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Research article

Medicated-related burden and adherence in patients with co-morbid type 2 diabetes mellitus and hypertension

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ABSTRACT

Background: Medication adherence is an integral component in the management of patients with co-morbid type 2 diabetes mellitus (T2DM) and hypertension. However due to their combined conditions, there is likelihood of polypharmacy and medication-related burden, which could negatively impact adherence to therapy. This study aimed to assess the perceived medication-related burden among patients with co-morbid T2DM and hypertension and to evaluate the association between the perceived burden and adherence to medication therapy.

Methods: A cross-sectional study was conducted among adult patients with co-morbid T2DM and hypertension attending a primary health facility. The living with medicines questionnaire and the medication adherence report scale were used to assess extent of medication-related burden and adherence respectively. Binary logistic regression model was used to estimate the adjusted odds and their corresponding 95% confidence interval for medication-related burden and adherence outcomes. All observed categorical variables were considered for the multivariable binary logistic regression model.

Results: The total number of participants was 329 with a median age of 57.5 ± 13.2 years. The median score for the overall burden was 99 (IQR: 93–113), and this significantly varied by sex ($p = 0.012$), monthly income ($p = 0.025$), monthly expenditure on medications ($p = 0.012$), frequency of daily dose of medications ($p = 0.020$) and family history of T2DM ($p < 0.001$). About 30.7% and 36.8% of participants reported moderate/high burden and medication adherence respectively. Uncontrolled diastolic blood pressure (AOR: 2.46, 95% CI: 1.20–5.05, $p = 0.014$), high glucose (AOR: 4.24, 95% CI: 2.13–8.46, $p < 0.001$) and no family history of T2DM (AOR: 2.14, 95% CI: 1.14–4.02, $p = 0.026$) were associated with moderate/high medication burden. Uncontrolled diastolic blood pressure (AOR: 0.48, 95% CI: 0.25–0.94, $p = 0.031$), at least 5 years since hypertension diagnosis (AOR: 0.55, 95% CI: 0.30–0.99, $p = 0.045$) and moderate/high medication-related burden (AOR: 0.33, 95% CI: 0.16–0.69, $p = 0.003$) were associated with lower odds of medication adherence.

Conclusion: These findings suggest that to improve the preventive and optimal care of patients with T2DM and hypertension, interventions that aim to reduce medication-related burden and morbidity are recommended. The study proposes that health stakeholders such as clinicians, pharmacists, and policy makers, develop multidisciplinary clinical and pharmaceutical care

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interventions to include provision of counselling to patients on adherence. In addition, developing policies and sensitization activities on deprescribing and fixed-dose drug combinations aimed at reducing medication-related burden, while promoting better adherence, blood pressure and blood glucose outcomes are recommended.

1. Introduction

Non-communicable diseases like diabetes mellitus and hypertension are major public health concerns globally due to their high mortality rates [1,2]. According to the 2021 International Diabetes Federation estimates, 537 million adults from the ages of 20–79 around the globe are living with diabetes with this number estimated to rise to 643 million by 2030 and 783 million by 2042, while the World Health Organization estimates that 1.28 billion adults from the ages of 30–79 years globally have hypertension, with two-thirds living in low- and middle-income countries (LMICs). Similarly, the prevalence of diabetes has been rising more rapidly in LMICs than in high-income countries due to increased transitions in health and disease patterns, including lifestyle choices [3,4], and low awareness of risk factors and preventive measures in LMICs [5,6].

In Africa, while the WHO estimates the highest prevalence of 27% for hypertension, about 25 million adults from the ages of 20–79 live with diabetes, and this number is predicted to increase by 33 million in 2030 and 55 million by 2045 [7]. In Ghana it is estimated that 329,200 adults from the ages of 20–79 have diabetes, accounting for 2.0% of the total Ghanaian population [3] and 6.46% from a systematic review on the prevalence and risk factors for diabetes mellitus in Ghana [8]. For hypertension, a systematic review reported a pooled prevalence of 30.3% in Ghana [9].

Diabetes and hypertension are inter-related diseases that have the tendency to co-exist [10]. The prevalence of hypertension is doubled in the presence of diabetes and it has been estimated that approximately 69% of adults live with both diabetes and hypertension [11]. In patients with diabetes, there is an increase in the formation of non-enzymatic glycosylation products and in sodium retention. These glycosylation products accumulate and cause vascular rigidity which together with the retention of sodium, ultimately lead to hypertension [12,13]. Aside the pathophysiological link between hypertension and diabetes, the two conditions share overlapping risk factors and complications. While risk factors include familial, race, dyslipidemia, and lifestyle, the complications are grouped into macrovascular and microvascular disorders. Macrovascular complications include stroke, myocardial infarction, peripheral vascular disease, congestive heart failure and coronary artery disease while microvascular complications include retinopathy, neuropathy and nephropathy [11,13].

Since lifestyle is a shared risk factor for both diabetes and hypertension, initial management focuses on weight reduction, increase in physical activity, and dietary modifications. In addition to the lifestyle modifications, multiple medications are given concomitantly to achieve treatment goals, prevent complications and improve quality of life of patients [13]. Previous studies have reported that three or more medications are prescribed for people with co-morbid diabetes and hypertension [14,15]. Although the clinical relevance of these multiple medications cannot be ruled out, issues of adverse effects, drug-drug interactions associated with the medications and the number of medicines to be taken, increase the burden for patients [16] and these have negative consequences on medication adherence [17,18]. Poor adherence to medications leads to increased risk of relapse, and worsening of both macrovascular and microvascular complications, resulting in drastic decline in quality of life of patients as well as an increase in healthcare cost and mortality [19,20]. The need for adherence to medications is therefore critical to achieving treatment goals and improved quality of life.

Type 2 diabetes mellitus (T2DM) and hypertension have been ranked among the top 15 causes of outpatient visits in a Ghana Ministry of Health report [21], and large volumes of medications are needed to manage affected patients [22]. These drugs will have limited impact in improving clinical outcomes and averting mortalities if patients poorly adhere to them. This study therefore aimed to assess the medication-related burden associated with adherence among patients with co-morbid T2DM and hypertension.

2. Methods

2.1. Study design and clinical setting

This hospital-based cross-sectional study was conducted to assess the medication-related burden and adherence among patients with T2DM and hypertension. Participants were selected from the Adabraka Polyclinic in Accra, which was established in 1945 and has since provided quality and comprehensive primary healthcare to people in Adabraka, and the Osu-Klottey sub metropolitan areas of Ghana. The Outpatient Department (OPD) runs twice weekly clinics for patients with diabetes and hypertension with an average attendance of about 80 patients each day. The clinics are part of the centers of the hospital, which is designated for care and follow-up of patients with diabetes and hypertension.

2.2. Study participants

The population of interest were adult out-patients ($\geq$18 years) with co-morbid T2DM and hypertension. Patients on prescribed medications for about six months were eligible for the study. Patients on admission, those diagnosed with type 1 and gestational diabetes, patients who showed signs of poor cognitive function, and those who did not provide informed consent for participation although meeting the eligibility criteria, were excluded.

The sample size was calculated based on the formula [23].

$$n = \frac{Z^2_{\alpha/2} \times P \times (1 - P)}{e^2}$$

where n is the estimated sample size, Z is the standard normal value corresponding to the 95% level of confidence (1.96), P is the estimated prevalence and e is the precision level (5%). Assuming a 74.05% prevalence rate of adherence based on a study among persons with diabetes and hypertension [24], 95% confidence interval, 5% error margin and a 10% non-response rate the sample size of 326 was obtained. Participants were consecutively recruited between October 2021 to November 2021. The medical records of patients were reviewed to confirm diagnosis of T2DM and hypertension and to gather clinical profiles of participants.

2.3. Variables, data sources and measurement

A structured questionnaire was used for data collection and it included general information on socio-demographic characteristics (e.g., age, sex, marital status, religion, education level, occupation, monthly income, payment method for drugs, monthly expenditure), clinical characteristics (number of medications, frequency of the daily dose of medication, living condition, have other comorbidities, systolic blood pressure (SBP), diastolic blood pressure (DBP), glucose level, family history of T2DM and hypertension, duration since diagnosis and frequency of follow-up visits), medication-related burden and adherence behavior.

The 41-item Living with Medicines Questionnaire (LMQ) was used to assess medication-related burden [25]. A 5-point Likert scale response ranging from (1) Strongly agree, (2) Agree, (3) Neutral, (4) Disagree and (5) Strongly disagree was used for this scale. The overall score of the LMQ-3 was computed as a composite score for the 41 items with a possible range from 41 to 205. All negatively worded statements were reverse coded before computations of the scores. The level of the medication related burden was categorized as no burden (41–73), minimum burden (74–106), moderate burden (107–139), high burden (140–172) and extreme burden (173–205) as has been previously reported [17,26]. The LMQ-3 was further dichotomized for further inferential analysis as moderate/high burden (coded 1) versus minimum burden (coded 0). The Cronbach alpha score for the LMQ-3 in this study was 0.9208.

The medication adherence report scale (MARS-5) was used to assess adherence to medication among the study participants [27]. Each of 5 items of the MARS-5 had 5 possible responses (1) Always, (2) often, (3) Sometimes, (4) Rarely and (5) Never. The composite score for the MARS-5 was computed with a possible range score from 5 to 25. The score was dichotomized into adherent for participants with MARS score 25 and non-adherent for those with MARS score below 25, similar to previously reported studies on hypertension, diabetes and their comorbidities [28,29]. The MARS scale was reliable in this study with Cronbach's alpha score of 0.8568.

Blood pressure was measured using a manual mercury sphygmomanometer. The readings were taken three times and the average noted. In this study, participants with SBP below 140 mmHg and DBP below 90 mmHg were considered to have controlled BP level.

The fasting blood sugar was measured using a certified automated glucometer (GOLD-ACCU). Blood glucose levels were categorized as low, moderate and high for levels below 5.6 mmol/L, 5.6 to 6.9 mmol/L and 7.0 mmol/L and above respectively.

2.4. Data analysis

All analysis were performed using Stata version 16 IC (StataCorp, College Station, TX, USA). Descriptive analysis were performed using frequency and percentages for categorical variables, means and standard deviations for continuous normally distributed variables and median and interquartile ranges (lower and upper quartiles) for non-normally distributed continuous variables. The Shapiro Wilks ("*swilk*") and the skewness and kurtosis ("*sktest*") in Stata were used to assess normality of continuous data. The LMQ-3 and MARS-5 scores were presented as frequencies and percentages based on the Likert responses.

