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Cardiovascular Risk and Inflammatory Hematological Indices in Men with Type 2 Diabetes Mellitus With and Without Rheumatoid Arthritis

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Abstract

Type 2 diabetes mellitus (T2DM) and rheumatoid arthritis (RA) are chronic inflammatory and metabolic disorders independently associated with increased cardiovascular disease (CVD) risk. Their coexistence may further increase cardiovascular risk through persistent systemic inflammation and metabolic alterations. This study aimed to evaluate selected hematological and inflammatory biomarkers in patients with T2DM and investigate their association with concomitant RA and cardiovascular risk. A cross-sectional study was conducted among 60 male patients attending Traghen Teaching Hospital, Libya, between August and November 2024. Participants were equally divided into two groups: T2DM alone (n = 30) and T2DM with concomitant RA (n = 30). Blood samples were analyzed for complete blood count (CBC) and glycated hemoglobin (HbA1c), while serum samples were assessed for total cholesterol (TC), high-density lipoprotein cholesterol (HDL-C), and rheumatoid factor (RF). The neutrophil-to-lymphocyte ratio (NLR), platelet-to-lymphocyte ratio (PLR), systemic immune-inflammation index (SII), and systemic inflammatory response index (SIRI) were calculated. Cardiovascular risk was assessed using the Framingham Risk Score (FRS) and Castelli Risk Index I (CRI-I). The FRS was significantly higher in patients with T2DM and concomitant RA than in those with T2DM alone (P = 0.003). The CRI-I did not differ significantly between the groups. No significant differences were observed in leukocyte, lymphocyte, monocyte, or granulocyte counts or in NLR, PLR, SII, and SIRI. RDW-SD was significantly lower in the RA group, indicating hematological alterations associated with chronic inflammatory activity. Overall, patients with T2DM and concomitant RA had a higher estimated cardiovascular risk, as reflected by FRS, although this finding should be interpreted cautiously given the age difference between the groups. The findings highlight differences in cardiovascular risk profiles but do not establish an independent contribution of RA. Further studies are needed to clarify the relationship between RA, hematological parameters, and cardiovascular risk in patients with T2DM.

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1. INTRODUCTION

Type 2 diabetes mellitus (T2DM) is a chronic metabolic disorder characterized by persistent hyperglycemia resulting from impaired insulin secretion, insulin resistance, or a combination of both. T2DM is a common metabolic disorder worldwide and is associated with increased morbidity and mortality, largely due to its vascular and systemic complications. Persistent hyperglycemia can impair vascular and endothelial function, contributing to the development of cardiovascular disease (CVD), a major cause of complications among individuals with diabetes. Beyond disturbances in glucose metabolism, growing evidence suggests that chronic low-grade systemic inflammation plays an important role in the pathophysiology of T2DM and may contribute to the development and progression of its vascular complications [1,2].

Rheumatoid arthritis (RA) is a chronic autoimmune disease in which persistent inflammation of the synovial membrane leads to progressive joint damage. Beyond its effects on the joints, RA can involve several extra-articular systems, including the cardiovascular system. The persistent immune activation associated with RA promotes the release of pro-inflammatory cytokines, particularly tumor necrosis factor-alpha (TNF-α), interleukin-1 (IL-1), and interleukin-6 (IL-6). The effects of these mediators extend beyond the synovial tissues, contributing to systemic inflammation, endothelial

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dysfunction, and vascular damage, which may partly explain the increased cardiovascular risk observed in patients with RA [3–5].

The coexistence of T2DM and RA may be particularly relevant from a cardiovascular perspective because both disorders share several inflammatory and metabolic mechanisms. Pro-inflammatory cytokines released during chronic inflammation may interfere with insulin signaling and contribute to insulin resistance, while persistent vascular inflammation may promote endothelial dysfunction and atherosclerotic plaque formation. In addition, some treatments used for RA, particularly glucocorticoids, may adversely affect glucose metabolism and increase blood glucose levels, potentially contributing to metabolic abnormalities [6,7,8]. Thus, the interaction between chronic inflammation, metabolic dysfunction, and traditional cardiovascular risk factors may place patients with concomitant T2DM and RA at increased cardiovascular risk [8,9].

Several studies have investigated cardiovascular risk and inflammatory alterations in patients with RA or T2DM separately. Patients with T2DM have been reported to have a substantially increased risk of myocardial infarction and other cardiovascular events, particularly in the presence of dyslipidemia and other conventional risk factors [9,10]. Similarly, patients with RA have demonstrated increased cardiovascular morbidity, with chronic inflammation, autoantibodies, and cytokine-mediated vascular injury considered important contributors to this excess risk [5]. Previous studies in patients with RA have documented changes in lipid profiles and inflammatory markers, including C-reactive protein (CRP), which may reflect the systemic inflammatory burden associated with the disease. Alterations in lipid parameters have also been linked to cardiovascular risk, which can be assessed using indices such as the Castelli Risk Index I (CRI-I), calculated as the ratio of total cholesterol (TC) to high-density lipoprotein cholesterol (HDL-C) [11]. In addition, elevated red cell distribution width (RDW) and changes in inflammatory hematological indices have been associated with increased cardiovascular risk and subclinical atherosclerotic changes in patients with RA [12].

Complete blood count (CBC)-derived inflammatory indices have received increasing attention because they are simple, inexpensive, and readily available in routine clinical practice. These indices can provide useful indirect information about the level of systemic inflammation. Among the most commonly studied are the neutrophil-to-lymphocyte ratio (NLR), platelet-to-lymphocyte ratio (PLR), systemic immune-inflammation index (SII), and systemic inflammatory response index (SIRI), which combine information from different circulating blood cell populations. Previous research has linked these indices to a range of inflammatory and cardiovascular conditions. For instance, NLR has been associated with type 2 diabetes mellitus (T2DM), while both SII and NLR have been reported to reflect inflammatory activity and cardiovascular risk in patients with rheumatoid arthritis (RA) [13–15]. Overall, these findings suggest that CBC-derived inflammatory indices may serve as practical and accessible measures for assessing systemic inflammation and may also help identify patients with an increased risk of cardiovascular complications [1].

