Saharan African countries: the Diabcare Africa study. *Diabetes research and clinical practice* 2012;95(1):30-36. doi: https://doi.org/10.1016/j.diabres.2011.10.018 [published Online First: 2011/11/11]
14. Kibirige D, Atuhe D, Sebunya R, et al. Suboptimal glycaemic and blood pressure control and screening for diabetic complications in adult ambulatory diabetic patients in Uganda: a retrospective study from a developing country. *Journal of Diabetes & Metabolic Disorders* 2014;13(1):40. doi: https://doi.org/10.1186/2251-6581-13-40
15. Pinchevsky Y, Butkow N, Chirwa T, et al. Glycaemic, blood pressure and cholesterol control in 25 629 diabetics. *Cardiovascular journal of Africa* 2015;26(4):188-92. doi: http://dx.doi.org/10.5830/cvja-2015-050 [published Online First: 2015/09/26]
16. Pinchevsky Y, Butkow W, Raal FJ, et al. The implementation of guidelines in a South African population with type 2 diabetes. *Journal of Endocrinology, Metabolism and Diabetes of South Africa* 2013;18(3):154-58. doi: https://doi.org/10.1080/22201009.2013.10844554
17. World Health Organization. The Abuja declaration: ten years on. 2011. 2016. http://www.who.int/healthsystems/publications/abuja_report_aug_2011.pdf?ua=1 (accessed August 25, 2018).

18. Chobanian AV, Bakris GL, Black HR, et al. The Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure: the JNC 7 report. *Jama* 2003;289(19):2560-72. doi: https://doi.org/10.1001/jama.289.19.2560 [published Online First: 2003/05/16]
19. SEMDSA Type 2 Diabetes Guidelines Expert Committee. SEMDSA 2017 guidelines for the management of type 2 diabetes mellitus. *J Endocr Metab Diabetes S Afr* 2017;22(1 Suppl 1):S1-S196.
20. James PA, Oparil S, Carter BL, et al. 2014 evidence-based guideline for the management of high blood pressure in adults: Report from the panel members appointed to the eighth joint national committee (JNC 8). *Jama* 2014;311(5):507-20. doi: https://doi.org/10.1001/jama.2013.284427 [published Online First: 2013/12/20]
21. American Diabetes Association. Standards of Medical Care in Diabetes-2017 Abridged for Primary Care Providers. *Clinical diabetes: a publication of the American Diabetes Association* 2017;35(1):5-26. doi: https://doi.org/10.2337/cd16-0067 [published Online First: 2017/02/02]
22. Work Group and Evidence Review Team Membership. K/DOQI clinical practice guidelines for chronic kidney disease: evaluation, classification, and stratification. *American journal of kidney diseases: the official journal of the National Kidney Foundation* 2002;39(2 Suppl 1):S1-266. doi: https://doi.org/10.1016/S0272-6386(02)70084-X [published Online First: 2002/03/21]
23. Levey AS, Greene T, Schluchter MD, et al. Glomerular filtration rate measurements in clinical trials. Modification of Diet in Renal Disease Study Group and the Diabetes Control and Complications Trial Research Group. *Journal of the American Society of Nephrology: JASN* 1993;4(5):1159-71. [published Online First: 1993/11/01]
24. World Health Organization. Waist circumference and waist-hip ratio: report of a WHO expert consultation, Geneva, 8-11 December 2008. 2011. http://www.who.int/iris/handle/10665/44583 (accessed 27/08/2018).
25. Hosmer DW, Hosmer T, Le Cessie S, et al. A comparison of goodness-of-fit tests for the logistic regression model. *Statistics in medicine* 1997;16(9):965-80. [published Online First: 1997/05/15]
26. Adeniyi OV, Yogeswaran P, Longo-Mbenza B, et al. Cross-sectional study of patients with type 2 diabetes in OR Tambo district, South Africa. *BMJ open* 2016;6(7):e010875. doi: http://dx.doi.org/10.1136/bmjopen-2015-010875 [published Online First: 2016/07/31]
27. Erasmus RT, Blanco Blanco E, Okesina AB, et al. Assessment of glycaemic control in stable type 2 black South African diabetics attending a peri-urban clinic. *Postgraduate medical journal* 1999;75(888):603-6. doi: http://dx.doi.org/10.1136/pgmj.75.888.603 [published Online First: 2000/01/06]
28. Burgess PI, Allain TJ, García-Fiñana M, et al. High prevalence in Malawi of sight-threatening retinopathy and visual impairment caused by diabetes: identification of population-specific targets for intervention. *Diabetic Medicine* 2014;31(12):1643-50. doi: http://dx.doi.org/10.1111/dme.12492
29. Shah BR, Hux JE, Laupacis A, et al. Clinical inertia in response to inadequate glycemic control: do specialists differ from primary care physicians? *Diabetes care* 2005;28(3):600-6. doi: http://dx.doi.org/10.2337/diacare.28.3.600 [published Online First: 2005/03/01]

