



**ORIGINAL RESEARCH PAPER**

**Biochemistry**

**STUDY FOR EVALUATION OF HbA1c TRENDS AND BMI IN GLYCEMIC CONTROL IN A TERTIARY MEDICAL COLLEGE, WEST BENGAL**

**KEY WORDS:** HbA1c, BMI, T2DM

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**ABSTRACT**

**OBJECTIVE:** To evaluate HbA1c trends and Body Mass Index (BMI) in glycemic controlled among adult diabetic patients & try to investigate the relationship between age, sex, demography & quality of life of type 2 Diabetes Mellites patients by measuring the concentration of HbA1c level in whole blood.

**MATERIALS AND METHOD:** This observational, cross sectional, hospital-based study was conducted among 150 diabetic patients attending the Diabetic outpatient department over a period of 6 months of a Medical College hospital of Kolkata. Collected data was analysed using descriptive statistics to determine the correlation of HbA1c trends and BMI in glycaemic controlled among adult diabetic patients and investigate the relationship between age, demography and gender and the quality of Type 2 DM care.

**RESULT:** In this study which has conducted among 150 diabetic patients, we have found that the predominant age group of diabetic patients is 50. There is a positive correlation between urbanization and occurrence of diabetes (around 87% from urban area). We have seen that females (61%) are more prone to diabetes than male participants. We found that the HbA1c trends of below 7(61%) are mostly predominating among the patients, that means we are having a desirable HbA1c control. We have also found that the study participants are mostly overweight, having a high BMI range, (37%) i.e., of more than 25. And lastly there is also a positive correlation between the high BMI and poor quality of T2DM, i.e., poor HbA1c trends.

**CONCLUSION:** Overall study suggests that BMI is associated with glycaemic control and hence HbA1c can be used as a helpful prospective biomarker and a reliable measure of chronic glycemia and correlates well with the risk of long-term diabetes complications. So, it can be the test of choice for monitoring and chronic management of diabetes and can provide the local standards of care and clinical practice guidelines for the management of diabetes that are easily affordable and available to the health care providers and applicable to our country at the national level.

**INTRODUCTION**

Diabetes is global endemic with rapidly increasing prevalence in both developing and developed countries. India has the highest number of diabetes patients and has been correctly termed as “**Diabetes Capital of World**” [1]. About 382 million people suffered from Diabetes in 2013 & this no will increase 542 million by 2035, 175 million people undiagnosed, 2. Diabetes mellitus (DM) is a chronic disorder that can alter carbohydrate, protein, and fat metabolism. It is caused by the absence of insulin secretion due to either the progressive or marked inability of the -Langerhans islet cells of the pancreas to produce insulin, or due to defects in insulin uptake in the peripheral tissue [2]. Diabetes affects our blood vessels and nerves and therefore can affect any part of the body. It is a silent killer which can causes high blood pressure, high cholesterol levels and lack of blood glucose control [3].

Type 2 diabetes mellitus (T2DM) has a different pathophy siology and etiology as compared to type 1 diabetes. The existence of many new factors – for example, the increased prevalence of obesity among all age groups and both sex physical inactivity, poor diet, and urbanization – means that the number of patients diagnosed with type 2 diabetes is rising [4].

Type 2 diabetes is described as a combination of low amounts of insulin production from pancreatic β-cells and peripheral insulin resistance. [5]. Insulin resistance leads to elevated fatty acids in the plasma, causing decreased glucose transport into the muscle cells, as well as increased fat breakdown, subsequently leading to elevated hepatic glucose production. Insulin resistance and pancreatic β-cell dysfunction must occur simultaneously for type 2 diabetes to develop. Anyone who is overweight and/or obese has some kind of insulin resistance that means Body mass index (BMI) has a strong relationship to diabetes and insulin resistance. In

obese individuals, the amount of non-esterified fatty acids, glycerol, hormones, cytokines, proinflammatory markers, and other substances that are involved in the development of insulin resistance, is increased. Most patients with type 2 diabetes are obese, and the global epidemic of obesity largely explains the dramatic increase in the incidence and prevalence of type 2 diabetes over the past 20 years. Therefore, excess weight is an established factor for type 2 diabetes. [6,7]. HbA1c is routinely used as biomarker for long term assessment of diabetes. HbA1c predict the risk for the development of diabetic complication of diabetic patient. This study aimed to reveal the correlation of HbA1c with BMI, and also try to find out the physiological factors like as Sex, Demography, Age of the patient, directly related to glycemic control of diabetic patient.

