Original Research

Glycemic and Cardiovascular Risk Control among Patients with Type 2 Diabetes: A Saudi Tertiary Care Hospital Experience

Rana AlHamwy¹, Mona Hafiz¹, Yacoub Abuzied²

¹Department of Family Medicine and Employee Health, King Fahad Medical City, Riyadh, Saudi Arabia, ²Department of Nursing, King Fahad Medical City, Riyadh, Saudi Arabia

Abstract

Introduction: Data on concomitant control of both glycemia and cardiovascular risk factors among patients with type 2 diabetes (T2D) are very limited in Saudi Arabia. The aim of this study was to assess the degree of achieving glycemic control and concomitant control of cardiovascular risk factors at a primary care setting. **Methods:** Between February and March 2017, we retrospectively reviewed the charts and laboratory records of adult patients with T2D who received primary care services at Family Medicine clinics at King Fahad Medical City for at least a year. Outcome goals were based on 2016 American Diabetic Association (ADA) standards of diabetic care. **Results:** A total of 268 patients were included in the study. The mean age was 55.0 ± 10.7 years and 60% of the patients were women. Patients who achieved ADA-recommended diabetic care goals were 43.7% for glycemic control, 46.7% for blood pressure, 87.9% for total cholesterol, 52.7% for low-density lipoprotein cholesterol, 44.7% for high-density lipoprotein cholesterol, 70.8% for triglycerides, 9.4% for diet control, 1.9% for practicing exercises, 98.1% for receiving health education, and finally 38.8% for the recommended number of glycated hemoglobin testing. In addition to glycemic control, concomitant control of blood pressure, blood lipids, and both blood pressure/blood lipids were 21.3%, 9.4%, and 4.9%, respectively. In multivariate analysis, glycemic control was independently associated with the type of diabetic medications, diet control, and smoking status. **Conclusion:** The concomitant control of multiple diabetic care goals is alarmingly low. Further research is required to better understand the responsible system barriers and strategies to improve.

Keywords: Adherence, diabetes, guidelines, primary care, Saudi Arabia

INTRODUCTION

Type 2 diabetes (T2D) is a major public health problem in Saudi Arabia. The age-adjusted prevalence of diabetes among Saudi adults aged 30–70 years was estimated in a national epidemiological study at approximately 22%, with close to 30% of the patients with diabetes unaware of having diabetes.[1] Furthermore, the burden of diabetes in Saudi Arabia is 2–3-fold higher than the global average (8.5%–8.8%) and is the highest among all Middle Eastern and North African counties.[2,3] This high burden was translated into 5-fold increase in the Saudi health-care expenditures on diabetic care over the last two decades.[4] The economic impact is expected to further increase as the burden of diabetes in Saudi Arabia is expected to considerably increase over the next decades forced by the high prevalence of diabetes risk factors such as obesity and smoking among Saudi adults.[5]

T2D is a complex chronic disease that requires continuous medical care targeting multiple risk factors to prevent diabetic complications.[6] Adequate glycemic control is a key element in diabetic care and has been shown to effectively delay the onset of diabetic complications such as retinopathy, nephropathy, and neuropathy or at least slows their progression.[7,8] Similarly, concomitant control of comorbid cardiovascular risk factors

Address for correspondence: Mr. Yacoub Abuzied, Department of Nursing, King Fahad Medical City, Riyadh, Saudi Arabia. E-mail: yabuzied@kfmc.med.sa

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such as hypertension and dyslipidemia can significantly reduce the risk of cardiovascular complications even more than nondiabetic patients.[9,10]

Similar to other countries,[11] the majority of nonemergency diabetic care in Saudi Arabia is performed at the primary care setting. Actually, 30% of Saudi patients seen by primary care physician are patients with diabetes.[12] Nevertheless, a number of local studies showed inadequate quality of diabetic care at the primary care setting involving different levels such as structure, resources, function, and outcome.[13-15] In addition, a number of local studies showed generally suboptimal control of patients with T2D at primary care setting when checked against the clinical goals set by the American Diabetic Association (ADA) and other similar bodies.[16-20] Although the achievement of one or more goals has been evaluated in these studies, data on concomitant control of both glycaemia and cardiovascular risk factors were very limited.[16,19] Moreover, none of the above studies showed the correlations between multiple target controls. The aim of this study was to assess the degree of achieving glycemic control and concomitant control of cardiovascular risk factors among patients with T2D attending primary care services.

