Pattern and predictors of glycemic control among type 2 diabetics in Armed Forces Hospital of Jizan, southwestern Saudi Arabia

Hassan A. Abdelwahid (1)
Saud M. Erwi (2)
Firas S. Alahmari (2)
Amany A. Koteb (3)
Hesham M. Dahlan (1)

(1) Consultant family medicine, Armed Forces Hospital of Jizan (AFHJ)
(2) Consultant internal medicine, AFHJ;
(3) Senior registrar family medicine, AFHJ.

Correspondence:
Dr. Hassan Ali Abdelwahid, Consultant of Family Medicine,
Armed Forces Hospital of Jizan,
PO 45911, Jizan,
Kingdom of Saudi Arabia;
and Professor of Family Medicine,
Suez Canal University.
Tel. +966 543075421; 0021093159111
Email: hassan22220000@yahoo.com

Abstract

Objectives: To assess pattern and predictors of glycemic control among type 2 diabetics based on glycosylated hemoglobin (HbA1c) and fasting plasma glucose (FPG).

Methods: This cross sectional study was performed at Family Medicine and internal medicine departments, Armed Forces Hospital of Jizan (AFHJ), Saudi Arabia. The field work was conducted during the period of July 2016 to August 2016. A sample size of 78 type 2 diabetics was calculated and selected randomly from the study population. The Socio-demographic and clinical data were collected using structured questionnaires. Also, FPG, HbA1c, total Cholesterol, Low Density Lipoprotein (LDL), High Density Lipoprotein (HDL), serum Triglycerides (TG) and renal function tests (serum urea and creatinine) were assessed using the appropriate kits.

Results: The total number of males was 37 (47.4%) and that of females was 41(52.6%). Their age ranged from 22-90 with a mean of 54.6±13 years. The mean of HbA1c was 8.79±2.17 gm % and that FPG was 180.64±42.27mg/dL. More than two thirds of the patients in the present study were poorly controlled. HbA1c target, <7 gm%, was detected only in 24.4 % (19/78). FPG, HDL and duration of diabetes were the only significant independent predictors of HbA1c in the present study.

Conclusion: Poor glycemic control and atherogenic lipid profile are highly prevalent among the study group necessitating aggressive screening and treatment for dyslipidemia, and appropriate management of diabetes.

Key words: Type 2 Diabetes mellitus, Glycemic control, Predictors, Glycosylated hemoglobin, Low-density lipoprotein, High-density lipoprotein, Triglycerides

Introduction

Diabetes mellitus, DM, is a chronic debilitating disease that has a serious complication if uncontrolled. Globally, its prevalence estimates indicate that it is approaching epidemic proportions.(1) It was considered a disease of minor significance to world health, now it is considered as one the main threats to human health in the 21st century.(2)

Worldwide, in 2014, it was estimated that almost 422 million people suffer from diabetes with a prevalence of 8.5 %.(3) The burden of the disease is expected to increase to 642 million by 2040. Diabetes caused 5 million deaths in 2015and it is estimated that every six seconds a person dies from diabetes. (1) The Kingdom of Saudi Arabia is not an exception because the prevalence of DM has been increased from 2.5% in 1982 to 23.7%(4) in 2004 due to the westernization of life habits and increased urbanization. (5) The long term microvascular and macrovascular complications are also highly prevalent among Saudi diabetics. (6)

Glycemic control is one of the primary goals of diabetes management because it is well established that improved glycemic control delays the onset and retards the progression of microvascular and macrovascular complications. (7) Glycemic control in type 2 diabetes (DM2) patients can be assessed by three parameters: glycosylated hemoglobin (HbA1c), fasting plasma glucose (FPG) and postprandial glucose (PPG). However HbA1c is the gold standard for assessing glycemic control. Acute glucose fluctuations could also be involved in the pathogenesis of chronic complications in type 2 diabetes and the treatment decisions should not be based only on HbA1c, but should also take into account glycemic variability. (8) The cutoff point of HbA1c for satisfactory diabetic control is 7% for the American Diabetes Association (ADA) and 6.5% for the American College of Endocrinologists. Regarding fasting blood glucose, recommended goals are within a range of 70-130 mg/dl (3.9-7.2 mmol/l) for the American Diabetes Association and at <110 mg/dl (6.1 mmol/l) and 100 mg/dl (5.5 mmol/l) for the American College of Endocrinologists and the International Diabetes Federation. The postprandial glucose threshold values are <180 mg/dl (American Diabetes Association) and <140 for American College of Endocrinologists and the International Diabetes Federation. Because of these large discrepancies that are observed in the guidelines regarding the thresholds of glycemic control, the ADA recommendations will be used in the present study. (9)

