



## RETRACTED ARTICLE: Antidiabetic medication adherence and associated factors among patients in Botswana; implications for the future

Godfrey Mutashambara Rwegerera, Thato Moshomo, Marea Gaenamong, Taibat Aderonke Oyewo, Sivasomnath Gollakota, Francis Apolinary Mhimbira, Joseph Fadare, Brian Godman, Johanna C. Meyer & Yordanka Piña Rivera

To cite this article: Godfrey Mutashambara Rwegerera, Thato Moshomo, Marea Gaenamong, Taibat Aderonke Oyewo, Sivasomnath Gollakota, Francis Apolinary Mhimbira, Joseph Fadare, Brian Godman, Johanna C. Meyer & Yordanka Piña Rivera (2018) RETRACTED ARTICLE: Antidiabetic medication adherence and associated factors among patients in Botswana; implications for the future, Alexandria Journal of Medicine, 54:2, 103-109, DOI: [10.1016/j.ajme.2017.01.005](https://doi.org/10.1016/j.ajme.2017.01.005)

To link to this article: <https://doi.org/10.1016/j.ajme.2017.01.005>



© 2017 Alexandria University Faculty of Medicine. Production and hosting by Elsevier B.V.



Published online: 17 May 2019.



Submit your article to this journal [↗](#)



Article views: 305



View related articles [↗](#)



View Crossmark data [↗](#)



Citing articles: 12 View citing articles [↗](#)



## RETRACTED ARTICLE: Antidiabetic medication adherence and associated factors among patients in Botswana; implications for the future



Godfrey Mutashambara Rwegerera<sup>a,\*</sup>, Thato Moshomo<sup>b</sup>, Marea Gaenamong<sup>c</sup>, Taibat Aderonke Oyewo<sup>b</sup>, Sivasomnath Gollakota<sup>b</sup>, Francis Apolinary Mhimbira<sup>d</sup>, Joseph Fadare<sup>e</sup>, Brian Godman<sup>f,g</sup>, Johanna C. Meyer<sup>h</sup>, Yordanka Piña Rivera<sup>a</sup>

<sup>a</sup> Faculty of Medicine, Department of Internal Medicine, University of Botswana and Department of Medicine, Princess Marina Hospital, Gaborone, Botswana

<sup>b</sup> Department of Medicine, Princess Marina Hospital, Gaborone, Botswana

<sup>c</sup> Department of Accident and Emergency, Princess Marina Hospital, Gaborone, Botswana

<sup>d</sup> Ifakara Health Institute, Morogoro, Tanzania

<sup>e</sup> Department of Pharmacology and Therapeutics College of Medicine, Ekiti State University, Ado-Ekiti, Nigeria

<sup>f</sup> Department of Laboratory Medicine, Division of Clinical Pharmacology, Karolinska Institutet, Karolinska University Hospital Huddinge, Stockholm, Sweden

<sup>g</sup> Strathclyde Institute of Pharmacy and Biomedical Sciences, University of Strathclyde, Glasgow, United Kingdom

<sup>h</sup> Department of Pharmacy, Faculty of Health Sciences, School of Health Care Sciences, Sefako Makgatho Health Sciences University, South Africa

### ARTICLE INFO

#### Article history:

Received 11 January 2017

Accepted 24 January 2017

Available online 6 March 2017

### ABSTRACT

**Background:** Diabetes mellitus (DM) is a major global public health problem. Lack of adherence to medication causes suboptimal glycaemic control increasing complication rates, costs and mortality. The objective of the study was to determine current antidiabetic medication adherence in Botswana and assess associated factors so as to direct potential future interventions.

**Materials and methods:** A cross-sectional study among 376 randomly selected diabetic patients attending a leading clinic in Gaborone, Botswana. Eight item Morisky Medication adherence questionnaire was used to assess antidiabetic medication adherence. A structured questionnaire was also used to collect information on factors influencing adherence including age, gender, education, type and duration of diabetes, treatment, complications and HIV status. Data were entered and analyzed using STATA Version 14, and logistic regression performed.

**Results:** Over forty percent (41.8%) of patients were non-adherent to antidiabetic medications. Studied sociodemographic characteristics and clinical variables did not affect adherence. HIV positive status was associated with a statistically significant better adherence at multivariate analysis.

**Conclusion:** Adherence to antidiabetic medication was found to be suboptimal in a setting where medicines are provided free of charge. Only HIV positivity was found to be significantly associated with better adherence, probably due to effect of greater psychosocial support and counselling as part of HIV treatment. There is a need to carry out studies to further improve understanding of factors associated with medication adherence that are pertinent to Botswana and similar settings given the growing prevalence of diabetes.

© 2017 Alexandria University Faculty of Medicine. Production and hosting by Elsevier B.V. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

Peer review under responsibility of Alexandria University Faculty of Medicine.

\* Corresponding author at: Godfrey Mutashambara Rwegerera, Department of Internal Medicine, Faculty of Medicine, University of Botswana, Botswana.

E-mail addresses: [grwege@yahoo.com](mailto:grwege@yahoo.com) (G.M. Rwegerera), [moshomotkl@gmail.com](mailto:moshomotkl@gmail.com) (T. Moshomo), [mareagaenamong@gmail.com](mailto:mareagaenamong@gmail.com) (M. Gaenamong), [aderonkeo@yahoo.co.uk](mailto:aderonkeo@yahoo.co.uk) (T.A. Oyewo), [siv\\_vagv@yahoo.com](mailto:siv_vagv@yahoo.com) (S. Gollakota), [fmhimbira@ihi.or.tz](mailto:fmhimbira@ihi.or.tz) (F.A. Mhimbira), [jofadare@gmail.com](mailto:jofadare@gmail.com) (J. Fadare), [Brian.Godman@ki.se](mailto:Brian.Godman@ki.se), [Brian.godman@strath.ac.uk](mailto:Brian.godman@strath.ac.uk) (B. Godman), [hannelie.meyer@smu.ac.za](mailto:hannelie.meyer@smu.ac.za) (J.C. Meyer), [yordankapr@yahoo.com](mailto:yordankapr@yahoo.com) (Y.P. Rivera).