Obesity is defined as the presence of a body mass index (BMI) ≥ 30 and is considered to be one of the fastest growing health problems in the modern world [8]. It is important to establish good health knowledge and attitudes toward overweight and obesity because it is associated with and considered to be an important risk factor for several chronic conditions, including diabetes (9). It is also considered one of the important preventable causes of death worldwide (10). A high BMI can be an indicator of high body fatness. Therefore, BMI can be used to screen for weight categories. BMI is actually a person's weight in kilograms divided by the square of height in meters that means-

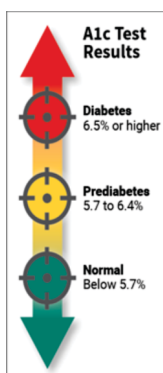
$$BMI = \frac{Weight (kg)}{[Height(m)]^2}$$

However, diabetes can be controlled by strictly maintaining a healthy diet, avoiding cigarettes, regular activity into your daily regime also help in order to keep blood sugar levels within recommended blood glucose level guidance. To keep blood glucose level in control diabetes should be detected in earlier stages. Blood glucose monitoring is used with frequent intervals in the management of condition. Some of the

common blood glucose tests include - fasting blood sugar (FBS) and post prandial blood sugar (PPBs). However, The American Diabetes Association has recommended glycated hemoglobin (HbA1c) as a possible substitute to fasting blood glucose for diagnosis of diabetes.

It has been established that HbA1c is an index of long-term blood glucose concentration and as a measure of the risk for the development of micro vascular complications in patients with diabetes mellitus. **Glycated hemoglobin ( HbA1c)** is a form of hemoglobin that is covalently bound to glucose. It is formed in a non-enzymatic glycation pathway by hemoglobin's exposure to plasma glucose. It is measured primarily to identify the three-month average plasma glucose concentration and thus can be used as a diagnostic test for diabetes and as assessment test for glycaemic control in people with diabetes [9].

The test is limited to a three-month average because the lifespan of a red blood cell is four months (120 days). However, since red blood cells do not all undergo lysis at the same time, HbA1c is taken as a limited measure of three months. HbA<sub>1c</sub> is a measure of the beta-N-1-deoxy fructosyl component of hemoglobin. (10) Normal levels of glucose produce a normal amount of glycated hemoglobin. As the average amount of plasma glucose increases, the fraction of glycated hemoglobin increases in a predictable way. This serves as an indicator that blood sugar is increasing and that action should be taken.



In diabetes mellitus, higher amounts of glycated hemoglobin, indicating poorer control of blood glucose levels, have been associated with cardiovascular disease, nephropathy, neuropathy, and retinopathy. For people without diabetes, the normal range for the hemoglobin A1c level is between 4% and 5.6%. Hemoglobin A1c levels between 5.7% and 6.4% mean you have a higher chance of getting diabetes. Levels of 6.5% or higher mean you have diabetes (6).

Despite high prevalence of diabetes, this study was carried out to examine the quality of type 2 diabetes mellitus (T2DM) care in a diabetes centre located in a tertiary hospital in West Bengal. The quality of T2DM care was examined by using quality indicators, both process and intermediate outcomes of care, in accordance with American Diabetes Association (ADA) targets 2012.

**AIMS AND OBJECTIVE**

- 1) To determine the correlation of Hb1c trends and BMI in glycaemic control among adult diabetic patients.
- 2) Investigate the relationship between age, demography and gender and the quality of T2DM care.
- 3) To assess the quality of care provided to diabetic patients with particular attention to glycaemic control, attending the outpatient department by using quality indicators laid down by the National Diabetes Quality Improvement Alliance (11)

**MATERIALS AND METHOD**

**SAMPLE SIZE**

We have conducted the study among 150 patients who

fulfilled the following criteria.

