International Journal of Science and Research Archive

eISSN: 2582-8185

Cross Ref DOI: 10.30574/ijsra

Journal homepage: https://ijsra.net/

(Research Article)

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Quantitative measurement of concentration of glucose in whole blood of teaching staff, non-teaching staff and postgraduate students and their data analysis category wise and classification wise

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International Journal of Science and Research Archive, 2025, 15(02), 1718–1741

Publication history: Received on 29 March 2025; revised on 17 May 2025; accepted on 20 May 2025

Article DOI: https://doi.org/10.30574/ijsra.2025.15.2.1342

Abstract

Blood sugar level: The blood sugar level, blood sugar concentration, blood glucose level, or glycemia is the measure of glucose concentrated in the blood. The body tightly regulates blood glucose levels as a part of metabolic homeostasis. Glucose that is not circulating in the blood is stored in skeletal muscle and liver cells in the form of glycogen; in fasting individuals, blood glucose is maintained at a constant level by releasing just enough glucose from these glycogen stores in the liver and skeletal muscle in order to maintain homeostasis. Glucose can be transported from the intestines or liver to other tissues in the body via the bloodstream. Cellular glucose uptake is primarily regulated by insulin, a hormone produced in the pancreas. Once inside the cell, the glucose can now act as an energy source as it undergoes the process of glycolysis. There are two ways of measuring blood glucose levels: In the United Kingdom and Commonwealth countries (Australia, Canada, India, etc.) and ex-USSR countries molar concentration, measured in mmol/L (millimoles per litre). In the United States, Germany, Japan and many other countries mass concentration is measured in mg/dl (milligrams per decilitre).

High blood sugar (Hyperglycemia): If blood sugar levels remain too high the body suppresses appetite over the short term. Long-term hyperglycemia causes many health problems including heart disease, cancer, eye, kidney, and nerve damage. The most common cause of hyperglycemia is diabetes. When diabetes is the cause, physicians typically recommend an anti-diabetic medication as treatment. From the perspective of the majority of patients, treatment with an old, well-understood diabetes drug such as metformin will be the safest, most effective, least expensive, and most comfortable route to managing the condition. Treatment will vary for the distinct forms of Diabetes and can differ from person to person based on how they are reacting to treatment. Diet changes and exercise implementation may also be part of a treatment plan for diabetes. Some medications may cause a rise in blood sugars of diabetics, such as steroid medications, including cortisone, hydrocortisone, prednisolone, prednisone, and dexamethasone.

Low blood sugar (Hypoglycemia): When the blood sugar level is below 70 mg/dL, this is referred to as having low blood sugar. Low blood sugar is very frequent among type 1 diabetics. There are several causes of low blood sugar, including, taking an excessive amount of insulin, not consuming enough carbohydrates, drinking alcohol, spending time at a high elevation, puberty, and menstruation. If blood sugar levels drop too low, a potentially fatal condition called hypoglycemia develops. Symptoms may include lethargy, impaired mental functioning; irritability; shaking, twitching, weakness in arm and leg muscles; pale complexion; sweating; loss of consciousness.

Glucose measurement: In the past to measure blood glucose it was necessary to take a blood sample, but since 2015 it has also been possible to use a continuous glucose monitor, which involves an electrode placed under the skin. Glucose testing in a fasting individual shows comparable levels of glucose in arterial, venous, and capillary blood. But following meals, capillary and arterial blood glucose levels can be significantly higher than venous levels.

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Two major methods have been used to measure glucose. The first, still in use in some places, is a chemical method exploiting the nonspecific reducing property of glucose in a reaction with an indicator substance that changes color when reduced. Since other blood compounds also have reducing properties, this technique can produce erroneous readings in some situations. The more recent technique, using enzymes specific to glucose, is less susceptible to this kind of error. The two most common employed enzymes are glucose oxidase and hexokinase. Average blood glucose concentrations can also be measured. This method measures the level of glycated hemoglobin, which is representative of the average blood glucose levels over the last, approximately, 120 days.

In either case, the chemical system is commonly contained on a test strip which is inserted into a meter, and then has a blood sample applied. Test-strip shapes and their exact chemical composition vary between meter systems and cannot be interchanged. More precise blood glucose measurements are performed in a medical laboratory, using hexokinase, glucose oxidase, or glucose dehydrogenase enzymes.

Present Paper deals with quantitative measurement of concentration of glucose in whole blood of 112 Teaching Staff, Non-Teaching Staff and Postgraduate Students of Brijlal Biyani Science College, Amravati. And their data analysis has been done on category wise and classification wise.Quantitative measurement of concentration of glucose in whole blood of 112 Teaching Staff, Non-Teaching Staff and Postgraduate Students is done on 25th April 2024 from 7 am to 6 pm. For measurement of Blood Glucose, Dr MorepenGluco One Blood Glucose Monitoring System Model: BG-03 is used. Glucose in the blood sample reacts with glucose oxidase (GOD) on the test strip and a harmless DC electrical current is produced. This current is measured by the Dr MorepenGluco One Blood Glucose Monitoring System and is displayed as blood glucose result. The strength of these currents changes with the amount of glucose in the blood sample. Gluco One automatically interprets this reaction.

Keywords: Blood Sugar level; Hyperglycemia; Hypoglycemia; Dr MorepenGluco One Blood Glucose Monitoring System; Blood Sugar Level status

1. Introduction

1.1. Blood sugar level

The blood sugar level, blood sugar concentration, blood glucose level, or glycemia is the measure of glucose concentrated in the blood. The body tightly regulates blood glucose levels as a part of metabolic homeostasis.For a 70 kg human, approximately four grams of dissolved glucose (blood glucose) is maintained in the blood plasma at all times. Glucose that is not circulating in the blood is stored in skeletal muscle and liver cells in the form of glycogen;in fasting individuals, blood glucose is maintained at a constant level by releasing just enough glucose from these glycogen stores in the liver and skeletal muscle in order to maintain homeostasis.Glucose can be transported from the intestines or liver to other tissues in the body via the bloodstream.Cellular glucose uptake is primarily regulated by insulin, a hormone produced in the pancreas. Once inside the cell, the glucose can now act as an energy source as it undergoes the process of glycolysis.

In humans, properly maintained glucose levels are necessary for normal function in a number of tissues, including the human brain, which consumes approximately 60% of blood glucose in fasting, sedentary individuals. A persistent elevation in blood glucose leads to glucose toxicity, which contributes to cell dysfunction and the pathology grouped together as complications of diabetes.[1]

Glucose levels are usually lowest in the morning, before the first meal of the day, and rise after meals for an hour or two by a few millimoles.Abnormal persistently high glycemia is referred to as hyperglycemia; low levels are referred to as hypoglycemia. Diabetes mellitus is characterized by persistent hyperglycemia from a variety of causes, and it is the most prominent disease related to the failure of blood sugar regulation. There are different methods of testing and measuring blood sugar levels.