30. Camara A, Balde NM, Sobngwi-Tambekou J, et al. Poor glycemic control in type 2 diabetes in the South of the Sahara: the issue of limited access to an HbA1c test. *Diabetes Res Clin Pract* 2015;108(1):187-92. doi: https://doi.org/10.1016/j.diabres.2014.08.025 [published Online First: 2015/02/24]
31. El-Kebbi IM, Cook CB, Ziemer DC, et al. Association of younger age with poor glycemic control and obesity in urban African Americans with type 2 diabetes. *Archives of internal medicine* 2003;163(1):69-75. doi: https://doi.org/10.1001/archinte.163.1.69 [published Online First: 2003/01/14]
32. Fox KM, Gerber Pharmd RA, Bolinder B, et al. Prevalence of inadequate glycemic control among patients with type 2 diabetes in the United Kingdom general practice research database: A series of retrospective analyses of data from 1998 through 2002. *Clinical therapeutics* 2006;28(3):388-95. doi: https://doi.org/10.1016/j.clinthera.2006.03.005 [published Online First: 2006/06/06]
33. Mengesha AY. Hypertension and related risk factors in type 2 diabetes mellitus (DM) patients in Gaborone City Council (GCC) clinics, Gaborone, Botswana. *African health sciences* 2008;7(4)
34. Forouzanfar MH, Liu P, Roth GA, et al. Global Burden of Hypertension and Systolic Blood Pressure of at Least 110 to 115 mm Hg, 1990-2015. *Jama* 2017;317(2):165-82. doi: https://doi.org/10.1001/jama.2016.19043 [published Online First: 2017/01/18]
35. Choukem SP, Kengne AP, Dehayem YM, et al. Hypertension in people with diabetes in sub-Saharan Africa: revealing the hidden face of the iceberg. *Diabetes Res Clin Pract* 2007;77(2):293-9. doi: http://dx.doi.org/10.1016/j.diabres.2006.11.007 [published Online First: 2006/12/23]
36. Adeniyi OV, Yogeswaran P, Longo-Mbenza B, et al. Uncontrolled Hypertension and Its Determinants in Patients with Concomitant Type 2 Diabetes Mellitus (T2DM) in Rural South Africa. *PloS one* 2016;11(3):e0150033. doi: http://dx.doi.org/10.1371/journal.pone.0150033 [published Online First: 2016/03/02]
37. Webb EM, Rheeder P, Van Zyl DG. Diabetes care and complications in primary care in the Tshwane district of South Africa. *Primary care diabetes* 2015;9(2):147-54. doi: https://doi.org/10.1016/j.pcd.2014.05.002 [published Online First: 2014/06/17]
38. Nashilongo MM, Singu B, Kalemeera F, et al. Assessing Adherence to Antihypertensive Therapy in Primary Health Care in Namibia: Findings and Implications. *Cardiovascular drugs and therapy* 2017;31(5-6):565-78. doi: https://doi.org/10.1007/s10557-017-6756-8. [published Online First: 2017/10/17]
39. Nielsen JO, Shrestha AD, Neupane D, et al. Non-adherence to anti-hypertensive medication in low- and middle-income countries: a systematic review and meta-analysis of 92443 subjects. *Journal of human hypertension* 2017;31(1):14-21. doi: https://doi.org/10.1038/jhh.2016.31 [published Online First: 2016/06/17]
40. Gudina EK, Amade ST, Tesfamichael FA, et al. Assessment of quality of care given to diabetic patients at Jimma University Specialized Hospital diabetes follow-up clinic, Jimma, Ethiopia. *BMC endocrine disorders* 2011;11:19. doi: http://dx.doi.org/10.1186/1472-6823-11-19 [published Online First: 2011/12/22]
41. Uloko AE, Ofoegbu EN, Chinenye S, et al. Profile of Nigerians with diabetes mellitus - Diabcare Nigeria study group (2008): Results of a multicenter study. *Indian journal of endocrinology and metabolism* 2012;16(4):558-64. doi: https://doi.org/10.4103/2230-8210.98011 [published Online First: 2012/07/28]

