Saudi Journal of Medical and Pharmaceutical Sciences **ISSN 2413-4929 (Print)**
Scholars Middle East Publishers **ISSN 2413-4910 (Online)**
Dubai, United Arab Emirates
Website: http://scholarsmepub.com/

Research Article

Glyceated Hemoglobin Control Among Type 2 Diabetes Patients Attending a Teaching Hospital in Malaysia

Salwa Selim Ibrahim Abougalambou [1]***, Amal K. Suleiman*** [2]***, Ayman S. Abougalambou*** [3]***,***
[1]*Discipline of Clinical Pharmacy, Qassim University, Pharmacy School*
[2]*Pharmaceutical Practices Department, Pharmacy College, Princess Nora bint Abdu Rahman University, Riyadh, Saudi Arabia*
[3]*Consultant Cardiologist, King Abdullah Medical City, Saudi Arabia*

***Corresponding Author:**
Salwa Selim Ibrahim Abougalambou
Email: salwas12005@yahoo.com

Abstract: Type 2 DM is rapidly raising as a global health care problem that threatens to reach pandemic levels by 2030. Type 2 Diabetes mellitus is a disease with no cure and chronic disease that results in major morbidity and mortality. The main objective of this study is to evaluate the glyceated hemoglobin control and to determine factors affect on glycemic control among type 2 diabetes outpatients attending diabetic clinics at Hospital Universiti Sains Malaysia (HUSM). The study design was observational prospective longitudinal follow-up study, the study was conducted with sample of 1077 Type 2 Diabetes Mellitus outpatient recruited via attended the diabetes clinics at HUSM. HbA1c is parameter to measure the glyceated hemoglobin control. Logistic regression analysis was used to assess the independent variables that affect the glycaemic control. The majority of patients 794 (73.7%) did not achieve target of HbA1c levels ≤ 7.0%. It has been found that age, race and antidiabetic medications are the factors that affect on the HbA1c.New strategy to improve the current status of control of diabetes is needed. The study recommends that health-care providers should pay more attention to type 2 dm patients with older age, Malay race and antidiabetic medications. The present study recommends that more time, money and attention must be given to the treatment of diabetic patients.
Keywords: Type 2 diabetes mellitus, prevalence, glyceated hemoglobin, risk factors.

INTRODUCTION

Type 2 DM is rapidly rising as a global health care problem that threatens to reach pandemic levels by 2030. In 2003, an estimated 194 million adults had diabetes worldwide 5.1% and 314 million people had impaired glucose tolerance 8.2% [1]. This prevalence increased to 6.0 % and 7.5 % in 2007 and is predicted to increase to 7.3 % and 8.0 % by 2025 [2]. 380 million people are expected to have diabetes in 2025 [2].

In Malaysia, the Third National Health and Morbidity Survey [3] showed that prevalence of Type 2 DM for adults aged 30 years old and above was found to be 14.9 % in 2006, upped by almost 79.5% in the space of 10 years from 1996 to 2006.

HbA1c is the gold standard in accessing glycaemic control indices of long-term blood glucose control, as they estimate blood glucose during the preceding three months [4].

The target glycaemic level (HbA1c), advocated by the American Diabetes Association (2007) and the American Association of Clinical Endocrinologists [5], should be aimed at ≤ 7% to reduce serious complications or premature death. However, research documents that 63% of patients with diabetes fail to achieve the advocated target goals [6]. This failure to achieve glycaemic control puts patients at risk for increased financial costs and increased serious complications and increased risk of mortality. If glycaemic control is not reached early in treatment, severe complications may develop.

It is important to reach the optimal glycaemic level as quickly as possible [7]. The longer a diabetic remains out of control the greater the risk of developing diabetic complications. Research by Weng *et al.,* [7] documented the importance of expedient glycaemic control to prevent the devastating complications of diabetes and for the preservation of β-cell function. The documented evidence demonstrates anything less is to put the patient at risk for blindness, kidney failure, heart disease, stroke, amputations, microvascular and macrovascular disease and early death [5].

In diabetic patients previous prospective studies have shown an association between the degree of hyperglycaemia and the increased risk of microvascular complications, sensory neuropathy, myocardial infarction [8], stroke [9], macrovascular mortality [10] and all cause mortality [7].

Knowing the factors that contribute to glycemic control is key to developing more effective treatment and identifying the needs of adults with Type 2 DM. Less is known about the factors that influence glycaemic control. That factors include influences of demographics, clinical conditions, and antidiabetic treatment on glycaemic control. Several studies examined that the effects of patients characteristics on HbA1c levels, controlling for documented correlates, including demographic characteristics [11, 12], clinical conditions [12,13], and treatment modalities [14,15].

Regarding demographics characteristics factors include age, race, gender, family history and level of educations. Previous studies have suggested that minority groups for example: African Americans, Hispanics, American Indians, Pacific Islanders had poor glycaemic control 16] and in study by Harris et al.[17] found that black women, Mexican-American men, and patients over 60 years of age had poorer glycaemic control.