Drinking 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.[2]

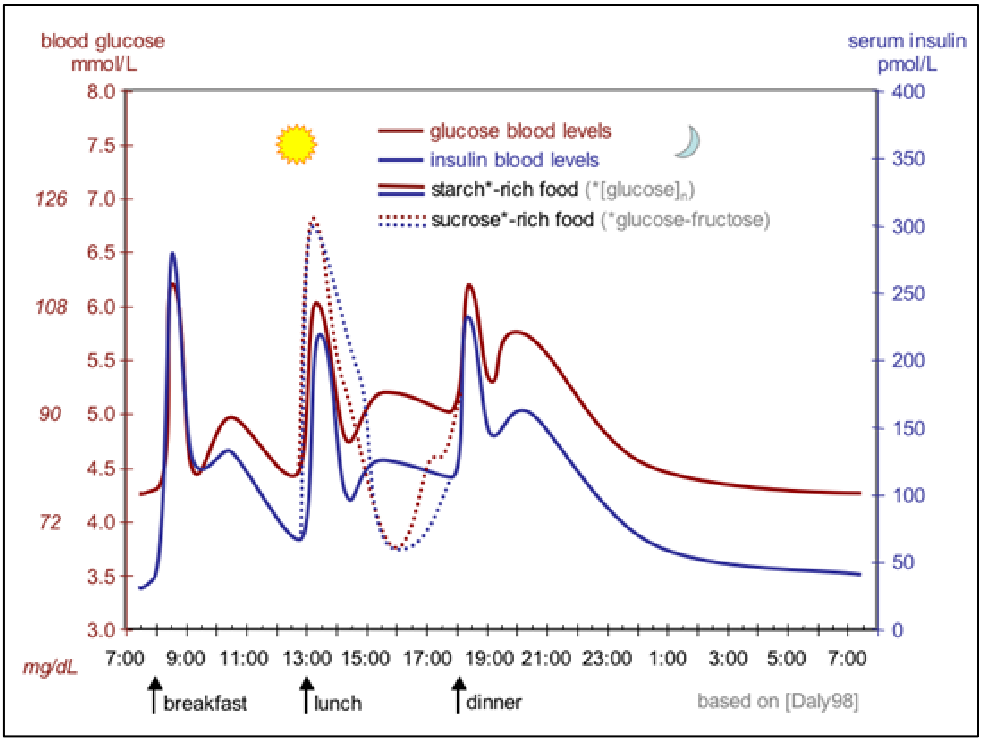

Figure 1 The fluctuation of blood sugar (red) and the sugar-lowering hormone insulin (blue) in humans during the course of a day with three meals. One of the effects of a sugar-rich vs a starch-rich meal is highlighted.[3]

There are two ways of measuring blood glucose levels: In the United Kingdom and Commonwealth countries (Australia, Canada, India, etc.) and ex-USSR countries molar concentration, measured in mmol/L (millimoles per litre, or millimolar, abbreviated mM). In the United States, Germany, Japan and many other countries mass concentration is measured in mg/dl (milligrams per decilitre).[4]

Since the molecular mass of glucose C6H12O6 is approximately 180 g/mol, the difference between the two units is a factor of about 18, so 1 mmol/L of glucose is equivalent to 18 mg/dL.[5]Normal blood glucose level (tested while fasting) for non-diabetics should be 3.9 - 5.5 mmol/L (70 -100 mg/dL).[6-8]

According to the American Diabetes Association, the fasting blood glucose target range for diabetics, should be 3.9 - 7.2 mmol/L (70 - 130 mg/dL) and less than 10 mmol/L (180 mg/dL) two hours after meals (as measured by a blood glucose monitor).[6, 7, 9]

Normal value ranges may vary slightly between laboratories. Glucose homeostasis, when operating normally, restores the blood sugar level to a narrow range of about 4.4 to 6.1 mmol/L (79 to 110 mg/dL) (as measured by a fasting blood glucose test).[10]

The global mean fasting plasma blood glucose level in humans is about 5.5 mmol/L (100 mg/dL);[5, 11] however, this level fluctuates throughout the day. Blood sugar levels for those without diabetes and who are not fasting should be below 6.9 mmol/L (125 mg/dL).[12]

Despite widely variable intervals between meals or the occasional consumption of meals with a substantial carbohydrate load, human blood glucose levels tend to remain within the normal range. However, shortly after eating, the blood glucose level may rise, in non-diabetics, temporarily up to 7.8 mmol/L (140 mg/dL) or slightly more.

The actual amount of glucose in the blood and body fluids is very small. In a healthy adult male of 75 kg (165 lb) with a blood volume of 5 L, a blood glucose level of 5.5 mmol/L (100 mg/dL) amounts to 5 g, equivalent to about a teaspoonful of sugar.[13] Part of the reason why this amount is so small is that, to maintain an influx of glucose into cells, enzymes modify glucose by adding phosphate or other groups to it.

1.2. Regulation

The body's homeostatic mechanism keeps blood glucose levels within a narrow range. It is composed of several interacting systems, of which hormone regulation is the most important. [14]

There are two types of mutually antagonistic metabolic hormones affecting blood glucose levels

- Catabolic hormones (such as glucagon, cortisol and catecholamines) which increase blood glucose;[15]
- And one anabolic hormone (insulin), which decreases blood glucose.

These hormones are secreted from pancreatic islets (bundles of endocrine tissues), of which there are four types: alpha (A) cells, beta (B) cells, Delta (D) cells and F cells. Glucagon is secreted from alpha cells, while insulin is secreted by beta cells. Together they regulate the blood-glucose levels through negative feedback, a process where the end product of one reaction stimulates the beginning of another reaction. In blood-glucose levels, insulin lowers the concentration of glucose in the blood. The lower blood-glucose level (a product of the insulin secretion) triggers glucagon to be secreted, and repeats the cycle.[16]

In order for blood glucose to be kept stable, modifications to insulin, glucagon, epinephrine and cortisol are made. Each of these hormones has a different responsibility to keep blood glucose regulated; when blood sugar is too high, insulin tells muscles to take up excess glucose for storage in the form of glycogen. Glucagon responds to too low of a blood glucose level; it informs the tissue to release some glucose from the glycogen stores. Epinephrine prepares the muscles and respiratory system for activity in the case of a "fight or flight" response. Lastly, cortisol supplies the body with fuel in times of heavy stress.[17]

1.3. High blood sugar (Hyperglycemia)

If blood sugar levels remain too high the body suppresses appetite over the short term. Long-term hyperglycemia causes many health problems including heart disease, cancer,[18] eye, kidney, and nerve damage.[19]

Blood sugar levels above 16.7 mmol/L (300 mg/dL) can cause fatal reactions. Ketones will be very high (a magnitude higher than when eating a very low carbohydrate diet) initiating ketoacidosis. The ADA (American Diabetes Association) recommends seeing a doctor if blood glucose reaches 13.3 mmol/L (240 mg/dL),[20] and it is recommended to seek emergency treatment at 15 mmol/L (270 mg/dL) blood glucose if Ketones are present.[21] The most common cause of hyperglycemia is diabetes. When diabetes is the cause, physicians typically recommend an anti-diabetic medication as treatment. From the perspective of the majority of patients, treatment with an old, well-understood diabetes drug such as metformin will be the safest, most effective, least expensive, and most comfortable route to managing the condition. Treatment will vary for the distinct forms of Diabetes and can differ from person to person based on how they are reacting to treatment.[22] Diet changes and exercise implementation may also be part of a treatment plan for diabetes.[23]

Some medications may cause a rise in blood sugars of diabetics, such as steroid medications, including cortisone, hydrocortisone, prednisolone, prednisone, and dexamethasone.[24]

1.4. Low blood sugar (Hypoglycemia)

When the blood sugar level is below 70 mg/dL, this is referred to as having low blood sugar. Low blood sugar is very frequent among type 1 diabetics. There are several causes of low blood sugar, including, taking an excessive amount of insulin, not consuming enough carbohydrates, drinking alcohol, spending time at a high elevation, puberty, and menstruation.[25] If blood sugar levels drop too low, a potentially fatal condition called hypoglycemia develops. Symptoms may include lethargy, impaired mental functioning; irritability; shaking, twitching, weakness in arm and leg muscles; pale complexion; sweating; loss of consciousness.

