



Relationship between Type 2 Diabetes Mellitus and Red Cell Distribution Width

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Abstract

Background and objectives: Type 2 diabetes mellitus is a prevalent health problem in the Kurdistan region/Iraq. Numerous biochemical parameters are important for screening and monitoring of diabetes mellitus, Red Cell Distribution Width is one of them.

Methods: A cross-sectional study was conducted in Erbil Teaching Hospital, Rizgary Teaching Hospital, and Layla Qassim primary health care center in Erbil city-Kurdistan region/Iraq from 1st of August, 2022 to 31st of July, 2023 on one hundred and twenty type 2 diabetic patients. Many biochemical and hematological parameters were evaluated and compared with Red Cell Distribution Width in this study.

Results: The mean Red Cell Distribution Width of diabetic patients was (16.64%); 61.7% of them had a high Red Cell Distribution Width. A weak positive correlation was observed between Red Cell Distribution Width -CV and each female gender, Body Mass Index, White Blood Cell count, and triglyceride ($p \leq 0.05$). A potent positive and significant correlation was noticed between Red Cell Distribution Width -CV and fasting blood sugar ($r=0.76$, $p < 0.001$) as well as HbA1c level ($r=0.92$, $p < 0.001$). A moderate positive significant correlation was observed between Red Cell Distribution Width -CV and cholesterol, low-density lipoprotein cholesterol as well as serum creatinine levels ($p \leq 0.05$). A weak negative correlation between Red Cell Distribution Width -CV and HDL ($p < 0.001$).

Conclusion: The red blood cell distribution width might be a helpful marker in monitoring and assessing the severity of type 2 diabetes mellitus and could also help in predicting cardiovascular and renal complications.

Keywords: HbA1c, RDW-CV, Type 2 diabetes mellitus.

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Introduction

Diabetes mellitus (DM) is a long-term metabolic disorder characterized by high blood sugar levels due to insufficient or ineffective insulin production or action by the body.¹ It is the most prevalent metabolic disease in many countries.² Type 2 diabetes mellitus (T2DM) accounts for more than 90% of DM cases. Type 2 diabetes mellitus raises the risk of death from cardiovascular diseases (CVDs) by 15%.³ The incidence of Type 2 diabetes mellitus has increased in recent decades due to the rise of multiple risk factors such as obesity, sedentary lifestyle, physical inactivity, and dietary changes.⁴ In Iraq, the estimated Type 2 diabetes mellitus incidence ranges from 8.5% to 13.9%.⁵ while in the Kurdistan region, it is 13%.⁶ Variability of red blood cell size (anisocytosis) leads to high red blood cell distribution width levels that are associated with impaired erythropoiesis and red blood cell breakdown, indicating chronic inflammation and high oxidative stress levels that are markers of Type 2 diabetes mellitus and contribute to the development of atherosclerotic diseases.^{7,8} In recent decades, there has been a growing debate on the role of red blood cell distribution width in predicting acute kidney injury and chronic kidney disease.^{9,10} Furthermore, high red blood cell distribution width level is also useful in predicting mortality, cardiovascular complications, and poor renal function outcomes among patients with Type 2 diabetes mellitus.¹¹ Some authors have recently found a significant link between high red blood cell distribution level and increased prevalence of macro and micro-vascular complications in patients with Type 2 diabetes mellitus.¹² The aim of this study was to examine the relationship between red blood cell distribution width - CV level and various hematological parameters like renal function test, lipid profile which include serum cholesterol, serum TG, HDL and LDL, C- reactive

protein, White blood cell count, Hemoglobin level, glycated hemoglobin (HbA1C) and Fasting blood glucose in patients with Type 2 diabetes mellitus in Kurdistan region.

Patients and methods

A cross-sectional study was conducted in Erbil Teaching Hospital, Rizgary Teaching Hospital, and Layla Qassim Primary Health Care Center in Erbil city-Kurdistan region/Iraq from 1st of August, 2022 to 31st of July, 2023. Initially, one hundred and fifty patients with type 2 diabetes were taken, thirty of them were excluded from the study because they did not meet the required criteria and because there was a lack in their test results. On this basis, this study was conducted on one hundred and twenty adult patients because they matched to the criteria of the study. Exclusion criteria were type 1 diabetes mellitus, pregnancy, hemoglobinopathies, liver disease, chronic kidney diseases stage 4–5 or patients on dialysis, any current infection, and anemia. The ethical issues were taken into consideration regarding the approval of the Ethical Committee of Kurdistan Higher Council of Medical Specialties and the hospital administration, oral informed consent of selected patients, and management of patients accordingly. The data was collected either directly from the patients or from their saved records and filled in a prepared questionnaire. The questionnaire included general characteristics of patients with type 2 DM (age, gender, body mass index, and disease duration), examination, and investigational findings [blood pressure, white blood cell count (WBC), hemoglobin (Hb) level, RDW-CV, cholesterol level, triglyceride level, high-density lipoprotein (HDL), low-density lipoprotein (LDL)] glycemic profile and renal function tests (fasting blood sugar (FBS), hemoglobin A1c (HbA1c) level, blood urea, serum creatinine) and CRP levels. The diagnosis of T2DM was





