

# Correlation between Fasting Blood Sugar Level, HbA1C Level and Serum Lipid Levels in Type 2 Diabetes Mellitus Patients

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## ABSTRACT

**Introduction:** Diabetes Mellitus is one of the most common endocrinal diseases in the world. Incidences of this disease are increasing worldwide and this disease is called disease of this millennium. This study was undertaken to correlate fasting blood sugar level, Glycosylated haemoglobin (HbA<sub>1c</sub>) level and serum lipid levels in patients with diabetes mellitus.

**Material and Methods:** This study was a cross sectional study conducted on 100 patients of diabetes mellitus came to M.B Govt. Hospital, Udaipur. The fasting blood sugar (FBS) levels, HbA<sub>1c</sub> levels and serum lipid levels were performed and then correlated fasting blood sugar level with HbA<sub>1c</sub> levels and FBS and HbA<sub>1c</sub> with serum lipid levels. There was a significant positive correlation between FBS and HbA<sub>1c</sub>, and FBS and HbA<sub>1c</sub> with serum cholesterol and serum triglycerides level and negative correlation with serum HDL-cholesterol levels.

**Results:** This study demonstrated that HbA<sub>1c</sub> level was increased in diabetics and it showed correlation with the status of control of diabetes.

**Conclusion:** Diabetics have got increased level of serum cholesterol, triglycerides and decreased levels of serum HDL-cholesterol. HbA<sub>1c</sub> showed stronger correlation with serum cholesterol and triglycerides as compared to FBS. HDL-cholesterol showed stronger correlation with FBS than HbA<sub>1c</sub>.

**Keywords:** Diabetes Mellitus (DM), Fasting Blood Sugar (FBS), Glycosylated Haemoglobin (HbA<sub>1c</sub>), Serum Cholesterol, Serum Triglycerides, Serum HDL-Cholesterol.

## INTRODUCTION

Diabetes Mellitus (DM) refers to a group of common metabolic disorder that share the phenotype of hyperglycaemia caused due to either deficiency of insulin secretion or insulin resistance.<sup>1</sup> Diabetes Mellitus is one of the most common endocrinal Diseases in the world. Incidences of this disease are increasing worldwide and this disease is called disease of this millennium. The worldwide prevalence of this disease has risen dramatically over the past two decades, from an estimated 30 million in 1985 to 85 million in 2010 and 415 million in 2017. India is thought to be capital for DM, the incidences of this disease is 73 million in 2015.<sup>1</sup>

Diabetes mellitus is commonly associated with abnormalities of carbohydrate metabolism, lipid metabolism, insulin resistance etc.

One of the common metabolic abnormalities in DM individuals is disturbed in lipid metabolism and several form of dyslipidemias has observed in these patients. As many as 60% of diabetics exhibit some degree of hyperlipidemia<sup>2</sup>

and lipid metabolism appears to be related to the severity and duration of hyperglycaemic state<sup>3</sup> and the degree of its control.<sup>4,5,6</sup>

It has also been reported that hyperlipidemia associated with uncontrolled diabetic state could revert to near normal levels with good control of diabetes and hence can prevent the development of various complications of diabetes.

A good control of DM is believed in diabetic individuals when he can obtain levels of fasting and postprandial blood glucose values as much close to those of the non-diabetic as possible. This concept may be philosophically correct but in actual practice difficult to obtain, and even with quite good control of diabetes, fluctuations in blood glucose level may be marked, not only from day to day but even from hour to hour. As our aim of treatment is not simply the control of blood glucose levels but to kept the total metabolic state to as much normal as possible, the study of hyperglycaemia has distinct limitations as a marker for proper diabetic control.

Therefore, many investigations have been suggested to look out for some other marker which could give us better idea for proper metabolic control. The study of Glycosylated haemoglobin (HbA<sub>1c</sub>) during last few years has been found to be very helpful in this respect.

The most common pattern of dyslipidemia in DM patients is increased triglyceride and reduced level of HDL cholesterol and it does not affect LDL level.

This study was undertaken to correlate between fasting blood sugar level, HbA<sub>1c</sub> level and serum lipid levels in type 2 diabetes mellitus.

