

## An Overview of Glycaemic Control Status among Diabetes Patients and Its Predictive Associated Factors: A Review

Pradip Panta,<sup>1</sup> Rubin Pote,<sup>1</sup> Parbati Thapa,<sup>1</sup> Anil Giri<sup>1</sup>

<sup>1</sup>School of Health and Allied Sciences, Pokhara University, Kaski, Nepal

### ABSTRACT

Diabetes Mellitus (DM) is a rapidly leading public health problem and responsible for three quarters of morbidity and 88% of mortality affecting millions of people worldwide. Achieving good glycaemic control is an important indicator in diabetes management. Glycated hemoglobin (HbA<sub>1c</sub> i.e. ≤7%) and fasting blood glucose (FBG i.e. <130mg/dl) were used to determine glycaemic control for type 2 diabetic patients. Factors associated with good glycemic control were older age, high medication adherence and better health literacy. Duration of DM >7 years was inversely related to good glycemic control and was higher in patients residence in rural areas along with hyperlipidemia, sedentary lifestyle, physical activity and oral hypoglycemic drug (OHD) as part of their T2DM therapeutic regimen. Patients on insulin and oral hypoglycemic agents, patients on insulin and low-medication adherents were more likely to have uncontrolled and poor glycaemic control while exercise contributed to glycaemic control status as a protective factor. Besides, patient's information on glycemic control and lifestyle modification, consultation is probably infrequent due to various reasons such as patients' economic issues, educational levels, health awareness and remote distance to health care centers, have direct impact to possess the good glycaemic control. Hence, data gotten by specialists can't exhaustively mirror patients' wellbeing status and may prompt have imperfect wellbeing choices. So, this is also the markable reason behind poor glycaemic control and has been now widely reported even though efforts have been implemented. Thus, to achieve wide-scale promotion of diabetes management, it is essential to explore knowledge of medication adherence and better health knowledge along with promoting good practices (regular exercise behavior, dietary habits and awareness of diseases).

**Keywords:** *HbA<sub>1c</sub>, Diabetes Mellitus, T2DM, FBG, Cross sectional and Glycaemic Control.*

### INTRODUCTION

With increasing serious acute and chronic complications and prevalence, diabetes has conveyed tremendous weight to individuals' living and production. Along these lines, accomplishing great glycaemic control is just a significant route in diabetes the board as hyperglycemia and hypoglycemia can both lead to genuine clinical results.<sup>1,3,9,10</sup> Glycated hemoglobin (HbA<sub>1c</sub> i.e. ≤ 7%) and fasting blood glucose (FBG i.e. <126mg/dl) were used to determine glycaemic control for type 2 diabetic patients. Since, health care provider just acquire patients' data on glycemic control and way of life during their consultation which is most likely inconsistent as different reasons, for example, patients' economic issues, instructive dimensions, wellbeing mindfulness and remote separation to health care centers have direct impact to possess the good glycaemic control level.<sup>2,5,7,13,17</sup>

With respect to population in China, almost 11% of all adults are currently living with T2DM which is associated with long term complication (eg, cardiovascular disease) and even death. Alarming, nearly 40% of these deaths are premature.<sup>1,5,9,16</sup> In South Korea, diabetes prevalence among ≥ 30-year-old adults has rapidly increased from 8.8% in 2001 to 10.1% in 2010 and 11.9% in 2013. Furthermore, diabetes-related complications and

hospitalizations have become more common which undermines patients' quality of life and emphasizes the related socio-economic burden that totally reflects the need of highlighting the importance of managing type 2 diabetes in South Korea.<sup>2,17,19,21</sup> With respect to India, more than 60% of subjects had not their HbA<sub>1c</sub> level checked in the past year in urban and rural areas and whoever had their preference checked were also found with poor glycaemic values. Also, it is accounted for that the high prevalence of iron deficiency anemia in India is another factor that could possibly have meddled with results since studies have demonstrated that this condition is probably going to dishonestly build HbA<sub>1c</sub> levels. In addition, a lower dimension of HbA<sub>1c</sub> need not really be a pointer of better glycemic control since it could likewise be because of an increase in hypoglycemic occasions especially in the older with an expanded span of diabetes.<sup>14,16,19</sup>