<http://dx.doi.org/10.1016/j.ajme.2017.01.005>

2090-5068/© 2017 Alexandria University Faculty of Medicine. Production and hosting by Elsevier B.V.

This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

### 1. Introduction

Diabetic mellitus (DM) is a metabolic disorder, characterized by elevated blood glucose levels. It is of growing public health importance.<sup>1</sup> The prevalence of diabetes was estimated to increase from 171 million in 2000 to 366 million by the year 2030.<sup>2</sup> However, recent data from the International Diabetes Federation (IDF) suggest that previous estimates have already been exceeded, with a prevalence of 415 million by 2015 and estimated to reach 642 million by 2040.<sup>3</sup> The World Health Organization (WHO) also estimated that there were 422 million adults living with DM in

2014, 8.5% of the adult population.<sup>1</sup> Global estimates further show that the rise in the prevalence of DM is unevenly distributed with over 70% of people with DM likely to live in developing countries, particularly sub-Saharan Africa, a region already heavily burdened by communicable diseases<sup>4–9</sup> as well as non-communicable diseases such as hypertension.<sup>10,11</sup> DM accounted for 1.5 million deaths in 2012 and rising.<sup>1</sup>

There is currently scarcity of data regarding the burden of DM in Botswana. However, according to the International Disease Federation, there were 52,000 documented diabetic patients (approximate prevalence of 2.4%) in 2015 in Botswana.<sup>3</sup> Data from the STEPS survey conducted by the WHO in 2007 documented that 34.7% and 38.7% of the population of Botswana performed low physical activity and were overweight respectively<sup>12</sup>; both variables being components of the metabolic syndrome leading to Type 2 diabetes (T2DM). This suggests that the burden of DM in Botswana may be higher than current estimates. It is well recognized that various forms of DM peculiar to sub-Saharan Africa exist, ranging from Type 1 and Type 2 DM, and malnutrition-related diabetes to ketosis-prone diabetes. However, T2DM is by far the most common type of diabetes, accounting for 90% of all cases.<sup>13,14</sup> T2DM occurrence is attributed to both modifiable and non-modifiable factors including but not limited to social and cultural behaviors, lack of physical activity, dietary habits, urbanization and ageing.<sup>15,16</sup> Patients with DM have increased morbidity and mortality<sup>17–22</sup> because of associated conditions as a result of the complications of DM. These range from cardiovascular diseases, neuropathy, nephropathy, and bacteremia to tuberculosis.<sup>23–26</sup>

The management of DM requires a multifaceted approach with a focus on dietary modification, physical exercise and pharmacotherapy.<sup>27,28</sup> Good adherence to treatment strategies is crucial for the successful management of chronic asymptomatic conditions such as hypercholesterolemia and hypertension.<sup>29–33</sup> For DM specifically, a combined approach of diet control, physical exercise and medication helps achieve sufficient glycemic control and avoids related short-term and long-term complications.<sup>34–38</sup> Good control of blood pressure and regular use of statins helps reduce cardio-vascular events and deaths.<sup>39,40</sup> However, the WHO estimates that only half of patients with chronic diseases are medication adherent.<sup>41</sup> Most of previous studies on adherence to antidiabetic medications have shown low adherence patterns to both pharmacotherapy and other aspects of diabetic care.<sup>33,42–45</sup>

Various factors are associated with non-adherence to medication in DM patients, which can be categorized as patient centered, therapy-related or healthcare system related.<sup>46,47</sup> Patient-centered factors include sociodemographic (age, gender and educational level) factors, psychological factors including motivation towards therapy taking, patient-prescriber relationship and patient knowledge.<sup>42,48,49</sup> Therapy-related factors include route, type and duration of treatment, complexity of treatment especially as patients may be on multiple medicines, cost of medication especially if co-payment is an issue and adverse effects.<sup>50–55</sup> Healthcare system factors include availability and accessibility of health care, and the health provider-patient interactions.<sup>56</sup>

Despite the fact that many studies have been performed globally on adherence to antidiabetic medicines, and the majority have showed varied non-adherence from low to high,<sup>28</sup> we felt it was justified to undertake a study in Botswana, as each community has its own culture and lifestyle that may affect adherence in a different way.<sup>57</sup> This is especially the case in Botswana with its high prevalence of HIV at over 22% of the adult population, with higher rates especially among women.<sup>58</sup> At one stage, nearly 50% of women aged 30–34 years had HIV<sup>59</sup>; however, rates are now decreasing among the young.<sup>58</sup> High prevalence rates are also seen in other African countries, with higher rates generally among

women than men.<sup>60,61</sup> This is important as this will appreciably enhance the pill burden in patients with both DM and HIV.

This study was conducted to determine the magnitude of antidiabetic medication adherence and assess associated factors among both patients with Type 1 and Type 2 DM in a tertiary diabetic clinic in Gaborone including those with HIV. If there were concerns with medication adherence in this specialized setting, this would reflect concerns generally throughout Botswana. The findings may also be of interest to other African countries with high prevalence rates of HIV and growing rates of DM to help improve their future management of these patients.

## 2. Materials and methods

### 2.1. Study design and setting

This was a cross-sectional study conducted at Block 6 clinic, a tertiary clinic specializing in the treatment of patients with both Type 1 and Type 2 DM. Block B clinic is situated in Gaborone, the capital city of Botswana, with a population of approximately 200,000. The clinic offers various services to over estimated 3000 diabetic patients. Services include physician consultations, health education, eye and foot screening and the issuing of medicines. Medicines are provided free-of-charge so co-payment is not an issue affecting medication adherence.<sup>62,63</sup> On average 1800–2000 diabetic patients visit the clinic monthly for various reasons, of which an average of 1400 patient visits are physician consultations.

