# Factors Associated with Glycemic Control among Patients with Type 2 Diabetes at Chittagong Medical College Hospital

Parvin Aktar[1*] Mohammad Moharam Ali[2] Salma Akter[3]
Md. Hafizul Islam[4] Nayeema Tasnim[5] Ripan Kumar Mandal[6] Mahmudul Haque[7]

## Abstract

**Background:** Glycemic control is the main therapeutic goal for the prevention of diabetes related complications. However, achieving optimal glycemic control on long term basis among patients with Type 2 diabetes remains challenging in developing countries like Bangladesh. The purpose of the study to determine the factors associated with glycemic control among patients with Type 2 diabetes at Chittagong Medical College Hospital, Chattogram, Bangladesh.

**Materials and methods:** This cross sectional study included 120 patients with Type 2 diabetes aged 40-75 years who attended at Outpatient Department of Endocrinology, Chittagong Medical College Hospital between July 2020 to June 2021. Important variables in this study were socio-demographics, fasting blood glucose, HbA1c, BMI, waist circumference, duration of DM, proteinuria and documented history of chronic complications. Patent's HbA1c were categorized into good glycemic control <7% and poor glycemic control ≥7%.

**Results:** 84.2% of the patient's had poor glycemic control. The mean (±SEM) BMI, waist circumference, SBP, DBP, HbA1c and FBG were significantly higher in patients with poor glycemic control. Majority of patients with poor glycemic control were female and ≥60 years old. Patients with a history of higher BMI (65.3%), waist circumference (85.1%), 10 years of diabetes (33%), combination of OHA and insulin (42.6%) had poor glycemic control. There was no significant association with glycemic control and family history of diabetes, history of smoking, other socio-demographic variables. Patients without complications and proteinuria had significantly better glycemic control.

**Conclusion:** The proportion of patients with poor glycemic control was high. Age, duration of diabetes, obesity, anti-diabetic agents and complications were associated with glycemic control.

**Key words:** Glycemic status; HbA1c;Type 2 diabetes.

1. Lecturer of Biochemistry
Chittagong Medical College, Chattogram.
2. Resident of Neurology
Chittagong Medical College Hospital, Chattogram.
3. Assistant Professor of Biochemistry
Central Medical College, Cumilla.
4. Professor of Biochemistry
Chittagong Medical College, Chattogram.
5. Associate Professor of Biochemistry
Chittagong Medical College, Chattogram.
6. Assistant Professor of Biochemistry
Colonel Malek Medical College, Manikgonj.
7. Professor of Biochemistry (Retired)
Chittagong Medical College, Chattogram.

***Correspondence:** **Dr. Parvin Aktar**
*Cell : 01818 66 87 11*
*E-mail: parvin13th@gmail.com*

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## Introduction

Diabetes Mellitus (DM) is the leading causes of mortality, morbidity and economic loss worldwide.[1-2] Type 2 Diabetes Mellitus (T2DM) is the most prevalent (>90%) form than other types.[3-4] Historically diabetes had a higher burden in high-income countries but the disease is growing rapidly in low-to-middle income countries.[5] DM and its related complications are the sailent threat to global development especially on the economy of the resource limited countries including Bangladesh.[6] The overall morbidity and mortality rates of diabetes are higher in low-to-middle income countries like Bangladesh.[7]

According to International Diabetes Federation, in 2019 globally approximately 463 million (9.3%) adult people were living with diabetes. It has been projected to rise 578 million (10.2%) by 2030 and 700 million (10.9%) by 2045.[1] The prevalence of diabetes (8.8% of adult people) has increased more rapidly in South East Asia (50% of global diabetes) with China and India the top two countries.[5] Approximately 8.4 million people were diagnosed with diabetes in Bangladesh in 2019, world ranked as 10$^{th}$ position putting an enormous pressure on fragile health system. This number is projected to reach 11.4 million by 2030 and 15 million by 2045.[1,5]