1.5. Glucose measurement

In the past to measure blood glucose it was necessary to take a blood sample, but since 2015 it has also been possible to use a continuous glucose monitor, which involves an electrode placed under the skin. Both methods, as of 2023, cost hundreds of dollars or euros per year for supplies needed.

1.6. Sample source

Glucose testing in a fasting individual shows comparable levels of glucose in arterial, venous, and capillary blood. But following meals, capillary and arterial blood glucose levels can be significantly higher than venous levels. Although these differences vary widely, one study found that following the consumption of 50 grams of glucose, "the mean capillary blood glucose concentration is higher than the mean venous blood glucose concentration by 35%."[26, 27]

1.7. Measurement techniques

Two major methods have been used to measure glucose. The first, still in use in some places, is a chemical method exploiting the nonspecific reducing property of glucose in a reaction with an indicator substance that changes color when reduced. Since other blood compounds also have reducing properties (e.g., urea, which can be abnormally high in uremic patients), this technique can produce erroneous readings in some situations (5–15 mg/dL has been reported). The more recent technique, using enzymes specific to glucose, is less susceptible to this kind of error. The two most common employed enzymes are glucose oxidase and hexokinase. Average blood glucose concentrations can also be measured. This method measures the level of glycated hemoglobin, which is representative of the average blood glucose levels over the last, approximately, 120 days.[28]

In either case, the chemical system is commonly contained on a test strip which is inserted into a meter, and then has a blood sample applied. Test-strip shapes and their exact chemical composition vary between meter systems and cannot be interchanged. Formerly, some test strips were read (after timing and wiping away the blood sample) by visual comparison against a color chart printed on the vial label. Strips of this type are still used for urine glucose readings, but for blood glucose levels they are obsolete. Their error rates were, in any case, much higher. Errors when using test strips were often caused by the age of the strip or exposure to high temperatures or humidity.[29] More precise blood glucose measurements are performed in a medical laboratory, using hexokinase, glucose oxidase, or glucose dehydrogenase enzymes.

Urine glucose readings, however taken, are much less useful. In properly functioning kidneys, glucose does not appear in urine until the renal threshold for glucose has been exceeded. This is substantially above any normal glucose level, and is evidence of an existing severe hyperglycemic condition. However, as urine is stored in the bladder, any glucose in it might have been produced at any time since the last time the bladder was emptied. Since metabolic conditions change rapidly, as a result of any of several factors, this is delayed news and gives no warning of a developing condition.[30] Blood glucose monitoring is far preferable, both clinically and for home monitoring by patients. Healthy urine glucose levels were first standardized and published in 1965[31] by Hans Renschler.

A noninvasive method of sampling to monitor glucose levels has emerged using an exhaled breath condensate. However this method does need highly sensitive glucose biosensors.[32]

Table 1 Measurement techniques of Glucose

I. Chemical methods		
A. Oxidation-reduction reaction		
$\text{Glucose} + \text{Alkaline copper tartarate} \xrightarrow{\text{Reduction}} \text{Cuprous oxide}$		
1. Alkaline copper reduction		
Folin-Wu method	$Cu^{2+} + \text{Phosphomolybdic acid} \xrightarrow{\text{Oxidation}} \text{Phosphomolybdenum oxide}$	Blue end-product
Benedict's method	Modification of Folin–Wu method for qualitative urine glucose.	
Nelson–Somogyi method	$Cu^{2+} + \text{Arsenomolybdic acid} \xrightarrow{\text{Oxidation}} \text{Arsenomolybdenum oxide}$	Blue end-product.
Neocuproine method	$Cu^{2+} + \text{Neocuproine} \xrightarrow{\text{Oxidation}} Cu^{2+} \text{ neocuproine complex}$	Yellow-orange colorneocuproine
Shaeffer–Hartmann–Somogyi	Uses the principle of iodine reaction with cuprous byproduct. Excess I_2 is then titrated with thiosulfate.	

2. Alkaline Ferricyanide reduction		
Hagedorn–Jensen	$\text{Glucose} + \text{Alkaline ferricyanide} \longrightarrow \text{Ferrocyanide}$	Colorless end product; other reducing substances interfere with reaction.
B. Condensation		
Ortho-toluidine method	Uses aromatic amines and hot acetic acid. Forms glycosylamineand Schiff's base which is emerald green in color. This is the most specific method, but the reagent used is toxic.	
Anthrone (phenols) method	Forms hydroxymethyl furfural in hot acetic acid	
II. Enzymatic methods		
A. Glucose oxidase		
$\text{Glucose} + O_2 \xrightarrow[\text{Oxidation}]{\text{glucose oxidase}} \text{D-glucono-1,5-lactone} + H_2O_2$		
Saifer–Gerstenfeld method	$H_2O_2 + O\text{-dianisidine} \xrightarrow[\text{Oxidation}]{\text{peroxidase}} H_2O + \text{oxidized chromogen}$	Inhibited by reducing substances like BUA, bilirubin, glutathione, ascorbic acid.
Trinder method	Uses 4-aminophenazone oxidatively coupled with phenol. Subject to less interference by increases serum levels of creatinine, uric acid or hemoglobin. Inhibited by catalase.	
Kodak Ektachem	A dry chemistry method. Uses spectrophotometry to measure the intensity of color through a lower transparent film.	
Glucometer	Home monitoring blood glucose assay method. Uses a strip impregnated with a glucose oxidase reagent.	
B. Hexokinase		
$\text{Glucose} + \text{ATP} \xrightarrow[\text{Phosphorylation}]{\text{Hexokinase}+Mg^{2+}} \text{G-6PO}_4 + \text{ADP}$ $\text{G-6PO}_4 + \text{NADP} \xrightarrow[\text{Oxidation}]{\text{G-6PD}} \text{6-Phosphogluconate} + \text{NADPH} + H^+$		
NADP as cofactor. NADPH (reduced product) is measured in 340 nm. More specific than glucose oxidase method due to G-6PO_4, which inhibits interfering substances except when sample is hemolyzed.		

Present Paper deals with quantitative measurement of concentration of glucose in whole blood of 112 Teaching Staff, Non-Teaching Staff and Postgraduate Students of Brijlal Biyani Science College, Amravati. And their data analysis has been done on category wise and classification wise.

2. Methodology

Quantitative measurement of concentration of glucose in whole blood of 112 Teaching Staff, Non-Teaching Staff and Postgraduate Students is done on 25th April 2024 from 7 am to 6 pm. For measurement of Blood Glucose, Dr MorepenGluco One Blood Glucose Monitoring System Model: BG-03 is used.

2.1. Dr MorepenGluco One Blood Glucose Monitoring System Model: BG-03

Dr MorepenGluco One Blood Glucose Monitoring System is for the quantitative measurement of the concentration of glucose in whole blood by diabetic patients or healthcare professionals as an aid in the management of diabetes. It is intended for using outside the body (in vitro diagnostic use), and not intended for use on neonates or arterial blood.

