**Rafidain Journal of Science**
https://rsci.uomosul.edu.iq
**Vol. 35, No. 2, pp. 14-21, 2026 (June)**

# Assessment of Biochemical Parameters in Patients with Type 2 Diabetes Mellitus for Early Detection of Diabetic Nephropathy

**Zena F. Al-Ozair** **Haitham L. Al-Hayali** **Thaer M. Al-Mashhadani**

*Department of Biology/ College of Science/ University of Mosul*

**p-ISSN: 1608-9391**
**e -ISSN: 2664-2786**

## Article information

**Received: 13/5/2025**
**Revised: 10/7/2025**
**Accepted: 16/7/2025**

**DOI: 10.33899/rsci.v35i2.63609**

**corresponding author:**
**Zena F. Al-Ozair**
zena.23scp24@student.uomosul.edu.iq
**Haitham L. Al-Hayali**
haysbio68@uomosul.edu.iq
**Thaer M. Al-Mashhadani**
thasbio42@uomosul.edu.iq

**ABSTRACT**

The research was undertaken to investigate the identification of early indicators of diabetic nephropathy by comparing declines in renal function between patients with (T2DM) and the non-diabetic population. Laboratory blood samples included 120 specimens from patients diagnosed with (T2DM) which were collected from the Al Wafaa Center for Diabetes and Endocrine Gland Disease and private laboratories in Mosul city and another 90 specimens obtained from healthy subjects as controls. The study participants underwent comprehensive medical evaluations, including fasting blood sugar tests (FBS), hemoglobin A1c level tests (HbA1c), and kidney tests for creatinine, urea, blood urea nitrogen (BUN), glomerular filtration rate (GFR), and urine albumin and creatinine ratio (ACR). Results indicated a significant increase in fasting blood sugar, HbA1c levels, ACR, and increased serum creatinine, urea, and BUN levels at $P \leq 0.05$ compared to healthy individuals, establishing these as reliable prognostic indicators to differentiate between diabetic patients with nephropathy and other healthy people.

**Keywords:** Diabetes Mellitus, Nephropathy, Fasting Blood Sugar (FBS), Hemoglobin A1c (HbA1c), creatinine.

## INTRODUCTION

Diabetes Mellitus (DM) is a multifaceted chronic illness characterized by hyperglycemia that can be brought on by insufficient insulin secretion, action, or both (Al-Juwary and Al-Hayali, 2025).

Diabetes is associated with long-term microvascular and macrovascular complications (Isam and Haimn, 2013). There are 3 major types of diabetes: type 1, type 2, and gestational diabetes. Type II diabetes is characterized by a progressive worsening in the secretion functions of the produced insulin and the development of peripheral insulin resistance, rather than a deficit in insulin production (Allwsh and Mohammad, 2013). Studies have confirmed that more than 533 million people around the world suffer from diabetes Mellitus, and this number may increase 2045 to 783 million people (Guzman and Carrillo, 2025). Evidence from the World Health Organization (WHO) suggests that (T2DM) have the highest prevalence, which represents roughly 90-95% of the cases recorded and damage, dysfunction, and degeneration of many organs, blood vessels, kidneys, eyes, nerves, feet, and the heart are all associated with chronic diabetes, that the main cause of renal involvement in diabetic patients is diabetic kidney disease (DKD), which is primarily diagnosed clinically (Shadab *et al.,* 2022).

Diabetic nephropathy is a kidney disease that arises as a complication of DM, characterized by a decreased GFR and elevated levels of urea and creatinine (Selby and Taal, 2020; Li *et al.,* 2025).

In individuals with T2DM, the development of kidney damage can vary. This variation is assessed using the estimated glomerular filtration rate (eGFR) and the degree of albuminuria, measured by the albumin-to-creatinine ratio (ACR), so albuminuria serves as a crucial prognostic indicator for the progression of renal function impairment, Diabetic Nephropathy brings about urinary albumin excretion that the ACR measures >30 mg/g for normal results and >300 mg/g for macroalbuminuria
(Jongs *et al.,* 2021).