The spearman rank correlation coefficient between the 8 themes and the overall medication-related burden score were estimated and presented on a heat plot. The T-test was used to compare the means of continuous variables between two groups. The median of non-normal distributed continuous variables was compared using the Wilcoxon rank sum test between two categories and the Kruskal Wallis test for 3 or more categorical variables. The Pearson's chi-square test was used to test the association between two categorical variables. The Fisher's exact test was used when the assumptions of the Pearson chi-square test was violated.

The binary logistic regression model was used to estimate the adjusted odds and their corresponding 95% confidence interval for medication-related burden and adherence. All observed categorical variables were considered for the multivariable binary logistic regression model. However, variables with high multicollinearity, that is, variance inflation factor (VIF) above 10, were excluded from the final regression model. The Hosmer-Lemeshow goodness of fit test was used to assess the appropriateness of the fit for multivariable binary logistic regression model. All statistical analysis were considered significant at a predetermined alpha level of 0.05.

2.5. Ethical consideration

Ethical clearance was obtained from the Ghana Health Service Ethical Review Committee (GHS-ERC 043/09/21) before the study commenced. Participants were consecutively selected and also based on their willingness to participate in the study. In addition, each participant provided a written consent before data collection.

Table 1
Socio-demographic and clinical characteristics of study participants.

Characteristics	Total
	N = 329
Sex	
Male	144 (43.8)
Female	185 (56.2)
Age, Median (IQR)	57.5 [±13.2]
Age	
<50	80 (24.3)
50–59 years	108 (32.8)
60-69	78 (23.7)
70+	63 (19.1)
Marital status	
Single	84 (25.5)
Married	192 (58.4)
Divorced	25 (7.6)
Others	28 (8.5)
Highest education	
No formal education	59 (17.9)
Primary	72 (21.9)
Secondary	128 (38.9)
Tertiary	70 (21.3)
Occupation	
Unemployed	41 (12.5)
Trader/artisan	176 (53.5)
Professional	53 (16.1)
Retired	48 (14.6)
Others	11 (3.3)
Monthly income	
0-500 cedis	150 (45.6)
501-1000 cedis	121 (36.8)
1001-2000 cedis	46 (14.0)
2000+ cedis	12 (3.6)
Payment method for drugs	
Self-sponsored	67 (20.4)
Health Insurance	259 (78.7)
Family and friends	3 (0.9)
Monthly expenditure on drugs, Median (IQR)	50.0 (30.0, 100.0)
Monthly expenditure on drugs	
None	68 (20.7)
<50 cedis	101 (30.7)
51-100 cedis	88 (26.7)
>100 cedis	72 (21.9)
Gets all drugs from the health insurance	
Yes	68 (20.7)
No	261 (79.3)
Number of medications	
<5 medicines	230 (69.9)
≥5 medicines	99 (30.1)
Formulation used for medications	
Tablets/capsules	326 (99.1)
Non-oral	3 (0.9)
Frequency of daily dose of medication	
Once	145 (44.1)
Twice	181 (55.0)
Three times	3 (0.9)
Living status	
Alone	25 (7.6)
Other people	304 (92.4)
Needs help with medication	
Yes	14 (4.3)
No	315 (95.7)
Persons assisting with medication	
Husband/wife	3 (21.4)
Relative	11 (78.6)
Have co-morbidities	
No	269 (81.8)
Hyperlipidaemia	57 (17.3)
Stroke	3 (0.9)
Systolic blood pressure level, Median (IQR)	140 (128, 157)

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Table 1 (*continued*)

Characteristics	Total
	N = 329
Systolic blood pressure level	
Controlled (<139 mmHg)	161 (48.9)
Uncontrolled (140+ mmHg)	168 (51.1)
Diastolic blood pressure level, Median (IQR)	85 (77, 92.)
Diastolic blood pressure level	
Controlled (<90 mmHg)	231 (70.2)
Uncontrolled (90+ mmHg)	98 (29.8)
Glucose level, Median (IQR)	6.5 (5.6, 8.3)
Glucose level	
Low (<5.6 mmol/L)	81 (24.6)
Moderate (5.6–6.9 mmol/L)	107 (32.5)
High (7.0+ mmol/L)	141 (42.9)
Family history of hypertension	
Yes	224 (68.1)
No	105 (31.9)
Family history of diabetes mellitus	
Yes	164 (49.8)
No	165 (50.2)
Duration since diagnosis of hypertension, Median (IQR)	5.0 (2.0, 6.0)
Duration since diagnosis of hypertension	
<5 years	151 (45.9)
5+ years	178 (54.1)
Duration since diagnosis of Diabetes Mellitus, Median (IQR)	3.0 (1.0, 5.0)
Duration since diagnosis of Diabetes Mellitus	
<5 years	243 (73.9)
5+ years	86 (26.1)
Frequency of follow-up	
Every 2 weeks	22 (6.7)
Monthly	86 (26.1)
Every 2 months	221 (67.2)

3. Results

3.1. Sociodemographic, clinical, and medication-related characteristics of participants

A total of 329 patients with co-morbid T2DM and hypertension participated in the study. The median age of the participants was 57.5 ± 13.2 years and married (58.4%). Less than a fifth (17.9%) had no formal education with 21.3% having tertiary level education. One of every eight (12.5%) of them were unemployed with the majority (53.5%) being traders/artisans (53.5%). Most (45.6%) of the participants earned 500 cedis or less monthly. Although 78.7% of the participants have their medicines covered by insurance, only 20.7% have all their medicines covered. About 30.1% take five (5) or more medications, 55.0% take twice daily doses and 4.3% need help with their medications. (Table 1). Most of the participants were on Metformin (93.0%), Amlodipine (94.2%), and Glimepiride (48.6%) (Fig. 1A). The median number of different medications was 4 (IQR: 3–5 medications) with most (30.1%) on exactly four (4)

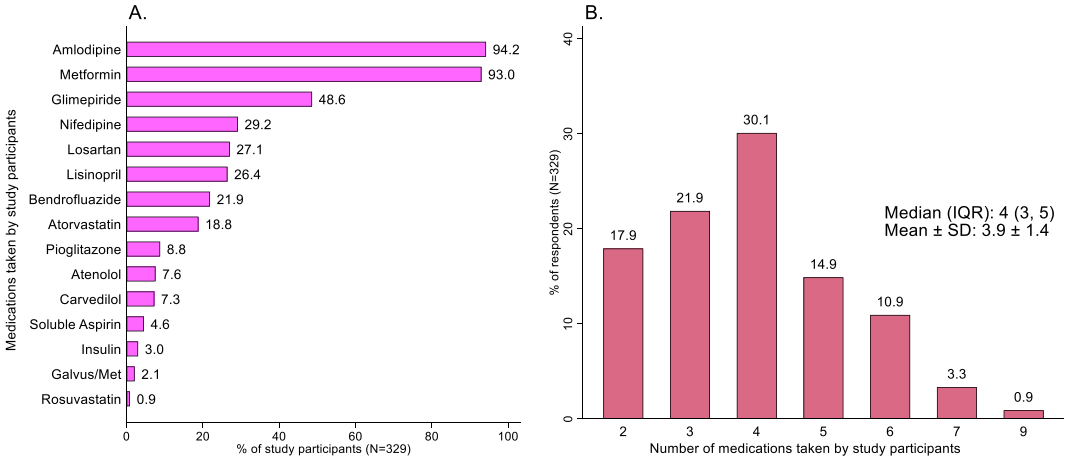

Fig. 1. Medications taken (A) and number of medications taken (B) among study participants.

Table 2
Responses to individual items in the eight domains of the Living with Medicines Questionnaire version-3 (LMQ-3).

Burden items	Strongly agree/ Agree	Neutral	Strongly disagree/ Disagree
	n (%)	n (%)	n (%)
Theme 1: Relationships/communication with healthcare professionals about medicines			
I trust the judgment of my doctor(s) in choosing medicines for me.	290 (88.1)	25 (7.6)	14 (4.3)
My doctor(s) listen to my opinions about my medicines.	294 (89.4)	16 (4.9)	19 (5.8)
My doctor(s) takes my concerns about side effects seriously.	263 (79.9)	35 (10.6)	31 (9.4)
I get enough information about my medicines from my doctor(s).	277 (84.2)	43 (13.1)	9 (2.7)
The health professionals providing my care know enough about my medicines and me.	249 (75.7)	61 (18.5)	19 (5.8)
Theme 2: Practical Difficulties			
I find getting my prescriptions from the doctor difficult. *	33 (10.0)	34 (10.3)	262 (79.6)
I find getting my medicines from the pharmacist difficult. *	35 (10.6)	30 (9.1)	264 (80.2)
I am comfortable with the times I should take my medicines.	141 (42.9)	46 (14.0)	142 (43.2)
I am concerned that I may forget to take my medicines. *	96 (29.2)	41 (12.5)	192 (58.4)
I have to put a lot of planning and thought into taking my medicines. *	93 (28.3)	77 (23.4)	159 (48.3)
It is easy to keep to my medicine's routine.	198 (60.2)	60 (18.2)	71 (21.6)
I find using my medicines difficult. *	96 (29.2)	45 (13.7)	188 (57.1)
Theme 3: Cost-related burden			
I worry about paying for my medicines. *	124 (37.7)	57 (17.3)	148 (45.0)
I sometimes have to choose between buying basic essentials or medicines. *	106 (32.2)	64 (19.5)	159 (48.3)
I have to pay more than I can afford for my medicines. *	89 (27.1)	60 (18.2)	180 (54.7)
Theme 4: Side-effect's burden of prescribed medications			
The side effects I get are sometimes worse than the problem for which I take medicines. *	49 (15.0)	38 (11.7)	239 (73.3)
The side effects I get from my medicines interfere with my day-to-day life (e.g., work, housework, sleep). *	36 (10.9)	45 (13.7)	248 (75.4)
The side effects I get from my medicines are bothersome. *	27 (8.2)	56 (17.0)	246 (74.8)
The side effects I get from my medicines adversely affect my wellbeing *	57 (17.3)	49 (14.9)	223 (67.8)
Theme 5: Perceived effectiveness of medicines			
I am satisfied with the effectiveness of my medicines.	201 (61.1)	42 (12.8)	86 (26.1)
My medicines prevent my condition getting worse.	254 (77.2)	26 (7.9)	49 (14.9)
My medicines live up to my expectations.	260 (79.0)	38 (11.6)	31 (9.4)
My medicines allow me to live my life as I want to.	247 (75.1)	55 (16.7)	27 (8.2)
My medicines are working.	245 (74.5)	71 (21.6)	13 (4.0)
The side effects are worth it for the benefits I get from my medicines.	194 (59.0)	60 (18.2)	75 (22.8)
Theme 6: Attitudes/concerns about medicine use			
I worry that I have to take several medicines at the same time. *	97 (29.5)	79 (24.0)	153 (46.5)
I would like more say in the brands of medicines I use. *	67 (20.6)	86 (26.5)	172 (52.9)
I feel I need more information about my medicines. *	54 (16.4)	70 (21.3)	205 (62.3)
I am concerned about possible damaging long-term effects of taking medicine *	64 (19.5)	58 (17.6)	207 (62.9)
I am concerned that I am too reliant on my medicines *	63 (19.1)	48 (14.6)	218 (66.3)
I am concerned that my medicines interact with my nutritional habits. *	59 (17.9)	54 (16.4)	216 (65.7)
I worry that my medicines may interact with each other *	67 (20.4)	57 (17.3)	205 (62.3)