METHODS
Population
This study was conducted at the Family Medicine clinics at King Fahad Medical City (KFMC) in Riyadh, Saudi Arabia. KFMC comprises eight hospitals and centers with a total bed capacity of 1200 beds. Family Medicine clinics serve as an outpatient unit for the purpose of screening and managing patients at the primary care level. The clinics are equipped with X-ray room, pharmacy, and laboratory. Local statistics showed that Family Medicine clinics are serving approximately 2000 patients with T2D every year. They are managed mainly by Family Medicine physicians, nurses, dieticians, and health educators.

Eligibility
Male and female adult patients above the age of 18 years who were diagnosed with T2D were included in the study. The included patients had to receive primary care services at Family Medicine clinics at KFMC for at least a year and had at least one visit over the year preceding the start of the study. The exclusion criteria of the study included patients with type 1 diabetes or gestational diabetes and patients with disorders that affect the accuracy of glycated hemoglobin (HbA1c) reading such as sickle cell anemia, history of recent acute blood loss, or end-stage renal disease. In addition, those with missing HbA1c measures or missing large amount of data were excluded in the study.

Study design
A retrospective design was used between February and March 2017 for data collection, through reviewing the patients' charts and laboratory records. The study was approved by the Research Committee at KFMC.

Data collection
Trained nurse collected the data using a structured study data collection form, which included questions on sociodemographic characteristics, clinical characteristics, comorbidity, duration of diabetes, use of diabetic medications, attended clinic visits, glycemic control, control of blood pressure, control of blood lipids, lifestyle behaviors including diet control and exercise, and received health education. The study data collection form was reviewed by two family physicians expert in diabetic care and research for feedback and modification (i.e., face validity). A pilot study was conducted on 10 patients' charts to test the logistics and applicability of the data collection.

Outcome definition
The main study outcome was the percentage of patients who met the ADA goal for glycemic control (HbA1c <7%). In addition, the recommended number of HbA1c testing over the year preceding the start of the study was at least twice a year in patients who are meeting treatment goals and quarterly in patients who are not meeting glycemic goals. Other outcomes included control of blood pressure and blood lipids. Controlled blood pressure was defined as systolic and diastolic blood pressures <140 and <90 mm Hg, respectively. If the patient was young age (<40 years) or had hypertension with one or more additional atherosclerotic cardiovascular disease risk factors, the goal was systolic and diastolic blood pressures <140 and <90 mm Hg, respectively. Controlled blood lipids were defined as total cholesterol <5.17 mmol/L (200 mg/dL), low-density lipoprotein (LDL) cholesterol <2.6 mmol/L (100 mg/dL), high-density lipoprotein (HDL) cholesterol >1.03 mmol/L (40 mg/dL) in men and >1.29 mmol/L (50 mg/dL) in women, and triglycerides <1.69 mmol/L (150 mg/dL). In case of multiple measurements of HbA1c, blood pressure, and blood lipids, the most recent value was recorded. Diet control was defined as following ADA dietary recommendations, including energy-balanced diet, rich in nutrients, and low in high-glycemic carbohydrates and fat.

Statistical methods
Data were presented as mean and standard deviation (SD) for continuous variables and frequency and percentages for categorical variables. The univariate associations between glycemic control and potential associates were examined. The chi-squared or Fisher's exact tests, as appropriate, were used to compare the significant differences in categorical data, whereas the t-test or Mann–Whitney U test, as appropriate, were used to compare the significant differences in continuous data. To identify independent predictors of glycemic control, a multivariate binary

logistic regression model was run with stepwise backward elimination. Glycemic control was used as an outcome, whereas the patient sociodemographic, clinical, and other characteristics were used as potential predictors. All *P* values were two-tailed. A value of *P* < 0.05 was considered to be significant. All statistical analyses were performed using Statistical Package for the Social Sciences software version 23.0 (IBM, Armonk, NY).

