The Egyptian Journal of Hospital Medicine (October 2020) Vol. 81 (2), Page 1457-1461

Factors Affecting Glycemic Control in Type II Diabetic Patients

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ABSTRACT
Background: Diabetes is a major public health problem that affects morbidity, fatality and health care resources. Many factors can influence diabetic control. Diabetic control remains the main goal in management of diabetes mellitus and the major therapeutic target for prevention of complications due to diabetes **Objective:** Is to assess factors affecting glycemic control among type 2 diabetic patients. **Patients and Method**: a cross sectional study was conducted on 200 diabetics at the Internal Medicine Department, Benha University hospital. A case record form was used including socio-demographic features, anthropometric measurements and metabolic disease profile. **Results**: Participants were classified according to their glycosylated hemoglobin level into good (7%) and poor (93%) diabetic control. There was a statistically significant association between diabetic control and diabetes duration ($p < 0.001$), exercise ($p = 0.001$) (OR (95% CI): 5.59 (1.77-17.62)), body mass index ($p < 0.001$). There was a statistically significant difference between those with poor and good diabetic control as regard LDL level (OR (95%CI): 50 (6.41-333.3)) ($p < 0.001$), total cholesterol level ($p < 0.001$), (median (range): (237 (178-320) and 100 (100-300)) respectively and the mean value of fasting blood sugar ((mean ± SD): 298.52± 55.97 and 170±37.41 respectively, $p < 0.001$)). **Conclusions:** Majority of participants had poor diabetic control. Diabetes duration, regular exercise, BMI, LDL and total cholesterol levels significantly affected glycemic control
Keywords: Type 2 diabetes – Glycemic control - Glycosylated haemoglobin.

INTRODUCTION
Diabetes mellitus is one of the most challenging public health problems worldwide. More than 366 million people worldwide are diabetics and this number may duplicate by 2030. The greatest burden of this health problem is present mainly in low and middle-income countries, representing about 80% of all cases of diabetes [(1)]**.** In Egypt diabetes is a major health problem which can affect morbidity, mortality, and health care resources. The prevalence of type 2 diabetes (T2D) among Egyptians is 15.6% of all adults from 20 to 79 years old. Diabetes is still a public health challenge with an influence on the Egyptian economy. Type 2 diabetic patients (T2D) represent about 90%-95% of all diabetic patients worldwide and this presents a growing epidemic [(2)]. Multiple factors like age, gender, educational level, marital status, body mass index (BMI), smoking, diabetes duration, and schedule of medications have an influence on diabetes control [(3)].

The increased spread of diabetes may be due to aging, changes in life style, diet, and lack of exercises [(4)]. Obesity remains a major risk factor for diabetes mellitus among Egyptians [(2)].

The risk factors associated with diabetes are either controllable, including obesity and inactive lifestyle or uncontrollable like ethnicity and genetics that also play a dramatic role [(1)].

Glycemic control remains the primary goal in management of diabetes mellitus and the major therapeutic target for preventing diabetic complications. In addition, identifying determinants of poor glycemic control may help for better diabetic control and patient outcomes [(5)]. World Health Organization reported that, only 37% of diabetic patients have controlled disease. Controlling blood glucose will improve the quality of life of the patients. The relationship between hemoglobin A1c (HbA1c) level and quality of life for diabetics became evidenced by several studies as every 1% reduction will improve 5% of life quality [(4)]. Measurement of glycosylated hemoglobin (HbA1c) is accepted nowadays as the most reliable indicator for long-term glycemic control because it accurately reflects patient's blood glucose levels over the previous 2-3 months and the quality of diabetes care available to the population [(5)].

Hypothesis: This study aims at evaluating the following hypothesis: There is a real effect of many factors (independent) on the degree of diabetic control among diabetic patients at Benha University Hospital (dependent).

Specific objectives of this study are to assess factors affecting glycemic control among type 2 diabetic patients.

PATIENTS AND METHODS
It is a cross sectional study, was conducted from July 2019 to December 2019 on type II diabetes mellitus patients who were admitted to the Internal Medicine Department at Benha University Hospital according to specific inclusion criteria.

Inclusion Criteria: All adult diabetic patients (type II DM), with age 18 years and above, agreed to sign the written consent. They were diagnosed as being diabetic according to the following criteria (HbA1c ≥ 6.5% or fasting plasma glucose ≥ 126 mg/dl).

Exclusion criteria: Patients less than 18 years of age, impaired mental capacity, impaired level of

Received:24 /6 /2020
Accepted:23 /8 /2020

consciousness, patients with end stage liver or renal disease, women with gestational diabetes.

