



# Assessment of Ferritin Level and Some Biochemical Variables in Iraqi Anemic Diabetic Mellitus in Both Gender

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Received: January 07, 2024; Revised: January 14, 2024; Accepted: February 05, 2024

## Abstract

Diabetes mellitus (DM) is a prevalent metabolic disorder characterized by elevated blood sugar levels caused by diminished tissue sensitivity to insulin, insufficient insulin production, or a combination of both factors. This is a non-communicable disease that is also highly prevalent globally. The aim of the study is to evaluate ferritin level and other biochemical variables in type 2 diabetes mellitus patients and study the effect of biochemical variables between male and female (T2DM). Method involves enrollment of 120 participant divided into two main groups (T2DM and control group) and every group has been subdivided based on gender to (30 male and 30 female) for each group. All the groups studied for determination of anthropometric and biochemical parameters to evaluate the relationship between the studied parameters and T2DM patients. Results: the result showed that (Age, body mass index (BMI), Fasting blood sugar (FBS), triglycerides (TC), Urea, systolic blood pressure (SBP), diastolic blood pressure (DBP) and Ferritin) were significantly difference in T2DM patients (male and female) as compared with control. While ( TG and Creatinine) were non-significantly differ in T2DM patients as compared with control. Furthermore, there was non-significant difference in the studied parameters between T2DM males and females. Conclusion: from the obtained result it could be concluded that patients with T2DM have a problem associated with ferritin level that effected by T2DM and decreased because of the impaired renal dysfunction and red blood cells decrease and that causes a decrease in the level of ferritin. Age and BMI levels have a direct effect and correlated with elevation of lipid continents and high level of FBS and blood pressure. Renal function is highly elevated because of the T2DM complication, and it is conceder as a risk factor for T2DM.

**Key words:** ferritin level, hypertension, Lipid profile, renal dysfunction, T2DM.

## 1. Introduction

Diabetes mellitus (DM) is a prevalent metabolic disorder characterized by elevated blood sugar levels caused by diminished tissue sensitivity to insulin, insufficient insulin production, or a combination of both factors. This is a non-communicable disease that is

also highly prevalent globally (Balaji, Duraisamy and Kumar 2019). Diabetes mellitus (DM) gives rise to a range of occurrences, encompassing both micro and macro-vascular problems. It explains a significant prevalence of illness or disease (Alam 2021). There is a lot of reasons and risk factors for T2DM including (age,

wrong nutrition, hormonal, obesity, genetic and low level physical activity) all of these factors may cause T2DM(Dietrich et al. 2019). Diabetes is a debilitating condition that can lead to many complications such as blindness, amputations, renal disease, anemia, cardiovascular diseases, brain difficulties, and a decline in functional capacity and autonomy(Mahapatra et al. 2022), ultimately affecting an individual's quality of life. The assessment and treatment of individuals with diabetes mellitus is performed by measuring glycosylated hemoglobin (HbA1c). HbA1c measures and evaluates the long-term management of blood sugar levels and predicts the likelihood of microvascular problems in individuals with diabetes(Yang et al. 2020). The HbA1c level in the blood sample indicates the average lifespan of red blood cells and offers a history of glycemic control(Rashed et al. 2020). Other organs could be harmed because of the long time effect of DM, so that, a lot of parameters changes in the body according to the aggressively and duration of the disease.

Anemia is a hematological condition characterized by a diminished capacity of the blood to transport oxygen, resulting from a below-average count of red blood cells, a decrease in the quantity of hemoglobin, or abnormalities in hemoglobin structure. Anemia is one of the most conditions that companies with DM(Wiciński et al. 2020)

Ferritin is an omnipresent intracellular protein that serves as a reservoir for iron and releases it in a regulated manner(Plays, Müller and Rodriguez 2021). The protein is synthesized by virtually all extant creatures, encompassing archaea, bacteria, algae, higher plants, and mammals. Hemosiderin serves as

the principal internal iron reservoir in both prokaryotes and eukaryotes, maintaining iron in a soluble and non-harmful state. In humans, it serves as a protective mechanism against both iron deficiency and iron overload.. Ferritin is present in the majority of tissues as a protein located in the cytoplasm, but it is also released in minute quantities into the bloodstream, where it acts as a transporter of iron. Plasma ferritin serves as an indirect indicator of the overall iron content stored in the body(Casiday and Frey 1998).