### 2.2. Study population

A total of 376 patients were randomly selected over the course of two months from 21st July 2015 to 21st September 2015. At the time of data collection, approximately 70 patients attended the clinic each day. *Inclusion criteria:* All patients above the age of 21 years who attended the clinic on working days (Monday to Friday) and who consented to participate in the study. *Exclusion criteria:* Patients with decision impaired illnesses such as mental illness, including schizophrenia, bipolar disorder and dementia, were excluded from the study along with those who refused to take part.

### 2.3. Sample size

Sample size was calculated using the formula for cross-sectional study using a prevalence of non-adherence to chronic medication of 67%<sup>64,65</sup> with standard score of 95% confidence level and margin of error of 5% giving a minimum sample size of 340 patients.

### 2.4. Data collection

Data were collected by two research assistants, who were qualified nurses, and trained in interview techniques prior to the study. A list of patients attending the clinic was obtained from the nurses doing vital signs, and a coin was tossed for the first 10 patients on the list to randomly obtain the first patient for each day of data collection. From there, every 5th patient was subsequently approached for consent to participate in the study. In case of refusal, either tossing the coin was repeated or a subsequent 5th patient was approached, without affecting the prior order, to ensure a random sample. About 8–10 patients were recruited on each week day of recruitment. A structured questionnaire, which was pre-tested, was used to obtain information on the socio-demographic characteristics, as well as factors affecting

medication adherence. Self-reported adherence to antidiabetic medication was determined during the interview using the Morisky 8-Item Medication Adherence Questionnaire (Box 1). All questions, except for the last question, were answered with a yes/no response, with corresponding 1 and 0 value. Overall adherence to medication was categorized based on patients' responses, according to the following scores: >2 = low adherence; 1 or 2 = medium adherence; 0 = high adherence.<sup>66–68</sup>

**Box 1** Morisky 8-Item Medication Adherence Questionnaire<sup>67</sup>

- Do you sometimes forget to take your medicine? (Y = 1; N = 0)
- People sometimes miss taking their medicines for reasons other than forgetting. Thinking over the past 2 weeks, were there any days when you did not take your medicine? (Y = 1; N = 0)
- Have you ever cut back or stopped taking your medicine without telling your doctor because you felt worse when you took it? (Y = 1; N = 0)
- When you travel or leave home, do you sometimes forget to bring along your medicine? (Y = 1; N = 0)
- Did you take all your medicines yesterday?(Y = 0; N = 1)
- When you feel like your symptoms are under control, do you sometimes stop taking your medicine? (Y = 1; N = 0)
- Taking medicine every day is a real inconvenience for some people. Do you ever feel hassled about sticking to your treatment plan? (Y = 1; N = 0)
- How often do you have difficulty remembering to take all your medicine? (A = 0; B–E = 1 where A. Never/rarely; B. Once in a while; C. Sometimes; D. Usually; E. All the time).

Clinical characteristics, past medical history and history of documented diabetic complications were obtained from patients' charts. Further information on the patients' history was obtained from outpatient charts. Results of previous laboratory investigations (undertaken within six months of the index visit) such as glycated haemoglobin were obtained from the Integrated Patients Management System (IPMS). As regards the HIV status, patients were categorized as either HIV negative/-positive/-unknown according to their response of being tested with evidence of documentation in the past year or known HIV seropositive results recorded in the IPMS.

Physical examination of patients by clinic staff is undertaken routinely. This involves measuring weight, using a calibrated weighing scale and entering the data onto the charts. The height of each patient taking part was measured by research assistants using calibrated height scale to enable calculations of the Body Mass Index (weight in kg/height in m<sup>2</sup>).

Patients' ages were recorded as whole numbers, e.g. if a patient was 50 years and 9 months, the age would be recorded as 50 years.

### 2.5. Data management and analysis

Data were entered and analyzed using STATA Version 14. To assess any associations, both univariate and multivariate logistic regression with odds ratios (OR) and 95% confidence interval (CI) were performed. Medication adherence was dichotomized as either adherent (Morisky score = 0/high adherence) or non-adherent (Morisky score  $\geq 1$ /low and medium adherence). The dichotomization in this study was according to previous studies

that used Morisky scale and categorized any score above zero as non-adherent.<sup>69–71</sup> A p-value of less than 0.05 was considered statistically significant.

### 3. Ethical considerations

Ethical clearance to conduct the study was obtained from the University of Botswana Ethics Committee and the Institutional Review Board (IRB) as well as the Ethics Committee at Princess Marina Hospital. Ethical clearance was also secured from the Botswana Ministry of Health Research Unit. All patients provided written informed consent for participation.

### 4. Results

#### 4.1. Baseline socio-demographic characteristics

A total of 376 patients were interviewed after excluding 4 patients who refused informed consent. The majority of patients were female (69.1%). The mean age of patients was 56.5 (SD: 13.7) years with a median duration of DM of 5.0 years. Most of the study participants were either overweight or obese accounting for 29.2% and 50.0% respectively (Table 1).

#### 4.2. Clinical and medication characteristics of study participants

Most of the interviewed patients were T2DM, accounting for 353 of the 376 patients (93.9%). As regards the duration of diagnosed diabetes, nearly half of the patients (46.8%) had been diagnosed less than 5 years ago. Over 80% of patients were either only on oral hypoglycemic agents or on a combination of oral hypoglycemic agents and insulin. The majority (81.8%) of patients had diabetic complications documented in their outpatients'

**Table 1**  
Sociodemographic characteristics of the study participants (n = 376).

Characteristic	n (%)
<b>Sex</b>	
Female	260 (69.1)
Male	116 (30.9)
<b>Age</b>	
<36	32 (8.5)
36–50	78 (20.7)
51–65	163 (43.4)
$\geq 66$	103 (27.4)
Age, mean (SD)	56.5 (13.7)
<b>Education level</b>	
No formal school	70 (18.6)
Less than primary school	78 (20.7)
Primary school completed	103 (27.4)
Secondary school completed	77 (20.5)
College/University completed	42 (11.2)
Post-graduate degree	6 (1.6)
<b>Marital status</b>	
Never married	102 (27.1)
Currently married	155 (41.2)
Separated	2 (0.5)
Divorced	13 (3.5)
Widowed	74 (19.7)
Cohabiting	30 (8.0)
<b>BMI, median (IQR)</b>	
Underweight	5 (1.5)
Normal weight	65 (19.3)
Overweight	98 (29.2)
Obese	168 (50)

SD: Standard deviation.