The glycated hemoglobin HbA1c levels increased progressively with age [18,19]. In a study done in India, Kutty et al. [20] reported lower plasma glucose levels in the young age group (20-29 years) and higher plasma glucose levels in the old age group (>69 years) in women than in men. In addition, the increase of plasma glucose per decade was almost twice as high in women as in men. In contrast with Shorr *et al.* [21] found that there is no significant difference between age groups and glycaemic control.

Alcohol consumption is oppositely associated with glycaemic control among diabetes patients. In study by Mackenzie *et al*, [53] who found that alcohol consumption was associated with lower HbA1c among patients with diabetes and Shai *et al.*, [22] recognised that consumption of 13 g of alcohol daily reduced FPG by 9% compared to non-alcohol consuming controls

The studies by [23,24] found that factors such as dietary practices, physical exercise, and education level were important predictors on glycaemic control.

Physical activity can effect on glycaemic control among patients with diabetes, the benefits of regular physical activity have been well documented: improved glycemic control and insulin sensitivity [25, 26]. In study by Pigman *et al.* [26] reported that diabetic patients do not do regular exercise was 2.71 times more likely to have HbA1c greater than or equal to eight compared to those reporting regular exercise.

BMI is the most important predictor of deterioration in glycemic control, regardless of the treatment regimen, according to a study from Finland [27]. In study by Nichols et al. [11] found that body mass index (BMI) significantly related to glycaemic control

Insulin resistance increased in smokers with and without diabetes [28,29], and study by Gunton *et al*., [54] documented that the improvement in HbA1c with smoking cessation.

Duration of diabetes is important factors affecting glycaemic control. In studies [12, 13] they found that disease duration for a long time in diabetic patients, who have comorbidities, have high HbA1c levels. Similar to study by Nichols et al. [11] found that the longer duration of diabetes, the harder it was to maintain glycaemic control.

Other studies [13, 14] found that diabetic patients who use insulin or multiple oral agents have poor control of HbA1c. Insulin use is a factor of disease severity and was a predictor of poorer glycaemic control. In the NHANES III data [17] they found that the mean HbA1c value 8.3% of insulin users.

The objective of this study to determine glycaemic control level and factors affect on glycaemic control level in Malaysian type 2 diabetic patients who attended diabetes clinics in Hospital University Sains Malaysia.

MATERIAL AND METHODS

The medical records were studied either directly from the diabetes clinic after the patients consulted the doctors or from the patient medical record center. The patients selected were type 2 diabetic outpatients, aged over 18 years, with active follow-up at the diabetic clinic. The exclusion criteria for this study included patients who were suffering from juvenile diabetes, gestational diabetes, thyroid problems, obstructive liver disease, advanced renal failure, and tuberculosis. A prospective study was conducted for a study period of one year (2008) in order to identify the characteristics of type 2 diabetic outpatients in a tertiary center, and to determine the prevalence of diabetic retinopathy associated with outpatient diabetic care at HUSM, which is located in the state of Kelantan, Malaysia. The study design is an observational, prospective cross-sectional study. Non-probability sampling method (convenience sample technique) was applied.

Ethical Considerations

The study was approved by the Human Research and Ethics Committee of the School of Medicine in the Universiti Sains Malaysia. Informed consent was obtained from all patients included in the study.

Data collection

The outpatient diabetic clinic recording lists of patients who attended the diabetic clinic in HUSM were captured from the diabetic clinic registration book. Based on glycaemic control tests (HbA1c, FPG, PPG), the medical records were then retrieved from the record

office using the patient's name. The medical records review was undertaken by a single researcher, and the required information including demographic, co-morbidity characteristics, detailed physical and biochemical information and therapy to be reviewed and recorded in a data collection form. Socio-demographic characteristics included age, sex and race, alcohol, smoking history, physical activity and level of education. Physical examination included: pulse rate, height, weight and waist circumference. Blood pressure was measured twice and average reading was taken. Hypertension was defined as systolic blood pressure of >130 mmHg or diastolic blood pressure of >80 mmHg or current use of antihypertensive drugs also has been diagnosed as hypertension [30].

Laboratory results included fasting plasma glucose (FPG), postprandial plasma glucose (PPG), HbA1c level, and lipid profile. Dyslipidaemia was defined as fasting cholesterol of greater than 4.5 mmol/l, LDL-C greater than 2.6 mmol/l, Triglyceride greater than 1.7 mmol/l, HDL-C less than 1.0 mmol/l in males and less than 1.3 mmol/l in females [31].

Diabetic retinopathy (DR) was diagnosed with the presence of retinal hemorrhages, exudates and macular edema [32]. Neuropathy was diagnosed in the presence of persistent numbness, paresthesia, loss of hearing of the tuning fork and sense of vibration [32]. Diabetic nephropathy (DN) was considered by positive persistent proteinuria for at least three consecutive readings per year, and/ or serum creatinine (SCr) >130 lmol/L and/or GFR <60 ml/min [32].