The aim of the study is to evaluate ferritin level and other biochemical variables in type 2 diabetes mellitus patients and study the effect of biochemical variables between male and female (T2DM) .

## **2. Material and Methods**

### **2.1 The Study Population**

The current study included 60 patients with T2DM, ages range 26-64 years. They the patients samples collected from Diabetes Research Center Al-Mustansiriyah University in Baghdad / Iraq for the time from January 2023 to June 2023. The participants were divided into two primary groups 30 males and 30 females, the two groups of the study compared with 60 control participants and even divided into 30 males and 30 females.

### **2.2 Inclusion criteria**

Patients are chosen to have anemia and T2DM. All patients were diagnosed with HB less than 10 g/dl, while control chosen to be healthy with no T2DM or anemia.

## 2.3 Exclusion criteria

Patients chosen to not to have renal failure or cardiovascular disease, smoker people are excluded.

## 2.4 Anthropometric study

The patients and control participants has been going to take the gender, age, weight and height to evaluate the body mass index, BMI measurement calculated by the use of the mathematical equation, it is calculated by dividing the weight of a person by the square of height  $W \div H^2$ .

Then, all participants submitted to blood pressure measurement to evaluate the systolic and diastolic blood pressure

## 2.5 Sample Collection

Ten milliliter venous blood samples were collected from patients with T2DM and control A volume of 3 milliliters was placed in a EDTA for determination of HbA1c%. The remaining blood was putted in a gel tube and left at a temperature (22-70) °C for 30

minutes to separate the clot, then, the collected blood centrifuged at 3500 rpm for 10 minutes to separate serum. The collected serum then used to evaluate the biochemical parameters (TC, TG , HDL, FBS, urea, Creatinine and ferritin).

## 2.6 Biochemical tests

The evaluation of ferritin were done by using direct ELISA technology by the using of the information provided from ( Sunlong / China ) kit absorbance were evaluated to be 450 nm and the standard curve calculated by the using of standard concentration and it is dilutions provided with the kit.

Other chemical parameters (TC, TG, HDL, FBS, Urea and Creatinine) were evaluated by the using of kits provided from (Human company / Spain) every parameter was measuring in a different wave length as it is provided in the kits.

## 2.7 Study Design

The study model has been designed to show the study map that used in this study

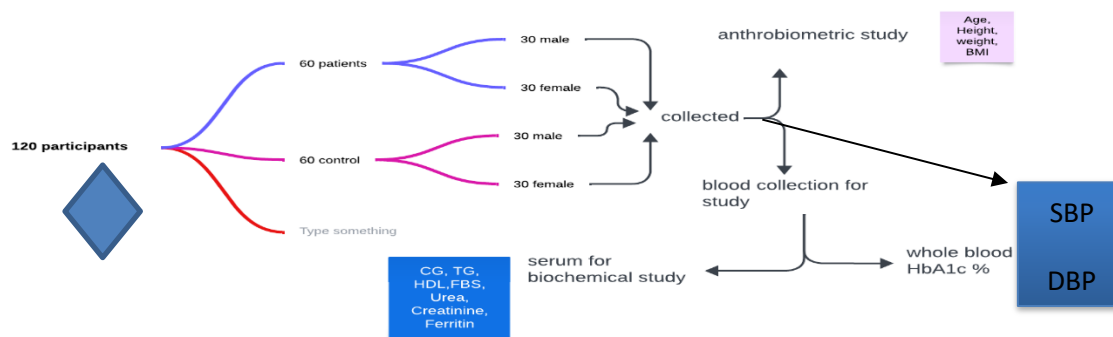


Figure 1: study design for the work.

## 2.8 Statistical analysis

The data has been analyzed using SPSS statistics. The descriptive statistics for

each parameter included the calculation of the mean  $\pm$  standard deviation (SD). The T-test was employed to compare the chemical



variables between patients and control groups at a significance level of probability ( $P < 0.05$ ) (Taha Mohammed 2023).

