

**Original article**

**Inequity of diagnosis of diabetes by plasma glucose and HbA1c**

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**Abstract**

**Objective:** Both plasma glucose and glycosylated hemoglobin are the recommended tools to diagnose diabetes by the International Expert Committee and World Health Organization (WHO). The aim of this study was to compare these two parameters in the diagnosis of diabetes in a selected group of Bangladeshi subjects. **Materials and Methods:** This cross-sectional study included 800 subjects attending the outdoor in a tertiary healthcare center during the period of September 2009 to September 2010. Fasting, postprandial (2 hours after glucose load) plasma glucose and HbA1c were measured. Diabetes is defined according to HbA1c and plasma glucose. Subjects were classified into three groups according to HbA1c values (HbA1c: =6.5%, HbA1c: 6.0-6.4% and HbA1c: < 6.0%) and also in the diabetics, prediabetics (IGT+IFG) and non-diabetics by plasma glucose. Results of the HbA1c classified subjects were compared with the plasma glucose classified subjects to see the inequity of classification. **Results:** Inequity of classification occurred for 11.87% of the total subjects with HbA1c =6.5% but impaired (8.25%) and nondiabetic (3.62%) by plasma glucose; for 10.13% of the subjects with HbA1c: 6.0-6.4% but diabetic (3.25%) and nondiabetic (6.88%) by plasma glucose, and for 8.5% of the total subjects with HbA1c <6.0% but diabetic (1.88%) and impaired (6.62%) by plasma glucose. Concordant classification occurred for 69.5% and inequity of classification occurred for 30.5% of the total study subjects. **Conclusion:** Inequity of classification of diabetes by HbA1c and plasma glucose is remarkable in the study population.

**Key words:** Plasma glucose, glycosylated hemoglobin, diagnostic criteria of diabetes

**Introduction**

Glycosylated hemoglobin (HbA1c) is formed from irreversible nonenzymatic glycosylation of N-terminal valine(s) of the beta chain of hemoglobin. The glycosylation is positively associated with the average plasma glucose level and represents the glycemic status of the previous 3 to 4 months.<sup>1,2</sup> HbA1c is not affected by day-to-day variation of carbohydrate intake and considerably more stable than plasma glucose (fasting glucose and postprandial plasma glucose). Measurement of HbA1c can be performed at any time of the day and does not require any special preparation such as fasting or oral glucose load. The relationship between HbA1c and prevalent retinopathy is similar to that of the plasma glucose.<sup>3,4,5</sup> The Early Diabetes Intervention Program (EDIP) showed that HbA1c measurement improves the sensitivity of screening in high-risk individuals.<sup>6</sup> Due to the inconvenience of measuring fasting plasma glucose or performing an oral glucose tolerance (OGT) test and day-to-day variability

in plasma glucose, HbA1c is now recommended as an alternative to glucose measurement for the diagnosis of diabetes by the International Expert Committee.<sup>7</sup> World Health Organization (WHO) recommended HbA1c value of 6.5% as a cut-off value to diagnose diabetes, but a value less than 6.5% does not exclude diabetes diagnosed by glucose tests.<sup>8</sup> In this study, we aimed to compare HbA1c level and plasma glucose level as a diagnostic tool in a Bangladeshi population selected conveniently.

**Materials and Methods**

This cross-sectional study was carried out in the Department of Biochemistry and Cell Biology, Bangladesh Institute of Health Sciences, Dhaka, Bangladesh during the period of September 2009 to September 2010. A total of eight hundred subjects of both sex were included conveniently. Fasting and 2 hours postprandial (after oral glucose load) plasma glucose concentrations were measured by hexoki-

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nase method using kits manufactured by Siemens Health Care Ltd by Dimension RxL Max automated chemistry analyzer. HbA1c was measured by cation-exchange high-pressure liquid chromatography (HPLC) using D-10™ (BioRad, USA) hemoglobin assay system. Diabetes is defined by plasma glucose and HbA1c.<sup>7,8,9</sup> Total subjects were categorized into three groups based on HbA1c (HbA1c: =6.5%, HbA1c: 6.0-6.4% and HbA1c: <6.0%). Concordance and inequity of classification in the three HbA1c groups and in the total population were calculated.

**Results**

Mean age of the study population was 43.32±12.19 years. Of the total population, 323 (40.38%) were males and 477 (59.62%) were females. Mean±SD of fasting plasma glucose and postprandial plasma glucose in the total population are presented in table I. Distribution of the total subjects in the three HbA1c groups and glycemic groups are presented in figure 1. Among the study subjects, 54.62 % were diabetic (HbA1c: =6.5%), 15.13% had high-risk for diabetes (HbA1c: 6.0-6.4%) and 30.25% had HbA1c<6.0%. On the basis of plasma glucose level, 47.87% of the study subjects were diabetic, 19.88% were prediabetic and 32.25% were nondiabetic (figure 1). The odds ratio of subjects with HbA1c =6.5% and HbA1c <6.0% with plasma glucose classified diabetic and nondiabetic subjects was 1.216 (95% CI: 0.97-1.52) and was not statistically significant (P=0.089).