RESULTS

Of 275 forms filled, seven were excluded from the analysis due to missing HbA1c testing (*n* = 6) or large amount of missing information (*n* = 1). A total of 268 patients with T2D were included in the study. As shown in Figure 1, the distribution of HbA1c was skewed to the right with few number of patients who had extremely high HbA1c levels. Those who were meeting the ADA goal for glycemic control (<7%) were 43.7%. On the contrary, those who had high (7–8.9) and very high (≥9) HbA1c levels were 32.8% and 23.5%, respectively.

Sociodemographic characteristics of the study patients are described in Table 1. Approximately 60% of the patients were women. The mean age was 55.0 ± 10.7 years. Approximately 60.8% of the patients were between the age of 40 and 60 years and 31.0% were above the age of 60 years. The mean body mass index (BMI) was 31.8 ± 6.7 with 33.7% classified as overweight (BMI 25–29) and 55.9% classified as obese (BMI ≥30). The most common level of education was college or graduate (45.2%), followed by secondary education (37.2%) and below secondary education (17.6%). The majority of the patients were married (68.7%) and had Saudi nationality (82%). The residence was slight more urban (54.9%) than rural (45.1%). Approximately 10.7% of the patients were smokers. Comparing sociodemographic characteristics by the status of glycemic control, glycemic control was significantly associated with nonsmoking (*P* = 0.011).
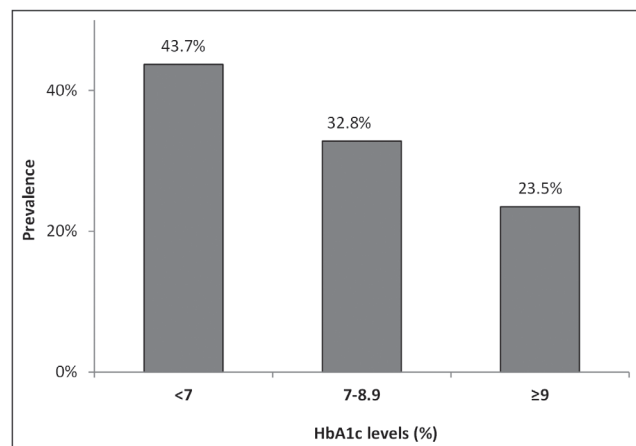
As shown in Table 2, the average blood pressure was 133.9 ± 19.8 mm Hg for systolic and 73.9 ± 12.7 mm Hg for diastolic, with 45.5% of the patients who had history of hypertension. The average blood lipids were 4.21 ± 0.89 mmol/L for total cholesterol, 3.27 ± 10.70 mmol/L for LDL cholesterol, 1.19 ± 0.33 mmol/L for HDL cholesterol, and 1.50 ± 0.75 mmol/L for triglycerides, with 35.4% of the patients who had history of dyslipidemia. Of six commonly recognized cardiovascular risk factors, the patients had on average 4.0 ± 0.9 risk factors. The average duration of diabetes was 7.5 ± 5.0 years, with 27.1% of the patients who had diabetes for 10 years or more. The most common diabetic complication was macrovascular complications (11.2%), with only 1.1% having one or more of all other complications. Approximately 93.3% of the patients were on diabetic medications, with oral hypoglycemic agents are the most common (87.3%) followed by insulin (21.6%). Among those who were using oral hypoglycemic agents, metformin was the most common agent (91.9%) followed by sitagliptin (36.3%), gliclazide (23.5%), and glyburide (1.7%). The average number of attended clinic visits over the last year was 5.07 ± 2.25 visits, whereas the average number of missed clinic visits over the last year was 0.58 ± 0.95 visits. Comparing clinical characteristics and diabetic care by the status of glycemic control, glycemic control was positively associated with high HDL cholesterol (*P* = 0.024), low triglycerides (*P* = 0.013), and smaller number of cardiovascular risk factors (*P* = 0.025) but negatively associated with using insulin (*P* < 0.001) and certain oral hypoglycemic agents such as sitagliptin and gliclazide (*P* < 0.001 for each).