### 3. Results

#### 3.1 Anthropometric and biochemical parameters between males

The mean and SD for the studied parameters going for statistical study and the results showed that in two groups ( control and T2DM patient ) for male have a significant increase ( $P < 0.05$ ) between patients ( $44.52 \pm 10.2$ ) as compared with control ( $37.1 \pm 10.9$ ), there is significant difference in BMI between patients ( $31.4 \pm 4.3$ ) as compared with control ( $27.1 \pm 3.4$ ), there is a significant increase ( $P < 0.05$ ) in the level of FBS in patient ( $171.3 \pm 26.4$ ) as compared with control ( $95.1 \pm 24.7$ ), there is a non-significant difference in TC between patient ( $183.2 \pm 38.2$ ) as compared with control ( $173 \pm 60$ ), there is a

significant increase ( $P < 0.05$ ) in the level of TG between patient ( $142.2 \pm 83$ ) as compared with control ( $87.2 \pm 34$ ), there is a significant decrease ( $P < 0.05$ ) in the level of HDL in patient ( $45.2 \pm 4.87$ ) as compared with control ( $67.6 \pm 22$ ), there is a significant increase ( $P < 0.05$ ) in the level of urea between patients ( $51.4 \pm 16.2$ ) as compared with control ( $40.43 \pm 15.9$ ), there is a non-significant difference in the level of creatinine in patients ( $1.1 \pm 0.45$ ) as compared with control ( $0.97 \pm 0.53$ ), there is a significant increase ( $P < 0.05$ ) in the level of SBP and DBP between patients ( $14.8 \pm 1.8$ ) ( $9.37 \pm 0.63$ ) as compared with the control ( $12.9 \pm 1.6$ ) ( $8.05 \pm 0.65$ ) respectively, in the last, there is a significant decrease ( $P < 0.05$ ) in the level of ferritin between patient ( $9.3 \pm 2.06$ ) as compared with control ( $40.7 \pm 12.2$ ) The result of the study shown in Table-1.

**Table 1:** T-Test result for the Studied Parameters between Control and T2DM Patients in Males.

Mean $\pm$ SD For the studied parameters	Control (Male) (N=30)	T2DM (Male) (N=30)	p-value
Age, years	$37.1 \pm 10.9$	$44.52 \pm 10.2$	<b>0.02</b>
BMI, Kg/m <sup>2</sup>	$27.1 \pm 3.4$	$31.1 \pm 4.3$	<b>0.04</b>
FBS mg/dl	$95.1 \pm 24.7$	$171.3 \pm 26.4$	<b>&lt;0.002</b>
TC mg/dl	$173.0 \pm 60$	$183.2 \pm 38.2$	<b>0.5</b>
TG mg/dl	$87.2 \pm 34$	$142.2 \pm 83$	<b>&lt; 0.004</b>
HDL mg/dl	$67.6 \pm 22$	$45.2 \pm 4.87$	<b>&lt;0.001</b>
Urea, mg/dl	$40.43 \pm 15.9$	$51.4 \pm 16.2$	<b>&lt;0.02</b>
Creatinine, mg/dl	$0.97 \pm 0.53$	$1.1 \pm 0.45$	<b>0.41</b>
SBP mmHg	$12.9 \pm 1.6$	$14.8 \pm 1.8$	<b>&lt;0.001</b>
DBP mmHg	$8.05 \pm 0.65$	$9.37 \pm 0.63$	<b>&lt;0.04</b>
Ferritin ng/mL	$40.7 \pm 12.2$	$9.3 \pm 2.06$	<b>&lt;0.001</b>



### 3.2 Anthropometric and biochemical parameters between females

The mean and SD for the studied parameters going for statistical study and the results showed that in two groups ( control and T2DM patient ) for female have a significant increase ( $P<0.05$ ) between patients ( $40.3\pm 8.2$ ) as compared with control ( $33.2\pm 7.9$ ), there is significant difference in BMI between patients ( $30.4\pm 4.4$ ) as compared with control ( $26.9\pm 5.4$ ), there is a significant increase ( $P<0.05$ ) in the level of FBS in patient ( $159.3\pm 39.4$ ) as compared with control ( $95.4\pm 20$ ), there is a non-significant difference in TC between patient ( $188.3\pm 31.7$ ) as compared with control ( $165.0\pm 61.2$ ), there is a significant increase ( $P<0.05$ ) in the level of TG between patient ( $140.1\pm 71.4$ ) as

compared with control ( $87.9\pm 32.8$ ), there is a significant decrease ( $P<0.05$ ) in the level of HDL in patient ( $45.6\pm 3.9$ ) as compared with control ( $65.3\pm 19$ ), there is a significant increase ( $P<0.05$ ) in the level of urea between patients ( $50.0\pm 18.35$ ) as compared with control ( $36.8\pm 13.7$ ), there is a non-significant difference in the level of creatinine in patients ( $0.94\pm 0.24$ ) as compared with control ( $0.82\pm 0.23$ ), there is a significant increase ( $P<0.05$ ) in the level of SBP and DBP between patients ( $14.8\pm 2.5$ ) ( $8.5\pm 0.9$ ) as compared with the control ( $12.3\pm 1.59$ ) ( $7.8\pm 0.47$ ) respectively, in the last, there is a significant decrease ( $P<0.05$ ) in the level of ferritin between patient ( $9.2\pm 2.7$ ) as compared with control ( $43.7\pm 11.1$ ) The result of the study shown in Table-2.

