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Research Article

To estimate the glucose and lipid profile levels in Diabetes without Nephropathy and in diabetic nephropathy patients

Maneesh Kumar Singh[1], Dr. Shreya Nigoskar[2]

1. Ph.D, Research Scholar, Dept. of Biochemistry IMCH&RC, Indore
2. Professor, Dept. of Biochemistry IMCH&RC, Indore

Corresponding Author:

Maneesh Kumar Singh, Ph.D, Research Scholar, Dept. of Biochemistry IMCH&RC, Indore

Abstract:

Background: Hyperglycemia, which results from impairments in insulin secretion, insulin action, or a combination of both, distinguishes diabetes mellitus (DM), a chronic metabolic condition. The way glucose metabolism and lipid homeostasis work together are a key part of how diabetic complications like nephropathy start and get worse. **Aim:** The study aimed to compare glucose and lipid profiles in diabetic patients without nephropathy with those affected by diabetic nephropathy. **Materials & methods:** A cross-sectional pilot study was conducted at a tertiary care hospital, involving 200 diabetic patients. The patients were divided into two groups: those with diabetes and nephropathy and those without nephropathy. The study included adults aged 30-70 years, diagnosed with Type 2 Diabetes Mellitus for at least five years, and had informed consent. Serum samples were collected and analyzed using various methods, including DPEC – GOD/POD technique, ClinRep full kit, LDN IRMA reagent, and CHOD/POD procedure. The study aimed to understand the effects of diabetes on kidney function and lipid profile. **Results:** We observed significant differences when compared between the two groups with regards to FBS ($t=2.692$, $df=198$, $P<0.05$), HbA1c ($t=5.279$, $df=198$, $P<0.05$), serum insulin ($t=6.123$, $df=198$, $P<0.05$), and HOMA-IR ($t=37.767$, $df=198$, $P<0.05$). On the other hand, we did not observe any significant difference when compared between the two groups with regards to age ($t=0.779$, $df=198$, $P>0.05$) and diastolic BP ($t=1.063$, $df=198$, $P>0.05$). We observed significant differences when compared between the two groups with regards to TC ($t=3.665$, $df=198$, $P<0.05$), LDL ($t=3.079$, $df=198$, $P<0.05$), and HDL ($t=9.225$, $df=198$, $P<0.05$). On the other hand, we did not observe any significant difference when compared between the two groups with regards to TAG ($t=0.216$, $df=198$, $P>0.05$) and VLDL ($t=0.501$, $df=198$, $P>0.05$). **Conclusion:** The study highlights the crucial role of glucose and lipid metabolism in diabetic nephropathy, aiding early detection and improved management. However, it acknowledges the need for longitudinal studies and further genetic predisposition research for effective therapies.

Key words: Diabetes mellitus, cholesterol, triacylglycerols, fasting blood sugar, end stage renal disease, low density lipoprotein, diabetic nephropathy.

Introduction:

Hyperglycemia, which results from impairments in insulin secretion, insulin action, or a combination of both, distinguishes diabetes mellitus (DM), a chronic metabolic condition. It impacts millions of individuals worldwide and serves as a significant contributor to both morbidity and mortality [1,2]. Another important problem that can happen with diabetes is diabetic nephropathy (DN), a progressive kidney disease that affects a lot of people with diabetes and is the main cause of end-stage renal disease (ESRD) [3-5]. The way glucose metabolism and lipid homeostasis work together is a key part of how diabetic complications like nephropathy start and get worse.

Over time, high blood sugar in people with diabetes causes oxidative stress, inflammation, and endothelial dysfunction, all of which hurt the structures of the kidneys [6]. Dyslipidemia, a characteristic hallmark of diabetes, further intensifies these mechanisms [7-15]. High levels of triglycerides (TG), high levels of low-density lipoprotein cholesterol (LDL-C), and low levels of high-density lipoprotein cholesterol (HDL-C) are all signs of dyslipidemia in people with diabetes [18]. This lipid problem is a major cause of and contributes to the development of both small and large vascular problems, including diabetic nephropathy [19,20].

Compared to diabetes without nephropathy, the lipid profile in diabetic nephropathy shows more significant abnormalities. Elevated concentrations of very low-density lipoprotein cholesterol (VLDL-C) and small dense low-density lipoprotein particles correlate with heightened glomerular injury, proteinuria, and inflammatory responses [18-20]. In the same way, high triglyceridemia and low HDL-C levels make renal injury worse by making it easier for lipids to build up inside renal cells, causing oxidative stress, and limiting the function of podocytes [18-20].

Understanding the differences in glucose and lipid profile levels between diabetics with nephropathy and those who don't is important for finding people who are likely to have problems with their kidneys early on [9=13]. Glucose levels, found in fasting blood glucose (FBG) and glycated hemoglobin (HbA1c), show how well blood sugar levels are controlled over time and are strongly linked to microvascular complications, such as nephropathy [9-17]. High glucose levels directly help create advanced glycation end products (AGEs), which play a key role in the glomerular basement membrane getting thicker and mesangial cells growing bigger. These are two of the most important pathological features of diabetic nephropathy [11-13].