As shown in Table 3, those who were meeting ADA-recommended diabetic care goals were 46.7% for blood pressure, 87.9% for total cholesterol, 52.7% for LDL cholesterol, 44.7% for HDL cholesterol, 70.8% for triglycerides, 20.1% for the four blood lipids combined, 9.4% for diet control, 1.9% for practicing exercises, 98.1% for receiving health education, and finally 38.8% for the recommended number of HbA1c testing. Among these goals, glycemic control was significantly associated with controlled triglycerides level (*P* = 0.039), diet control (*P* = 0.010), and sufficient number of HbA1c testing (*P* < 0.001). As shown in Figure 2, the number of patients who met multiple ADA-recommended diabetic care goals was smaller than those who met individual goals. For example, only 9.4% of the patients had both glycemic and blood lipid control, whereas even lower percentage (4.9%) had glycemic, blood lipids, and blood pressure control.

The findings of multivariate logistic regression analysis of potential predictors of glycemic control are shown in Table 4. After adjusting for sociodemographic, clinical, and diabetic care factors that showed significant (*P* < 0.05) or trend of significance (*P* < 0.010) with glycemic control in univariate analysis (as shown in Tables 1 through 3), the use of oral hypoglycemic agents only (odds ratio

Figure 1: Distribution of HbA1c among the examined patients.

Table 1: Sociodemographic characteristics by the status of glycemic control

	Glycemic control		Total	P value
	No (HbA1c ≥ 7)	Yes (HbA1c < 7)		
Age (years)				
Mean ± SD	55.7 ± 10.6	54.2 ± 10.9	55.0 ± 10.7	0.264
<40	11 (7.3%)	11 (9.4%)	22 (8.2%)	0.620
40–60	90 (59.6%)	73 (62.4%)	163 (60.8%)	
>60	50 (33.1%)	33 (28.2%)	83 (31.0%)	
Sex				
Male	68 (45.3%)	40 (34.2%)	108 (40.4%)	0.066
Female	82 (54.7%)	77 (65.8%)	159 (59.6%)	
Weight (kg)	82.8 ± 16.1	80.6 ± 17.8	81.8 ± 16.8	0.301
Height (cm)	161.2 ± 9.4	160.1 ± 7.9	160.8 ± 8.8	0.317
BMI				
Mean ± SD	32.0 ± 6.3	31.5 ± 7.2	31.8 ± 6.7	0.621
Normal (<25)	17 (11.6%)	10 (8.8%)	27 (10.4%)	0.208
Overweight (25–29)	43 (29.3%)	45 (39.5%)	88 (33.7%)	
Obese (≥30)	87 (59.2%)	59 (51.8%)	146 (55.9%)	
Educational level				
Below secondary education	27 (18.4%)	19 (16.7%)	46 (17.6%)	0.644
Secondary education	51 (34.7%)	46 (40.4%)	97 (37.2%)	
College or graduate	69 (46.9%)	49 (43.0%)	118 (45.2%)	
Marital status				
Married	102 (69.4%)	78 (67.8%)	180 (68.7%)	0.786
Single	18 (12.2%)	14 (12.2%)	32 (12.2%)	
Divorced	24 (16.3%)	18 (15.7%)	42 (16.0%)	
Widow	3 (2.0%)	5 (4.3%)	8 (3.1%)	
Nationality				
Saudi	128 (85.3%)	91 (77.8%)	219 (82.0%)	0.111
Non-Saudi	22 (14.7%)	26 (22.2%)	48 (18.0%)	
Residence				
Urban	78 (54.9%)	62 (54.9%)	140 (54.9%)	0.992
Rural	64 (45.1%)	51 (45.1%)	115 (45.1%)	
Smoking				
No	125 (85.0%)	109 (94.8%)	234 (89.3%)	0.011
Yes	22 (15.0%)	6 (5.2%)	28 (10.7%)	

HbA1c = glycated hemoglobin (%)

Data are presented as number and percentage unless otherwise specified

[OR] = 4.49, $P = 0.009$) and diet control (OR = 5.32, $P = 0.016$) were independently associated with glycemic control. On the contrary, smoking (OR = 0.27, $P = 0.017$), use of sitagliptin (OR = 0.25, $P < 0.001$), and use of gliclazide (OR = 0.23, $P = 0.001$) were independently associated with lack of glycemic control.