**Table 2:** T-Test result for the Studied Parameters between Control and T2DM Patients in Females

Mean $\pm$ SD For the studied parameters	Control (Female) (N=30)	T2DM (Female) (N=30)	p-value
Age, years	33.2 $\pm$ 7.9	40.3 $\pm$ 8.2	<b>0.04</b>
BMI, Kg/m <sup>2</sup>	26.9 $\pm$ 5.4	30.4 $\pm$ 4.4	<b>0.032</b>
FBS mg/dl	95.4 $\pm$ 20	159.3 $\pm$ 39.4	<b>&lt;0.001</b>
TC mg/dl	165.0 $\pm$ 61.2	188.3 $\pm$ 31.7	<b>0.94</b>
TG mg/dl	87.9 $\pm$ 32.8	140.1 $\pm$ 71.4	<b>&lt; 0.003</b>
HDL mg/dl	65.3 $\pm$ 19	45.6 $\pm$ 3.9	<b>&lt;0.001</b>
Urea, mg/dl	36.8 $\pm$ 13.7	50.0 $\pm$ 18.35	<b>&lt;0.008</b>
Creatinine, mg/d	0.82 $\pm$ 0.23	0.94 $\pm$ 0.24	<b>0.77</b>
SBP mmHg	12.3 $\pm$ 1.59	14.8 $\pm$ 2.5	<b>&lt;0.025</b>
DBP mmHg	7.8 $\pm$ 0.47	8.5 $\pm$ 0.9	<b>&lt;0.006</b>
Ferritin ng/mL	43.7 $\pm$ 11.1	9.2 $\pm$ 2.7	<b>&lt;0.001</b>



### 3.3 Anthropometric and biochemical parameters T2DM patients (males and females )

The mean and SD for the studied parameters going for statistical study and the

result between males and females showed that there is non-significant differences between all parameters for the comparison between males and females. The result of the study shown in Table-3.

**Table 3:** T-Test result for the Studied Parameters between T2DM Males and Females

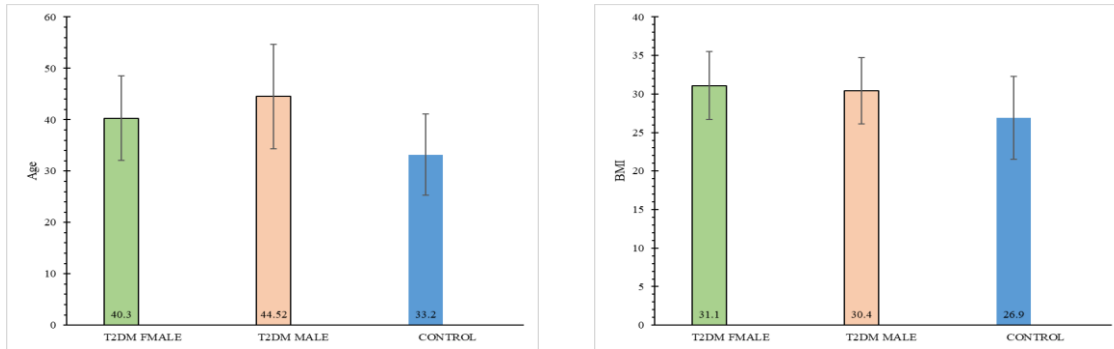
Mean $\pm$ SD For the studied Parameters	T2DM (Female) (N=30)	T2DM (Male) (N=30)	p-value
Age, years	40.3 $\pm$ 8.2	44.52 $\pm$ 10.2	<b>0.106</b>
BMI, Kg/m <sup>2</sup>	31.1 $\pm$ 4.4	30.4 $\pm$ 4.3	<b>0.66</b>
FBS mg/dl	159.3 $\pm$ 39.4	171.3 $\pm$ 26.4	<b>0.448</b>
TC mg/dl	188.3 $\pm$ 31.7	183.2 $\pm$ 38.2	<b>0.627</b>
TG mg/dl	140.1 $\pm$ 71.4	142.2 $\pm$ 83	<b>0.34</b>
HDL mg/dl	45.6 $\pm$ 3.9	45.2 $\pm$ 4.87	<b>0.176</b>
Urea, mg/dl	50.0 $\pm$ 18.35	51.4 $\pm$ 16.2	<b>0.154</b>
Creatinine, mg/dl	0.94 $\pm$ 0.24	1.1 $\pm$ 0.45	<b>0.102</b>
SBP mmHg	14.8 $\pm$ 2.5	14.8 $\pm$ 1.8	<b>0.416</b>
DBP mmHg	8.5 $\pm$ 0.9	9.37 $\pm$ 0.63	<b>0.963</b>
Ferritin ng/mL	9.2 $\pm$ 2.7	9.3 $\pm$ 2.06	<b>0.969</b>

