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**Glycated Hemoglobin Versus Fasting Plasma Glucose as a Predictor of Left Ventricular
Dysfunction After ST-Elevation Myocardial Infarction**

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SUMMARY

Glycated hemoglobin (HbA1c) $\geq 6.5\%$ has been recommended as an alternative diagnostic criterion for diabetes. However, its concordance with fasting plasma glucose level (FPG) in acutely unwell patients such as during ST-elevation myocardial infarction (STEMI) is unknown. Moreover, its prognostic implication is unclear. This study demonstrated that the diagnostic concordance between HbA1c and FPG in STEMI patients was poor. Furthermore, only HbA1c was predictive of worse left ventricular diastolic dysfunction and elevated filling pressures after STEMI.

STRUCTURED ABSTRACT

Background: World Health Organization and American Diabetes Association recommend HbA1c $\geq 6.5\%$ as diagnostic for diabetes. However, concordance between fasting plasma glucose (FPG) and HbA1c in acutely unwell patients is unknown. Furthermore, prognostic value of HbA1c for left ventricular (LV) dysfunction is unclear. This study aimed to evaluate the concordance between HbA1c and FPG in consecutive acute ST-elevation myocardial infarction (STEMI) patients, and compare their prognostic value in predicting LV dysfunction and elevated filling pressures on echocardiography.

Methods: A total of 142 first STEMI patients were prospectively recruited. LV diastolic function was defined as mean septal and lateral early diastolic velocities (average e'); filling pressure was the ratio of transmitral E velocity to average e' (average E/e').

Results: Mean FPG and HbA1c were 7.7 ± 2.8 mmol/L and $6.5 \pm 1.6\%$ respectively. Of 109 patients without prior diabetes, HbA1c identified an additional 18 patients (16.5%) as diabetic, and the concordance with FPG was poor. Between diabetic and non-diabetic patients, there were no differences in LV end-diastolic volume (116 ± 37 vs. 118 ± 43 mL, $p=0.78$), end-systolic volume (69 ± 33 vs. 68 ± 35 mL, $p=0.93$), ejection fraction (42 ± 12 vs. $44 \pm 11\%$, $p=0.49$). On multivariable analyses, average e' was independently associated with HbA1c ($\beta=-0.161$, $p=0.045$), but not FPG ($p=0.82$). Similarly, average E/e' was independently associated with HbA1c ($\beta=0.168$, $p=0.04$), but not FPG ($p=0.32$). ROC analysis showed HbA1c cut-off of 6.4% (AUC=0.68, $p=0.002$) was associated with an elevated LV filling pressure.

Conclusion: Only HbA1c was independently associated with impaired LV diastolic function and increased filling pressures after STEMI.

Keywords: Diabetes mellitus, Myocardial infarction, Glycated hemoglobin

INTRODUCTION

Diabetes mellitus is a major risk factor for myocardial infarction and a predictor of adverse outcomes.^{1,2} In patients presenting with acute myocardial infarction, the association between high blood sugar level (FPG) on admission and adverse outcomes have been well described in various studies.^{1,3,4} However, non-diabetic patients can often develop stress hyperglycemia in the setting of an acute illness, complicating the diagnosis of diabetes. Although stress hyperglycemia in non-diabetic patients is associated with worse outcomes, previous studies included both fasting and post-prandial admission plasma glucose concentrations. Therefore, it is unclear if hyperglycemia is a marker of a sicker patient or causative for worse outcome.

Recently, the World Health Organization and American Diabetes Association endorsed the use of glycated hemoglobin (HbA1c) for the diagnosis of diabetes.^{5,6} Although the evaluation of HbA1c is more convenient compared to FPG in the setting of acute illness, no studies to date have used it or compared it to FPG in patients with acute ST-elevation myocardial infarction (STEMI). Furthermore, only 1 study to date has evaluated the association between HbA1c and left ventricular (LV) dysfunction on echocardiography 2 months after STEMI⁷, and none have compared the prognostic values of HbA1c versus FPG for LV dysfunction acutely after STEMI. Therefore, the aims of the present study were to evaluate the concordance between HbA1c and FPG in consecutive acute STEMI patients, and compare their prognostic value in predicting the extent of LV dysfunction and elevated filling pressures on echocardiography.