2.1.1. Test Principle

Glucose in the blood sample reacts with glucose oxidase (GOD) on the test strip and a harmless DC electrical current is produced. This current is measured by the Dr MorepenGluco One Blood Glucose Monitoring System and is displayed as blood glucose result. The strength of these currents changes with the amount of glucose in the blood sample. Gluco One automatically interprets this reaction.

2.1.2. Special Features:

- Gluco One Monotoring System is designed for home usage.
- Accurate result in 5 seconds with using only 0.5 µL of blood sample (Fresh capillary whole blood).
- Large display screen.
- Stores upto 300 test results.
- The unit of measurement is mg/dL.
- Measuring range 20-600 mg/dL (1.1-33.3 mmol/L).

Figure 2 Dr. MorepenGlucoOne Blood Glucose Monitoring system

Figure 3 Dr. MorepenGlucoOne Blood Glucose Test Strips

2.2. Dr. MorepenGlucoOne Blood Glucose Test Strips

Test strip should be used with Gluco One Blood Glucose Meter, to monitor glucose concentration of capillary whole blood. Test strips for in-vitro diagnostic use only, result could only be used for reference, not as diagnostic tools. The test strip ascertains and displays glucose concentration in blood sample measuring current produced by glucose oxidase solidified on test strip. Normal blood glucose reference values for non-diabetics are as follows

- Before eating : 70 – 110 mg/dL (3.9-6.1 mmol/L)
- 2 hours after meal : Below 140 mg/dL (7.8mmol/L)

Figure 4 Battery Installation

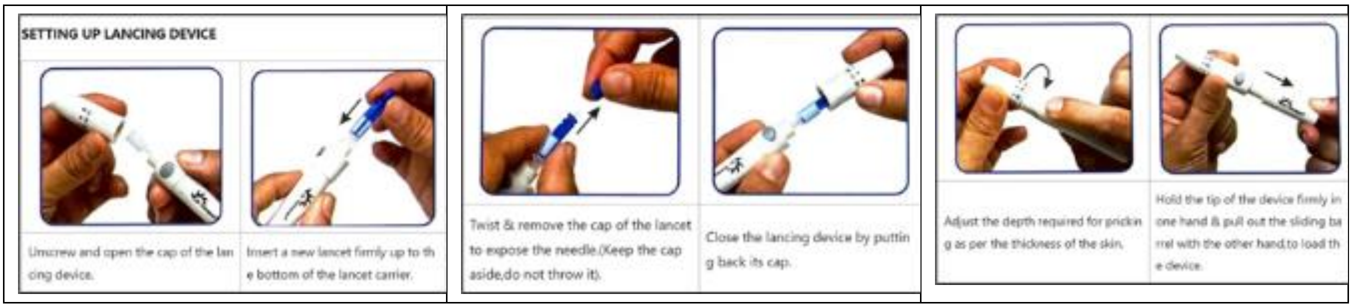

Figure 5 Setting up Lancing Device

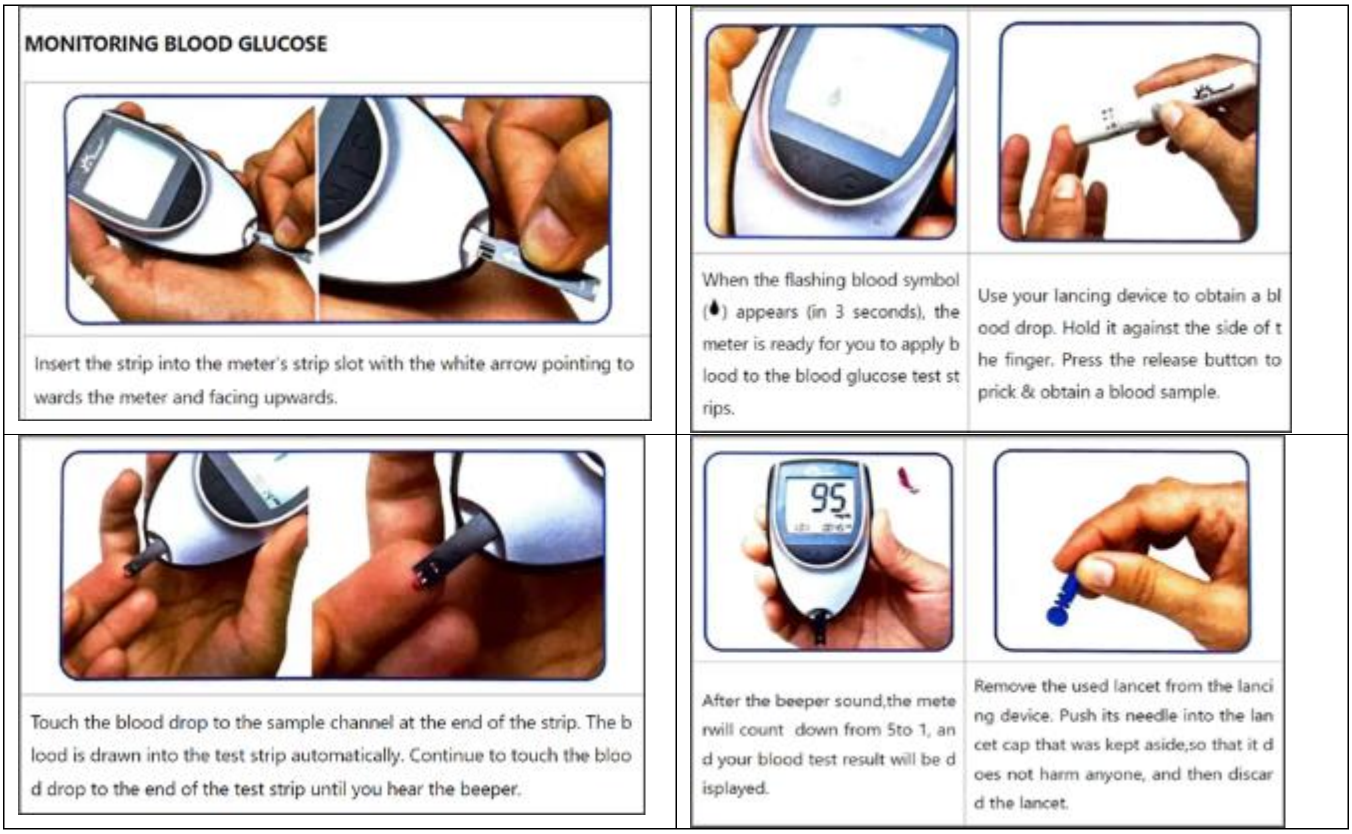

Figure 6 Monitoring Blood Glucose

Table 2 Quantitative measurement of concentration of glucose (2 Hour After Meal) in whole blood of teaching staff, non-teaching staff and postgraduate students

Case No	**Male / Female**	**Age**	**Blood Sugar level**
Teaching Staff Members			
1	Female	59	110
2	Male	58	188
3	Female	56	146
4	Female	56	111
5	Female	54	191
6	Female	53	379
7	Female	50	99
8	Female	49	110
9	Female	49	93
10	Male	48	144
11	Female	48	107
12	Female	47	99
13	Male	46	185
14	Female	45	130
15	Female	42	167
16	Female	41	154
17	Female	39	114
18	Female	38	106
19	Female	35	94
20	Male	35	98
21	Female	34	121
22	Female	33	107
23	Female	32	101
24	Female	32	80
25	Female	30	90
26	Female	29	124
27	Male	30	111
28	Female	29	99
29	Female	29	107
30	Female	27	151
31	Male	27	146
32	Female	26	109
33	Female	25	85
34	Female	24	85