## 4. Discussion

The result obtained from this study shoes that there is a significant different between age for patients as compared with control, and a significant different in BMI too, this result is in agreement with the study of (Suastika et al. 2012) who shows that people with older ages is more likely to be exposed to T2DM in both male and female patients. T2DM is related directly with age, when people get older a lot of body function is differ and the body well not be able to control on its

metabolism and organs secretion (Cevenini et al. 2010), In individuals with obesity, a significant amount of the increased fasting glucose content in the blood is attributed to insulin resistance. The development of insulin resistance in obesity may be attributed to the limited capacity of hypertrophied adipocytes to accommodate and process glucose. This phenomenon may also apply to muscle, liver, and  $\beta$ -pancreatic cells in the presence of lipid buildup. Consequently, glucose will forfeit a valuable accumulation(Taay et al. 2021).



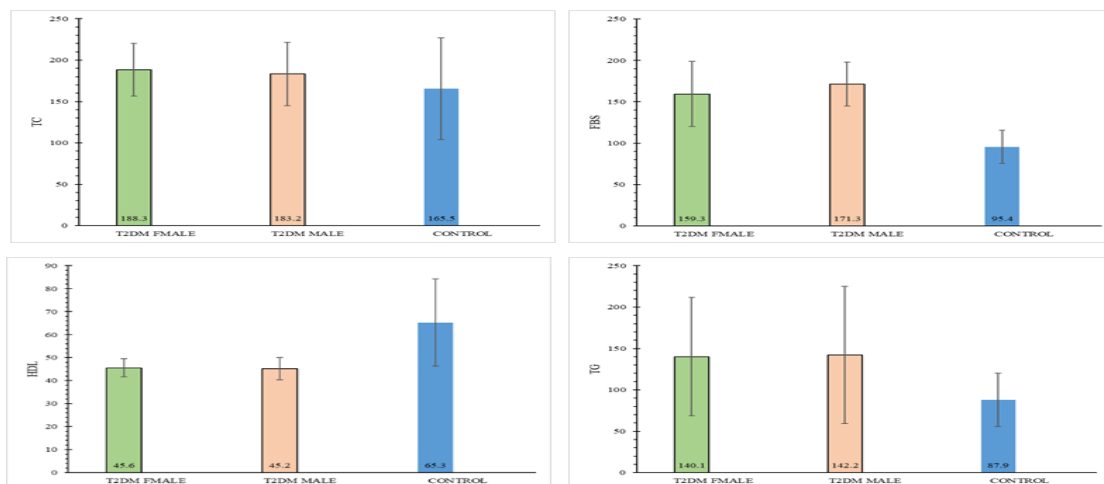


**Figure 2:** Mean and SD for Age and BMI between T2DM and Control.

FBS and TC showed to be significantly raised in T2DM patients. While TG is non significantly elevated. in another hand, HDL is significantly decreased in T2DM as compared with control This result is in agreement with other studies like Biadgo et al, Ghari et al (Biadgo et al. 2017, Ghari Arab et al. 2018).