Although several studies have examined the relationships between T2DM, RA, systemic inflammation, and CVD, relatively little is known about the cardiovascular and hematological characteristics of patients who have both T2DM and RA. This is particularly the case in local clinical settings, where evidence on this combined patient profile remains limited. In addition, it remains unclear whether CBC-derived inflammatory indices provide additional value for cardiovascular risk assessment in patients with both conditions when considered alongside conventional cardiovascular risk measures. The Framingham Risk Score (FRS), which incorporates established cardiovascular risk factors including age, sex, cholesterol levels, blood pressure, smoking, and diabetes, provides a widely used approach for estimating predicted cardiovascular risk [16]. However, conventional cardiovascular risk scores may not fully capture the additional cardiovascular burden associated with chronic inflammatory diseases such as RA [17]. Lipid-based indices such as the Castelli Risk Index I (CRI-I), represented by the ratio of total cholesterol to HDL cholesterol, may provide an additional simple measure for characterizing an atherogenic lipid profile and cardiovascular risk [18,19].

Therefore, the present study aimed to evaluate selected hematological and inflammatory biomarkers in male patients with T2DM and to investigate their association with concomitant RA and predicted cardiovascular risk. Specifically, the study compared CBC parameters, CBC-derived inflammatory indices, selected lipid parameters, the FRS, and the CRI-I (TC/HDL-C ratio) between patients with T2DM alone and those with T2DM and concomitant RA attending Traghen Teaching Hospital, Libya.

2. MATERIALS AND METHODS

2.1. Study design and participants

A cross-sectional study was conducted among male patients attending the Male Department of Traghen Teaching Hospital, Traghen, Libya, from August to November 2024. The study included 60 male participants over 35 years of age. They were divided equally into two groups, with 30 participants diagnosed with type 2 diabetes mellitus (T2DM) and 30 with both T2DM and rheumatoid arthritis (RA). The diagnoses were based on the participants' medical history and clinical findings. The diagnosis of RA was confirmed by the treating physician; however, the specific diagnostic criteria used, including whether the 2010 ACR/EULAR classification criteria were applied, could not be verified. The diagnosis of T2DM was based on the patients' medical records.

Demographic and clinical data were collected using a structured questionnaire, which covered age, medical history, treatment type, and disease-related symptoms. In addition, blood pressure, height, and weight were measured and recorded for each participant. However, reliable data on RA disease activity and duration were not precisely documented.

2.2. Inclusion and exclusion criteria

Eligible participants were male patients aged >35 years who agreed to participate and met the study group requirements. The T2DM group included patients with a diagnosis documented in their medical records, whereas the T2DM+RA group included patients whose RA diagnosis had been confirmed by the physician. No specific minimum disease duration or treatment status was stipulated as an inclusion criterion.

Smokers, patients with hereditary hematological disorders, and those with active inflammatory infections or inflammatory symptoms at the time of blood collection were excluded to minimize potential effects on hematological and inflammatory parameters.

Official authorization to conduct the study was obtained through a formal letter from the university to the hospital. Verbal informed consent was obtained from all participants before data collection.

2.3. Materials and equipment

Sterile disposable 5-mL syringes, tourniquets, gloves, medical cotton, medical alcohol, micropipettes and tips, Eppendorf tubes, cuvettes, and blood collection tubes were used. K2-EDTA tubes were used for complete blood count (CBC) and glycated hemoglobin (HbA1c), whereas plain tubes were used for serum preparation and measurement of rheumatoid factor (RF), total cholesterol (TC), and high-density lipoprotein cholesterol (HDL-C).

The instruments included a refrigerator maintained at 2–8°C, centrifuge, Sysmex XP-300 automated hematology analyzer (Sysmex, Japan), Afinion 2 Analyzer (Afinion, Norway), sphygmomanometer, weighing scale, and PHOTOMETER 4040 (Germany). Reagents included CBC kits for the Sysmex XP-300, Afinion™ HbA1c test cartridges (Abbott Laboratories, USA), cholesterol reagents (Biomaghreb, Tunisia), HDL-C reagents (Human, Germany), and RF latex reagents (Biomaghreb, Tunisia).

2.4. Anthropometric measurements and blood pressure

Height was measured in centimeters with participants standing upright without shoes, and body weight was measured in kilograms using a weighing scale. Body mass index (BMI) was calculated as weight in kilograms divided by height in meters squared [20].

$$\textbf{BMI (kg/m}^2\textbf{) = weight (kg) / height}^2\textbf{ (m}^2\textbf{)}$$

Participants were classified as underweight (<18.5 kg/m²), normal weight (18.5–24.9 kg/m²), overweight (25.0–29.9 kg/m²), or obese (≥30 kg/m²) [20].

Blood pressure was measured using a sphygmomanometer, and systolic and diastolic blood pressure were recorded in mmHg.

2.5.Blood sample collection and preparation

Five milliliters of venous blood were collected from each participant following skin disinfection with medical alcohol. Two milliliters were transferred into K2-EDTA tubes for CBC and HbA1c

analysis, while 3 mL were transferred into plain tubes. The latter were allowed to clot for 15 minutes and centrifuged at 5,000 rpm for 5 minutes.

2.6.Laboratory analyses

2.6.1.Complete blood count and inflammatory indices

CBC was performed using a Sysmex XP-300 automated hematology analyzer within 3 hours of sample collection, according to the manufacturer's instructions. The measured parameters included WBC, lymphocyte, neutrophil, monocyte, RBC, hemoglobin, and platelet counts.
The following inflammatory indices were calculated from the CBC results:

Neutrophil-to-lymphocyte ratio (NLR):
NLR = neutrophil count / lymphocyte count [21].

