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Correlation of Biochemical Parameters among Type 2 Diabetes Mellitus Patients in Jordan

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KEYWORDS

T2DM, biochemical parameters, lipid profile, glucose,

ABSTRACT:

Introduction: Diabetes mellitus is a chronic metabolic disorder characterized by elevated blood glucose levels resulting from insufficient insulin utilization or production. Type 2 diabetes mellitus (T2DM) poses substantial risks to various bodily systems, particularly the cardiovascular system.

Objectives: To investigate the role of biochemical parameters with T2DM in Jordanian patients.

Methods: Forty normal, healthy controls (24 males and 16 females) and 120 T2DM patients (73 males and 47 females) were recruited from the Islamic hospital in Amman for this study. Standard laboratory tests, including Glycated Hemoglobin A1c (HbA1c), Fasting Plasma Glucose (FPG), Insulin (INS), Homeostasis Model Assessment 2 (HOMA2), C-Reactive Protein (CRP), creatinine, Estimated Glomerular Filtration Rate (eGFR), Alanine Transaminase (ALT), Cholesterol (CHT), Triglycerides (TRG), High-Density Lipoprotein (HDL), Low-Density Lipoprotein (LDL), and CHT/HDL ratio, were conducted.

Results: Significant difference was recorded in different variables in male and female. The levels of serum HbA1c, FPG, INS, HOMA2, CRP, ALT, CHT, TRG, and HDL showed significant increase in T2DM patients as compared to control group ($P<0.0001$), whereas the levels of Creatinine, eGFR and LDL showed no significant in patients with T2DM compared to control subjects ($P>0.05$).

Conclusions: Many biochemical parameters can be increased as well as correlated in T2DM. Insulin levels, insulin resistance, CHT, TRG, and CHT/HDL ratio can be elevated significantly while others such as LDL can be decreased. Correlation was seen between parameters such as blood sugar and lipid profile assuming that they are important in diagnosis and follow up of T2DM.

1. Introduction

Diabetes mellitus is a group of heterogeneous metabolic disorders, which is mainly characterized by an increase in blood glucose concentrations (chronic hyperglycemia [1]. Diabetes mellitus is a group of metabolic disorders of carbohydrate metabolism in which glucose is both underutilized as an energy source and overproduced due to inappropriate gluconeogenesis and glycogenolysis, resulting in hyperglycemia [2,3].

It is widely recognized as an emerging epidemic that has a cumulative impact on almost every country, age group, and economy across the world. According to the International Diabetes Federation [4], in 2015, approximately 415 million people were suffering from diabetes worldwide, and this number is expected to increase to more than 640 million by the year 2040. It is estimated that half of the patients with diabetes are not diagnosed, and they are more susceptible to developing diabetes mellitus complications [5].

Diabetes is divided into several types: type 1, type 2, and gestational diabetes. All these types are related to the body's ability to produce or use insulin, which is a hormone produced by the pancreas that allows glucose to enter the body's cells and convert it into energy [1].

Patients with type 1 or type 2 diabetes mellitus are prone to developing diabetic complications, and they contribute to significant morbidity and mortality [6]. Diabetes mellitus is usually associated with serious complications

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divided into acute and chronic complications. Acute complications include hyperglycemia, hypoglycemia, diabetic ketoacidosis, and hyperglycemic hyperosmolar nonketotic coma. If hyperglycemia is not treated, it will develop life-threatening complications that affect and damage the heart, kidneys, nerves, eyes, and peripheral vascular system [7]. Chronic complications of diabetes can be roughly divided into microvascular complications and macrovascular complications. Microvascular complications include neuropathy, nephropathy, and retinopathy, while macrovascular complications include cardiovascular disease, stroke, and peripheral arterial disease (PAD) [6].