This is because there is an increase in the liver's production of very low-density lipoprotein (VLDL) and a delay in the removal of triglyceride-rich lipoproteins, resulting in higher levels of substances that contribute to the production of total cholesterol (TC)(Dhoj et al. 2017). Additionally, there is an increase in the release of free fatty acids (FFA) from adipose

tissue and an increase in their presence in the blood of patients with diabetes mellitus (DM)(Kahn et al. 2005), as observed in this study. High levels of total cholesterol (TC) are frequently observed in persons with dyslipidemia associated with type 2 diabetes mellitus (T2DM) and prediabetes. These elevated TC levels are considered as criteria for identifying individuals who are at a high risk for cardiovascular disease (CVD) and T2DM(Liu et al. 2022).obese people having an insulin resistance due to the acumination of lipid in their bodies those the body will not be able to maintain glucose and hence it caused an elevation of BG and an elevation in the TG and TC and also decrease in the level of HDL.

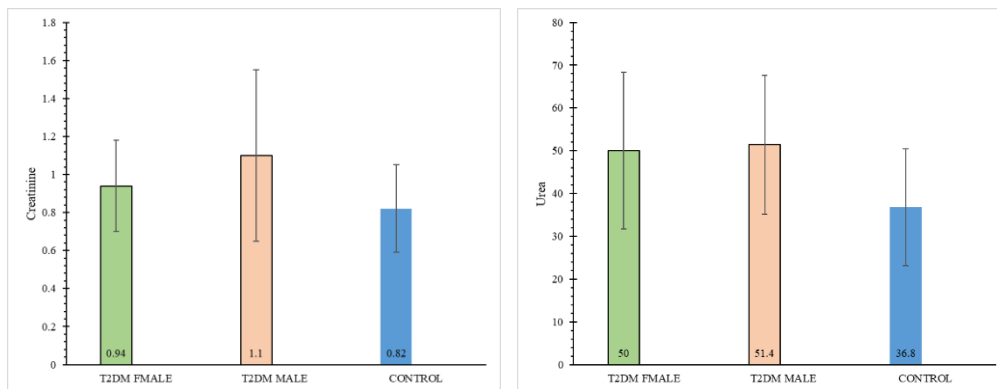


**Figure 3:** Mean and SD for FBS, TC, TG and HDL between T2DM and Control

Urea showed to be significantly elevated in T2DM patients, but there is a non-significant elevation in the level of creatinine. Previous studies showed an elevation in both urea and creatinine like Kene et al (Kene et al. 2021). Elevated levels of serum creatinine and serum urea are indicative of renal injury or dysfunction. Elevated blood sugar levels can potentially result in renal impairment.

The kidneys would fail to effectively eliminate serum creatinine, resulting in an abnormal increase in its levels. Intensive treatment can effectively reduce elevated HbA1c levels (Chen et al. 2020). However, the increased levels of serum urea and creatinine, caused by permanent kidney damage, are difficult to reverse. Kidney damage in

diabetes mellitus is a permanent condition (van der Slikke et al. 2020). The heightened concentrations of serum urea and creatinine serve as indicators of glomerular damage, which cannot be reversed with an aggressive therapy regimen. Early detection and intervention are the sole means of managing the increasing glomerular injury and the resulting increase in serum and creatinine levels (Desanti De Oliveira et al. 2019). The non-significant elevation of creatinine in our study may be due to the low level damage in the kidney. It is mean that the creatinine level should be raised as a feature complications of T2DM and Causes kidney dysfunction development in the collected patients in this study.



**Figure 4:** Mean and SD for Urea and Creatinine between T2DM and Control

DPB and SBP showed to be significantly elevated in T2DM patients as compared with control. This results in agreement with previous studies like (Chiriaco et al. 2019, Yu et al. 2020).

People with obese and high level of lipid experience a high blood pressure, patients with T2DM always have obese and so they have high BP, suggesting that there is a favorable association between high blood pressure and markers of obesity (Cai et al. 2019). The prevalence of overweight/obesity

is strongly linked to excessive consumption of affordable and appetizing diets that are rich in fats and processed carbohydrates. There is a clear connection between an incremental rise in body mass index (BMI) within the normal and overweight categories and the likelihood of developing hypertension and cardiovascular disease (CVD) (Sikand and Severson 2020).

