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# HbA1c as A Diagnostic Tool for Screening Purposes At The Community Level


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## ABSTRACT

***Background:*** *The increase in the incidence of Diabetes in both the urban and rural sectors of population demands a proper screening strategy for early diagnosed, to delay the complications associated with this disorder.*

***Aim:*** *To evaluate HbA1c as a diagnostic tool for screening purposes at the community level. Materials and Methods: 100 Type 2 Diabetics were included as cases and 100 healthy individuals were taken as controls in this study from the people attending medical outdoor and indoor facilities in the Department of Medicine, Sardar Patel Medical College and Associated Group of Hospitals, Bikaner, Rajasthan, India. FBS and HbA1c were estimated in them. The data was statistically analyzed using SPSS software version 21.*

***Results:*** *A significantly ($p<0.001$) strong and positive correlation between FBS and HbA1c with a "r" value 0.908 was observed. HbA1c showed 100% sensitivity and specificity at a best cut off value of 6.7%.*

***Conclusion:*** *Hba1c can be used as an effective screening tool at the community level, provided that the test should be performed using a method that is standardized.*


KEYWORDS : FBS, HbA1c, Type 2 Diabetes

**Introduction:**

The high prevalence of diabetes mellitus in the recent years has emerged as a worldwide public health problem, with type 2 accounting for 85–90% of cases. [1] Diabetes is under diagnosed as the average lag between onset and diagnosis is 7 years.[2,3,1,4] Early diagnosis, lifestyle modification, and tight glycemic control can reduce the risk of long-term complications.[5,3,6] Fasting plasma glucose (FPG) and oral glucose tolerance test (OGTT) are the most widely used screening tests for detection of diabetes. Both the tests measure blood glucose.

The problems with blood glucose estimations include high individual biological variability, preanalytical variability like the method of collection and storage, lifestyle measures like exercise and calorie restriction and difficulty in ensuring fasting state.[7] The glycated hemoglobin ($HbA_{1c}$) test has been suggested as an alternative screening test for Type 2 diabetes.[1] HbA1c overcomes many of these difficulties as fasting state is not required, analytical variability is less than 2% and gives glycemic status over the past 2–3 months. [7,6]

HbA1C values are relatively stable after collection, and the recent introduction of a new reference method to calibrate all HbA1C assay instruments should further improve HbA1C assay standardization. There are recommendations to use HbA1c ≥ 6.5% as a diagnostic tool to detect type 2 diabetes based on the International Expert Committee (IEC) in 2009, the American Diabetes Association (ADA) in 2010 [10,12] and the World Health Organization (WHO) in 2011. This cut-point represents the approximate level above which prevalent retinopathy begins to increase.[8] Its recommendation for diagnosis of diabetes mellitus has evoked mixed response worldwide. The diagnostic test should be performed using a method that is certified by the National Glycohemoglobin Standardization Program (NGSP) and standardized or traceable to the Diabetes Control and Complications Trial (DCCT) reference assay.[9]

**Materials & Methods1**

In this study subjects were divided into 100 cases and 100 controls in medical outdoor and indoor patients in Department of Medicine, Sardar Patel Medical College and Associated Group of Hospitals, Bikaner, Rajasthan, India. Cases included recently diagnosed Type 2 Diabetics (<1yr) in the age group of 30 to 50 years and controls comprised of healthy individuals not suffering from any ailments in the same age group i.e. 30-50 years.

**Exclusion Criteria:** Type 1 diabetics

Individuals suffering from any condition that changes red cell turnover, such as hemolytic anemia, chronic malaria, major blood loss, glucose-6-phosphate dehydrogenase deficiency, sickle cell anemia or blood transfusions, hemoglobinopathies, recent hemolysis

Individuals with high triglyceride levels

Individuals taking drugs like salicylates, vitamin C and vitamin E

In both these groups FBS and HbA1c were estimated in the blood samples taken from them after taking written consent. After an overnight fast, peripheral venous blood samples were collected in two vaccutainers 5ml in gel vaccutainer and 2 ml in the EDTA vaccutainer. Serum separated after centrifuge; was used to analyze FBS by GOD-POD method. The EDTA sample was used to measure HbA1C that was determined by Ion-exchange resin method. The association between HbA1c and FBS and also their sensitivity, specificity and predictive values in detection of abnormal values of each other were determined using SPSS software version 21.

