

## Fasting Blood Glucose Level Higher than Post-meal in Healthy Subjects

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### ABSTRACT

**Aim:** The aim of the study is to make attempt to find out reasons behind higher fasting blood glucose value than postprandial blood glucose value in healthy subjects. **Methods:** Fasting and postprandial blood glucose was estimated in 738 subjects. The estimation was done by hexokinase method on Cobas Integra 400 plus. **Results:** Out of these 738 subjects of which 424 were found to have absolutely normal value whereas remaining 314 subjects were having fasting values more than postprandial glucose values. Out of these 314 only 13 were known cases of diabetes mellitus. The abnormal results were studied and some reasons were formulated for such types of results. The reason for such type of results may be the previous night diet, early morning growth hormone and cortisol surge, physiological insulin resistance where body is unable to maintain basal insulin levels during fasting, delay in gastric emptying. Apart from these, increased hepatic output and decrease peripheral utilization, stress, infection, blood pressure medication may be the possible reasons in some of the subjects. **Conclusion:** Fasting blood glucose levels may be higher than the post meal blood glucose in many of the healthy subjects. Such individuals may be said to have physiological insulin resistance and may develop diabetes mellitus as long term complication.

**KEY WORDS:** *Fasting Blood Glucose, Postprandial blood Glucose, Insulin, Growth Hormone, hyperglycemia, cortisol.*

## **INTRODUCTION**

The blood sugar concentration or blood glucose level is the amount of glucose (sugar) present in the blood of a human or animal. Glucose is the primary source of energy for the body's cells, and blood lipids (in the form of fats and oils) are primarily a compact energy store. Glucose is transported from the intestines or liver to body cells via the bloodstream, and is made available for cell absorption via the hormone insulin, produced by the body primarily in the pancreas. The mean normal blood glucose level in humans is about 4 mM (4 mmol/L or 72 mg/dL, i.e. milligrams per deciliter); however, this level fluctuates throughout the day. <sup>(1, 3, 5)</sup>

Glucose levels are usually lowest in the morning, before the first meal of the day (termed "the fasting level"), and rise after meals for an hour or two by a few millimolar <sup>(5, 20)</sup>. Normal human glucose blood test results

should be 70 - 110 (mg/dL) before meals and less than 140 mg/dL after meals <sup>(7, 15)</sup>. A persistently high level is referred to as hyperglycemia; low levels are referred to as hypoglycemia. Diabetes mellitus is characterized by persistent hyperglycemia from any of several causes, and is the most prominent disease related to failure of blood sugar regulation <sup>(3, 6, 8, 10)</sup>. A temporarily elevated blood sugar level may also result from severe stress, such as trauma, stroke, myocardial infarction, surgery, or illness <sup>(9)</sup>. Intake of alcohol causes an initial surge in blood sugar, and later tends to cause levels to fall. Also, certain drugs can increase or decrease glucose levels <sup>(1)</sup>. In clinical and laboratory practices, many of the time a healthy normal subject will present a fasting blood glucose value higher than the post meal blood glucose value. This creates confusion since there is a common perception that in blood, postprandial (PP) glucose level should be higher than

fasting, (F), glucose level <sup>(16, 20)</sup>. The repeated investigation subsequently yields somewhat similar type of result. A review of fasting blood glucose and post meal blood glucose is been presented here in such cases and possible explanations are formulated for such type of laboratory results.

## **MATERIALS AND METHODS**

### **Subjects Population**

The subjects were instructed accordingly and strict 8 - 10 hour fasting sample was collected. Also they were given sufficient meal and post meal sample was collected 2 hour after the meal. Fasting and post meal blood samples from 738 subjects over a period of 3 months were collected in fluoride vacutainers. The entire subjects included in the study were from master health checkup camps. The age group for the subjects was 21-50 years. Detailed history of each subject was taken before collecting the sample.

### **Laboratory determinations**

The samples were centrifuged and

plasma was separated. Glucose estimation was done in fasting and post meal samples. The method used for determination of glucose is hexokinase method (2) and the analyzer used is Cobas Integra 400 Plus. The reference range for fasting and post meal glucose was taken as <110 mg/dl and <140 mg/dl respectively. Fasting blood glucose values between 111 mg/dl to 126 mg/dl were supposed to be pre-diabetic value or impaired fasting glucose. The IQC data for both levels of glucose was within acceptable limit. ( $\pm 2SD$ ). EQAS result was also within acceptable limit for this period.

### **Statistical analysis**

Data was entered into Microsoft Excel data sheets and was analyzed with paired "t" test.