Platelet-to-lymphocyte ratio (PLR):
PLR = platelet count / lymphocyte count [21].

Systemic immune-inflammation index (SII):
SII = (platelet count × neutrophil count) / lymphocyte count [21].

Systemic inflammatory response index (SIRI):
SIRI = (monocyte count × neutrophil count) / lymphocyte count [21].

2.6.2. Glycated hemoglobin

HbA1c was measured using Afinion™ HbA1c test cartridges and the Afinion™ Analyzer according to the manufacturer's instructions. The blood sample was automatically diluted and reacted with the reagents in the test cartridge, and HbA1c was determined by reflectance measurement of the glycated and total hemoglobin fractions.

2.6.3. Total cholesterol

Serum total cholesterol was determined using an enzymatic colorimetric method (Biomaghreb, Tunisia). According to the manufacturer's instructions, 1,000 µL of working reagent was added to blank, standard, and sample tubes. Standard or serum (10 µL) was added to the respective tubes, followed by mixing and incubation at 37°C for 5 minutes. Absorbance was measured at 500 nm using a PHOTOMETER 4040 after zero adjustment with the blank and calibration with the standard.

2.6.4. High-density lipoprotein cholesterol

HDL-C was measured using enzymatic colorimetric reagents (Human, Germany). Briefly, 750 µL of R1 reagent was added to blank, standard, and sample tubes, followed by the addition of 10 µL distilled water, standard, or serum, respectively. After mixing and incubation at 37°C for 5 minutes, 250 µL of R2 reagent was added. The tubes were mixed and incubated for an additional 5 minutes at 37°C. Absorbance was measured at 570 nm using a PHOTOMETER 4040 after blank adjustment and standard calibration.

2.6.5. Rheumatoid factor

RF was determined qualitatively in serum using an RF latex agglutination test (Biomaghreb, Tunisia). Fifty microliters of serum were placed on a black reaction circle, followed by one drop of RF latex reagent. The mixture was rotated for approximately 2 minutes. Visible agglutination was considered positive, whereas its absence was considered negative, according to the manufacturer's instructions. Participants with RA had been clinically diagnosed by the treating physician before enrollment; the qualitative RF test was used to assess RF positivity rather than to establish the diagnosis.

2.7. Cardiovascular risk assessment

2.7.1. Framingham Risk Score

The 10-year risk of general cardiovascular disease was estimated using the Framingham Risk Score (FRS), specifically the Framingham General Cardiovascular Disease Risk Profile developed by D'Agostino et al. (2008) [22]. The model incorporated sex, age, total cholesterol, HDL-C, systolic blood pressure, antihypertensive treatment status, smoking status, and diabetes status. As smokers were excluded from the study, all participants were classified as nonsmokers for the risk calculation. The estimated 10-year risk was used to categorize participants as having low (<10%), intermediate (10–20%), or high (>20%) risk according to the selected Framingham risk model [16,18].

2.7.2. Castelli Risk Index I (CRI-I) (Total cholesterol-to-HDL cholesterol ratio)

The total cholesterol-to-HDL-C ratio was calculated as follows:

Castelli Risk Index I (CRI-I) = total cholesterol (mg/dL) / HDL-C (mg/dL) [18,19].

2.8. Statistical analysis

Data were entered and organized using Microsoft Excel 2010 and analyzed using IBM SPSS Statistics version 26.0 for Windows 10. Descriptive statistics were presented as mean ± standard deviation. The normality of continuous variables was assessed before applying parametric tests. Differences between the two groups were assessed using the independent-samples t-test. Pearson's correlation coefficient was used to evaluate correlations between selected variables. A p-value ≤0.05 was considered statistically significant. No a priori sample-size calculation was performed; the final sample consisted of 30 participants in each group, reflecting recruitment constraints during the study period. No formal adjustment for multiple comparisons was applied.

3. RESULTS AND DISCUSSION

3.1. Characteristics of the study participants

The study included 60 male patients with type 2 diabetes mellitus (T2DM) who attended the Men's Department at Traghen Teaching Hospital, Traghen, Libya, between August and November 2024. The participants were equally divided into two groups: 30 patients with T2DM and RA and 30 patients with T2DM without RA (the T2DM-only comparison group).

The age of the study participants ranged from 35 to 82 years, with an overall mean ± standard deviation (SD) of 61.32 ± 11.15 years. The duration of T2DM ranged from 2 to 37 years, with a mean of 13.63 ± 7.60 years. BMI ranged from 16.65 to 38.06 kg/m², with an overall mean of 26.90 ± 4.24 kg/m². Overall, 70.0% of the participants were classified as overweight or obese.The distribution of participants across the predefined age categories did not differ significantly ($\chi^2 = 15.0$, $P = 0.241$) as it is shown in Table 1. However, the mean age was significantly higher in patients with RA than in the the T2DM-only group (66.83 ± 9.18 vs. 55.80 ± 10.29 years, respectively; $P < 0.001$). This difference in age is relevant when interpreting cardiovascular risk-related findings, as age is an established determinant of cardiovascular risk.

Table 1. Distribution of Participants According to Age Groups

Age group (years)	Frequency	Percentage (%)
35–44	5	8.3
45–54	9	15.0
55–64	20	33.3
65–74	20	33.3
75–84	6	10.0
Total	**60**	**100.0**

($\chi^2 = 15.0$, $P = 0.241$)

The distribution of BMI categories did not differ significantly between the two groups ($P > 0.05$), the percentages are shown in Tabel 2. Nevertheless, overweight was more frequently observed among

patients with RA than the T2DM-only group (50.0% vs. 40.0%), whereas obesity was more frequent among T2DM-only group (33.3% vs. 16.7%). These findings indicate that excess body weight was common in both groups, although the pattern of BMI classification differed descriptively between them.