T2DM remains asymptomatic for many years, about 30% individuals have chronic diabetic complications including ASCVD, nephropathy, neuropathy, retinopathy at clinical presentations.[3,8] A previous study in Bangladesh reported that 63.4% of the participants had complications.[6]

Approximately, globally 4.2 million adults were estimated to die as a result of diabetes and its complications in 2019. The SEA Region has the second highest number of diabetes related deaths with 1.2 million adults.[1] In a study in Bangladesh reported that loss of 4 million life years and 9.2 million PALYs (20.4%) were attributable of having diabetes. The loss in PALYs equated to a total US$ 97.4 billion lost (US$ 16987 per person) in GDP.[9] In 2019, annual global health expenditure on diabetes and related complications were estimated to be USD 760 billion.[1] Within SEA, the lowest diabetes-related health expenditure in Bangladesh was USD 64.[5]

Poor glycemic control in T2DM is a significant risk factor for the development of diabetic complications through activation of five major pathways.[10-11]HbA1c reflects average glycemic control over the previous 3 months and predicts long term complications especially micro vascular. The ADA has designed HbA1c level <7% as glycemic goal for many non-pregnant adults.[12] Epidemologic analyses of the Diabetes Control and Complications Trial (DCCT) and The United Kingdom Prospective Diabetes Study (UKPDS) demonstrated that HbA1c is strongly related to microvascular complications in Type 2 DM.[13-14] In UKPDS 35, it was found that 1% reduction in HbA1c was associated with 37% reduction in microvascular complications, 21% reduction in the risk of any end point or death related to diabetes.[14] Intensive therapy (HbA1c <7%) reduced the adjusted mean risk for retinopathy 76% and microalbuminuria 39%.[13]

However glycemic control remains an elusive goal for many patients with T2DM globally. In Bangladesh only 13% of DM patients showed appropriate control of blood glucose in a nationwide survey.[15] A similar high prevalence of poor glycemic control was also identified in other small scale study.[16-17]

Despite numerous advanced in management of this complex disease, in clinical practice achieving optimal glycemic control on long term basis is challenging. Many factors can influence optimal glycemic target including age, duration of illness, obesity, HDL level, type of medication, life expectancy, comorbidities, vascular complications, resource and patient preference.[11-12] The purpose of the study to identify socio-demographics and clinical factors which associate with poor glycemic control as measured by HbA1c.

**Materials and methods**

This was a cross sectional study and carried out in the Department of Biochemistry, Chittagong Medical College, Chattogram. The study population were established T2DM patients attending Outpatient Department of Endocrinology, Chittagong Medical College Hospital, Chattogram. A total 120 T2DM patients were recruited using non-probability purposive sampling from July 2020 to June 2021 (One year). The inclusion criteria for cases were established patients of type 2 diabetes mellitus aged 40-75 years. People with other types of diabetes and haemoglobin disorders like thalassemia were excluded. Exclusion done by medical history with records and clinical examinations. Then they were requested to report to the Department of Biochemistry, Chittagong Medical College at next morning following an overnight (8-10 hours) fasting.

Ethical clearance for this research protocol was taken from the Ethical Review Committee of Chittagong Medical College. Memo No: CMC/PG/2020/662. A written informed consent from all patients before the interview and explained the study objectives and procedures to them in their native language (Bengali).

Patient's socio-demographics duration of diabetes, family history of diabetes, smoking history, history of anti-diabetic agents, history of chronic diabetic complications were collected using a predesigned data collection form. Patient's complication status (IHD, stroke, diabetic foot, neuropathy, nephropathy and retinopathy) and prescribed anti-diabetic agents were ensured by asking the patients and reviewing their documented medical records. The participants were interviewed face to face by researcher herself.