Coronary artery disease was diagnosed by documented angina symptoms and confirmed by ECG, or from the results of percutaneous transluminal coronary angiography (PTCA) in patients records (Al-Maskari et al, 2007). Cerebrovascular disease was defined by the presence of transient ischemic attack or stroke in the past medical history [33].

Statistical analysis

Statistical Package for the Social Sciences (SPSS) software version 12.0 (Chicago, IL, USA) was used for data analysis. The data obtained were analysed using descriptive statistics to determine the glycaemic control level among diabetic patients. Logistic regression analyses were performed to assess the independent effect on glycaemic control.

A bivariate association between HbA1c level control (uncontrol > 7% / control ≤ 7%) and each independent variable.

Independent variables contain model one which included personal characteristics (gender, race, age, physical exercise, level of education, smoking history, alcohol history and family history). Model two included health characteristics (diabetes duration, WC, BMI and anti diabetic medications).

In simple logistic analysis, each independent variable was analysed to look at any significant association with dependent variable (glycaemic control) and preceded to multiple logistic regressions to confirm the association after excluding confounders. The results of simple logistic regression analysis were recorded as beta, p-value, crude odds ratio and 95% confidence interval. Multivariate analysis was done on numerical and categorical analysis variable by using binary logistic regression to eliminate confounding effect as there are more than one independent variables. The first step was to do variable selection. Second step for further multivariate analysis, and selection step was to do manual backward or forward analysis of each variables was excluded of p value which was more than 0.05. The third step was to find a model when all variables have a p value of less than 0.05.

RESULTS

A total of 1077 type 2 diabetic patients were involved in this study, demographic characteristics of type 2 diabetic patients were demonstrated in Table 1.

Evaluating the factors influencing HbA1c measurement

In order to evaluate factors influencing HbA1c measurement among patients in this cohort study. Several analysis techniques were used; those are shown in the following subsections:

1-Univariate analysis on HbA1c control

Univariate analysis was done for each variable separately, using binary logistics of HbA1c (uncontrol/control). Any variable with p value <0.05 is considered significant.

1-(a) Univariate analysis of personal characteristics on HbA1c control

In simple logistic regression analysis, each independent variable was analysed to look for any significant association with the dependent variable (HbA1c). In personal characteristics, age and race were significantly associated with control of HbA1c. as shown in Table 3.

Table-1: Socio-Demographic characteristics of Type 2 diabetic patients

Variable	n (%)
Gender	
Male	476 (44.2)
Female	601(55.8)
Age (years)	
≤ 35 yaers	15 (1.4)
>35-50 years	194 (18)
>50-65years	626 (58.1)
>65 years	242 (22.5)
Race	
Malay	916 (85.1)
Chinese	150 (13.9)
Indian	11 (1.0)
Smoking History	
Current smoker	66 (6.1)
Previous smoker	81 (7.5)
Never smoked	930 (86.4)
Alcohol History	
Current drinker	10 (0.9)
Previous drinker	6 (0.6)
Never drink	1061 (98.5)
Physical activity	
Active ≥ 150 min/wk	471 (43.7)
Non active < 150 min/wk	606 (56.3)
Level of education	
< secondary school	580 (53.9)
≥ secondary school	497 (46.1)
Family history of diabetes	
Yes	141 (13.1)
No	936 (86.9)

Table-2: Health characteristics of Type 2 diabetic patients

Variable	n (%)
BMI (kg/m^2) ADA	
Underwight < 18.5 kg/m^2	20 (1.9)
Normal range 18.5 - 22.9 kg/m^2	179 (16.6)
Preobese 23- 27.4 kg/m^2	457 (42.4)
Obese I 27.5- 35.9 kg/m^2	364 (33.8)
Obese II 35-39.9 kg/m^2	39 (3.6)
Obese III > 40 kg/m^2	18 (1.7)
BMI (kg/m^2) Asia pacific	
Target ≤ 23 kg/m^2	199 (18.5)
Non target > 23 kg/m^2	878 (81.5)
Waist Circumference Category AP (cm)	
Target (Male) ≤ 90 cm	100 (9.3)
Non target (Male) > 90 cm	376 (34.9)
Target (female) < 80 cm	50 (4.6)
Non target (Female) ≥ 80cm	551(51.2)
Diabetes duration (years)	
≤5 years	273 (25.4)
>5-10 years	294 (27.3)
>10-15 years	256 (23.7)
>15-20 years	136 (12.6)
>20 years	118 (11)
HPT duration category (years)	
Free from HPT	56 (5.2)
≤ 3 years	204 (18.9)
> 3-6 years	288 (26.7)
> 6-9 years	160 (14.9)
>9 years	369 (34.3)
Cardiovascular history	
No disease	79 (7.3)
Hypertension	810 (75.3)
Hypertension +IHD	137 (12.7)
Hypertension + Cerebrovascular accident	51 (4.7)

Table-3: Univariate analysis of personal characteristics factors affecting HbA1c control