Exercise behavior, dietary habits and awareness of diseases could be the major steps for helping the patients and targeting

**Correspondence:** Pradip Panta, Master of Pharmaceutical Sciences(Clinical Pharmacy), School of Health and Allied Sciences, Pokhara University, Kaski, Nepal, E-mail: panta.pradip89@gmail.com

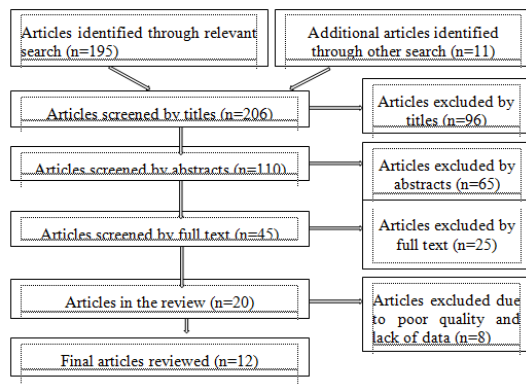
interventions to improve their glycemic control and prevent diabetes-related complications on forwards. In additions to these, a proficient, effectively accessible and cost-effective way to deal with geological-economic holes and achieve more extensive Populaces ought to be considered.<sup>1, 5,15,16,18</sup>

## METHODS

### Data Sources, Searches and selection

For this study, a search was conducted in PubMed, HINARI and Google Scholar to identify relevant study to this topic published from 2004 to 2018 using keywords: type 2 diabetes, diabetes mellitus, onset maturity, glycaemic control and HbA<sub>1c</sub>. To achieve a searching scope that was sufficiently wide, the previously mentioned keywords were not encased. To expand the search scope and incorporate more studied in this field, we manually looked through the reference records that may be related to the study.

### Data screening and Extraction



### Study selection

We here considered the cross sectional study at any clinical settings that explored the impact of glycaemic control level with Type2 DM. The inclusion criteria for the participants were any patient with T2DM, aged between 18 and 85 years. The primary outcome must include: glycaemic control which was measured by glycosylated haemoglobin (HbA<sub>1c</sub>). We defined poor glycaemic control as HbA<sub>1c</sub> more than 7.5% (53 mmol/mol) and FBS more than 130mg/dl. Our secondary outcomes were the impact of other possible risk factors on the poor glycaemic control with T2DM e.g. duration of DM, patients' age, gender, medication adherence, type of medication, residential area, hypertension and smoking. During the initial review for titles and abstracts, studies that did not meet our criteria were excluded. Studies were prohibited if they were nonrandomized, reviews, protocols, case reports or editorials; did not utilize HbA<sub>1c</sub> as the result measure or there was a fragmented report of HbA<sub>1c</sub>.

## RESULTS

Studies included were published between 2013 and 2018. Total sample size was 79,077 patients; they were conducted in the Libya (523 participants), Palestine (369 participants), China (1387 participants), South Korea (171 participants), Malaysia (340 participants), Dubai (250 participants), Ireland (569 participants), India (14,277 participants), Scotland (60,375 participants), Ethiopia (343 participants), USA (287 participants) and Zambia (186 participants). Summarize characteristics and the main findings of the studies are presented in Table 1.

