

Effect of Different Factors on Glycosylated Hemoglobin (HbA1c) Levels Among Diabetes Mellitus Patients

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ABSTRACT

Aim: To describe the rate of the controlled level of glycosylated hemoglobin (HbA1c) among diabetes mellitus patients in Dammam city, Kingdom of Saudi Arabia (KSA). To assess the association between the status of HbA1c and the different patient-related factors namely: insulin use, metformin, dyslipidemia, and statin use.

Methods: This cross-sectional study was performed at Security Forces Hospital, Dammam, KSA, between November 2020 and February 2021. A sample of two hundred known diabetic patients who were regularly followed up at the outpatient department (OPD) was selected randomly for the current study.

Results: A very low rate (24%) of controlled HbA1C levels in patients with diabetes (type 1 DM and type 2 DM), The data showed that 85 % of all participants in our study are T2DM patients, while only 15% are T1DM patients, Our data showed that patients with dyslipidemia, hypothyroidism, or hypertension have a high level of uncontrolled HbA1C levels. Surprisingly, both dyslipidemia and statin use were predictors of uncontrolled HbA1C, Unexpectedly, non-metformin use has a protective effect toward controlling HbA1C, While insulin use is a strong predictor of uncontrolled HbA1C (OD 5.20).

Conclusion: A low rate of controlled glycated hemoglobin (HbA1c) level among patients with diabetes (T1DM and T2DM) in our sample urges the need for immediate intervention to investigate and improve the current findings. Further investigations are needed to fully explain the high rate of uncontrolled HbA1c among insulin, metformin and statins users.

Keywords: Glycated hemoglobin, HbA1c, Diabetes mellitus, Statins, Metformin.

INTRODUCTION

Diabetes mellitus is a long-lasting metabolic condition presented by increased glucose levels in the blood, either because decreased of insulin discharge, or because of insulin resistance. Globally DM is one of the high concern diseases among health care, and it causes 5 % of deaths every year¹. The commonness of diabetes was around 2.8% in 2000, and this percentage increased in 2013 to 8.3%². Saudi Arabia has an appreciable number of diabetic people (23.9%), which keeps on increasing³. In the last decade, the frequency of diabetes among children and adolescents increased, and earlier screening should be considered⁴. The persistent elevation of glucose level is associated with acute life-threatening difficulties of diabetes mellitus such as diabetic ketoacidosis (DKA) or the hyperosmolar hyperglycemic state (HHS) or long-term complications such as neuropathy, retinopathy, ischemic heart disease, nephropathy, diabetic foot, and stroke⁵. Studies have shown that the importance of patient self-management continuous monitoring and continuous medical care to lessen the menace of long-term problems and to prevent acute complications⁶. Monitoring of glucose levels is considered a cornerstone of care among diabetes mellitus patients. In clinical practice, fasting plasma sugar (FPS) has been used to diagnose diabetes mellitus in

spite oral glucose tolerance test (OGTT) is more delicate and precise. Patients preferred the FPS test because of its ease of use, acceptable and lower cost⁶.

The level of Glycated hemoglobin (HbA1c) is proportional to blood glucose level over the preceding 4-weeks to 3-months or the erythrocyte's lifecycle^{7,8}. The HbA1c is recommended as a means to diagnose diabetes, and its high levels affect the blood vessels as well as the lipid metabolism along with other complications⁷⁻¹⁰. It has been advised that the HbA1c examination should be done at least twice in a year¹¹.

There are several studies have been revealed that factors such as blood cholesterol levels, medications, levels of thyroid hormone, hypertension, and weight can play an important part in the successful control of glycosylated hemoglobin (HbA1c) among diabetic patients^{12,10}. The high levels of HbA1c are linked with cardiac diseases, retinopathy, and nephropathy^{2,8}. Several studies have been revealed that an HbA1c level of less than 6.5% can decrease the risk of microvascular and macrovascular problems¹³. It also can be used to predict the risk for diabetic complications, such as dyslipidemia and cardiovascular disease (CVD)¹⁴.

Previous studies have reported an association between HbA1c and various circulating lipid parameters¹⁴⁻¹⁶.

