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Evaluation of Kidney and Liver Functions in type 2 Diabetic patients in Al-Muthanna Province

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***Abstract*—Type 2 diabetes (T2D) is associated with hepatic and renal complications that may be detectable by routine biochemical tests. Regional data on hepatic and renal functions in T2D are limited. This study evaluated liver and kidney biomarkers in patients with T2D from Al-Muthanna province. In this case-control study, 60 patients with T2D and 60 age- and sex-matched healthy controls were enrolled, after obtaining informed consent from all participants. Demographic data and laboratory measurements, including hemoglobin A1c (HbA1c), Random Blood Sugar (RBS), aspartate aminotransferase (AST), alanine aminotransferase (ALT), albumin, Total serum bilirubin (TSB), blood urea, and serum creatinine were collected and compared between groups using a t-test.**

***Keywords*—T2DM, Urea, Creatinine, and liver function**

I. INTRODUCTION

Type 2 diabetes mellitus (T2D) is a major and growing public-health problem worldwide and is associated with substantial morbidity and mortality due to micro- and macrovascular complications [1]. The prevalence of T2D in Iraq and neighboring countries has risen markedly in recent decades, with regional estimates of a growing burden of the disease and its complications [2]. In a MENA Region study (including Iraq), diabetes accounted for 51.8% of deaths in patients aged below 60 [3]. T2D is characterized by chronic hyperglycemia, which promotes oxidative stress, low-grade inflammation, and metabolic dysregulation, increasing the risk of hepatic and renal injury [4]. Therefore, early detection of liver and kidney dysfunction is an essential strategy in diabetes care.

Liver involvement in T2D most commonly manifests as non-alcoholic fatty liver disease (NAFLD), which ranges from simple steatosis to steatohepatitis and fibrosis [5]. Importantly, the liver is a crucial organ in regulating glycemic balance. As such, liver enzymes' plasma levels must be routinely measured in patients with T2D, primarily aspartate aminotransferase (AST) and alanine aminotransferase (ALT). A series of previous clinical studies have associated hyperglycemia with elevated liver enzymes, ALT and AST, which marked liver injury and represented a relevant risk for T2D [6-7]. Frequently, abnormal liver enzymes (ALT, AST, GGT) are used for screening and risk stratification. On the other hand, T2D also reflects on the kidneys, as diabetic kidney disease marks functional and biochemical changes, albuminuria, and reduced estimated glomerular filtration rate (eGFR), which precede rises in serum creatinine [8].

Despite the growing prevalence of T2D in Iraq, few studies have systematically evaluated liver and kidney biomarkers in diabetic populations. To address this gap, the present study aimed to evaluate renal and hepatic biochemical markers in patients with T2D in Al-Muthanna province.

II. MATERIALS AND METHODS

A. *Study population:*

Between November 2024 and February 2025, 60 patients with T2D were recruited in the study from the Endocrinology and Diabetes Center at Al-Hussein Teaching Hospital, Al-Muthanna province, according to the American Diabetes Association classification (ADA) (Committee, 2024). Information related to patients: age, sex. A healthy control group of 60 healthy individuals, who had normal fasting glucose and HbA1c levels and no family history of diabetes, was enrolled. Exclusion criteria involved children with thyroid problems, type 1 diabetes, secondary or monogenic types of diabetes, or intake of drugs known to affect glucose metabolism. Further exclusion included patients with autoimmune diseases, chronic illnesses, or recent infections.

B. *Biochemical measurements:*

Venous blood (5 mL) was drawn from each participant, and 2 mL were collected into EDTA tubes for HbA1c measurement. HbA1c was quantified using a High Fact automated analyzer (HMG, Germany). An additional 3 ml of blood was subjected to centrifugation in order to obtain serum, which was subsequently utilized for conducting the remaining biochemical analyses.

C. *Statistical analysis:*

All statistical analyses were performed using SPSS version 27.0. Continuous variables (hepatic and renal parameters, HbA1c, and RBS) are presented as mean ± standard deviation (SD), while categorical variables (age and gender) are expressed as frequencies and percentages.

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Hepatic and renal profile parameters were compared between study groups by an independent-samples t-test. A p-value < 0.05 was considered statistically significant.

III. Results

A. Study population and general characteristics

The study included 60 patients with type 2 diabetes (T2D) and 60 age- and sex-matched healthy controls. Among the 60 patients with T2D, most patients belonged to the age groups 40–49 years (31.6%) and 50–59 years (35.0%) (Table 1). Sex distribution was balanced between groups, with 30 (50%) males and 30 females in each group (Fig. 1).