Table1: Study sample, outcomes and confounder included

| Study                           | Study Aim   | Sample characteristics   | Outcomes  | Confounder included   |
|---------------------------------|---|--|---|---|
| Ashur T S et. al., <sup>3</sup> | Evaluate glycaemic control status among type 2 diabetic patients in Tripoli.  | 523 respondents<br>HbA <sub>1c</sub> =8.9%(2.1),<br>Mean duration± SD=10.48(8.12), Good glycaemic control ≤6.4%                                  | Bad health literacy, low adherence to medication, low adherence to age  | z   |
| RadwanM et. al., <sup>1</sup>   | Assess the level of good glycemic control and to examine factors influencing good glycemic control.   | 369 respondents<br>Mean HbA1c± SD= 8.97(2.02)<br>Mean duration ± SD= 10.48(8.12),<br>Good glycaemic control ≤7%, Duration of DM=≥7yrs            | Glycaemic control suboptimal, multivariate logistic analysis showed age, duration of DM, high adherence and better health literacy to good glycaemic control. | HbA <sub>1c</sub> , age, gender, diabetes duration, medication adherence, blood glucose testing, behaviours, consultation time, doctor consultation, previous complications |
| Li J et. al., <sup>2</sup>      | Assess glycaemic control in patients with type 2 diabetes (T2DM) at a tertiary care diabetes centre in Ningbo, China and to determine factors that independently predict their Glycaemic control. | 1387 respondents<br>Mean HbA1c± SD= ≥6.9(2.01)<br>Mean duration ± SD=17.45 (1.3)<br>Good glycaemic control ≤7% or fasting blood glucose ≥7mmol/l | Glycaemic control associated with age, education, residence, duration of DM and Type2 therapeutic regimen   | HbA <sub>1c</sub> , FBG, age, gender, diabetes duration, medication adherence, blood glucose testing, smoking, alcohol drinking, BMI, hypertension, hyperlipidaemia         |

|                                      |   |   |  |  |
|--------------------------------------|---|---|--|--|
| Choi H W et. al., <sup>4</sup>       | Examine specific self-care behaviours, depression, and diabetes-related stress among South Korean patients with type 2 diabetes and to evaluate whether these factors are related to Glycaemic control.   | 171 respondents<br>Mean HbA1c± SD=7.37%±1.27<br>Mean age SD=59.55 yrs ( 9.75)<br>Good glycaemic control ≤6.5%                       | Poor glycaemic control had significantly lower values for medication adherence and significantly Greater values for regimen-related distress. Depression was not significantly associated with Glycaemic control. In logistic regression analysis, only medication adherence was independently associated with glycaemic control.                  | HbA1c, age, gender, diabetes duration, medication adherence, blood glucose testing, behaviors( diet, exercise) |
| Tharek Z et. al., <sup>5</sup>       | Determine the level of self-efficacy, self-care behavior and glycaemic control among patients with type 2 diabetes mellitus in the Malaysian primary care setting   | 186 respondents<br>Mean self-efficacy ± SD= 7.33(2.25)<br>Mean self-care behavior ± SD= 3.76(1.87),<br>Good glycaemic control ≤6.4% | Positive relationship self-efficacy and self-care behavior.<br>Linear regression demonstrated higher self-efficacy, shorter duration associated to good glycaemic control.   | HbA <sub>1c</sub> , age, gender, diabetes duration, medication adherence, blood glucose testing, behaviors     |
| Szabo et. al., <sup>6</sup>          | Estimate the proportion of patients receiving recommended monitoring at the Dubai Hospital for T2DM over one year   | 150 respondents<br>Mean age ± SD=58yrs( 12.4),<br>Good glycaemic control ≤6.5%  | Rate of monitoring for selected measures were comparable to Benchmarks from the United States. Greater understanding of factors leading to high adherence would be useful for other areas of Preventive care and other jurisdictions.  | HbA <sub>1c</sub> , low-density lipoprotein (LDL), blood pressure, retinopathy, and nephropathy                |
| Fitzgerald et. al., <sup>7</sup>     | Determine whether there is an association between patient empowerment and diabetes management in terms of the 5 primary outcomes of metabolic control as measured by glycaemic control (Glycated haemoglobin, HbA1c), high-density lipoprotein (HDL), low-density lipoprotein (LDL), total cholesterol (TC) and triglycerides | 569 respondents<br>Mean HbA1c± SD=7.01(1.3)<br>Good glycaemic control ≤7%   | Partial correlation analyses failed to show any statistically significant relationship between patient empowerment and glycaemic control or other diabetes Management variables. Age and gender were significant predictors of HDL and LDL levels, while gender and age were associated with changes in TC and triglycerides levels, respectively. | HbA1c, HDL, LDL, TC and Triglycerides values.  |
| Unnikrishnan R et. al., <sup>8</sup> | Estimate the levels of glycemic control among subjects with self-reported diabetes in urban and rural areas of four regions in India<br>Population-based data to investigate the relationships between ethnicity and glycaemic control in men and women with diabetes mellitus living in Scotland                             | 480 respondents<br>Mean HbA1c± SD=8.5%(1.3)<br>Good glycaemic control ≤7%   | Multiple logistic regression analysis revealed younger age, Duration of diabetes, insulin use, and high triglyceride levels to be significantly associated with poor glycemic control.   | HbA <sub>1c</sub> , age, gender, diabetes duration, medication adherence, blood glucose testing, behaviours    |
| Negandhi H P et. al., <sup>9</sup>   | Improve the patient's quality of life, to maintain satisfactory metabolic control and to retain minimal complications caused by diabetes mellitus   | 56,333 respondents<br>Good glycaemic control ≤7.5%  | All other ethnic groups had significantly (p,0.05) greater proportions of people with suboptimal glycaemic control   | HbA <sub>1c</sub> , age, gender, diabetes duration, medication adherence, blood glucose testing, behaviours    |
| Endalew H E et. al., <sup>10</sup>   |   | 343 respondents<br>Good glycaemic control ≤126mg/dl<br>BMI ±SD =23.4 kg/m <sup>2</sup> ± 4.22 kg/m <sup>2</sup>                     | Level of knowledge about diabetes and self-care practices amongst diabetic patients was meager. In addition, it showed that respondents' level of physical activity, their educational status, and the dose of oral hypoglycemic agents taken by the respondents significantly affected glycaemic control  | FBG, age, gender, diabetes duration, medication adherence, behaviours  |