DISCUSSION

We are reporting suboptimal glycemic control among a sample of patients with T2D managed at a primary care center in Saudi Arabia. Only 43.7% of the patients achieved the ADA-recommended level of HbA1c (<7%). Despite the non-doubtful evidence of clear benefits[7,8] and the presence of achievable guidelines,[6] glycemic control is still suboptimal or even poor at primary care setting in several countries around the world, including Saudi Arabia. For example, glycemic control that is defined mainly as HbA1c < 7% ranged between 18% and 27.5% in previous studies carried out in primary care setting in Saudi Arabia.[16-22] Similarly, the prevalence of glycemic control was usually less than 20% and at best 35% in Gulf[23-25] and other Arab countries.[26,27] Even in Western countries where better resources and use of primary care services are observed, glycemic control ranged between 40% and 50%.[28-30] It has been suggested that both patient factors such as compliance and comorbidity and health-care factors such as use and communication may contribute to this suboptimal glycemic control.[31,32]

Although suboptimal, the glycemic control level achieved in this study was much better than the levels achieved in previous studies carried out in primary care setting in Saudi Arabia.[16-22] In addition, those who had very poor glycemic control defined as HbA1c>9%-9.5% were lower in this study (23.5%) compared with previous local

Table 2: Clinical characteristics and diabetic care by the status of glycemic control

	Glycemic control		Total	P value
	No (HbA1c ≥ 7)	Yes (HbA1c < 7)		
Blood pressure (mean ± SD)				
Systolic (mm Hg)	135.4 ± 20.3	132.0 ± 18.9	133.9 ± 19.8	0.178
Diastolic (mm Hg)	74.0 ± 12.0	73.7 ± 13.6	73.9 ± 12.7	0.864
Blood lipids (mean ± SD)[a]				
Total cholesterol (mmol/L)	4.21 ± 0.87	4.21 ± 0.91	4.21 ± 0.89	0.908
LDL cholesterol (mmol/L)	3.79 ± 14.23	2.60 ± 0.82	3.27 ± 10.70	0.602
HDL cholesterol (mmol/L)	1.16 ± 0.32	1.23 ± 0.33	1.19 ± 0.33	0.024
Triglycerides (mmol/L)	1.57 ± 0.77	1.40 ± 0.72	1.50 ± 0.75	0.013
Medical history				
Hypertension	67 (44.4%)	55 (47.0%)	122 (45.5%)	0.667
Dyslipidemia	56 (37.1%)	39 (33.3%)	95 (35.4%)	0.524
Asthma	7 (4.6%)	5 (4.3%)	12 (4.5%)	0.887
Cardiovascular risk factors				
Age >40 (years)	140 (92.7%)	106 (90.6%)	246 (91.8%)	0.531
Obesity	87 (59.2%)	59 (51.8%)	146 (55.9%)	0.230
Hypertension[b]	103 (68.2%)	76 (65.0%)	179 (66.8%)	0.575
High LDL or low HDL cholesterol	115 (77.2%)	88 (76.5%)	203 (76.9%)	0.900
Physical inactivity	149 (99.3%)	112 (96.6%)	261 (98.1%)	0.171
Smoking	22 (15.0%)	6 (5.2%)	28 (10.7%)	0.011
Number of risk factors (mean ± SD)	4.1 ± 0.9	3.8 ± 1.0	4.0 ± 0.9	0.025
Duration of diabetes				
Mean ± SD	7.8 ± 5.2	7.1 ± 4.8	7.5 ± 5.0	0.266
<5 years	47 (32.6%)	39 (35.1%)	86 (33.7%)	0.831
5–9 years	56 (38.9%)	44 (39.6%)	100 (39.2%)	
≥10 years	41 (28.5%)	28 (25.2%)	69 (27.1%)	
Diabetic complications				
Macrovascular complications	19 (12.6%)	11 (9.4%)	30 (11.2%)	0.413
Neuropathy	2 (1.3%)	0 (0.0%)	2 (0.7%)	0.506
Acute complications	1 (0.7%)	0 (0.0%)	1 (0.4%)	>0.900
Nephropathy	1 (0.7%)	0 (0.0%)	1 (0.4%)	>0.900
Retinopathy	0 (0.0%)	0 (0.0%)	0 (0.0%)	–
Type of diabetic medications				
None	11 (7.3%)	7 (6.0%)	18 (6.7%)	<0.001
Oral hypoglycemic agent only	90 (59.6%)	102 (87.2%)	192 (71.6%)	
Insulin only	13 (8.6%)	3 (2.6%)	16 (6.0%)	
Both	37 (24.5%)	5 (4.3%)	42 (15.7%)	
Oral hypoglycemic agents				
Metformin	116 (91.3%)	99 (92.5%)	215 (91.9%)	0.741
Sitagliptin	63 (49.6%)	22 (20.6%)	85 (36.3%)	<0.001
Gliclazide	44 (34.6%)	11 (10.3%)	55 (23.5%)	<0.001
Glyburide	4 (3.1%)	0 (0.0%)	4 (1.7%)	0.127
Attended clinic visits over the last year				
Mean ± SD	4.92 ± 2.16	5.25 ± 2.36	5.07 ± 2.25	0.242
<6 visits	89 (61.8%)	65 (57.0%)	154 (59.7%)	0.436
≥6 visits	55 (38.2%)	49 (43.0%)	104 (40.3%)	
Missed clinic visits last year (mean ± SD)	0.61 ± 1.01	0.54 ± 0.86	0.58 ± 0.95	0.572