METHODS

Patient population and study protocol

A total of 142 consecutive patients who presented with first STEMI were prospectively recruited. STEMI was defined as cardiac chest pain with ECG changes consistent with acute myocardial infarction (ST elevation $> 2\text{mm}$ in the precordial leads and $> 1\text{mm}$ in the limb leads) as per current recommendations.⁸ Exclusion criteria included patients with previous myocardial infarction, in-hospital death before echocardiogram could be performed, cardiogenic shock requiring inotropic support in intensive care unit, admission with acute coronary syndrome/non-STEMI, previously known LV systolic dysfunction, greater than moderate valvular heart disease, and known conditions that may affect HbA1c measurements (including hemoglobinopathies, chronic liver disease, chronic renal failure, previous splenectomy).

On admission, all patients had baseline clinical variables recorded that included cardiac risk factors such as previously diagnosed diabetes, FPG, HbA1c, serial cardiac troponin I (cTnI), creatinine kinase MB isoform (CK-MB), glomerular filtration rates (GFR) calculated by the Modification of Diet in Renal Disease formula.⁹ All patients underwent a transthoracic echocardiography, invasive coronary angiography, and revascularization if required prior to hospital discharge. The median time difference between admission and echocardiography was 1 day (25th and 75th percentile 1 and 2 days respectively).

In patients not previously known to be diabetic, respective new diagnosis of diabetes by HbA1c ($\geq 6.5\%$) and FPG ($\geq 7.0\text{ mmol/L}$) were based on recommendations by the World Health Organization and American Diabetes Association^{5,6}, and their concordance in diagnosis was determined. Patients with abnormal results on initial testing were confirmed with repeat testing as recommended by current guidelines.^{5,6} To compare the prognostic value of HbA1c versus FPG after STEMI, their independent predictive value for LV diastolic function (average e') and filling pressures (average E/e') were determined.

FPG and HbA1c

HbA1c measurements were performed using high performance liquid chromatography cation-exchange analyzers by Bio-Rad D-10™ Hemoglobin Testing System (Bio-Rad Laboratories, Inc., Hercules, CA). This assay is National Glycohemoglobin Standardization Program (NGSP) and International Federation of Clinical Chemistry and Laboratory Medicine (IFCC) certified, and standardized to the Diabetes Control and Complications Trial (DCCT) assay. The overall precision of the assay expressed as percentage of coefficient of variation for normal and diabetic patients were 1.16% and 1.22% respectively. FPG readings were derived from plasma. HbA1c and FPG were measured after an overnight fast on the first morning after admission.

Echocardiography

Transthoracic echocardiography was performed with the subjects at rest using commercially available ultrasound systems (Vivid 7 and E9, GE-Vingmed, Horten, Norway; iE33, Philips Medical System, Andover, MA, USA). All images were digitally stored on hard disks for offline analysis. A complete 2D, color, pulsed and continuous-wave Doppler echocardiogram was performed according to standard techniques.^{10, 11} LV end-diastolic volume (EDV) and end-systolic volume (ESV) were calculated using Simpson's biplane method of discs, and LV ejection fraction (EF) was calculated and expressed as a percentage. LV mass was calculated from the formula as recommended by the American Society of Echocardiography.¹²

Mitral inflow velocities were recorded using conventional pulsed-wave Doppler echocardiography in the apical 4-chamber view using a 2 mm sample volume. Transmitral early (E wave) and late (A wave) diastolic velocities as well as deceleration time were recorded at the mitral leaflet tips.

Pulsed-wave tissue Doppler velocities were recorded at the septal and lateral mitral annulus in the apical 4 chamber view. To quantify LV diastolic function, mean septal and

lateral early diastolic velocities were calculated (average e') at end-expiration as recommended.¹³ Similarly, LV filling pressure (average E/e') was calculated as the ratio of transmitral E wave velocity to average e' .

In 15 randomly selected patients, the intra- and interobserver measurement variabilities for average e' expressed as absolute differences were 0.25 ± 0.24 cm/s and 0.53 ± 0.63 cm/s respectively (intraclass correlations 0.99 and 0.97 respectively). Similarly, the intra- and interobserver measurement variabilities for average E/e' were 0.30 ± 0.18 and 0.73 ± 0.38 respectively (intraclass correlations 0.99 and 0.98 respectively).