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Table 2 (*continued*)

Burden items	Strongly agree/ Agree	Neutral	Strongly disagree/ Disagree
	n (%)	n (%)	n (%)
Theme 7: Interferences with day-to-day life			
My medicines interfere with my social or leisure activities. *	55 (16.7)	34 (10.3)	240 (72.9)
Taking medicines affects my driving. *	39 (11.9)	29 (8.8)	261 (79.3)
My medicines interfere with my social relationships. *	38 (11.6)	40 (12.2)	251 (76.3)
Taking medicines causes me problems with daily tasks such as (work, housework, hobbies). *	42 (12.8)	27 (8.2)	260 (79.0)
My medicines interfere with my sexual life. *	38 (11.6)	39 (11.9)	252 (76.6)
My life revolves around using my medicines. *	22 (6.7)	48 (14.6)	259 (78.7)
Theme 8: Control/autonomy of medicine use			
I can vary the dose of the medicines I take.	13 (4.0)	39 (11.9)	277 (84.2)
I can choose whether to take my medicines.	15 (4.6)	29 (8.8)	285 (86.6)
I can vary the times I take my medicines.	12 (3.6)	21 (6.4)	296 (90.0)

*Negatively worded statements were reverse coded for calculation of the score.

medications (Fig. 1B).

Other morbidities like hyperlipidemia (17.3%) and stoke (0.9%) were recorded. The median systolic and diastolic blood pressure levels were 140 mmHg (IQR: 128–157 mmHg) and 85 mmHg (IQR: 77–92 mmHg) respectively. Less than half (48.9%) had their SBP under control whilst 70.2% had their DBP under control. The median glucose level was 6.5 mmol/L (IQR: 5.6–8.3 mmol/L) with 42.9% having high glucose level (Table 1). About half (49.8%) of the participants had a family history of T2DM and 68.1% for hypertension (Table 1).

3.2. Burden of living with medicines among participants

Frequency and percentage distribution of the LMQ-3 items and the significant pairwise linear correlation across the 8 different themes ($p < 0.001$) are shown in Table 2 and Fig. 2 respectively. About 69.3% were categorized as having minimal burden, 28.0% had moderate burden and 2.7% had high burden. Prevalence of moderate/high burden was 30.7% with a 95% confidence interval estimate of 25.8% to 36.0%. The median score for the overall burden was 99 (IQR: 93–113) from a possible range of 41 to 205 and this significantly varied by sex ($p = 0.012$), monthly income ($p = 0.025$), monthly expenditure on medications ($p = 0.012$), frequency of daily dose of medications ($p = 0.020$) and family history of T2DM ($p < 0.001$) (Table 3).

3.3. Adherence to medication among study participants

The majority of the participants rarely or never forget to take their medications (77.8%), alter the dose of their medications (86.5%), stopped taking their medications for a while (77.8%), missed out a dose (84.3%) or took less medicines than prescribed (90.3%). Overall, adherence to medication was 36.8% with a 95% confidence interval of 31.6% to 42.2% (Table 4).

Bivariate analysis of the association between level of medication burden and the characteristics of study participants

Prevalence of high/moderate burden was significantly higher among males compared to females (45.8% vs. 18.9%, $p < 0.001$), those with tertiary (51.4%) or secondary (32.4%) compared to those with primary (31.8%) or no formal education (16.9%) ($p < 0.001$), higher monthly income earners ($p < 0.001$) and the median monthly expenditure of 100 cedis (IQR: 30–110 cedis) for medicines being significantly higher than 50 cedis (IQR: 30–100 cedis) ($p = 0.015$). Higher burden was also reported among those with two or three doses of daily medication compared with single daily doses (38.6% vs. 20.7% $p < 0.001$). Moderate/high burden was also significantly high among those with hyperlipidemia/stroke multimorbidity (43.3% vs. 27.9%, $p = 0.006$), no family history of hypertension (38.1% vs. 27.2%, $p = 0.046$) and no family history of T2DM (41.2% vs. 20.1%, $p < 0.001$) compared to their counterparts. Moderate/high burden was significantly higher among those who visit the clinic every 2 months compared to those who visit the clinic every 2 weeks or each month (34.8% vs. 22.2%, $p = 0.020$) (Table 5).

Bivariate analysis of the association between adherence to medication and the characteristics of study participants

Adherence to medication was significantly higher among females compared to males (41.6% vs. 30.6%, $p < 0.039$), lower monthly income earners ($p = 0.001$), those with 5 or more medication compared to those with less than 5 medications (48.5% vs. 31.7%, $p = 0.004$), participants with controlled DBP level compared to those with uncontrolled DBP (40.3% vs. 28.6%, $p = 0.044$), those with family history of hypertension (42.9% vs. 23.8%, $p < 0.001$) and family history of T2DM (42.7% vs. 30.9%, $p < 0.027$) compared to

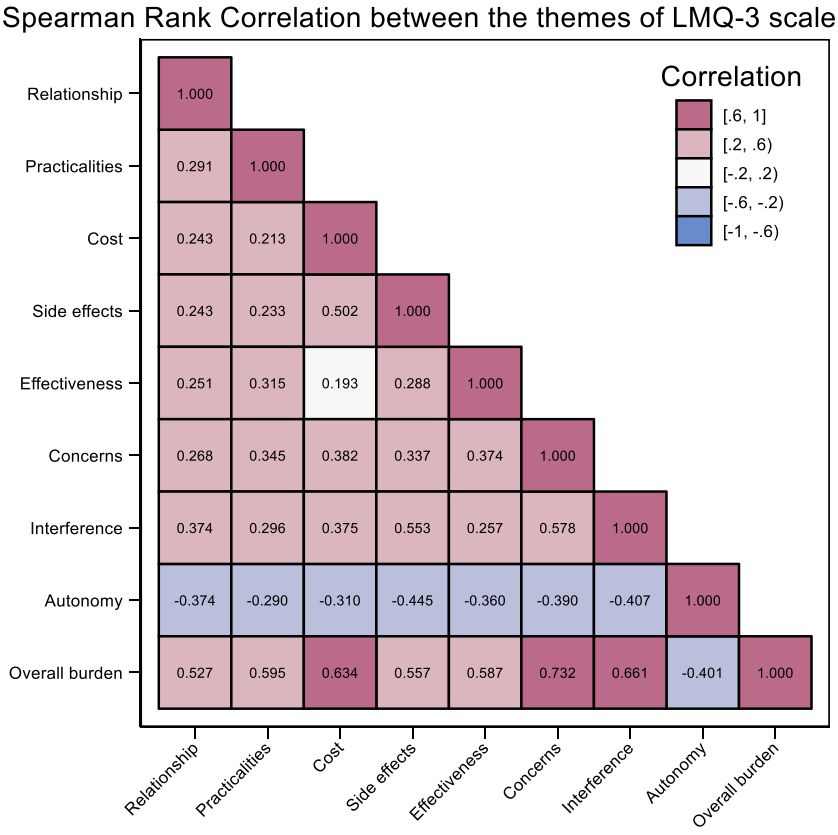

Fig. 2. The Spearman correlation between the themes of the LMQ-3 scale.

those with no family history. Low adherence was recorded among those with secondary education (27.3%) compared to those with no formal education (39.0%), primary (48.6%) or tertiary (40.0%) ($p < 0.022$). All 3 (100.0%) participants on non-oral medication adhered to the medication compared to 36.2% adherence among those taking tablets or capsules ($p = 0.023$) (Table 5).

The median scores of 99.5 (IQR: 94–122) for overall burden was significantly higher among participants with poor adherence compared with a score of 96 (IQR: 93–106) among those adhering to medications ($p = 0.005$) with 42.5% and 23.8% adherence being recorded among participants with low and moderate/high burden respectively ($p = 0.001$) (Table 5).

Multivariable binary logistic regression analysis of the factors associated with moderate/high medication-related burden

The final multivariable models had reasonable levels of multicollinearity with VIF values of 2.93 (range: 1.65–6.64) medication adherence models after excluding variables with high multicollinearity (VIF>10) such as payment method for drugs, getting all medication with health insurance, formulation of medications, participants living with others and participants needing help with taking their medications. The Hosmer-Lemeshow goodness of fit test with 10 quantiles was non-significant (p-value = 0.0596) indicating that the model was appropriately fit.

The adjusted odd of moderate/high burden was 66% less among females than males (AOR: 0.34, 95% CI: 0.17–0.66, $p = 0.001$). Compared to those below 50 years of age, moderate/high burden was about 3 times high among those aged 60–69 years (AOR: 2.99, 95% CI: 1.12–7.99, $p = 0.029$) and over 3 times high among those aged 70 years and above (AOR: 3.26, 95% CI: 1.01–10.51, $p = 0.048$). Moderate/high burden was also 70% less among the married compared to singles (AOR: 0.30, 95% CI: 0.11–0.77, $p = 0.013$) and also 70% less among the divorced/separated/widowed (AOR: 0.30, 95% CI: 0.11-0.083, $p = 0.020$). Compared to those with no formal education, the adjusted odd of moderate/high burden was over 6 times high among those with tertiary education (AOR: 6.50, 95% CI: 2.25–18.80, $p = 0.001$). (Table 6).