Type 2 Diabetes Mellitus (T2DM) is considered one of the most common metabolic disorders in the world, and almost 90% of diabetes mellitus cases are T2DM. It is primarily developed due to the inability of cells to respond to insulin and a defect in insulin secretion by β cells in the pancreas [8]. The most common pathological features of T2DM are increased blood glucose (hyperglycemia) because of insulin resistance and excessive glucose released from the liver [8].

2. Objectives

Monitoring various biochemical parameters and conducting numerous laboratory tests is a crucial step in the diagnosis and treatment of patients with diabetes mellitus. Thus, the purpose of this study was to determine the relationship between various biochemical parameters among diabetic patients who were seen at an Islamic hospital in Amman in order to create a suitable plan for reducing the diabetes epidemic in Jordan.

3. Methods

Study Population and Control Group

In this study, a total of 160 participants, 120 (73 males and 47 females) aged between 31 and 85 years (mean age ± SD: 56.5 ± 13.24 years) and 40 healthy controls (24 males and 16 females) aged between 30 and 85 years (mean age ± SD: 53.0 ± 13.95 years) were examined. All participants samples underwent routine chemistry tests, FPG, HbA1c, INS, CRP, Creatinine, ALT, and Lipid Profile (LP).

Samples were collected from participants from the Islamic hospital in Amman, whose patients are from all cities in Jordan.

Sample Collection and Storage

Vacutainer blood samples were collected from the participants in gel-containing tubes, allowed to clot, then centrifuged to obtain serum in order to perform routine chemistry tests. Routine chemistry tests include (HbA1c, FPG, insulin, creatinine, ALT, CHT, TRG, HDL, LDL and CRP) were performed using Cobas Pro, an automated chemistry instrument, as per the manufacturer's instructions.

Statistical analysis

The data was entered to SPSS version 20 statistical package for analysis. Descriptive statistics were used to summarize the frequency distributions. Independent 't' test was applied to observe the difference between T2DM group and healthy group, P values were calculated by unpaired T-test, Mann-Whitney test using Prism 9.0.0 (121). Pearson correlation test was applied to observe correlation between different biochemical parameters among diabetes patients. P-value <0.05 was considered to be significant.

Ethics and Consent Form

The ethical approval for this study has been obtained by The Ethical Committee and Institutional Review Board (IRB) of the Islamic hospital in Amman, Jordan on (IRB number:13285/18/3/2/18). Also, the consent form was obtained from the patients.

4. Results

The total number of patients with T2DM was 120, with an age distribution of 30 to 85 years old. In this study gender distribution was as follows, 73 males with a percentage of (60.83%) and mean age of (52.84), and 47 females with a percentage of (39.17%) and mean age of (62.06) with a ratio of male: female of 1.56:1, as shown in Figure 1. The control group consisted of 40 healthy individuals. The age and gender were also matched with the study group, gender distribution was as follows, (24) males with a percentage of (60.0%) and mean age of (48.21), and (16) females with a percentage of (40.0%) and mean age of (58.06) with a ratio of male: female of (1.5:1), Figure 2 and Table 1 shows control group gender

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distribution and participants age distribution, respectively in the current study.