**Table 2**  
Clinical and medication characteristics of study participants (n = 376).

Clinical and medication characteristics	n (%)
<i>Type of diabetes mellitus</i>	
Type 1	23 (6.1)
Type 2	353 (93.9)
<i>Duration of diabetes</i>	
<5 years	176 (46.8)
5–10 years	89 (23.7)
>10 years	93 (24.7)
Missing	18 (4.8)
<i>Modality of treatment for diabetes</i>	
Oral hypoglycemic agents (OHA)	224 (59.6)
Insulin	51 (13.6)
Both OHA and insulin	101 (26.8)
<i>Number of OHA currently in use</i>	
One	164 (43.6)
Two	161 (42.8)
Missing	51 (13.6)
<i>Diabetic complications</i>	
No	65 (17.3)
Yes	311 (82.7)
<i>Diabetic complications (multiple responses)</i>	
Eye complications-retinopathy	142 (37.4)
Skin complications with or without itching	133 (35.0)
Postural hypotension	116 (30.5)
Palpitations	113 (29.7)
Gastroparesis	77 (20.3)
Erectile dysfunction	59 (15.5)
Neuropathy	55 (14.5)
Heart failure	32 (8.4)
Diabetic foot/hand with or without ulcer	23 (6.1)
Kidney complications-nephropathy	18 (4.7)
Stroke	3 (0.8)
<i>HIV status</i>	
Positive	38 (10.1)
Negative	234 (62.2)
Unknown	104 (27.7)

**Table 3**  
Prevalence of adherence to antidiabetic medication according to Morisky scale (n = 376).

Adherence category (Morisky score)	n (%)
High adherence (0)	219 (58.2)
Medium adherence (1–2)	91 (24.2)
Low adherence (>2)	66 (17.6)

charts, despite their duration of diagnosed diabetes being less than 5 years. Nearly two thirds (62.2%) of patients were HIV negative and for 27.7% the HIV-status was unknown (Table 2).

#### 4.3. Prevalence of antidiabetic medication adherence

The prevalence of high adherence to antidiabetic medication according to the Morisky scale was 58.2%. Medium and low adherence was 24.2% and 17.6% respectively accounting for 41.8% of non-adherent group (Table 3).

#### 4.4. Factors associated with antidiabetic adherence

Several factors, including sociodemographic characteristics (age, gender, educational level and marital status) and clinical and medication characteristics (HIV status, type of diabetes, duration of diabetes and modality of treatment) were analyzed to determine any association with adherence to antidiabetic medication. For this purpose as mentioned, patients were categorized as either adherent (Morisky score = 0/high adherence) or non-adherent (Morisky score  $\geq 1$ /low and medium adherence).

For all the studied factors, only HIV-positive status was associated with high antidiabetic medication adherence; 30/38 (78.9%) of HIV-positive patients were adherent to antidiabetic medication compared to 122/234 (52.1%) (p-value = 0.017, AOR = 0.31, 95% CI = 0.13–0.74) (Table 4).

#### 4.5. Association between antidiabetic medication adherence and glycaemic control

Overall, the analysis of the extent of antidiabetic medication adherence to glycaemic control from using glycated haemoglobin (HbA1c levels) revealed no statistically significant association (p-value = 0.09; COR = 1.45; 95% CI = 0.94–2.23). The association between HIV positive status and better antidiabetic medication was still significant in multivariate analysis (Table 5).

### 5. Discussion

The duration of diagnosed diabetes was less than 5 years for nearly half of the patients in this study, however; over 80% of patients had documented complications in their charts. This implies either the possibility of late diagnosis, calling for an increase in screening programmes in the community especially given the likelihood of the high prevalence rates of diabetes in Botswana; alternatively poor adherence to combined treatment approaches, including diet, exercise and medicines. Screening programs to diagnose diabetes mellitus earlier will help reduce both microvascular and macrovascular complications as well as associated costs.<sup>34,72,73</sup>

Overall, adherence to antidiabetic medication was found to be suboptimal with only 57.6% of patients demonstrating high adherence (Table 3). This is higher though than in a Nigerian study using the same instrument which reported only 40.6% of patients with high medication adherence.<sup>74</sup> While other studies have shown costs, i.e. patient co-payments, to significantly affect adherence to antidiabetic medication,<sup>50,55,75</sup> the same cannot be said for Botswana as medication for the treatment of DM are provided free of charge. However, this rate of adherence was low compared to other studies undertaken in Nigeria (72.5%),<sup>76</sup> as we; as Uganda (71%)<sup>55</sup> and Tanzania (71.2%).<sup>50</sup> The reason for the differences seen may partly be explained by the different methodologies used to estimate adherence rates in the various studies. These studies typically used patients' recall on adherence or pill counts. However, we feel that the use of the Morisky scale is justified in our study to estimate adherence as this methodology is well validated and has been used widely.<sup>77</sup> In any event, our findings mean more educational and other input needs to be undertaken in the clinics to improve adherence rates in Botswana.

Interestingly in our study, high adherence to diabetes medicines was not significantly associated with better glycaemic control, which is similar though to other studies.<sup>50,78,79</sup> However, it is important to point out that only antidiabetic medication adherence was studied and not other factors including physical exercise and diet, in addition to HIV medication.<sup>80–82</sup>

Other studies have also shown contrasting results on factors affecting adherence to antidiabetic medication, with factors ranging from demographic characteristics such as age, gender and level of education<sup>55,83–85</sup> to clinical and medication factors such as duration of diagnosed diabetes, modality of treatment and complexity of treatment.<sup>40</sup> The findings of our study (Table 4) did not reveal any association to any of these commonly studied variables. This may again reflect different methodologies and settings, and needs further investigation.