Participants taking two or three daily medication doses had over 2 times higher odds of moderate/high medication burden compared to those taking single daily doses (AOR: 2.78, 95% CI: 1.40–5.51, $p = 0.004$). Also, those with multi morbid hyperlipidemia/stroke had over 3 times higher odds of moderate/high medication burden (AOR: 3.13, 95% CI: 1.21–8.10, $p = 0.019$). Moderate/high medication burden was over 4 times high among those with high glucose level (AOR: 4.24, 95% CI: 2.13–8.46, $p < 0.001$). No family history of T2DM was associated with over 2 times higher odds of moderate/high medication burden (AOR: 2.14, 95% CI: 1.14–4.02, $p = 0.018$). Participants who follow-up hospital reviews every 2 months (AOR: 2.29, 95% CI: 1.04–5.05, $p = 0.040$) had higher odds of moderate/high medication burden compared those who follow-up every month or 2 weeks respectively. On the other hand, the odd of

Table 3
Effect of demographic and medication-related characteristics of respondents on individual domains of Living with Medicines Questionnaire version-3 (LMQ-3) (n = 329).

Characteristics [minimum possible, maximum possible]	Themes								
	Relationships	Practicalities	Cost	Side effects	Effectiveness	Concerns	Interference	Autonomy	Overall
	[5,25]	[7,30]	[3,15]	[4,20]	[6,31]	[7,30]	[6,31]	[3,15]	[41, 205]
	median (IQR)	median (IQR)	median (IQR)	median (IQR)	median (IQR)	median (IQR)	median (IQR)	median (IQR)	median (IQR)
Overall	10 (7, 11)	18 (16, 21)	13 (10, 16)	4 (4, 6)	13 (12, 16)	17 (15, 21)	12 (12, 14)	12 (12, 12)	99 (93, 113)
Sex									
Male	10 (8, 12)	18 (16, 22)	13 (10, 16)	5 (4, 6)	14 (12, 16)	18 (15, 23)	14 (12, 17)	12 (11, 12)	103 (93, 123)
Female	10 (7, 10)	18 (15, 21)	13 (10, 16)	4 (4, 5)	12 (11, 15)	16 (14, 19)	12 (12, 13)	12 (12, 12)	98 (94, 104)
P-value [W]	0.001	0.203	0.485	<0.001	<0.001	0.053	<0.001	<0.001	0.012
Age group									
<50	10 (7, 13)	18 (16, 22)	13 (10, 16)	4 (4, 6)	14 (12, 16)	17 (14, 21)	12 (12, 14)	12 (12, 12)	101 (91, 113)
50–59 years	10 (7, 10)	18 (16, 21)	12 (10, 16)	4 (4, 6)	13 (10, 16)	16 (15, 24)	12 (12, 14)	12 (12, 12)	98 (92, 108)
60-69	10 (8, 11)	18 (15, 20)	12 (10, 18)	4 (4, 6)	12 (10, 13)	18 (15, 21)	12 (12, 16)	12 (12, 12)	97 (92, 109)
70+	10 (9, 11)	20 (16, 22)	14 (10, 17)	4 (4, 6)	14 (12, 16)	17 (16, 21)	12 (12, 14)	12 (12, 12)	100 (97, 113)
P-value [K]	0.308	0.159	0.654	0.297	<0.001	0.685	0.532	0.162	0.154
Marital status									
Single	10 (8, 11)	19 (16, 22)	13 (12, 16)	4 (4, 6)	14 (12, 16)	17 (14, 20)	12 (12, 13)	12 (12, 12)	99 (96, 109)
Married	10 (7, 11)	18 (15, 20)	13 (10, 17)	4 (4, 6)	12 (11, 14)	16 (15, 23)	12 (12, 16)	12 (12, 12)	97 (91, 109)
Divorced/separated/widowed	10 (9, 10)	18 (17, 21)	11 (10, 16)	5 (4, 6)	14 (12, 15)	17 (15, 20)	14 (12, 14)	12 (12, 12)	101 (95, 113)
P-value [K]	0.220	0.019	0.082	0.067	0.004	0.025	0.021	0.193	0.147
Highest education									
No formal education	10 (7, 10)	17 (16, 21)	12 (10, 16)	4 (4, 4)	12 (12, 16)	16 (14, 18)	12 (12, 13)	12 (12, 12)	96 (94, 100)
Primary	10 (7, 10)	18 (16, 21)	14 (10, 16)	4 (4, 6)	13 (12, 15)	16 (15, 18)	12 (12, 13)	12 (12, 12)	97 (95, 102)
Secondary	10 (7, 11)	18 (16, 20)	13 (10, 17)	4 (4, 6)	13 (12, 15)	18 (14, 25)	12 (12, 16)	12 (12, 12)	102 (91, 123)
Tertiary	10 (9, 12)	18 (15, 23)	12 (10, 16)	4 (4, 7)	13 (12, 17)	19 (15, 22)	14 (12, 16)	12 (11, 12)	107 (93, 119)
P-value [K]	0.092	0.839	0.348	0.262	0.663	0.009	0.013	0.008	0.153
Occupation									
Unemployed/retired	10 (8, 10)	18 (15, 21)	14 (10, 17)	4 (4, 6)	14 (12, 16)	17 (16, 22)	12 (12, 14)	12 (12, 12)	100 (96, 114)
Employed	10 (7, 11)	18 (16, 21)	12 (10, 16)	4 (4, 6)	12 (12, 15)	16 (14, 21)	12 (12, 15)	12 (12, 12)	98 (92, 111)
P-value [W]	0.373	0.303	0.039	0.010	0.158	0.425	0.933	0.450	0.091
Monthly income									
0-500 cedis	10 (8, 10)	18 (15, 20)	14 (12, 16)	4 (4, 6)	13 (12, 16)	16 (14, 18)	12 (12, 13)	12 (12, 12)	99 (95, 106)
501-1000 cedis	10 (7, 10)	18 (15, 21)	10 (10, 16)	4 (4, 6)	12 (11, 15)	16 (14, 24)	12 (12, 17)	12 (12, 12)	96 (91, 120)
1001+ cedis	11 (9, 13)	19 (17, 22)	11 (10, 16)	5 (4, 6)	14 (12, 17)	21 (15, 25)	15 (12, 20)	12 (9, 12)	107 (93, 125)
P-value [K]	0.002	0.001	0.006	0.019	0.001	<0.001	<0.001	<0.001	0.025
Payment of medication									
Out-of-pocket	10 (9, 13)	18 (15, 22)	13 (10, 16)	4 (4, 6)	12 (12, 18)	18 (15, 21)	13 (12, 16)	12 (12, 12)	104 (93, 120)
Health insurance	10 (7, 10)	18 (16, 21)	13 (10, 17)	4 (4, 6)	13 (12, 15)	16 (14, 21)	12 (12, 14)	12 (12, 12)	98 (94, 108)
P-value [W]	0.001	0.654	0.787	0.485	0.074	0.117	0.083	0.206	0.366
Monthly expenditure on medication									
None	10 (8, 10)	18 (16, 20)	13 (10, 17)	4 (4, 6)	13 (12, 16)	18 (16, 22)	13 (12, 15)	12 (12, 12)	100 (96, 113)
<50 cedis	10 (7, 10)	16 (15, 20)	12 (10, 14)	4 (4, 6)	13 (12, 16)	16 (14, 18)	12 (12, 14)	12 (12, 12)	96 (91, 104)
51-100 cedis	11 (7, 13)	18 (17, 23)	14 (10, 18)	4 (4, 6)	14 (9, 16)	18 (15, 23)	12 (12, 16)	12 (12, 12)	101 (91, 122)
>100 cedis	10 (7, 10)	18 (16, 22)	15 (10, 18)	4 (4, 6)	12 (11, 16)	17 (14, 21)	12 (12, 14)	12 (12, 12)	100 (94, 117)
P-value [K]	0.041	<0.001	0.001	0.548	0.468	<0.001	0.349	0.003	0.008
Gets all drugs from the health insurance									
Yes	10 (8, 10)	18 (16, 20)	12 (10, 16)	4 (4, 6)	12 (12, 15)	17 (16, 20)	12 (12, 15)	12 (12, 12)	98 (96, 106)
No	10 (7, 11)	18 (15, 21)	13 (10, 16)	4 (4, 6)	13 (12, 16)	16 (14, 21)	12 (12, 14)	12 (12, 12)	99 (92, 114)

(*continued on next page*)

Table 3 (*continued*)