done according to American Diabetes Association (ADA) guidelines and the selected patients were presented for either management or monitoring. The blood samples were measured by laboratory machine (Siemens Advia 2120). The normal value for RDW-CV in this study was 11–15%.¹³ The statistical analysis was done using SPSS, version 24 (SPSS Inc., Chicago, Illinois, USA). The data was arranged in tables and graphs and the statistical test used was the Pearson correlation test. Descriptive statistics (e.g., mean, and standard deviation) were applied. A significant P-value was considered at ≤ 0.05 .

Results

This study included one hundred and twenty patients with type 2 DM with a mean age of (58.6 years) and a range of 40-84 years. Female patients were more than males (50.8% vs. 49.2%). The mean body mass index of studied patients was (27.9 Kg/m²); 54.2% of them were overweight and 30.8% of them were obese. The mean disease duration of type 2 DM was (7.9 years); 73.3% of them had a disease duration of less than 10 years, Table (1).

Table (1): General characteristics of type 2 diabetic patients.

Variable	No.	%
Age mean±SD (58.6±10.2 years)		
Gender		
Male	59	49.2
Female	61	50.8
Body mass index mean±SD (27.9±3.3 Kg/m ²)		
Normal	18	15.0
Overweight	65	54.2
Obese	37	30.8
Disease duration mean±SD (7.9±6.4 years)		
<10 years	88	73.3
>10 years	32	26.7
Total	120	100.0

The mean blood pressure of the patients was (151/87 mmHg); 63.3% of them had high blood pressure. The mean WBC count was (7.5 10⁹/L); all patients had normal WBC count. The mean hemoglobin level of the patients was (14 g/dl); all patients had normal Hb levels. The Mean RDW-CV was (16.64%); 61.7% of patients had high RDW-CV. The mean cholesterol level of the

patients was (253.6 mg/dl); 69.2% of them had high cholesterol level. The Mean triglyceride level was (187.5 mg/dl); 81.7% of the patients had high triglycerides level. The Mean HDL of the patients was (59.2 mg/dl); 2.5% of them had low HDL, while the Mean LDL of type 2 diabetic patients was (126.3 mg/dl); 67.5% of them had high LDL, Table (2).

Table (2): Examination and investigations findings of type 2 diabetic patients.

Variable	No.	%
Blood pressure mean±SD (151/87±19/12 mmHg)		
Normal	44	36.7
High	76	63.3
WBC mean±SD (7.5±1.5 10 ⁹ /L)		





Normal	120	100.0
Hb level mean±SD (14±1.46 g/dl)		
Normal	120	100.0
RDW-CV mean±SD (16.64±5.82 %)		
Normal	46	38.3
High	74	61.7
Cholesterol level mean±SD (253.6±79.2 mg/dl)		
Normal	37	30.8
High	83	69.2
Triglyceride level mean±SD (187.5±56.2 mg/dl)		
Normal	22	18.3
High	98	81.7
HDL mean±SD (59.2±11.9 mg/dl)		
Normal	117	97.5
Low	3	2.5
LDL mean±SD (126.3±41.2 mg/dl)		
Normal	39	32.5
High	81	67.5
Total	120	100.0

The Mean FBS of the patients was (190.5 mg/dl); 55% of them had high FBS, while the Mean HbA1c level was (8.6%); all the patients had high HbA1c levels. Mean blood urea was (24.4 mg/dl); 63.3% of the patients had high blood urea. The mean serum

creatinine was (1.11 mg/dl); 27.5% of the patients had high serum creatinine levels. The Mean C-reactive protein level was (0.69 mg/dl); only 1.7% of the patients had high CRP levels, Table (3).

Table (3): Glycemic profile and renal function tests of type 2 diabetic patients.