Data were processed and analysed using IBM-SPSS (Statistical Package for Social Science) v 25.0 for Windows. Data were expressed as mean ± Standard Error of Means (SEM), frequency and percentages. p value ≤0.05 was considered statistically significant. Hypothesis testing was done by Chi-square ($\chi^2$) test, Independent sample-t test, Pearson's correlation co-efficient.

**Results**

Of the total 120 T2DM patients, 15.8% showed good glycemic control, while significant proportion of patients (84.2%) had poor glycemic

control (Table I). The mean (±SEM) BMI, waist circumference, SBP, DBP, weight, HbA1c and FBG were significantly higher in T2DM patients with poor glycemic control (Table II). Majority of T2DM patients with poor glycemic control were female and ≥60 years old. In this study there was no significant association between glycemic control and other socio-demographic variables like socio-economic status, education and residence (Table III). 33% of the cases with poor glycemic control had history of long duration of diabetes (>10 years). Diabetes was more likely to be poorly controlled among those with higher BMI (65.3%), waist circumference (85.1%). The highest level of poor glycemic control was found among patients on combination of oral anti-diabetic agents and insulin (42.6%). There was no significant association with glycemic control and family history of diabetes and history of smoking (Table IV). In this study, 63.3% of the cases had proteinuria on strip test. Most of the cases (64.17%) had no chronic diabetic complications in their medical history. Patients without complications and proteinuria had significantly better glycemic control compared to patients with complications and proteinuria (Table V). HbA1c had significant weak positive correlation with BMI and SBP and significant strong positive correlation with fasting blood glucose in cases (Table VI).

**Table I** Distribution of cases according to glycemic control (n=120)

| Cases | Frequency (%) |
|---|---|
| Cases with good glycemic control, HbA1c <7% | 19 (15.8%) |
| Cases with poor glycemic control, HbA1c ≥7% | 101 (84.2%) |

**Table II** Baseline characteristics of cases according to glycemic control (n=120)

| Variables | HbA1c<7% (n=19) | HbA1c≥7% (n=101) | Total (n=120) | p value# |
|---|---|---|---|---|
| Weight(kg) | 57.13±1.56 | 65.89±0.97 | 64.50±0.90 | <0.001 |
| Height(cm) | 157.85±1.5 | 157.29±0.89 | 157.37±0.82 | 0.804 |
| Waist Circumference(cm) | 83.47±1.57 | 89.84±0.75 | 88.83±0.71 | 0.001 |
| BMI | 22.94±0.52 | 26.63±0.35 | 26.05±0.33 | <0.001 |
| Systolic Blood Pressure(mmHg) | 129±2.3 | 138.71±1.6 | 137.18±1.47 | 0.015 |
| Diastolic Blood Pressure (mmHg) | 78.95±1.3 | 85.89±.85 | 84.79±0.78 | 0.001 |
| HbA1c (%) | 5.51±0.17 | 10.81±0.25 | 9.97±0.27 | <0.001 |
| Serum FBG (mg/dl) | 97.63±7.69 | 214.03±7.71 | 195.60±7.66 | <0.001 |

Results were expressed in mean±SEM. #Independent Sample t- test.

**Table III** Association of socio-demographic variables with glycemic control in T2DM (n=120)

| Variables | | HbA1c <7% (n=19) | HbA1c ≥ 7% (n=101) | Total (n-=120) | p-value # |
|---|---|---|---|---|---|
| Age (Years) | 40-49 | 9(47.4) | 21(20.8) | 30(25) | |
| | 50-59 | 3(15.8) | 18(17.5) | 21(17.5) | 0.044 |
| | ≥60 | 7(36.8) | 62(61.4) | 69(57.50) | |
| Gender | Male | 12(63.2) | 44(43.6) | 56(46.7) | 0.116 |
| | Female | 07(36.8) | 57(56.4) | 64(53.3) | |
| Education | Illiterate | 00 | 16(15.8) | 16(13.3) | |
| | Primary | 8(42.1) | 45(44.6) | 53(44.2) | |
| | secondary | 10(52.6) | 39(38.6) | 49(40.8) | 0.135 |
| | Higher | 01(5.3) | 01(1.0) | 02(1.7) | |
| Socioeconomic status | Lower | 6(31.6) | 21(20.8) | 27(22.5) | |
| | Middle | 12(63.2) | 57(56.4) | 69(57.5) | 0.182 |
| | Upper | 01(5.3) | 23(22.8) | 24(20.0) | |
| Residence | Urban | 09(47.4) | 60(59.4) | 69(57.5) | 0.330 |
| | Rural | 10(52.6) | 41(40.6) | 51(42.5) | |