Characteristics [minimum possible, maximum possible]	Themes								
	Relationships	Practicalities	Cost	Side effects	Effectiveness	Concerns	Interference	Autonomy	Overall
	[5,25]	[7,30]	[3,15]	[4,20]	[6,31]	[7,30]	[6,31]	[3,15]	[41, 205]
	median (IQR)	median (IQR)	median (IQR)	median (IQR)	median (IQR)	median (IQR)	median (IQR)	median (IQR)	median (IQR)
P-value [W]	0.715	0.063	0.384	0.909	0.983	0.149	0.543	0.039	0.640
Number of medications									
<5 medicines	10 (7, 11)	18 (15, 20)	13 (10, 17)	4 (4, 6)	13 (12, 15)	16 (14, 22)	12 (12, 15)	12 (12, 12)	98 (93, 113)
≥5 medicines	10 (7, 10)	18 (16, 22)	12 (10, 14)	4 (4, 6)	12 (11, 16)	17 (16, 21)	12 (12, 14)	12 (12, 12)	100 (94, 111)
P-value [W]	0.464	0.070	0.187	0.785	0.468	0.224	0.438	0.511	0.713
Formulation used for medications									
Tablets/capsules	10 (7, 11)	18 (16, 21)	13 (10, 16)	4 (4, 6)	13 (12, 16)	17 (15, 21)	12 (12, 14)	12 (12, 12)	99 (93, 113)
Non-oral	10 (10, 10)	20 (20, 20)	10 (10, 10)	4 (4, 4)	12 (12, 12)	14 (14, 14)	11 (11, 11)	15 (15, 15)	96 (96, 96)
P-value [W]	0.668	0.270	0.058	0.300	0.390	0.025	0.002	<0.001	0.487
Frequency of daily dose of medication									
Once	10 (7, 10)	18 (15, 20)	13 (10, 16)	4 (4, 6)	12 (10, 14)	16 (15, 20)	12 (12, 13)	12 (12, 12)	97 (94, 104)
Twice/thrice	10 (8, 11)	18 (16, 21)	12 (10, 16)	4 (4, 6)	14 (12, 16)	17 (15, 23)	13 (12, 17)	12 (12, 12)	101 (93, 124)
P-value [W]	0.062	0.007	0.704	0.001	0.001	0.097	<0.001	0.052	0.005
Living status									
Alone	10 (9, 11)	18 (15, 21)	13 (10, 14)	4 (4, 4)	12 (12, 14)	14 (14, 20)	12 (12, 12)	12 (12, 12)	96 (91, 113)
Other people	10 (7, 11)	18 (16, 21)	13 (10, 17)	4 (4, 6)	13 (12, 16)	17 (15, 22)	12 (12, 14)	12 (12, 12)	99 (94, 111)
P-value [W]	0.257	0.912	0.239	0.007	0.327	0.007	0.091	0.369	0.150
Needs help with medication									
Yes	10 (9, 10)	19 (13, 23)	17 (16, 20)	5 (4, 8)	10 (9, 12)	19 (14, 19)	13 (12, 14)	12 (12, 12)	104 (96, 109)
No	10 (7, 11)	18 (16, 21)	12 (10, 16)	4 (4, 6)	13 (12, 16)	17 (15, 21)	12 (12, 14)	12 (12, 12)	99 (93, 113)
P-value [W]	0.468	0.918	<0.001	0.097	0.001	0.435	0.697	0.042	0.180
Have co-morbidities									
No	10 (7, 10)	18 (15, 21)	13 (10, 16)	4 (4, 6)	13 (11, 16)	17 (14, 21)	12 (12, 14)	12 (12, 12)	98 (93, 108)
Hyperlipidaemia/stroke	10 (10, 13)	19 (16, 22)	12 (10, 17)	4 (4, 6)	14 (12, 15)	17 (15, 22)	12 (12, 15)	12 (12, 12)	100 (95, 122)
P-value [W]	0.002	0.038	0.819	0.086	0.429	0.454	0.090	0.255	0.088
Systolic blood pressure level									
Controlled (<139 mmHg)	10 (7, 11)	18 (16, 20)	12 (10, 16)	4 (4, 6)	14 (12, 16)	17 (14, 22)	12 (12, 15)	12 (12, 12)	99 (94, 113)
Uncontrolled (140+ mmHg)	10 (7, 11)	18 (16, 22)	13 (10, 16)	4 (4, 5)	12 (11, 16)	17 (15, 21)	12 (12, 14)	12 (12, 12)	99 (93, 109)
P-value [W]	0.757	0.400	1.000	0.009	0.008	0.569	0.513	0.258	0.601
Diastolic blood pressure level									
controlled (<90 mmHg)	10 (8, 11)	18 (16, 21)	13 (10, 16)	4 (4, 6)	13 (12, 15)	16 (14, 21)	12 (12, 14)	12 (12, 12)	98 (93, 113)
Uncontrolled (90+ mmHg)	10 (7, 11)	18 (15, 21)	12 (10, 17)	4 (4, 6)	12 (11, 16)	17 (16, 21)	12 (12, 15)	12 (12, 12)	99 (94, 108)
P-value [W]	0.646	0.861	0.671	0.659	0.304	0.430	0.577	0.626	0.969
Glucose level									
Low/moderate (<7.0 mmol/L)	10 (7, 10)	18 (16, 21)	12 (10, 16)	4 (4, 6)	13 (12, 16)	17 (15, 22)	12 (12, 15)	12 (12, 12)	100 (95, 108)
High (7.0+ mmol/L)	10 (7, 11)	18 (15, 21)	13 (10, 16)	4 (4, 6)	12 (11, 16)	16 (15, 21)	12 (12, 14)	12 (12, 12)	99 (92, 113)
P-value [W]	0.523	0.995	0.896	0.021	0.243	0.622	0.076	0.119	0.322
Family history of hypertension									
Yes	10 (8, 11)	18 (15, 21)	13 (10, 16)	4 (4, 6)	13 (12, 16)	16 (15, 21)	12 (12, 14)	12 (12, 12)	99 (94, 108)
No	10 (6, 11)	18 (16, 20)	12 (10, 16)	4 (4, 6)	13 (12, 15)	18 (15, 24)	12 (12, 20)	12 (12, 12)	96 (91, 113)
P-value [W]	0.038	0.781	0.706	0.931	0.840	0.016	0.020	0.405	0.970
Family history of diabetes mellitus									
Yes	10 (7, 10)	18 (14, 20)	12 (10, 15)	4 (4, 6)	13 (11, 15)	16 (14, 18)	12 (12, 13)	12 (12, 12)	97 (92, 104)
No	10 (7, 11)	18 (16, 22)	13 (10, 17)	4 (4, 6)	13 (12, 16)	18 (15, 23)	14 (12, 17)	12 (12, 12)	104 (94, 120)
P-value [W]	0.148	<0.001	0.459	0.027	0.381	0.007	<0.001	0.864	<0.001

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Table 3 (*continued*)

Characteristics [minimum possible, maximum possible]	Themes								
	Relationships	Practicalities	Cost	Side effects	Effectiveness	Concerns	Interference	Autonomy	Overall
	[5,25]	[7,30]	[3,15]	[4,20]	[6,31]	[7,30]	[6,31]	[3,15]	[41, 205]
	median (IQR)	median (IQR)	median (IQR)	median (IQR)	median (IQR)	median (IQR)	median (IQR)	median (IQR)	median (IQR)
Duration since diagnosis of hypertension									
<5 years	10 (7, 10)	18 (16, 21)	12 (10, 16)	4 (4, 6)	12 (12, 16)	17 (16, 21)	12 (12, 14)	12 (12, 12)	100 (94, 111)
5+ years	10 (7, 11)	18 (15, 21)	13 (10, 16)	4 (4, 6)	13 (12, 15)	16 (14, 22)	12 (12, 14)	12 (12, 12)	98 (93, 114)
P-value [W]	0.427	0.135	0.868	0.597	0.679	0.123	0.767	0.102	0.745
Duration since diagnosis of Diabetes Mellitus									
<5 years	10 (8, 11)	18 (16, 21)	13 (10, 16)	4 (4, 6)	12 (11, 15)	16 (14, 19)	12 (12, 14)	12 (12, 12)	98 (93, 109)
5+ years	9 (6, 12)	18 (14, 20)	13 (10, 16)	4 (4, 5)	14 (12, 16)	21 (15, 25)	13 (12, 18)	12 (12, 12)	101 (95, 119)
P-value [W]	0.139	0.038	0.574	0.035	0.004	<0.001	0.020	0.644	0.140
Frequency of follow-up									
Every 2 weeks/monthly	10 (7, 10)	17 (16, 20)	12 (10, 16)	4 (4, 4)	13 (12, 15)	17 (15, 19)	12 (12, 14)	12 (12, 12)	99 (93, 106)
Every 2 months	10 (7, 11)	18 (16, 21)	13 (10, 16)	4 (4, 6)	13 (12, 16)	17 (14, 22)	12 (12, 15)	12 (11, 12)	98 (93, 120)
P-value [W]	0.051	0.008	0.994	0.001	0.233	0.957	0.162	<0.001	0.195

Higher scores indicating a greater burden. P-value [W]: P-values from the Wilcoxon rank sum test. P-value [K]: P-values from the Kruskal Wallis test.

Table 4
Participants responses on the medication adherence report (MARS) scale.

Adherence scale	Always/often	Sometimes	Rarely/Never
	n (%)	n (%)	n (%)
I forget to take my medicines	25 (3.8)	65 (9.9)	512 (77.8)
I alter the dose of my medicine	12 (1.8)	16 (2.4)	569 (86.5)
I stopped taking my medicine for a while	13 (2.0)	34 (5.2)	512 (77.8)
I decide to miss out a dose of my medicine	19 (2.9)	39 (5.9)	554 (84.2)
I take less medicines than instructed	10 (1.5)	19 (2.9)	594 (90.3)
Overall medication adherence			
Non-adherence	208 (63.2)		
Adherence	121 (36.8)		
95% CI of adherence	31.6% to 42.2%		

Participants who responded never to all the five MARS scale questions were considered adhering to medication.

moderate/high burden 56% less among those within 5 years of diagnosis with hypertension (AOR: 0.44, 95% CI: 0.21–0.91, p = 0.026) (Table 6).

Multivariable binary logistic regression analysis of the factors associated with adherence to medication

The final multivariable models had reasonable levels of multicollinearity with VIF values of 2.92 (range: 1.70–6.66) medication adherence models after excluding variables with high multicollinearity (thus VIF>10) such as payment method for drugs, getting all medications with health insurance, formulation of medications, participants living with others and participants needing help with taking their medications. The Hosmer-Lemeshow goodness of fit test with 10 quantiles was non-significant (p-value = 0.1886) indicating that the model was appropriately fit.

The adjusted odd of adherence to medication was over 3 times high among those whose monthly expenditure on medications were over 100 cedis (1 cedi ≈ 0.166USD at the time of data collection) compared to no expenditure (AOR: 3.30, 95% CI: 1.27–8.58, p = 0.014). Participants with uncontrolled DBP had lower odds of adhering to medications compared to those with controlled DBP (AOR: 0.48, 95% CI: 0.25–0.94, p = 0.031). Also, participants diagnosed of hypertension for at least 5 years had 45% reduced odds of medication adherence (AOR: 0.55, 95% CI: 0.30–0.99, p = 0.045). Also, those with moderate/high medication-related burden had 67% lower odds of adhering to medications compared to those with minimum burden (AOR: 0.33, 95% CI: 0.16–0.69, p = 0.003) (Table 6).