Despite available health services, glycemic control is poor in the kingdom. The results of an interesting study that was conducted on all patients attending the diabetic clinic of King Khalid National Guard Hospital in Jeddah showed that glycemic control was good in, only, 8.1% (HbA1C<7%), fair in 23.2% (HbA1C 7.1-8%), poor in 26.6% (HbA1C 8.1-9%) and very poor in 41.9% (HbA1C >9%).(10) In order to improve the provided care of type 2 diabetics, in Armed Forces Hospital of Jizan (AFHJ), there is an urgent need to study the pattern and predictors of glycemic control based on scientific research outcomes because there are no previous studies dealing with that topic in AFHJ.

Methods

This cross sectional study was performed at Family Medicine (FM) and internal medicine (IM) departments, Armed Forces Hospital of Jizan (AFHJ), Jizan, Saudi Arabia. Jizan is the capital city of Jizan region that lies in the southwest corner of Saudi Arabia on the Red Sea coast, just north of Yemen and has a large agricultural community. The AFHJ is a 36-bed secondary hospital that provides health care for military personnel and their families (approximately 50,000). The target population included all patients eligible for medical care in AFHJ and the study population consisted of type 2 diabetics attending FM and IM outpatient clinics that are affiliated to AFHJ.

A sample size of 78 was calculated (11) from the study population with an estimated prevalence of diabetes to be 25% (from a previous study)(12), 95% confidence coefficient, 10% confidence interval, and 5% non-response rate. Systematic random sampling method was used in which every 3rd patient, according to their order of attendance at the reception desk, presenting to the FM and IM clinics for care, was included in the study.

The inclusion criteria were:
1) Type 2 diabetics,
2) age ≥ 18 years;
3) eligibility for medical care in AFHJ; and
4) Informed consent to participate in the study.

The exclusion criteria included:
1) Patients with type 1 diabetes mellitus;
2) those for whom the study procedures would not be feasible due to severe dementia, history suggestive of mental retardation, or unstable medical condition; and
3) female patients with gestational diabetes.

The field work was conducted, after we obtained the ethical approval from the hospital Research and Ethics committee, from July 2016 to end of August 2016 and the study was completed in October 2016. The operational design of the present study included the following steps:

1) Verbal and written consent was obtained from the participants by trained Saudi nurses for better communications;
2) the Socio-demographic data were, also, collected by trained Saudi nurses using pre-designed structured questionnaire that was constructed by the researchers to collect data about patients' characteristics e.g. age, gender, nationality, marital status, number of children if any, housing, income, occupation, education level and family size. The socio-demographic data and patients' consent were collected before the doctor consultation.;
3) Important clinical data were collected during the doctor consultation by the researchers, using a predesigned structured questionnaire, e.g. duration of DM, type of

medication, family history, the presence of diabetic complications, height, weight, BMI, blood pressure, etc.; and

4) Venous blood samples were collected from all the participants after at least 8 hours of overnight fasting. Fasting plasma glucose (FPG), glycosylated hemoglobin (HbA1C), total Cholesterol (TC) , Low Density Lipoprotein (LD), High Density Lipoprotein (HDL), serum Triglycerides (TG)) and renal function tests (serum urea and creatinine) were assessed using the appropriate kits in the hospital laboratory.

The following ethical points were taken into consideration based on Helsinki Declaration (13):

1) Confidentiality: the information was treated in confidence and the names of the patients could not be identified.

2) The activities of the research did not lead the patients and physicians to commit acts, which diminish their self-respect.

3) Approval of research and ethics committee to conduct the study.

4) Written consent of the participant was taken. 5) Appropriate management of patients based on the results of the comprehensive history taking, physical examination and Lab work-up.