The study aims to compare glucose and lipid profiles in diabetic patients without nephropathy with those affected by diabetic nephropathy. It aims to understand the pathophysiological processes causing diabetic nephropathy by identifying specific metabolic patterns. The results could help doctors decide when to start interventions to control glucose and lipid levels, potentially preventing or delaying diabetic nephropathy.

Materials & methods:

A cross-sectional pilot study was conducted at a tertiary care hospital after getting Ethics clearance from the Institutional Ethics Committee. Patients were recruited from outpatient and inpatient departments of endocrinology and nephrology. 200 diabetic patients were enrolled, equally divided into two groups: Group 1: 100 patients with diabetes and nephropathy (defined by albuminuria and/or reduced eGFR). Group 2:

100 patients with diabetes without nephropathy (normal renal function and absence of albuminuria).

Inclusion Criteria: Adults aged 30–70 years. Diagnosed with Type 2 Diabetes Mellitus for at least five years. Availability of informed consent.

Exclusion Criteria: Pregnant or lactating women, patients with chronic illnesses other than nephropathy, and use of vitamin supplements within three months prior to the study.

Using a disposable syringe and cannula in a sterile environment, 5ml of each individual's fasting venous blood was extracted into flat containers in both groups. After being separated from blood by centrifugation at 3000 rpm for 20 minutes, serum samples were aliquoted and stored at 20 ° C. Avantor laboratories' DPEC – GOD/POD technique measured plasma glucose. The manual's instructions generated the reagents. The ClinRep full kit was used on the BioRad Diamant and Variant to measure HbA1C. 4.5-6.1% is normal. Serum insulin levels were measured with an LDN IRMA reagent. Supplier instructions were followed. With sensitivity of 0.5 IU/mL, inter- and intra-assay CVs were 4.3% and 3.4%, respectively. According to Muniyappa et al. (2008), HOMA-IR was calculated. In the case of lipid profile; to measure serum TC, CHOD/POD procedure was used. Glycerol Phosphate Oxidase and Peroxidase (Liquid stable) assessed serum TAGs. All reagents were purchased from Avantor Performance Materials India Limited, Dehradun, Uttarakhand, India, and the estimation followed the kit manual. Supplier instructions were followed.

Statistical analysis:

The study used Microsoft Excel to analyze data, representing categorical variables as frequencies and percentages, and continuous variables as mean ± SD. The t test was used to compare diabetic patients with and without nephropathy. Statistical significance was with a p-value of less than 0.05.

Results:

Table 1: Glucose profile in the study populations.

Variable	**Diabetes with nephropathy (n=100)**	**Diabetes without nephropathy (n=100)**	**P Value**
Fasting Blood Sugar (FBS) (mg/dL)	133.9 ± 56	117.7 ± 22	=0.0077 T=2.692 Df = 198
Post prandial blood sugar (PPBS) (mg/dL)	196.8±73.3	169.8±22.6	=0.3691 T= 0.900 Df = 198
	8.1 ± 2.6	6.4 ± 1.9	=0.001 T= 5.279

Glycosylated hemoglobin (HbA1C) (gm%)			Df= 198
Insulin (µU/mL)	22.2 ± 5.9	15.3 ± 9.6	=0.0001 T= 6.123 Df = 198
Homeostasis metabolic assessment- insulin resistance (HOMA-IR)	24.9 ± 2.3	6.8 ± 3.9	= 0.0001 T = 37.767 Df = 198

In the present study (Table 1), glucose profile details of the present study participants are given. We observed significant differences when compared between the two groups with regards to FBS (t=2.692, df=198, P <0.05), HbA1c (t=5.279, df=198, P <0.05), serum insulin (t=6.123, df=198, P <0.05), and HOMA-IR (t=37.767, df=198, P <0.05). On the other hand, we did not observe any significant difference when compared between the two groups with regards to age (t=0.779, df=198, P >0.05) and diastolic BP (t=1.063, df=198, P >0.05).

Table 2: Laboratory details of lipid profile in the study population.

Variable	**Diabetes with nephropathy (n=100)**	**Diabetes without nephropathy (n=100)**	**P Value**
Total Cholesterol (TC) (mg/dL)	175.8 ± 39.2	158.6 ±25.8	= 0.003 T = 3.665 Df = 198
Triacylglycerols (TAG) (mg/dl)	178.5 ± 54.3	177 ± 43.2	= 0.829 T = 0.216 Df = 198
Low density lipoprotein (mg/dL)	162.2± 64.7	139.9 ± 32.5	= 0.0024 T = 3.079 Df = 198
High Density Lipoproteins (HDL) (mg/dl)	23.2 ± 9.8	35.6 ± 9.2	= 0.0001 T = 9.225 Df = 198
Very Low Density Lipoproteins (VLDL) (mg/dl)	35.7 ± 10.9	35.4 ± 8.7	= 0.616 T = 0.501 Df = 198

In the present study (Table 2), lipid profile details of the present study participants are given. We observed significant differences when compared between the two groups with regards to TC (t=3.665, df=198, P <0.05), LDL (t=3.079, df=198, P <0.05), and HDL

(t=9.225, df=198, P <0.05). On the other hand, we did not observe any significant difference when compared between the two groups with regards to TAG (t=0.216, df=198, P >0.05) and VLDL (t=0.501, df=198, P >0.05).