ADA = American diabetic association, HbA1c = glycated hemoglobin (%), LDL = low-density lipoprotein, HDL = high-density lipoprotein

Data are presented as number and percentage unless otherwise specified

[a]P values were based on non-parametric tests

[b]Hypertension diagnosis was based on history and/or blood pressure measurement

studies (28.5% to 50.0%).[16,19,22] It is difficult to explain the observed difference in glycemic control due to lack of comparable information for several important care items such as the patient adherence, severity of the disease, and service use. However, the observed difference may reflect a better patient profile or better diabetic care at

Table 3: Status of ADA diabetic care goals by the status of glycemic control

	Glycemic control		Total	P value
	No (HbA1c ≥ 7)	Yes (HbA1c < 7)		
Blood pressure				
<140/90 (mm Hg)	78 (53.4%)	68 (61.3%)	146 (56.8%)	0.178
<130/80 (mm Hg)	45 (30.8%)	46 (41.4%)	91 (35.4%)	0.864
Control of blood pressure				
No	82 (56.2%)	55 (49.5%)	137 (53.3%)	0.292
Yes (<130/80 or <140/90 mm Hg)[a]	64 (43.8%)	56 (50.5%)	120 (46.7%)	
Control of total cholesterol				
No (≥5.17 mmol/L)	17 (11.4%)	15 (13.0%)	32 (12.1%)	0.687
Yes (<5.17 mmol/L)	132 (88.6%)	100 (87.0%)	232 (87.9%)	
Control of LDL cholesterol				
No (≥2.6 mmol/L)	72 (48.3%)	53 (46.1%)	125 (47.3%)	0.718
Yes (<2.6 mmol/L)	77 (51.7%)	62 (53.9%)	139 (52.7%)	
Control of HDL cholesterol				
No (≤1.29/1.03 mmol/L for men/women)	87 (58.8%)	58 (50.9%)	145 (55.3%)	0.202
Yes (>1.29/1.03 mmol/L for men/women)	61 (41.2%)	56 (49.1%)	117 (44.7%)	
Control of triglycerides				
No (≥1.69 mmol/L)	51 (34.2%)	26 (22.6%)	77 (29.2%)	0.039
Yes (<1.69 mmol/L)	98 (65.8%)	89 (77.4%)	187 (70.8%)	
Overall control of blood lipids				
No	121 (81.2%)	90 (78.3%)	211 (79.9%)	0.553
Yes	28 (18.8%)	25 (21.7%)	53 (20.1%)	
Diet control				
No	142 (94.7%)	99 (85.3%)	241 (90.6%)	0.010
Yes	8 (5.3%)	17 (14.7%)	25 (9.4%)	
Practicing exercise				
No	149 (99.3%)	112 (96.6%)	261 (98.1%)	0.171
Yes	1 (0.7%)	4 (3.4%)	5 (1.9%)	
Received health education				
No	1 (0.7%)	4 (3.5%)	5 (1.9%)	0.171
Yes	148 (99.3%)	111 (96.5%)	259 (98.1%)	
Number of HbA1c testing a year				
<2	54 (35.8%)	24 (20.5%)	78 (29.1%)	0.016
2–3	86 (57.0%)	86 (73.5%)	172 (64.2%)	
≥4	11 (7.3%)	7 (6.0%)	18 (6.7%)	
Sufficient HbA1c testing				
No	140 (92.7%)	24 (20.5%)	164 (61.2%)	<0.001
Yes (2 or 4 per year)[b]	11 (7.3%)	93 (79.5%)	104 (38.8%)	