TABLE 1. Age distribution of T2D patients and healthy controls

Age (years)	T2D Patients N (%)	Healthy control N (%)	p-value
30-39	4 (6.6%)	19 (31.6%)	0.006*
40-49	19 (31.6%)	15 (25%)	
50-59	21 (35%)	14 (23.3%)	
60-69	13 (21.6%)	7 (11.6%)	
70-79	3 (5%)	5 (8.3%)	

* P-value <0.05 is considered statistically significant

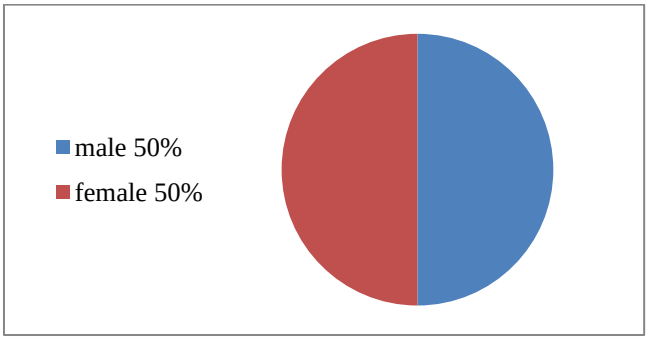

Fig.1: Sex distribution of T2D patients

B. Glycemic control

Mean HbA1c was significantly higher in the T2D group than in healthy controls (8.19 ± 1.60% and 4.74 ± 0.53%, respectively; p < 0.0001). As well, RBS was also significantly elevated in patients with T2D compared with healthy controls (247.12 ± 103.27 mg/dL and 106.56 ± 13.95 mg/dL; p < 0.0001; Table 3).

TABLE 2. Glycemic profile of T2D patients and healthy controls

Parameters	Groups	Mean ± SD	P-Value
HbA1c (%)	T2D	8.19 ± 1.6	<0.001*
	Healthy controls	4.74 ± 0.53	
RBS (mg/dl)	T2D	247.12±103.27	<0.001*
	Healthy controls	106.56 ± 13.95	

* p-value <0.05 is considered statistically significant

C. Liver function tests

Serum AST was significantly higher in the T2D group than in healthy controls (24.99 ± 10.41 U/L vs 20.74 ± 8.52 U/L; p = 0.016), while the ALT did not differ significantly between groups (23.66 ± 12.30 U/L vs 20.56 ± 9.69 U/L; p = 0.127). Mean serum albumin was similar in patients and healthy controls (4.37 ± 0.79 g/dL vs 4.16 ± 0.45 g/dL; p = 0.082). However, TSB was higher in the T2D group compared with healthy controls (0.69 ± 0.24 mg/dL vs 0.54 ± 0.26 mg/dL; p = 0.002; Table 3).

TABLE 3. Hepatic function tests of T2D patients and healthy controls

Parameters	Groups	Mean ± SD	P-Value
AST (U/L)	T2D	24.99 ± 10.41	0.016*
	Healthy controls	20.74 ± 8.52	
ALT (U/L)	T2D	23.66 ± 12.3	0.127
	Healthy controls	20.56 ± 9.69	
Albumin (g/dl)	T2D	4.37 ± 0.79	0.082
	Healthy controls	4.16 ± 0.45	
TSB (mg/dl)	T2D	0.69 ± 0.24	0.002*
	Healthy controls	0.54 ± 0.26	

* P-value <0.05 is considered statistically significant

D. Renal function markers

Blood urea concentration was significantly greater in patients with T2D than in healthy controls (33.38 ± 8.85 mg/dL vs 29.39 ± 6.84 mg/dL; p = 0.007), while serum creatinine did not differ significantly between groups (0.773 ± 0.09 mg/dL vs 0.798 ± 0.09 mg/dL; p = 0.168; Table 4).

TABLE 4. Renal function tests of T2D patients and healthy controls

Parameters	Groups	Mean ± SD	P-Value
Urea (mg/dL)	T2D	33.38 ± 8.85	0.007*
	Healthy controls	29.39 ± 6.84	
Creatinine (mg/dL)	T2D	0.7730 ± 0.09	0.168
	Healthy controls	0.7730 ± 0.09	

* p-value <0.05 is considered statistically significant

IV. Discussion

In our case-control study of 60 T2D patients and 60 healthy controls from Al-Muthanna province, patients with T2D showed markedly worse glycemic and statistically significant elevations in serum AST, TSB, and blood urea compared with controls. The age distribution of T2D was overrepresented in the 40-49 and 50-59 age groups, while the sex distribution was balanced.

Age is a major determinant of both diabetes prevalence and complications. In Iraq and the Middle East, studies report substantial burdens of T2D concentrated in older adults, and age is consistently associated with higher prevalence of severe complications. In Iraq, around 1.4 million patients have diabetes, with T2D prevalence ranging from 8.5%-13.9% in older patients [9]. A local study in the city of Basrah, Southern Iraq, reported a 19.7% age-adjusted prevalence of diabetes that peaked at age 46-60 years [10].

Biological sex affects glucose metabolism, fat distribution, and the expression of metabolic complications [11]. Females and males differ in visceral adiposity, insulin sensitivity, and the risk profiles for NAFLD and diabetic nephropathy. While sex differences in metabolic regulation emphasize their impact on diabetes, our sample population showed an equal distribution between males and females among T2D patients. Local studies in Baghdad, Basrah, and Kurdistan provinces show a slight predominance of T2D in females compared to males [12-13]. Prior studies have found that males are often diagnosed earlier and with lower body fat, while females may experience a higher risk factor burden at diagnosis, especially obesity [14].