Patients with an HIV-positive status in this study were found to be more adherent than those with an HIV-negative or -unknown

**Table 4**

The relationship between sociodemographic, clinical, and other characteristics on adherence to antidiabetic medication.

Characteristics	Adherent <sup>a</sup>	Non-adherent <sup>a</sup>	Crude OR (95% CI)	p-Value
<i>Age group</i>				0.43
<36	24	8	1 (Ref)	
36–50	41	37	2.72 (1.82–9.04)	
51–65	96	67	2.21 (0.64–7.66)	
>66	54	49	2.31 (0.62–8.62)	
<i>Sex</i>				0.50
Male	71	45	1 (Ref)	
Female	144	116	1.18 (0.73–1.93)	
<i>Education level</i>				0.16
No/primary	148	103	1 (Ref)	
Secondary or higher	67	58	1.47 (0.86–2.50)	
<i>Marital status</i>				0.73
Married/cohabiting	105	80	1 (Ref)	
Single/separated/divorced/widowed	110	81	1.08 (0.69–1.69)	
<i>HIV status</i>				0.01
Negative	122	112	1 (Ref)	
Positive	30	8	0.29 (0.12–0.69)	
Unknown	66	38	0.68 (0.41–1.41)	
<i>Type of diabetes</i>				0.56
Type 1	17	6	1 (Ref)	
Type 2	198	155	0.63 (0.14–2.91)	
<i>Diabetes duration</i>				0.92
<5 years	114	64	1 (Ref)	
5–10 years	50	41	1.53 (0.89–2.65)	
>10 years	47	46	1.83 (1.02–3.28)	
<i>Modality of treatment</i>				0.28
OHA	127	97	1 (Ref)	
Insulin	38	13	0.24 (0.05–1.18)	
Both OHA and Insulin	57	44	0.46 (0.11–1.86)	

Note: 4 patients with no Morisky score results excluded from analysis.

<sup>a</sup> Adherent: Morisky score = 0/high adherence; Non-adherent: Morisky score  $\geq 1$ /low and medium adherence.**Table 5**

Logistic regression output showing factors associated with antidiabetic medication adherence.

	Adjusted OR (95% CI)	p-Value
<i>HIV status</i>		0.007
Negative	1 (Ref)	
Positive	0.29 (0.13–0.67)	
Unknown	0.68 (0.43–1.09)	

status. HIV care and services are well developed within Botswana's health care system. A patient in a diabetes clinic in Botswana was previously overheard, saying in Setswana (local language), "Go ka bo go ne go le botoka go nna le HIV gona le bolwetse jwa sukiri", and when translated to English, "It would have been better if I had HIV instead of diabetes."<sup>86</sup> These words imply that diabetic patients may feel they are not cared for as well as their HIV positive counterparts. Screening for diabetes does not take place routinely; hence patients with diabetes are often diagnosed and come to the attention of specialist clinics only when they have already developed complications.<sup>84</sup> This will be explored further in future research in view of the growing prevalence of diabetes in Botswana, the need to ensure high adherence with prescribed treatment approaches, and the fact that our study revealed a positive association between HIV-positive status and better antidiabetic medication adherence (Table 5). Some of the 'unknowns' (Table 5) are also likely to be HIV positive in view of the prevalence in Botswana.<sup>58</sup> This phenomenon may possibly be explained by the fact that HIV positive patients receive counseling sessions and psychosocial support to enhance their antiretroviral medication adherence. As a result, also improving antidiabetic medication adherence, despite an appreciably increased pill burden. This will also be the subject of future research projects.

## 6. Study limitations

Our findings should be interpreted with caution. Firstly, we only conducted the study in one centre in Botswana. However, this was a leading clinic in Botswana and if poor adherence rates were seen here, the situation may be worse in other centres.

We also did not include psychosocial factors in our questionnaire. We acknowledge that other published studies have shown the role of factors including language, health literacy, social support, cultural factors and stigma, which can contribute to low adherence.<sup>57</sup> This will be investigated further in future studies.

Our study also only included aspects of pharmacotherapy. The importance of the other two components of diabetes care, namely physical exercise and dietary modifications, cannot be over stated in their role to enhance glycemic control and improve the outcome of patients with DM.

However, we do believe that this first study on antidiabetic medication adherence in Botswana including patients with concomitant HIV, and will encourage further research to improve future patient management in Botswana, given the current low adherence rates and high numbers of patients with DM, having complications early in their disease state.

## 7. Conclusion

About two in every five patients was non-adherent to antidiabetic medication. This is quite a significant number especially in this specialist clinic in Botswana where medicines are provided monthly at no cost to the patients. Only HIV-positive status was found to be significantly associated with better medication adherence, probably due to the effect of greater patient support and counseling offered at HIV clinics, despite appreciably increasing

the pill burden. This has important implications for improved management of patients with DM in Botswana in the future and will be the subject of further research along with exploring psychosocial factors associated with medication adherence that are pertinent to the Botswana setting. There is also a need for greater screening of patients to identify patients earlier to reduce complication rates.

### Conflicts of interest

The authors declare they have no conflicts of interest and all the authors have read and approved the final submitted version.

### Acknowledgments

We would like to thank the staff at Block 6 clinic, for their cooperation in the study and their efforts to brief the patients about the study. Many thanks also to all the patients for their willingness to participate in this study.