ACR functions as a delicate nephrological marker for initial kidney injuries, and the first clinical indicator of (DKD) appears through microalbuminuria in affected diabetic patients, when ACR levels higher than 30 mg/g are markers for predicting future kidney function, integrating ACR screening into T2DM routine care practice should become a standard procedure (Pierre *et al.,*2023).

Our current study was designed to evaluate some biochemical variables whose alterations in levels may provide insight into diabetes and its effects on the human body, particularly detecting early signs of kidney dysfunction.

## MATERIALS AND METHODS

### Study subjects

Samples for this study were collected from the Al Wafaa Center for Diabetes and Endocrine Gland Disease and private laboratories in Mosul city. The case was involving 210 participants; 120 patients with (T2DM) including 64 females and 56 males. The control group comprised 90 non-diabetic participants; 53 females and 37 males. The study was conducted between October 2024 and March 2025, and patients were evaluated by specialized physicians.

### Samples collection:

**Blood:** After a fasting period of 8-12 h, a volume of 5 ml of blood was procured from both patients and control subjects, subsequently partitioned into three distinct components: 2 ml of whole blood was allocated to an EDTA tube for the assessment of HbA1c, and the remaining 3 ml was transferred into a gel tube for various biochemical analyses. Following the collection, the blood was allowed to clot, and then subjected to centrifugation for 15 min at 3000 x g. The blood serum was divided into Eppendorf tubes of 1.5 ml, and then kept at a temperature -80 °C using a deep freeze for further experiments.

**Urine:** Each participant's urine specimen was randomly collected in a sterilized container to calculate the albumin-to-creatinine ratio.

**Measurement of biochemical parameters**

A standard kit from the Roche German Company determined the fasting blood sugar (FBS), Glycated hemoglobin (HbA1c), creatinine, urea, and blood urea nitrogen (BUN). The Roche/Hitachi Cobas 6000 analyzer series operate as a random-access automated system that conducts photometric analysis and immunoassays to perform measurements of diverse tests, and also the Standard kit from Hitachi Japan for urine to estimate ACR.GFR is calculated according to the Modification of Diet in Renal Disease (MDRD) (Levey *et al.,* 2006).

**Statistical analysis:**

The data was statistically analyzed according to the Duncan multiple range test, with a significance level P ≤0.05. The analysis utilized a completely randomized design, and differences between data were indicated by distinct alphabet letters in SPSS version 26 (Jalolov, 2024).

## RESULTS AND DISCUSSION

(Table 1) shows a significant increase in FBS and HbA1c levels in patients compared to healthy subjects, with a *P*-value of ≤ 0.05. These results agree with (Galicia *et al.,* 2020), where the researchers confirmed that elevated (FBS) levels reflect inadequate diabetes management, and weak insulin production occurs together with insulin resistance, along with impaired β-cell insulin secretion within the pancreas to cause elevated blood glucose levels and studies also confirmed that individuals with insulin resistance find it harder to transform glucose into glycogen, thus, glucose removal from the bloodstream becomes more challenging, so the blood glucose level reaches substantially elevated levels because of this situation (Sgro *et al.,* 2021).

Studies have confirmed that prolonged elevated blood glucose levels create the conditions for microvascular complications with DN (Fiseha *et al.,* 2018). Cells in red blood tissue contain hemoglobin protein, which functions as a transporter of oxygen to the body's tissues, and hemoglobin in blood cells forms glycated hemoglobin when blood glucose level rises, causing glucose molecules to bind with hemoglobin, the duration of glycated hemoglobin retention in the bloodstream lasts about 3 months since it provides middle-term glucose level information (El malahi *et al.,* 2022). Research findings show that HbA1c levels strongly affect kidney function in type 2 diabetes patients, leading to severe renal health deterioration (Merlin and Pusparini, 2020).