**STUDY DESIGN**

The study design was cross-sectional, observational where the diabetic patients were interviewed by the principal investigator. Study was conducted in Medical College, Kolkata.

**STUDY PERIOD AND STUDY POPULATION**

The audit was conducted among patients with diabetes who attended the Diabetic outpatient department over a period of 6 months. All type II diabetic patients, 18 years and above, who were diagnosed at least one year back without any other co-morbidity satisfied the inclusion criteria. The purpose of the study was explained to the patients and informed consents were taken from those who were willing to take part in the study.

**INCLUSION AND EXCLUSION CRITERIAS**

**Inclusion criteria:**

Patients were eligible for inclusion if they were aged ≥18 years, who had been diagnosed with T2DM and attended the Centre for more than one year. Patient demographic characteristics such as age, sex and duration of diabetes were collected using a data collection sheet. Other characteristics related to the lifestyle including BMI was collected as well. Relevant clinical data including the measurements of blood glucose was retrieved by reviewing each medical record, i.e., prescriptions.

**Exclusion criteria:**

- Patients < 18years of age.
- Patients with major systemic alignment according to physician's discretion.

**METHOD –**

HbA1c measurement - 5 ml blood was collected; venous blood was drawn in to EDTA vial.

Quantitative turbidimetric inhibition immunoassay by cobas 513 analyzer.

Weight-Measured by using electronic digital scales.

Height -Measured by using wall mounted stadiometer.

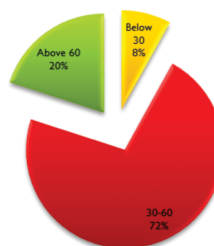
BMI was subsequently calculated as weight(kg) per height(m<sup>2</sup>)

Results of this study were statistically analysed using analysed using spss 20 version.

**RESULT AND ANALYSIS**

After conducting the study, we have determined determine the rate of poor glycaemic control and its associated factors (such as BMI) among patients. We also established the relationship between age, demography, gender and the quality of T2DM care.

**RELATIONSHIP BETWEEN AGE & QUALITY OF T2DM CARE**

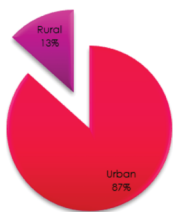


**Fig 1: The above chart shows the age range of patients participated in the study.**

Fig 1 shows the age of the study participants, the age range of below 30 is 8%, the age range of 30-60 is 72% and above 60 is 20%.

From this observation we found that the mean age of patients is- 50.

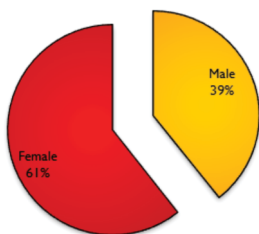
**RELATIONSHIP BETWEEN DEMOGRAPHY & QUALITY OF T2DM CARE**



**Fig 2: The chart shows the demography of the patients participated in the study.**

Fig 2 shows the demography of the study participants, 13% of them are from rural area and 87% are from urban area.

**RELATIONSHIP BETWEEN GENDER & QUALITY OF T2DM CARE**



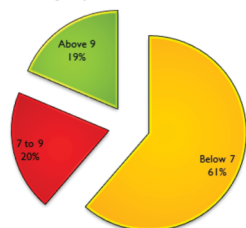
**Fig3: The chart shows the male-female ratio of the patients participated in the study.**

Fig 3 shows the gender ratio of the study participants. Among them 61% is female patients and 39% is male patients.

