International Journal of Environmental Sciences
ISSN: 2229-7359
Vol. 11 No. 23s, 2025
https://theaspd.com/index.php

Prevalence of Hematological Disorders in Autoimmune Diseases in Beni-Suef Governorate. A Single Center Study

Asmaa Kamel Sayed[1], Hanan Ali Taha[1], Tamer Hifnawy[2], Nilly Helmy Abd Allah[1], Khaled Sayed Elnoishy[1]
[1]Department of Internal Medicine Department Faculty of Medicine, Beni-Suef University, Egypt.
[2]Department of Community Medicine Faculty of Medicine, Beni-Suef University and Secretary General of the Supreme Council for Clinical Research Ethics.

ABSTRACT

Background: *Autoimmune diseases such as systemic lupus erythematosus (SLE), rheumatoid arthritis (RA), systemic sclerosis (SSc), and vasculitis are often associated with hematologic abnormalities that may reflect disease activity and prognosis.*

Objective: *To assess the prevalence and types of hematologic disorders in patients with autoimmune diseases and explore their correlation with disease activity.*

Methods: *This cross-sectional analytical study included 420 patients diagnosed with SLE (n=201), RA (n=180), SSc (n=20), and vasculitis (n=19), recruited from Beni-Suef University Hospital. Patients underwent clinical assessment, complete blood count, inflammatory and immunological markers, and disease activity scoring (SLEDAI, DAS28, and others). Hematologic findings were compared across groups and correlated with disease activity.*

Results: *the most common haematological disorders in SLE group 201 patients were anemia, 178 patients have anemia mostly ACD followed by thrombocytopenia 41(20%). In RA group, 180 patients, the most prevalent hematological disorder was anemia, 112(62%) cases, most them ACD 85(47%) followed by leuckopenia 14(7.7%). In systemic sclerosis patients (20) cases were 15 patients with anemia 9 of them anemia of chronic illness, 5 iron deficiency anemia. In vasculitic group, there were 19 patients were 10 without anemia and 9 with anemia mostly anemia of chronic illness, regarding leuckocytic count was 3 leuckocytosis and 3 leuckopenia. Regarding disease activity, In SLE group, there was a statistically higher level of RDW, and lower mean of MPV among cases with sever SLEIDAI score with p-value 0.04. In RA cases, there was a statistically significant higher level of neutrophils, Neutrophil/Lymphocyte, and NHL levels among cases with severe degrees of DAS with p-value <0.05. Cases of SSc with lung fibrosis and PAH show statistically significant lower mean of HB and higher level of neutrophil, and NHL levels with p-value <0.05.*

Conclusion: *Anemia was the most common hematological disorders between all study groups mostly anemia of chronic illness. higher percentage of iron deficiency anemia in SSc cases. MPV, RDW may be useful in prediction of systemic lupus activity. neutrophil, Neutrophil/Lymphocyte, and NHL levels may be used for prediction of RA activity. lower mean of HB and higher level of neutrophil, and NHL levels may be used for prediction of lung fibrosis in systemic sclerosis.*

Keywords: *Autoimmune diseases, Hematological abnormalities, Anemia of chronic disease, Disease activity, Systemic lupus erythematosus*

INTRODUCTION

Rheumatic autoimmune diseases (RADs), such as rheumatoid arthritis (RA) and systemic lupus erythematosus (SLE), are chronic inflammatory disorders characterized by multi-organ involvement and the presence of pathogenic autoantibodies [1]. Hematological abnormalities are frequently observed in RADs and can often serve as the first clinical sign. These include cytopenias in SLE, neutropenia in Felty's syndrome, and thrombocytopenia in antiphospholipid syndrome (APS). Furthermore, some antirheumatic biological agents can induce hematologic side effects, which complicates diagnosis and management [2].

Anemia is one of the most common hematologic manifestations in autoimmune connective tissue diseases (ACTDs). Anemia of chronic disease (ACD), typically normocytic normochromic or microcytic hypochromic, is the most prevalent form, driven by persistent immune activation and elevated cytokine levels [3]. ACD often coexists with iron deficiency anemia (IDA), especially in RA patients with chronic gastrointestinal blood loss due to NSAIDs or corticosteroids [5,6]. IDA has been reported in 50–75% of RA cases with active disease [4].

Leukopenia, defined as a white blood cell count <4,000/mm^3, is another frequent hematologic finding in ACTDs. It is commonly seen in SLE (20–64%) and is part of the American College of

Rheumatology (ACR) classification criteria for the disease [5]. Neutropenia is often associated with Felty's syndrome, a rare RA variant, and occurs in up to 47% of SLE patients, though severe cases are uncommon [6]. Lymphopenia is also prevalent, observed in 15–30% of RA patients and up to 82% of SLE cases, and is often linked to renal involvement and anti-Ro/SS-A antibodies [7].
Thrombocytopenia, defined as platelet count <100,000/mm³, may be immune or drug-induced. It is more commonly seen in SLE than RA and occurs in 8–31% of SLE patients, with severe thrombocytopenia (<50,000/mm³) being less frequent (~5%) [8]. In SLE, platelet destruction may result from anti-platelet antibodies and impaired thrombopoiesis. Evans' syndrome, the co-occurrence of autoimmune hemolytic anemia (HA) and thrombocytopenia, may also arise in association with SLE, APS, or dermatomyositis (DM) [9].
The aim of this study was to evaluate prevalence of hematological disorders in autoimmune diseases patients and their relation with disease activity in Beni-Suef governorate.

PATIENT AND METHODS

This Cross sectional analytical observational study was conducted on 40 patients with autoimmune disease especially SLE and rheumatoid arthritis, systemic scelerosis and vasculitis selected from rheumtology and clinical immunology outpatient clinics and inpatients in Beni-suef university hospital during one year from January 2022 to January 2023

Sample size

Sampl size was calculated using StatCalc under Epi info softwares:

Incidence of Rheumatoid patients in Egypt 3/1000 Gibofsky., [10], and SLE 6/100000
Total number of patients: Outpatients 2400, Inpatients 180-20, Total 2600 with a total population size 2600 patients distributed as mentioned above with expected frequency of 7.8% Putting in consideration a prevalence of RA of 3/1000 Gibofsky., [10] and with a level of error of 0.05 the following sample size were calculated using StatCalc under Epi info software

Inclusion criteria:

Patients diagnosed as systemic lupus eythromatosis, rheumatoid arthritis, systemic scelerosis, or vasculitis .

Exclusion criteria:

Patients with the following conditions were excluded from this study: Patients less than 13 or older than 65 years old, Pregnancy and Known hepatic patients.

Ethical consideration:

Informed consent was taken from all the patients before the study and after ethical committee approval in Beni-Suef Faculty of Medicine. Approval number: FMBSUREC/09012022/Sayed.