Table 2. Frequency and Percentage Distribution of Participants According to BMI Categories

BMI category	Overall participants (n=60) Frequency (%)	RA patients (n=30) Frequency (%)	T2DM-only group (n=30) Frequency (%)
Obese	15 (25.0%)	5 (16.7%)	10 (33.3%)
Overweight	27 (45.0%)	15 (50.0%)	12 (40.0%)
Normal weight	17 (28.3%)	9 (30.0%)	8 (26.7%)
Underweight	1 (1.7%)	1 (3.3%)	0 (0.0%)
Total	***60 (100.0%)**	****30 (100.0%)**	*****30 (100.0%)**

P > 0.05 indicates no statistically significant difference. indicates ($x^2 = 12$, P=0.213), .** indicates ($x^2 = 12$, P=0.213),*** indicates ($x^2 = 6$, P=0.213).*

3.2. Medical history and medication use

A comparison of medical history-related parameters between patients with RA and T2DM-only patients is presented in Table 3. All participants had T2DM. The duration of diabetes ranged from 2 to 37 years among patients with RA and from 3 to 35 years among T2DM-only group. No significant difference was observed in the mean duration of diabetes between the two groups (14.27 ± 7.90 vs. 13.00 ± 7.36 years, respectively; P = 0.523).

Most participants (68.0%) reported no diabetes-related complications. Among the reported complications, visual complications were the most frequently observed, affecting 26.7% of the total study population, while combined visual and renal complications were reported by 5.0% of participants, as this is presented in Tabel 4. The distribution of these complications did not indicate a significant difference between the study groups.

Table 3. Comparison of general parameters between patients with rheumatoid arthritis and T2DM-only group

Parameters	Mean ± S.D		P-value
	RA group (No.=30)	**T2DM-only group (No.=30)**	
Age (years)	66.83 ± 9.18	55.80 ± 10.29	<0.001*
Diabetes duration (years)	14.13 ± 7.86	13.00 ± 7.36	0.523
BMI (kg/m²)	25.96 ± 3.79	27.85 ± 4.51	0.084
HbA1c (%)	8.53 ± 2.03	8.63 ± 1.68	0.778

** Significant at (p≤0.05).*

All participants were receiving oral glucose-lowering therapy. Metformin alone was used by 35.0% of participants, other oral antidiabetic medications by 36.7%, and combinations of two antidiabetic medications by 28.3%. A family history of cardiac disease was reported by 11.7% of the participants. In addition, no significant difference was observed between the two groups in the use of medications for hypertension or dyslipidemia (P = 0.592).

Among the 30 male patients with rheumatoid arthritis, 15 (50.0%) had a recorded medication, whereas the remaining 15 (50.0%) reported no use of the listed medications. Tocilizumab (Actemra) was recorded for 3 patients (10.0%), methotrexate for 3 (10.0%), hydroxychloroquine for 2 (6.7%), leflunomide for 1 (3.3%), and tofacitinib for 1 (3.3%). SingJoint was recorded for 5 patients (16.7%); however, this sodium hyaluronate product is used for intra-articular viscosupplementation rather than as a disease-modifying treatment for rheumatoid arthritis. No glucocorticoid use was identified in the medication records available for this analysis.

Table 4. Clinical Characteristics and Diabetes-Related Factors among Study Groups

Variable		Overall participants (n=60)	RA patients (n=30)	T2DM-only group (n=30)
Duration of diabetes	**(years)**	13.63 ± 7.60	14.27 ± 7.90	13.00 ± 7.36
Diabetes-related complications	Yes*	19 (31.7%)	14 (46.7%)	5 (16.7%)
	No	41 (68.3%)	16 (53.3%)	25 (83.3%)
Type of complications	Renal problems	3 (5.0%)	2 (6.7%)	1 (3.3%)
	Visual problems	16 (26.7%)	12 (40.0%)	5 (16.7%)
Antidiabetic medication	**60 (100%)**	Metformin only	Without metformin	Combination 2 or more
		21 (35.0%)	22 (36.7%)	17 (28.3%)

** Statistically significant difference ($p < 0.05$) (Fisher's exact test, $p = 0.025$).*

3.3. Biochemical, and cardiovascular risk parameters

The comparison of cardiovascular risk-related parameters between patients with RA and T2DM-only group is presented in Table 5.

Patients with RA had significantly higher mean age, total cholesterol (TC), and Framingham Risk Score (FRS) values than T2DM-only group. The mean TC concentration was 152.93 ± 55.96 mg/dL in patients with RA compared with 105.63 ± 31.99 mg/dL in T2DM-only group (P < 0.001). Similarly, the mean FRS was significantly higher among patients with RA than T2DM-only group (15.33 ± 8.48 vs. 9.27 ± 7.73, respectively; P = 0.003).

Table 5. Comparison of cardiovascular risk parameters between patients with rheumatoid arthritis and T2DM-only group

Parameters	Mean ± S.D		P-value
	RA group (No.=30)	**Control group (No.=30)**	
TC (mg/dL)	152.93 ± 55.96	105.63 ± 31.99	<0.001*
HDL-C (mg/dL)	41.25 ± 9.52	36.50 ± 11.88	0.090
Castelli Risk Index I (CRI-I)	3.92 ± 1.85	3.36 ± 1.96	0.260
Framingham Risk Score (FRS)	15.33 ± 8.48	9.27 ± 7.73	0.003*

** Significant at ($p \leq 0.05$).*

In contrast, no significant differences were observed between the two groups in diabetes duration, BMI, HbA1c, HDL-C, or CRI I (P > 0.05). The mean HDL-C concentration was 41.25 ± 9.52 mg/dL in the RA group and 36.50 ± 11.88 mg/dL in T2DM-only group (P = 0.090). The CRI I was also not significantly different between the groups (3.92 ± 1.85 vs. 3.36 ± 1.96, respectively; P = 0.260). Regarding glycemic control, HbA1c was slightly lower in the RA group than in the diabetic T2DM-only group (8.54 ± 2.02% vs. 8.68 ± 1.68%, respectively), but the difference was not statistically significant (P = 0.778). Similarly, the duration of diabetes did not differ significantly between the groups (14.27 ± 7.90 vs. 13.00 ± 7.36 years; P = 0.523). These findings suggest that differences in glycemic T2DM-only or diabetes duration alone were unlikely to account for the observed differences in cardiovascular risk. Although the RA group showed a slightly higher mean ratio, the absence of statistical significance does not provide sufficient evidence of a difference between the groups. These findings may be explained by the small sample size, individual differences in lipid metabolism, and variation in lipid-lowering treatment among the participants.