**Table (1): The effect of fasting blood sugar, glycated hemoglobin, creatinine, urea, blood urea nitrogen, glomerular filtration rate, and albumin-to-creatinine ratio on T2DM patients**

| Groups / Parameters | Control (n=90) | Patients (n=120) |
|---|---|---|
| | Mean ± SD | Mean ± SD |
| FBS (mg/dl) | 88.59 ± 7.31$^{b}$ | 189.15 ± 37.71$^{a}$ |
| HbA1c (mg/dl) | 5.13 ± 0.50$^{b}$ | 8.57 ± 1.37$^{a}$ |
| Creatinine (mg/dl) | 0.73 ± 0.14$^{b}$ | 1.16 ± 0.73$^{a}$ |
| Urea (mg/dl) | 28.04 ± 6.69$^{b}$ | 40.16 ± 8.17$^{a}$ |
| BUN (mg/dl) | 12.13 ± 3.58$^{b}$ | 21.39 ±3.39$^{a}$ |
| GFR (mg/dl) | 117.7 ± 17.5$^{a}$ | 73.6 ± 21.2$^{b}$ |
| ACR (mg/dl) | 1.85 ± 0.56$^{b}$ | 66.3 ± 16.9$^{a}$ |

*Significant at ($P \leq 0.05$); the no. followed by different letters means there is a significant difference according to the Duncan test
**The values are means ± standard deviation SD, n=numbers

The results confirm that poor glycemic control is a significant risk factor contributing to renal deterioration, as evidenced by increasing urea and creatinine levels and decreasing GFR values (Shah *et al.,* 2024). This result agrees with Kamel and others who explain that early detection of diabetic nephropathy and its effective management depend on regular HbA1c level assessments because increased microalbuminuria links to higher HbA1c levels (Kamel *et al.,* 2024).

Additionally, (Table 1) illustrates a significant increase in creatinine, urea and BUN values, and serum creatinine is a metabolic byproduct of muscle protein creatine, so DN represents a frequent diabetes-related kidney damage, which reduces creatinine filtration capacity in the kidneys (Bramlage *et al.,* 2020). Elevated urea and BUN levels serve as signs of kidney dysfunction because the kidneys provide reduced efficiency in removing waste products from blood circulation, including urea, and in diabetes, increased protein metabolism often results from underlying metabolic disturbances (Hu *et al.,* 2025). This agrees with research demonstrating that diabetes has a complicated association with protein metabolism (Mensink, 2024).

As well as the results, of (Table 1) indicate that T2DM patients present with a significant decrease in GFR, a reduced GFR level indicates worsening kidney function while also elevating the chances of unfavorable results (Kim *et al.,* 2022). The risk of incident diabetes shows a distinctive pattern as the relationship becomes stronger when eGFR measures beyond 98.034 mL/min 1.73 $m^2$ (Lee *et al.,* 2020). Furthermore, ACR showed a significant increase in patients; the reason may be due to HbA1c at higher levels leads to increased ACR amounts, demonstrating deteriorating kidney function, the prevention of diabetic nephropathy depends on effective blood sugar control, since uncontrolled blood sugar levels increase diabetic nephropathy risks. (Indriani *et al.,* 2021). Monitoring of ACR and HbA1c levels regularly is essential for discovering kidney impairment in the early stages among T2DM patients, according to (Karar *et al.,* 2015).

In (Table 2), the data illustrate how gender affects biochemical measures in both the control and patient groups, Firstly, FBS and HbA1c levels in the control groups are in normal value in males and females, but a significant increase in male and female patients because glucose metabolism differs between male and female subjects when measuring Fasting Blood Sugar (FBS) and HbA1c, and the male population typically shows higher levels of fasting blood sugar than females, but females maintain better glucose control because estrogen protects insulin sensitivity duo to problems from diabetes cause elevated blood sugar in both male and female patients, although males occasionally face worse health issues than females (Sportiello and Capuano, 2024).