METHODS

All participants were subjected to the following: History taking, Clinical Examination and Laboratory investigations include: Complete blood count (CBC),(blood cell indices, platelet indices, WBCs indices and reticulocytic count from peripheral blood samples, Anti-nuclear antibody (ANA), Anti dsDNA, complement (C3&C4), Rheumatoid factor, anti-cyclic citrvnated peptide (Anti CCP), Erythrocyte sedimentation rate (ESR) / C reactive protein (CRP), Kidney function testes as S. Creatinine, Urea, Livre enzymes (ALT, AST) and Iron study as serum iron, ferritin and TIBC.
Disease activity assessed in each group accordingly, in SLE group activity assessed by SLEDI score, in RA group assessed by DAS 28 score, in vasculitis secondary to behcet assessed by The severity score for each BD patient was determined according to the entire spectrum of disease manifestations: 1 point for each mild symptom (oral ulcers, genital ulcers, skin lesions, arthralgia, recurrent headaches, epididy- mitis, mild gastrointestinal symptoms, pleuritic pain, and superficial vein thrombosis), 2 points for each moderate symptom (arthritis, deep vein thrombosis in the legs, anterior uveitis, and gastrointestinal bleeding), and 3 points for each severe symptom (posterior/panuveitis, retinal vasculitis, arterial thrombosis or aneurysms, major vein thrombosis, neuro-involvement, and bowel perforation) [11].

RESULTS

Table (1): Demographic characteristics in the study groups.

Variables	SLE (n=201)	RA (n=180)	SSc (n=20)	Vasculitis (n=19)	P-value
	Mean±SD	Mean±SD	Mean±SD	Mean±SD	
Age(years)	29.9±9.5	41.7±11.2	41.1±12.2	36.9±9.4	<0.001*
Sex	No. (%)	No. (%)	No. (%)	No. (%)	
Male	30(14.9%)	14(7.8%)	3(15%)	10(52.6%)	<0.001*
Female	171(85.1%)	166(92.2%)	17(85%)	9(47.4%)	
Marital status					
Married	117(58.2%)	144(80%)	15(75%)	14(73.7%)	<0.001*
Single	78(38.8%)	14(7.8%)	3(15%)	4(21.1%)	
Divorced	5(2.5%)	5(2.8%)	0(0%)	1(5.3%)	
Widow	1(0.5%)	17(9.4%)	2(10%)	0(0%)	
Working					
Occupy	32(15.9%)	24(13.3%)	1(5%)	7(36.8%)	0.03*
Not occupy	169(84.1%)	159(86.7%)	19(95%)	13(63.2%)	

Table (1) demonstrated a statistically significant younger age among cases of SLE and higher percentage of males among cases of vasculitis, and females represent higher percentage in RA group with p-value <0.001. As regards marital status higher percentage of single status was found among cases of SLE, and married cases represent higher percentage among RA cases with p-value <0.001. For working status higher significant percentage of working among cases with vasculitis, versus higher percentage of non-working among cases with SSc with p-value <0.001.

Table (2): Clinical presentations in different study groups.

Clinical items	SLE (n=201)	RA (n=180)	SSc (n=20)	Vasculitis (n=19)	P-value
	No. (%)	No. (%)	No. (%)	No. (%)	
Skin	88(43.8%)	8(4.4%)	20(100%)	4(21.1%)	**<0.001***
Arthralgia	190(94.5%)	179(99.4%)	20(100%)	16(84.2%)	**0.001***
Arthritis	69(34.3%)	137(76.1%)	6(30%)	1(5.3%)	**<0.001***
Eye	2(1%)	1(0.6%)	0(0%)	5(26.3%)	**<0.001***
CNS	27(13.4%)	1(0.6%)	0(0%)	8(42.1%)	**<0.001***
Vasculitis	9(4.5%)	0(0%)	1(5%)	19(100%)	**<0.001***
GIT	41(20.4%)	99(55%)	18(90%)	3(15.8%)	**<0.001***
CVS	23(11.4%)	0(0%)	4(20%)	5(26.3%)	**<0.001***
Chest	33(16.4%)	18(10%)	16(80%)	1(5.3%)	**<0.001***
FMS	1(0.5%)	17(9.4%)	3(15%)	0(0%)	**<0.001***
Renal	**104(51.7%)**	**7(3.9%)**	**4(20%)**	**3(15.8%)**	**<0.001***

CNS central nervous system, CVS cardiovascular system, FMS fibromyalgia syndrome, GIT gastrointestinal tract

Table (2) demonstrated the distribution of different clinical symptoms in different autoimmune disease with significant higher percentage of renal affection in cases with SLE, and higher prevalence of arthritis among RA cases, and higher percentage of skin, arthralgia, GIT, CVS, chest, and FMS

symptoms among cases with SSc, finally higher percentage of eye, CNS, and vasculitis among cases with vasculitis cases with p-value
<0.001.

Table (3): Comparisons of hematological parameters in different study groups.

Variables	SLE (n=201)	RA (n=180)	SSc (n=20)	Vasculi tis (n=19)	P-value
	Mean ± SD	Mean ±SD	Mean ±SD	Mean ±SD	
RBCs parameters					
HB	9.3±2.1	11.2±1.9	10.8±1.6	11.5±2.1	**<0.001***
MCV	79.6±9.2	78.6±10	79.6±11.5	77.7±8.6	**0.70**
RDW	14.9±2.4	14.1±2.7	14.9±2.6	14.3±1.3	**0.01***
HCT	34.02±6.2	34.6±4.8	33.3±4.5	35.1±5.2	**0.52**
TLC	7.02±4	6.8±2.8	7.3±3.7	7.6±2.9	**0.73**
Neutrophil	4.6±3.2	4.1±2.1	4.5±2.6	4.3±2.4	**0.33**
Lymphocyte	1.8±0.96	2.1±1	2.1±1.3	2.5±0.78	**0.006***
MPV	8.6±1.4	9.2±1.8	8.9±1.2	9.2±0.99	**0.02***
PLT	226.8±36.2	279.1±86.7	304.2±96.3	295.9±76.6	**<0.001***
Type of anemia	No. (%)	No. (%)	No. (%)	No. (%)	
No	23(11.4%)	68(37.8%)	5(25%)	10(52.6%)	**<0.001***
Chronic disease	127(63.2%)	85(47.2%)	9(45%)	8(42.1%)	**0.007***
Iron deficiency	27(13.4%)	25(13.9%)	5(25%)	1(5.3%)	**0.35**
Hemolytic	24(11.9%)	2(1.1%)	1(5%)	0(0%)	**0.004***
Severity					
Mild <7mg/dl	137(77%)	107(94.7%)	15(100%)	8(88.9%)	**<0.001***
Sever >7 mg/dl	**41(23%)**	**6(5.3%)**	**0(0%)**	**1(11.1%)**	

HB hemoglobin, HT hematocrit, TLC total leuckocytic count, MPV mean platelet volume, PLT platelet, MCV mean corpuscular volume, WBCs White blood cells)

Table (3) illustrated that SLE cases show lower mean of hemoglobin, lymphocyte, MPV, and PLT. A lower level of RDW was found in RA cases with p-value <0.05. In addition, there was a statistical significance higher percentage of anemia of chronic disease and hemolytic anemia in SLE cases, and higher percentage of iron deficiency anemia in SSc cases. Finally, SLE cases show sever degree of anemia with p-value <0.001. On the other hands there was no statistically significant different as regards MCV, and HT with p-value >0.05

Table (4): Percentage of differential leuckocytic count parameters in study groups.