Personal characteristic	b	Crude OR (95% CI)	P- value
Gender			
Male	0	1	-
Female	-0.20	0.81 (0.62,1.07)	0.145
Race			
Malay	0	1	-
Non-Malay	-0.54	0.58 (0.40,0.83)	0.003
Age	0.13	1.12 (0.95,1.30)	<0.001
Physical activity			
Active ≥ 150 min/wk	0	1	-
Non active < 150 min/wk	0.07	1.07 (0.82,1.41)	0.596
Level of education			
≥Secondary school	0	1	-
< Secondary school	0.11	1.12 (0.85,1.47)	0.410
Smoking history			
Non smoker	0	1	-
Smoker	-0.12	0.87 (0.59,1.29)	0.515
Alcohol drinking			
Non alcohol drinker	0	1	-
Alcohol drinker	0. 44	1.56 (0.44, 5.51)	0.489
Family history of diabetes			
No	0	1	-
Yes	-0.34	0.96 (0.64,1.44)	0.867

Simple logistic regression (outcome as HbA1c control)

2. Univariate analysis of health characteristics on HbA1c control

Among the variables related to health characteristic affecting HbA1c control, were for BMI and antidiabetic medications (Table 4).

2-Multiple logistic Regression analysis on HbA1c control

Each group of similar variable categorically related was introduced together in one model of multivariate analysis, by using backward stepwise logistic regression at p value of <0.05 were accepted.

2- (a) Multiple logistic regression analysis of personal characteristics on HbA1c control

Table 5 shows multivariate analysis of personal characteristics.

2-(b) Multiple logistic regression analysis of health characteristics on HbA1c control

Multiple logistic regression analysis has shown that BMI and antidiabetic medications are the significant factors which influenced the control of HbA1c (Table 6).

Table-4: Univariate analysis of health characteristic factors affecting HbA1c control

Health characteristic	b	Crude OR (95% CI)	P value
BMI	0.036	1.03 (1.00,1.06)	0.017
WC	0.013	1.01 (0.99,1.02)	0.060
Duration of diabetes	0.016	1.01 (0.99,1.03)	0.127
Antidiabetic medications			0.023
Metformin	0	1	-
Gliclazide	0.26	1.30 (0.68,2.47)	0.421
Mixtard insulin	0.59	1.81 (0.88,3.69)	0.102
Metformin + Gliclazide	0.47	1.61 (0.96,2.69)	0.069
Metformin + Mixtard insulin	-0.06	0.93 (0.51,1.70)	0.836
Gliclazide + Acarbose	-0.14	0.86 (0.42,1.76)	0.689
Metformin + Gliclazide + Rosiglitazone	0.21	1.23 (0.64,2.39)	0.525
Metformin + Gliclazide + Acarbose	0.42	1.52 (0.826,2.81)	0.177
Metformin + Gliclazide + NPH insulin	0.88	2.42 (1.30,4.50)	0.005

Simple logistic regression (outcome as HbA1c control)

Table-5: Multiple logistic regression of personal characteristics affecting HbA1c control

Personal characteristic	b	Adjusted OR (95 % CIb)	P value
Race			
Malay	0	1	-
Non-Malay	-0.49	0.61 (0.42,0.87)	0.008
Age	0.13	1.22 (0.95,1.50)	<0.001

Multiple logistic regression
Overall correctly classified percentage = 73.4%
Area under curve = 61.9%

Table-6: Multiple logistic regression of health characteristics factors affecting HbA1c control

Health characteristic	b	Adjusted OR (95% CI)	P value
BMI	0.03	1.03 (1.00,1.06)	0.019
Antidiabetic medication			0.024
Metformin	0	1	-
Gliclazide	0.27	1.31 (0.68,2.50)	0.407
Mixtard insulin	0.63	1.88 (0.92,3.84)	0.083
Metformin + Gliclazide	0.47	1.60 (0.95,2.68)	0.074
Metformin + Mixtard insulin	-0.03	0.92 (0.51,1.68)	0.804
Gliclazide + Acarbose	-0.10	0.90 (0.44,1.84)	0.778
Metformin + Gliclazide + Rosiglitazone	0.18	1.20 (0.62,2.33)	0.582
Metformin+ Gliclazide + Acarbose	0.40	1.50 (8.12,2.78)	0.195
Metformin + Gliclazide + NPH insulin	0.88	2.41 (1.29,4.49)	0.006

Multiple logistic regression
Overall correctly classified percentage = 73.6%
Area under curve = 60.

3- Final model of multivariate analysis on HbA1c control

Using backward stepwise logistic regression, all factors that were found to be significant at p value <0.05 during the previous analysis were introduced together in multivariate analysis (model one and model two). Statistical variables at value <0.05 were accepted. Three variables remained in the final model. They were race, age and antidiabetic medications (Table 7).

