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RESEARCH ARTICLE
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EVALUATING THE EFFECT OF VITAMIN D SUPPLEMENTATION ON PROTEINURIA IN PATIENTS WITH TYPE 2 DIABETES MELLITUS, FOCUSING ON CHANGES IN THE URINARY ALBUMIN/CREATATININE RATIO (UACR)

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ABSTRACT

Introduction: Vitamin D deficiency exists to a high extent among patients with type 2 diabetes mellitus (T2DM) because it contributes to proteinuria development in diabetic nephropathy. The research examines vitamin D supplementation effects on T2DM patient proteinuria while focusing specifically on urinary albumin/creatinine ratio modifications (UACR).

Objective: The analysis aims to determine the influence of vitamin D supplements on proteinuria coupled with HbA1c and UACR levels management for T2DM patients.

Materials and Method: This randomized controlled trial was conducted at the Punjab Institute of Diabetes and Endocrinology in Lahore between January 2024 to June 2024. The research team randomly placed participants into groups that received either vitamin D supplements or inactive substances. The research design includes testing UACR levels and HbA1c levels before and after implementation.

Results: Vitamin D supplements decreased UAR measurements by 30% while lowering HbA1c readings by 7.7% versus the placebo test recipients.

Conclusion: The administration of vitamin D shows effectiveness in both lowering proteinuria and controlling blood glucose in patients with T2DM.

Keywords: Vitamin D, Proteinuria, Type 2 Diabetes Mellitus, UACR, Glycemic Control, Diabetic Nephropathy.

INTRODUCTION

Vitamin D performs essential functions inside the body, including immune system control, anti-inflammatory processes, and regulatory effects on the renin-angiotensin-aldosterone system after

calcium management. Multiple important mechanisms attract increasing scientific scrutiny because they influence diabetic nephropathy pathogenesis as a severe condition that affects type 2 diabetes mellitus patients. During persistent albuminuria and reduced glomerular filtration rate in diabetic nephropathy patients, the elevated cardiovascular risk elevates this condition to become one of the main factors causing global end-stage renal disease. The urinary albumin/creatinine ratio (UACR) is the best method to detect early T2DM kidney damage because it shows sensitivity to disease changes and measurement accuracy, yet strict control is required to prevent disease progression (1). Medical research demonstrates that vitamin D supplements help kidneys stay healthy by lowering protein production while steadily halting kidney damage in individuals with diabetes (2).

According to medical literature, patients with T2DM frequently demonstrate low vitamin D levels, and patients with proteinuria appear to display this deficit pattern, as vitamin D insufficiency may accelerate renal damage (3). Research among different populations showed vitamin D deficiency leads to higher HbA1c levels and increased albuminuria results (4). The relationship between vitamin D intake and anti-diabetic drugs has become a subject of ongoing scientific research. According to experimental research reports, the pharmacological effect of drugs, including glibenclamide, demonstrates increased effectiveness when combined with vitamin D supplements (5). Multiple clinical studies have documented the relationship between vitamin D concentration and albuminuria levels in patients with T2DM by demonstrating a negative connection between vitamin D status and albuminuria severity (6).

The decrease of protein and other kidney markers found in type 2 diabetic patients occurs because vitamin D exerts anti-inflammatory, antifibrotic, and antiproteinuric effects that protect glomerular integrity. The ability of vitamin D to control immune system activation and suppress cytokine inflammation dynamics provides additional protection against diabetic kidney disease development (7). The cardiovascular system of diabetes and chronic kidney disease patients benefits from vitamin D supplementation through reduced left ventricular mass index, according to research, while this metric indirectly enhances renal health by controlling systemic blood pressure and cardiac workload (8).

The extensive occurrence of vitamin D deficiency in diabetic patients stems from various contributing factors, poor sun exposure, unhealthy dietary habits, body weight issues, and persistent inflammation, which makes insulin resistance and albuminuria more severe (9). Academic research via meta-analysis shows that vitamin D supplements result in minor yet significant enhancement of diabetes control, which manifests in reduced HbA1c values. Better management of blood glucose leads to enhanced renal outcomes since it decreases the amount of hyperglycemia-based renal damage (10). Diabetic patients who show vitamin D deficiency patterns often experience accelerated diabetic nephropathy because their blood tests show high inflammatory biomarkers, including CRP and IL-6. Treating vitamin D deficiency simultaneously reduces inflammatory processes in the body (11).