Hematological complications	SLE (n=201)	RA (n=180)	SSc (n=20)	Vasculitis (n=19)	P-value
	No. (%)	No. (%)	No. (%)	No. (%)	
No	112(55.7%)	132(73.3%)	15(75%)	11(57.9%)	**0.002***
Leucopenia	27(13.4%)	14(7.8%)	1(5%)	0(0%)	**0.21**

Lymphopenia	20(10%)	9(5%)	2(10%)	1(5.3%)	**0.31**
Neutropenia	4(2%)	5(2.8%)	0(0%)	3(15.8%)	**0.01***
Lymphocytosis	5(2.5%)	6(3.3%)	0(0%)	1(5.3%)	**0.82**
Leukocytosis	21(10.4%)	7(3.9%)	2(10%)	3(15.8%)	**0.48**
Monocytosis	0(0%)	1(0.6%)	0(0%)	0(0%)	**0.99**
Leucopenia &lymphopenia	9(4.5%)	3(1.7%)	0(0%)	0(0%)	**0.43**
Leucopenia &neutropenia	**3(1.5%)**	**3(1.7%)**	**0(0%)**	**0(0%)**	**0.49**

Table (4) illustrated that SLE cases show higher percentage of leucopenis and lymphopenia, SSc cases show lymphopenia, and leukocytosis, in cases with vasculitis show neutropenia, lymphocytosis, and leuckocytosis with p-value 0.02

Table (5): comparison of disease severity in different clinical manifestations and medications among SLE cases.

SLE Group	**SLEIDAI score**				**P-value**
	Mild	Moderate	Sever	No flare	
	No. (%)	No. (%)	No. (%)	No. (%)	
Clinical manifestations					
Skin	36(46.8%)	18(37.5%)	30(49.2%)	4(26.7%)	**0.31**
Arthralgia	73(94.8%)	46(95.8%)	60(98.4%)	11(73.3%)	**0.002***
Arthritis	17(22.1%)	21(43.8%)	31(50.8%)	0(0%)	**<0.001***
Eye	1(1.3%)	0(0%)	1(1.6%)	0(0%)	**0.81**
CNS	2(2.6%)	5(10.4%)	20(32.8%)	0(0%)	**<0.001***
Vasculitis	2(2.6%)	3(6.3%)	4(6.6%)	0(0%)	**0.51**
Oral ulcers	14)18.2	12(25%)	13(21.3%)	3(20%)	**0.84**
CVS	5(6.5%)	8(16.7%)	10(16.4%)	0(0%)	**0.08**
Chest	9(11.7%)	5(10.4%)	19(31.1%)	0(0%)	**0.002***
FMS	1(1.3%)	0(0%)	0(0%)	0(0%)	**0.65**
Renal	26(33.8%)	32(66.7%)	46(75.4%)	0(0%)	**<0.001***
medications					
Steroids	77(100%)	48(100%)	61(100%)	15(100%)	**0.99**
NSAID	2(2.6%)	2(4.2%)	0(0%)	0(0%)	**0.41**
MTX	13(16.9%)	6(12.5%)	5(8.2%)	2(13.3%)	**0.61**
Hydroxychloroquine	74(96.1%)	47(97.9%)	59(96.7%)	15(100%)	**0.84**
Cyclosprine	1(3%)	0(0%)	0(0%)	0(0%)	**0.60**
Sulphasalazine	1(1.3%)	1(1.3%)	0(0%)	0(0%)	**0.70**
Cyclophosphamide	8(10.4%)	14(29.2%)	34(55.7%)	4(26.7%)	**<0.001***
Azathioprine	38(49.4%)	21(43.8%)	32(52.5%)	9(60%)	**0.68**
Leflonamide	6(7.8%)	3(6.3%)	2(3.3%)	0(0%)	**0.51**
MMF	9(11.7%)	11(22.9%)	20(32.8%)	3(20%)	**0.02***
Biologic	0(0%)	0(0%)	0(0%)	0(0%)	**----**
Rutiximab	0(0%)	3(6.3%)	8(13.1%)	0(0%)	**0.007***
Colchicine	7(9.1%)	4(8.3%)	6(9.8%)	1(6.7%)	**0.98**
Anticoagulant	**3(3.9%)**	**5(10.4%)**	**5(8.3%)**	**0(0%)**	**0.32**

CNS central nervous system, CVS cardiovascular system, FMS fibromyalgia syndrome, NSAID non-steroidal antiinfilamatory drugs, MTX methotrexate, HCQ Hydroxychloroquine, MMF mycophenolate mofetyle

Table (5) illustrated that SLE cases who show higher score of SLEIDAI score (sever degree of severity) had higher percentage of arthralgia, arthritis, CNS, chest and renal manifestations with p-value <0.05. In addition, severe degree shows higher percentage of treatment with CYC, MMF, and

Rutiximab with p-value <0.05. On the other hands, there was no statistically significant difference with p- value >0.05 in SLEIDAI score degrees as regards other clinical manifestations and medications.

Table (6): Comparison of hematological parameters in different disease activity score in SLE cases.

SLE Group	SLEIDAI score				P-value
	Mild	Moderate	Sever	No flare	
	Mean± SD	Mean± SD	Mean± SD	Mean± SD	
Hemoglobin(mg/dl)	9.7±2.1	9.2±2	9.2±2.1	8.1±2.2	0.06
RDW	14.3±2.7	14.7±2.4	15.8±1.9	14.4±2.3	0.04*
Neutrophil (cs/mm)	4.9±3.5	4.3±2.9	4.4±2.9	5.1±3.7	0.73
Lymphocyte (cs/mm)	1.7±0.74	2±1	1.8±1.1	2.1±1	0.16
MPV	8.6±1.3	8.9±1.4	7.6±1.4	8.8±1.9	0.04*
Platelet(cs/mm)	219.5±135.5	252.5±117.6	219.5±147.6	211.7±149.7	0.51
NLR	4.3±1.5	2.3±1.4	2.8±1.7	2.3±0..94	0.56
PLR	1561±124.7	154.8±107.2	177.9±187.8	121.5±95.7	0.53
NHLR	1.48±1.8	1.21±0.26	1.24±0.25	1.30±0.32	0.55
RDW/PLT	0.23±0.74	0.07±0.05	0.147±0.23	0.31±0.53	0.35
HB/RDW	0.65±0.19	0.65±0.18	0.64±0.19	0.54±0021	0.33
HB/PLT	0.13±0.37	0.04±0.04	0.09±0.17	0.11±0.15	0.27

RDW (red blood cell distribution width), MPV mean platelet volume), NLR (Neutrophil/Lymphocyte ratio), PLR (Platelet / Lymphocyte ratio), NHLR (Neutrophil /Hemoglobin Lymphocyte ratio, HB (hemoglobin)

Table (6) illustrated that SLE cases there was a statistical higher level of RDW, and lower mean of MPV among cases with sever SLEIDAI score with p-value 0.04. Whoever there was no statistically significant difference in other laboratory investigations between different SLEIDA score degrees with p-value >0.05.