The RA group had significantly higher total cholesterol (TC) levels than the diabetic control group (152.9 ± 55.96 vs. 105.6 ± 31.99 mg/dL, respectively; P < 0.001), indicating a difference in lipid profile between the two groups. This result is consistent with previous findings showing that lipid abnormalities can occur in patients with RA and may be related to cardiovascular risk. Dessie *et al.* (2020), for example, found significantly higher TC levels in patients with RA than in healthy controls and reported a relationship between inflammatory activity in RA and lipid-related cardiovascular risk [11]. In the current study, the higher TC level may be partly related to changes in lipid metabolism associated with chronic inflammation. However, lipid profiles in RA are influenced by several factors and may differ depending on disease activity, treatment, and the individual's metabolic status. Since all participants in this study had T2DM, the presence of diabetes may also have contributed to the

lipid findings. Therefore, the higher TC level observed in patients with RA may represent an additional metabolic factor that could contribute to their cardiovascular risk.

A notable finding in this study was the significantly higher Framingham Risk Score (FRS) in patients with T2DM and RA compared with those with T2DM alone (15.33 ± 8.48 vs. 9.27 ± 7.73, respectively; p = 0.003). This finding suggests a higher estimated cardiovascular risk in the T2DM + RA group. Chronic systemic inflammation associated with RA may contribute to endothelial dysfunction, accelerated atherosclerosis, and metabolic disturbances, potentially increasing cardiovascular risk. This finding is consistent with Zhang et al. (2022), who reported increased cardiovascular risk among patients with RA and attributed this association partly to chronic inflammation and vascular dysfunction [5]. However, the older age of patients in the RA group may have substantially influenced the FRS, as age is a major component of its calculation. Therefore, the observed difference should be interpreted cautiously.

The higher FRS observed in the RA group was consistent with the findings of Tekeoglu *et al.* (2024), who reported a greater burden of cardiovascular disease and cardiovascular risk factors among patients with RA, particularly among older individuals [23]. Given that age is a well-established cardiovascular risk factor, the significantly greater age of the RA group in the present study may have contributed, at least in part, to the observed differences in cardiovascular risk. Therefore, the age difference between the study groups should be considered when interpreting the higher cardiovascular risk observed among patients with RA. In addition to age, chronic inflammation and other disease-related mechanisms may contribute to the increased cardiovascular burden associated with RA, as emphasized by Zhang *et al.* (2022) [5,24].

3.4. White blood cell parameters

The comparison of white blood cell parameters is presented in Table 6. The mean WBC count was higher among patients with RA than T2DM-only group (6.21 ± 2.71 vs. 6.03 ± 1.64 ×10⁹/L, respectively; P = 0.722). Similarly, the mean lymphocyte count was higher in the RA group (2.53 ± 2.08 vs. 2.30 ± 0.61 ×10⁹/L; P = 0.561), whereas the mean neutrophil count was slightly higher among T2DM-only group (3.33 ± 1.29 vs. 3.24 ± 1.43 ×10⁹/L; P = 0.819). The mean monocyte count was comparable between the groups (0.38 ± 0.20 vs. 0.37 ± 0.21 ×10⁹/L; P = 0.851).

Table 6. Comparison of White blood cell parameters between patients with rheumatoid arthritis and T2DM-only group

Parameters	Mean ± S.D		P-value
	RA group (No.=30)	**T2DM-only group (No.=30)**	
WBC (×10⁹/L)	6.21 ± 2.71	6.03 ± 1.64	0.722
Lymphocytes (×10⁹/L)	2.53 ± 2.08	2.30 ± 0.61	0.561
Monocytes (×10⁹/L)	0.38 ± 0.20	0.37 ± 0.21	0.851
Neutrophils (×10⁹/L)	3.24 ± 1.43	3.33 ± 1.29	0.819

P > 0.05 indicates no statistically significant difference

None of the leukocyte parameters differed significantly between patients with RA and diabetic T2DM-only group. Although WBC, lymphocyte, and monocyte counts were slightly higher in the RA group, neutrophil counts were slightly lower, none of these differences reached statistical significance. Thus, conventional leukocyte counts did not sufficiently discriminate between the two groups in the present T2DM population. The coexistence of T2DM in both groups, which may itself influence immune and inflammatory responses, could partly explain these findings.

3.5. Red blood cell parameters

The red blood cell parameters are presented in Table 7. No significant differences were observed between the RA and T2DM-only groups in RBC count, hemoglobin, hematocrit, MCV, MCH, MCHC, or RDW-CV (P > 0.05).

The mean RBC count was 4.61 ± 0.55 ×10⁹/L in patients with RA and 4.59 ± 0.53 ×10⁹/L in T2DM-only group (P = 0.918). Mean hemoglobin concentrations were 13.40 ± 2.06 g/dL and 13.75 ± 1.38 g/dL, respectively (P = 0.443), while mean hematocrit values were 39.73 ± 4.69% and 40.55 ± 3.77%, respectively (P = 0.457).

Similarly, MCV, MCH, and MCHC did not differ significantly between the groups. However, RDW-SD was significantly lower among patients with RA than T2DM-only group (43.71 ± 3.98 vs. 45.80 ± 3.38; P = 0.033).