**Table (2): The effect of FBS, HbA1C, creatinine, urea, BUN, GFR, and ACR on T2DM patients according to gender factor**

| Groups / Parameters | Control | | Patients | |
|---|---|---|---|---|
| | Mean ± SD | | | |
| | Males (n= 37) | Females (n=53) | Males (n=56) | Females (n=64) |
| FBS (mg/dl) | 89.45 ± 6.28$^b$ | 87.96 ± 7.97$^b$ | 183.97 ± 39.97$^a$ | 176.03 ± 36.02$^a$ |
| HbA1c (mg/dl) | 5.19 ± 0.52$^b$ | 5.08 ± 0.49$^b$ | 8.51 ± 1.49$^a$ | 8.64 ± 1.26$^a$ |
| Creatinine(mg/dl) | 0.78 ± 0.17$^b$ | 0.70 ± 0.09$^b$ | 1.26 ± 0.83$^a$ | 1.08 ± 0.63$^a$ |
| Urea (mg/dl) | 27.03 ± 4.65$^b$ | 25.23 ± 6.33$^b$ | 41.53 ± 9.67$^a$ | 39.34 ±7.63$^a$ |
| BUN (mg/dl) | 12.64 ±3.12$^b$ | 11.75± 3.83$^b$ | 19.91±5.39$^a$ | 18.89± 4.69$^a$ |
| GFR (mg/dl) | 125.5± 16.3$^a$ | 109.5±7.87 $^b$ | 76.8 ±14.50$^c$ | 71.0 ± 13.51$^c$ |
| ACR (mg/dl) | 1.96 ± 0.62$^b$ | 1.75 ± 0.46$^b$ | 64.16 ± 19.7$^a$ | 68.5 ± 20.9 $^a$ |

*Significant at ($P \leq 0.05$); the no. followed by different letters means there is a significant difference according to the Duncan test
**The values are means ± standard deviation SD, n=numbers

Research shows that glucose metabolism and diabetes control work differently between male and female bodies, due to estrogen appears to protect against beta-cell damage in the pancreas, which is crucial for insulin production and glucose regulation (Tramunt *et al.,*2020). Hemoglobin A1c readings from female patients show a significant increase levels compared to those of male patients, indicating that females may experience a more significant long-term impact on blood glucose regulation, so recent rises in HbA1c levels have been observed in female populations, particularly after their menopausal years according to a big Saudi study (Alghamdi *et al.,* 2021).

Males generally have significantly increased serum creatinine, urea, and BUN levels than females because of their greater muscle mass, as creatinine is a byproduct of muscle metabolism (Bhatia *et al.,* 2019). While urea levels can vary based on diet and health conditions, males often have slightly higher levels due to greater protein intake and metabolic activity (Liu *et al*., 2021).

Females exhibited comparable elevations in pathological states, so these differences are likely influenced by physiological factors, such as muscle mass and hormonal variations (Kautzky-Willer *et al.,* 2016). Having diabetes treatment over a longer period reduced the chances of having high urea and creatinine levels, compared to the first 5-6 years of treatment (Aderibigbe *et al.,* 2018). Still, one study showed that patients who had diabetes for 6 to 10 years were more likely to have raised levels of urea and creatinine (Kurniawan and Kusrini, 2020).

It has been shown that glucose increases mitochondrial activity, produces more oxidative stress, and causes males' tubular epithelial cells to release more glucose in the tricarboxylic acid cycle, at the same time, females have higher levels of pyruvate, so the different metabolic patterns in males may accelerate the development of diabetic kidney disease (Clotet-Freixas *et al.,* 2024). Moreover, type 2 diabetes is connected to higher blood ammonia, citrulline, and urea levels, particularly in red blood cells, which often disturbs the nitrogen-related metabolism management of people based on their gender (Contreras-Zentella *et al.,* 2019)

A significant decrease in GFR in female patients directly indicates declining kidney function, and research reveals that females with T2DM show greater annual eGFR reductions than male patients (Kajiwara *et al.,*2016). T2DM with elevated HbA1c indicators depicts poor glucose control that creates a negative relationship with eGFR value in females more than men (Leena *et al.,* 2021).

Hypertension, obesity, and proteinuria are common predictors of the decline in eGFR and are common in female T2DM patients, so in a study, the incidence of rapid deterioration of renal function was 20.83 percent in diabetic patients, and poor glycemic control and high amounts of urinary protein excretion were especially prevalent in females (Fujii *et al.,* 2023).