Table (7): Sensitivity and specificity of labs in diagnosis of SLE Activity (severe degree).

Variable	Sensitivity	Specificity	AUC	p-value	Cut off point
Hemoglobin(mg/dl)	62.3%	49.3%	53.8%	0.39	9.55
Lymphopenia	65.6%	45.7%	56.4%	0.29	1.85
MPV	55.7%	35.7%	51.6%	0.72	9.25
RDW	63.9%	49.3%	55.3%	0.24	14.85

MPV mean platlet volume, RDW red cell distribution width

Table (8): Relation of hematological parameters with disease Activity among RA cases.

RA Group	DASS28 score			P-value
	Mild	Moderate	Sever	
	Mean± SD	Mean± SD	Mean± SD	
Hemoglobin(mg/dl)	11.9±1.8	11.5±1.9	10.9±1.8	0.07
RDW	15.2±0.32	14.1±3.2	14.3±2.2	0.7
Neutrophil(cs/ml)	4.2±3.8	3.6±1.8	4.6±2.1	0.003*
Lymphocyte(cs/ml)	1.5±0.34	2.1±1	2.1±0.98	0.46
MPV	8.3±1.6	9.2±2.1	9.3±1.3	0.56
Platelet (mg/dl)	229.3±44.5	267.1±80.1	295.7±96.2	0.06
NL R	2.2±2	1.8±0.85	2.6±1.6	0.001*
PLT/ LR	168.9±78.2	145.6±67.6	162.9±77.9	0.26
NHLR	1.18±0.25	1.11±0.13	1.20±0.16	0.001*
RDW/PLT	0.06±0.01	0.07±0.14	0.05±0.01	0.08
HB/RDW	0.78±0.12	0.84±0.20	0.78±0.18	0.13
HB/PLT	0.05±0.01	0.06±0.12	0.04±0.01	0.02*

RDW (red blood cell distribution width), MPV mean platlet volume), NLR (Neutrophil/Lymphocyte ratio), PLR (Platelet / Lymphocyte ratio), NHLR (Neutrophil /Hemoglobin Lymphocyte ratio, HB (hemoglobin)

Table (8) illustrated that RA cases there was a statistically significant higher level of neutrophil, Neutrophil/Lymphocyte, and NHL levels and lower level of HB/PLT ratio among cases with sever degrees of DAS with p-value <0.05. On the other hands there was no statistical significance difference in other laboratories in different severity degrees. With p-value >0.05.

Table (9): Sensitivity and specificity of hematological parameters as regard to RA severity (severe degree).

Variable	Sensitivity	Specificity	AUC	p-value	Cut off point
Neutrophil(cs/l)	65.5%	61.5%	66.3%	<0.001*	3.65
NHL	67.8%	62.6%	66.9%	<0.001*	1.125
NLR	70.1%	52.7%	65.9%	<0.001*	1.74
HB/PLT ratio	60.9%	58.1%	60.7%	0.01*	0.0425

NHL neutrophil /hemoglobin ratio, NLR neutrophil /lymphocytr ratio, HB/PLT hemoglobin /platelet ratio

Sensitivity and specificity test for different laboratory tests illustrated a statistically significant diagnostic effect to neutrophil, NHL, HB/PLT ratio, NLR in diagnosis of RA Activity degree

Table (10): Correlation of hematological indices in different disease activity score among Behcet cases.

Behcet Group	Behcet disease severity degrees			P-value
	Mild	Moderate	Sever	
	Mean± SD	Mean± SD	Mean± SD	
RDW	14.9±0.51	14.2±1.3	14.3±0.35	0.60
Neutrophil(cs/mm)	3.9±1.6	3.4±1.3	9±0.71	0.007*
Lymphocyte(cs/mm)	2.5±0.58	2.5±0.53	3.4±0.98	0.31
MPV	8.4±0.56	9.2±0.62	9.25±0.35	0.21
PLT (cs/mm)	307±28.9	215.3±75.8	268±43.8	0.20
CRP (mg/dl)	3.3±2.3	22.2±28.8	27±29.6	0.50
TLC (cs/mm)	6.9±2.1	6.6±1.3	13.4±1.3	0.006*
ESR (mm/hr)	35±13.2	58.8±38.8	28.5±2.1	0.42
NLR	1.5±0.55	1.4±0.75	2.7±0.58	0.14
PLR	124.3±22.1	91.8±41.9	80.4±10.5	0.33
NHL	1.09±0.08	1.07±0.15	1.35±0.09	0.09

RDW (red blood cell distribution width), MPV mean platelet volume), NLR (Neutrophil/Lymphocyte ratio), PLR (Platelet / Lymphocyte ratio), NHLR (Neutrophil /Hemoglobin Lymphocyte ratio, HB (hemoglobin)

Table (10) illustrated that Behcet cases there was a statistically significant higher level of neutrophil, and TLC levels among cases with sever degrees with p-value <0.05. On the other hands there was no statistical significance difference in other laboratories in different severity degrees. With p-value >0.05.

Table (11): Correlation of hematological indices in disease presentation among SSc cases.

Scleroderma Group	Raynauds		P-value	ILD+PAH		P-value
	No	Yes		No	Yes	
	Mean± SD	Mean± SD		Mean± SD	Mean± SD	
Hemoglobin(mg/dl)	10.6±1.6	12.1±1.6	0.13	11.3±1.8	9.9±0.86	**0.04***

Neutrophil(cs/mm)	4.6±2.8	3.9±0.96	0.69	3.5±1.2	6.1±3.6	**0.03***
Lymphocyte(cs/mm)	2.1±1.2	2.5±1.8	0.67	2±0.94	2.4±1.8	**0.56**
NHL	1.19±0.15	1.11±0.08	0.38	1.11±0.07	1.29±0.17	**0.005***
ESR (mm/hr)	55.1±31.1	33±18.1	0.26	46.4±20.5	60.6±42.5	**0.33**
CRP (mg/dl)	15.6±18.3	1.7±0.57	0.008*	10.3±17.4	18.7±17.6	**0.33**
RDW	14.6±2.3	14±1	0.71	14.7±2.4	14.3±1.8	**0.83**
MPV	9.02±1.3	9.03±0.95	0.99	8.8±1.4	9.4±0.91	**0.29**
PLT (cs/mm)	28.3±76.3	343.3±85	0.17	319±78.9	243.3±54.3	**0.04***
RDW/PLT	0.06±0.01	0.04±0.009	0.10	0.05±0.01	0.06±0.01	**0.08**
HB/RDW	0.74±0.18	0.86±0.08	0.21	0.79±0.20	0.71±0.12	**0.29**
HB/PLT	**0.04±0.01**	**0.037±0.009**	**0.56**	**0.04±0.01**	**0.04±0.01**	**0.53**

RDW (red blood cell distribution width), MPV mean platelet volume), NLR (Neutrophil/Lymphocyte ratio), PLR (Platelet / Lymphocyte ratio), NHLR (Neutrophil /Hemoglobin Lymphocyte ratio, HB (hemoglobin)

Table (11) illustrated that scleroderma cases who had Raynauds there was a statistically significant lower level of CRP with p-value <0.05. For cases with lung fibrosis and PAH that show statistically significant lower mean of HB and PLT with higher level of neutrophil, and NHL levels with p-value <0.05. On the other hands there was no statistical significance difference in other laboratories with p-value >0.05.