4. Discussion

In this study, moderate to high medication-related burden was prevalent among 30.7% of the study participants. While this value is relatively lower than a similar study conducted in Kuwait where 97.4% burden was reported, similar to our study, the burden was higher in males and people of old age [17]. Older people tend to be at a higher risk of forgetting their dosing regimens, treatment guidelines and developing co-morbidities which may account for the high burden. Gender roles and health seeking behaviours may influence differences in burden response among males and females as well [31]. Unlike other studies which found no relationship between educational status and medication burden [[17], [28,32]], this study revealed a high medication burden among those with tertiary level education. People with tertiary level education are often employed in the formal sector and their busy work schedules could account for the burden. In addition, participants who were not married reported lower medication burden compared to those who are married, and this may be due to reduced pressures around social responsibilities [28].

Medication burden was high among those who took two/three doses of medications daily. This result is comparable to several studies that also showed that treatment burden was high among patients suffering from chronic conditions who take frequent doses of medications in a day [33–35]. An increase in the frequency of medications leads to a subsequent increase in the complexity of dosing regimens which could result in interference with the daily routines of patients including taking medications at certain intervals during the day. Similarly, patients with multi morbid hyperlipidemia and stroke showed high medication burden and this corroborates a study conducted among patients with T2DM in the United States [30]. The multiple morbidities may result in an increase in the number of medications and thus an increase in the complexity of dosing regimens, side effects and cost. Thus, consequently leading to an increased burden experienced by these patients. This study further revealed a high burden among patients with high glucose levels and among those who had been diagnosed withT2DM for 5 or more years. This finding is consistent with a previous study which reported increased treatment burden among patients with high glucose levels and also among patients who had lived with the condition for many years [28].

Our study also reports high medication burden among patients who had been diagnosed with hypertension for 5 or more years and also among patients who had long intervals in their follow up appointments. In comparison to a similar study, although no relationship was found between treatment burden and follow up appointments, a high burden was reported among patients who had co-morbidities like hypertension for many years [28]. Another study conducted in Wales reported a high burden related to cost and time among patients who also had long interval follow ups [36]. When patients are initially diagnosed with chronic conditions, the anxieties around complication prevention and possible mortality compels them to follow through with medicine acquisition, adherence to

Table 5
Bivariate analysis of the association between socio-demographic and clinical characteristics and burden and medication adherence.

	Total	Burden			Medication adherence		
		Minimum burden	Moderate/high burden	p-value	Non-adherence	Adherence	p-value
	N = 329	N = 228	N = 101		N = 208	N = 121	
Sex				<0.001			0.039
Male	144	78 (54.2)	66 (45.8)		100 (69.4)	44 (30.6)	
Female	185	150 (81.1)	35 (18.9)		108 (58.4)	77 (41.6)	
Age, Median (IQR)	57.5 [±13.2]	57.3 [±13.4]	57.9 [±12.7]	0.690[T]	56.9 [±12.3]	58.5 [±14.6]	0.300[T]
Age				0.570			0.110
<50	80	60 (75.0)	20 (25.0)		49 (61.3)	31 (38.8)	
50–59 years	108	75 (69.4)	33 (30.6)		78 (72.2)	30 (27.8)	
60-69	78	52 (66.7)	26 (33.3)		46 (59.0)	32 (41.0)	
70+	63	41 (65.1)	22 (34.9)		35 (55.6)	28 (44.4)	
Marital status				0.160			0.089
Single	84	63 (75.0)	21 (25.0)		50 (59.5)	34 (40.5)	
Married	192	131 (68.2)	61 (31.8)		131 (68.2)	61 (31.8)	
Divorced	25	19 (76.0)	6 (24.0)		14 (56.0)	11 (44.0)	
Others	28	15 (53.6)	13 (46.4)		13 (46.4)	15 (53.6)	
Highest education				<0.001			0.022
No formal education	59	49 (83.1)	10 (16.9)		36 (61.0)	23 (39.0)	
Primary	72	59 (81.9)	13 (18.1)		37 (51.4)	35 (48.6)	
Secondary	128	86 (67.2)	42 (32.8)		93 (72.7)	35 (27.3)	
Tertiary	70	34 (48.6)	36 (51.4)		42 (60.0)	28 (40.0)	
Occupation				0.471			0.559
Unemployed/retired	89	59 (66.3)	30 (33.7)		54 (60.7)	35 (39.3)	
Employed	240	169 (70.4)	71 (29.6)		154 (64.2)	86 (35.8)	
Monthly income				<0.001			0.001
0-500 cedis	150	121 (80.7)	29 (19.3)		83 (55.3)	67 (44.7)	
501-1000 cedis	121	80 (66.1)	41 (33.9)		77 (63.6)	44 (36.4)	
1001+ cedis	58	27 (46.6)	31 (53.4)		48 (82.8)	10 (17.2)	
Payment method for drugs				0.057			0.081
Self-sponsored	70	42 (60.0)	28 (40.0)		38 (54.3)	32 (45.7)	
Health Insurance	259	186 (71.8)	73 (28.2)		170 (65.6)	89 (34.4)	
Monthly expenditure on drugs, Median (IQR)	50 (30, 100)	50 (30, 100)	100 (30, 110)	0.015[W]	50 (30, 100)	60 (50, 150)	0.190[W]
Monthly expenditure on drugs				0.013			0.468
None	68	49 (72.1)	19 (27.9)		46 (67.6)	22 (32.4)	
<50 cedis	101	81 (80.2)	20 (19.8)		65 (64.4)	36 (35.6)	
51-100 cedis	88	54 (61.4)	34 (38.6)		57 (64.8)	31 (35.2)	
>100 cedis	72	44 (61.1)	28 (38.9)		40 (55.6)	32 (44.4)	
Gets all drugs from the health insurance				0.150			1.000
Yes	68	52 (76.5)	16 (23.5)		43 (63.2)	25 (36.8)	
No	261	176 (67.4)	85 (32.6)		165 (63.2)	96 (36.8)	
Number of medications				0.870			0.004
<5 medicines	230	160 (69.6)	70 (30.4)		157 (68.3)	73 (31.7)	
≥5 medicines	99	68 (68.7)	31 (31.3)		51 (51.5)	48 (48.5)	
Formulation used for medications				0.250[F]			0.023[F]
Tablets/capsules	326	225 (69.0)	101 (31.0)		208 (63.8)	118 (36.2)	
Non-oral	3	3 (100.0)	0 (0.0)		0 (0.0)	3 (100.0)	
Frequency of daily dose of medication				<0.001			0.124
Once	145	115 (79.3)	30 (20.7)		85 (58.6)	60 (41.4)	
Twice/thrice	184	113 (61.4)	71 (38.6)		123 (66.9)	58 (33.2)	
Living status				0.880			0.610
Alone	25	17 (68.0)	8 (32.0)		17 (68.0)	8 (32.0)	
Other people	304	211 (69.4)	93 (30.6)		191 (62.8)	113 (37.2)	
Needs help with medication				0.110			0.520
Yes	14	7 (50.0)	7 (50.0)		10 (71.4)	4 (28.6)	
No	315	221 (70.2)	94 (29.8)		198 (62.9)	117 (37.1)	
Have co-morbidities				0.006			0.240
No	269	194 (72.1)	75 (27.9)		174 (64.7)	95 (35.3)	
Hyperlipidaemia/Stroke	60	34 (56.7)	26 (43.3)		34 (56.7)	26 (43.3)	
Systolic blood pressure level, Median (IQR)	140 (128, 157)	140.5 (128, 158)	139 (120, 156)	0.045[W]	139 (127, 157)	141 (128, 157)	0.310[W]
Systolic blood pressure level				0.270			0.160
Controlled (<139 mmHg)	161	107 (66.5)	54 (33.5)		108 (67.1)	53 (32.9)	
Uncontrolled (140+ mmHg)	168	121 (72.0)	47 (28.0)		100 (59.5)	68 (40.5)	

(*continued on next page*)

Table 5 (*continued*)

	Total	Burden			Medication adherence		
		Minimum burden	Moderate/high burden	p-value	Non-adherence	Adherence	p-value
	N = 329	N = 228	N = 101		N = 208	N = 121	
Diastolic blood pressure level, Median (IQR)	85 (77, 92)	85 (79, 92)	81 (74, 95)	0.070	85 (77, 95)	85 (78, 89)	0.260
Diastolic blood pressure level				0.980			0.044
controlled (<90 mmHg)	231	160 (69.3)	71 (30.7)		138 (59.7)	93 (40.3)	
Uncontrolled (90+ mmHg)	98	68 (69.4)	30 (30.6)		70 (71.4)	28 (28.6)	
Glucose level, Median (IQR)	6.5 (5.6, 8.3)	6.5 (5.8, 8.3)	6.1 (5.3, 8.0)	0.200[W]	6.5 (5.7, 8.6)	6.2 (5.3, 8.0)	0.110[W]
Glucose level				0.430			0.180
Low/Moderate (<7.0 mmol/L)	141	101 (71.6)	40 (28.4)		95 (67.4)	46 (32.6)	
High (7.0+ mmol/L)	188	127 (67.6)	61 (32.4)		113 (60.1)	75 (39.9)	
Family history of hypertension				0.046			<0.001
Yes	224	101 (72.8)	61 (27.2)		128 (57.1)	96 (42.9)	
No	105	65 (61.9)	40 (38.1)		80 (76.2)	25 (23.8)	
Family history of diabetes mellitus				<0.001			0.027
Yes	164	131 (79.9)	33 (20.1)		94 (57.3)	70 (42.7)	
No	165	97 (58.8)	68 (41.2)		114 (69.1)	51 (30.9)	
Duration since diagnosis of hypertension, Median (IQR)	5 (2, 6)	5 (2, 7)	5 (2, 6)	0.210	5 (2, 7)	4 (2, 6)	0.560
Duration since diagnosis of hypertension				0.530			0.087
<5 years	151	102 (67.5)	49 (32.5)		88 (58.3)	63 (41.7)	
5+ years	178	126 (70.8)	52 (29.2)		120 (67.4)	58 (32.6)	
Duration since diagnosis of Diabetes Mellitus, Median (IQR)	3 (1, 5)	3 (1, 5)	3 (1, 5)	0.490	3 (1, 5)	2 (1, 4)	0.100
Duration since diagnosis of Diabetes Mellitus				0.660			0.140
<5 years	243	170 (70.0)	73 (30.0)		148 (60.9)	95 (39.1)	
5+ years	86	58 (67.4)	28 (32.6)		60 (69.8)	26 (30.2)	
Frequency of follow-up				0.020			0.126
Every 2 weeks/Monthly	108	84 (77.8)	24 (22.2)		62 (57.4)	46 (42.6)	
Every 2 months	221	144 (65.2)	77 (34.8)		146 (66.1)	75 (33.9)	
Burden of Medication							
Themes of the LMQ-3 scale							
Relationship, Median (IQR)	10 (7, 11)	10 (7, 10)	12 (10, 15)	<0.001[W]	10 (7, 11)	10 (8, 10)	0.380[W]
Practicalities, Median (IQR)	18 (16, 21)	16 (15, 18.5)	22 (18, 23)	<0.001[W]	18 (16, 21)	18 (15, 21)	0.330[W]
Cost, Median (IQR)	13 (10, 16)	10 (10, 14)	17 (14, 19)	<0.001[W]	13 (10, 17)	12 (10, 16)	0.150[W]
Side effects, Median (IQR)	4 (4, 6)	4 (4, 4)	6 (5, 7)	<0.001[W]	4 (4, 6)	4 (4, 6)	0.170[W]
Effectiveness, Median (IQR)	13 (12, 16)	12 (11, 14)	16 (13, 18)	<0.001[W]	13 (11, 16)	12 (12, 15)	0.190[W]
Concerns, Median (IQR)	17 (15, 21)	16 (14, 17)	23 (20, 28)	<0.001[W]	18 (15, 24)	16 (14, 18)	<0.001[W]
Interference, Median (IQR)	12 (12, 14)	12 (12, 12)	17 (14, 22)	<0.001[W]	12 (12, 17)	12 (12, 13)	<0.001[W]
Autonomy, Median (IQR)	12 (12, 12)	12 (12, 12)	11 (9, 12)	<0.001[W]	12 (12, 12)	12 (12, 12)	<0.001[W]
Overall burden, Median (IQR)	99 (93, 113)	95.5 (91, 99.5)	123 (114, 130)	<0.001[W]	99.5 (94, 122)	96 (93, 106)	0.005[W]
Overall burden							0.001
Minimum burden	228	n/a	n/a	n/a	131 (57.5)	97 (42.5)	
Moderate/High burden	101	n/a	n/a	n/a	77 (76.2)	24 (23.8)	