Medical research indicates that active vitamin D supplementation is effective at reducing UACR and proteinuria levels among diabetic patients with nephropathy (12). Vitamin D contributes positive effects to diabetic nephropathy through its ability to stop podocyte death while preserving the glomerular basement membrane structure to prevent albumin from leaking into urine. Studies reveal that combined therapy with vitamin D and omega-3 fatty acids helps decrease inflammation and cardiac stress markers in people with diabetes through comprehensive diabetes complications management (13). Scientists have extensively researched the biochemical relationship between vitamin D and osteocalcin markers of early kidney disease. Research shows that vitamin D deficiency is linked to increased lipoprotein-associated phospholipase A2 levels, which lead to vascular inflammation and early kidney damage (14).

Researchers in recent cohort studies have identified that enough vitamin D in the blood decreases the likelihood of diabetic kidney disease in patients who have T2DM (15). The evidence from this research supports the concept that vitamin D supplementation could provide additional value to early diabetic nephropathy management because it results in quantifiable improvements of UACR biomarkers. Multiple research findings demonstrate why medical professionals must examine vitamin

D levels in T2DM patients while exploring vitamin D supplementation as a possible treatment option. Vitamin D presents an encouraging therapeutic method to simultaneously target inflammation and metabolism to reduce proteinuria while protecting kidney function.

Objective

A clinical research study aims to determine the effects of vitamin D supplementation on the proteinuria levels of type 2 diabetes mellitus patients through urinary albumin/creatinine ratio assessment (UACR).

MATERIALS AND METHODS

Study Design: Randomized controlled trial designed.

Setting: The research takes place at the Punjab Institute of Diabetes and Endocrinology in Lahore, the leading diabetes institution in Pakistan.

Duration: The research duration was from January 2024 to June 2024.

Inclusion Criteria

The research includes patients who have type 2 diabetes mellitus, are between 40 and 70 years old, and show confirmed albuminuria (UACR > 30 mg/g). People who received vitamin D supplements less than three months ago or grant written consent was qualified for participation. Entry into the study program is limited to patients whose blood glucose stability meets the criteria of HbA1c levels between 6.5% and 9.0%.

Exclusion Criteria

The research does not accept individuals who have kidney disease at stages three or higher and patients with significant comorbidities beyond cardiovascular or autoimmune conditions, as well as pregnant women and those breastfeeding. Patients taking medications affecting vitamin D metabolism or renal function need to be excluded from this study, along with those receiving corticosteroids and antihypertensive drugs, among others.

Methods

The research took place at the Punjab Institute of Diabetes and Endocrinology in Lahore between January 2024 and June 2024 as a randomized controlled trial. The study recruited 120 T2DM patients showing albuminuria (UACR > 30 mg/g) randomly distributed between two groups, including 60 patients in the vitamin D treatment group and 60 patients in the placebo control group. The vitamin D group members took thousands of international units for six months, while the placebo group received an identical inert substance daily. Principal researchers obtained baseline results for HbA1c and urinary albumin/creatinine ratio (UACR) measurement. The researchers conducted another measurement collection when the study reached completion. The primary outcomes analyzed to study vitamin D's impact on kidney and blood sugar control involved UACR and HbA1c measurements. The statistical analyses determined the differences between groups for significant results at $p < 0.05$.

RESULTS

One hundred and twenty participants with Type 2 diabetes mellitus received research enrollment into two groups containing sixty members who received vitamin D supplements and sixty more receiving placebo treatments. Statistical data describing the fundamental characteristics between the two studied groups can be found in **Table 1**. The examined participants averaged 55.2 years of age with a standard deviation of 8.1 years, and among these participants, males made up 55 percent. The research groups matched one another for demographic features and diabetes length, as well as standard renal function measurements at baseline.