**TABLE 1: Reference Values of HbA1c according to American Diabetic Association (ADA) criteria**

HbA1c %	CLASSIFICATION
4.5-5.6%	Normal
5.7-6.4%	Prediabetic
More than 6.5%	Adequate control
6.6-7%	Adequate Control
7-9%	Inadequate Control
More than 9%	Very poor Control

**RATE OF HbA1c TRENDS**



**Fig 4: the chart shows the HbA1c range of the patients participated in the study.**

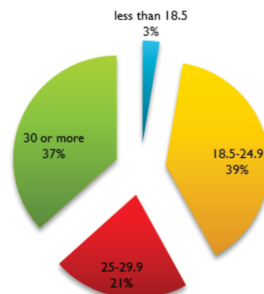
Fig 4 shows the HbA1c range of the study participants. Patients with HbA1c range of below 7 are 61%, 7 to 9 are 20% and above 9 are 19%.

**TABLE 2:WHO classification of BMI grading**

BMI	CLASSIFICATION
Less than 18.5	Underweight

18.5-24.9	Normal Weight
25.0-29.9	Overweight
30.0-34.9	Class I obesity
35.0-39.9	Class II obesity
More than 40.0	Class III obesity

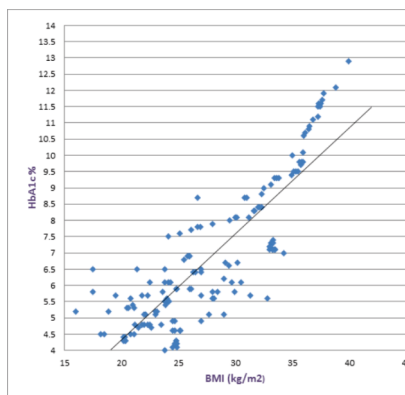
**RATE OF BMI**



**Fig 5: the chart shows the Body Mass Index (BMI) of the patients participated in the study.**

Fig 5 shows the BMI range of the study Participants. 3% of the patients are in the BMI range of less than 18.5, 39% of the patients are in the BMI range of 18.5 to 24.9, 21% of the patients are in the BMI range of 25 to 29.9 and 37% of the patients are in the BMI range of 30 or more.

**CORELATION BETWEEN HBA1C TRENDS AND BMI**



**Fig 6: Scatter plot explains the correlation between HbA1c levels and Body Mass Index (BMI) in Type 2 Diabetes Mellitus (T2DM) care.**

The scatter plot shows that higher the BMI range, higher the HbA1c %. This means BMI shares a positive correlation with HbA1c%.

**DISCUSSION**

Even though India is regarded as the Diabetic Capital of the World and multiple players are dealing diabetes at different settings, there are not many Indian studies which have assessed the quality of diabetes care. DEDICOM study done in Delhi is the only published study which had similar objective in mind.

Diabetes mellitus poses a major health challenge both epidemiologically and economically in India. Today's challenges do not arise from a lack of efficacious diabetes treatments. Rather, these challenges lie with effectively implementing them across the population. Numerous barriers to implementation are located at several levels including the societal, health care system, provider, and patient levels. A quality indicator is a measurable element of practice performance for which there is evidence or consensus that it can be used to assess the quality, and hence change the quality of care provided [11]. A well-planned audit conducted regularly can bring about beneficial change for patient and clinician.

In this study which has conducted among 150 diabetic patients, we have found that the predominant age group of diabetic patients is 50.

Fig 1 shows the age of the study participants, the age range of below 30 is 20%, the age range of 30-60 is 72% and above 60 is 20%.

From this observation we found that the mean age of patients is- 50. Fig 2 shows the demography of the study participants, 13% of them are from rural area and 87% are from urban area. Fig 3 shows the gender ratio of the study participants. Among them 61% is female patients and 39% is male patients. Fig 4 shows the HbA1c range of the study participants. Patients with HbA1c range of below 7 are 61%, 7 to 9 are 20% and above 9 are 19%.

Fig 5 shows the BMI range of the study Participants. 3% of the patients are in the BMI range of less than 18.5, 39% of the patients are in the BMI range of 18.5 to 24.9, 21% of the patients are in the BMI range of 25 to 29.9 and 37% of the patients are in the BMI range of 30 or more.