Discussion:

DM is a complex metabolic disorder characterized by chronic hyperglycemia and associated with various microvascular and macrovascular complications, including nephropathy. Evaluating biomarkers such as fasting FBS, HbA1c, and the HOMA-IR provides insights into the metabolic state and progression of diabetes, particularly when nephropathy develops.

FBS levels serve as a primary diagnostic and monitoring tool for diabetes. In patients without nephropathy, FBS is often elevated due to insulin resistance and impaired glucose utilization. However, in patients with diabetic nephropathy, further dysregulation is observed, often due to reduced renal gluconeogenesis and altered glucose clearance. Studies have shown that FBS levels correlate with the severity of nephropathy, as the kidney plays a critical role in glucose homeostasis [9,10].

HbA1c reflects the average blood glucose levels over the preceding 2–3 months, offering a reliable measure of long-term glycemic control. Research highlights that HbA1c levels tend to be higher in diabetic nephropathy due to persistent hyperglycemia and increased oxidative stress [11]. Additionally, advanced glycation end-products (AGEs), associated with high HbA1c, are implicated in the progression of renal damage. Interestingly, some studies have noted discrepancies in HbA1c interpretation in nephropathy due to factors such as anemia and altered erythrocyte lifespan, which are common in advanced renal disease [12].

HOMA-IR, an index of insulin resistance derived from fasting insulin and glucose levels, provides valuable insights into the pathophysiology of diabetes and its complications. Insulin resistance plays a central role in both diabetes progression and nephropathy. Studies have demonstrated significantly higher HOMA-IR values in patients with diabetic nephropathy compared to those without nephropathy, underscoring the role of systemic insulin resistance in renal dysfunction [13,14]. Moreover, elevated HOMA-IR in nephropathy is associated with inflammation, oxidative stress, and dyslipidemia, further exacerbating renal injury.

The interplay of FBS, HbA1c, and HOMA-IR highlights the complexity of diabetes and its complications. Early and regular assessment of these markers is crucial for identifying patients at risk of nephropathy. Additionally, interventions targeting improved glycemic control and insulin sensitivity may help delay the onset or progression of nephropathy.

Emerging research is exploring novel therapies, including SGLT2 inhibitors and GLP-1 receptor agonists, which have shown promise in improving glycemic parameters and providing renal protection [15-17]. Further studies are warranted to understand the molecular mechanisms linking these markers to diabetic nephropathy and to refine therapeutic strategies.

This discussion integrates findings from recent research, emphasizing the clinical significance of FBS, HbA1c, and HOMA-IR in diabetic patients with and without nephropathy.

Dyslipidemia is a hallmark of diabetes and is characterized by elevated triglycerides, low HDL cholesterol, and elevated LDL cholesterol. In patients with diabetic nephropathy, dyslipidemia tends to be more pronounced, with increased small dense LDL particles and lipoprotein(a), which are strongly associated with atherogenesis and glomerular injury. Studies such as that by [18-20] indicate that lipid abnormalities in diabetic nephropathy exacerbate the decline in renal function and cardiovascular risk.

Patients with diabetes and nephropathy have significantly lower serum Vitamin D levels than those without nephropathy, possibly due to impaired hydroxylation of Vitamin D in the kidney. Diabetic nephropathy is associated with higher prevalence and severity of deficiencies due to altered renal clearance and metabolic derangements. The lipid profile abnormalities are more severe in diabetic nephropathy, contributing to accelerated cardiovascular and renal complications. Addressing deficiencies in Vitamin D, Vitamin B12, and folic acid, alongside aggressive management of dyslipidemia, may help mitigate complications in diabetic patients. Regular monitoring and early supplementation can improve metabolic and renal outcomes. Further longitudinal and interventional studies are required to elucidate the precise roles of these parameters in the progression of diabetes-related complications.

Conclusion:

We conclude that the interaction between glucose and lipid metabolism is essential to the onset and advancement of diabetic nephropathy. Looking at these parameters gives us important information about how this condition starts, which makes it easier to find it early and improves management plans for groups that are at risk. However, it has several drawbacks, including the need for longitudinal studies and further investigation into genetic predisposition in status determination. Future research with varied populations is needed to address these gaps and develop more effective population-specific therapies.

Conflict of interest:

The present study authors do not possess any conflict of interest among themselves.

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