The substantially elevated HbA1c and RBS in the T2D group confirm poor glycemic control in our sample study and might mechanistically explain hepatic and renal dysfunction. Poor glycemic control is well established as a driver of microvascular complications (including nephropathy) and is also associated with liver abnormalities such as NAFLD, which is highly prevalent in patients with T2D [5]. Epidemiological studies link worse glycemic control with a greater risk of both hepatic enzyme elevations (particularly ALT) and progressive kidney injury [15-16]. Because hyperglycemia independently promotes hepatic steatosis, oxidative stress, and low-grade inflammation, and because hyperglycemia damages renal microvasculature [17-19], both hepatic and renal functions are associated with the glycemic state of a patient.

Liver plays a vital role in the regulation of glucose homeostasis, and T2D is related to different liver diseases, which contribute to morbidity and mortality among patients [20]. Thus, changes in the levels of liver enzymes might be considered as markers for the diagnosis and prognosis of diabetes. Herein, we found that AST was significantly increased, and ALT didn't differ significantly, but it is generally considered more hepatocyte-specific and commonly elevated in NAFLD. In contrast, elevated AST may reflect non-hepatic sources such as muscle or cardiac tissue, or indicate advanced hepatic fibrosis [21]. Epidemiological studies report that elevated AST levels increase progressively metabolic indicators, such as BMI, serum lipid profile (e.g., total cholesterol, LDL, triglyceride), HbA1c, and fasting plasma glucose, which are associated with an increased risk of T2D [22]. Likewise, Karimabad et al. showed that highly elevated AST levels could be a risk factor for diabetes [23]. Therefore, the elevated AST levels in our study mark a state of mild hepatocellular stress among T2D patients. Furthermore, albumin levels did not differ significantly between groups, consistent with the fact that albuminemia, in early diabetes, typically remains normal [24], suggesting mild hepatic involvement rather than chronic liver disease. Interestingly, T2D patients had higher TSB than controls. TSB is a nonspecific biomarker. It rises whenever bilirubin production, hepatic uptake/conjugation, or biliary excretion is disturbed. Clinically, it helps to distinguish unconjugated (indirect) from conjugated (direct) hyperbilirubinemia. Primarily, elevated TSB might be due to unconjugated hyperbilirubinemia, which typically reflects increased hemolysis, impaired conjugation\ hepatocellular dysfunction (e.g., NAFLD, viral or drug-induced injury), or hereditary conjugation defects (e.g., Gilbert syndrome). In contrast, conjugated hyperbilirubinemia indicates defective hepatic excretion or post-hepatic obstruction [25]. While some epidemiological studies reported inverse associations between bilirubin and diabetes, other clinical experiments showed variable associations depending on hemolysis, cholestasis, hepatocellular dysfunction, or genetic and environmental factors [26-27].

Hyperglycemia is one of the major causes of progressive renal damage, and blood urea is usually associated with a non-functional or damaged kidney [28]. Our results show a significant increase in urea but no significant difference in serum creatinine. This pattern can reflect early/pre-renal changes, mild decline in renal perfusion, or early diabetic kidney involvement that is not yet reflected by creatinine-based indices.

V. Conclusion

In this case-control study, patients with type 2 diabetes demonstrated markedly worse glycemic control and elevations in serum AST, TSB, and blood urea. These findings suggest early hepatic stress and possible preclinical renal perturbation in T2D of Al-Muthanna province. Therefore, routinely monitoring liver and kidney biomarkers in patients with T2D in Iraq should emphasize improved glycemic control to reduce the risk of progressive hepatic and renal disease. From a public health perspective, strengthening preventive strategies, optimizing glycemic control, and integrating biochemical testing into diabetes management programs in Al-Muthanna province are essential steps to reduce the long-term burden of complications.

No published studies from Al-Muthanna have directly assessed hepatic and renal function in diabetic patients. One COVID-19–era study measured ALT and AST in patients with and without diabetes, but not in the context of diabetic complications [29]. Therefore, our findings were contextualized using Iraqi data from other provinces (e.g., Ramadi and Karbala) and national reports on diabetic nephropathy, thereby filling a province-level gap for Al-Muthanna.

VI. Conclusion

In the present study, patients with T2D demonstrated poor glycemic control and evidence of hepatic dysfunction (elevated AST and TSB) and early renal perturbation (high urea) compared with healthy controls. Routinely monitoring liver and kidney biomarkers in patients with T2D in Iraq should be integrated into diabetes management programs in Al-Muthanna province as an essential step to reduce the long-term burden of complications.

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ETHICAL APPROVAL

This study was approved by the Al-Muthanna Health Department and College of Science, Al-Muthanna University (Approval NO.354/2025).

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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