### References

- World Health Organisation. Global report on diabetes; 2016. Available at [http://apps.who.int/iris/bitstream/10665/204871/1/9789241565257\\_eng.pdf?ua=1](http://apps.who.int/iris/bitstream/10665/204871/1/9789241565257_eng.pdf?ua=1).
- Wild S, Roglic G, Green A, Sicree R, King H. Global prevalence of diabetes. Estimates for the year 2000 and projections for 2030. *Diabetes Care*. 2004;27:1047–1053. <http://dx.doi.org/10.2337/diacare.27.5.1047>.
- International Diabetes Federation (IDF). Diabetes atlas. 7th ed.; 2015. <http://www.diabetesatlas.org/>.
- Ogbera AO, Kuku SF. Insulin use, prescription patterns, regimens and costs—a narrative from a developing country. *Diabetol Metabol Syndrom*. 2012;4:50.
- Inzucchi SE. Diabetes facts and guidelines. Yale Diabetes Center; 2011. Available at [http://www.endocrinology.yale.edu/patient/Yale%20National%20F\\_50135\\_1095\\_4813.pdf](http://www.endocrinology.yale.edu/patient/Yale%20National%20F_50135_1095_4813.pdf).
- Shaw JE, Sicree RA, Zimmet PZ. Global estimates of the prevalence of diabetes for 2010 and 2030. *Diabetes Res Clin Pract*. 2010;87:4–14.
- UNAIDS: 2010 report on the global AIDS epidemic. Geneva: UNAIDS; 2010. Available at [http://www.unaids.org/globalreport/Global\\_report.htm](http://www.unaids.org/globalreport/Global_report.htm).
- World Health Organisation: WHO global tuberculosis control report; 2010. Available at [http://apps.who.int/iris/bitstream/10665/44425/1/9789241564069\\_eng.pdf](http://apps.who.int/iris/bitstream/10665/44425/1/9789241564069_eng.pdf).
- World Health Organisation. *World malaria report 2010*. Geneva: WHO; 2010.
- Irazola VE, Gutierrez L, Bloomfield G, et al. Hypertension prevalence, awareness, treatment, and control in selected LMIC communities: results from the NHLBI/UHG network of centers of excellence for chronic diseases. *Global Heart*. 2016;11:47–59.
- WHO. A global brief on hypertension – silent killer, global public health crisis. World Health Day; 2013. Available at [http://apps.who.int/iris/bitstream/10665/79059/1/WHO\\_DCO\\_WHD\\_2013.2\\_eng.pdf?ua=1](http://apps.who.int/iris/bitstream/10665/79059/1/WHO_DCO_WHD_2013.2_eng.pdf?ua=1). (11).
- WHO. Botswana steps survey; 2007. [http://www.who.int/chp/steps/2007-STEPS\\_Report\\_Botswana.pdf](http://www.who.int/chp/steps/2007-STEPS_Report_Botswana.pdf).
- Levitt NS. Diabetes in Africa: epidemiology, management and healthcare challenges. *Heart*. 2008;94:1376–1382.
- Hall V, Reimar T, Ole H, Nicolai L. Diabetes in Sub Saharan Africa 1999–2011: epidemiology and public health implications. A systemic review. *BMC Public Health*. 2011;11:564.
- Kasper DL, Fauci AS, Longo DL, Braunwald E, Hauser SL, Jameson JL. *Harrison's principles of internal medicine*. 16th ed. New York, NY, USA: McGraw-Hill; 2012.
- Smeltzer SC, Bare BG, Hinkle JL, Cheever KH. *Brunner & Suddarth's textbook of medical-surgical nursing*. 12th ed. Philadelphia, PA, USA: Lippincott Williams & Wilkins; 2010.
- Rudan I, Boschi-Pinto C, Biloglav Z, Mulholland K, Campbell. Epidemiology and etiology of childhood pneumonia. *Bull World Health Org*. 2008;86:408–416.
- Seale AC, Mwaniki M, Newton CR, Berkley JA. Maternal and early onset neonatal bacterial sepsis: burden and strategies for prevention in sub-Saharan Africa. *Lancet Infect Dis*. 2009;9:428–438.
- Mayanja BN, Todd J, Hughes P, et al. Septicaemia in a population-based HIV clinical cohort in rural Uganda, 1996–2007: incidence, aetiology, antimicrobial drug resistance and impact of antiretroviral therapy. *Trop Med Int Health*. 1996;15:697–705.
- Reddy EA, Shaw AV, Crump JA. Community-acquired bloodstream infections in Africa: a systematic review and meta-analysis. *Lancet Infect Dis*. 2010;10:417–432.
- Steen TW, Aruwa JE, Hone NM. The epidemiology of adult lung disease in Botswana. *Int J Tuberc Lung Dis*. 2001;5:775–782.
- Lonnroth K, Castro KG, Chakaya JM, et al. Tuberculosis control and elimination 2010–50: cure, care, and social development. *Lancet*. 2010;375:1814–1829.
- Saydah SH, Eberhardt MS, Loria CM, Brancati FL. Age and the burden of death attributable to diabetes in the United States. *Am J Epidemiol*. 2002;156:714–719.
- Brown WV. Microvascular complications of diabetes mellitus: renal protection accompanies cardiovascular protection. *Am J Cardiol*. 2008;102:10L–13L.
- Thomsen RW, Hundborg HH, Lervang HH, Johnsen SP, Schonheyder HC, Sørensen HT. Risk of community-acquired pneumococcal bacteremia in patients with diabetes: a population-based case-control study. *Diabetes Care*. 2004;27:1143–1147.
- Jeon CY, Murray MB. Diabetes mellitus increases the risk of active tuberculosis: a systematic review of 13 observational studies. *PLoS Med*. 2008;5:e152.
- Cramer JA. A systematic review of adherence with medications for diabetes. *Diabetes Care*. 2004;27:1218–1224.