The minimal required sample size was calculated according to the following equation: (n= (Z^2* P*Q)/ (E^2)); Z=1.96, P: prevalence of affected population = 0.15 *(according to previous published literature* [(2)], Q =1-p, E: standard deviation=0.05

n= ($(1.96)^2$*0.15*0.85)/0.0025=196 patients

In the current study, 200 diabetic patients fulfilling the previous inclusion criteria accepted to participate were chosen.

A Case Record Form (CRF) was used to collect the information of the Type II diabetes patients attending the Internal Medicine Department at Benha University Hospital. It included data about the socio-demographic features, anthropometric measurements and metabolic disease profile.

Socio-demographic profile included age, gender, smoking and physical activity practice. Anthropometric and metabolic profile showed (body weight/kg and height then Body Mass Index (BMI) was calculated as weight in kilograms divided by height in meter squared, BMI was categorized as normal if less than 25 kg/m^2, overweight between 25 and 29 kg/m^2 and as Obese if more than 30 kg/m^2 **[(6)].**

The ideal waist circumference (WC) for males was considered as less than 90 cm, and less than 85 cm for females **[(7)]**. Data about Low-Density Lipoprotein (LDL) and cholesterol were obtained from patients records. Hypercholesterolemia refers to a total cholesterol level ≥200 mg/dl. LDL was considered high when the extent was ≥100 mg/dl **[(8)]**. Data about hemoglobin A1c (HbA1c), fasting blood sugar (FBS) measurements was obtained. Degree of diabetic control was categorized according to HbA1c level as good glycemic control if HbA1c was below 7% and poor glycemic control if it was more than or equal to 7% [(9)]. An official permission from the dean of Benha Faculty of Medicine was obtained to conduct this study.

Ethical consideration:

An approval from the Research Ethics Committee in Benha Faculty of Medicine was obtained before conduction of this work. An informed written consent was obtained from all patients before participation; it included data about aim of the work, study design, site, time, subject and gear. They were informed that all collected data would be confidential and would be used for scientific purposes only. They were informed also that no painful techniques would be carried upon them.

Statistical analysis

The collected data were tabulated and analyzed using the Statistical Package for the Social Sciences (SPSS 20.0). Categorical data were expressed as number and percentage and were compared by Chi-square test and Fishers Exact test when suitable. Continuous variables were expressed as mean and standard deviation for normally distributed data or median and (minimum-maximum) for not normally distributed data, and were compared using the unpaired t–test or Mann-Whitney test when it was suitable. Odds ratio (OR) and 95% confidence interval (CI) were calculated. Correlation analysis to determine the association between HbA1c and other independent variables was done using Pearson correlation coefficient and Spearman correlation coefficient. Multiple linear regression analysis was used to find out the independent predictors of HbA1c level. The accepted level of significance during this work was 0.05 ($p<0.05$).

RESULTS

Patients with good diabetic control constituted only 7% while most of them (93%) had poor diabetic control **(Figure 1**). Regarding factors that may affect diabetes control, this study showed that there was a statistically significant association between diabetic control and diabetes duration and regular exercise as those with poor diabetic control are about 6 times more likely not to practice regular exercise **(Table 1).**

Table (1): Association between diabetic control and some socio-demographic factors among studied population

Characteristics	Diabetic control (n=200)				X^2	P value	OR (95% CI)
	Poor (n=186)		Good (n=14)				
	N	%	N.	%			
Gender							
Male (n=86)	82	44.1	4	28.6	1.27	0.258	1.97 (.59-6.51)
Female (n=114)	104	55.9	10	71.4			
Smoking							
Yes (n=73)	70	37.6	3	21.4	1.47	0.225	2.21 (.59-8.20)
No (n=127)	116	62.4	11	78.6			
Regular exercise							
No (n=172)	164	88.2	8	57.1	10.41	0.001	5.59 (1.77-17.62)
Yes (n=28)	22	11.8	6	42.9			
Age (years) (mean ± SD)	55.38± 8.24		57±2.88		t=0.731	0.466	-
Diabetes duration (years) (median(min-max)	6 (1-14)		2 (1-9)		z=4.03	<0.001	-