Table (12): Comparison between autoimmune disease duration according to hematological parameters in each study groups.

Variables	**Disease duration (years)**			
	SLE	RA	SSc	Vasculitis
	r (p-value)	r (p-value)	r (p-value)	r (p-value)
Hemoglobin(mg/dl)	0.04(0.55)	0.17(0.01*)	-0.25(0.28)	-0.02(0.92)
MCV	-0.02(0.73)	0.08(0.25)	-0.09(0.69)	0.19(0.42)
RDW	0.01(0.85)	0.5(0.47)	0.23(0.33)	0.06(0.80)
HCT (mg/dl))	0.05(0.45)	0.06(0.41)	-0.26(0.27)	-0.09(0.71)
TLC (cs/mm)	-0.06(0.36)	-0.12(0.09)	0.17(0.46)	0.22(0.36)
Neutrophil (cs/mm)	-0.09(0.21)	-0.11(0.16)	0.12(0.62)	0.17(0.48)
Lymphocyte(cs/mm)	-0.007(0.92)	-0.17(0.02*)	0.11(0.64)	0.22(0.35)
MPV	-0.02(0.70)	-0.01(0.84)	-0.14(0.56)	-0.34(0.16)
PLT mg/dl))	-0.02(0.72)	-0.18(0.01*)	0.25(0.29)	-0.23(0.34)

SLE systemic lupus erythromatosis, RA reumatoid arthritis, SSc systemic sclerosis, HB hemoglobin, MCV mean corpuscular volume, RDW red cell distribution width, HT hematocrit MPV mean platlet volume, PLT platlet.S

Table (12) demonstrated comparison between autoimmune disease duration with hematological investigations in each study groups, there was statistically significant positive correlation with p-value <0.05 between disease duration and hemoglobin level in addition to negative correlation between disease duration and each of lymphocytes, and PLT count among RA cases.

DISCUSSION

Hematologic abnormalities affecting one or more cellular lineages are frequent manifestations of autoimmune diseases, and may represent an important prognostic factor, reflecting the rate of activation of autoimmune/inflammatory processes [2].

In our study, we try to evaluate prevalence of hematological disorders in autoimmune diseases in Beni-suef governorate in four groups of autoimmune diseases patients: SLE, RA, SSc and vasculitis. Our study including 420 patients, 201 patients SLE,180 patient's RA, 20 patients SSc,19 vasculitis mostly 2ndry to behcet and other causes as GCA, Takayasu disease, burger disease.

Demographic characteristics in our study groups: We found that there was a statistically significant higher percentage of males among cases of vasculitis and this mostly due to most of cases secondary to behcet disease that are characterized by male sex predominance in middle East [12], younger age among cases of SLE, females represent higher percentage in RA group with p-value <0.001and this agrees with Gheita et al., [13].

As regards marital status, higher. percentage of single status was found among cases of SLE, and married cases represent higher percentage among RA cases with p-value <0.001. This data nearly agrees Senna et al., [14] a study in Brazil on demographic data on rheumatic diseases report also lupus and rheumatoid are more in female lupus younger age but rheumatoid wide range of age with mean age 50 years old but Gheita et al., [13] a cross-sectional Egyptian study included large cohort of 10,364 RA patient reported that mean age of rheumatoid patients was 44.8 and was significantly lower in female

For working status, higher significant percentage of working among cases with vasculitis, mostly due to acute insult with resolution and also predominance of male sex versus higher percentage of not working among cases with SSc with p-value <0.001. This is mostly due to disability and limitation of movement caused by SSc disease and also depression and psychological troubles as mentioned in Müller et al., [15] that 48 out of 70 had depression and disability in patients with dermatological symptoms with SSc and Hudson et al., [16]132 out of 643 were work disabled.

By comparisons of hematological parameters in different study groups, we found that the most common hematological disorders in SLE group (201 patient) was that anemia 178(88.5%) patients have anemia with mean HB 9.3±2.1 followed by thrombocytopenia 41(20%) out of 201 with thrombocytopenia less than 100,000 then hemolytic anemia 24(11.9%) then lymphopenia 20(10%) and this nearly agrees with Aleem et al., [17] study which concluded that regarding hematological abnormalities in SLE, anemia was the most common disorder present in 63% of patients followed by lymphopenia in 40.3%, leukopenia in 30.0%,thrombocytopenia in 10.9% and autoimmune hemolytic anemia (AIHA) in 4.6% patients.

The most prevalent type anemia of chronic illness in 127 patients, then IDA 27 patients, then hemolytic anemia 24 and this agrees with Voulgarelis et al., [18] a cohort study on 132 SLE patient. This may be due to suppressed erythropoietin in chronic inflammation and also agree with Sufian, et al., [19], a study on 89 patients with SLE. The two studies reported that most common type anemia of chronic illness then iron deficiency anemia then hemolytic anemia. Most of the cases were mild degree 137case and 41case with severe degree.

Regarding total leucocytic count, there were 112 patients without abnormality in leucocytic count, 27 (10%) patients with leukopenia. lymphopenia was the most prevalent between our SLE cases about 20 patients with lymphopenia that agree with another study by Debarre et al., [20], lymphopenia was detected in 84% of the cases and was found to be independent of leucopenia and also in vitro studies suggest that lymphopenia is caused by the production of autoantibodies against lymphocytes by the genesis of IgG antibodies, correlating inversely with their cell counts and complement levels Noguchi et al., [21] but this disagree with Sufian, et al., [19] that documents that Neutropenia was predominant (51.5%) among the WBC disorder, 21 patient with leukocytosis mostly secondry to steroids and may be due to activity. Chen et al., [22] reported increase in prephral lymphocyte with active lupus nephritis patients.

In RA group 180 patients, the most prevalent hematological disorder was anemia 112 (62.2%) cases have anemia and 68 have not anemia similar to this study Udayamma et al., [23] was 60% has anemia. The most common type anemia of chronic illness 85(75.8%) patients, 25 (22.3%) patients IDA and 2 cases with hemolytic anemia and this agree with this chinese study Chen et al., [22], but against Udayamma et al., [23] that reported that most common type of anemia in RA was IDA then ACD and this may be different number of cases in this study, 107 with mild degree and only 6 with

severe anemia.