The Statistical Package for Social Sciences (SPSS version 16.0) was used for data analysis. Descriptive statistics and appropriate significance tests were used according to types of variables. Glycosylated hemoglobin and fasting plasma glucose were compared between different categories of important baseline socioeconomic and clinical variables, using the group t-test. Pearson's bivariate correlation analysis was used to assess linear associations between HbA1c and other continuous variables, One way analysis of variance (ANOVA) was conducted to test the significance of differences in HbA1c and FPG levels in different categories of medical treatment and body mass index (BMI). Multiple linear regression analysis was computed to identify the predictors of glycemic control (HbA1c). The $p<0.05$ was considered the significance cut-off point.

Results

The study included 78 Saudi type 2 diabetics. The total number of males was 37 (47.4%) and that of females was 41(52.6%). Their age ranged from 22-90 with a mean of 54.6±13 (Table 1). The age of males (57.9±15.9) was significantly higher (t-value, 2.1 and P, 0.037) than that of females (51.7±8.9), (not illustrated in Table 1). Their BMI ranged from 21-46 with a mean of 31.6±6.14 kg/m2. The mean of HbA1c was 8.79±2.17 gm % and that FPG was 180.64±42.27mg/dL. The other biochemical findings are illustrated in Table 1.

Table 2 illustrates that the majority of the participants were married (88.5 %), living in rural areas (83.3%) and had nuclear families (75.6%). Positive family history of diabetes (56.4%) and present history of hypertension (64.1%) were, also, highly prevalent among the study group. Most of the patients were illiterate (n=46, 59.0 %) and not working (Housewife or retired Male, n=59, 75.6%). Glycosylated hemoglobin and fasting plasma glucose were compared between different categories of important baseline socioeconomic and clinical variables, using the group t-test. The results showed that there were no significant differences between different categories of all variables that are listed in Table 2. Pearson's bivariate correlation analysis was used to study the significance of linear associations between HbA1c and other continuous variables (results are not presented in Table 2). The results showed that HbA1c was significantly correlated with diabetes duration (r=0. 338, P=0.002), FPG (r=0.704, P=0.000), total cholesterol (r=0.311 P=0.006), Low Density Lipoprotein (r=0.354, P=0.001), and High Density Lipoprotein (r= -0.278, P=0.014). On the other hand there were no significant linear associations between HbA1c and other continuous variables like age of patients, serum triglycerides, serum urea, serum creatinine, BMI, and blood pressure (systolic and diastolic blood pressure).

The type 2 diabetics, n=78, were classified according to types of medical treatment into 3 subgroups: group 1 received insulin secretagogues or sensitizer, n= 24 (30.8%); group 2 received insulin secretagogues and sensitizer, n= 34 patient (43.6%); and group 3 was managed by Insulin ± oral hypoglycemic, n= 20 (25.6%). There were no significant differences between different categories of medical treatment by one way ANOVA. Also there is insignificant difference between different BMI categories regarding HbA1c and FPG as illustrated in Table 3.

The following independent variables were subjected to the multiple linear regression analysis with HbA1c as a dependent variable and FPG, TC, LDL, HDL and duration of diabetes as independent variables. Table 4 illustrates that FPG, HDL and duration of diabetes were the only significant independent predictors of HbA1c in the present study.

The standard targets of HbA1c, FPG were detected in 24.4 % (19/78), and 28.2% (22/78) respectively. Also, the target of total cholesterol, LDL, HDL and TG were observed in 66.7% (52/78), 46.2% (36/78), 50 % (39/78) and 71.8% (56/78), respectively, as illustrated in Figure 1.

Table 1: Baseline characteristics of the study group (n, 78)

	Minimum	Maximum	Mean	SD▼
Age in years	22.00	90.00	54.64	13.05
Duration of diabetes (years)	0.16	30.00	7.48	7.08
Systolic blood pressure	100.00	175.00	131.27	14.59
Diastolic blood pressure	60.00	104.00	76.52	10.12
Body Mass index (kg/m²)	21.00	46.00	31.60	6.14
HbA1c (gm%)*	5.10	14.00	8.79	2.17
FPG (mg/dL)**	80.00	324.00	179.42	59.77
Total cholesterol (mg/dL)	108.66	271.08	180.64	42.27
LDL (mg/dL)+	41.38	247.49	111.95	40.84
HDL(mg/dL) ++	13.92	77.00	46.18	12.69
Serum triglycerides (mg/dL)	48.80	380.85	140.19	69.84
Serum Urea (mg/dL)	7.83	78.31	28.2453	12.41
Serum Creatinine (mg/dL)	0.33	2.00	0.88	0.38

▼, SD, Standard deviation; *, HbA1c, Glycosylated hemoglobin; **, FPG, Fasting plasma glucose; +, LDL, Low Density Lipoprotein; and ++, HDL, High Density Lipoprotein;.