42. Simoens S, Sinnaeve PR. Patient co-payment and adherence to statins: a review and case studies. *Cardiovascular drugs and therapy* 2014;28(1):99-109. doi: http://dx.doi.org/10.1007/s10557-013-6497-2 [published Online First: 2013/10/24]
43. Pokharel Y, Akeroyd JM, Ramsey DJ, et al. Statin Use and Its Facility-Level Variation in Patients With Diabetes: Insight From the Veterans Affairs National Database. *Clinical cardiology* 2016;39(4):185-91. doi: http://dx.doi.org/10.1002/clc.22503 [published Online First: 2016/04/10]
44. Pinchevsky Y, Shukla V, Butkow N, et al. The achievement of glycaemic, blood pressure and LDL cholesterol targets in patients with type 2 diabetes attending a South African tertiary hospital outpatient clinic. *Journal of Endocrinology, Metabolism and Diabetes of South Africa* 2015;20(2):81-86. doi: http://dx.doi.org/10.1080/16089677.2015.1056468

Table 1: Clinical and socio-demographic characteristics of patients with type 2 diabetes at a specialised Diabetes clinic in Gaborone (N= 500)

Characteristics	All (N=500)	Males (n= 170)	Females (n= 330)	p-value
Mean age (SD), years	58.9 (12.2)	55.4 (12.6)	60.8(11.6)	**<0.001**
Age <50 years n (%)	109(21.80)	57 (33.5)	52 (15.8)	**<0.001**
Age ≥ 50 years n (%)	391 (78.20)	113 (66.5)	278(84.2)	
Diabetes duration, median, IQR,years	6 (2 - 13)	6.5 (2 - 14)	6 (2.5 - 13)	0.927
HbA1c mean (SD), %	8.4 (2.4)	8.6 (2.7)	8.4 (2.4)	0.199
Diabetes treatment				
Diet alone n (%)	11(2.2)	3(1.8)	8 (2.4)	
Insulin alone n (%)	68 (13.6)	38(22.3)	30 (9.1)	**0.001**
OHA alone n (%)	271(54.2)	82(48.2)	189 (57.3)	
Insulin and OHA	150 (30.0)	47(27.7)	103(31.2)	
BMI, mean (SD) kg/m^2	30.5(6.0)	28.7(5.2)	31.4(6.2	**<0.001**
Normal weight n (%)	93 (18.7)	46(27.1)	49 (14.9)	**<0.001**
Overweight n (%)	155(31.1)	61(36.3)	94 (28.5)	
Obese n (%)	250(50.2)	63 (37.1)	187(56.7)	
Marital status				
Living alone n (%)	266 (53.20)	55 (32.4)	211(63.9)	**<0.001**
Living with a partner n (%)	234(46.8)	115 (67.6)	119(36.01)	
Education status				
No formal education, n (%)	77(15.4)	26(15.3)	51 (15.5)	**<0.001**
Primary School, n (%)	229(45.8)	56 (32.9)	173 (52.4)	
Secondary school, n (%)	131(26.2)	55(32.4)	76 (23.0)	
College/University, n (%)	63(12.6)	33 (19.4)	30 (9.1)	
WC, mean (SD), cm	103.3(12.5)	101.7 (11.9)	104.0 (12.7)	**0.049**
WHR	0.94(0.10)	0.97(0.09)	0.93(0.10)	**<0.001**
Low WHR n (%)	75 (44.1)	16(4.9)		**<0.001**
High WHR n (%)	95 (55.9)	314(95.2)		
CKD n (%)	54 (10.8)	24 (14.1)	30 (9.1)	**0.086**
eGFR, Median, IQR (ml/min/1.73m^2)	112.5(84.3-138.1)	113.1(80.8 -139.5)	112.3(84.4 - 137.9)	0.737
Cholesterol, mean (SD), mmol/L	4.4(1.1)	4.3(1.2)	4.5(1.1)	**0.030**
LDL-C mean (SD), mmol/L	2.8(1.0)	2.6(1.0)	2.9(1.0)	**0.006**
Proteinuria n (%)	51(10.20)	27 (15.9)	24(7.27)	**0.003**
Hypertension n (%)	404 (80.80)	120 (70.59)	284(86.06)	**<0.001**
Dyslipidaemia n (%)	358 (71.60)	114 (67.06)	244(73.94)	0.106