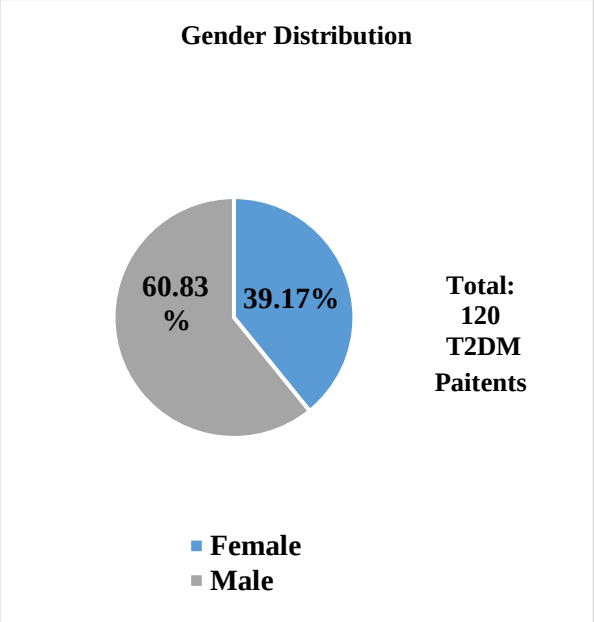

Figure 1: Gender Distribution for Patients with T2DM

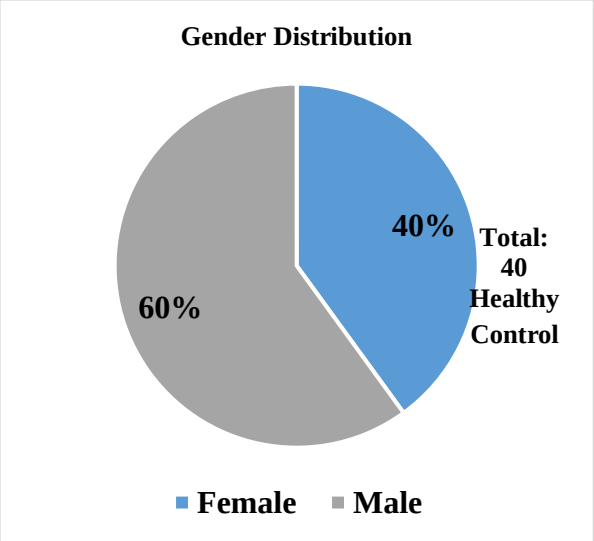

Figure 1: Gender Distribution for Healthy Control

Table 1: Participants Age Distribution

Age (Years) characteristic	Patients with T2DM	Healthy Control
Males age range	30-85	30-85
Females age range	31-84	32-83
Males age mean with a standard deviation	52.84 ± 12.49	48.21 ± 13.76
Females age mean with a standard deviation	62.06 ± 12.51	58.06 ± 14.64
Males age standard error of the mean (SEM)	1.462	2.808
Females age standard error of the mean (SEM)	1.825	3.66

Comparison between T2DM group and healthy group was done to find the significant variables between these two groups. Data in Table 2 are presented as mean ± standard deviation. Data shows a significant difference between patients with T2DM and healthy control in the following blood tests: HbA1c, FPG, INS, HOMA2, TRG, HDL, and CHT/HDL. In addition to ALT with P value = 0.0142, and CHT with P value = 0.0426.

Table 3 shows difference between T2DM females and healthy females. The significant difference is in the following blood tests: HbA1c, FPG, TRG, HDL at P value ≤ 0.05, In addition to INS with P value = 0.0012, HOMA2 with P value = 0.0001, CRP with P value = 0.0057, ALT with P value = 0.0064, CHT/HDL with P value = 0.0004. Adding to that, Table 4 shows a significant difference between T2DM males and healthy males in the following blood tests: HbA1c, FBS, and TRG with P value = <0.0001. In addition to HOMA2 with P value = 0.0141, CRP with P value = 0.0051, HDL with P value = 0.0002, CHT/HDL with P value = 0.0001.

Table 2: Biochemical Tests of Study Participants

Variables	Patients with T2DM (n = 120) Mean ± SD	Healthy Control (n = 40) Mean ± SD	P value*
HbA1c (%)	7.91 ± 1.305	5.318 ± 0.321	<0.0001
FPG (mg/dL)	167.1 ± 60.18	91.98 ± 8.119	<0.0001