Table 7. Comparison of red blood cell parameters between patients with rheumatoid arthritis and T2DM-only group

Parameters	Mean ± S.D		P-value
	RA group (No.=30)	T2DM-only group (No.=30)	
RBC (×10¹²/L)	4.61 ± 0.55	4.59 ± 0.53	0.918
Hemoglobin (g/dL)	13.40 ± 2.06	13.75 ± 1.38	0.443
Hematocrit (%)	39.73 ± 4.69	40.55 ± 3.77	0.457
MCV (fL)	85.69 ± 5.10	87.75 ± 5.55	0.139
MCH (pg)	29.16 ± 2.11	29.83 ± 1.76	0.188
MCHC (%)	33.91 ± 1.76	33.93 ± 1.39	0.859
RDW-CV (%)	13.90 ± 1.57	13.79 ± 0.68	0.735
RDW-SD (fL)	43.71 ± 3.98	45.80 ± 3.38	0.033*

** Significant at (p≤0.05).*

The significant difference in RDW-SD observed in the present study differed from the findings of González-Sierra *et al*. (2023) [12], who reported increased RDW among patients with RA and identified associations between RDW and cardiovascular risk factors and subclinical atherosclerosis. The difference between these findings may be related to variations in the study populations, duration of disease, treatment status, metabolic characteristics, and the specific RDW measure used. Consequently, the observed RDW-SD difference should be interpreted cautiously.

3.6. Platelet parameters

The platelet-related parameters are presented in Table 8. No statistically significant differences were observed between patients with RA and T2DM-only group in platelet count, MPV, PCT, or PDW.

The mean platelet count was 237.50 ± 73.73 ×10⁹/L in the RA group compared with 225.00 ± 47.55 ×10⁹/L in T2DM-only group (P = 0.438). The mean MPV was 9.15 ± 1.44 fL and 9.50 ± 1.20 fL, respectively (P = 0.318), while PCT and PDW also showed no significant between-group differences (P > 0.05).

Table 8. Comparison of platelet parameters between patients with rheumatoid arthritis and T2DM-only group

Parameters	Mean ± S.D		P-value
	RA group (No.=30)	T2DM-only group (No.=30)	
Platelet count (×10⁹/L)	237.50 ± 73.73	225.00 ± 47.55	0.438
MPV (fL)	9.15 ± 1.44	9.50 ± 1.20	0.318
PCT (%)	0.200 ± 0.048	0.208 ± 0.036	0.473
PDW (fL)	14.33 ± 2.02	13.89 ± 1.72	0.373

P > 0.05 indicates no statistically significant difference

Although platelet count and PDW tended to be higher in patients with RA, these differences were not statistically significant. Thus, platelet parameters did not demonstrate a significant association with RA in the present study.

3.7. Inflammatory indices

The inflammatory indices NLR, PLR, SII, and SIRI are presented in Table 9. No statistically significant differences were observed between patients with RA and those in the T2DM-only group in any of the four inflammatory indices (all P > 0.05).

The mean NLR was 1.61 ± 1.20 in patients with RA compared with 1.53 ± 0.80 in T2DM-only group (P = 0.771). The corresponding PLR values were 124.20 ± 92.89 and 104.30 ± 34.67, respectively (P = 0.277). Similarly, SII was higher in patients with RA than T2DM-only group (445.30 ± 539.40 vs. 350.02 ± 205.40, respectively; P = 0.370), while SIRI showed comparable values between the groups (0.65 ± 0.60 vs. 0.63 ± 0.57, respectively; P = 0.882).

Table 9. Comparison of Inflammatory indices between patients with rheumatoid arthritis and T2DM-only group

Parameters	Mean ± S.D		P-value
	RA group (No.=30)	**T2DM-only group (No.=30)**	
NLR	1.61 ± 1.20	1.53 ± 0.797	0.771
PLR	124.20 ± 92.89	104.30 ± 34.67	0.277
SII	445.30 ± 539.40	350.02 ± 205.40	0.370
SIRI	0.653 ± 0.60	0.630 ± 0.57	0.882

P > 0.05 indicates no statistically significant difference.

Although the differences were not statistically significant, the consistently higher NLR, PLR, SII, and SIRI values in patients with RA suggested a tendency toward greater systemic inflammatory activity. This observation is biologically plausible because RA is characterized by chronic systemic inflammation. Previous studies have demonstrated the potential value of these hematological indices in assessing inflammatory and cardiovascular risk. Ye et al. (2022) reported that SII could serve as a useful predictor of cardiovascular disease risk in a large pooled population [25]. González-Sierra *et al*. (2023) also reported associations between NLR and SIRI and cardiovascular risk-related parameters in patients with RA [14]. Similarly, Dervisevic *et al.* (2024) found that patients with RA had significantly higher SII and NLR values than healthy T2DM-only group. They also reported a positive association between SII and hs-CRP [15]. The lack of statistical significance in this study may be related to the relatively small sample size and the fact that all participants had T2DM, which may itself affect systemic inflammatory indices. However, the differences were generally in the same direction, suggesting that this finding warrants further investigation in studies involving larger populations.

3.8. Correlation between total cholesterol and some variables

Pearson's correlation analysis showed several significant relationships between TC and the variables examined in this study, as presented in Table 10.

TC showed significant positive correlations with age (r = 0.474, P < 0.001), FRS (r = 0.437, P = 0.007), and CRI I (r = 0.580, P < 0.001). Conversely, significant negative correlations were observed between TC and RDW-CV (r = −0.345, P = 0.007), RDW-SD (r = −0.424, P = 0.001), and HbA1c (r = −0.302, P = 0.019).