Non Teaching Staff Members - Technical staff			
35	Male	69	153
36	Male	54	147
37	Male	53	154
38	Male	52	329
39	Male	50	88
40	Male	50	355
41	Male	49	140
42	Male	49	380
43	Male	47	93
44	Male	45	97
45	Male	43	94
46	Male	43	163
47	Female	43	155
48	Female	42	121
49	Male	41	132
50	Male	41	118
51	Male	40	101
52	Male	40	109
53	Male	38	83
54	Male	37	97
55	Male	34	113
56	Male	32	97
57	Male	30	208
58	Female	30	145
59	Male	27	112
60	Male	23	125
61	Male	22	105
62	Male	20	102
Non Teaching Staff Members - Laboratory Attendant			
63	Female	56	120
64	Male	56	149
65	Male	56	131
66	Male	53	86
67	Female	52	135
68	Male	52	104
69	Male	52	94
70	Female	51	120

71	Male	51	270
72	Male	50	113
73	Female	48	372
74	Female	48	151
75	Male	46	188
76	Male	45	109
77	Male	43	124
78	Female	36	122
79	Male	36	97
80	Female	33	116
81	Female	33	86
82	Male	32	81
83	Female	28	117
84	Male	28	88
Post Graduate Students – Chemistry Department			
85	Male	29.0	103
86	Female	27.0	108
87	Female	26	105
88	Female	25.5	87
89	Male	24.0	125
90	Male	24.0	95
91	Male	23.0	100
92	Female	23.0	107
93	Female	23.0	93
94	Female	23.0	102
95	Female	23.0	136
96	Female	22.0	94
97	Female	23.0	121
98	Male	23.0	92
99	Female	22.5	113
100	Female	22.5	101
101	Female	22.5	102
102	Male	22.0	155
103	Female	22.0	126
104	Female	22.0	100
105	Female	22.0	109
106	Male	22.0	92
107	Female	22.0	93