Table 2: Glycosylated hemoglobin and fasting blood glucose levels in the different categories of socioeconomic and clinical variables

	N (%)	Glycosylated hemoglobin (gm%)▼		Fasting plasma glucose (mg/dL)▼	
		Mean	SD	Mean	SD
Sex: Male	37 (47.4)	8.80	2.37	176.23	61.21
Female	41 (52.6)	8.78	1.99	182.29	59.04
Marital status:					
Married	69 (88.5)	8.84	2.24	182.67	60.28
Unmarried♠	9 (11.5)	8.39	1.58	154.49	52.02
House type:					
Owned	63(80.8)	8.83	2.27	177.55	62.19
Rented	15 (19.2)	8.59	1.72	187.25	49.33
Family type:					
Nuclear	59 (75.6)	8.86	2.23	184.23	7.89
Extended	19 (24.4)	8.53	2.00	164.47	12.86
Source of health care:					
Governmental	67 (85.9)	8.86	2.22	182.35	7.62
Others+	11 (14.1)	8.30	1.88	161.52	11.34
Family history of diabetes:					
Positive	44 (56.4)	8.61	1.94	178.84	8.26
Negative	34 (43.6)	9.02	2.43	180.15	11.40
Smoking history:					
Smoker	9 (11.5)	9.43	2.09	183.81	17.37
Negative▲	69 (88.5)	8.70	2.17958	178.84	7.34
History of Hypertension:					
Hypertensive	50 (64.1)	8.65	1.98	175.61	57.21
Normotensive	28 (35.9)	9.03	2.49	186.21	64.59
Residency:					
Rural	65 (83.3)	8.82	2.28	179.64	62.23
Urban	13 (16.7)	8.63	1.54	178.30	47.52

▼, the P value of the independent t test > 0.05; ♠, unmarried (2 diabetics were single and 7 were widows); +, Governmental health centers, private and traditional healer/self-care; ▲, includes 48 nonsmokers (61.5%) and 21 Ex-smoker (26.9%)

Table 3: One way analysis of variance: the significance of differences in glycosylated hemoglobin and fasting blood glucose levels according to type medical treatment and BMI Category

	Glycosylated hemoglobin (gm%)▼		Fasting plasma glucose (mg/dL)▼	
	Mean	SD	Mean	SD
Type medical treatment:				
Insulin secretagogues or sensitizer[1]	8.3	2.0	164.1	55.3
Insulin secretagogues and sensitizer[2]	8.9	2.1	176.2	54.8
Combination (oral and Insulin) [3]	9.0	2.4	203.2	68.2
BMI Category:**				
Normal weight (BMI <25 kg/m², n=11)	9.8	2.5	199.9	79.7
Overweight (BMI, 25-30 kg/m² n=22)	8.8	2.5	171.7	57.0
Obese (BMI >30 kg/m² n=45)	8.6	1.9	178.2	55.8

▼, P of F ratio, >0.05; [1], n= 24 patient (30.8%); [2], n=34 patient (43.6%); [3], n=20 patient (25.6%); and **, BMI, Body Mass Index