Table-7: Factors significantly associated with HbA1c control

Independent variables	b	Adjusted OR (95 %CI)	P value
Race			
Malay	0	1	-
Non- Malay	-0.51	0.59 (0.41,0.86)	0.006
Age	0.13	1.30 (0.95,1.7)	<0.001
Anti diabetic medications			0.012
Metformin	0	1	-
Gliclazide	0.47	1.61 (0.83,3.12)	0.155
Mixtard insulin	0.66	1.93 (0.93,3.99)	0.074
Metformin + Gliclazide	0.53	1.70 (1.00,2.88)	0.046
Metformin +Mixtard insulin	-0.16	0.84 (0.46,1.55)	0.587
Gliclazide + Acarbose	0.01	1.01 (0.48,2.09)	0.975
Metformin + Gliclazide + Rosiglitazone	0.18	1.19 (0.61,2.34)	0.600
Metformin + Gliclazide + Acarbose	0.42	1.52 (0.81,2.84)	0.186
Metformin + Gliclazide + NPH	0.88	2.41 (1.28,4.52)	0.006

Multiple logistic Regression
Overall correctly classified percentage = 73.2%
Area under curve = 64.7%.

DISCUSSION

In this study population, the mean of HbA1c were 8.7% (± 2.3). At same time, most of these diabetic patients had unsatisfactory control with regard to HbA1c level and according to the Guidelines of the American Diabetes Association [38], the majority of patients 794 (73.7%) did not achieve target of HbA1c levels ≤ 7.0%. This finding is similar to previous studies [34-37]. Research documents that 63% of patients with diabetes fail to achieve the advocated target goals [6]. American Diabetes Association Guideline [38] reports 26.3% of Type 2 DM patients had ideal glycaemic control (A1C ≤ 7%). However, the American Diabetes Association (ADA) guidelines have shown that glycaemic control cannot always be achieved in specialist clinic practice. Roubideaux et al., [39] analysed for a sample of 9,626 individuals from the Indian Health Services Diabetes Care and Outcomes

they found mean glycosylated hemoglobin of 8.8% ± 2.2 and in another study by Hu D *et al.* [40] found a similar glycaemic level, with a median of 8.4%.

Little is known about the predictors that influence changes in glycaemic control in patients with poorly controlled diabetes. In the present study the focus on predictors have been correlated with diabetic control and can be classified into personal characteristics (age, gender, education, physical activity, smoking and alcohol history and family history), and health characteristics (body mass index, waist circumference, duration of diabetes and antidiabetic medications). Evaluating the influencing factors which affect on HbA1c is done by performing logistic regressions for the entire variables.

This work is aimed at identifying factors that influencing glycaemic control among adult diabetes. In the current study it found that there were significant associations between the glycaemic control (HbA1c) and the following variables: age (OR = 1.30), diabetic medications have different OR for each regimens and race (OR = 0.59).

A analysis of the data found a substantially greater proportion of older adults with poor glycaemic control, which was similar to study conducted by [41], but in contrast Nichols *et al.* [11] found poorer metabolic control among the younger age group and Kabadi *et al.* [42] reported that no significant association between age and HbA1c. Explanation of this finding may be because increasing age is associated with several physiological changes including insulin resistance [43, 44] which is frequently characterised by compensatory and sustained hyperinsulinemia and subsequently Type 2 DM [45]. In aged patients, the fear of hypoglycemia makes achievement of optimal glycaemic control and HbA1c levels difficult and generally only partially successful. Besides the majority of elderly patients have comoribidities which may affect the glycaemic control.

The study showed that Malay race constitute high percentage with poor glycaemic control but this result is not conclusive since the majority of patients recruited in study were Malays. Usually ethnic differences in Type DM were due to both genetic and environmental factors. In this study the antidiabetic medications regimens used had association with poor glycaemic control. It has been found the antidiabetic medications associated with uncontrol of HbA1c level. The resultof current study found that patients on metformin plus gliclazide and NPH insulin were 2.42 times liklehood uncontrolled HbA1c by comparing with metformin alone then mixtard insulin alone were 1.81 times possibility uncontrolled HbA1c with comparing metformin alone and regimen of metformin plus gliclazide were 1.61 times liklehood uncontrolled of HbA1c by comparing with metformin. Conversely previous studies have shown that excellent glycaemic control can be achieved with insulin therapy in patients with Type 2 DM [46, 47].

Furthermore, in this study, it don't found the relationship between glycaemic control and BMI as in previous studies [35, 52], in which both waist circumference and BMI were strongly and positively associated with HbA_1c concentrations [11,49]. Also the study found that gender, family history of diabetes mellitus and smoking had no significant effects on glycaemic control in Type 2 diabetic patients as seen in other study [35]. The present study findings did not show significant associations between glycaemic control and disease duration, also contradictory with previous studies [11, 50].

Possibility the causes of long-standing hyperglycaemia or glycaemia uncontrolled were multifactorial and include genetic predisposition, free radical oxidative damage, protein glycosylation, and endothelial changes. In addition, lower socioeconomic status, psychological issues that lead to lack of motivation, emotional distress, poor eating habits and depression, inadequate knowledge on the part of the person with diabetes and the health professionals caring for them, have been implicated [51]. The consequences of long standing uncontrolled DM can be more serious in elderly patients due to functional disabilities, frequent presence of other comorbidities (renal, hepatic, cardiac impairment, etc.) and polypharmacy. Both acute and chronic complications can have catastrophic consequences in elderly diabetic patients. Increase in adipose tissue with ageing and the concurrent decrease in physical activity and the use of various potentially diabetogenic medicines (thiazide diuretics, beta-blockers, corticosteroids, etc.) most likely contribute to DM [52].