108	Female	22.0	101
109	Female	22.0	94
110	Female	23.0	102
111	Female	22.0	97
112	Female	21	92

3. Results and discussion

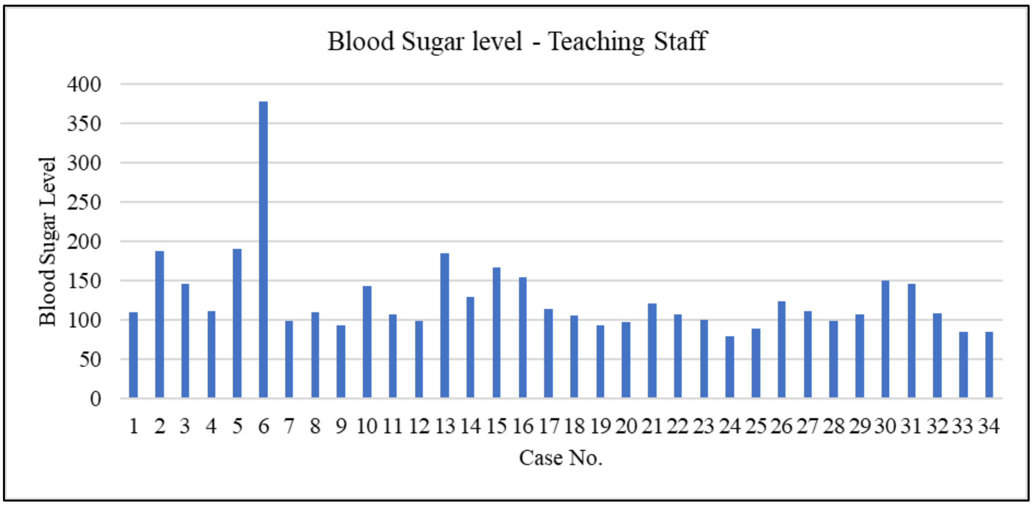

Figure 7 Blood Sugar level - Teaching Staff

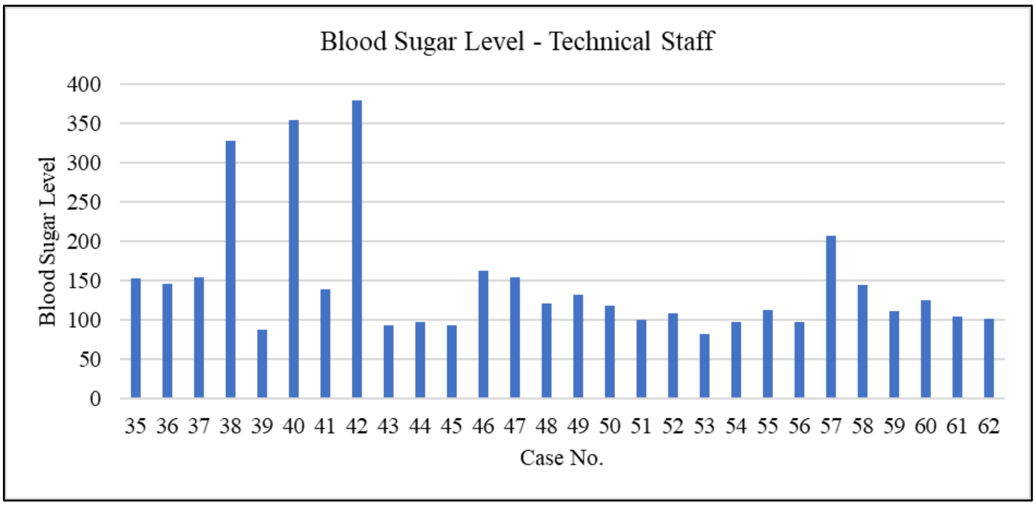

Figure 8 Blood Sugar Level - Technical Staff

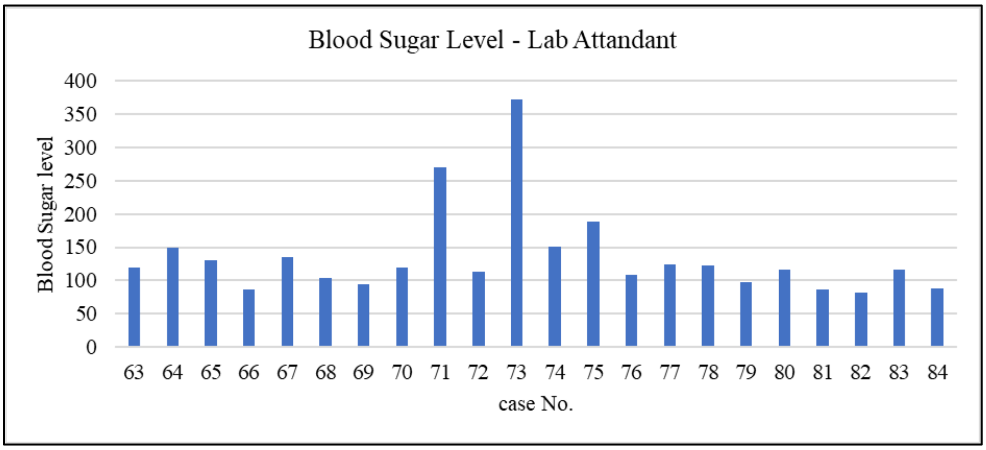

Figure 9 Blood Sugar Level - Lab Attandant

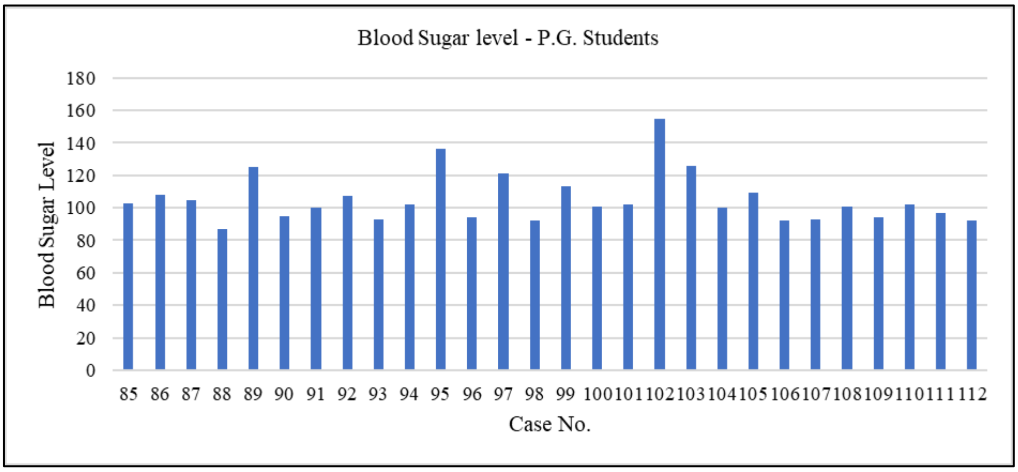

Figure 10 Blood Sugar level - P.G. Students

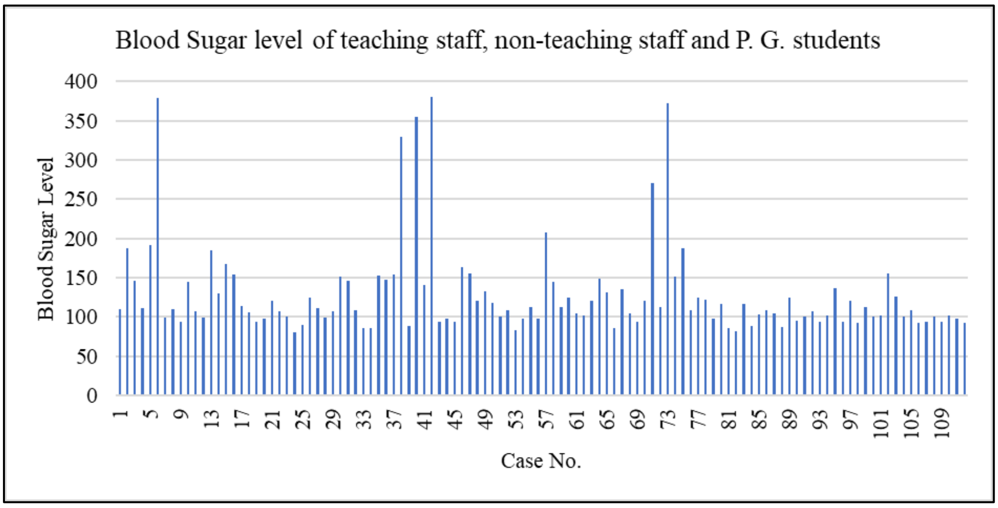

Figure 11 Blood Sugar level of teaching staff, non-teaching staff and P. G. students

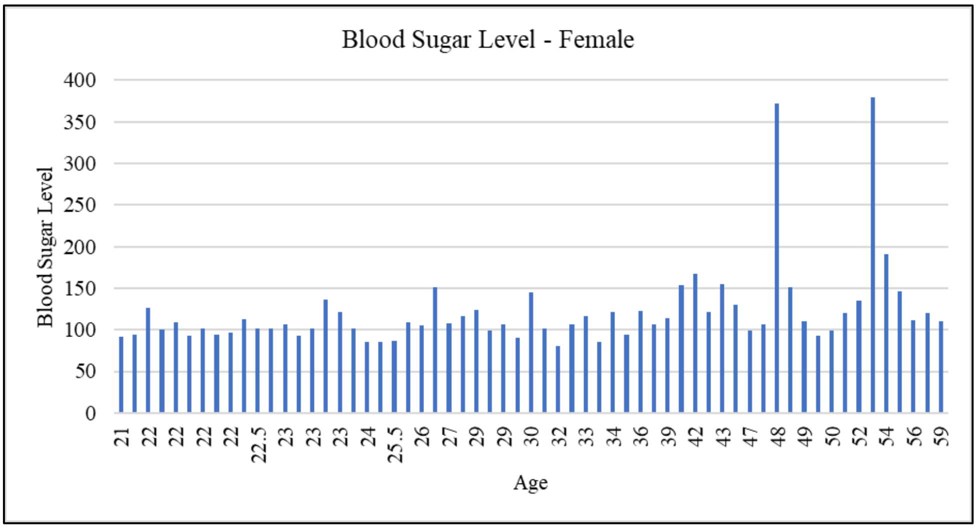

Figure 12 Blood Sugar Level - Female

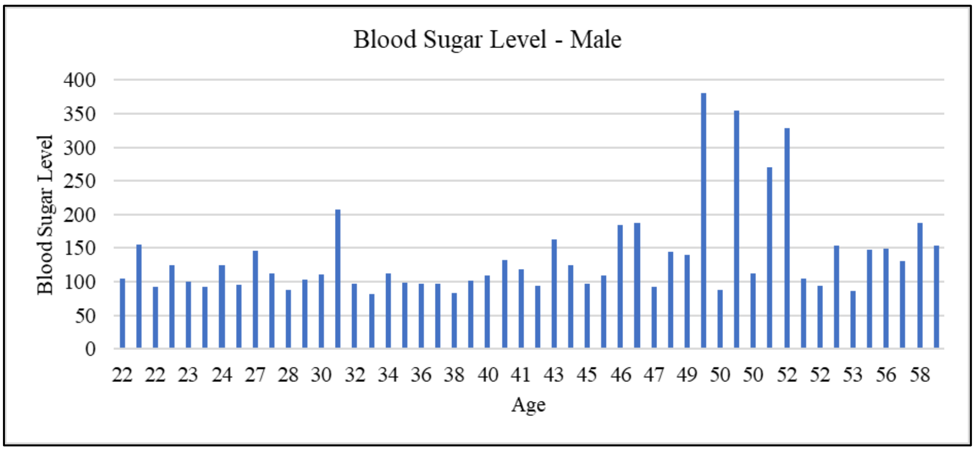

Figure 13 Blood Sugar Level - Male

Table 3 Blood Glucose Levels, mg/dL

Classification	Fasting	After eating	2 Hours after eating
Hypoglycemia	<70	<170	<100
Normal	70-100	170-200	100-140
Hyperglycemia			
Pre-Diabetes	101-125	201-230	141-200
Diabetes	>125	>230	>200

Table 4 Blood Sugar Status of teaching staff, non-teaching staff and postgraduate students