Results of monitoring glucose level and glycosylated hemoglobin (HbA1c) are used for the assessment of the efficacy of therapy and adjustment of medicines, medical nutrition therapy (MNT) and exercise, and the achievement of the best possible blood glucose control¹⁷. American Diabetes Association recommended routine blood glucose testing by patients through self-monitoring of blood glucose (SMBG) and by health care providers for out-patient management of diabetes mellitus¹⁸. Self-monitoring of blood glucose for maximum people having type I diabetes is suggested three or more times every day and for people with type II diabetes is not recognized, but it should be adequate to reach glucose objectives⁵. Special consideration should likewise be specified to the part of diabetic consciousness plans, public-based screening promotions, and different fitness informative courses in dipping health glitches produced by diabetes, which in the stretched run, aids to drop the national liability of this disease¹⁹. Therefore, our study aims to describe the rate of the controlled level of HbA1c among diabetes mellitus patients and to assess the association between the status of HbA1c and the different patient-related factors namely: insulin use, metformin, dyslipidemia, and statin use.

MATERIALS AND METHODS

Design: This cross-sectional study was piloted at Security forces hospital, Dammam, Kingdom of Saudi Arabia, between November 2020 and February 2021.

Sampling and Sample Size: A sample of two hundred known diabetic patients who were regularly followed up at the outpatient department (OPD) was selected randomly for the current study. Their ages ranged from 14-84 years, and the mean age was 47 years.

Data Collection: We collected data on HbA1c from the diabetes mellitus clinic for three months (Between November 2020 and February 2021). The data was collected from the patient file in the diabetes mellitus clinic, included all patients with DM disease, collected data includes all patient information (demographic information), Regarding DM detailed information was recorded which included, type of DM (type I or type II) glycated hemoglobin values (HbA1c), Then we categorized the data based on variables as described in Table 2, like Hypertension, dyslipidemia, hypothyroidism, statin use, gender, and age.

Data Analysis: The SPSS 23 version program was used for data

processing, simple descriptive statistics, and inferential statistics were used as frequency, percentage, odd ratio, p-value.

RESULT

In this recent study, we found that 24% of the patients with controlled HbA1C and 76% of the patients with uncontrolled HbA1C. Mean age of participants 47 years old. Also, this study revealed that 75.9% of males (42%) with type 2 (90.6%) have uncontrolled HbA1C, and only 24.1 % of the patients with controlled HbA1C. Also, 77.8% of males with type 1 (9.4%) have uncontrolled HbA1C, and only 22.2 % of the patients with controlled HbA1C. On the other hand, 73.8% of females (52%) with type 2 (80.7%) have uncontrolled HbA1C, and only 26.2 % of the patients with controlled HbA1C. Also, 75% of the female with type 1(19.3%) have uncontrolled HbA1C, and only 15 % of the patients with controlled HbA1C. Our data showed that patients with dyslipidemia, hypothyroidism, or hypertension have a high level of uncontrolled HbA1C levels. Surprisingly, both dyslipidemia and statin use was a predictor of uncontrolled HbA1C. Unexpectedly, non-metformin use has a protective effect on controlling HbA1C. While insulin use is a strong predictor of uncontrolled HbA1C. (OD 5.20).

The following information's show demographic information about the participants:

Table 1: Primary outcome univariate analysis.

Intercept	Total sample % (n)	Uncontrolled Hba1c % (n)	Controlled Hba1c % (n)	P value
Geriatric	6% (12)	83%(10)	17%(2)	0.54
Dyslipidemia	11% (22)	91%(20)	9%(2)	0.1
Female	52% (104)	76%(79)	24%(25)	0.99
HTN	33% (66)	73%(48)	27%(18)	0.45
Metformin	73% (147)	74%(107)	26%(40)	0.07
Statin	49.5% (99)	77%(76)	23%(23)	0.8
Hypothyroidism	10% (20)	75%(15)	25%(5)	0.9
Insulin	62% (124)	88%(109)	12%(15)	<0.001

Table 2: Results of multivariate logistic regression for the predictors of HbA1c.