HbA1c = glycated hemoglobin (%), LDL = low-density lipoprotein, HDL = high-density lipoprotein

Data are presented as number and percentage

[a]On the basis of age and the presence of other cardiovascular risk factors

[b]On the basis of the status of meeting treatment goals for HbA1c (<7%)

the currently examined primary care center compared with previous local studies. For example, our patients had shorter duration of diabetes compared with previous local studies: 7.5 vs. 8.3–11.8 years.[18,19,22] Similarly, our patients had less than 1% neuropathy/nephropathy complications compared with 12%–17% in previous studies.[22] In addition, our patients had on average five completed visits and less than one missed visit over the last year, which is better than reported before.[13,16] Nevertheless, we did not find better adherence with glycemic control monit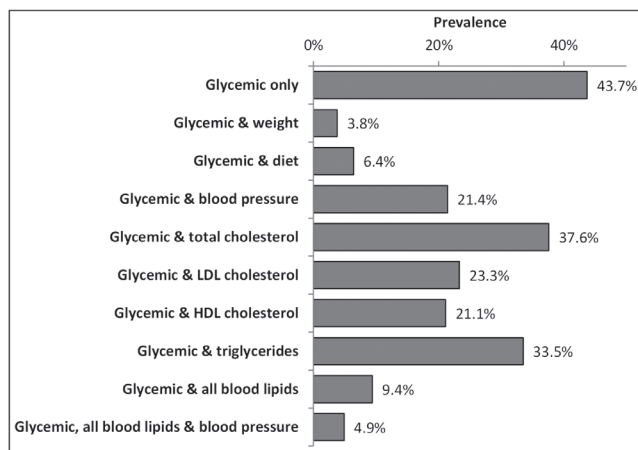oring. For example, 64.2% of our patients assessed HbA1c at least twice a year compared with 58.6%–68.7% in previous local studies.[13,16]

Glycemic control in this study was independently associated with the type of diabetic medications, diet control, and nonsmoking. Poor glycemic control among our patients taking insulin alone or combined with oral hypoglycemic agents is expected, as insulin is usually prescribed to patients with T2D who are not achieving glycemic goals with oral hypoglycemic agents only.[6] Similarly, poor glycemic control among our patients taking

sitagliptin and gliclazide can be explained by the fact that 83% of sitagliptin or gliclazide use in our study with uncontrolled diabetes with metformin alone. Concurring with the current finding, insulin use and combined therapy as well as noncompliance with recommended diet control, exercise, and smoking cessation have been identified in previous local studies as predictors of poor glycemic control in primary care setting.[33-35] Therefore, the suboptimal glycemic control observed in this study may be partially attributed to the very low compliance rates of diet control and physical activity. On the contrary, obesity was not associated with glycemic control in this study in neither univariate nor multivariate analysis. Such association was not consistent in previous studies[36,37] and may have been masked by the fact that close to 90% of our patients were either obese or overweight. Smoking in this study was slightly lower than the national average (10.7% vs. 12.2%)[38] and as expected it was an independent predictor for poor glycemic control.

Figure 2: Prevalence of patients meeting the recommended goals for multiple diabetic care items including glycemic control. LDL = low-density lipoprotein, HDL = high-density lipoprotein.