Table 4: Predictors of glycosylated hemoglobin level among the study group

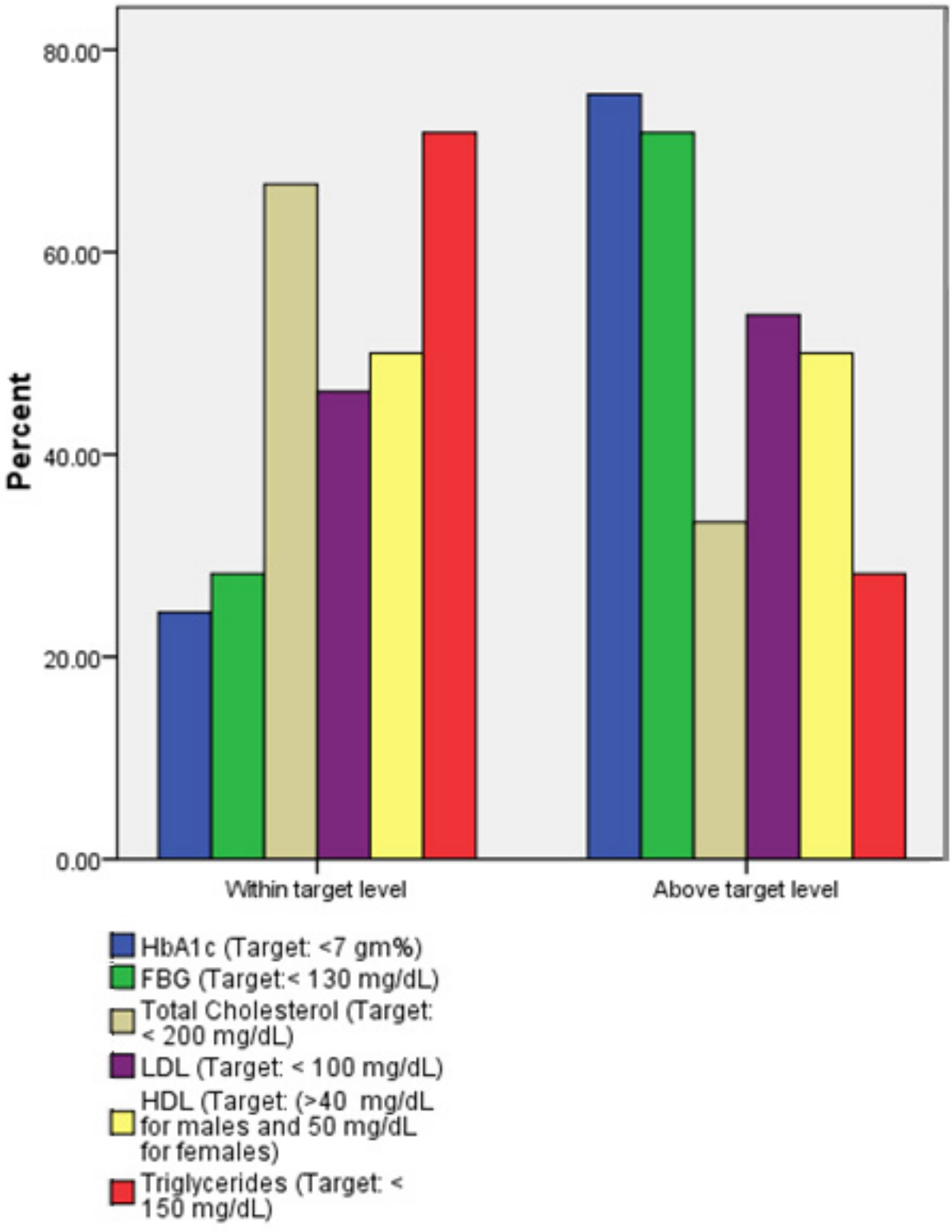
	Unstandardized Coefficients		Standardized B Coefficients	*t* value	P
	B	Std. Error			
Constant	5.433	1.017	-	5.342	0.000
Fasting blood glucose	0.021	0.003	0.568	5.960	0.000
Total Cholesterol	-0.003	0.008	-0.062	-0.377	0.708
Low Density Lipoprotein	0.011	0.008	0.198	1.262	0.211
High Density Lipoprotein	-0.030	0.014	-0.177	-2.125	0.037
Duration of Diabetes	0.060	0.025	0.197	2.408	0.019

Discussion

More than two thirds of the patients in the present study were poorly controlled with a mean of glycosylated hemoglobin of 8.79±2.17 gm %. The cutoff point for standard target of HbA1c in type 2 diabetics,< 7 gm%, was detected only in 24.4 % (19/78), a result that is consistent with a nationwide cross sectional study, in which data was collected from 28 health centers all over Kingdom of Saudi Arabia with HbA1c mean of 8.20±1.89 gm% and only 27% had reached the target HbA1c of <7 gm%.(14) In Saudi Arabia, the prevalence of poor glycemic control (AIC > 7%) among type 2 diabetics is high in the literature. For example, it was 67.7%(15) in type 2 diabetics attending the Primary Care Clinic of King Khalid University Hospital, in 2012; 67.9% in Al Hasa area of KSA(16); 76.4% in Al-Madinah(17), and 79.4% in patients attending a primary care center in Riyadh(18). So we can conclude that despite available health services , the glycemic control is poor in the kingdom. The low prevalence of good glycemic control in the present study, 24%, is consistent with the reported figures from other Gulf countries and some neighbouring Arabic countries where good glycemic control ranges from 11% to 41%.(19-24) Also, 25% of European outpatients with Type 2DM had adequate glycemic control (HbA1c < 6.5%).(25) However in Canada, the glycemic control is much better where 50% of type 2 diabetes patients had HbA1c < 7.0%,.(26) In the USA, the mean HbA1c nationally was 7.2% in 2007-2010 according to the National Health and Nutrition Examination Survey. However, 33-49% of patients still do not meet targets for glycemic, blood pressure, or cholesterol control. (27)