HbA1c	p-Value	OR	95% Confidence Interval	
			Lower CI	Upper CI
Insulin Use	<0.001	5.20	2.436	11.137
Non-Metformin Use	0.735	0.84	0.324	2.214
Dyslipidemia	0.161	3.11	0.636	15.272
Stati Use	0.890	1.05	0.503	2.206

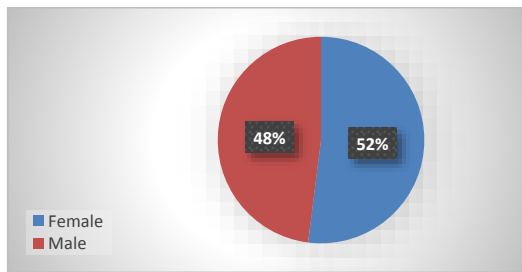


Figure 1: Shows the sum of male and female

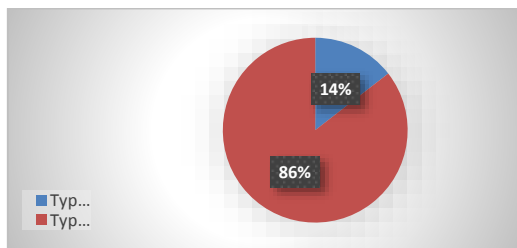


Figure 2: Percentage of each type of DM patients involved in the study

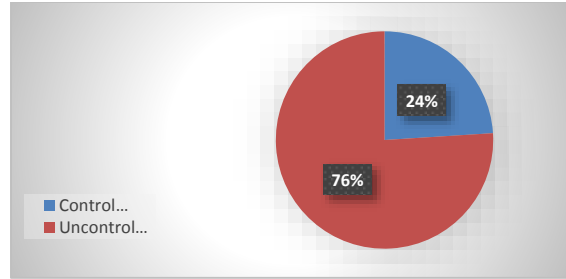


Figure 3: Shows uncontrolled HbA1C and controlled HbA1C among all patients

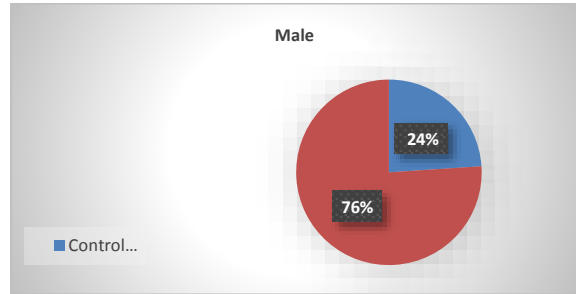


Figure 4: Shows the percentage of uncontrolled HbA1c and controlled HbA1c among male patients

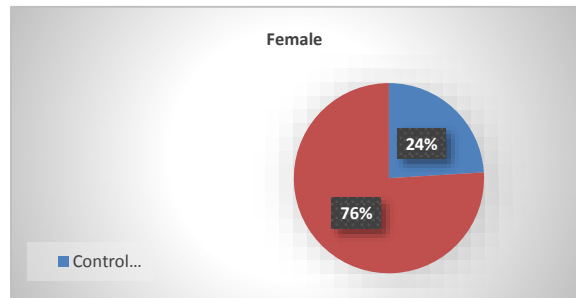


Figure 5: Shows the percentage of uncontrolled HbA1C and controlled HbA1C among female patients.