Table 2 shows the inequity of classification by HbA1c and plasma glucose in the total study subjects. Three hundred and forty two (42.75%) subjects were classified as diabetics by both HbA1c and plasma glucose. Inequity of classification occurred for 95 (11.87%) of the total subjects (diabetic by HbA1c but impaired and nondiabetic by plasma glucose) and for 41 (5.13%) of the total subjects with HbA1c <6.5% but diabetic by plasma glucose. One

hundred and seventy four (21.75%) subjects were classified as nondiabetic by both HbA1c and plasma glucose. Inequity of classification occurred for 68 (8.5%) of the total subjects (nondiabetic by HbA1c but diabetic and impaired by plasma glucose) and for 84 (10.5%) of the total subjects (diabetes and high-risk for diabetes by HbA1c but nondiabetic by plasma glucose. Forty subjects (5.0%) were classified as prediabetic or high-risk for diabetes by both HbA1c and plasma glucose. Inequity of classification occurred for 87 (10.13%) of the total study subjects (high-risk for diabetes by HbA1c but diabetic and nondiabetic by plasma glucose) and for 119 (14.87%) of the total subjects (nondiabetic and diabetic by HbA1c but prediabetic by plasma glucose). In the total study population, concordance of classification occurred for 69.5% and inequity of classification occurred for 30.5% (Table 2).

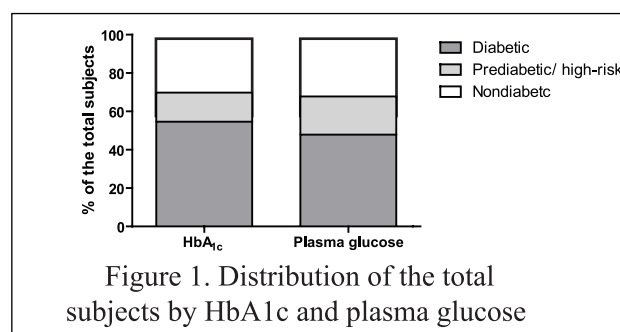


Figure 1. Distribution of the total subjects by HbA1c and plasma glucose

**Table 1.** Mean±SD and range of age, fasting plasma glucose, postprandial plasma glucose and HbA1c in the total study population.

	Mean±SD	Range
Age (years)	43.32±12.19	11-85
Fasting plasma glucose (mmol/L)	7.33±3.69	3.3-30.0
Postprandial plasma glucose (mmol/L)	11.99±6.44	3.4-41.5
HbA1c (%)	7.63±2.66	4.1-18.9

**Table 2.** Comparison of HbA1c and plasma glucose classification.

	Number of subjects	Diabetic by plasma glucose (47.87%)	Impaired by plasma glucose (19.88%)	Nondiabetic by plasma glucose (32.25%)
HbA1c: =6.5%	437 (54.62%)	342 (42.75%)	66 (8.25%)	29 (3.62%)
HbA1c: 6.0-6.4%	121 (15.13%)	26 (3.25%)	40 (5.0%)	55 (6.88%)
HbA1c: <6.0%	242 (30.25%)	15 (1.88%)	53 (6.62%)	174 (21.75%)
Concordance of classification	556 (69.5%)	342 (42.75%)	40 (5.0%)	174 (21.75%)
Inequity of classification	244 (30.5%)	41 (5.12%)	119 (14.88%)	84 (10.5%)

Parenthesis indicate the percentage of the total population

### **Discussion**

In this study, the number of diabetic and nondiabetic subjects classified by HbA1c is not statistically different from the number of diabetic and nondiabetic subjects classified by plasma glucose (OR=1.216, p=0.089). The inequity of classification at HbA1c =6.5% is 11.87% in which 8.25% is prediabetic and 3.62% is nondiabetic by plasma glucose. Inequity of classification at HbA1c: 6.0-6.4% is 10.13% in which 3.25% is diabetic and 6.88% is nondiabetic by plasma glucose, and at HbA1c <6.0% is 8.5% in which 1.88% is diabetic and 6.62% is impaired by plasma glucose. But overall concordant classification is observed for 69.5% of the total study subjects and overall inequity of classification is observed for 30.5% of the total study subjects.

In our study, the overall inequity and the inequity of classification at the three HbA1c groups (HbA1c: =6.5%, 6.0-6.4% and <6.0%) are remarkably high and discordant classification may become negligible in population-based study. But it may be important to classify subjects by HbA1c as diabetic or others in Hospitals, healthcare centers where possible cases of diabetes is likely to be high in number.

### **Conclusion**

The inequity of classification of diabetes by HbA1c and plasma glucose is remarkable in the study population.

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