Legend: DM - Diabetes mellitus; WC- waist circumference; BMI- Body Mass Index; SD- standard deviation; IQR – interquartile range; eGFR- estimated glomerular filtration rate; LDL-C – Low-density lipoprotein; WHR – Waist-hip ratio, HbA1c- Haemoglobin A1c; CKD- Chronic kidney disease; OHA – oral hypoglycaemic agent

Table 2: Factors associated with optimal glycaemic control among patients with type 2 diabetes at a specialised diabetes clinic in Gaborone (N= 500)

Characteristic	Unadjusted OR (95% CI)	p-value	Adjusted OR (95%CI)	p-value
Age group				
> 50 years	1			
≤ 50 years	2.16(1.29 - 3.61)	**0.003**	5.79 (1.08 - 31.14)	**0.041**
Diabetes duration, years	0.97(0.95 - 0.99)	**0.040**	0.91 (0 .85 - 0.98)	**0.011**
Use of Insulin alone				
No	1			
Yes	0.80(0.45- 1.43)	0.590		
Use of OHA alone				
No	1			
Yes	2.785 (1.862 - 4.167)	**<0.001**	0.90 (0.46 - 1.74)	0.745
Use of Insulin plus OHA				
No	1			
Yes	0.185 (0.124 - 0.356)	**<0.001**	0.34 (0 .07 - 1.70)	0.188
BMI	0.99(0.96 - 1.02)	0.427	–	–
Normal weight	1	–	–	–
Overweight	1.10 (0.64 - 1. 90)	0.721	–	–
Obese	0. 83(0. 50 - 1.39)	0.476	–	–
Gender			–	–
Men	1	–	–	–
Women	0.92(0.62 - 1.36)	0.663	0.42 (0.14 - 1.25)	0.120
Education status				
None	1	1	–	–
Primary School	1.58(0.88 - 2.81)	0.124	–	–
Secondary school	1.14 (0.60 - 2.16)	0.687	–	–
College/University	1.00(0.47 - 2.13)	0.996	–	–
Marital status				
Living alone	1	–	–	–
Living with a partner	0.93 (0.64 - 1.36)	0.703	–	–
WHR	0.92 (0.13 - 6.58)	0.937		–
Low WHR	1	–	–	–
High WHR	0.92(0.57 - 1.50	0.745	–	–
Weight, kg	0.99 (0.98 - 1.01)	0.298		–
eGFR, (ml/min/1.73m²)	1.00 (0.99 - 1.00)	0.074	1.00(0.99 - 1.01)	0.766
CKD				
No	1			
Yes	1.053 (0.578 - 1.920	0.866	–	–
Proteinuria				
No	1		–	
Yes	1.16(0.63 - 2.14)	0.624	–	–
Optimal hypertension control				
No	1		–	
Yes	2.53 (1.63 - 3.93)	**<0.001**	1.61(0.63 - 4.13)	0.322
Optimal LDL-C control				
No	1			
Yes	2.10 (0.90 - 4.88)	0.086	2.20 (0.64 - 7.57)	0.209

Legend: Legend: BMI- Body Mass Index; CKD- Chronic kidney disease; DM - Diabetes mellitus; eGFR- estimated glomerular filtration rate; IQR – interquartile range; LDL-C – Low-density lipoprotein; OHA – oral hypoglycaemic agent; SD- standard deviation; WHR – Waist-hip ratio.