The explanation of study subjects to the poor control of diabetes can be linked to dietary habits. An earlier study in Kelantan [36] reported that the local diet contains high carbohydrates especially rice, sugar, eggs, coconut, and milk and its products. The second factor may be reduced by daily physical activity by the subjects. Most of them had no regular daily physical activity especially female patients who completely lacked daily physical activities [36]. The third contributory factor may be the diabetic patients in this study have high prevalence of micro- and macrovascular complications that accompanied diabetes mellitus. The researcher thinks that the patients did not know about their disease and the complications of their disease and also they did not comply with medications. The high rate of glycaemic uncontrolled could also be explained on the basis that majority of diabetic patients treated in HUSM are referred not only for their diabetic state, but rather for being more complicated cases of diabetes.

The goal of diabetes therapy should be to achieve glycaemic status as close to normal and as safely possible in HbA1c.

Despite the increase in the use antidiabetic medications, overall glycaemic control has not improved; in fact, it seems to have worsened. The majority of Type 2 DM patients in this study population had suboptimal control. This development may contribute to increased rates of diabetic complications and increased healthcare costs. Knowledge about the variables associated with poor glycaemic control is necessary for aiding the efforts aimed at reversing this trend. This supports the importance of education of patients in the adequate use of the available medications.

CONCLUSION

It has been found that age, race and antidiabetic medications are the factors that affect on the HbA1c, but age and smoking history are the factors affecting FPG, while gender and duration of diabetes are factors affecting PPG. The study recommends that health-care providers should pay more attention to Type 2 DM patients with older age, high duration diabetes, and should educate patients to quit smoking.

Acknowledgments

The authors would like to thank Universiti Sains Malaysia (USM) for the financial support provided for this research.

Conflicts of interest: We would like to declare that there were no conflicts of interest in conducting this research

REFERENCES

1. Sicree, R., Shaw, J. & Zimmet, P. (2003) Executive Summary. In: Gan D, ed. Diabetes atlas, 2nd edn. Brussels*: International Diabetes Federation and World Diabetes Foundation*.
2. Sicree, R., Shaw, J. & Zimmet, P. (2006) Prevalence and projections. In: Gan D, ed. Diabetes atlas, 3rd edn. Brussels: *International Diabetes Federation, 16-104*.
3. Nor, M., Safiza, N., Khor, G. L., Shahar, S., Kee, C. C., Haniff, J., ... & Ab Rahman, J. (2008). The Third National Health and Morbidity Survey (NHMS III) 2006: nutritional status of adults aged 18 years and above. *Malaysian Journal of Nutrition*, *14*(2), 1-87.
4. Couper, J. & Prins, J. (2003). Recent advances in therapy of diabetes. *MJA*, 179**,** 441- 447.
5. American Association of Clinical Endocrinologists (AACE) (2007). Medical guidelines for clinical practice for the management of diabetes mellitus. *Endocrine Practice*, *13*, 1, 4- 60.
6. Saydah, S., Fradkin, J. & Cowie, C. (2004). Poor control of risk factors for vascular disease among adults with previously diagnosed diabetes. *Journal of American Medical Associatio, 291***,** 335-342.
7. Weng, J., LI, Y., XU, W., SHI, L., Zhang, Q. & Zhu, D. et al. (2008) Effect of intensive insulin therapy on B-cell function and glycaemic control in patients with newly diagnosed Type 2 DM: A multicentre randomized parallel-group trial. *The Lancet*, 37**,** 1753.
8. (UKPDS)UK Prospective Diabetes Study (1998). Risk factors for coronary artery disease in noninsulin dependent diabetes (UKPDS 23). *BMJ*, 316**,** 823-828.
9. Lehto, S., Ronnemaa, T., Pyörälä, K. & Laakso, M. (1996). Predictors of stroke in middle aged patients with noninsulindependent diabetes. *Stroke*, 27**,** 63-68.
10. Groeneveld, Y., Petri, H., Hermans, J. & Springer, M (1999). Relationship between blood glucose level and mortality in Type 2 DM: a systematic review. *Diabet Med*, 16, 2–13.
11. Nichols, G., Hillier, T., Javor, K. & Brown, J. (2000) Predictors of glycemic control in insulin-using adults with Type 2 DM. *Diabetes Care*, 23**,** 3**,** 273-277.
12. Heisler, M., Faul, JD., Hayward, RA., Langa, KM., Blaum, C. & Weir, D. (2007). Mechanisms for racial and ethnic disparities in glycemic control in middle-aged and older Americans in the health and retirement study. *Arch Intern Med*, 167, 17, 1853-1860.
13. Benoit, S., Fleming, R., Philis-Tsimikas, A. & Ji M. (2005). Predictors of glycemic control among patients with Type 2 DM: a longitudinal study. *BMC Public Health*, 5, 36.
14. Turner, R., Cull, C. , Frighi, V. & Holman R. (1999). Glycemic control with diet , sulfonylurea ,metformin, or insulin in patients with Type 2 DM: progressive requirement for multiple therapies (UKPDS 49). UK Prospective diabetes study (UKPDS) GROUP. *JAMA* 281**,** 21, 2005-2012.
15. Hensrud, D. (2001). Dietary treatment and long-term weight loss and maintenance in type 2 diabetes. *Obes Res*, 9, 4, 348S-353S
16. Chou, A., Brown, A., Jensen, R., Shih, S., Pawlson, G. & Scholle, S. (2007). Gender and racial disparities in the management of diabetes mellitus among Medicare patients. *Womens Health Issues*, 17, 3, 150-161.
17. Harris, M., Eastman, R., Cowie, C., Flegal, K. & Eberhardt, M. (1999). Racial and ethnic differences in glycemic control of adults with type 2 diabetes. *Diabetes Care*, 22, 403–40.
18. Kilpatrick, E., Dominiczak, M. & Small, M. (1996). The effects of ageing on glycation and the interpretation of glycaemic control in Type 2 diabetes. *QJM*, 89, 307-312.
19. Ko, G., Chan, J., Woo, J., Lau, E., Yeung, V. & Chow, C. et al. (1997). The effect of age on