Statistical analysis

Continuous variables were presented as mean \pm 1 SD unless otherwise stated, and categorical variables were presented as frequencies and percentages. Comparisons between diabetic and non-diabetic patients were performed using independent t-test and Mann Whitney U test for continuous variables of Gaussian and non-Gaussian distribution respectively, Chi square test for categorical variables when no cells have an expected count of < 5 , and Fisher's exact test for categorical variables when at least 1 cell has an expected count of < 5 . Kappa was used to determine the concordance between newly diagnosed diabetes by HbA1c versus FPG in patients not previously known to be diabetic on clinical history. Pearson correlation was employed to examine the linear association between 2 continuous variables. Multiple linear regression analyses were then performed to identify independent clinical and echocardiographic determinants of LV diastolic function (average e') and filling pressure (average E/e') for patients after STEMI. All univariable predictors with $p < 0.10$ were simultaneously entered into the multiple linear regression models. To avoid multicollinearity between the univariate predictors, a tolerance of < 0.5 (which corresponds to a correlation coefficient > 0.7) was set. Due to significant correlation between

FPG and HbA1c, they were entered separately in 2 different models. Validity of the multiple linear regression models were established by confirming the residuals to be normally distributed. ROC curve was used to determine the optimal HbA1c cut-off value associated with an elevated LV filling pressure (average $E/e' \geq 13$). A 2-tailed p value of < 0.05 was considered significant. All statistical analyses were performed using IBM SPSS Statistics for Windows, version 22.0 (Armonk, NY).

The study was approved by the Institutional Review Board.

RESULTS

A total of 142 first STEMI patients were recruited. Table 1 outlines the baseline characteristics for the entire study population. The mean age was 61.8 ± 12.1 years, 106 (74.6%) male. On admission, the mean FPG and HbA1c were 7.7 ± 2.8 mmol/L and $6.5 \pm 1.6\%$ respectively. FPG was significantly correlated with HbA1c ($r = 0.79$, $p < 0.001$). A total of 33 (23.2%) patients were previously known to be diabetic on admission based on history. These patients had significantly higher FPG (11.2 ± 3.4 vs. 6.7 ± 1.5 mmol/L, $p < 0.001$) and HbA1c (8.4 ± 2.1 vs. $6.0 \pm 0.9\%$, $p < 0.001$). There were no differences in the proportion of pre-existing diabetic versus non-diabetic patients who underwent coronary angioplasty ($p = 0.50$) or coronary artery bypass surgery ($p = 0.39$).

New diagnosis of diabetes by HbA1c versus FPG

Of the 109 patients not previously known to be diabetic, HbA1c $\geq 6.5\%$ identified an additional 18 patients (16.5%) as diabetic (Figure 1). Of these 18 patients, 67% had FPG ≥ 7.0 mmol/L on admission. In contrast, of the 109 patients not previously known to be diabetic, 31 patients had FPG ≥ 7.0 mmol/L on admission, but only 29% of them had HbA1c $\geq 6.5\%$. The concordance between newly diagnosed diabetes by FPG versus HbA1c was poor ($\kappa = 0.27$)

Table 1 outlines the comparisons between patients identified as diabetic based on clinical history and HbA1c versus non-diabetic patients. Patients identified as diabetic by clinical history and HbA1c had significantly higher average E/e' (12.5 ± 4.7 vs. 10.0 ± 3.3 , $p = 0.001$) and a trend towards lower average e' (6.6 ± 2.1 vs. 7.4 ± 2.7 cm/s, $p = 0.057$). There were no significant differences in LVEDV (116 ± 37 vs. 118 ± 43 mL, $p = 0.78$), LVESV (69 ± 33 vs. 68 ± 35 mL, $p = 0.93$) and LVEF (42 ± 12 vs. $44 \pm 11\%$, $p = 0.49$).

In contrast, patients labeled as diabetic by clinical history and FPG had no differences in average E/e' (11.4 ± 4.1 vs. 10.5 ± 3.6 , $p = 0.22$), average e' (7.0 ± 3.1 vs. 7.3 ± 2.0 cm/s, $p = 0.56$), LVEDV (115 ± 33 vs. 119 ± 47 mL, $p = 0.64$), LVESV (69 ± 29 vs. 69 ± 38 mL, $p > 0.99$) or LVEF (42 ± 12 vs. $44 \pm 12\%$, $p = 0.27$).