Case No	Male / Female	Age	Blood Sugar level	Blood Sugar level Status
Teaching Staff Members				
1	Female	59	110	Normal
2	Male	58	188	Pre-Diabetes
3	Female	56	146	Pre-Diabetes
4	Female	56	111	Normal
5	Female	54	191	Pre-Diabetes
6	Female	53	379	Diabetes
7	Female	50	99	Hypoglycemia
8	Female	49	110	Normal
9	Female	49	93	Hypoglycemia
10	Male	48	144	Pre-Diabetes
11	Female	48	107	Normal
12	Female	47	99	Hypoglycemia
13	Male	46	185	Pre-Diabetes
14	Female	45	130	Normal
15	Female	42	167	Pre-Diabetes
16	Female	41	154	Pre-Diabetes
17	Female	39	114	Normal
18	Female	38	106	Normal
19	Female	35	94	Hypoglycemia
20	Male	35	98	Hypoglycemia
21	Female	34	121	Normal
22	Female	33	107	Normal
23	Female	32	101	Normal
24	Female	32	80	Hypoglycemia
25	Female	30	90	Hypoglycemia
26	Female	29	124	Normal
27	Male	30	111	Normal
28	Female	29	99	Hypoglycemia
29	Female	29	107	Normal
30	Female	27	151	Pre-Diabetes
31	Male	27	146	Pre-Diabetes
32	Female	26	109	Normal
33	Female	25	85	Hypoglycemia
34	Female	24	85	Hypoglycemia

Non Teaching Staff Members - Technical staff				
35	Male	69	153	Pre-Diabetes
36	Male	54	147	Pre-Diabetes
37	Male	53	154	Pre-Diabetes
38	Male	52	329	Diabetes
39	Male	50	88	Hypoglycemia
40	Male	50	355	Diabetes
41	Male	49	140	Normal
42	Male	49	380	Diabetes
43	Male	47	93	Hypoglycemia
44	Male	45	97	Hypoglycemia
45	Male	43	94	Hypoglycemia
46	Male	43	163	Pre-Diabetes
47	Female	43	155	Pre-Diabetes
48	Female	42	121	Normal
49	Male	41	132	Normal
50	Male	41	118	Normal
51	Male	40	101	Normal
52	Male	40	109	Normal
53	Male	38	83	Hypoglycemia
54	Male	37	97	Hypoglycemia
55	Male	34	113	Normal
56	Male	32	97	Hypoglycemia
57	Male	30	208	Diabetes
58	Female	30	145	Pre-Diabetes
59	Male	27	112	Normal
60	Male	23	125	Normal
61	Male	22	105	Normal
62	Male	20	102	Normal
Non Teaching Staff Members - Laboratory Attendant				
63	Female	56	120	Normal
64	Male	56	149	Pre-Diabetes
65	Male	56	131	Normal
66	Male	53	86	Hypoglycemia
67	Female	52	135	Normal
68	Male	52	104	Normal
69	Male	52	94	Hypoglycemia
70	Female	51	120	Normal

71	Male	51	270	Diabetes
72	Male	50	113	Normal
73	Female	48	372	Diabetes
74	Female	48	151	Pre-Diabetes
75	Male	46	188	Pre-Diabetes
76	Male	45	109	Normal
77	Male	43	124	Normal
78	Female	36	122	Normal
79	Male	36	97	Hypoglycemia
80	Female	33	116	Normal
81	Female	33	86	Hypoglycemia
82	Male	32	81	Hypoglycemia
83	Female	28	117	Normal
84	Male	28	88	Hypoglycemia
Post Graduate Students – Chemistry Department				
85	Male	29	103	Normal
86	Female	27	108	Normal
87	Female	26	105	Normal
88	Female	25.5	87	Hypoglycemia
89	Male	24	125	Normal
90	Male	24	95	Hypoglycemia
91	Male	23	100	Normal
92	Female	23	107	Normal
93	Female	23	93	Hypoglycemia
94	Female	23	102	Normal
95	Female	23	136	Normal
96	Female	22	94	Hypoglycemia
97	Female	23	121	Normal
98	Male	23	92	Hypoglycemia
99	Female	22.5	113	Normal
100	Female	22.5	101	Normal
101	Female	22.5	102	Normal
102	Male	22	155	Pre-Diabetes
103	Female	22	126	Normal
104	Female	22	100	Normal
105	Female	22	109	Normal
106	Male	22	92	Hypoglycemia
107	Female	22	93	Hypoglycemia

108	Female	22	101	Normal
109	Female	22	94	Hypoglycemia
110	Female	23	102	Normal
111	Female	22	97	Hypoglycemia
112	Female	21	92	Hypoglycemia

Table 5 Blood Sugar Level Status - Male and Female wise

Case No	Male / Female	Age	Blood Sugar level	Blood Sugar level Status
Female				
112	Female	21	92	Hypoglycemia
96	Female	22	94	Hypoglycemia
103	Female	22	126	Normal
104	Female	22	100	Normal
105	Female	22	109	Normal
107	Female	22	93	Hypoglycemia
108	Female	22	101	Normal
109	Female	22	94	Hypoglycemia
111	Female	22	97	Hypoglycemia
99	Female	22.5	113	Normal
100	Female	22.5	101	Normal
101	Female	22.5	102	Normal
92	Female	23	107	Normal
93	Female	23	93	Hypoglycemia
94	Female	23	102	Normal
95	Female	23	136	Normal
97	Female	23	121	Normal
110	Female	23	102	Normal
34	Female	24	85	Hypoglycemia
33	Female	25	85	Hypoglycemia
88	Female	25.5	87	Hypoglycemia
32	Female	26	109	Normal
87	Female	26	105	Normal
30	Female	27	151	Pre-Diabetes
86	Female	27	108	Normal
83	Female	28	117	Normal
26	Female	29	124	Normal
28	Female	29	99	Hypoglycemia

29	Female	29	107	Normal
25	Female	30	90	Hypoglycemia
58	Female	30	145	Pre-Diabetes
23	Female	32	101	Normal
24	Female	32	80	Hypoglycemia
22	Female	33	107	Normal
80	Female	33	116	Normal
81	Female	33	86	Hypoglycemia
21	Female	34	121	Normal
19	Female	35	94	Hypoglycemia
78	Female	36	122	Normal
18	Female	38	106	Normal
17	Female	39	114	Normal
16	Female	41	154	Pre-Diabetes
15	Female	42	167	Pre-Diabetes
48	Female	42	121	Normal
47	Female	43	155	Pre-Diabetes
14	Female	45	130	Normal
12	Female	47	99	Hypoglycemia
11	Female	48	107	Normal
73	Female	48	372	Diabetes
74	Female	48	151	Pre-Diabetes
8	Female	49	110	Normal
9	Female	49	93	Hypoglycemia
7	Female	50	99	Hypoglycemia
70	Female	51	120	Normal
67	Female	52	135	Normal
6	Female	53	379	Diabetes
5	Female	54	191	Pre-Diabetes
3	Female	56	146	Pre-Diabetes
4	Female	56	111	Normal
63	Female	56	120	Normal
1	Female	59	110	Normal
Male				
62	Male	20	102	Normal
61	Male	22	105	Normal
102	Male	22	155	Pre-Diabetes
106	Male	22	92	Hypoglycemia