Less than half (46.7%) of our patients were able to control their blood pressure as per ADA recommendations. Although suboptimal, this was better than previous studies performed in primary care setting in Saudi Arabia, where 16%–32% of their patients had blood pressure less than 130/80 mm Hg and 39% had blood pressure less than 140/90 mm Hg.[16-19] Interestingly, none of the above studies calculated the compliance with blood pressure recommendations using both cut points (130/80 and 140/90) taking in consideration the patient age and the presence of other cardiovascular risk factors.[6] The control of blood lipids in this study was best for total cholesterol (88.6%), followed by triglycerides (70.8%), and finally LDL and HDL cholesterol (44.7% and 52.7%, respectively). However, only 20.1% of our patients were able to control the four components of blood lipids. It is difficult to compare the current finding with previous studies performed in primary care setting in Saudi Arabia as few studies reported the four components[16] and none actually reported the concomitant control of the four components. However, the current finding is generally comparable or slightly better than sporadically reported blood lipid components in these studies.[16-19]

Despite the clear benefit of concomitant control of comorbid cardiovascular risk factors,[9,10] only a small proportion of our patients were able to achieve glycemic control in addition to controlled blood pressure and/or blood lipids. For example, only 21.3% additionally controlled blood pressure, 9.4% additionally controlled blood lipids, and 4.9% additionally controlled both. Although multiple target control is expected to be lower than individual target control, the very low concomitant control figures may reflect the fact that control of blood pressure and blood lipids in this study (with the exception of triglycerides) was not significantly associated with glycemic control. This may also indicate

Table 4: Multivariate logistic regression analysis of potential predictors[a] of glycemic control				
	Odds ratio	95% confidence interval		*P* value
		Lower	Upper	
Type of diabetic medications				
Oral hypoglycemic agents only	4.49	1.46	13.80	0.009
Insulin only	0.53	0.10	2.76	0.447
Both	0.26	0.05	1.27	0.095
Use of sitagliptin	0.25	0.13	0.51	<0.001
Use of gliclazide	0.23	0.10	0.54	0.001
Number of HbA1c testing a year				
2–3 vs. once	1.89	0.94	3.82	0.074
≥4 vs. once	0.32	0.06	1.65	0.174
Diet control	5.32	1.37	20.63	0.016
Smoking	0.27	0.10	0.79	0.017

HbA1c = glycated hemoglobin (%), HDL = high-density lipoprotein

[a]Adjusted for age, sex, HDL cholesterol, triglycerides, type of diabetic medications, use of sit gliptin, use of gliclazide, number of cardiovascular risk factors, number of HbA1c testing last year, smoking, and diet control

that concomitant control of comorbid cardiovascular risk factors is performed sporadically rather than systematically. In addition, the control of triglycerides and HDL has been shown to be beneficial only in men, who represented approximately 40% of our patients. Similar finding has been reported by the few local studies that reported multiple target control.[16,19] For example, only 4.5%–7.2% of the patients with T2D attending primary care service in Saudi Arabia were able to achieve concomitant control for glycaemia, blood pressure, and LDL/blood lipids.[16,19] The finding reconfirms the challenge faced by diabetic care physician in real setting to meet the recommended guidelines.[39] Several diabetic care strategies have been suggested to improve the compliance with recommended diabetic care goals, such as integrated care approach,[40] intensified educational programs,[41] organizational support, and computerized tracking systems.[42]

Practical strategies aimed at more effective management of T2D patients are strongly needed. Programs that both motivate patients to make the important lifestyle modifications need to be initiated and further research is required to better understand the responsible system barriers and strategies to improve.

This study filled an important gap about the concomitant control of multiple diabetic care goals at primary care setting in Saudi Arabia. In addition, the use of standardized definition can facilitate the comparisons with future studies. Nevertheless, few limitations are acknowledged; being a single-center study, the findings should be generalized cautiously. The retrospective design and the self-reported compliance may introduce some sort of information bias. Such limitations can be avoided by conducting multisite prospective studies.

In conclusion, we are reporting suboptimal control of glycaemia and comorbid cardiovascular risk factors among a sample of patients with T2D managed at a primary care center in Saudi Arabia. The concomitant control of multiple diabetic care goals is alarmingly low. Further research is required to better understand the responsible system barriers and strategies to improve.

Conflicts of interest
The authors disclosed no potential conflicts of interest related to this article.

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