## MATERIAL AND METHODS

It was a cross sectional study conducted on 100 patients of diabetes mellitus, who were admitted/attended in medical wards, medical OPD, diabetic clinic at M.B Govt. Hospital and RNT Medical College, Udaipur (Raj). Approval was

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taken by the Ethical committee. Written informed consent was taken in all patients. Detailed history and examination was done in all patients who were having typical history suggestive of diabetes and satisfied the inclusion criteria. Following criteria were used for diagnosis of Diabetes (inclusion criteria) and following were exclusion criteria:

- Diagnostic criteria for diabetes mellitus:
  - FBS after at least 8 hours of fasting  $\geq 126$  mg/dl or
  - 2 hours after meal plasma glucose level  $\geq 200$  mg/dl or
  - Glycosylated haemoglobin  $\geq 6.5$  % or
  - Symptoms of diabetes plus random blood glucose concentration  $\geq 200$  mg/dl.
- Exclusion criteria includes:
  - Patients with evidence of primary hyperlipoproteinemia
  - Patients with secondary hyperproteinemia due to endocrine diseases such as acromegaly, hypothyroidism, cushing syndrome
  - Patients with nephrotic syndrome
  - Patients with liver diseases
  - Pregnancy
  - Patients of chronic kidney disease and on dialysis
  - Decompensated heart failure.

Somogyi Nelson's (1945)<sup>7</sup> methods were used for blood sugar (fasting, postprandial, random) estimation. Modified method of Fluckiger and Winterhalter was used for estimation of glycosylated haemoglobin (HbA<sub>1c</sub>). The plasma lipoproteins were estimated by electrophoretic separation of lipoproteins on agarose gel (Nobel, 1968). Plasma cholesterol was determined by liberman-Buchard reaction.

## STATISTICAL ANALYSIS

Statistical analysis was carried out using standard formulae. P value of  $< 0.05$  was considered as a significant. Statistical significance was calculated by using Chi square test.

## RESULTS

A total number of 100 patients were enrolled in our study, out of which 47(47%) were male and 53(53%) were female and maximum were in the age group of 60-69 (table-1,2).

Fasting blood sugar level varied from 86 mg/dl to 310 mg/dl with a mean level of  $167.63 \pm 54.53$  mg/dl. HbA<sub>1c</sub> level varied from 5.42% to 14.78% with a mean level of  $9.86 \pm 2.56$ . The correlation of FBS and HbA<sub>1c</sub> level in different groups of diabetics shows that patients in good control had FBS level  $104.09 \pm 11.96$  mg/dl and HbA<sub>1c</sub> level of  $6.82 \pm 0.92\%$ . Patients in fairly controlled group had FBS level and HbA<sub>1c</sub> level of  $161 \pm 22.97$  mg/dl and  $8.99 \pm 1.61$  % respectively. In poorly controlled groups FBS level were  $202.5 \pm 43.72$  mg/dl and HbA<sub>1c</sub> level were  $11.74 \pm 1.99\%$  (table-3).

In these 100 patients serum cholesterol level varied from 145 mg/dl to 300 mg/dl with a mean level of  $219.70 \pm 41.46$  mg/dl and serum triglyceride level varied from 90 mg/dl to 269 mg/dl with a mean level of  $193.60 \pm 43.14$  mg/dl and serum HDL-cholesterol level varied from 20 mg/dl

Age group (years)	No. of patients	%
40-49	25	25.0
50-59	18	18.0
60-69	31	31.0
70-79	21	21.0
$\geq 80$	5	5.0

Table-1: Age wise distribution

Sex	No. of patients	%
Male	47	47.0
Female	53	53.0

Table-2: Sex wise distribution

Degree of control		Good	Fair	Poor
No. of cases		27	30	53
FBS (mg/dl)	Mean	104.09	161.0	202.50
	S.D.	11.96	22.97	43.72
	S.E.	0.36	0.81	0.95
HbA <sub>1c</sub> (%)	Mean	6.82	8.99	11.74
	S.D.	0.92	1.61	1.99
	S.E.	0.02	0.05	0.04

Table-3: Showing levels of FBS and HbA1C level in different groups according to control of diabetes

	Correlation coefficient (r)	Significance (P value)
HbA <sub>1c</sub> and cholesterol	+0.395	$< 0.02$
HbA <sub>1c</sub> and triglycerides	+0.397	$< 0.02$
HbA <sub>1c</sub> and HDL-cholesterol	-0.45	$< 0.01$

Table-4: Showing correlation of HbA1C to serum lipid levels in diabetic subjects

	Correlation coefficients (r)	Significance (P value)
FBS and cholesterol	+0.35	$< 0.05$
FBS and triglycerides	+0.34	$< 0.05$
FBS and HDL-cholesterol	-0.69	$< 0.001$