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INS (µU/mL)	15.83 ± 13.76	9.375 ± 5.503	<0.0001
HOMA2	2.139 ± 1.549	1.193 ± 0.6837	<0.0001
CRP (mg/L)	7.876 ± 18.76	1.759 ± 2.371	0.0007
Creatinine (mg/dL)	0.9384 ± 0.424	0.8639 ± 0.2139	0.1496
eGFR (mL/min/1.73m2)	86.19 ± 27.99	89.53 ± 17.12	0.3725
ALT (U/L)	28.91 ± 19.65	22.08 ± 13.08	0.0142
CHT (mg/dL)	183.1 ± 50.54	168.4 ± 34.42	0.0426
TRG (mg/dL)	222.7 ± 152.4	86.33 ± 30.06	<0.0001
HDL (mg/dL)	42.16 ± 10.96	54.83 ± 14.31	<0.0001
LDL (mg/dL)	99.15 ± 41.98	95.88 ± 29.26	0.5870
CHT/HDL Ratio	4.713 ± 2.378	3.22 ± 0.8367	<0.0001

* Significant if (P value ≤ 0.05)

Discussion

L The gender distribution of diabetic cases in our study was 73 (60.83%) and 47 (39.17%) for males and females, respectively. This distribution is consistent with a study done in Ethiopia where 152 (39.6%) of the 384 participants were female and 232 (60.4%) were

Table 3: Biochemical Tests of Female Participants in T2DM and Healthy Control

Variables	Females with T2DM (N = 47) Mean ± SD	Healthy Control Females (N = 16) Mean ± SD	P value*
HbA1c (%)	7.73 ± 1.355	5.3 ± 0.2757	<0.0001
FPG (mg/dL)	167.5 ± 68.39	88.94 ± 7.937	<0.0001
INS (µU/mL)	16.16 ± 11.86	7.606 ± 4.079	0.0012
HOMA2	2.371 ± 1.829	0.9188 ± 0.3544	0.0001
CRP (mg/L)	7.466 ± 8.598	1.975 ± 2.682	0.0057
Creatinine (mg/dL)	0.8234 ± 0.3352	0.6963 ± 0.1035	0.1869
eGFR (mL/min/1.73m 2)	82.02 ± 28.10	92.13 ± 17.77	0.2248
ALT (U/L)	23.38 ± 13.83	15.5 ± 5.404	0.0064
CHT (mg/dL)	186.9 ± 49.42	178.6 ± 32.30	0.6586
TRG (mg/dL)	208.4 ± 121.7	84.69 ± 36.71	<0.0001
HDL (mg/dL)	48.49 ± 10.95	63.81 ± 12.02	<0.0001
LDL (mg/dL)	99.19 ± 42.18	98 ± 28.84	0.9036
CHT/HDL Ratio	4.028 ± 1.428	2.865 ± 0.6479	0.0004

* Significant if (P value ≤ 0.05).

male [9]. Another study revealed that the prevalence of diabetes was 1.1% in women and 1.6% in men [10].

Table: 4 Biochemical Tests of Male Participants in T2DM and Healthy Control

Variables	T2DM Males (N = 72) Mean ± SD	Healthy Control Males (n = 23) Mean ± SD	P value*
HbA1c (%)	8.042 ± 1.270	5.294 ± 0.3207	<0.0001
FPG (mg/dL)	167.2 ± 55.04	93.96 ± 7.917	<0.0001
INS (µU/mL)	15.64 ± 15.04	9.901 ± 5.287	0.0643
HOMA2	1.993 ± 1.343	1.291 ± 0.6901	0.0141
CRP (mg/L)	8.244 ± 23.26	1.678 ± 2.216	0.0051
Creatinine (mg/dL)	1.022 ± 0.4591	0.9739 ± 0.2027	0.6236
eGFR (mL/min/1.73m2)	88.73 ± 27.92	88.54 ± 16.80	0.9880

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ALT (U/L)	31.99 ± 21.79	26.4 ± 15.19	0.2559
CHT (mg/dL)	181.4 ± 51.34	163.7 ± 33.99	0.2164
TRG (mg/dL)	233.8 ± 169.8	87.35 ± 26.06	<0.0001
HDL (mg/dL)	37.95 ± 8.928	48.58 ± 12.84	0.0002
LDL (mg/dL)	99.32 ± 42.41	96.65 ± 28.72	0.8410
CHT/HDL Ratio	5.188 ± 2.750	3.504 ± 0.8562	0.0001

* Significant if (P value ≤ 0.05).