Determinants of LV diastolic function and filling pressures

Table 2 outlines all the significant univariable and multivariable determinants of LV diastolic function by average e'. On univariable analyses, LV diastolic function was correlated with age ($r = -0.239$, $p = 0.005$) and LVEF ($r = 0.272$, $p = 0.001$). There was a trend towards more impaired average e' with higher HbA1c ($r = -0.161$, $p = 0.059$) and higher FPG ($r = -0.161$, $p = 0.20$). There was no significant difference in average e' between men and women (7.3 ± 2.7 vs. 6.5 ± 2.0 cm/s, $p = 0.12$). To identify the independent determinants of LV diastolic function after STEMI by average e', all univariable predictors with $p < 0.10$ (age, LVEF, HbA1c) were simultaneously entered into the multiple linear regression model. Table 2 shows that HbA1c was an independent determinant of LV diastolic function after STEMI (standardized $\beta = -0.161$, $p = 0.045$). In contrast, when FPG was forced into the model in place of HbA1c, it was not an independent determinant of LV diastolic function.

On univariable analyses, LV filling pressure by average E/e' was correlated with age ($r = 0.256$, $p = 0.002$), LVEF ($r = -0.236$, $p = 0.005$) and HbA1c ($r = 0.223$, $p = 0.008$). There

was a trend towards higher average E/e' with FPG ($r = 0.162$, $p = 0.078$). Men also had significantly lower average E/e' compared to women (10.2 ± 3.5 vs. 13.0 ± 4.9 , $p = 0.004$). On multivariable analysis, HbA1c (standardized $\beta = 0.168$, $p = 0.04$) was an independent determinant of LV filling pressure after STEMI (Table 2). Similarly, when FPG on admission was entered into the model in place of HbA1c, it was not an independent determinant of LV filling pressure after STEMI.

ROC analysis showed that an optimal HbA1c cut-off of 6.4% (AUC = 0.68, $p = 0.002$) was associated with an elevated LV filling pressure (average E/e' ≥ 13) (Figure 2).

DISCUSSION

The present study is first to utilize HbA1c to diagnose diabetes in STEMI patients. The authors demonstrated that although there was good correlation between FPG and HbA1c, their concordance in acute STEMI patients was poor due to the epiphenomenon of stress hyperglycemia. Compared to FPG, only HbA1c was an independent determinant of diastolic dysfunction and elevated filling pressures after acute STEMI, and a cut-off value of 6.4% was associated with elevated filling pressures on echocardiography.

Diagnosing diabetes during acute illness

Traditionally, the diagnostic criteria for diabetes include FPG ≥ 7.0 mmol/L, 2 hour FPG ≥ 11.1 mmol/L after an oral glucose tolerance test, or random plasma glucose concentration of ≥ 11.1 mmol/L with symptoms of hyperglycemia. However, both the World Health Organization and American Diabetes Association recently also recommended HbA1c $\geq 6.5\%$ as diagnostic of diabetes.^{5,6} Compared to the "traditional" diagnostic criteria for diabetes, HbA1c has the advantage of avoiding the need for patient fasting, special dietary preparations for an oral glucose tolerance test, and the usual day-to-day variability in random plasma glucose concentration levels.

The various cut-off values for HbA1c, FPG and 2 hour plasma glucose levels post oral glucose tolerance test were based on threshold levels associated with an increased retinopathy prevalence in epidemiological studies.^{5,6} However, diagnostic tests that utilize blood glucose readings are inaccurate in acutely unwell patients due to the epiphenomenon of stress hyperglycemia whereby FPG becomes elevated in the absence of underlying diabetes. Therefore, if FPG was used as a diagnostic criterion, the overall incidence of diabetes in this study would have been significantly overestimated at 45.0%.