Table-5: Showing correlation of FBS to serum lipid levels in diabetic subjects

dl to 129 mg/dl with a mean level of  $44.33 \pm 17.49$  mg/dl. There was significant correlation between HbA<sub>1c</sub> and serum cholesterol ( $r = 0.395$ ,  $P < 0.02$ ) and between HbA<sub>1c</sub> and serum triglycerides ( $r = 0.397$ ,  $p < 0.02$ ). HbA<sub>1c</sub> and serum HDL-cholesterol show significant negative correlation ( $r = -0.45$ ,  $P < 0.01$ ) (table-4).

There was just significant correlation between FBS and serum cholesterol ( $r = 0.35$ ,  $P < 0.05$ ) and also just significant correlation between FBS and serum triglycerides level ( $r = 0.34$ ,  $P < 0.05$ ). Correlation between FBS and serum HDL-cholesterol was highly significant ( $r = -0.69$ ,  $P < 0.001$ ) but correlation was negative. Significant correlation was observed after applying Chi Square test and Student t test (table-5).

## DISCUSSION

Out of the 100 patients we studied, 47(47%) was male and

53 (53%) was female. In our studied FBS level varies 86 mg/dl to 310 mg/dl with a mean level of  $167.63 \pm 54.53$  mg/dl. Values of HbA<sub>1c</sub> level was in range of 5.42% - 14.78% with a mean level of  $9.86 \pm 2.56$ . This increase in HbA<sub>1c</sub> level in these patients was significant ( $P < 0.001$ ).

Paulsen et al. (1976)<sup>8</sup>, Javid et al. (1978) studied demonstrated similar type of results in their studies. Mean fasting blood sugar level in diabetic patients with good control was 104.09 mg/dl and level of HbA<sub>1c</sub> was 6.82%, while in fairly control, the FBS level was 161 mg/dl and level of HbA<sub>1c</sub> was 8.99% and in those with poor control, the FBS was 202.50 mg/dl and level of HbA<sub>1c</sub> was 11.74%. The P value (0.001) for FBS and HbA<sub>1c</sub> between those three groups of diabetic patients was highly significant. This shows that the level of HbA<sub>1c</sub> in diabetic patients is linearly correlated with the abnormal blood glucose level.

Same has been reported by various workers including Gabbay et al. (1976)<sup>9</sup> and Elkeles et al. (1978).<sup>10</sup>

Kennedy et al. (1979)<sup>11</sup> found correlation between FBS and HbA<sub>1c</sub> levels were satisfactory while Nabarro et al. (1979)<sup>12</sup> found correlation between HbA<sub>1c</sub> and FBS were not satisfactory. However, in some individual cases, there was no correlation between HbA<sub>1c</sub> and FBS.

Compagnucci et al. (1981)<sup>13</sup> observed that during periods of wide fluctuations in blood sugar, HbA<sub>1c</sub> level remains nearly constant and in these patients measurement of HbA<sub>1c</sub> is much more valuable in providing the assessment of diabetic control not available from random blood sugar measurements.

In our studied, serum cholesterol level varied from 145 mg/dl to 300 mg/dl (mean  $219.70 \pm 41.46$  mg/dl) which was statistically significant.

Diabetic cases studied by Dinesh Kumar et al. (1967)<sup>14</sup> also showed high serum cholesterol level (238.50 mg/dl) in older untreated diabetics.

Similar observations were also reported by Maleva (1961)<sup>15</sup>, Sharma et al. (1970)<sup>4</sup> and Sosenko et al. (1980).<sup>5</sup> Nikkila et al. (1978)<sup>16</sup> found high serum cholesterol levels in poorly controlled diabetic males as well as in well controlled obese males.

The increase in cholesterol level appears to be due to increased cholesterol synthesis during poor or no control of hyperglycaemic state, which returns to normal or near normal after good control of their diabetic state. Obesity is an additional cause of enhanced cholesterol production.

In our studied, serum triglycerides level varied from 90 mg/dl to 269 mg/dl with a mean level of  $193.60 \pm 43.14$  mg/dl which was statistically significant. Our finding was consistent with many studies.

However, these levels were elevated in diabetics who were in poor control as compared to well controlled diabetics and also in obese male diabetics, although they were in good control.