Table 1: Baseline Characteristics of Study Participants

Characteristic	Vitamin D Group (n=60)	Placebo Group (n=60)
Age (years)	54.7 ± 7.9	55.7 ± 8.3
Gender (Male %)	60%	50%
Duration of Diabetes (years)	6.5 ± 2.4	6.3 ± 2.6
Baseline UACR (mg/g)	110.5 ± 54.3	113.2 ± 58.7
HbA1c (%)	7.8 ± 0.7	7.9 ± 0.8

The vitamin D supplementation group ended with more substantial reductions in urinary albumin/creatinine ratio (UACR) measurements than the placebo group. Most participants in the vitamin D group achieved a 30% decrease in UACR, which dropped from 110.5 mg/g to 77.4 mg/g ($p < 0.01$), yet the placebo group had only a 5% reduction from 113.2 mg/g to 107.5 mg/g ($p = 0.35$). The reduction between groups demonstrated significant statistical differences in results (**Table 2**).

Table 2: Changes in UACR Before and After Treatment

Group	Baseline UACR (mg/g)	Final UACR (mg/g)	Change (%)	p-value
Vitamin D Group	110.5 ± 54.3	77.4 ± 34.1	-30%	<0.01
Placebo Group	113.2 ± 58.7	107.5 ± 50.3	-5%	0.35

The HbA1c levels of participants who took vitamin D supplementation significantly improved, reaching 7.2% from 7.8% ($p < 0.05$). The placebo-treated participants demonstrated no substantial variation in HbA1c because their measurements stayed at 7.9% throughout the research period. The analysis suggests that vitamin D supplementation benefits blood sugar management after proving its protective effects on the kidneys.

Table 3: Changes in HbA1c Levels before and After Treatment

Group	Baseline HbA1c (%)	Final HbA1c (%)	Change (%)	p-value
Vitamin D Group	7.8 ± 0.7	7.2 ± 0.6	-7.7%	<0.05
Placebo Group	7.9 ± 0.8	7.9 ± 0.8	0%	0.88

Patient safety remained high as no serious adverse effects stemmed from vitamin D dosage during the study. Previous research confirms the safety profile vitamin D supplementation provides to this population. The study evidence establishes that vitamin D supplements effectively control both proteinuria and glycemic control among diabetic patients.

DISCUSSION

This research aimed to understand how vitamin D supplements influenced proteinuria progression through urinary albumin/creatinine ratio (UACR) modification among patients with type 2 diabetes mellitus (T2DM). Vitamin D supplementation produced substantial UACR reduction among patients, while placebo administration showed no such effect, thus revealing the protective benefits of vitamin D on kidneys in this patient group. Supplementing with vitamin D reduced proteinuria while leading to better glycemic control measurements among patients with type 2 diabetes mellitus. The partnership between vitamin D and kidney function is a significant research topic for patients who have T2DM. The pathogenesis of diabetic nephropathy heavily depends on vitamin D because the supplement supports the regulation of inflammation while managing the renin-angiotensin-aldosterone system and calcium-phosphate metabolic processes. Research findings demonstrate that vitamin D deficiency affects numerous T2DM patients and enhances their chance of developing diabetic nephropathy (1, 2). Data from our research backs previous findings because we detected

significant renal function enhancement measured through UACR testing in patients who took vitamin D supplements. UACR levels decreased by 30% in patients receiving vitamin D supplementation, demonstrating this group may obtain protection against glomerular filtration barrier damage that obstructs albumin excretion in urine measurements.

The research findings match other investigations demonstrating that vitamin D dietary supplementation helps decrease proteinuria and enhances kidney performance in diabetic patients. Active vitamin D therapy led to substantial decreases in proteinuria, according to Aref et al. (1) findings in patients with type 2 diabetic nephropathy. Results from Akram et al. (2) demonstrate that diabetic patients receive beneficial effects from vitamin D supplementation, which confirms our study's findings. The research indicates that vitamin D elicits anti-inflammatory and antifibrotic effects on kidneys, potentially explaining its protective benefits for renal health. The UACR improvement in our study shows that vitamin D could help manage one of the first indicators of diabetic nephropathy. Albuminuria, along with proteinuria, functions as an essential marker of kidney damage throughout diabetic patients since it determines disease progression toward end-stage renal failure (3). Vitamin D supplementation's therapeutic effects on proteinuria help decelerate diabetic nephropathy progression, decreasing the probability of requiring lifelong dialysis. The management of diabetic complications requires cost-effective interventions in Pakistan since diabetic nephropathy stands as the significant origin of chronic kidney disease throughout the country.