There is a positive correlation between urbanization and occurrence of diabetes. We have seen that females are more prone to diabetes than male participants. We found that the HbA1c trends of below 7 are mostly predominating among the patients, that means we are having a desirable HbA1c control. We have also found that the study participants are mostly overweight, having a high BMI range, i.e., of more than 25. And lastly there is also a positive correlation between the high BMI and poor quality of T2DM, i.e., poor HbA1c trends.  $r = 0.2812$ ,  $p \leq 0.0001$ , Alam et al (12) reported that HbA1c can be used as potential biomarker for diabetes control, Bella et al (13) shows that there is strong correlation between HbA1c level with BMI level in poor controlled diabetic patient.

**CONCLUSION**

HbA1c is the important Biomarker for glycemic control of type 2 Diabetes mellitus patient. If BMI of the patient is high, this high BMI may cause the increased level of HbA1c of diabetic patient, indicator poor control. From this study, females are more prone to diabetes, aged people 50 year or above are suffering from diabetes. More Urban people has diabetes than village people. Physiological parameters are also responsible for poor glycemic control. Lifestyle modification takes important role for controlling diabetes. Through this study, we have tried to educate the patients about the physiological parameters directly involved in controlling diabetes.

**LIMITATION OF THE STUDY**

We still have very lacking of knowledge as there are no proper clinical practice guidelines for checking the quality care of diabetes and our duration of study is also short, i.e., 2 months.

**REFERENCES**

1. International Diabetes Federation - About WDD. *Worlddiabetesday.org*. 2018. Available from: <https://www.worlddiabetesday.org/about-wdd.html>.
2. Florence JA, Yeager BF (1999) Treatment of type 2 diabetes mellitus. *Am Fam Physician* 59: 2835-2844, 2849-2850.
3. King H, Aubert R, Herman W (1998) Global burden of diabetes, 1995-2025: prevalence, numerical estimates, and projections. *Diabetes Care* 21:1414-1431.
4. American Diabetes Association Position Statement: Standards of Medical Care in Diabetes 2013. *Diabetes Care*. 2013;36: S11-S66. doi: 10.2337/dc13-S011. [PMC free article] [PubMed]
5. Canadian Diabetes Association. *Clinical Practice Guidelines Expert Committee. Canadian Diabetes Association 2008. Clinical Practice Guidelines for the Prevention and Management of Diabetes in Canada. Can J Diabetes*. 2008;32:S1-201. [cited May 2012]
6. Use of Glycated Hemoglobin (HbA1C) in the Diagnosis of Diabetes Mellitus: Abbreviated Report of a WHO Consultation. Geneva:World Health Organization. 2011. p. 2. Glycated hemoglobin (HbA1c) for the diagnosis of diabetes. Retrieved 2 December 2018
7. Miedema K (2005). "Standardization of HbA1c and Optimal Range of Monitoring". *Scandinavian Journal of Clinical and Laboratory Investigation*. 240: 61-72. doi:10.1080/00365510500236143. PMID 16112961.
8. .Calculator BMI. Basics about Childhood Obesity

9. World Health Organization. *Obesity: Preventing and Managing the Global Epidemic*. World Health Organization: Geneva, 2000. Accessed Aug 2016
10. Guidelines for management of type 2 Diabetes. New Delhi ICMR [Internet] 2005 [cited 2012 Mar 04]. Available from: [http://icmr.nic.in/guidelines\\_diabetes/prelim.pdf](http://icmr.nic.in/guidelines_diabetes/prelim.pdf).
11. Peters A, Leogorreta AP, Ossorio RC, Davidson MB. Quality of Outpatient Care Provided to Diabetic Patients: A health maintenance organization experience *Diabetes Care*. 1996;9(6):601-06. [pubMed]
12. Alam R, Verma MK, Verma Glycated hemoglobin as a Dual Biomarker in Type 2 Diabetes Mellitus Predicting Glycemic Control in Dyslipidemia Riskier *Jrnal Sci Res*. 2015;1:6.
13. Benot SR, Fleming R, Philis-Tsimika A, Ji M. Predictors of glycemic control among patients with type 2 diabetes: A longitudinal study. *BMC Public Health*. 2005;5:36. [PMC free article] [PubMed].