Akeel bai-Yaqobi et al. (2011)<sup>17</sup>, Piia P et al. (2012)<sup>18</sup> showed higher level of triglyceride in diabetics.

American Heart Association: Triglyceride (2011), American diabetic service (2012), Diabetic Health-Pub. Med-Metabolic

syndrome also showed that triglycerides level increases in patients with diabetes mellitus.

In our studied, serum HDL-cholesterol level varied from 20 mg/dl to 129 mg/dl with a mean level of  $44.33 \pm 17.49$  mg/dl. The value of plasma HDL-cholesterol was significant low in diabetic subjects. This is in conformity with the studies of Lopes-Virella et al. (1982).<sup>19</sup>

In our studied, there was statistically significant direct correlation between HbA<sub>1c</sub> levels and cholesterol, triglycerides while significant negative correlation was observed between HbA<sub>1c</sub> levels and plasma HDL-cholesterol levels.

Peterson et al. (1977)<sup>20</sup> showed direct correlation between HbA<sub>1c</sub> and serum triglycerides and cholesterol levels.

On the contrary Gonen et al. (1977)<sup>21</sup> did not demonstrated any correlation between HbA<sub>1c</sub> and serum cholesterol and triglyceride levels while Gabbay et al. (1977)<sup>22</sup> demonstrated direct correlation between HbA<sub>1c</sub> and serum cholesterol.

Lopes-Virella et al. (1981)<sup>19</sup> and Falko et al. (1981)<sup>23</sup> demonstrated significant inverse correlation between HbA<sub>1c</sub> and serum HDL-cholesterol level.

In our studied there was statistically significant direct correlation between FBS level and total cholesterol level, triglycerides level, while significant negative correlation with was observed between FBS level and serum HDL cholesterol level.

Samatha P et al (2012)<sup>24</sup> studied that negative correlation of FBS with HDL cholesterol level and a positive correlation of FBS with total cholesterol level and triglycerides level.

On comparison we found that HbA<sub>1c</sub> was definitely a better marker of diabetic control as compared to FBS.

While correlation of HbA<sub>1c</sub> to serum cholesterol was significant ( $r = 0.39$ ,  $P < 0.02$ ), it was just significant between FBS and serum cholesterol ( $r = 0.35$ ,  $P < 0.05$ ).

Similarly correlation between HbA<sub>1c</sub> to serum triglycerides was significant ( $r = 0.39$ ,  $P < 0.02$ ), it was just significant between FBS and serum triglycerides ( $r = 0.34$ ,  $P < 0.05$ ).

HDL cholesterol correlates more significantly with FBS ( $r = -0.69$ ,  $P < 0.001$ ) than with HbA<sub>1c</sub> ( $r = -0.45$ ,  $P < 0.01$ ).

## CONCLUSION

100 patients of diabetes mellitus were studied to determine correlation between FBS level, HbA<sub>1c</sub> level and serum lipid levels. In this study we observed that mean value for FBS in diabetics was 167.63 mg/dl and mean value of HbA<sub>1c</sub> were found to be raised in diabetic patients and in this study it was 9.86%. In good control group, FBS was 104.09 mg/dl and HbA<sub>1c</sub> level was 6.82%. In fairly controlled group, FBS was 161.0 mg/dl and HbA<sub>1c</sub> level was 8.99%. In poorly controlled group, FBS was 202.5 mg/dl and HbA<sub>1c</sub> level was 11.74%. Analysis of some individual cases revealed discrepancy between FBS and HbA<sub>1c</sub> level. However HbA<sub>1c</sub> showed better correlation to status of diabetic control than fasting blood sugar level. Serum cholesterol, triglycerides were also raised in diabetic patients. Mean value of these were 219.70 mg/dl and 193.60 mg/dl respectively. Serum HDL-cholesterol level were lower in these studied patients. Mean

value was 44.33 mg/dl. Both HbA<sub>1c</sub> and FBS showed direct positive correlation with serum cholesterol, triglycerides and negative correlation with HDL-cholesterol. Correlation of HbA<sub>1c</sub> to serum cholesterol, triglycerides was stronger as compared to that of FBS but HDL-cholesterol showed better correlation with FBS than with HbA<sub>1c</sub>.

Hence we conclude that HbA<sub>1c</sub> level was increased in diabetics and it shows correlation with the status of control of diabetes. Diabetics have got increased level of serum cholesterol, triglycerides and decreased levels of serum HDL-cholesterol. HbA<sub>1c</sub> showed stronger correlation with serum cholesterol, triglycerides as compared to FBS. HDL-cholesterol showed more stronger correlation with FBS than HbA<sub>1c</sub>.