This research protected kidney function and enhanced glycemic control in participants given vitamin D supplements as they demonstrated reduced HbA1c measurement results. Many studies confirm that vitamin D supplementation improves insulin sensitivity and controls blood glucose in people who have T2DM (4, 5). The insulin secretion and sensitivity regulator vitamin D use pancreatic beta cells VDRs and skeletal muscle cells VDRs to achieve this effect (6). The data shows that vitamin D's effectiveness in lowering systemic inflammation levels could help prevent insulin resistance in T2DM patients (7). The results of our study demonstrate that diabetic patients experience decreased HbA1c levels after vitamin D supplementation, which supports the therapeutic role of vitamin D in the metabolic management of diabetes. Supplementing with vitamin D provides a two-fold advantage to T2DM patients by enhancing blood sugar management and reducing proteinuria. Maintaining proper blood glucose levels is essential because they are the primary protective against diabetic nephropathy progression and additional microscopic complications (8).

The outcomes of our study confirm various advantages, yet researchers must recognize significant limitations during this investigation. The study was conducted at a single medical facility, which could diminish the global applicability of its results. Further research with wide-reaching locations and increased tested patient numbers will generate comprehensive findings about the effects of vitamin D treatment on proteinuria reduction and diabetes control for T2DM patients. A research study that spans longer than six months should be conducted to examine how vitamin D supplements affect T2DM patients' glucose management and continued kidney health. Medical practitioners need additional research regarding various vitamin D dosages which affect the markers because they lack confidence regarding optimal levels for T2DM patients with nephropathy (9). The safety assessment of vitamin D administration for chronic kidney disease patients should continue as future research to monitor possible adverse effects that could worsen because of increased hypocalcemia and hypophosphatemia risks.

Research supports that vitamin D effectively reduces systemic inflammation and may stop insulin resistance in patients with T2DM (7). Study outcomes show that HbA1c amounts decrease in diabetic patients after vitamin D supplementation, thus indicating vitamin D's therapeutic value for diabetes metabolic control. Supplementing with vitamin D provides a two-fold advantage to T2DM patients by enhancing blood sugar management and reducing proteinuria. Maintaining proper blood glucose levels is essential because they are the primary protective against diabetic nephropathy progression and additional microscopic complications (8). The outcomes of our study confirm various advantages, yet researchers must recognize significant limitations during this investigation. The research took place at one medical centre only, so its findings may not readily apply to different

patient groups worldwide. Further research with wide-reaching locations and increased tested patient numbers will generate comprehensive findings about the effects of vitamin D treatment on proteinuria reduction and diabetes control for T2DM patients. A more extended research period beyond six months should be established to determine the impact of vitamin D supplements on glycemic control and kidney function sustainability in the treatment of T2DM patients.

Research should explore diverse doses of vitamin D supplementation on these indicators since healthcare providers still doubt the right amount for T2DM patients with nephropathy (9). Further study of vitamin D long-term safety measures among chronic kidney disease patients should be pursued to evaluate possible adverse effects that may become more pronounced due to elevated risks of hypercalcemia and hyperphosphatemia. Vitamin D supplementation produces convincing research insights about its effectiveness in lowering proteinuria while enhancing glycemic control in patients with type 2 diabetes mellitus. Research data shows that vitamin D protects kidney health, which, therefore, slows down the progression of diabetic nephropathy. The growing body of research demonstrates that vitamin D supplementation is an economical approach to handling diabetic complications alongside its performance in vitamin D-deficient populations. Additional research focused on more significant populations and longer observation durations with various vitamin D intake levels must continue to verify and explain how this vitamin affects diabetic nephropathy development alongside blood sugar management.

CONCLUSION

The data from this research shows that vitamin D supplementation creates significant proteinuria reductions and better diabetic control among patients who have type 2 diabetes mellitus. The vitamin D treatment group decreased their urinary albumin/creatinine ratio, which points to protective kidney effects that slow down the evolution of diabetic nephropathy. Supplementing with vitamin D shows favorable effects on HbA1c levels, strengthening the capability to manage diabetes. The research confirms existing scientific evidence that vitamin D plays a vital role in caring for diabetic patients who experience renal and metabolic difficulties. Type 2 diabetes patients showing widespread vitamin D deficiency should receive supplementation as it presents an affordable approach for decreasing diabetic nephropathy risk and yielding better health results. Research with extended periods and increased participant numbers should be carried out to validate these findings and develop ideal treatment plans.

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