Table 10. Pearson correlations between total cholesterol and selected variables

Parameters	Correlation coefficient (r)	P-value
RDW-CV	−0.345	0.007**
RDW-SD	−0.424	0.001**
HbA1c (%)	−0.302	0.019*
Age (years)	0.474	<0.001**
Framingham Risk Score	0.437	0.007**
Castelli Risk Index I (CRI-I)	0.580	<0.001**

** Significant at (p≤0.05), ** Significant at (p≤0.001) .The correlation between TC and CRI-I should be interpreted with caution because TC is mathematically included in the calculation of CRI-I.*

The positive correlation between TC and age was consistent with the recognized contribution of increasing age to lipid-related cardiovascular risk. The positive association between TC and FRS further indicated that higher cholesterol concentrations were accompanied by greater estimated cardiovascular risk in the study population. The strong positive correlation between TC and the CRI I was expected because TC is a direct component of this lipid ratio.

The inverse correlations between TC and the RDW parameters were noteworthy. González-Sierra et al. (2023) previously reported an association between RDW and cardiovascular risk-related lipid abnormalities in patients with RA, although the direction and magnitude of the association may vary between populations. The negative association between TC and HbA1c in the present study should also be interpreted cautiously because it may be influenced by treatment patterns, metabolic characteristics, or other unmeasured factors [12].

3.9. Association between blood pressure classification and cardiovascular risk parameters

Participants were categorized according to blood pressure status, and one-way analysis of variance was performed to evaluate differences in selected biochemical and cardiovascular risk parameters.

No significant differences were observed in TC, CRI I, or HbA1c across the different blood pressure categories ($P > 0.05$). In contrast, FRS differed significantly across blood pressure categories ($P < 0.001$).

This finding is consistent with the established role of blood pressure in cardiovascular risk assessment. The significant differences in FRS across the blood pressure categories further emphasize the contribution of blood pressure status to the overall cardiovascular risk profile of patients with T2DM and RA.

3.10. Correlation between Framingham Risk Score and Some variables

Pearson's correlation analysis showed significant positive relationships between FRS and several of the variables examined, including age, duration of diabetes, blood pressure classification, TC, and the TC/HDL-C ratio (Table 11).

Table 11. Pearson correlations between Framingham Risk Score and selected variables

Variable	Correlation coefficient (r)	P-value
RDW-SD	−0.271	0.036*
HbA1c (%)	−0.372	0.003**
Age (years)	0.840	<0.001**
Diabetes duration (years)	0.347	<0.001**
Blood pressure class	0.525	<0.001**
Total cholesterol	0.437	0.007**
Castelli Risk Index I (CRI-I)	0.487	<0.001**

** Significant at (p≤0.05), ** Significant at (p≤0.001)*.

The strongest correlation was observed between FRS and age ($r = 0.840$, $P < 0.001$). Significant positive correlations were also observed with duration of diabetes ($r = 0.347$, $P < 0.001$), blood pressure classification ($r = 0.525$, $P < 0.001$), TC ($r = 0.437$, $P = 0.007$), and TC/HDL-C ratio ($r = 0.487$, $P < 0.001$).

In contrast, FRS showed significant negative correlations with HbA1c ($r = −0.372$, $P = 0.003$) and RDW-SD ($r = −0.271$, $P = 0.036$).

The strong positive association between age and FRS was consistent with the established role of age as a major determinant of cardiovascular risk. The associations with duration of diabetes, blood pressure, and TC further demonstrated the contribution of multiple cardiometabolic factors to estimated cardiovascular risk in the study population.

3.11. Cardiovascular risk classification according to Framingham Risk Score and CRI I

The categorical assessment of cardiovascular risk showed a greater proportion of participants with moderate and high estimated cardiovascular risk among patients with RA than T2DM-only group.

Among patients with RA, 40.0% were classified as having moderate cardiovascular risk and 40.0% as having high cardiovascular risk according to the reported FRS categories. In comparison, 33.0% and 13.0% of T2DM-only group were classified within the corresponding categories, respectively[16,17].

A similar descriptive pattern was observed using the CRI I. A ratio above 3.5 was observed in 56.0% of patients with RA compared with 30.0% of T2DM-only group. Although the difference in mean TC/HDL-C ratio between the groups was not statistically significant, the categorical distribution suggested a greater proportion of patients with RA exceeding the predefined threshold [23].

Taken together, these findings indicated a greater cardiovascular risk burden among men with concomitant RA and T2DM compared with men with T2DM alone. The most prominent statistically significant differences were observed in age, TC, and FRS, while the inflammatory indices showed consistently higher values in the RA group without reaching statistical significance.

Overall, the findings suggest that RA may add to the cardiovascular risk profile of patients with T2DM. The presence of both diabetes and a chronic inflammatory condition highlights the importance of regular cardiovascular risk assessment, together with monitoring of relevant metabolic and hematological parameters. Further research with larger study populations and longer follow-up is needed to determine whether hematological inflammatory indices can independently predict cardiovascular outcomes in patients with coexisting RA and T2DM.

Medication profile use should be taken into account when interpreting these findings. Although all participants were receiving oral antidiabetic treatment, the treatment regimens were not the same. Metformin alone was used by 35.0% of the participants, while 36.67% received metformin in combination with other antidiabetic medications. The remaining 28.33% were treated with other antidiabetic medications without metformin. These differences in treatment may have influenced body weight, glycemic control, lipid metabolism, and inflammatory status, and could therefore represent potential confounding factors. Alser and Elrayess (2022) reported that certain antidiabetic medications, particularly sulfonylureas, may contribute to weight gain. Therefore, future studies should consider medication type and duration when investigating relationships among RA, inflammation, metabolic factors, and cardiovascular risk [26].

Antirheumatic treatment should be considered when interpreting inflammatory and lipid parameters in patients with rheumatoid arthritis. Methotrexate, hydroxychloroquine, and leflunomide are conventional synthetic disease-modifying antirheumatic drugs (csDMARDs), whereas tocilizumab is a biologic DMARD targeting the interleukin-6 receptor and tofacitinib is a targeted synthetic DMARD that inhibits Janus kinase signalling. Tocilizumab can markedly suppress C-reactive protein (CRP) levels and may increase circulating lipid concentrations. Tofacitinib has also been associated with changes in lipid levels and warrants consideration in cardiovascular risk assessment. Glucocorticoids may additionally influence metabolic parameters and cardiovascular risk. However, the contribution of these treatments to the present findings could not be determined because detailed information on treatment duration, dosage, and timing relative to blood sampling was unavailable [27-30].