In contrast, epidemiological studies demonstrated that the incidence of diabetes in patients with acute myocardial infarction was significantly lower at 20-30%.¹⁴⁻¹⁷ In the latest Worcester Heart Attack Study, a population-based investigation on 478,000 residents in the greater Worcester region hospitalized with acute myocardial infarction, the incidence of diabetes was only 26.6%.¹⁶ However, history of diabetes was based on medical records and the authors were unlikely to have utilize HbA1c as a diagnostic criteria back in 2005.¹⁶ Therefore, the true incidence of diabetes were likely to be underestimated in all these epidemiological studies. In the present study, HbA1c identified an additional 16.5% of patients as diabetic who were previously undiagnosed. This was similar to previous study that reported a diabetes incidence of 12% in acute myocardial infarction patients who underwent glucose tolerance test at 2 months post-discharge.⁷ Therefore, using HbA1c as a diagnostic criteria, the present study demonstrated an overall diabetes incidence of 35.9%. As FPG and HbA1c are measuring different physiological processes in acutely unwell patients, their concordance in diagnosing diabetes is poor despite a significant correlation.

Prognostic value of FPG versus glycated hemoglobin

Previous studies suggest that the pathophysiological relationship between HbA1c and FPG in acutely unwell patients may be conceptualized into “cause” and “effect”.^{3, 18} An elevated HbA1c, indicative of long term poor glycemic control, is associated higher baseline

cardiovascular risk profile and therefore the cause of the acute myocardial infarction.¹⁸ In contrast, the effect of a subsequent larger myocardial infarct size is the observed epiphenomenon of stress hyperglycemia.³

Timmer and co-workers demonstrated that stress hyperglycemia was an epiphenomenon reflecting more extensive myocardial damage during acute STEMI.¹⁸ This is due to a relative insulin deficiency during acute stress, and increased stress hormones associated with extensive myocardial infarction leading to glycogenolysis and hyperglycemia.³ Although, stress hyperglycemia was associated with in-hospital and 30 day mortality, it was not predictive of long term mortality after correcting for blood pressure, heart rate and angiographic findings.¹⁸

In contrast, an elevated HbA1c is associated with higher baseline cardiovascular risk characteristics such as higher incidences of hypertension, hypercholesterolemia and multi-vessel coronary disease on angiography in patients presenting acute myocardial infarction.¹⁸ It is well recognized that diabetic patients with acute myocardial infarction constitutes a high risk population and are more likely to have diffuse interstitial fibrosis in the remote, non-infarcted myocardium¹⁹, leading to greater impairment of myocardial function and predispose patients to development of heart failure after myocardial infarction. Therefore, the present study provided further incremental evidence that “long term” poor glycemic control with an elevated HbA1c was independently associated with more diastolic dysfunction and elevated filling pressures after acute STEMI.

Glycated hemoglobin and left ventricular dysfunction after STEMI

Although several previous studies showed conflicting results on the association between HbA1c and both short and long term mortality in STEMI patients with or without diabetes^{3, 18, 20, 21}, only 1 study to date has assessed the association between HbA1c and LV dysfunction on echocardiography. Salmasi and co-workers evaluated HbA1c and transmitral

E/A ratio/deceleration time 2 months post-myocardial infarction in previously non-diabetic patients.⁷ The authors failed to show a significant correlation between HbA1c and transmitral E/A ratio at rest and during isometric exercise. Although the authors claimed that LV systolic and diastolic function were related to HbA1c after acute myocardial infarction, it was based on a multivariable analysis with HbA1c entered as the dependent outcome variable, and transmitral E/A ratio at rest and isometric exercise, deceleration time, and LVEF entered as independent predictive variables.⁷ In contrast, the present study is first in the literature to show HbA1c, not FPG, as an independent predictor for LV diastolic dysfunction and filling pressures acutely in STEMI patients.

CONCLUSIONS

Due to the epiphenomenon of stress hyperglycemia in acute STEMI patients, the concordance between HbA1c and FPG criteria for the diagnosis of diabetes in previously undiagnosed patients is poor. An elevated HbA1c has prognostic value for worse diastolic dysfunction and higher filling pressures after acute STEMI compared to FPG. The value of routine HbA1c in guiding therapy and predicting outcomes in STEMI patients is worth consideration and study in future prospective trials.

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ACCEPTED MANUSCRIPT

Figure Legends

Figure 1. Scatterplot for FPG and HbA1c on admission in acute STEMI patients. Circles indicate non-diabetic patients on clinical history, and crosses indicate pre-existing diabetic patients on clinical history. Of the non-diabetic patients, 18 patients had HbA1c \geq 6.5% on admission.