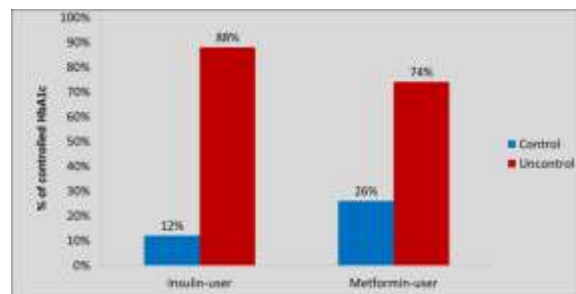


Figure 6: The effect of insulin and metformin use on HbA1c status

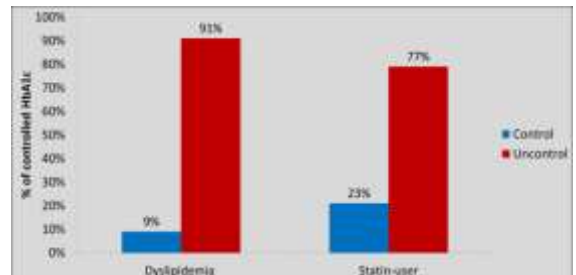


Figure 7: The effect of dyslipidemia and statin use on HbA1c status

DISCUSSION

The rising practice of HbA1c to regulate long-term glycemic control in diabetic people is mainly the consequence of information from the Diabetes Control and Complications Trial (DCCT) and the U.K. Future diabetes study showing that Complications of DM are highly correlated with HbA1c level. To fulfill specific HbA1c targets, patients and health care providers should understand the association between plasma glucose (PG) and HbA1c level for setting suitable day-to-day PG testing objectives. The relevance between HbA1c and PG is multifaceted. Some studies have exposed mean plasma glucose (MPG) indexing HbA1c over the previous weeks to months. Therefore, there is an expected relationship between PG and HbA1c. To achieve the HbA1c goal, the patient and health care provider must understand this relationship that will allow them to set suitable day-to-day PG targets.

The American Diabetes Association (ADA) recently endorses that people with diabetes endeavor to achieve HbA1c less than 7% to prevent DM complications¹⁰. According to DCCT, HbA1c is considered as the gold standard toward glycemic control and reducing the risk of cardiovascular complication when the level of HbA1c is equal to or less than 7.0%²⁰. The data shows in the present study that a very low rate (24%) of controlled HbA1c levels in people with diabetes (T1DM and T2DM) this recognition was revealed by previous studies where most patients with diabetes with uncontrolled HbA1c^{21,22}.

Many studies have reported a relationship between HbA1c and lipid profile in addition to the current study showed that patients with dyslipidemia have a high level of uncontrolled HbA1c levels and both dyslipidemia and statin use was a predictor of uncontrolled HbA1c¹⁴. Unexpectedly, non-metformin use has a protective effect toward controlling HbA1c, while insulin use is a strong predictor of uncontrolled HbA1c. (OD 5.20) In this current study, HbA1c showed no significant association with patient demographic factors while HbA1c was uncontrolled in most dyslipidemia patients. This study revealed that intraindividual variation such as gender, blood pressure and thyroid function in HbA1c among DM patients is minimal, his finding compatible with the previous studies^{8,9}.

There was a significant difference regarding HbA1c levels among patients on insulin. This has been shown by this study ($p < 0.001$) and previous study²¹. The high percentages of uncontrolled HbA1c (76%) dyslipidemia (91%), hypertension (66%), and hypothyroidism (75%). This could be referred to the high percentages of microvascular and macrovascular complications in this study where several studies revealed that poor control of hypertension and dyslipidemia would increase DM complications²²⁻²⁴. The data of this study consists of previous studies that upgraded glycemic control is linked with reduced rates of DM complications^{24,25}.

In these trials, treatment routines that condensed usual HbA1c to 7% were related to less extended-term microvascular and macrovascular problems. In conclusion, it was observed that HbA1c level is not applied for regular follow-up among diabetes mellitus patients and international guidelines are not followed.

CONCLUSIONS

The outcomes of the current study specify that the Hb1Ac is underestimated during the regular treatment in the hospital because 76% of patients involved in this study have higher HbA1c reading, and no immediate intervention was done. Thus, Patients education should be provided to all DM patients regarding the disease and treatment of DM either non-pharmacology or pharmacology. A low rate of controlled glycated hemoglobin (HbA1c) level among patients with diabetes (T1DM and T2DM) in our sample urges the need for immediate intervention to investigate and improve the current findings. Our data shows that there is a high association between dyslipidemia and uncontrolled Hb1Ac. Further investigations are needed to fully explain the high

rate of uncontrolled HbA1c among insulin, metformin, and statin users.

Recommendation: The following issues are recommended:

1. Stick with international guidelines recommendations such as ADA for monitoring HbA1c levels to ensure glycemic control and prevent complications.
2. Correction of a lipid profile to improve HbA1c level.
3. Patient education and counseling should be provided to all DM patients regarding the disease and treatment.

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