cardiovascular risk factors in Chinese women. *Int J Cardiol*, 61, 221-227.

20. Kutty, V., Soman, C., Joseph, A., Kumar, K. & Pisharody, R. (2002). Random capillary blood sugar and coronary risk factors in a south Kerala population. *J Cardiovasc Risk*, 9, 361-7.
21. Shorr, RI., Franse, LV., Resnick, HE., Di Bari, M., Johnson, KC. & Pahor, M. (2000). Glycemic control of older adults with type 2 diabetes: Findings from the Third National Health and Nutrition Examination Survey, 1988–1994. *J Am Geriatr Soc*, 48, 264–267.
22. Shai, I ., Wainstein, J. , Harman-Boehm, I., Raz, I. & Fraser, D. et al. (2007). Glycemic Effects of Moderate Alcohol Intake Among Patients With Type 2 diabetes A multicenter, randomized, clinical intervention trial. *Diabetes Care*, 30, 12, 3011-3016.
23. Goldman, D. & Smith, J. (2002). Can patient self-management help explain the SES health gradient? *PNAS*, 99, 10929 –10934.
24. Schillinger, D., Grumbach, K., Piette, J., Wang, F., Osmond, D. & Daher, C. (2002). Association of health literacy with diabetes outcomes. *JAMA*, 288, 475-482.
25. Kriska, A.M., Pereira, M.A., Hanson, R.L., De Courten, M.P., Zimmet, P.Z. & Alberti, K.G. et al. (2001). Association of physical activity and serum insulin concentrations in two populations at high risk for Type 2 DM but differing by MI. *Diabetes Care*, 24, 1175–1180
26. Pigman, H.T., Gan, D.X. & Krousel-Wood, M.A. (2002). Role of exercise for type 2 diabetic patient management. *South Med J*, 95, 72–77.
27. (UKPDS) UK Prospective Diabetes Study Group (1998). Intensive blood-glucose control with sulphonylureas or insulin compared with conventional treatment and risk of complications in patients with type II diabetes (UKPDS 33). *Lancet*, 352**,** 837-853.
28. Ronnemaa, T., Ronnemaa, E., Puukka, P., Pyorala, K. & Laakso, M. (1996). Smoking is independently associated with high plamsa insulin levels in nondiabetic men. *Diabetes Care*, 19, 1229-1232.
29. Targher, G., Alberiche, M., Zenere, M., Bonadonna, R., Muggeo, M. & Bonora, E. (1997). Cigarette smoking and insulin resistance in patients with noninsulin-dependent diabetes mellitus. *J Clin Endocrinol Metab*, 82, 3619–3624.
30. JNC II (2003). Complete report. The seventh report of the joint national committee on prevention, detection, evaluation and treatment of high blood pressure. Hypertension, 42,1206–1252.
31. Asian-Pacific Type 2 Diabetes Policy Group (2005). Type 2 DM practical targets and treatments: screening, diagnosis, management, treatment, monitoring, education and prevention. 4th ed.
32. Alwakeel, J. S., Al-Suwaida, A., Isnani, A. C., Al-Harbi, A., & Alam, A. (2009). Concomitant macro and microvascular complications in diabetic nephropathy. *Saudi journal of kidney diseases and transplantation*, *20*(3), 402.
33. Al-Maskari, F., El-Sadig, M., & Norman, J. N. (2007). The prevalence of macrovascular complications among diabetic patients in the United Arab Emirates. *Cardiovasc Diabetol*, *6*(1), 24.
34. Mohamad, M., Mohd Noor, MI. & Ali, R. (1997). Prevalence of dyslipidaemia in non-insulin-dependent diabetic patients attending armed forces clinics in Kuala Lumpur. *Asia Pacific J Clin Nutr*, 6**,** 203 – 206.
35. Valle, T., Koivisto, V., Reunanen, A., kangas, T. & Rissanen, A. (1999). Glycemic control in patients with diabetes in Finland . *Diabetes Care*, 22**,** 575 - 579.
36. Eid, M., Mafauzy, M. & Faridah, A. (2003). Glycaemic control of type 2 diabetic patients on follow up at hospital universiti sains Malaysia. *Malaysian journal of medical sciences*, 10**,** 2, 40-49.
37. Abouglambou, A., (2007). Prevalence and control of dyslipidaemia among patients with Type 2 diabetes mellitus in Hospital Universiti Sains Malaysia. Master thesis in medicine (internal medicine), Universiti Sains Malaysia, Kubang Kerian, Kelantan (unpublished study).
38. American Diabetic, A. (2008). Guidelines American Diabetic Assassociation. *Diabetes Care*, 31**,** S12- S554.
39. Roubideaux, Y., Buchwald, D. & Beals, J. et al. (2004). Measuring the quality of diabetes care for older American Indians and Alaskan Natives. *Am J Public Health*, 94**,** 60-65.
40. Hu, D., Henderson, J. & Welty, T. et al. (1999). Glycemic control in diabetic American Indians. Longitudinal data from the Strong Heart Study. *Diabetes Care*, 22**,** 11, 1802-1807.
41. Östgren, C., Lindblad, U., Ranstam, J., Melander, A. & Råstam, L. (2002). Glycaemic control, disease duration and □-cell function in patients with Type 2 DM in a Swedish community. Skaraborg hypertension and diabetes project. *Diabetic Medicine*, 19**,** 125-129.
42. Kabadi, U. (1998). Glycosylation of proteins. Lack of influence on aging. *Diabetes Care*, 11**,** 421-432.
43. Basu, R., Breda, E., Oberg, A., Powell, C. la Man, C. & Basu, A. et al. (2003). Mechanisms of the age-associated deterioration in glucose tolerance: contribution of alterations in insulin secretion, action, and clearance. *Diabetes*, 52, 1738–1748.