**Results**

Data obtained was analyzed using SPSS v 21 software. It was observed that the mean FBS in control group (n=100) and diabetic group (n=100) was 87 mg/dl (±17.24) and 211.08 mg/dl (±112.4) respectively. The difference in mean was compared using independent sample t test and it was observed to be significantly higher in diabetics than controls ($p<0.001$) at a t value of 12. Mean HbA1c in control group was 5.25 ± 0.75 and in diabetic group was 8.70 ± 2.72, the mean difference was significantly more in diabetics ($p=<0.001$) at a t value 17.54

Using ROC curve analysis it was observed that at a best cut off value of 117.0 mg/dl, FBS had a sensitivity and specificity of 100% respectively in differentiating cases from controls compared to HbA1c which showed a similar 100% sensitivity and specificity at a best cut off value of 6.7% and the positive predictive value for both the parameters at above mentioned best cut off value was 100%. If we consider the best cut of value for Fbs at 103.5 mg/ dl and HbA1c at 6.05% we observe a decrease in specificity to 98% and sensitivity remains 100 %, this combination would be more helpful in differentiating the prediabetics or early diabetics from non diabetic population as the negative predictive value was 100% for the above sensitivity and specificity.

We also observed a significantly (p<0.001) strong and positive correlation between FBS and HbA1c with a "r" value 0.908, suggesting increase in FBS will lead to increase in HbA1c. On subjecting the patient data to ROC curve analysis it was observed that both FBS and HbA1c had an Area under the curve of 1.0. At the best cut of value 117 mg/dl and 6.7 % respectively both the parameters were found to be 100 % sensitive and 100 % specific in differentiating the diabetic patients from non diabetic.

## Discussion

In the present study which was aimed at validating the use of HbA1c as a screening modality at the community level, it was found that HbA1c has some advantages over the age old FBS. HbA1c is unaffected by transient hyperglycemia from acute stress or illness[3]. $HbA_{1c}$ is related to both elevated OGTT and FPG, and the various complications,[1] therefore it can be used for assessing the risk of complications of diabetes as well as for monitoring glycemic control. HbA1c seems a more practical alternative, as it is an established measure of long-term glycemia [3,10] and also correlates directly with subsequent development and progression of microvascular complications.[9] Thus it is helpful in early detection of cases in order to prolong the occurrence of complications. It is rare for the screening tests to have both high sensitivity and specificity[1]. In the case of diabetes, which is a relatively common disease, the efficiency of screening, and therefore the specificity of the test used, is arguably more important. However in the present study HbA1c had 100% specificity which is a prerequisite for a good screening test. HbA1c value of 6.5% has a very high specificity and is a useful supportive marker to diagnose diabetes[11] and as per this study a HbA1c value of 6.7% has good specificity and thus is in close agreement. The $HbA_{1c}$ cut-off point of > 6.1% was the recommended optimum cut-off point for $HbA_{1c}$ in most reviewed studies; however, there is an argument for population-specific cut-off points as optimum cut-offs vary by ethnic group, age, gender and population prevalence of diabetes.

HbA1c laboratory methods are now well standardized and reliable. The errors caused by nonglycemic factors affecting HbA1c such as hemoglobinopathies are infrequent and can be minimized by confirming the diagnosis of diabetes with a plasma glucose (PG)-specific test.[2] It has been shown that risk stratification improves the predictive validity of HbA1c in screening for undiagnosed diabetes[3], this can be applied to the present study to improve the effectiveness of Hba1c as a screening tool. Also the combined use of FPG and HbA1c levels predicts the progression to diabetes in individuals with no apparent risk[12,13,14], this is in contrast to the present study which targets the use of HbA1c as a sole screening test.

According to Ghazanfari Z et al[5] there was a relatively strong association of HbA1c with FBS which is in concordance with this study as it was observed that a significantly (p<0.001) strong and positive correlation existed between FBS and HbA1c with a "r" value 0.9 08, suggesting increase in FBS will lead to increase in HbA1c.

## Conclusion

Although screening with HbA1c would improve detection of undiagnosed diabetes, standardization of the procedure used and cost-effectiveness studies are needed before implementation of specific screening strategies using HbA1c.

**Table 1: Mean FBS and HbA1c value**

| Parameter | Mean ± SD | | T value | Significance |
|---|---|---|---|---|
| | Control | Case | | |
| FBS | 87 ± 17.24 | 211.08 ± 112.4 | 12 | 0.001 |
| HbA1c | 5.25 ± 0.75 | 8.70 ± 2.72 | 17.54 | 0.001 |

**Table 2: Cut of value on the basis of ROC curve for sensitivity and specificity**

| Parameter | AUC | Best cut off value | Sensitivity | Specificity |
|---|---|---|---|---|
| FBS | 1.000 | 117 | 100 % | 100% |
| HbA1c | 1.000 | 6.7 | 100 % | 100 % |

**Table 3: Correlation between FBS AND HbA1c**

| | | FBS | $HbA_1C$ |
|---|---|---|---|
| FBS Correlation | Pearson | 1 | 0.908 |
| | Significance | | 0.000 |
| | N | 100 | 100 |
| $HbA_1C$ Correlation | Pearson | 0.90 | 1 |
| | Significance | | |
| | N | 100 | 100 |

****Correlation is significant at the 0.01 level (2-tailed).**

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