- Sankar UV, Lipska K, Mini GK, Sarma PS, Thankappan KR. The adherence to medications in diabetic patients in rural Kerala, India. *Asia Pac J Public Health*. 2015;27:NP513–NP523.
- Adebolu FA, Naidoo M. Blood pressure control amongst patients living with hypertension presenting to an urban district hospital outpatient clinic in Kwazulu-Natal. *Afr J Primary Health Care Family Med*. 2014;6:E1–E6.
- Adeyemo ATB, Luke A, Ogedegbe OO, Durazo-Arvizu R, Cooper RS. The Nigerian anti-hypertensive adherence trial (NA-HAT): a community-based randomized trial. *J Hypertens*. 2013;31:201–207.
- Khatib R, Schwalm JD, Yusuf S, et al. Patient and healthcare provider barriers to hypertension awareness, treatment and follow up: a systematic review and meta-analysis of qualitative and quantitative studies. *PLoS ONE*. 2014;9:e84238.
- Simpson Jr RJ, Mendys P. The effects of adherence and persistence on clinical outcomes in patients treated with statins: a systematic review. *J Clin Lipidol*. 2010;4:462–471.
- Ahmad NS, Ramli A, Islahudin F, Paraidathathu T. Medication adherence in patients with type 2 diabetes mellitus treated at primary health clinics in Malaysia. *Patient Preference Adheren*. 2013;7:525–530.
- Khan AR, Al-Abdul Lateef ZN, Al Aithan MA, Bu-Khamseen MA, Al Ibrahim I, Khan SA. Factors contributing to non-compliance among diabetics attending primary health centers in the Al Hasa district of Saudi Arabia. *J Family Commun Med*. 2012;19:26–32.
- White JR. Improving adherence in the treatment of type 2 diabetes. *US Pharm*. 2010;36:11–15.
- Sontakke S, Jadhav M, Pimpalkhute S, Jaiswal K, Bajait C. Evaluation of adherence to therapy in patients of type 2 diabetes mellitus. *J Young Pharm*. 2015;7(4 Suppl):462–469.
- American Diabetes Association. Standards of medical care in diabetes. *Diabetes Care*. 2008;31:S12–S54.
- American Diabetes Association. The economic costs of diabetes in the US in 2007. *Diabetes Care*. 2008;31:1–20.
- Tight blood pressure control and risk of macrovascular and microvascular complications in type 2 diabetes: UKPDS 38. UK Prospective Diabetes Study Group. *BMJ*. 1998;317:703–713.
- Collins R, Armitage J, Parish S, Sleight P, Peto R. MRC/BHF heart protection study of cholesterol-lowering with simvastatin in 5963 people with diabetes: a randomised placebo-controlled trial. *Lancet*. 2003;361:2005–2016.
- World Health Organization. *Adherence to long-term therapies: evidence for action*. Geneva: WHO; 2003. Available at: [http://www.who.int/chp/knowledge/publications/adherence\\_report/en/](http://www.who.int/chp/knowledge/publications/adherence_report/en/).
- Glasgow RE. Compliance to diabetes regimens: conceptualization, complexity, and determinants. In: Cramer JA, Spilker B, eds. *Patient compliance in medical practice and clinical trials*. New York: Raven Press; 1991:209–224.
- Pugh MJ, Anderson J, Pogach LM, Berlowitz DR. Differential adoption of pharmacotherapy recommendations for type 2 diabetes by generalists and specialists. *Med Care Res Rev*. 2003;60:178–200.
- Johnson SB. Methodological issues in diabetes research: measuring adherence. *Diabetes Care*. 1992;15:1658–1667.
- Cramer JA, Benedict A, Muszbek N, Keskinaslan A, Khan ZM. The significance of compliance and persistence in the treatment of diabetes, hypertension and dyslipidaemia: a review. *Int J Clin Pract*. 2008;62:76–87.
- Pollack MF, Purayidathil FW, Bolge SC, Williams SA. Patient-reported tolerability issues with oral antidiabetic agents: associations with adherence; treatment satisfaction and health-related quality of life. *Diabetes Res Clin Pract*. 2010;87:204–210.
- van Bruggen R, Gorter K, Stolk RP, Zuithoff P, Klungel OH, Rutten GE. Refill adherence and polypharmacy among patients with type 2 diabetes in general practice. *Pharmacoepidemiol Drug Saf*. 2009;18:983–991.
- Jin J, Sklar GE, Min Sen OV, Chuen Li S. Factors affecting therapeutic compliance: a review from the patients' perspective. *Ther Clin Risk Manag*. 2008;4:269–286.
- Wong MCS, Kong APS, So W-Y, Jiang JY, Chan JCN, Griffiths SM. Adherence to oral hypoglycemic agents in 26 782 Chinese patients: a cohort study. *J Clin Pharmacol*. 2011;51:1474–1482.
- Rwegerera GM. Adherence to anti-diabetic drugs among patients with Type 2 diabetes mellitus at Muhimbili National Hospital, Dar es Salaam, Tanzania-A cross-sectional study. *Pan Afr Med J*. 2014;17:252.
- McHorney CA. The adherence estimator: a brief, proximal screener for patient propensity to adhere to prescription medications for chronic disease. *Curr Med Res Opin*. 2009;25:215–238.
- Odegard PS, Capocchia K. Medication taking and diabetes: a systematic review of the literature. *Diabetes Educ*. 2007;33:1014–1029.
- Nam S, Chesla C, Stotts NA, Kroon L, Janson SL. Barriers to diabetes management: patient and provider factors. *Diabetes Res Clin Pract*. 2011;93:1–9.

