



## **BLOOD GLUCOSE TEST FOR DM TYPE 2**

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### **ABSTRACT**

Indonesia is one of the countries with a high prevalence of diabetes, with total cases of diabetes in adults reaching 10 million cases, 6.2% of the total adult population. Diabetes mellitus (DM) is a group of metabolic diseases characterized by hyperglycemia due to defects in insulin secretion, insulin action, or both. Insulin resistance in muscle and liver cells and pancreatic beta-cell failure has been recognized as the pathophysiology of major damage of type 2 diabetes. The blood glucose test is an important laboratory examination that can be used to diagnose, screen, and monitor DM type 2. There are several types of blood glucose levels, including random blood glucose tests, fasting blood glucose tests, post prandial blood glucose tests, oral Glucose Tolerance Test (OGTT), and HbA1c. Type 2 DM is often called the silent killer because sufferers are often late for self-examination and treatment so that complications arise early. Early symptoms of type 2 diabetes can be identified through blood sugar examination and risk factor screening. Screening for type 2 DM can detect abnormalities as early as possible so that interventions can start as early as possible to minimize the complication rate so that the quality of life can be maintained or better.

Keywords: Laboratory, Diabetes Mellitus Type 2.

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### **INTRODUCTION**

Diabetes mellitus (DM) is a group of metabolic diseases characterized by hyperglycemia due to defects in insulin secretion, insulin action, or both. Insulin resistance in muscle and liver cells and pancreatic beta-cell failure has been recognized as the pathophysiology of central damage of type 2 diabetes.<sup>1</sup>

Indonesia is one of the countries with a high prevalence of diabetes, with total cases of diabetes in adults reaching 10 million cases, 6.2% of the total adult population. Worldwide, the prevalence of diabetes is increasing steadily. In 2019, 463 million people worldwide lived with diabetes, representing 9.3% of the total global adult population (aged 20-79 years). This number is expected to continue to increase to 578 million (10.2%) in 2030 and 700 million (10.9%) in 2045.<sup>2</sup>

In type 2 diabetes mellitus, insulin resistance contributes to increased glucose production in the liver and decreased glucose uptake in muscle, liver, and adipose tissue. In



addition, fat metabolism also increases, resulting in the formation of ketones. Increased ketones in plasma will result in ketonuria and sodium levels will decrease, and serum pH will decrease, and acidosis occurs. Abnormalities in insulin secretion can also decrease glucose utilization, resulting in high plasma glucose levels, known as hyperglycemia. Hyperglycemia can affect various organs, such as the kidneys and the gastrointestinal tract. Hyperglycemia also affects small blood vessels, causing a reduced supply of nutrients and oxygen to the periphery and causing problems in various organs, such as the eyes, skin, and nerves.<sup>3</sup> Laboratory tests related to type 2 DM can be used for diagnostic, screening, and monitoring purposes. The diagnosis of type 2 diabetes can be established based on the examination of blood glucose levels. The recommended blood glucose test is an enzymatic glucose test with venous blood plasma. Screening is aimed at those who are at risk of DM but do not show any symptoms of DM.<sup>4</sup>

The criteria for the diagnosis of diabetes mellitus are fasting plasma glucose examination  $\geq 126$  mg/dL, plasma glucose examination  $\geq 200$  mg/dL 2 hours after oral glucose tolerance test with a glucose load of 75 grams, random plasma glucose examination  $\geq 200$  mg/dL with classic complaints, or examination of HbA1c 6.5%.<sup>1,5</sup> Screening examination can be done by checking blood glucose levels during or fasting blood glucose levels. If the screening test results in an increase in blood glucose levels following the criteria for diagnosing diabetes, it is necessary to carry out further examinations to confirm with a repeat fasting plasma glucose test or an oral glucose tolerance test (OGTT).<sup>6</sup>

Laboratory tests for diagnosis and monitoring diabetes mellitus treatment are blood glucose levels, HbA1c (glycated hemoglobin), and albumin glycate.

Tests for screening and diagnosing DM are widely available. Public knowledge about laboratory tests related to type 2 DM is one of the important strategies in preventing and managing the disease.