Results were expressed in frequency (%). # Chi-square ($\chi^2$) test.

**Table IV** Association of clinical variables with glycemic control in cases (n=120)

| Variables | | HbA1c <7% (n=19) | HbA1c ≥7% (n=101) | Total (n=120) | p-value # |
|---|---|---|---|---|---|
| Duration of DM (Years) | < 5 | 12(63.2) | 35(34.7) | 47(39.2) | |
| | 5-10 | 05(26.3) | 33(32.7) | 38(31.7) | 0.045 |
| | >10 | 02(10.5) | 33(32.7) | 35(19.2) | |
| History of anti-diabetic agents | Diet only | 2(10.5) | 17(16.8) | 19(15.8) | |
| | OHA | 14(73.7) | 35(34.7) | 49(40.8) | 0.015 |
| | Insulin | 00(00) | 06(5.9) | 06(05) | |
| | Combined | 03(15.8) | 43(42.6) | 46(38.3) | |
| BMI | Normal | 16(84.2) | 18(17.8) | 34(28.3) | |
| | Overweight | 00(0.0) | 17(16.8) | 17(14.2) | <0.001 |
| | Obese | 03(15.8) | 66(65.3) | 69(57.5) | |
| Hypertension | Absent | 15(78.9) | 53(52.5) | 68(56.7) | |
| | Present | 04(21.1) | 48(47.5) | 52(43.3) | 0.033 |
| Waist | Normal | 16(84.2) | 15(14.9) | 31(25.8) | |
| Circumference, cm | Increased | 03(15.8) | 86(85.1) | 39(74.2) | <0.001 |
| Family history of | Yes | 11(57.9) | 61(60.4) | 72(60) | 0.838 |
| diabetes | No | 08(42.1) | 40(39.6) | 48(40) | |
| History of | Current smoker | 7(36.80) | 21(20.8) | 28(23.3) | |
| smoking | Former smoker | 4(21.1) | 23(22.8) | 27(22.5) | 0.302 |
| | Never smoker | 8(42.1) | 57(56.4) | 65(54.2) | |

Results were expressed in frequency (%). # Chi-square ($\chi^2$) test.

**Table V** Association of documented complications and proteinuria with glycemic control in T2DM (n=120)

| Variables | | HbA1c <7% (n=19) | HbA1c ≥7% (n=101) | Total (n-120) | p-value # |
|---|---|---|---|---|---|
| Documented diabetic complications | Absent | 17(89.5) | 60(59.4) | 77(64.2) | 0.012 |
| | Present | 02(10.5) | 41(40.6) | 43(35.8) | |
| Proteinuria | Absent | 11(57.9) | 33(32.7) | 44(36.7) | 0.036 |
| | Present | 08(42.1) | 68(67.3) | 76(63.3) | |

Results were expressed in frequency (%). # Chi-square ($\chi^2$) test.