Table 3: Factors associated with optimal hypertension control among patients with type 2 diabetes at a specialised diabetes clinic in Gaborone (N= 500)

Characteristic	Unadjusted OR (95% CI)	p-value	Adjusted OR (95% CI)	p-value
Age group				
< 50 years	1	–	–	–
≥50 years	0.89(0.48 - 1.62)	0.691	–	–
Diabetes duration, years	0.97(0.94 - 0.99)	**0.023**	0 .98 (0.92 - 1.03)	0.352
Use of Insulin alone				
No	1	–	–	–
Yes	0.45 (0.24 - 0.82)	**0.009**	1.15 (0.30 - 4.44)	0.837
Use of OHA alone				
No		–	–	–
Yes	1.94 (1.30 - 2.91)	**0.001**	1.37 (0.51 - 3.66)	0.531
Use of Insulin plus OHA				
No	1	–	–	–
Yes	0.59 (0.40 - 0.95)	**0.028***	–	–
BMI, kg/m^2	0.98 (0.94 - 1.01)	0.149	0.93(0.86 - 1.01)	
Normal weight	1		–	–
Overweight	0.79 (0.42 - 1.47	0.449	–	–
Obese	0.77(0.44 -1.38	0.384	–	–
Gender				
Men	1	–	–	–
Women	1.43(0.92 - 2.22)	0.117	0.97 (0.36 - 2.61)	0.949
Marital				
Living alone	1	–	–	–
Living with a partner	0.68 (0.61 - 1.37)	0.67	–	–
Education status				
No formal education	1		–	–
Primary School	1.03(0.58 - 1.83)	0.09	–	–
Secondary school	1.08(0.56 - 2.09)	0.22	–	–
College/University	0.89(0.41 - 1.92)	0.761	–	–
WHR	1.29 (0 .14 - 12.00)	0.821		–
Low WHR	1			
High WHR	1.18 (0.65 - 2.12)	0.589		
eGFR, (ml/min/1.73m^2)	1.00 (1.00 - 1.01	0.139	1.00(0.99 -1.02)	0.412
Total serum Cholesterol	0.964 (0.80 - 1.16)	0.693	–	–
Proteinuria				
No	1	–	–	–
Yes	0.48(0.26 - 0.92)	**0.027**	0.36(0.07 - 1.80)	0.213
Use of CCB				
No	1	–	–	–
Yes	0.73(0.72 - 1.61)	0.729	–	–
Use of Thiazides				
No	1	–	–	–
Yes	1.58(1.06 - 2.37)	**0.026**	1.44(0.62 - 3.39)	0.399
Use of ACE inhibitors				
No	1	**-**	–	–
Yes	0.64 (0.43 - 0.95)	**0.028**	0.35(0.14 - 0.85)	**0.020**
Use of ARB				
No	1	–	–	–
Yes	0.95(0.57 - 1.58)	0.834	–	–
Alpha blocker				

No	1	–	–	–
Yes	0.24(0.09 - 0.68)	**0.007**	0.76 (0.14 - 4.20)	0.749
Beta-blocker				
No	1	–	–	–
Yes	0.70 (0.43 -1.14)	0.149	0.51(0.19 - 1.37)	0.184
Optimal Glycaemic control				
No	1	–	–	–
Yes	2.53 (1.63- 3.93)	**<0.001**	1.92 (0.71 - 5.23)	0.201
Optimal LDL-C control				
No	1	–	–	–
Yes	0.55 (0.23 - 1.36)	0.199	0.75 (0.25 - 2.32	0.623

Legend: * omitted because of collinearity. ACE INHIBITORS – angiotensin-converting-enzyme inhibitor; ARB – Angiotensin II receptor blocker; BMI- Body Mass Index; CCB- Calcium Channel Blockers; DM - Diabetes mellitus; eGFR- estimated glomerular filtration rate; HbA1c- Haemoglobin A1c; IQR – interquartile range; LDL-C – Low-density lipoprotein; OHA – oral hypoglycaemic agent; SD- standard deviation; WHR – Waist-hip ratio.