In subjects with T2DM, the ACR also showed a significant increase in both sexes, so ACR is a key indicator of kidney damage, particularly in diabetic conditions (Persson and Rossing, 2018). Current studies confirm the establishment of gender-accurate ACR reference ranges that demonstrate females typically have elevated values than males (Xu *et al.,* 2008). The urinary ACR amounts are significantly raised in female patient, so presence of elevated ACR values indicates an increased amount of protein found in the urine, which points to kidney damage and women with T2DM have a higher risk of cardiovascular diseases, which may influence ACR levels and kidney health (Ramírez-Morros *et al.,* 2022).

## CONCLUSION

Tight blood glucose regulation is crucial in averting the progression of renal failure. Diabetic nephropathy is a major cause of chronic renal failure. To prevent diabetes mellitus from developing into diabetic nephropathy, one needs to monitor the ratio of albumin and creatinine in urine. Therefore, ACR in urine is a simple and useful marker that can be utilized as a predictive test for the assessment of renal function because ACR detects diabetic nephropathy when serum creatinine is normal, so it is more reliable in detecting early stages of diabetic nephropathy, particularly those suffering from advanced diabetic disease, to interval and routine blood examinations for fasting blood glucose, HbA1c, and ACR to avoid renal failure.

## REFERENCES

Alghamdi, A. S.; Alqadi, A.; Jenkins, R. O.; Haris, P. I. (2021). The influence of gender and menopausal status on HbA1c variation in a big data study of a Saudi population. *Curr. Diab. Rev.,* **17**(3), 365-372. doi.org/10.2174/1573399816999200729143238

Al-Juwary, R.; Al-Hayali, H. (2025). Obesity and insulin resistance. *Raf. J. Sci.*, **34**(1), 100-109. doi.org/10.33899/rjs.2025.186499

Allwsh, Th., A.; Mohammad, J. A. (2013) Clinical study of obe statin hormone and its relation to diabetes mellitus. *Raf. J. Sci*., **24**(7),74-87. doi.org/10.33899/rjs.2013.77818

Bramlage, P.; Lanzinger, S.; Hess, E. (2020). Renal function deterioration in adult patients with type 2 diabetes. *BioMed. Central. Nephr*., **21**(1), 312. doi.org/10.1186/s12882-020-01952-0

Clotet-Freixas, S.; Zaslaver, O.; Kotlyar, M.; Pastrello, C.; Quaile, A. T.; McEvoy, C. M.; Konvalinka, A. (2024). Sex differences in kidney metabolism may reflect sex-dependent outcomes in human diabetic kidney disease. *Sci. Transl. Med*., **16**(737), doi.org/10.1126/scitranslmed. abm2090

Contreras-Zentella, M. L.; Sánchez-Sevilla, L.; Suárez-Cuenca, J. A.; Olguín-Martínez, M.; Alatriste-Contreras, M. G.; García-García, N.; Hernández-Muñoz, R. (2019). The role of oxidant stress and gender in the erythrocyte arginine metabolism and ammonia management in patients with type 2 diabetes. *PloS One*., **14**(7), e0219481. doi.org/10.1371/journal.pone.0219481

El Malahi, A.; Van Elsen, M.; Charleer, S.; Dirinck, E.; Ledeganck, K.; Keymeulen, B.; De Block, C. (2022). Relationship between time in range, glycemic variability, HbA1c, and complications in adults with type 1 diabetes mellitus. *The J. Clin. Endocr. Metab*.,**107**(2), e570-e581. doi.org/10.1210/clinem/dgab688

Fiseha, T.; Alemayehu, E.; Kassahun, W.; Adamu, A.; Gebreweld, A. (2018). Factors associated with glycemic control among diabetic adult out-patients in Northeast Ethiopia. *BioMed. Centr. Rese. Not.,* **11**(2), 1-5. doi.org/10.1186/s13104-018-3423-5