## REFERENCES

- Harrison's principles of internal medicine 20<sup>th</sup> edition: page no. 2850-2851
- Reimer F et al: Incidence of hyperlipoproteinemia in patients with chemical and clinical diabetes. *Klin Wochenshr* 1973; 51:973.
- Ricketts HT. Derangement vascular disease in diabetes *Am J Med* 1955;29:933.
- Sharma D, Bansal BC nad Prakash C. Serum lipid studies in insulin dependent diabetes below the age of 30 years. *JIMA* 1970;54:416.
- Sosenko JM, Breslow JL and Miettinen OS. Hyperglycemia and plasma lipid levels. A prospective study of insulin dependent diabetic patients. *New Eng J Med* 1980; 302:650.
- Pietri A, Dunn FL and Raskin P. The effect of improved diabetic control on plasma lipid and lipoprotein level: a comparison of conventional therapy and continuous subcutaneous insulin infusion. *Diabetes* 1980; 29:1001-5.
- Somogyi M. and Nelson. Determination of blood sugar. *J. Biochem.* 19: 160, 1945.
- Paulsen E.P.: Glycosylated haemoglobin in childhood diabetes. *Metabolism* 1973;22: 269.
- Gabbay K.H. Glycosylated haemoglobin and diabetic control.(editorial) *New.Engl.J.Med.* 1976;295: 443.
- Elkeles R.S., Wu J. and Hambley J. Glycosylated haemoglobin, blood glucose and HDL-cholesterol in insulin requiring diabetics. *Lancet* 1978;2: 547.
- Kennedy L., Kandell T.W. and Merimee T.J. Serum protein bound hexose in diabetes. The effect of glycemic control. *Diabetes* 1979;28:1006.
- Nabarro J.D.N., Mustaffa B.E., Morris D. et al. Insulin deficient diabetes. *Diabetologia* 1979;16:5.
- Compagnucci P., Cartechini M.G., Bolli G. et al. The importance of determining irreversible glycosylated haemoglobin in diabetes. *Diabetes* 1981;30:607.
- Dinesh kumar and Gupta N.N: Serum cholesterol, phospholipids and betalipoproteins in untreated diabetics. *J.A.P.I.* 1967;15:357.
- Maleva I.J. A study of protein fractions and blood lipoproteins in diabetes. *Abs. W. Med.* 1961;30:229.
- Nikkila E.A. and Gormilla P. Serum lipids and lipoproteins in insulin treated diabetes. Demonstrations of increased HDL-cholesterol concentration. *Diabetes* 1978;27:1078-86.
- Akeel bai-Yaqobi, Adnan al-Khafaji, Dheaa K. Alomar. Thi-qui medic singh G and Kumar A al journal(T.Q.M.J.) 2011;52:39-44.
- Piia P., Simonen, Helena K. Gylling and Tatu A., Miettinen. Serum cholesterol level in diabetics. *A.D.A.* 2011.
- Lopes-Virella M.F., Wohltmann H.J., Loadholt C.B., and Buse M.G. plasma lipids and lipoproteins in young insulin dependent diabetic patients. *Diabetologia* 1981;21:216-23.
- Peterson C.M., Koenig R.J., Jones R.L., Saudek C.D. and Cerami A. Correlation of serum triglycerides levels and glycosylated haemoglobin concentration in diabetes mellitus. *Diabetes* 1977;26:507-509.
- Gonen B. and Rubenstein A.H., Rochman H., Tanega S.P. and Horwitz D.L. Glycosylated haemoglobin: an indicator of the metabolic control of diabetic patients. *Lancet* 1977;2:734-70.
- Gabbay K.H., Hasty K., Breslow J.L., Ellison R.C., Bunn H.F. and Gallop P.M. Glycosylated haemoglobin and long term blood glucose control in diabetes mellitus.*J.Clin.endocr.meta* 1977;44:859.
- Falko J.M., O Dorisio T.M. and Cataland S. Long term improvement of HDL-cholesterol and cholesterol/HDL-CH ratio in ambulatory type2 diabetics, treated using subcutaneous insulin pump. *Diabetes.* 1981;30:280.
- Samatha P, Venketeswarum and Siva Praboh. *Journal of clinical and diagnostic research* 2012;4302:0012.

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