## **RESULTS**

Out of the 738 subjects in the study, 424 subjects were found to have absolutely normal values of fasting and postprandial glucose. But, remaining 314 subjects were having fasting glucose values more than post meal glucose value. Though out of these 314 subjects 233 subjects were having both fasting

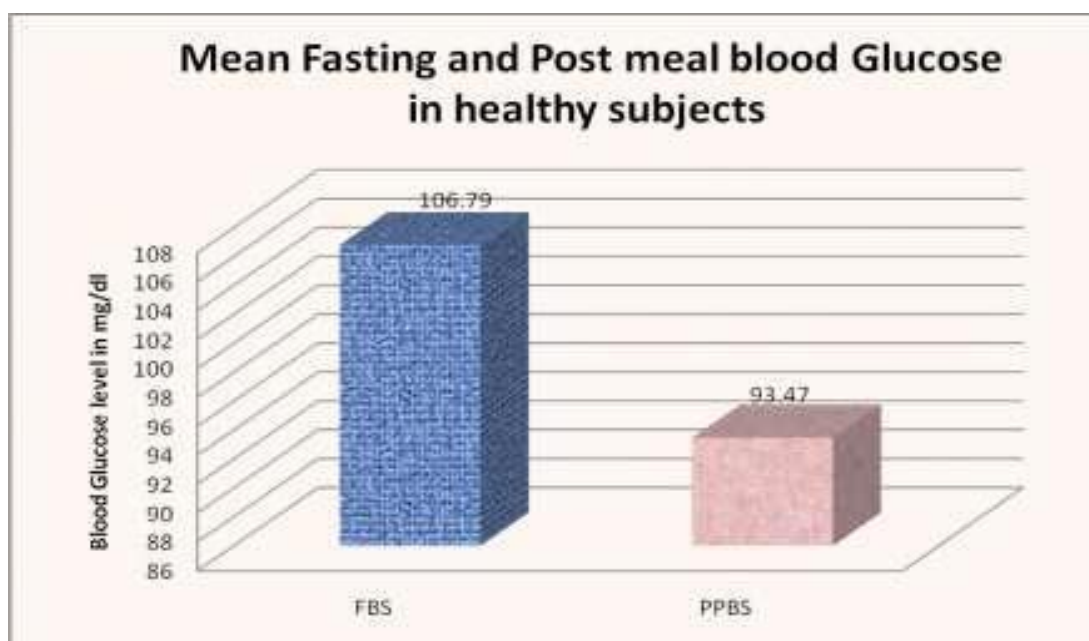
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and post meal glucose values within normal limit their fasting blood sugar was higher than the post meal blood glucose level. Out of these 314 subjects 13 were known cases of diabetes and their values were in diabetic range. 68 of the subjects were having fasting blood glucose values in pre-diabetic range

(impaired fasting glucose, 111-126 mg/dl). 233 subjects which were having normal values of fasting and post meal glucose but were having significantly higher fasting glucose value than post meal glucose. The difference between mean fasting glucose value and post meal blood glucose value of the subject is 13.32 mg/dl, (Figure 1).

**Table No. 1 Particular physiological conditions and environmental factors**

• > 40–45 years of age; <sup>(18,19)</sup>
• obesity; <sup>(18,19)</sup>
• body storing fat predominantly in the abdomen, as opposed to storing it in hips and thighs. <sup>(19)</sup>
• sedentary lifestyle, lack of physical exercise <sup>(18,19)</sup>
• hypertension; <sup>(18)</sup>
• high triglyceride level (Hypertriglyceridemia); <sup>(18)</sup>
• low level of "good cholesterol"; <sup>(18)</sup>
• having developed gestational diabetes during past pregnancies; <sup>(18,19)</sup>
• giving birth to a baby weighing more than 9 pounds [a bit over 4 kilograms] <sup>(18,19)</sup>



## Figure 1

### DISCUSSION

The results obtained in the study were interpreted considering biological variation in morning fasting glucose level. Fasting glucose value higher than post meal glucose value in these subjects may be due to variety of reasons.

Early morning fasting blood sugar is influenced by

- Post dinner sugar levels,
- Insulin resistance and
- Presence of other hormones which stimulate and increase blood sugar level. Glucagon and cortisol are two such hormones. The level of cortisol is highest at around 6-8 AM and it drops gradually to reach the lowest at midnight. Also a good meal inhibits glucagon. All these factors may be the responsible for higher fasting blood sugar and a low postprandial blood sugar.