60	Male	23	125	Normal
91	Male	23	100	Normal
98	Male	23	92	Hypoglycemia
89	Male	24	125	Normal
90	Male	24	95	Hypoglycemia
31	Male	27	146	Pre-Diabetes
59	Male	27	112	Normal
84	Male	28	88	Hypoglycemia
85	Male	29	103	Normal
27	Male	30	111	Normal
57	Male	30	208	Diabetes
56	Male	32	97	Hypoglycemia
82	Male	32	81	Hypoglycemia
55	Male	34	113	Normal
20	Male	35	98	Hypoglycemia
79	Male	36	97	Hypoglycemia
54	Male	37	97	Hypoglycemia
53	Male	38	83	Hypoglycemia
51	Male	40	101	Normal
52	Male	40	109	Normal
49	Male	41	132	Normal
50	Male	41	118	Normal
45	Male	43	94	Hypoglycemia
46	Male	43	163	Pre-Diabetes
77	Male	43	124	Normal
44	Male	45	97	Hypoglycemia
76	Male	45	109	Normal
13	Male	46	185	Pre-Diabetes
75	Male	46	188	Pre-Diabetes
43	Male	47	93	Hypoglycemia
10	Male	48	144	Pre-Diabetes
41	Male	49	140	Normal
42	Male	49	380	Diabetes
39	Male	50	88	Hypoglycemia
40	Male	50	355	Diabetes
72	Male	50	113	Normal
71	Male	51	270	Diabetes
38	Male	52	329	Diabetes

68	Male	52	104	Normal
69	Male	52	94	Hypoglycemia
37	Male	53	154	Pre-Diabetes
66	Male	53	86	Hypoglycemia
36	Male	54	147	Pre-Diabetes
64	Male	56	149	Pre-Diabetes
65	Male	56	131	Normal
2	Male	58	188	Pre-Diabetes
35	Male	69	153	Pre-Diabetes

Table 6 Blood Sugar status of teaching staff, non-teaching staff and undergraduate students

S. N.	**Blood Sugar Status**	**Blood Glucose Levels, mg/dL (2 Hours after eating)**				**Total**
		Hypoglycemia	**Normal**	**Hyperglycemia**		
				Pre-Diabetes	**Diabetes**	
	Blood Sugar Classification →	**<100**	**100-140**	**141-200**	**>200**	
01 to 34	Teaching Staff	10	14	09	01	34
35 to 62	Technical Staff	07	11	06	04	28
63 to 84	Lab Attendant	06	11	03	02	22
85 to 112	PG Student	10	17	01	00	28
	All Category	33	53	19	07	112
	Female	17	34	08	02	61
	Male	16	19	11	05	51

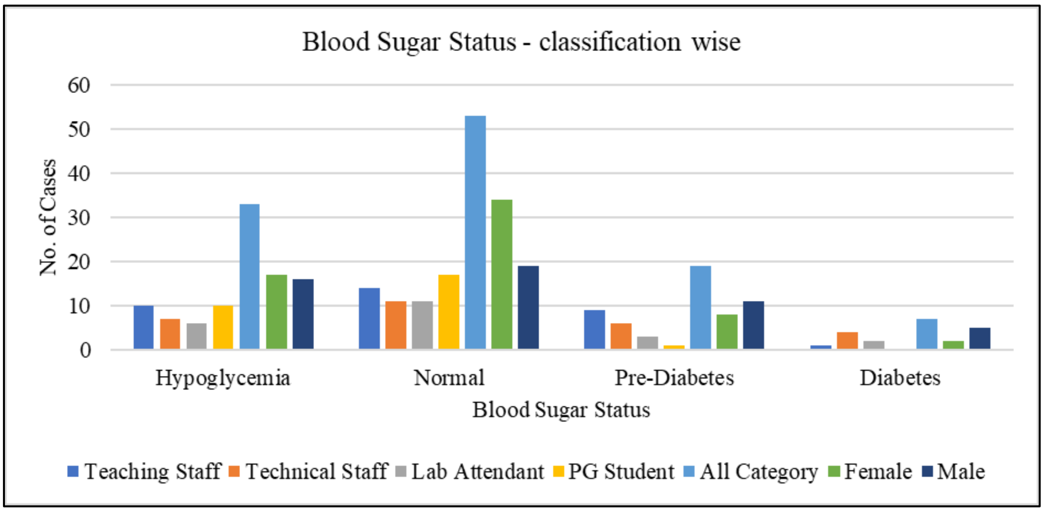

Figure 14 Blood Sugar Status - classification wise

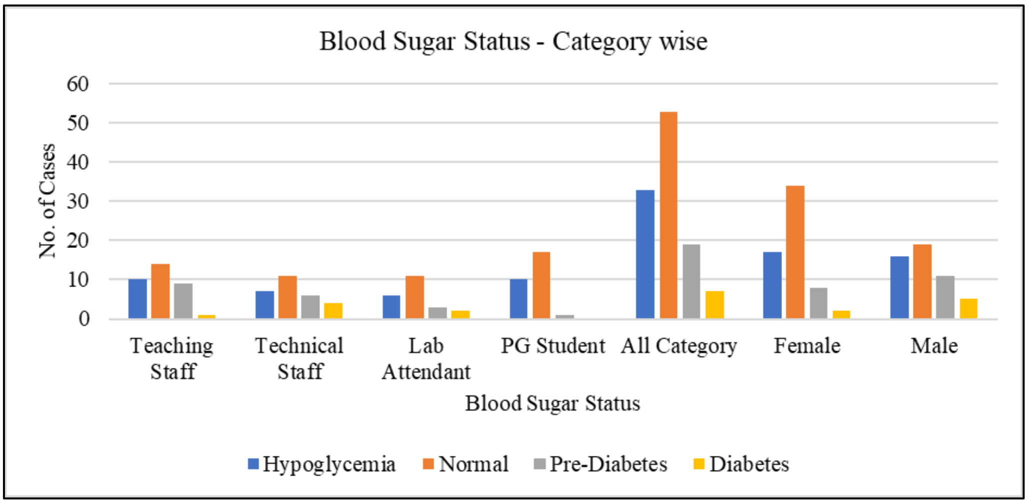

Figure 15 Blood Sugar Status - Category wise

4. Conclusion

Blood Sugar status of teaching staff, non-teaching staff and postgraduate students shows that

- Out of 34 Teaching Staff– 10 Hypoglycemia, 14 Normal, Hyperglycemia (09 Pre-Diabetes, 01 Diabetes) are found.
- Out of 28Technical Staff – 07Hypoglycemia, 11Normal, Hyperglycemia (06Pre-Diabetes, 04Diabetes) are found.
- Out of 22Lab attendant– 06Hypoglycemia, 11Normal, Hyperglycemia (03Pre-Diabetes, 02Diabetes) are found.
- Out of 28PG student– 10 Hypoglycemia, 17Normal, Hyperglycemia (01Pre-Diabetes, 00Diabetes) are found.
- Out of 112All category– 33Hypoglycemia, 53Normal, Hyperglycemia (19 Pre-Diabetes, 07Diabetes) are found.
- Out of 61Female– 17Hypoglycemia, 34 Normal, Hyperglycemia (08Pre-Diabetes, 02Diabetes) are found.
- Out of 51 Male– 16Hypoglycemia, 19Normal, Hyperglycemia (11Pre-Diabetes, 05Diabetes) are found.

Compliance with ethical standards

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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