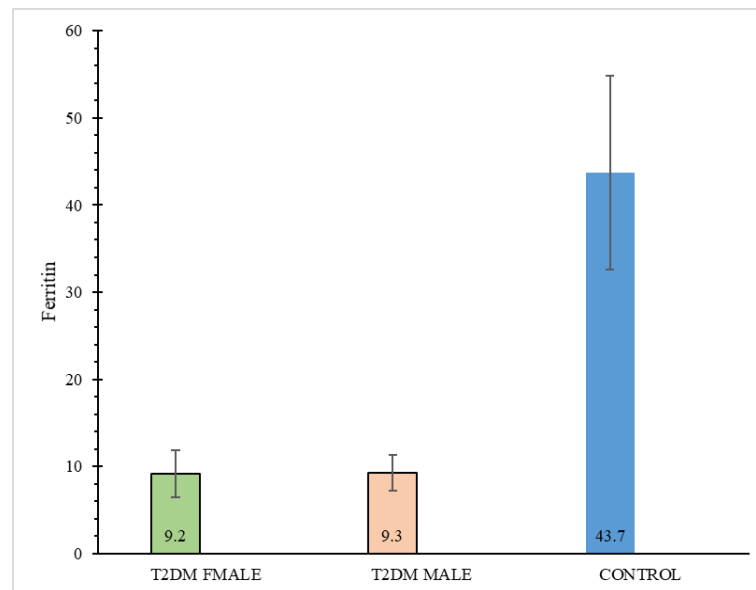
The level of ferritin is significantly decreased in T2DM patients as compared with control, this result is also in agreement with



studies like (Manikandan, Ganesh and Silambanan 2015)

Patient with T2DM that having obesity and hypertension suffering from anemia, which is a reason of decreasing the level of ferritin in the serum of T2DM patients. Anemia is a common additional health condition in individuals with T2DM and hypertension. When anemia is present,

patients experience more severe symptoms, less functional capacity, and higher mortality rates. The awareness that anemia exacerbates the symptoms of hypertension is not novel; nonetheless, in recent years, the extent of the anemia linked to this condition has been more apparent. Nutritional deficiencies, particularly iron deficiency, and chronic inflammation are the primary factors that contribute to anemia in patients with hypertension.



**Figure 5:** Mean and SD for Ferritin between T2DM and control

The comparison between male and female as a T2DM patients shows that there is no significant difference between them, all parameters showed to be effected in nearly the same level and that perform that T2DM patient could have the same conditions and suffering from the same complications. Both male and female develops iron deficiency anemia and renal dysfunction abnormalities.

## Conclusion

Ferritin levels is associated with anemia and shows a real condition of complexities appearing the risk of long term diabetic mellitus infection on patients. However, it's

important to note that future researches may provide further insights into these associations the relationship between age, BMI, FBS, lipid profile, urea, creatinine, blood pressure, ferritin, and T2DM is intricate and interdependent. These factors collectively contribute to the pathophysiology of diabetes, impacting insulin sensitivity, inflammation, and cardiovascular health. Understanding these relationships is crucial for developing effective strategies for the prevention, early detection, and management of T2DM and its associated complications. The exposure to lots of this complexities like obesity,



dyslipidemia, and renal dysfunction could be a reason of having T2DM.

## Acknowledgment

The author thank the National Center for Diabetes Treatment and Research, a special thank for all participant in this work for their role in information collection.

## Conflict of interest

There is no conflict of interest regarding this work

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## تقييم مستوى الفيريتين وبعض المتغيرات الكيموحيوية في مرضى السكري العراقي المصابين بفقر الدم عند كلا الجنسين

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### خلاصة

داء السكري (DM) هو اضطراب أيضي سائد يتميز بارتفاع نسبة السكر في الدم المستويات الناجمة عن انخفاض حساسية الأنسجة للأنسولين، أو عدم كفاية إنتاج الأنسولين، أو مزيج من كلا العاملين. وهذا مرض غير معدٍ وهو منتشر أيضًا بشكل كبير عالميًا. الهدف من الدراسة هو تقييم مستوى الفيريتين والمتغيرات البيوكيميائية الأخرى في النوع الثاني من مرضى السكري ودراسة تأثير المتغيرات الكيموحيوية بين الذكور والإناث. تتضمن الطريقة تسجيل ١٢٠ مشاركاً مقسمين إلى مجموعتين رئيسيتين من النوع الثاني لمرضى السكري T2DM وتم تقسيم كل مجموعة حسب الجنس إلى (٣٠ ذكر و ٣٠ أنثى) لكل مجموعة. تمت دراسة جميع المجموعات لتحديد القياسات الجسمية والبارامترات البيوكيميائية لمرضى السكري ومقارنتها مع الأصحاء.