4. CONCLUSIONS

In this study, men with both T2DM and RA had a significantly higher estimated cardiovascular risk, based on the Framingham Risk Score, as well as higher total cholesterol levels compared with those with T2DM alone. However, the higher estimated cardiovascular risk should be interpreted cautiously, given the significant age difference between the groups. Conventional hematological parameters and CBC-derived inflammatory indices, including NLR, PLR, SII, and SIRI, did not differ significantly between the groups. These findings highlight differences in cardiovascular risk profiles between the groups, although the independent contribution of RA cannot be established. Further research involving larger and more diverse populations is needed. Future studies should also include detailed evaluation of RA disease activity and duration, document the type, dosage, and duration of antidiabetic and antirheumatic treatments, including glucocorticoids where applicable, and incorporate

longitudinal follow-up to clarify their potential contributions to inflammatory markers, lipid profiles, and cardiovascular risk.

The higher prevalence of diabetes-related complications in the T2DM + RA group may also have influenced the observed differences in cardiovascular risk and inflammatory indices. Therefore, these findings should not be attributed solely to the coexistence of RA and T2DM.

5. LIMITATIONS

This study has several limitations, including the relatively small sample size, which may have limited the ability to detect differences between the groups. In addition, patients with T2DM and RA were significantly older than those in the T2DM-only group. Since age is an important determinant of cardiovascular risk and a component of the Framingham Risk Score, this difference should be considered when interpreting the findings. Therefore, the higher estimated cardiovascular risk observed in patients with RA may partly reflect the age difference between the groups, and the independent contribution of RA cannot be determined from the present results alone.

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مخاطر أمراض القلب والأوعية الدموية والمؤشرات الدموية الالتهابية لدى الرجال المصابين بداء السكري من النوع الثاني مع التهاب المفاصل الروماتويدي أو بدونه

الملخص

يُعد داء السكري من النوع الثاني (T2DM) والتهاب المفاصل الروماتويدي (RA) من الاضطرابات المزمنة الالتهابية والاستقلابية المرتبطة بزيادة خطر الإصابة بأمراض القلب والأوعية الدموية (CVD). هدفت هذه الدراسة إلى تقييم بعض المؤشرات الدموية والالتهابية ودراسة ارتباطها بوجود التهاب المفاصل الروماتويدي وخطر الإصابة بأمراض القلب والأوعية الدموية لدى مرضى T2DM.

أُجريت دراسة مقطعية شملت 60 مريضًا من الذكور المترددين على مستشفى تراغن التعليمي، ليبيا، خلال الفترة من أغسطس إلى نوفمبر 2024. قُسّم المشاركون إلى مجموعتين متساويتين: مرضى T2DM فقط (n=30) ومرضى T2DM المصابون بالتزامن بـ RA (n=30). شملت الفحوصات تعداد الدم الكامل(CBC) ، والهيموغلوبين السكري (HbA1c)، والكوليسترول الكلي (TC) ، وكوليسترول البروتين الدهني عالي الكثافة (HDL-C)، والعامل الروماتويدي (RF). كما حُسبت مؤشرات NLR ، PLR ، SII وSIRI، وقُيّم خطر القلب والأوعية الدموية باستخدام درجة فرامنغهام (FRS) ومؤشر كاستيلي من النوع الأول (CRI-I).

أظهرت النتائج ارتفاعًا ذا دلالة إحصائية في درجة مقياس فرامنغهام (FRS) لدى المرضى المصابين بالسكري من النوع الثاني المصحوب بالتهاب المفاصل الروماتويدي مقارنة بالمرضى المصابين بالسكري فقط (P=0.003)، في المقابل، لم يُظهر مؤشر كاستيلي للمخاطر القلبية من النوع الأول (CRI-I) اختلافًا ذا دلالة إحصائية بين المجموعتين .كما لم تُسجّل فروق ذات دلالة إحصائية في أعداد كريات الدم البيضاء أو الخلايا اللمفاوية أو الوحيدات أو الخلايا المحببة، وكذلك في المؤشرات الالتهابية NLR و PLR وSII وSIRI. في حين كان عرض توزيع كريات الدم الحمراء المعياري (RDW-SD) أقل بصورة ذات دلالة إحصائية في مجموعة المرضى المصابين بالتهاب المفاصل الروماتويدي، مما يشير إلى وجود تغيرات في المؤشرات الدموية قد ترتبط بالنشاط الالتهابي المزمن.

بصورة عامة، أظهر المرضى المصابون بالسكري من النوع الثاني المصحوب بالتهاب المفاصل الروماتويدي ارتفاعًا في خطر الإصابة المقدّر بأمراض القلب والأوعية الدموية، وفقًا لمقياس فرامنغهام (FRS)، إلا أنه ينبغي تفسير هذه النتيجة بحذر في ضوء الاختلاف في العمر بين المجموعتين .وتسلط هذه النتائج الضوء على الاختلافات في أنماط مخاطر القلب والأوعية الدموية، لكنها لا تثبت وجود تأثير مستقل لالتهاب المفاصل الروماتويدي في زيادة هذا الخطر .وهناك حاجة إلى إجراء مزيد من الدراسات لتوضيح العلاقة بين التهاب المفاصل الروماتويدي والمؤشرات الدموية وخطر الإصابة بأمراض القلب والأوعية الدموية لدى مرضى السكري من النوع الثاني.

الكلمات المفتاحية: داء السكري ، التهاب المفاصل الروماتويدي ، أمراض القلب ، المؤشرات الالتهابية ، مقاييس الخطر القلبي