T: P-value from the *t*-test. W: P-value from the Wilcoxon rank sum test. F: P-value from the Fischer's exact test. All other p-values are from the Pearson's chi-square test.

treatment guidelines and attendance to all follow up sessions. But as these patients live with their conditions for many years, they may tend to feel burdened by the medications they take for long periods or the frequent follow up sessions, thus accounting for the observed results.

Prevalence of adherence to medication was 36.8%, which is relatively lower that what has been reported in other studies where adherence rates of 42.9 and 54.7 were recorded using MARS-5 with similar cut-off points [28,29]. The distinctions in these results may be associated with the geographic variations, sensitization and awareness about the complications associated with T2DM and hypertension, and the need to adhere adequately to treatment [37].

Patients with higher medication expenditure showed high adherence to their medications. In a related study, patients who were adherent to their medications reported lower outpatient and inpatient expenditures with higher prescription drug costs compared to their non-adherent counterparts [38]. While these results may be due to the socio-economic status of participants, or could imply that people who adequately adhered to their medications invariably incurred higher costs compared to those not taking their medications.

The results obtained from this study also showed that adherence was low among patients with uncontrolled diastolic blood pressure and those diagnosed with hypertension for at least 5 years. The uncontrolled diastolic blood pressure could be a complication from non-adherence to prescribed medications as has been observed in a study where poor adherence to medications was associated with

Table 6
Binary logistic regression model of factors associated moderate/high burden and medication adherence.

Variables and categories	Moderate/High burden		Adherence	
	AOR [95% CI]	P-value	AOR [95% CI]	P-value
Sex				
Male	1.00 [reference]		1.00 [reference]	
Female	0.34 [0.17, 0.66]	0.001	0.94 [0.50, 1.79]	0.857
Age				
<50	1.00 [reference]		1.00 [reference]	
50–59 years	1.54 [0.62, 3.82]	0.354	0.77 [0.35, 1.70]	0.513
60-69	2.99 [1.12, 7.99]	0.029	1.76 [0.67, 4.64]	0.250
70+	3.26 [1.01, 10.51]	0.048	1.88 [0.65, 5.42]	0.244
Marital status				
Single	1.00 [reference]		1.00 [reference]	
Married	0.30 [0.11, 0.77]	0.013	0.66 [0.31, 1.40]	0.279
Divorced	0.30 [0.11, 0.83]	0.020	1.54 [0.56, 4.20]	0.403
Highest education				
No formal education	1.00 [reference]		1.00 [reference]	
Primary	1.22 [0.44, 3.42]	0.702	1.07 [0.43, 2.65]	0.882
Secondary	2.06 [0.86, 4.93]	0.105	0.83 [0.34, 2.02]	0.675
Tertiary	6.50 [2.25, 18.80]	0.001	1.85 [0.68, 5.02]	0.229
Occupation				
Unemployed/retired	1.00 [reference]		1.00 [reference]	
Employed	1.12 [0.46, 2.73]	0.812	1.81 [0.74, 4.47]	0.196
Monthly income				
0-500 cedis	1.00 [reference]		1.00 [reference]	
501-1000 cedis	1.44 [0.68, 3.05]	0.337	0.72 [0.37, 1.39]	0.324
1001+ cedis	1.69 [0.68, 4.21]	0.257	0.41 [0.15, 1.13]	0.084
Monthly expenditure on drugs				
None (Health insurance)	1.00 [reference]		1.00 [reference]	
<50 cedis	0.51 [0.16, 1.62]	0.254	1.47 [0.58, 3.71]	0.416
51-100 cedis	1.41 [0.47, 4.21]	0.535	1.81 [0.78, 4.24]	0.168
>100 cedis	1.76 [0.62, 5.02]	0.287	3.30 [1.27, 8.58]	0.014
Number of medications				
<5 medicines	1.00 [reference]		1.00 [reference]	
≥5 medicines	0.60 [0.29, 1.24]	0.166	1.32 [0.74, 2.38]	0.348
Frequency of daily dose of medication				
Once	1.00 [reference]		1.00 [reference]	
Twice/thrice	2.78 [1.40, 5.51]	0.004	1.08 [0.61, 1.91]	0.795
Have co-morbidities				
No	1.00 [reference]		1.00 [reference]	
Hyperlipidaemia/Stroke	3.13 [1.21, 8.10]	0.019	1.19 [0.54, 2.61]	0.671
Systolic blood pressure level				
Controlled (<139 mmHg)	1.00 [reference]		1.00 [reference]	
Uncontrolled (140+ mmHg)	0.56 [0.28, 1.11]	0.096	1.45 [0.79, 2.69]	0.232
Diastolic blood pressure level				
controlled (<90 mmHg)	1.00 [reference]		1.00 [reference]	
Uncontrolled (90+ mmHg)	2.46 [1.20, 5.05]	0.014	0.48 [0.25, 0.94]	0.031
Glucose level				
Low/moderate (<7.0 mmol/L)	1.00 [reference]		1.00 [reference]	
High (7.0+ mmol/L)	4.24 [2.13, 8.46]	<0.001	1.44 [0.77, 2.68]	0.257
Family history of hypertension				
Yes	1.00 [reference]		1.00 [reference]	
No	1.00 [0.46, 2.17]	1.000	0.71 [0.33, 1.51]	0.369
Family history of diabetes mellitus				
Yes	1.00 [reference]		1.00 [reference]	
No	2.14 [1.14, 4.02]	0.018	0.76 [0.40, 1.47]	0.421
Duration since diagnosis of hypertension				
<5 years	1.00 [reference]		1.00 [reference]	
5+ years	0.44 [0.21, 0.91]	0.026	0.55 [0.30, 0.99]	0.045
Duration since diagnosis of Diabetes Mellitus				
<5 years	1.00 [reference]		1.00 [reference]	
5+ years	1.54 [0.66, 3.60]	0.317	0.96 [0.49, 1.87]	0.895
Frequency of follow-up				
2 weeks/1 months	1.00 [reference]		1.00 [reference]	
Every 2 months	2.29 [1.04, 5.05]	0.040	0.94 [0.52, 1.70]	0.828
Overall burden				
Minimum burden	n/a		1.00 [reference]	
Moderate/high burden	n/a		0.33 [0.16, 0.69]	0.003

AOR: adjusted odds ratio. CI: confidence interval.

uncontrolled blood pressure in patients with T2DM and hypertension [24].

This study further revealed a low adherence rate among patients with high medication burden, which supports studies conducted in other countries for patients with hypertension, T2DM and their comorbidities [17,26]. Consequently, patients who feel burdened by their medications may not adhere to their treatment regimen, thus resulting in a failure to achieve treatment goals, a deterioration of their conditions and a reduction in their quality of life [39,40].

The study acknowledges the limitations of information, recall and other biases which may be associated with cross-sectional studies. To minimize the biases, a standardized questionnaire was used, and the research officers were also trained to standardize the data collection process. In addition, although measures of burden and adherence are self-reported and prone to recall bias, they also have the advantages of being inexpensive and readily appropriate for use in clinical settings.

Despite the above limitations, the strength of this study is that some information relevant for managing comorbid T2DM and hypertension has been provided. A low medication adherence rate among patients with co-morbid T2DM and hypertension was observed, and this was influenced by the medication-related burden they experienced and blood pressure control. This clearly has clinical practice and pharmaceutical policy implications for the development of interventions for optimum T2DM and hypertension care outcomes. These interventions are critical to Ghana and other LMICs with similar context since diabetes is an important cardiovascular risk factor in the development of cardiac and vascular pathologies. It is therefore recommended that health stakeholders including clinicians, pharmacists, and policy makers, develop multidisciplinary strategies to include the provision of counselling to patients on adherence and morbidity, as well as develop policies and sensitization activities on deprescribing. The interventions should also encourage fixed-dose drug combination to reduce medication-related burden while promoting better adherence and clinical outcomes.

Author contribution statement

Emmanuella Baah-Nyarkoh: Conceived and designed the experiments; Performed the experiments; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Yakubu Alhassan: Conceived and designed the experiments; Analyzed and interpreted the data; Wrote the paper.

Andrews K. Dwomoh: Conceived and designed the experiments; Analyzed and interpreted the data; Wrote the paper.