Obesity and overweight are important risk factors for type 2 diabetes and its glycemic control through increasing insulin resistance.(28) Unfortunately, both risk factors are highly prevalent, among type 2 diabetics in general and the participants of the present study specifically. The BMI of the study group ranged from 21-46 with a mean of 31.6±6.14 kg/m2 and prevalence rates of 28% (22/78) and 58% (45/78) for overweight and obesity respectively. Despite insignificant linear association between HbA1c and BMI, the clinical significance of overweight and obesity as risk factors for poor glycemic control cannot be excluded because of the small number of patients with normal body weight among the study group and a further study with larger sample size based on prevalence of normal weight, overweight and obesity is recommended. The same explanation can be applied to the results of bivariate analysis, where there were no significant

Figure 1: Frequency distribution of type 2 diabetes based on standard targets of glycemic control and lipoproteins (n=78)



differences between different categories of all clinical and socioeconomic variables that are listed in Table 2, like marital status, smoking and hypertension.

The bivariate analysis of the present study indicates that fasting blood glucose, total cholesterol, LDL, HDL and duration of diabetes are associated with glycemic control. However the regression model illustrates that FPG, HDL and duration of diabetes were the only significant independent predictors of HbA1c. The finding that the duration of diabetes was associated with poor control study is consistent with other studies and may be explained by deterioration of beta cell function over time. (7, 29, 30)

The significant linear associations between HbA1c and cholesterol, TG, HDL and LDL in diabetic patients, are in agreement with the findings of several other investigators who reported significant correlations between HbA1c and lipid profiles and suggested the importance of good management of diabetes in controlling dyslipidaemia (31). The stronger association of HbA1c with FBG is supported by an earlier study reporting higher correlation coefficients for HbA1c and FPG. (32) HbA1c is a measure of the degree hemoglobin glycosylation in red blood cells and is expressed as a percentage of total hemoglobin concentration.(33) It reflects the mean glycemic values in the previous 2-3 months and is an indicator for overall glucose exposure reflecting both fasting and postprandial hyperglycemia. (34-35) A number of studies have reported significant correlation between HbA1c levels and FPG and PPG level. (36) However, a clear understanding of the relationship between different plasma glucose measurements and HbA1c is necessary for achieving specific HbA1c targets.(37)

The positive linear association of HbA1c with LDL and TG; and its negative linear association with HDL can be explained by the fact that type 2 diabetes is associated with a cluster of lipid abnormalities, including reduced HDL cholesterol and elevated LDL particles and triglycerides (38), atherogenic lipid profile. These changes are also a feature of the insulin resistance syndrome which is prevalent in type 2 diabetes. Also, it was reported that efforts to reduce cardiovascular risks resulted in the improvement of HbA1c even in the absence of any specific intervention targeted at improving glycemic control (32) indicating the clinical significance of complex interactions involved in carbohydrate and lipid metabolism. The atherogenic lipid profile of the present study is consistent with other studies that were conducted in the southern region (39) of Saudi Arabia and at the national level of the Kingdom.(40)

The linear associations of HbA1c in the present study with LDL, TG and HDL are in agreement with the findings of other investigators who reported significant correlations between HbA1c and lipid profiles and recommended aggressive screening and treatment for dyslipidemia, with appropriate management of diabetes, as it is associated with increased risk of cardiovascular disease. (32, 33, 38)

The study has some limitations. Although the study sample was appropriately calculated based on sound sample size equation, it was not large enough to compute subgroup analysis. Further studies should be conducted in the future with larger sample sizes to allow for subgroup analysis. The study group, also, was derived from one practice in a specific region.

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