## **DISCUSSION**

**Blood Glucose Test.** Blood glucose level or blood sugar level is a term that refers to the level of glucose in the blood. Blood sugar concentration, or serum glucose level, is tightly regulated in the body. Glucose flowing through the blood is the main source of energy for the body's cells. Glucose (blood sugar level) is a monosaccharide sugar, the most important carbohydrate used as the main source of energy in the body. Glucose is the precursor for the synthesis of all other carbohydrates in the body such as glycogen, ribose, and deoxyribose in nucleic acids, galactose in milk lactose, in glycolipids, and in glycoproteins and proteoglycans.<sup>7</sup> Examination of blood sugar levels is a direct measurement of the state of controlling the patient's blood sugar levels at a certain time when testing. There are several types of blood glucose levels, including:<sup>8</sup>

- a. Random blood glucose test,  
Examinations carried out to determine blood sugar levels at a random time, before fasting or after consuming food, are usually used to detect early diabetes mellitus.



- b. Fasting blood glucose test  
Examinations were carried out to determine blood sugar levels with a 12-hour fasting preparation to determine fasting blood sugar levels.
- c. Postprandial blood glucose test  
Examinations carried out to determine blood sugar levels two hours after eating (postprandial) as blood sugar levels will increase after consuming food.
- d. Oral Glucose Tolerance Test (OGTT)  
Examinations are carried out to measure the body's ability to absorb glucose in the blood. Blood samples were taken for examination 2 hours after administering 75 grams of glucose in 300 ml of water.
- e. HbA1c  
Examinations were carried out to measure glycosylated hemoglobin. This assay was used to assess the effect of changing therapy from an estimated blood glucose level of 8-12 weeks earlier.

Patient preparation should be carried out prior to the collection of blood specimens. At this stage, patients are informed about the time of blood collection and the treatment or action that will be experienced based on the type of examination. Sampling is better done in the morning than in the afternoon to avoid diurnal variations. In the afternoon, blood glucose is lower so that many cases of DM go undiagnosed. Venous plasma, serum or capillary blood samples can be used to test for the diagnosis or control of DM. For diagnostic tests, venous plasma should be selected because the molarity of glucose in venous plasma is almost the same as glucose in whole blood. Plasma samples were stable for less than 1 hour. For cases more than 1 hour, the glucose concentration will drop due to ex vivo glycolysis.

### **Diagnostic Test for DM Type 2**

The diagnosis of DM is made based on an examination of blood glucose levels. The recommended blood glucose test is an enzymatic glucose test with venous blood plasma. Monitoring the results of treatment can be done with a glucometer. The diagnosis cannot be made based on the presence of glucosuria.<sup>1</sup>

Various complaints can be found in people with DM. Suspicion of DM should be considered if there are complaints such as:

- a. The classic complaints of DM: polyuria, polydipsia, polyphagia and unexplained weight loss.
- b. Other complaints: weakness, tingling, itching, blurred vision and erectile dysfunction in men, and pruritus vulva in women.

The criteria for the diagnosis of diabetes mellitus are fasting plasma glucose examination  $\geq 126$  mg/dL, plasma glucose examination  $\geq 200$  mg/dL 2 hours after oral glucose tolerance test with a glucose load of 75 grams, random plasma glucose examination  $\geq 200$



mg/dL with classic complaints, or examination of HbA1c 6.5% using the standardized method by the National Glycohaemoglobin Standardization Program (NGSP). Not all laboratories in Indonesia meet the NGSP standard, so caution must be exercised in interpreting the HbA1c test results. In certain conditions such as anemia, hemoglobinopathy, history of blood transfusion in the last 2-3 months, conditions that affect erythrocyte age, and impaired kidney function, HbA1c cannot be used as a diagnostic or evaluation tool.<sup>1</sup>

Examination results that do not meet normal or DM criteria are classified into the pre-diabetes group, including impaired glucose tolerance and impaired fasting blood glucose.<sup>9</sup>

- Impaired Fasting Glucose (IFG): Results of fasting plasma glucose between 100 – 125 mg/dL and 2-hour plasma glucose OGTT < 140 mg/dL;
- Impaired Glucose Tolerance (IGT): Plasma glucose test results 2-hours after OGTT between 140 – 199 mg/dL and fasting plasma glucose < 100 mg/dL
- Impaired Fasting Glucose and Impaired Glucose Tolerance are obtained together.
- The pre-diabetes diagnosis is based on the results of the HbA1c examination, which shows a rate of 5.7 – 6.4%.