Figure 2. ROC curve for HbA1c in predicting elevated LV filling pressures (average E/e' \geq 13) in acute STEMI patients.

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Table 1. Baseline Clinical, Laboratory and Echocardiographic Characteristics of all Patients, and Between Diabetics by History and Glycated Hemoglobin versus Non-Diabetics

Variable	Total population (n = 142)	Diabetics (n = 51)	Non-Diabetics (n = 91)	p value*
<i>Clinical</i>				
Age (years)	61.8 ± 12.1	63 ± 12	61 ± 12	0.22
Male gender (%)	74.6	64.7	80.2	0.041
Systolic BP (mmHg)	126 ± 22	123 ± 23	127 ± 21	0.22
Diastolic BP (mmHg)	72 ± 12	70 ± 13	74 ± 11	0.05
Active smoker (%)	31.0	25.5	34.1	0.29
Hypertension (%)	48.6	66.7	38.5	0.001
<i>Laboratory</i>				
Hemoglobin (g/dL)	144 ± 18	141 ± 22	146 ± 15	0.15
GFR (mL/min/1.73m ²)	80 ± 26	76 ± 32	81 ± 22	0.34
Total cholesterol (mmol/L)	4.7 ± 1.1	4.5 ± 1.1	4.8 ± 1.1	0.16
Triglyceride (mmol/L)	1.7 ± 1.4	2.2 ± 2.1	1.4 ± 0.8	0.019
Low density lipoprotein (mmol/L)	2.8 ± 1.0	2.6 ± 1.0	3.0 ± 1.0	0.028
High density lipoprotein (mmol/L)	1.1 ± 0.3	1.0 ± 0.2	1.1 ± 0.3	0.038
Peak cTnI (median, 25 th and 75 th percentile) (µg/L)	25.5 (4.3, 83.3)	27.0 (3.6, 73.3)	24.5 (5.4, 90.3)	0.52
Peak CK-MB (median, 25 th and 75 th percentile) (U/L)	1810 (831, 3585)	1650 (694, 2800)	1910 (976, 3940)	0.12
HbA1c (%)	6.6 ± 1.6	8.1 ± 1.9	5.7 ± 0.3	<0.001
FPG (mmol/L)	7.7 ± 2.8	10.4 ± 3.4	6.4 ± 1.0	<0.001
<i>Echocardiographic</i>				

LVEDV (mL)	117 ± 41	116 ± 37	118 ± 43	0.78
LVESV (mL)	69 ± 34	69 ± 33	68 ± 35	0.93
LVEF (%)	43 ± 12	42 ± 12	44 ± 11	0.49
LV mass (g)	184 ± 57	184 ± 58	184 ± 57	0.99
Transmitral E wave (m/s)	0.71 ± 0.18	0.75 ± 0.18	0.69 ± 0.18	0.06
Transmitral A wave (m/s)	0.68 ± 0.22	0.71 ± 0.22	0.66 ± 0.22	0.15
Transmitral E/A ratio	1.1 ± 0.5	1.1 ± 0.4	1.1 ± 0.5	0.68
Transmitral deceleration time (ms)	196 ± 48	188 ± 45	200 ± 49	0.17
Average e' (cm/s)	7.1 ± 2.5	6.6 ± 2.1	7.4 ± 2.7	0.057
Average E/e' ratio	10.9 ± 4.1	12.5 ± 4.8	10.0 ± 3.3	0.001

*p value by t-test and Mann Whitney U test for Gaussian and non-Gaussian continuous data, and Chi square test for categorical data. BP = blood pressure; cTnI = cardiac troponin I; CK-MB = creatinine kinase-MB isoenzyme; HbA1c = glycated hemoglobin; EDV = end-diastolic volume; ESV = end-systolic volume; EF = ejection fraction; FPG = fasting plasma glucose; LV = left ventricular.