Regarding total leuckoctic count was132 patients without abnormality in TLC, only 14 patients with leuckopenia that may be drug induced specially most of our patients on MTX and 7 patients with leuckocytosis may be due to RA activity or 2ndy bacterial infection. The principal leukopenic disorder among patients with RA is Felty's syndrome, which is defined as a triad of RA, splenomegaly, and neutropenia that should be excluded. Platlet count was only 2 with thrombocytopenia.

In scleroderma patients, 20 cases with mean HB10.6 were 15 patients with anemia 9 of them anemia of chronic illness, 5 iron deficiency anemia and one case with haemolytic anemia, all of them mild degree of anemia. According to Frayha et al., [24], who examined 180 patients with systemic sclerosis, anemia was found.

In about 25% of patients while severe anemia with hemoglobin < 10 g/dl was found in 10% of them, still another clinical issue is iron deficiency in systemic sclerosis patients, Ruiter et al., [25] found iron deficiency in about 40% of systemic sclerosis patients.

In vasculitis group, there were 19 patients with mean HB 11.5, 10 without anemia and 9(47%) with anemia mostly anemia of chronic illness

Regarding SLE cases with correlation of laboratory investigations in disease severity among SLE cases, we found that there was a statistical higher level of RDW, and lower mean of MPV among cases with sever SLEIDAI score with p-value 0.04. However, there was no statistically significant difference in other laboratory investigations between different SLEIDA score degrees with p-value >0.05

In the present study, we showed that compared to the other groups, the numbers of lymphocytes and platelets, hemoglobin mean and MPV were lower in SLE than other groups and this partially agrees with Peirovy, et al., [26] study but their study of the comparison with healthy control which showed that compared to the healthy subjects, the numbers of lymphocytes and platelets were lower, and the NLR, PLR, and RDW were higher, in patients with SLE, Sensitivity and Specificity test for different laboratory tests illustrated no significant value for HB, lymphocytes, MPV, or RDW in diagnosis of SLE severity degree. Miglio et al., [27] and Akorsu et al., [28], The discussion of these findings sheds light on the potential utility of RDW in assessing disease activity, highlights methodological variations, and highlights the need for further research.

Regarding RA group, there was statistically significant positive correlation with p-value <0.05 between disease severity (DAS score) and TLC, neutrophils and NLR and NHL levels also as Fu et al., [29] reported positive correlation between the DAS28 score and WBCs count, neutrophil count and NLR in RA patients.

Abd -Elazeem et al., [30] found that the DAS28 positively correlated with the NLR and PLR. These studies support the present study and may reflect the importance of WBCs indices as a marker of inflammation and disease activity in patients with RA.

Current results showed that the RBCs parameters may give an idea about the inflammatory status and activity status in RA patients, and that the alterations in these parameters go hand in hand with alterations in the inflammatory markers. The current study found that active patients had significantly lower level of HB/PLT ratio among cases with sever degrees of DAS score with p-value <0.05 as Farouk et al., [31] study that found that active patients had significantly higher RDW%, while HCT value, Hb levels, Hb/PLT ratio, RDW%/PLT.

The current study didn't find any significant correlations of RDW% with DAS SCORE or activity as two studies Al-Rawi et al., [32] did not find correlation between RDW and DAS-28.

In RA group, the ROC analysis showed that neutrophil, NHL, HB/PLT ratio, NLR had the best predictive performance for disease activity.

The ROC curve showed that the best neutrophil, NHL cut-off value for predicting disease activity in RA patients was 3.65, 1.125 respectively with a sensitivity of 65.5%, 67.8% respectively and a specificity of 61.5%%, 62.6% respectively. Also, NLR, HB/PLT ratio cut-off value for predicting disease activity in RA patients was 1.74, 0.0425 respectively with a sensitivity of 70.1%, 60.9% respectively and a specificity of 52.7%,58.1% respectively.

Remalante et al., [33] found that RDW and NLR had poor performance (AUC: 0.516, 0.629, respectively) with low sensitivity and specificity for predicting RA activity. Also, in Taha et al., [34] study showed that integrated markers in the multi-ROC analysis performed better than a single biomarker, combining RDW (13.7%) and NLR (3.4%) improved the predictive performance for

RA activity.

Systemic sclerosis is characterized by generalized micro and macroangiopathy. Mortality in SSc is primarily due to pulmonary complications: In the largest observational study conducted to date, the leading cause of death was ILD; 17% and PH 15%. Amoda et al., [35]

In this study, we investigated the relationship between parenchymal and vascular involvements of the pulmonary system and CBC parameters.

Cases with lung fibrosis and PAH show statistically significant lower mean of HB and PLT with p value< 0.04. This partially agrees with Dilek Tezcan, et al., [36] study which noted that the platelet count was significantly lower, and the RPR level was significantly higher in those with ILD and PH coexistence compared to those with only ILD (adj. p1=0.034, adj. p1= 0.045; respectively). In our study, RPR was low in with ILD and PH coexistence compared to those but without significant value p value 0.08

Also, the current study noted that higher level of neutrophil, and NHL levels with p-value <0.05 with patients with ILD and PH, Jung et al., [37] reported that SSc-ILD could be predicted in patients with SSc with NLRs above 2.59 (70% sensitivity, 72% specificity) and that NLR could be used as a marker for SSc-ILD.

In a study of patients with SSc, NLR was reported to be associated with digital ulcers, PAH, and ILD. Yayla et al. confirmed that NLR was associated with SSc-PAH and reported that NLR and MLR were associated with digital ulcers [38].

Atilla et al. [39] reported that Hb and counts of leukocytes and platelets were not different in patients with SSc with or without ILD, whereas NLR was above 3.21, indicating ILD (81% sensitivity, 81% specificity).

In vasculitic group, 19 of different causes 9 cases vasculitis 2ndry to behcet diseases, regarding their clinical assessment and disease severity, out of 9 cases 2 cases with severe degree, 4 cases moderate and 3 cases with mild degree.

With correlation of laboratory investigations in disease severity among Behcet cases, there was a statistically significant higher level of neutrophil, and TLC levels among cases with sever degrees with p-value <0.05. On the other hand, there was no statistical significance difference in other laboratories in different severity degrees.

By comparisons of disease duration in different hematological complications among study groups, there was statistically significant positive correlation with p-value <0.05 between disease duration and hemoglobin level in addition to negative correlation between disease duration and each of lymphocytes, and PLT count among RA cases. On the other hand, there was no statistically significant correlation with p-value >0.05 between disease duration and other hematological parameters in each disease.

Morse et al., [40] study of the 252 patients with RA, 83% were women; they had a median disease duration of 14 years and moderate disease activity at the time of arthroplasty. ...These findings suggest that preoperative optimization of the patient with RA might focus on improving anemia and this may dive us our explanation that with long duration and good medication to control inflammation and treatment of anemia, this raises HB level. It may also be related to disease activity as in Padjen et al., [41]. Baseline hemoglobin was lower in the subgroup of active patients (mean ± SD: 12.8 ± 1.7 g/dL) compared to patients inactive at baseline (13.5 ± 1.3 g/dL) ($p = 0.023$, $t = -2.320$). The active subgroup receiving a new DMARD improved significantly in the CDAI,

But this is against this study Udayamma et al., [23] reported that Anemia was more prevalent in patients with rheumatoid arthritis disease duration more than 5 years

CONCLUSION

Hematological abnormalities are common in autoimmune diseases and may reflect disease activity. Anemia was the most common hematological disorders between all study groups mostly anemia of chronic illness. higher percentage of iron deficiency anemia in SSc cases. MPV, RDW may be useful in prediction of systemic lupus activity. neutrophil, Neutrophil/Lymphocyte, and NHL levels may be used for prediction of RA activity. lower mean of HB and higher level of neutrophil, and NHL levels may be used for prediction of lung fibrosis in systemic sclerosis.