Fujii, M.; Ohno, Y.; Ikeda, A.; Godai, K.; Li, Y.; Nakamura, Y.; Yabe, D.; Tsushita, K.; Kashihara, N.; Kamide, K.; Kabayama, M. (2023). Current status of the rapid decline in renal function due to diabetes mellitus and its associated factors: analysis using the National Database of Health Checkups in Japan. *Japanese Soci. Hypert.,* **46**(5), 1075-1089. doi.org/10.1038/s41440-023-01185-2

Galicia, U.; Benito, A.; Jebari, S.; Larrea, A.; Siddiqi, H.; Uribe, K. B.; Martín, C. (2020). Pathophysiology of type 2 diabetes mellitus. *Intern. J. Molec. Sci.,* **21**(17), 6275. doi.org/10.3390/ijms21176275

Guzman-Vilca, W. C.; Carrillo-Larco, R. M. (2025). Number of people with type 2 diabetes mellitus in 2035 and 2050: a modelling study in 188 countries. *Curr. Diab. Revi.*, **21**(1), 120124225603. doi.org/10.2174/0115733998274323231230131843

Hu, F.; Chen, H.; Wang, J.; Li, B.; Luo, Y.; Wang, W. (2025). Association of different insulin resistance surrogates with risk of incident type 2 diabetes mellitus, major adverse cardiovascular events and mortality: Evidence from UK biobank cohort study. *Soci. Sci. Rese. Netw.* **32**(4), 5278524. doi.org/10.2139/ssrn.5278524

Indriani, V.; Siswandari, W.; Andreas, T. L. (2021). Effect of glycosylated hemoglobin with microalbuminuria and albumin creatinine ratio in type 2 diabetes. *Pakistan J. Med. Health Sci.,* **15**(7), 1974-1977. doi.org/10.53350/pjmhs211571974

Jalolov, T.S. (2024). Use of SPSS software in psychological data analysis. *Psixol. Sotsiol. Ilmiy J.*, **2**(7), 1-6. doi.org/10.53885/edinres.2024.02.1.063.

Jongs, N.; Greene, T.; Chertow, G. M.; McMurray, J. J.; Langkilde, A. M.; Correa, R.; Heerspink, H. J. (2021). Effect of dapagliflozin on urinary albumin excretion in patients with chronic kidney disease with and without type 2 diabetes: A prespecified analysis from the DAPA-CKD trial. *Lancet Diab. Endocr.,* **9**(11), 755-766. doi.org/10.1016/S2213-8587(21)00243-6

Kajiwara, A.; Kita, A.; Saruwatari, J.; Miyazaki, H. Kawata, Y., Morita, K.; Nakagawa, K. (2016). Sex differences in the renal function decline of patients with type 2 diabetes. *J. Diab. Rese*., **20**(1), 4626382. doi.org/10.1155/2016/4626382

Karar, T.; Alniwaider, R.A.; Fattah, M.A. (2015). Assessment of microalbuminuria and albumin creatinine ratio in patients with type 2 diabetes mellitus. *J. Nat. Sci. Biol. Med*., **6**(11), S89-92. doi.org/10.4103/0976-9668.166095

Kamel, I. A.; Mohammed, H. J.; Mohammed, M. M.; Altimimy, R. N. R. (2024). High HbA1C and glycemic control as diabetic nephropathy etiology. *Angioth. J.*, **8**(3), 547–553. doi.org/10.25163/angiotherapy.839547

Kautzky-Willer, A.; Harreiter, J.; Pacini, G. (2016). Sex and gender differences in risk, pathophysiology, and complications of type 2 diabetes mellitus. *Endocr. Revi.,* **37**(3), 278-316. doi.org/10.1210/er.2015-1137

Kim, H. J.; Kim, S. S.; Song, S. H. (2022). Glomerular filtration rate as a kidney outcome of diabetic kidney disease: A focus on new antidiabetic drugs. *Korean J. Int. Medic.*, **37**(3), 502. doi.org/10.3904/kjim.2021.515