|                                    |   |  |   |   |
|------------------------------------|---|--|---|---|
| Aikens E J et. al., <sup>11</sup>  | Determine whether self-reported medication adherence predicts future glycaemic control in Type 2 diabetes, after accounting for baseline control. | 287 respondents<br>Mean HbA1c± SD<br>Mean duration ± SD=<br>Good glycaemic control ≤6.4% | Even after stringent adjustment for baseline glycaemic control, self-reported Adherence to diabetes medication predicts long-term glycaemic control. Morisky scale is an easy-to-use clinical tool to identify patients whose glycaemic control will subsequently worsen, regardless of age, gender and psychological distress. Adherence and fasting plasma glucose Predicted glycaemic control status of the patients. However, self-blood glucose monitoring, self-blood glucose monitoring means And exercise did not predict glycaemic control status of the patients. | HbA <sub>1c</sub> , age, gender, diabetes duration, medication adherence, blood glucose testing, behaviours |
| Musenge M E wt. al., <sup>12</sup> | Assess glycaemic Control status and self-management behaviours that may influence glycaemic control among diabetic outpatients.                   | 369 respondents<br>Good glycaemic control ≤6.8%  |   | HbA <sub>1c</sub> , age, gender, diabetes duration, medication adherence, blood glucose testing, behaviours |

## DISCUSSION

Generally, in terms of HbA<sub>1c</sub> and FBG, type 2 diabetic patients around different places are meant to have their glycaemic control within the estimated level in order to prevent from other clinical complexity. But, actually, it was not the case and the glycaemic control is mostly found to be much poorer in the developing countries like India, Palestine and Libya,<sup>1,3,19</sup> in comparison to the developed countries like USA, Scotland, Ireland, Ethiopia, Zambia and Dubai while in China, Malaysia and South Korea.<sup>6,9,10</sup>