REFERENCES

1. Askanase, A. D., Nguyen, S. C., Costenbader, K., Lim, S. S., Kamen, D., Aranow, C., Grossman, J., Kapoor, T. M., Baker-Frost, D., Aberle, T., Thanou-Stavraki, A., Hanrahan, L. M., Kim, M., & Merrill, J. T. (2018). Comparison of the Lupus Foundation of America-Rapid Evaluation of Activity in Lupus to More Complex Disease Activity Instruments as Evaluated by Clinical Investigators or Real-World Clinicians. Arthritis care & research, 70(7), 1058–1063. https://doi.org/10.1002/acr.23445
2. Liu, X., Li, J., Sun, L., Wang, T., & Liang, W. (2023). The association between neutrophil-to-lymphocyte ratio and disease activity in rheumatoid arthritis. Inflammopharmacology, 31(5), 2237–2244. https://doi.org/10.1007/s10787-023-01273-2
3. Adachi, J. D., Bensen, W. G., Kassam, Y., Powers, P. J., Bianchi, F. A., Cividino, A., Kean, W. F., Rooney, P. J., Craig, G. L., & Buchanan, W. W. (1987). Gold induced thrombocytopenia: 12 cases and a review of the literature. Seminars in arthritis and rheumatism, 16(4), 287–293. https://doi.org/10.1016/0049-0172(87)90006-0
4. Akesson, A., & Wollheim, F. A. (1989). Organ manifestations in 100 patients with progressive systemic sclerosis: a comparison between the CREST syndrome and diffuse scleroderma. British journal of rheumatology, 28(4), 281–286. https://doi.org/10.1093/rheumatology/28.4.281
5. Akorsu, E. E., Adjabeng, L. B., Sulleymana, M. A., & Kwadzokpui, P. K. (2023). Variations in the full blood count parameters among apparently healthy humans in the Ho municipality using ethylenediamine tetraacetic acid (EDTA), sodium citrate and lithium heparin anticoagulants: A laboratory-based cross-sectional analytical study. Heliyon, 9(6), e17311. https://doi.org/10.1016/j.heliyon.2023.e17311
6. Aletaha, D., Martinez-Avila, J., Kvien, T. K., & Smolen, J. S. (2012). Definition of treatment response in rheumatoid arthritis based on the simplified and the clinical disease activity index. Annals of the rheumatic diseases, 71(7), 1190–1196. https://doi.org/10.1136/annrheumdis-2012-201491
7. Allanore, Y., Simms, R., Distler, O., Trojanowska, M., Pope, J., Denton, C. P., & Varga, J. (2015). Systemic sclerosis. Nature reviews. Disease primers, 1, 15002. https://doi.org/10.1038/nrdp.2015.2
8. Amiot, A., Joly, F., Alves, A., Panis, Y., Bouhnik, Y., & Messing, B. (2009). Long-term outcome of chronic intestinal pseudo-obstruction adult patients requiring home parenteral nutrition. The American journal of gastroenterology, 104(5), 1262–1270. https://doi.org/10.1038/ajg.2009.58
9. Amoda, O., Ravat, V., Datta, S., Saroha, B., & Patel, R. S. (2018). Trends in Demographics, Hospitalization Outcomes, Comorbidities, and Mortality Risk among Systemic Sclerosis Patients. Cureus, 10(5), e2628. https://doi.org/10.7759/cureus.2628
10. Gibofsky A. (2012). Overview of epidemiology, pathophysiology, and diagnosis of rheumatoid arthritis. The American journal of managed care, 18(13 Suppl), S295–S302.
11. Krause, I., Mader, R., Sulkes, J., Paul, M., Uziel, Y., Adawi, M., & Weinberger, A. (2001). Behçet's disease in Israel: the influence of ethnic origin on disease expression and severity. The Journal of rheumatology, 28(5), 1033–1036.
12. Benamour, S., Bennis, R., & Amraoui, A. (1991). A study of 285 cases of Behçet's disease. Behçet's Disease Basic and Clinical Aspects. New York: Marcel Dekker Inc, 259-67.
13. Gheita, T. A., Raafat, H. A., El-Bakry, S. A., Elsaman, A., El-Saadany, H. M., Hammam, N., El-Gazzar, I. I., Samy, N., Elsaid, N. Y., Al-Adle, S. S., Tharwat, S., Ibrahim, A. M., Fawzy, S. M., Eesa, N. N., Shereef, R. E., Ismail, F., Elazeem, M. I. A., Abdelaleem, E. A., El-Bahnasawy, A., Selim, Z. I., ... Egyptian College of Rheumatology (ECR) Rheumatoid Arthritis Study Group (2023). Rheumatoid arthritis study of the Egyptian College of Rheumatology (ECR): nationwide presentation and worldwide stance. Rheumatology international, 43(4), 667–676. https://doi.org/10.1007/s00296-022-05258-2
14. Senna, E. R., De Barros, A. L., Silva, E. O., Costa, I. F., Pereira, L. V., Ciconelli, R. M., & Ferraz, M. B. (2004). Prevalence of rheumatic diseases in Brazil: a study using the COPCORD approach. The Journal of rheumatology, 31(3), 594–597.
15. Müller, H., Rehberger, P., Günther, C., & Schmitt, J. (2012). Determinants of disability, quality of life and depression in dermatological patients with systemic scleroderma. The British journal of dermatology, 166(2), 343–353. https://doi.org/10.1111/j.1365-2133.2011.10624.x
16. Hudson, M., Steele, R., Lu, Y., Thombs, B. D., Canadian Scleroderma Research Group, & Baron, M. (2009). Work disability in systemic sclerosis. The Journal of rheumatology, 36(11), 2481–2486. https://doi.org/10.3899/jrheum.081237
17. Aleem, A., Al Arfaj, A. S., khalil, N., & Alarfaj, H. (2014). Haematological abnormalities in systemic lupus erythematosus. Acta reumatologica portuguesa, 39(3), 236–241.
18. Voulgarelis, M., Kokori, S. I., Ioannidis, J. P., Tzioufas, A. G., Kyriaki, D., & Moutsopoulos, H. M. (2000). Anaemia in systemic lupus erythematosus: aetiological profile and the role of erythropoietin. Annals of the rheumatic diseases, 59(3), 217–222. https://doi.org/10.1136/ard.59.3.217
19. Sufian, A. B. M. A., Kashem, M. A., & Biswas, S. (2017). Pattern of hematological manifestations in patients with systemic lupus erythematosus attending in a tertiary care hospita. Journal of Medicine, 18(2), 86-91.
20. Debarre, S., Karinthi, L., Delamanche, S., Fuché, C., Desforges, P., & Calvet, J. H. (1999). Comparative acute toxicity of o-chlorobenzylidene malononitrile (CS) and oleoresin capsicum (OC) in awake rats. Human & experimental toxicology, 18(12), 724–730. https://doi.org/10.1191/096032799678839617
21. Noguchi, M., Iwamori, M., Hirano, T., Kobayashi, S., Hashimoto, H., Hirose, S., & Nagai, Y. (1992). Autoantibodies to T and B cell lines detected in serum samples from patients with systemic lupus erythematosus with lymphopenia and hypocomplementaemia. Annals of the rheumatic diseases, 51(6), 713–716. https://doi.org/10.1136/ard.51.6.713
22. Chen, Y. C., Yu, H. H., Hu, Y. C., Yang, Y. H., Lin, Y. T., Wang, L. C., Chiang, B. L., & Lee, J. H. (2024). Peripheral blood cells RNA-seq identifies differentially expressed gene network linked to lymphocyte subsets alterations and active lupus nephritis associated with declines in renal function. Heliyon, 10(11), e32303. https://doi.org/10.1016/j.heliyon.2024.e32303
23. Udayamma, K. P., & Joseph, T. Prevalence of Hematological Manifestations in Seropositive Rheumatoid Arthritis in a Tertiary Care Centre in South Kerala.
24. Frayha, R. A., Shulman, L. E., & Stevens, M. B. (1980). Hematological abnormalities in scleroderma. A study of 180 cases. Acta haematologica, 64(1), 25–30. https://doi.org/10.1159/000207206