X^2: Chi square test t= student t test z = Mann Whitney test

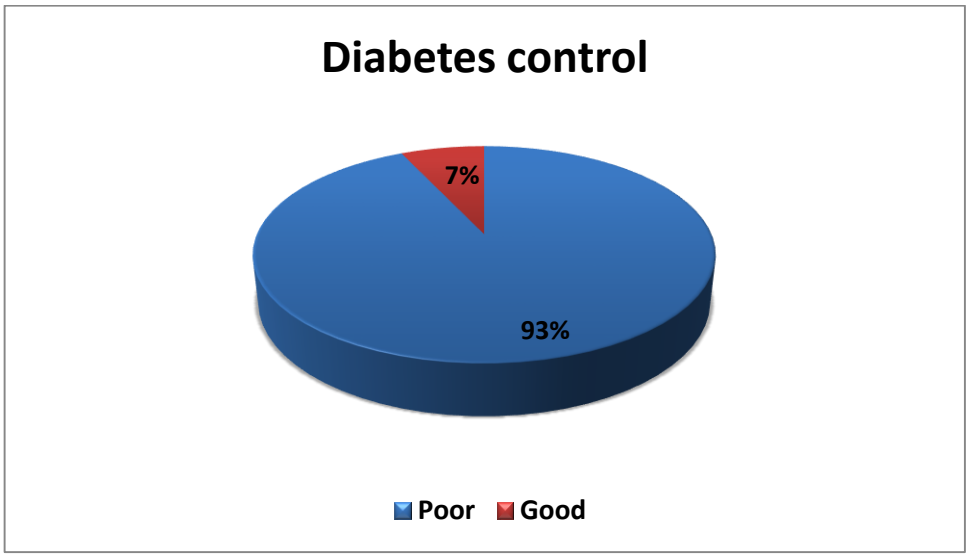

Figure (1): Distribution of diabetic control among the studied population

It was noticed that there was a statistically significant association between diabetic control and anthropometric measurements including BMI and waist circumference for female, as female with poor diabetic control were about 20 times more likely to have increased waist circumference. It was obvious that diabetic patients with poor diabetic control were more likely to have diabetic complications. Lipid profile investigation revealed that there is a statistically significant difference between diabetic patients with poor and good diabetic control regarding LDL level and total cholesterol level. There is a statistically significant difference between the mean value of fasting blood sugar of those with poor and good diabetic control **(Table2)**. Correlation analysis revealed that there was a statistically significant positive correlation between HbA1c level and each of diabetes duration, BMI, fasting blood sugar, level of total blood cholesterol and LDL **(Table 3)**. Multiple linear regression analysis revealed that increased BMI, fasting blood sugar, LDL and total cholesterol level were significant predictors of increased HbA1c level **(Table 4).**

Table (2): Association between diabetic control and some contributing factors among studied population

	Diabetic control (n=200)				**FET**	**P**	**OR (95% CI)**
	Poor (n=186)		**Good (n=14)**				
	N	**%**	**N**	**%**			
BMI							
Normal (N=3)	3	1.6	0	0.0	17.79	<0.001	-
Over weight (n=132)	130	69.9	2	14.3			
Obese (n=65)	53	28.5	12	85.7			
Waist circumference (cm) in females							
High (196)	186	100.0	10	71.4	54.22	<0.001	19.6(10.71-35.84)
Normal (4)	0	0.0	4	28.6			
Waist circumference (cm) in males							
Normal (n=19)	19	10.2	0	0.0	1.58	0.370	1.084(1.03-1.13)
High (n=181)	167	89.8	14	100.0			
LDL (mg/dL)							
High (n=149)	148	79.6	1	7.1	35.95	<0.001	50(6.41-333.3)
Normal (n=51)	38	20.4	13	92.9			
Presence of complications							
Yes (n=125)	120	64.5	5	35.7	4.60	.032	3.26(1.05-10.20)
No (n=75)	66	35.5	9	64.3			
Fasting blood sugar (mg/dL) (mean ± SD)	298.52± 55.97		170±37.41		t=8.44	<0.001	-
Total cholesterol (mg/dL) (median (min-max)	237 (178-320)		100 (100-300)		Z=3.66	<0.001	

FET: Fishers Exact test. t= student t test. z = Mann-Whitney test

Table (3): Correlation between HBA1c level and some other variables among studied population (n=200)**.**

HBA1c / Variable	r	p
Duration of diabetes	rho= 0.169	0.017
BMI	0.149	0.035
Fasting blood sugar	0.755	<0.001
Total cholesterol	rho= 0.166	0.019
LDL	0.231	0.001

r: Pearson correlation coefficient **rho** : Spearman correlation coefficient

Table (4): multiple linear regression analysis for predictors of increased HbA1c level among studied population (n=200)