Table 4: Factors associated with optimal LDL-C control among patients with type 2 diabetes at a specialised diabetes clinic in Gaborone (N= 500)

Characteristic	Unadjusted OR (95% CI)	p-value	Adjusted OR (95% CI)	p-value
Age group				
<50 years	1		–	–
≥ 50 years	0.56 (0.21 - 1.50)	0.249	–	–
Diabetes duration, years	1.02(0. 97 - 1.06)	0.525		–
Use of Insulin alone				
No	1	–	–	–
Yes	1.58 (0.56 - 4.46)	0.389	–	–
Use of OHA alone				
No	1	–	–	–
Yes	0.95 (0.43 - 2.12)	0.900	–	–
Use of Insulin plus OHA				
No	1	–	–	–
Yes	0.83 (0.35 - 1.97)	0.664	–	–
BMI	1.00 (0.93 -1.07)	0.951		–
Normal weight	1	–	–	–
Overweight	1.43 (0.34 - 5.94)	0.624	–	–
Obese	1.27(0.33 - 4.89)	0.730	–	–
Gender				
Men	1		–	–
Women	0.2 (0.09 - 0.47)	**<0.001**	0.24(0.09- 0.59)	**0.002**
Education status				
No formal education	1	1	–	–
Primary School	0.79 (0. 29 - 2.14)	0.647	–	–
Secondary school	0.28 (0.07 - 1.20)	0.087	–	–
College/University	0.79(0.20 - 3.11)	0.731	–	–
Marital status				
Living alone	1		–	–
Living with a partner	0.99 (0.44 - 2.20)	0.973	–	–
HbA1c	1.00 (0.85 - 0.20)	0.917		–
WHR	7.59(0.19 - 303.60)	0.281	–	–
Low WHR	1			
High WHR	0.31(0.11 – 0.89)	**0.030**	0.64(0.20 - 2.10	0.463
Proteinuria				
No		–	–	–
Yes	0.69 (0.14 - 3.27)	0.64	–	–
eGFR, (ml/min/1.73m²)	1.00(0.99 - 1.01)	0.878	–	–
CKD				
No	1	–	–	–
Yes	1.88(0 .73 - 4.83)	0.193	1.67 (0.61 - 4.58)	0.321
Hypertension				
No		–	–	–
Yes	1.13 (0.30 - 4.23)	0.86	–	–

Legend: Legend: BMI- Body Mass Index; CKD- Chronic kidney disease; DM - Diabetes mellitus; eGFR- estimated glomerular filtration rate; IQR – interquartile range; LDL-C – Low-density lipoprotein; OHA – oral hypoglycaemic agent; SD- standard deviation; WHR–Waist-hip ratio

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	1
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	2
Objectives	3	State specific objectives, including any prespecified hypotheses	2
Methods			
Study design	4	Present key elements of study design early in the paper	2
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	2
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	2
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	2
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	2
Bias	9	Describe any efforts to address potential sources of bias	*2*
Study size	10	Explain how the study size was arrived at	2
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	3
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	3
		(*b*) Describe any methods used to examine subgroups and interactions	3
		(*c*) Explain how missing data were addressed	
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	
		(*e*) Describe any sensitivity analyses	
Results			3

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	3
		(b) Give reasons for non-participation at each stage	
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	4
		(b) Indicate number of participants with missing data for each variable of interest	
Outcome data	15*	Report numbers of outcome events or summary measures	4,5
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	4,5
		(*b*) Report category boundaries when continuous variables were categorized	4,5
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	
Discussion			
Key results	18	Summarise key results with reference to study objectives	5
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	1
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	8
Generalisability	21	Discuss the generalisability (external validity) of the study results	8
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	8

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.