Also the factors for postprandial hypoglycemia excluding the causes for alimentary hypoglycemia, renal

glycosuria, hereditary fructose intolerance and galactosemia are:

- high insulin sensitivity <sup>(3)</sup>,
- exaggerated response of insulin and glucagon like peptide 1 <sup>(1,2,3,4)</sup>,
- defects in counter regulation,
- very lean and /or anxious individuals,
- after massive weight reduction,
- women with lower body fat and overweight etc. <sup>(5,6)</sup>

The first and most important reason for this is physiological insulin resistance. The function of insulin in body is to keep check on blood glucose levels. But in case of physiological insulin resistance, blood sugar may remain elevated even after fasting. This fact may be correlated with higher morning fasting blood glucose level. If the diet consumed is particularly rich in carbohydrate or food with low glycemic index, though considered as good carbohydrate, the blood glucose level rises slowly and may remain elevated for longer period and if the body insulin is not able to

counteract these elevated glucose concentration.<sup>(7, 8)</sup> This may reflect in high morning fasting blood glucose level. The other reasons related with such types of result may be the hormonal secretion which generally occurs early in the morning. Growth hormone surge and cortisol hormone surge occurs at 4:00 am in the morning. Also, deep sleep stimulates growth hormone secretion.<sup>(9)</sup> These are gluconeogenic hormone which stimulates the glucose synthesis inside the body as well as increasing the hepatic outflow of the glucose<sup>(10)</sup>, which could not be normalized by circulating body insulin and may be referred as Dawn phenomenon in non-diabetics. This physiological insulin resistance and dawn phenomenon in long term effect may reflect into diabetes mellitus. Delay in gastric emptying may lead to increase in higher fasting morning glucose levels.

Non-formal reason behind higher fasting glucose values may be that the body prepares itself for the coming up day leading to increase in morning blood glucose level. Also, after heavy

meal, insulin is released in two stages; this "first phase" of insulin secretion promotes peripheral utilization of the prandial nutrient load, suppresses hepatic glucose production, and limits postprandial glucose elevation. First-phase insulin secretion begins within 2 minutes of nutrient ingestion and continues for 10 to 15 minutes. The second phase of prandial insulin secretion follows, and is sustained until normoglycemia is restored<sup>(11)</sup>. This hyper response of insulin may decrease the blood glucose level severely sometimes below fasting level causing fasting blood glucose higher than post meal blood glucose.

High levels of lipids in the bloodstream have the potential to result in accumulation of triglycerides and their derivatives within muscle cells, which activate proteins Kinase C- $\epsilon$  and C- $\theta$ , ultimately reducing the glucose uptake at any given level of insulin<sup>(12,13)</sup>. Stress, Infection<sup>(14)</sup>, Blood pressure medication may be the other possible reason for higher fasting blood glucose level than post meal glucose level. Due to the physiological

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insulin resistance body becomes unable to counteract elevated glucose levels. The reasons stated in literature for this physiological insulin resistance are stated in Table no.1.

Fasting blood glucose higher than post meal blood glucose in diabetic may be due to *dawn* phenomenon and *somogyi* phenomenon<sup>(15)</sup>. Dawn phenomenon states that, up in the morning, body produces a host of counter regulatory hormones like epinephrine, glucagon, growth hormone and cortisol to stimulate the liver to produce glucose<sup>(11, 16)</sup> These hormones counter the effect of insulin and blood glucose levels rise to prepare for the start of a working day and somogyi phenomenon states that, if a subject

## CONCLUSION

The conclusion drawn from the study is that, healthy subject may get fasting blood glucose value higher than post meal blood glucose due to variety of reasons. Such individuals may be having physiological insulin resistance. Further studies are needed to confirm the actual prevalence of

suffers a „hypo“ or low blood sugar levels at 2-3 am in the morning, his body is likely to rebound by causing the liver to release extra glucose into. Moderate consumption of alcohol in the evening may predispose patients to hypoglycemia after breakfast the next morning. This is associated with reduced nocturnal growth hormone secretion<sup>(17,18)</sup>. Healthy subjects with fasting blood glucose higher than post meal blood glucose should be followed to determine the possibility of getting Type II Diabetes Mellitus in recent or remote future. Also, the lifestyle changes, diet modification should be suggested for such subjects as a step towards primary prevention of diabetes mellitus.

this condition in general population and its long term effect if any. This study can be helpful in clinical and laboratory practices where many of the healthy subjects get fasting blood glucose level higher than the post meal levels.

## ACKNOWLEDGEMENTS

I am deeply indebted to mother who spared no effort behind in encouraging me to the last moments. No less I feel immensely overwhelmed by the unlimited support of my uncle, Professor Ali Elwakeel, without whose assistance this piece of work would have never

seen light.

I would like to express my heartiest gratitude to my family and friends for their tolerance, patience, moral support and affection that really gratified and encouraged my person to persevere and carry on. For that I see them ten times taller

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