Similar findings to ours were also reported in the Endocrinology and Isfahan Diabetes Prevention Study database [11]. The higher prevalence of T2DM in males might be related to central obesity associated with android obesity [12, 13]. According to other studies, women are more likely to develop diabetes because they have less total muscle mass to absorb more glucose load and higher levels of progesterone and estrogen, which lower insulin sensitivity [14].

In the present study, the, mean age for males and females was 52.84 ± 12.49 and 62.06 ± 12.51, respectively. Males and females in a similar study of T2DM patients in Nepal had mean (±SD) ages of 52.7 ± 11.9 and 51.84 ± 12.1 years, respectively [15]. The findings of Salih et al. [16] and Shrestha et al. [17] were nearly identical.

Hematological parameters exhibit significant abnormalities in patients with diabetes mellitus [18]. Increased A1C in the blood or higher glucose concentrations in venous plasma are indicators of diabetes [2]. A poorly managed or uncontrolled level of hyperglycemia may be linked to various organ damage, including cardiovascular disease (CVD), nerve and kidney damage (neuropathy and nephropathy), lower limb amputation, and eye disease (primarily affecting the retina), which can cause blindness and vision loss. [4,19].

A positive and significant increase in HbA1c, FBS, INS, HOMA2, CRP, ALT, CHT, TRG, and the CHT/HDL ratio was observed in the current study. These results are in agreement with the findings of other previous studies. [20,21]. A study by Kizilgul et al. [21] on 135 type 2 patients and 121 controls from Turkey showed that the DM group had higher SBP, DBP, WC, and FPG, PPG, HbA1c, and TG levels (p<0.0001).

Males and females have a positive correlation for FBS and lipid profile parameters, according to research by Prakash et al. [22]. Similarly, there was a positive correlation between FBS and urea, creatinine, and uric acid. Additionally, uric acid showed a markedly elevated correlation with TC, TG, VLDL, and LDL.

In a study by Konecna et al. [23], 327 participants were involved (191 T2DM patients and 136 controls). The mean age of the T2DM patients was 65.06 (SD ± 10.88) years, while the mean age of the healthy individuals was 58.89 (SD ± 6.59) years. Biochemical analysis in this study confirmed statistically significant lower values of high-density lipoprotein (HDL) and cholesterol ($p < 0.001$) and significantly higher mean values of total cholesterol (TC), triglyceride (TG), glucose (GLU), and uric acid (UA) in T2DM patients ($p < 0.001$).

The study's findings revealed a significant increase in glucose levels in T2DM patients compared to controls. This condition, which typically develops around the age of 40, may be caused by weak cells, little insulin synthesis and/or function, and rising insulin resistance. These results are in accordance with the study characterized by Abd and Al-Jumaili [24], who observed that the levels of serum glucose, total cholesterol, triglycerides, very low-density lipoprotein, and low-density lipoprotein showed a significant increase in T2DM patients as compared to the control group, whereas the levels of high-density lipoprotein showed no significant difference in patients with type 2 diabetes mellitus compared to control subjects. The study's findings demonstrated that, in comparison to healthy controls, diabetes patients had a significantly higher total HbA1C. These findings are consistent with those of Wondifraw [25], who found that diabetics have elevated HbA1C.

Conclusions

The diagnosis of diabetes is strongly correlated with the biochemical parameters FBS, HbA1C, cholesterol, triglycerides, HDL, LDL, and VLDL. Many biochemical parameters may be significantly altered in patients with T2DM. For an early diagnosis and appropriate treatment, biochemical parameters should be routinely tested of diabetes-related complications.

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