While in case of South Korea, China and Malaysia, self-considerations in term of disease, duration of medication, age, self-blood monitoring, and exercise have not shown a good termination in their glycaemic control.<sup>2,4,5,8</sup> So, here glycaemic control are meant to get within the optimized level through deeper level of exercise, knowledge and frequency of clinical test required for time period. As in the term, the patients should be of having patients' empowerment.<sup>24</sup>

In most of the study, patients' self-managements were found to have better glycaemic control while in Palestine and India self-reporting glycaemic controlled did not contribute for the predicting good glycaemic control in the diabetes patients. Indian Study of glycaemic control were found to have in alarming conditions which represents that the HbA<sub>1c</sub> value may not be the trustable basis as it depend to the average life span of the RBCs. So, here the limitation to the HbA<sub>1c</sub> should be accounted to have with respect to the conditions of the patients (such as anaemic conditions, hemolytic, liver diseases, cancer etc). The reason behind this may be insufficient or improper delivered knowledge or practice in the patients. So, here they need an appropriate and proper knowledge on disease, the way of taking medicines, diet and use of regular validated glucose monitoring equipment.<sup>19</sup>

Also, from the study of the South Korean, it was found that the

Asian are more prone to the Diabetic disease due to the ethnicity basis as well as due to their cultural attitudes. So, here also the patients should be categorized so as to prevent them from getting the disease in early ages.<sup>4</sup>

So, immediate actions are to be taken to optimize the level of glycaemic control in respect to the developing countries, while in developed countries self-patient considerations to their disease were found better. With respect to developing countries, health care providers can just get patients' data on glycemic control and way of lifestyle during their consultation which is most likely rare as a result of different reasons, for example, patients' economic issues, educational dimensions, wellbeing mindfulness, and remote separation to health care centers. Data acquired by specialists can't completely mirror patients' wellbeing status and may prompt problematic wellbeing choices. So, poor glycaemic control has been widely reported even though efforts have been implemented in improving the glycaemic conditions in most of the developing countries.

From the study, it was also found that the factors such as age, gender, life style, education, adherence to medication, residency, smoking, alcohol drinking, duration of therapy, BMI, hypertension, diet, regular exercise, comorbidities and hyperlipidaemia are associated with the glycaemic control status in diabetes patients. With respect to gender, female patients were more likely to have uncontrolled and poor glycaemic control than males even though adhered to medication here the possible factor may be BMI.

In diabetes medication (oral hypoglycaemic agent, combo with insulin or insulin only), especially, insulin treated patients have found higher to have uncontrolled and poor glycaemic control diabetes. The reason for this could be the pathology of diabetes or a shift to exogenous insulin to control their high HbA<sub>1c</sub> levels.



Hence, the reasons for inappropriate control may be the variation of services at different hospitals, different population characterization, unused of newer hypoglycaemic drugs, inadequate self-management practice and failure of clinicians to improve therapy in a timely manner. In this way, health care provider experience just patients' data on glycemic control and lifestyle during their consultation which is likely rare because of different reasons, for example, patients' economic issues, educational levels, wellbeing awareness, and remote separation to health centers basically in underdeveloped or developed countries in patients are past their constraint for evaluating the services.

## CONCLUSION

Glycated haemoglobin (HbA<sub>1c</sub> i.e.  $\leq 7\%$ ) and fasting blood glucose (FBG i.e.  $< 130\text{mg/dl}$ ) are the major biomarkers for determining glycaemic control for type 2 diabetic patients. Accomplishing great glycaemic control is wide-scale advancement of diabetes self-management, it is fundamental to investigate learning of prescription adherence and better wellbeing information alongside advancing great practices (regular exercise, dietary habits and attention to infections) with respect to the predictive associated factors (continuous medication adherence, thought of diabetes-related trouble, self-administration, type of medicine). Thus, the predictive associated factors could be the significant strides for helping the patients and focusing on medications to improve their glycemic control and prevent diabetes-related complications on advances.

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## Conflicts of interest

The authors declare that they have no competing interests.

## Ethical approval and consent to participate

Not applicable.

## Availability of data and materials

Not applicable.

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