Kurniawan, M. R.; Kusrini, E. (2020). Urea and Creatinine Health Study in Patients with Diabetes Mellitus. *Indon. J. Med. Labor. Sci. Techn.,* **2**(2), 85-92. doi.org/10.33086/ijmlst.v2i2.1565

Lee, Y.B.; Kim, D. H.; Roh, E.; Hong, S.H.; Kim, J. A.; Yoo, H. J.; Baik, S. H.; Han, K.; Choi, K. M. (2020). Variability in estimated glomerular filtration rate and the incidence of type 2 diabetes: A nationwide population-based study. *BMJ Open Diab. Res. Care.*, **8**(1). doi.org/10.1136/bmjdrc-2020-001187

Leena, C. O.; Ajith, T. A.; Vijayasimha, M.; Sah, A. K. (2021). A gender wise correlation analysis between glycated hemoglobin level and estimated glomerular filtration rate among type 2 diabetes patients. *Intern. J. Adv. Medic.*, **8**(8), 1132. doi.org/10.18203/2349-3933.ijam20212856

Levey, A. S.; Coresh, J.; Greene, T.; Stevens, L. A.; Zhang, Y.; Hendriksen, S. (2006). Chronic kidney disease epidemiology collaboration. using standardized serum creatinine values in the diet modification in renal disease study equation for estimating glomerular filtration rate. *Ann. Int. Med.,* **145**(4), 247-254. doi.org/10.7326/0003-4819-145-4-200608150-00004

Li, G.; Yu, Y.; Lin, C.; Zheng, S.; Tu, H.; Xu, W. (2024). Association between major depressive disorder or depressive symptoms and the risk of vascular complications among patients with type 2 diabetes, and the mediating role of metabolic biomarkers: an analysis of the UK Biobank cohort*. Clin. Medic***., 79**. doi.org/10.1016/j.eclinm.2024.102982

Liu, Q.; Wang, Y.; Chen, Z.; Guo, X.; Lv, Y. (2021). Age- and sex-specific reference intervals for blood urea nitrogen in the Chinese general population. *Scient. Rep.*, **11**(1), 1-7. doi.org/10.1038/s41598-021-89565-x

Isam, H. M.; Haimn A. T. (2013). Effects of metformin vs. glibenclamide on serum leptin concentration in type 2 diabetic patients. *Raf. J. Sci.*, **24**(7), 34-41. doi.org/10.33899/rjs.2013.77814

Mensink, M. (2024). Dietary protein, amino acids, and type 2 diabetes mellitus: A short review. *Front. Nutr.*, **11**, 1445981. doi.org/10.3389/fnut.2024.1445981

Merlin, J.; Pusparini, P. (2020). Correlation between HbA1c and albuminuria in Type 2 diabetes mellitus. *Maj. Kedokt. Band.,* **52**(3), 125-130. doi.org/10.15395/MKB.V52N3.2013

Persson, F.; Rossing, P. (2018). Diagnosis of diabetic kidney disease: State of the art and future perspective. *Kidney Intern. Suppl*., **8**(1), 2-7. doi.org/10.1016/j.kisu.2017.10.003

Pierre, C. C.; Marzinke, M. A.; Ahmed, S. B.; Collister, D.; Colón-Franco, J. M.; Hoenig, M. P.; Greene, D. N. (2023). AACC/NKF guidance document on improving equity in chronic kidney disease care. *J. Appl. Labor. Medic.*, **8**(4), 789-816. doi.org/10.1093/jalm/jfad022

Ramírez-Morros, A.; Josep F. N.; Jordi R.; Mònica G.; Didac M. (2022). Sex differences in cardiovascular prevention in type 2: Diabetes in a real-world practice database. *J. Clin. Med.,***11**(8), 2196. DOI: 10.3390/jcm11082196

Selby, N. M.; Taal, M. W. (2020). An updated overview of diabetic nephropathy: Diagnosis, prognosis, treatment goals, and latest guidelines. *Diab. Obes. Metab.*, **22**, 3-15. doi.org/10.1111/dom.14007