44. Zamami, Y., Takatori, S., Yamawaki, K., Miyashita, S., Mio, M. & Kitamura, Y. et al. (2008). Acute hyperglycemia and hyperinsulinemia enhance adrenergic vasoconstriction and decrease calcitonin gene-related peptide-containing nerve-mediated vasodilation in pithed rats, *Hypertens. Res*, 31, 1033–1044.
45. Reimann, M., Schutte, A. & Schwarz, P. (2007). Insulin resistance the role of ethnicity: evidence from Caucasian and African cohorts, Horm. *Metab Res*, 39, 853–857.
46. Roach, P., Koledova, E., Metcalfe, S., Hultman, C. & Milicevic, Z. (2001). the Romania/Russia Mix25 Study Group: Glycemic control with Humalog Mix25 in Type 2 DM inadequately controlled with glyburide. *Clin Ther*, 23**,** 1732-1744.
47. Niskanen, L., Jensen, L., Rastam, J., Nygaard-Pedersen, L. & Erichsen, K. et al. (2004). Randomized, multinational, open-label, 2-period, crossover comparison of biphasic insulin aspart 30 and biphasic insulin lispro 25 and pen devices in adult patients with Type 2 DM. *Clin Ther*, 26**,** 531-540.
48. Suhaiza, S., Ahmad, N.S., Jeriah, I., Aziz, A.S., Wan Mohamad, W.B. & Mafausy, M. (2004). *Glycaemic control among type 2 diabetic patients in kelantan. NCD Malaysia the bulletin of Epidemiology and Public Health on Non communicable Disease in Malaysia*, 3**,** 2-5.
49. Daigo, Y. A., Kengo, T.A., Jin, F.A., Naoyuki, U.A., Keizo O.B. & Masahiro, A. C. et al. (2005). Comparison of abdominal adiposity and overall obesity in predicting risk of type 2 diabetes among men. *Am J Clin Nutr* 81**,** 555-563.
50. Shera, A., Jawad, F., Maqsood, A., Jamal, S., Azfar, M. & Ahmed, U. (2004). Prevalence of chronic complications and associated factors in type 2 diabetes. *J Pak Med Asso*, 54**,** 54- 59.
51. De Vries, J., Snoek, F. & Heine, R. (2004). Persistent poor glycaemic control in adult type 1 diabetes: a closer look at the problem. *Diabetic Medicin* , 21**,** 1263-1268.
52. Konstantinos, M. (2006). Diabetes in Clinical Practice: Questions and Answers from Case Studies, Nicholas Katsilambros et al. John Wiley & Sons, Ltd.
53. Mackenzie, T., Brooks, B., & O'Connor, G. (2006). Beverage intake, diabetes, and glucose control of adults in America. *Annals of epidemiology*, *16*(9), 688-691.
54. Gunton, J. E., Davies, L., Wilmshurst, E., Fulcher, G., & McElduff, A. (2002). Cigarette smoking affects glycemic control in diabetes. *Diabetes Care*, *25*(4), 796-797.