Variable	No.	%
FBS mean±SD (190.5±52.4 mg/dl)		
Normal	54	45.0
High	66	55.0
HbA1c level mean±SD (8.6±1.2 %)		
High	120	100.0
Blood urea mean±SD (24.4±5.5 mg/dl)		
Normal	44	36.7
High	76	63.3
Serum creatinine level mean±SD (1.11±0.35 mg/dl)		
Normal	87	72.5
High	33	27.5
CRP level mean±SD (0.69±0.23 mg/dl)		
Normal	118	98.3
High	2	1.7
Total	120	100.0

No significant relationship was detected between RDW-CV and each of age, disease duration, blood pressure, hemoglobin level,

and CRP level ($p>0.05$). A weak, but positive association was noticed between RDW-CV and each of the female gender, BMI, WBC,





and triglyceride ($p \leq 0.05$). A moderate positive correlation was detected between RDW-CV and each of cholesterol, LDL, and serum creatinine levels ($p \leq 0.05$). A weak, but significant negative correlation was noticed between RDW-CV and HDL ($p < 0.001$). A

strong positive relationship was detected between RDW-CV and fasting blood sugar ($r = 0.76$, $p < 0.001$). A very strong positive correlation was seen between RDW- and HbA1c levels ($r = 0.92$, $p < 0.001$), Table (4).

Table (4): Correlation between RDW-CV level and other characteristics of type 2 diabetic patients.

Variable	RDW-CV	
	Pearson correlation	P value
Age	0.17	0.6
Gender	0.21	0.01*
BMI	0.21	0.02*
Disease duration	0.08	0.3
Blood pressure	0.03	0.7
WBC	0.29	0.001*
Hb	-0.1	0.25
Cholesterol	0.47	<0.001*
Triglyceride	0.28	0.001*
HDL	-0.32	<0.001*
LDL	0.4	<0.001*
FBS	0.76	<0.001*
HbA1c	0.92	<0.001*
Blood urea	0.4	<0.001*
Serum creatinine	0.54	<0.001*
CRP	0.09	0.28

*Significant.

Discussion

In the current study, the mean age of the participants was (58.6 years), with minimal predominance of female gender (50.8%). These results resemble those of Mansour et al study in the Republic of Iraq which reported a predominance of female gender (54.4%) in the study.¹⁴ This study showed that 54.2% of the patients were overweight and 30.8% of them were obese. These findings are in agreement with the conclusions of Mohammed et al study in the Kurdistan region of the Republic of Iraq which revealed that more than two-thirds of diabetic patients were overweight and obese.¹⁵ In this study, the mean RDW-CV of the patients was (16.64%); 61.7% of patients had high RDW-CV. This is consistent with the results of Zanganeh study which found that RDW-CV

was remarkably higher among type 2 diabetic patients and also correlated with poor cardiovascular complications.¹⁶ A study conducted by Akrew et al, found that mean RDW-CV was notably higher among patients with type 2 DM by comparison to controls.¹⁷ Xanthopoulos et al study revealed that RDW-CV is a significant foreteller of type 2 DM and highly related to heart failure complications of T2DM. In our study, a strong positive significant association was detected between RDW-CV and fasting blood sugar ($r = 0.76$, $p < 0.001$).¹⁸ This outcome matches the results of Zhang et al cross-sectional study which revealed a substantial positive connection between RDW-CV and fasting blood sugar of patients with type 2 diabetes.¹⁹ The current study found a very strong positive noteworthy





association between RDW-CV and HbA1c level ($r=0.92$, $p<0.001$). This finding matches the conclusions of several studies such as Zangana study in Iraq.¹⁶ Buhatto et al cross-sectional retrospective cohort study all showed a substantial positive association between increased RDW-CV levels and high HbA1c levels among patients with T2DM which helped in the use of RDW-CV as a predictor for glycemic control of T2DM.^{20, 21} Increased blood glucose level causes many changes in red blood cell structure and other hemodynamic changes and it also affects the lifespan of red blood cells and their volume.^{22, 23} Also, different proinflammatory cytokines might affect the erythropoietin production and activity that might stimulate the gradual elevation of RDW levels.^{24, 25} The present study showed a weak significant correlation between RDW-CV and female gender. This finding is in parallel to the results of Sampath Kumar et al study.²⁶ In addition, the study established a weak correlation between RDW-CV and increased BMI. A similar result was detected in the Nada study which found that RDW-CV level was increased among obese patients with type 2 DM. In our study, the RDW-CV level was significantly correlated with the poor lipid profile of diabetic patients.²⁷ This finding agrees with the outcomes of the Yin et al study which found a strong connection between RDW-CV and hyperlipidemia in diabetic patients.²⁸ This study also showed an important relationship between RDW-CV and poor renal function tests in diabetic patients. This finding is similar to the results of Roumeliotis et al study which reported that RDW-CV is predictive for the worsening of renal function among patients with T2DM.²⁹

Conclusion:

The red blood cell distribution width might be a helpful marker in the monitoring of type 2 DM. The red blood cell distribution width could also help in predicting cardiovascular

and renal complications of type 2 DM. This study recommended the use of RDW-CV in the screening of diabetes complications in type 2 DM and in the monitoring of glycemic control.

Conflict of interest:

The authors declare that there is no conflict of interest related to this study.

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