Irene A. Kretchy: Conceived and designed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

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Data availability statement

Data associated with this study has been deposited at https://data.mendeley.com/datasets/stb99vj4fb/1.

Declaration of interest's statement

The authors declare no competing interests.

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References

[1] S. Akter, M.M. Rahman, S.K. Abe, P. Sultana, Prevalence of diabetes and prediabetes and their risk factors among Bangladeshi adults: a nationwide survey, Bull. World Health Organ. 92 (3) (2014) 204–213A, pmid:24700980.

[2] A.M. Sarki, C.U. Nduka, S. Stranges, N.B. Kandala, O.A. Uthman, Prevalence of hypertension in low- and middle-income countries: a systematic review and meta-analysis, Med 94 (50) (2015).

[3] International Diabetes Federation, IDF Diabetes Atlas, 2021. https://diabetesatlas.org/#:~:text=Diabetes%20around%20the%20world%20in%202021%3A,with%20diabetes%20-%201%20in%2010. (Accessed 18 March 2022). Accessed.

[4] P. Lloyd-Sherlock, J. Beard, N. Minicuci, S. Ebrahim, S. Chatterji, Hypertension among older adults in low-and middle-income countries: prevalence, awareness and control, Int. J. Epidemiol. 43 (1) (2014) 116–128, pmid:24505082.

[5] M.M. Ibrahim, A. Damasceno, Hypertension in developing countries, Lancet 380 (9841) (2012) 611–619.

[6] M. Pereira, N. Lunet, A. Azevedo, H. Barros, Differences in prevalence, awareness, treatment and control of hypertension between developing and developed countries, J. Hypertens. 27 (5) (2009) 963–975, pmid:19402221.

[7] M. Asamoah-Boaheng, O. Sarfo-Kantanka, A.B. Tuffour, B. Eghan, J.C. Mbanya, Prevalence and risk factors for diabetes mellitus among adults in Ghana: a systematic review and meta-analysis, Int. Health. 11 (2) (2019) 83–92.

[8] World Health Organization, Hypertension, 2021. https://www.who.int/news-room/fact-sheets/detail/hypertension. (Accessed 18 March 2022). Accessed on.

[9] F. Atibila, G.T. Hoor, E.T. Donkoh, A.I. Wahab, G. Kok, Prevalence of hypertension in Ghanaian society: a systematic review, meta-analysis, and GRADE assessment, BMC Med. 10 (220) (2021).

[10] K. Venugopal, M. Mohammed, Prevalence of hypertension in type-2 diabetes mellitus, CHRISMED J. Health Res. 1 (4) (2014) 223.

[11] Centre for Disease Control and Prevention. https://www.cdc.gov/diabetes/managing/problems.html, 2022. Accessed on 30th March, 2022.
[12] F. Contreras, M. Rivera, J. Vasquez, M.A. De la Parte, M. Velasco, Diabetes and hypertension physiopatholoy and therapeutics, J. Hum. Hypertens. 14 (1) (2000) 26–31.
[13] D.O. Long, S. Dagogo-Jack, Comorbidities of diabetes and hypertension: mechanisms and approach to target organ protection, J. Clin. Hypertens. 13 (4) (2011) 244–251.
[14] M.A. Munger, Polypharmacy and combination therapy in the management of hypertension in elderly patients with co-morbid diabetes mellitus, Drugs Aging 27 (2010) 871–883.
[15] S. Rambhade, A. Chakarborty, A. Shrivastava, U.K. Patil, A. Rambhade, A survey on polypharmacy and use of inappropriate medications, Toxicol. Int. 19 (2010) 68–73.
[16] J. Jyrkkä, H. Enlund, M.J. Korhonen, R. Sulkava, S. Hartikainen, Polypharmacy status as an indicator of mortality in an elderly population, Drugs Aging 26 (2009) 1039–1048.
[17] A. Awad, A. Alhadab, A. Albassam, Medication- related burden and medication adherence among geriatric patients in Kuwait: a cross-sectional study, Front. Pharmacol. (2020), https://doi.org/10.3389/fphar.2020.01296.
[18] R. Indu, A. Adhikari, A.K. Das, Polypharmacy and comorbidity status in the treatment of type 2 diabetic patients attending a tertiary care hospital: an observational and questionnaire-based study, Persp. Clin. Res. 9 (3) (2018) 139–144.
[19] K. Khunti, S. Seidu, S. Kunutsor, M. Davies, Association between adherence to pharmacotherapy and outcomes in Type 2 diabetes: a meta-analysis, Diabetes Care 40 (11) (2017) 1588–1596, https://doi.org/10.2337/dc16-1925.
[20] S. Mattke, M.C. Haims, N. Ayivi-Guedehoussou, E.M. Gillen, L.E. Hunter, L. Klautzer, in: Santa Monica (Ed.), Improving Access to Medicines for Non-communicable Diseases in the Developing World, Rand Corporation, Carlifonia, 2011.
[21] Ministry of Health, National Policy for the Prevention and Control of Chronic Non-communicable Disease in Ghana, 2012. https://www.iccp-portal.org/sites/default/files/plans/national_policy_for_the_prevention_and_control_of_chronic_non-communicable_diseases_in_ghana(1).pdf. Accessed on 30th March, 2022.
[22] R.A. Atinga, L. Yarney, N.M. Gavu, Factors influencing long-term medication non-adherence among diabetes and hypertensive patients in Ghana: a qualitative investigation, PLoS One (2018), https://doi.org/10.1371/journal.pone.0193995.
[23] W.G. Cochran, Sampling techniques, JWS 3 (1977).
[24] S. Muleta, T. Melaku, L. Chelkeba, D. Assefa, Blood pressure control and its determinants among diabetes mellitus co-morbid hypertensive patients at Jimma University medical center, South West Ethiopia, BMC (Biomed. Chromatogr.): Clin Hypertens. 23 (2017) 29, https://doi.org/10.1186/s40885-017-0085-x.
[25] J. Krska, B. Katusiime, S.A. Corlett, Validation of an instrument to measure patients' experiences of medicine use: the living with medicines questionnaire, Patient Prefer. Adherence 11 (2017) 671.
[26] A. Zidan, Awaisu A. El-Hajj, M.S. Al-Abdulla, S.A. Figueroa, D.C.R. Kheir, N. Medication-related burden among patients with chronic disease conditions: perspectives of patients attending non-communicable disease clinics in a primary healthcare setting in Qatar, Pharm. Times 85 (6) (2018), https://doi.org/10.3390/pharmacy6030085.
[27] R. Horne, J. Weinman, Patients' beliefs about prescribed medicines and their role in adherence to treatment in chronic physical illness, J. Psychosom. Res. 47 (6) (1999) 555–567.
[28] G.C.Y. Kang, E.Y.L. Koh, N.C. Tan, Prevalence and factors associated with adherence to anti-hypertensives among adults with hypertension in a developed Asian community: a cross-sectional study, Proc. Singapore Healthc. 29 (3) (2020) 167–175.
[29] C.S. Lee, J.H.M. Tan, U. Sankari, Y.L.E. Koh, N.C. Tan, Assessing oral medication adherence among patients with type 2 diabetes mellitus treated with polytherapy in a developed Asian community: a cross-sectional study, BMJ Open 7 (9) (2017) e016317.
[30] H.W. Rodbard, , Green, A.J. Fox, K.M, S. Grandy, Shield Study Group, Impact of type 2 diabetes mellitus on prescription medication burden and out-of-pocket healthcare expenses, Diabetes Res. Clin. Pract. 87 (2010) 360–365.
[31] D.M. Griffith, R.J. Thorpe Jr., Men's physical health and health behaviors, in: Y.J. Wong, S.R. Wester (Eds.), APA Handbook of Men and Masculinities, APA, 2016, pp. 709–730, https://doi.org/10.1037/14594-.
[32] A. Sav, M.A. King, J.A. Whitty, E. Kendall, S.S. McMillan, F. Kelly, et al., Burden of treatment for chronic illness: a concept analysis and review of the literature, Health Expect. 18 (2015) 312–324, https://doi.org/10.1111/hex.12046.
[33] Bernhard J Maibach, R. Thurlimann, B. Sessa, C. Aapro, M. S. Swiss Group for Clinical Cancer Research. Patients' estimation of overall treatment burden: why not ask the obvious? Am. J. Clin. Oncol. 20 (2002) 65–72.
[34] K. Gallacher, C.R. May, V.M. Montori, F.S. Mair, Understanding patients' experiences of treatment burden in chronic heart failure using normalization process theory, Ann. Fam. Med. 9 (2011) 235–243.
[35] J. Krska, B. Katusiime, S.A. Corlett, Patient experiences of the burden of using medicines for long-term conditions and factors affecting burden: a cross-sectional survey, Health Soc. Care Community 26 (2018) 946–959, https://doi.org/10.1111/hsc.12624.
[36] A. Zucca, A. Boyes, A. Girgis, A. Hall, G. Newling, Travelling all over the countryside: travel-related burden and financial difficulties reported by cancer patients in New South Wales and Victoria, Aust. J. Rural Health 19 (2011) 298–305.
[37] V. Learnihan, R.D. Schroers, P. Coote, M. Blake, N.T. Coffee, M. Daniel, Geographic variation in and contextual factors related to biguanide adherence amongst medicaid enrolees with type 2 Diabetes Mellitus, SSM-Pop. Heal. 17 (2022), 101013.
[38] P.J. Campbell, D.R. Axon, A.M. Taylor, K. Smith, M. Pickering, H. Black, T. Warholak, C. Chinthammit, Hypertension, cholesterol and diabetes medication adherence, health care utilization and expenditure in a Medicare Supplemental sample, Medicine 100 (2021) 35.
[39] I.A. Kretchy, F. Acheampong, J. Laryea, J. Osafo, E. Asampong, E. Dickson, Personality traits, clinical characteristics, and health-related quality of life of patients with hypertension in a primary hospital in Ghana, Int. J. Hyper. (2019) 9, https://doi.org/10.1155/2019/7489875.
[40] S. Hamine, E. Gerth-Guyette, D. Faulx, B.B. Green, A.S. Ginsburg, Impact of mHealth chronic disease management on treatment adherence and patient outcomes: a systematic review, J. Med. Internet Res. 17 (2) (2015), e3951.