HBA1c / Variable	B	p	95% CI	F & p	r^2	Adjusted r^2
Age	0.005	0.139	0.011- 0.002	82.044 and <0.001	0.749	0.740
Diabetes duration in years	0.010	0.185	0.005- 0.026			
BMI	0.058	<0.001	0.032-0.084			
FBS	0.010	<0.001	0.009- 0.011			
LDL	0.011	<0.001	0.008-0.014			
Total cholesterol	0.008	<0.001	0.006-0.010			

DISCUSSION

The present study assessed the glycemic status among participating patients and accordingly categorized them as having good glycemic control (HbA1c <7 %) and poor glycemic control HbA1c (≥7 %). It was noticed that those with good diabetic control constituted only 7% while the majority of patients (93%) had poor diabetic control. These findings came in accordance with the results of **Khattab *et al.*** [(5)] who conducted a study for assessment of factors associated with poor glycemic control among patients with type II diabetes mellitus and revealed that the proportion of patients who have ideal glycemic control were only 8.2%. Similar observation was also recorded in another study [(10)].

Out of the 200 diabetic patients in this study, 86 (43%) of them were male. the mean age was (55.38± 8.24 SD) and (57±2.88 SD) years among those with poor and good diabetic control respectively. This was supported by the results of a study of factors that correlate with poor glycemic control in type 2 diabetes mellitus patients with complications that included 657 patients and the mean age was 59.67± 9.617 years [(9)].

Assessment of factors that may affect diabetes control in this study revealed that there was a statistically significant association between diabetic control and diabetes duration. Correlation analysis also revealed that there was a statistically significant positive association between HbA1c level and duration of diabetes. These findings are supported by **Sasi *et al.*** [(11)] who stated that longer duration of diabetes was associated significantly with a poor glycemic control. A longer duration of diabetes is known to be associated with a poor glycemic control, possibly due to a progressive impairment of the insulin secretion, as a result of beta cell failure.

In this study, it was noticed that there was a statistically significant association between diabetic control and regular exercise as those with poor diabetic control were about 6 times more likely not to practice regular exercise. This was supported by several studies that revealed that sports could help in control of diabetes through increasing body sensitivity to insulin and reducing FBS [(12)]. Culturally, Egyptians tend to avoid exercise in public areas, as few are able to afford membership in athletic facilities. Additionally there are many social factors that prevent women from exercising in public areas [(2)].

In this study, it was noticed that there was a statistically significant association between diabetic control and anthropometric measurements including BMI and waist circumference for female, as female with poor diabetic control were about 20 times more likely to have increased waist circumference. Also correlation analysis revealed that there was a statistically significant positive association between HbA1c and BMI. Similar observation was seen in a study where most of obese patients had poor glycemic control [(10)], and it was also supported by findings of **Khattab *et al.*** [(5)] where diabetic patients who were categorized as obese were more in the poor glycemic control group (95.1%) as compared to good glycemic control group (4.9%).

Lipid abnormalities are common in patients with diabetes. In this study lipid profile investigation revealed that there was a statistically significant difference between diabetic patients with poor and good diabetic control regarding LDL and total cholesterol level. Correlation analysis revealed that there was a statistically significant positive correlation between HbA1c and each of level of total blood cholesterol and LDL. Also multiple linear regression analysis revealed that increased LDL and total cholesterol level were

significant predictors of increased HbA1c level. This was supported by several studies that found that almost all the diabetic patients with dyslipidemia (97.9 %) had poor glycemic control and statistically significant difference (P=0.03) was found between dyslipidemia and glycemic control [(13)]. Another study by **Adham *et al.*** [(14)] revealed that factors related to better glycemic control were lower levels of total cholesterol, low-density lipoprotein and triglycerides.

This study showed that, there was a statistically significant difference between the mean value of fasting blood sugar of those with poor and good diabetic control. There was also a statistically significant positive correlation between the level of FBS and HbA1c**.** Multiple linear regression analysis revealed that increased fasting blood sugar was a significant predictor of increased HbA1c level. This was similar to the results of a study about effective factors in controlling diabetes progression among patients in the northwest of Iran and demonstrated that there was a relationship between HbA1c and FBS [(4)].

CONCLUSION

Majority of type II DM patients had poor diabetic control. Diabetes duration, physical activity, BMI, LDL and total cholesterol levels were found to be factors significantly affect glycemic control.

ACKNOWLEDGMENT

I would like to thank all participants of this study.

Funding source: This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Conflicts of interest: The author declares that there is no conflict of interest.

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