Sgro, P.; Emerenziani, G. P.; Antinozzi, C.; Sacchetti, M.; Di Luigi, L. (2021). Exercise as a drug for glucose management and prevention in type 2 diabetes mellitus. *Curr. Opin. Pharm.,* **59**, 95-102. doi.org/10.1016/j.coph.2021.05.006

Shadab, S.; Mittal, P.; Barwad, A. (2022). Characterizing predictors of non-diabetic kidney disease (NDKD) in diabetic patients. *Intern. Urol. Nephr.,* **54**, 1303-1309 doi.org/10.1007/s11255-021-02998-1

Shah, H. S.; McGill, J. B.; Hirsch, I. B.; Wu, C.; Galecki, A.; de Boer, I. H.; Mauer, M.; Doria, A. (2024). Poor glycemic control is associated with more rapid kidney function decline after the onset of diabetic kidney disease. *J. Clin. Endocr. Metab.*, **109**(8), 2124-2135. doi.org/10.1210

Sportiello, L.; Capuano, A. (2024). Sex and gender differences and pharmacovigilance: A knot still to be untied. *Front. Pharm.*,**15**, 1397291. doi.org/10.3389/fphar.2024.1397291

Tramunt, B.; Smati, S.; Grandgeorge, N. (2020) Sex differences in metabolic regulation and diabetes susceptibility. *Diabet.,* **63**, 453-461. doi.org/10.1007/s00125-019-05040-3.

Xu, R.; Zhang, L.; Zhang, P.; Wang, F.; Zuo, L.; Zhou, Y.; Shi, Y.; Li, G.; Jiao, S.; Liu, Z.; Xu, G.; Liang, W.; Wang, H. (2008). Gender-specific reference value of urine albumin-creatinine ratio in healthy Chinese adults: Results of the Beijing CKD survey. *Clin. Chim. Acta*., **398** (2), 125-9. doi.org/10.1016/j.cca.2008.09.002

---

# تقييم بعض المتغيرات الكيموحيوية لدى مرضى السكري من النوع الثاني كطريقة للكشف المبكر عن اعتلال الكلية السكري

زينة فارس مصطفى هيثم لقمان شهاب الحيالي ثائر محمد حسن المشهداني

قسم علوم الحياة/ كلية العلوم/ جامعة الموصل

**الملخص**

أُجري البحث لتحديد المؤشرات المبكرة لاعتلال الكلية السكري من خلال مقارنة انخفاض وظائف الكلى بين مرضى السكري من النوع الثاني وغير المصابين به. شملت عينات الدم المخبرية 120 عينة من مرضى تم تشخيص إصابتهم بداء السكري من النوع الثاني (T2DM) من مركز الوفاء للسكري وأمراض الغدد الصماء والمختبرات الخاصة في مدينة الموصل و90 عينة أخرى تم الحصول عليها من أشخاص أصحاء كمجموعة سيطرة. خضع المشاركون في الدراسة لتقييمات طبية شاملة، بما في ذلك اختبارات سكر الدم الصائم (FBS)، واختبارات مستوى الهيموغلوبين A1c (HbA1c)، واختبارات الكلى للكرياتينين واليوريا ونيتروجين اليوريا في الدم (BUN)، ومعدل الترشيح الكبيبي (GFR)، ونسبة ألبومين البول إلى الكرياتينين (ACR). أشارت النتائج إلى زيادة كبيرة في نسبة السكر في الدم أثناء الصيام، ومستويات الهيموجلوبين السكري التراكمي، وزيادة مستويات الكرياتينين واليوريا واليوريا نتروجين في المصل عند $P \leq 0.05$ مقارنة بالأفراد الأصحاء، مما يثبت أنها مؤشرات تشخيصية موثوقة للتفريق بين مرضى السكري المصابين باعتلال الكلية وغيرهم من الأشخاص الأصحاء.

**الكلمات الدالة:** داء السكري، اعتلال الكلى، سكر الدم الصائم (FBS)، الهيموجلوبين A1c (HbA1c)، الكرياتينين.