54. Nau DP. Recommendations for improving adherence to type 2 diabetes mellitus therapy – focus on optimizing oral and non-insulin therapies. *Am J Manag Care*. 2012;18(3 Suppl):S49–S54.
55. Kalyango JN, Owino E, Nambuya AP. Non-adherence to diabetes treatment at Mulago Hospital in Uganda: prevalence and associated factors. *Afr Health Sci*. 2008;8:67–73.
56. Hutchins V, Zhang B, Fleurence RL, Krishnarajah G, Graham J. A systematic review of adherence, treatment satisfaction and costs, in fixed-dose combination regimens in type 2 diabetes. *Curr Med Res Opin*. 2011;27:1157–1168.
57. Nash J. Understanding barriers to medication adherence in people with diabetes. *J Diabetes Nurs*. 2013;17:263–267.
58. UNAIDS gap report; 2016. Available at: <http://www.avert.org/professionals/hiv-around-world/sub-saharan-africa/botswana>.
59. UNDP on Botswana HIV. Available at: [http://www.bw.undp.org/content/botswana/en/home/ourwork/hiv\\_aids/overview.html](http://www.bw.undp.org/content/botswana/en/home/ourwork/hiv_aids/overview.html).
60. Gaida R, Truter I, Grobler C, Kotze T, Godman B. A review of trials investigating efavirenz-induced neuropsychiatric side effects and the implications. *Expert Rev Anti-infect Therapy*. 2016;14:377–388.
61. Kalemeeera F, Mbango C, Mubita M, Naikaku E, Gaida R, Godman B. Effect of changing from first- to second-line antiretroviral therapy on renal function: a retrospective study based on data from a single health facility in Namibia. *Expert Rev Anti-infect Therapy*. 2016;14:777–783.
62. Simoens S, Sinnaeve PR. Patient co-payment and adherence to statins: a review and case studies. *Cardiovasc Drugs Therapy*. 2014;28:99–109 [sponsored by the International Society of Cardiovascular Pharmacotherapy].
63. Shrank WH, Hoang T, Ettner SL, et al.. The implications of choice: prescribing generic or preferred pharmaceuticals improves medication adherence for chronic conditions. *Arch Intern Med*. 2006;166:332–337.
64. Klein R, Klein BE, Moss SE, Cruickshanks KJ. Relationship of hyperglycemia to the long-term incidence and progression of diabetic retinopathy. *Arch Intern Med*. 1994;154:2169–2178.
65. Jin J, Sklar GE, Min Sen OhV, Chuen Li S. Factors affecting therapeutic compliance: a review from the patient's perspective. *Ther Clin Risk Manag*. 2008;4:269–286.
66. Divya S, Nadig P. Factors contributing to non-adherence to medication among type 2 diabetes mellitus in patients attending tertiary care hospital in South India. *Asian J Pharm Clin Res*. 2015;8:274–276.
67. Morisky 8-item medication adherence questionnaire. [http://www.uk.stage.cecentral.com/assets/9544/MMAS-8\\_-\\_UNTHSC.pdf](http://www.uk.stage.cecentral.com/assets/9544/MMAS-8_-_UNTHSC.pdf).
68. Al-Haj Mohd MM, Phung H, Sun J, Morisky DE. The predictors to medication adherence among adults with diabetes in the United Arab Emirates. *J Diabetes Metabolic Disorders*. 2015;15:30.
69. Natarajan N, Putnam W, Van Aarsen K, Lawson KB, Burge F. Adherence to antihypertensive medications among family practice patients with diabetes mellitus and hypertension. *Can Fam Physician*. 2013;59.
70. Teklay G, Hussien J, Tesfaye D. Non-adherence and associated factors among type 2 diabetic patients at Jimma University Specialized Hospital, Southwest Ethiopia. *J Med Sci*. 2013;2013:578–584.
71. Sajith M, Pankaj M, Pawar A, Modi A, Sumariya R. Medication adherence to antidiabetic therapy in patients with type 2 diabetes mellitus. *Int J Pharm Pharm Sci*. 2014;6(Suppl 2).
72. Menzin J, Langley-Hawthorne C, Friedman M, Boulanger L, Cavanaugh R. Potential short-term economic benefits of improved glycemic control: a managed care perspective. *Diabetes Care*. 2001;24:51–55.
73. Garcia-Perez LE, Alvarez M, Dilla T, Gil-Guillen V, Orozco-Beltran D. Adherence to therapies in patients with type 2 diabetes. *Diabetes Therapy*. 2013;4:175–194.
74. Fadare J, Olamoyegun M, Gbadegesin BA. Medication adherence and direct treatment cost among diabetes patients attending a tertiary healthcare facility in Ogbomoso, Nigeria. *Malawi Med J*. 2015;27:65–70.
75. Wabe NT, Angamo MT, Hussein S. Medication adherence in diabetes mellitus and self-management practices among type-2 diabetics in Ethiopia. *N Am J Med Sci*. 2011;3:418–423.
76. Pascal IGU, Ofoedu JN, Uchenna NP, Nkwa AA, Uchamma GUE. Blood glucose control and medication adherence among adult type 2 diabetic Nigerians attending a primary care clinic in under-resourced environment of eastern Nigeria. *N Am J Med Sci*. 2012;4:310–315.
77. Mann DE, Ponieman D, Leventhal H, Halm EA. Predictors of adherence to diabetes medications: the role of disease and medication beliefs. *J Behav Med*. 2009;32:278–284.
78. Kravitz R, Hays RD, Sherbourne CD, et al.. Recall of recommendations and adherence to advise among patients with chronic medical conditions. *Arch Intern Med*. 1993;153:1869–1878.
79. Hays R, Kravitz RL, Mazel RM, et al.. The impact of patient adherence on health outcomes for patients with chronic disease in medical outcomes study. *J Behav Med*. 1994;17:347–360.
80. Capeau J, Bouteloup V, Katlama C, et al.. Ten-year diabetes incidence in 1046 HIV-infected patients started on a combination antiretroviral treatment. *AIDS*. 2012;26:303–314.
81. Tien PC, Schneider MF, Cole SR, et al.. Antiretroviral therapy exposure and incidence of diabetes mellitus in the Women's Interagency HIV Study. *AIDS*. 2007;21:1739–1745.
82. Brown TT, Cole SR, Li X, et al.. Antiretroviral therapy and the prevalence and incidence of diabetes mellitus in the multicenter AIDS cohort study. *Arch Intern Med*. 2005;165:1179–1184.
83. Heloisa G, Zannetti ML, Vanderlei Haas. Factors related to patient adherence to antidiabetic therapy. *Revista Latino American de Enfermagem*. 2009;17.
84. Chapman R, Benner JS, Petrilla AA, et al.. Predictors of adherence with antihypertensive and lipid-lowering therapy. *Arch Intern Med*. 2005;165:1147–1152.
85. Sud A, Kline-Rogers EM, Eagle KA, et al.. Adherence to medications by patients after acute coronary syndromes. *Ann Pharmacother*. 2005;39:1792–1797.
86. Reid MJ, Tsima B. It would have been better if I had HIV instead of diabetes. *S Afr Med J*. 2014;104:325.