**Table 1. Blood laboratory test levels for the diagnosis of diabetes and pre-diabetes:**

	HbA1c (%)	Fasting blood glucose (mg/dL)	Post prandial blood glucose (mg/dL)
<b>Diabetes</b>	≥ 6,5	≥ 126	≥ 200
<b>Pre-diabetes</b>	5,7-6,4	100-125	140-199
<b>Normal</b>	< 5,7	70-99	70-139

### Screening Test for DM Type 2

Screening is aimed at those at risk of DM but do not show any symptoms of DM. Screening aims to find patients with DM, IGT, and IFG, so that they can be treated early. Patients with IGT and IFG are also referred to as prediabetic patients. Pre-diabetes is a temporary stage towards DM.

Screening examination can be done by checking blood glucose levels during or fasting blood glucose levels. If the screening test increases blood glucose levels following the criteria for diagnosing diabetes, it is necessary to carry out further examinations to confirm with a repeat fasting plasma glucose test or an oral glucose tolerance test (OGTT). Screening for mass screening is not recommended, considering the high cost. Screening is recommended at the time of examination for other diseases (ex. in patients with metabolic syndrome) or general check-up.<sup>10</sup>

The American Diabetes Association recommends screening for type 2 diabetes on an annual basis for patients >45 years of age, or patients <45 years of age with 1 or more risk factors, such as lack of physical activity, hypertension, HDL levels <35 mg/dL or triglycerides > 250 mg/dL, first-line family with a history of DM, BMI 23 kg/m<sup>2</sup>, women with a history of



gestational diabetes, A1c 5.7%, impaired fasting blood sugar, impaired glucose tolerance, or a history of cardiovascular disease.<sup>6</sup>

### **Monitoring Evaluation for DM Type 2**

Laboratory tests for diagnosis and monitoring diabetes mellitus treatment are blood glucose levels, HbA1c (glycate hemoglobin), and albumin glycate. For screening for diabetes mellitus, fasting blood glucose levels can be checked, 2 hours postprandial (after eating) or while, or HbA1c levels. The diagnosis is made by the same examination where if there are clinical signs and symptoms, 1 x abnormality is enough, but if there are no clinical signs, at least 2 x abnormalities are needed. If the results are still doubtful, then blood glucose levels are checked 2 hours after loading by drinking a solution of 75 grams of glucose.<sup>11</sup> HbA1c, which is the main and most abundant component of glycated hemoglobin, describes glucose levels during the previous 2-3 months according to the half-life of erythrocytes. It is recommended to be checked every three months in stable diabetes mellitus. HbA1c examination has been standardized (standardized) and harmonized. Therefore, in addition to monitoring the treatment of diabetes mellitus, it is now also proposed to screen and diagnose diabetes mellitus. However, the results of the examination of HbA1c levels are influenced by changes in erythrocytes and Hb. Hb variants so that in conditions with these abnormalities, the results can be wrong. The latest parameter is albumin glycate (AG) which describes glucose levels according to the half-life of albumin, which is much shorter than erythrocytes. Thus doctors can monitor treatment more quickly. In addition, the AG parameter also shows several advantages over HbA1c. For example, more accurately reflects glycemic control, retinopathy in type 2 DM patients, and postprandial glucose changes and causes all mortality in hemodialysis patients. However, this parameter is also influenced by changes in albumin levels, so it must be considered if there is a significant change in albumin levels.<sup>11</sup>

### **CONCLUSION**

The blood glucose test is an important laboratory examination that can be used to diagnose, screen, and monitor DM type 2. There are several types of blood glucose levels, including random blood glucose test, fasting blood glucose test, post-prandial blood glucose test, Oral Glucose Tolerance Test (OGTT), and HbA1c. The criteria for the diagnosis of diabetes mellitus are fasting plasma glucose examination  $\geq 126$  mg/dL, plasma glucose examination  $\geq 200$  mg/dL 2 hours after oral glucose tolerance test with a glucose load of 75 grams, random plasma glucose examination  $\geq 200$  mg/dL with classic complaints, or examination of HbA1c 6.5%. Screening examination can be done by checking blood glucose levels during or fasting blood glucose levels. Laboratory tests for diagnosis and monitoring diabetes mellitus treatment are blood glucose levels, HbA1c (glycate hemoglobin), and albumin glycate.



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