**Table VI** Correlation of HbA1c with BMI, SBP and FBG in cases (n=120)

| Variables | | HbA1c (%) |
|---|---|---|
| BMI | Pearson correlation (r) | 0.221 |
| | p value | 0.015 |
| SBP (mm of Hg) | Pearson correlation (r) | 0.254 |
| | p value | 0.005 |
| Serum FBG (mg/dl) | Pearson correlation (r) | 0.854 |
| | p value | <0.001 |

## Discussion

Despite the availability of latest management tools for management of diabetes, poor glycemic control was present in 84.2% of the patients in this study. Similar findings have been reported in Bangladesh in previous studies.[15-19] In India, 78.2% of the patients had poor glycemic control.[11] In Jordan, 65.1% of the studied population had HbA1c>7%.[20] In Malaysia, 79.6% had poor glycemic control.[21] In UK, 69% had HbA1c>7.5%.[22] Many factors can influence optimal glycemic control including age, gender, duration of diabetes, obesity, socioeconomic status, education, diabetes self-care management behavior (Diet, physical activity, blood glucose monitoring, scheduled clinic visits), medication adherence, attitude towards diabetes, hypertension, dyslipidemia and chronic complications.[11,19,20,23,24]

In this designed study, most of the patients with poor glycemic control belongs to the age ≥60 years, which was similar to the other studies.[11,24] This result is not similar with the findings of a number of studies which reported younger age was associated with poor glycemic control.[18,19,21] A South Korean study had found that older adults considered 'positive attitude and self-confidence' are important in achieving good glycemic control.[25]

Previous studies have reported that long duration of diabetes was associated with poor glycemic control.[11,20,21] This study also revealed similar results. Long duration of diabetes is related to progressive impairment of insulin secretion which subsequently will cause poor glycemic control regardless of treatment regime.[26]

In this designed study obesity was significantly associated with poor glycemic control. This finding was similar with the finding of other study.[11]The significant effects of obesity on poor glycemic control could be explained by secretion of inflammatory markers and insulin resistance.[27]

In the present study, patients with poor glycemic control were significantly associated with insulin +OHA treatment regime which may indicate more aggressive disease that physicians are attempting multi-therapy to provide better glycemic control. The findings is consistent with other reported studies.[11,20]

It was observed that patients with documented history of complications and having proteinuria appeared to have poor glycemic control which is similar to the findings of other study.[11,19]

In this study these was no significant association of glycemic control with smoking, family history of diabetes which is consistent with the findings of other study.[11] In this designed study socioeconomic status did not impact glycemic control significantly which is similar with the findings of previous studies.[11,19,26] However in a study of Bangladesh it was found that, diabetes individuals belonging to low socioeconomic status had poorer glycemic control.[27]

Though in this study, there was no association of glycemic control with educational status and residencebut in another studyeducational status and residence were significantly associated with glycemic control.[24]

## Limitations

This was cross sectional study where causal relationships cannot be established. This was small sample study done by purposive sampling which cannot be generalized to the entire diabetic population. This study did not include important variables like diabetes self-care management behavior, medication adherence, attitudes towards diabetes. These factors are the well-known significant predictors for poor glycemic control as reported by other studies.

**Recommendations**

Multicenter prospective study with large sample size should be done in order to further evaluation of the factors which predict poor glycemic control among patients with T2DM.Inclusion of important variables like diabetes self-care management behavior, medication adherence, attitudes towards diabetes may provide a better assessment of factors affecting glycemic control in this context. Community based interventions should be aimed to convey awareness regarding maintenance of target HbA1c (<7%) by regular monitoring of HbA1c along with lifestyle changes. These can help greatly to prevent or retard further chronic diabetic complications.

**Conclusion**

In this study the proportion of T2DM patients with poor glycemic control was high. Age, anti-diabetic agents, duration of diabetes, obesity and complications status were significantly associated with poor glycemic control.

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**Contribution of authors**

MMA-Data collection, drafting and final approval.
SA-Interpretation of data, drafting & final approval.
MHI-Data analysis, critical revision & final approval.
NT-Data collection, data analysis, drafting & final approval.
RKM-Interpretation of data, critical revision & final approval.
MH-Interpretation of data, critical revision & final approval.

**Disclosure**

The authors declared no conflicts of interest.

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