Table 2. Univariable and Multivariable Linear Regression Models for Left Ventricular Diastolic Function (Average e') and Filling Pressures (Average E/e') After ST-Elevation Myocardial Infarction

Variable	<u>Univariable</u>		<u>Multivariable</u>			
	Beta	p value	<u>Model 1</u>		<u>Model 2</u>	
			Beta	p value	Beta	p value
<u>LV diastolic function by average e'</u>						
Age	-0.239	0.005	-0.273	0.001	-0.254	0.005
LVEF	0.272	0.001	0.265	0.001	0.231	0.010
HbA1c	-0.161	0.059	-0.161	0.045	-	-
FPG	-0.025	0.78	-	-	-0.020	0.82
<u>LV filling pressure by average E/e'</u>						
Age	0.256	0.002	2.15	0.001	0.232	0.007
Gender	-0.297	< 0.001	-0.218	0.008	-0.268	0.003
LVEF	-0.236	0.005	-0.231	0.003	-0.206	0.015
HbA1c	0.223	0.008	0.168	0.040	-	-
FPG	0.162	0.078	-	-	0.086	0.323

HbA1c = glycated hemoglobin; Beta = standardized beta; FPG = fasting plasma glucose; LV = left ventricular; EF = ejection fraction. Model 1 included HbA1c and excluded FPG. Model 2 included FPG and excluded HbA1c.

Figure 1

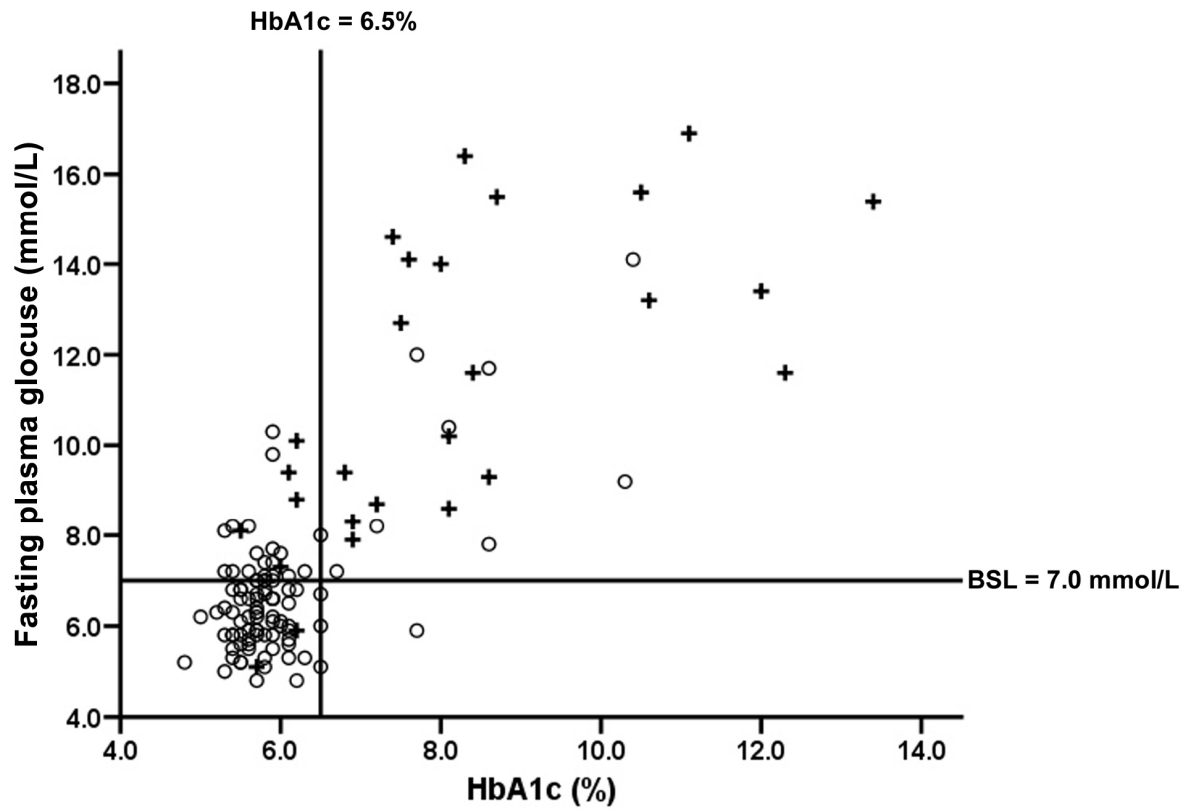


Figure 2