25. Ruiter, G., Lanser, I. J., de Man, F. S., van der Laarse, W. J., Wharton, J., Wilkins, M. R., Howard, L. S., Vonk-Noordegraaf, A., & Voskuyl, A. E. (2014). Iron deficiency in systemic sclerosis patients with and without pulmonary hypertension. Rheumatology (Oxford, England), 53(2), 285–292. https://doi.org/10.1093/rheumatology/ket331
26. Peirovy, A., Malek Mahdavi, A., Khabbazi, A., Hajialilo, M., Sakhinia, E., & Rashtchizadeh, N. (2020). Clinical Usefulness of Hematologic Indices as Predictive Parameters for Systemic Lupus Erythematosus. Laboratory medicine, 51(5), 519–528. https://doi.org/10.1093/labmed/lmaa002
27. Miglio, A., Valente, C., & Guglielmini, C. (2023). Red Blood Cell Distribution Width as a Novel Parameter in Canine Disorders: Literature Review and Future Prospective. Animals: an open access journal from MDPI, 13(6), 985. https://doi.org/10.3390/ani13060985
28. Akorsu, E. E., Adjabeng, L. B., Sulleymana, M. A., & Kwadzokpui, P. K. (2023). Variations in the full blood count parameters among apparently healthy humans in the Ho municipality using ethylenediamine tetraacetic acid (EDTA), sodium citrate and lithium heparin anticoagulants: A laboratory-based cross-sectional analytical study. Heliyon, 9(6), e17311. https://doi.org/10.1016/j.heliyon.2023.e17311
29. Fu, H., Qin, B., Hu, Z., Ma, N., Yang, M., Wei, T., Tang, Q., Huang, Y., Huang, F., Liang, Y., Yang, Z., & Zhong, R. (2015). Neutrophil- and platelet-to-lymphocyte ratios are correlated with disease activity in rheumatoid arthritis. Clinical laboratory, 61(3-4), 269–273. https://doi.org/10.7754/clin.lab.2014.140927
30. Abd-Elazeem, M. I., & Mohamed, R. A. (2018). Neutrophil-lymphocyte and platelet-lymphocyte ratios in rheumatoid arthritis patients: Relation to disease activity. The Egyptian Rheumatologist, 40(4), 227-231.
31. Farouk, A. M., Abdel Rahman, S. M., Abou Elwafa, M. A. Z., & Aboud, F. M. (2023). Hematological parameters in rheumatoid arthritis and their relationship with disease activity. Ain Shams Medical Journal, 74(2), 493-503.
32. Al-Rawi, Z. S., Gorial, F. I., & Al-Bayati, A. A. (2018). Red Cell Distribution Width in Rheumatoid arthritis. Mediterranean journal of rheumatology, 29(1), 38–42. https://doi.org/10.31138/mjr.29.1.38
33. Remalante, P. P. M., Salido, E. O., Penserga, E. G., & Gauiran, D. T. V. (2020). Red cell distribution width and neutrophil-lymphocyte ratio in rheumatoid arthritis. Rheumatology international, 40(10), 1631–1637. https://doi.org/10.1007/s00296-020-04685-3
34. Taha, S. I., Samaan, S. F., Ibrahim, R. A., Moustafa, N. M., El-Sehsah, E. M., & Youssef, M. K. (2022). Can Complete Blood Count Picture Tell Us More About the Activity of Rheumatological Diseases? Clinical medicine insights. Arthritis and musculoskeletal disorders, 15, 11795441221089182. https://doi.org/10.1177/11795441221089182
35. Amoda, O., Ravat, V., Datta, S., Saroha, B., & Patel, R. S. (2018). Trends in Demographics, Hospitalization Outcomes, Comorbidities, and Mortality Risk among Systemic Sclerosis Patients. Cureus, 10(5), e2628. https://doi.org/10.7759/cureus.2628
36. Tezcan, D., Turan, Ç., Hakbilen, S., & Yilmaz, S. (2022). Role of hematological parameters in systemic sclerosis patients with pulmonary system involvement. Journal of Contemporary Medicine, 12(5), 608-616.
37. Jung, J. H., Lee, Y. M., Lee, E. G., Yoo, W. H., & Lee, W. S. (2017). Neutrophil-to-lymphocyte ratio in diagnosis of systemic sclerosis for prediction of interstitial lung disease. Journal of Rheumatic Diseases, 24(3), 138-142.
38. Yayla, M. E., İlgen, U., Okatan, İ. E., UsluYurteri, E., Torgutalp, M., Keleşoğlu Dinçer, A. B., Aydemir Gülöksüz, E. G., Sezer, S., Turgay, T. M., Kınıklı, G., & Ateş, A. (2020). Association of simple hematological parameters with disease manifestations, activity, and severity in patients with systemic sclerosis. Clinical rheumatology, 39(1), 77–83. https://doi.org/10.1007/s10067-019-04685-0
39. Atilla, N., Yıldırım Çetin, G., & Balkarlı, A. (2016). Association of neutrophil/lymphocyte ratio with the degree ofinterstitial lung disease in systemic sclerosis. Turkish journal of medical sciences, 46(6), 1871–1874. https://doi.org/10.3906/sag-1601-87
40. Morse, K. W., Heinz, N. K., Abolade, J. M., Wright-Chisem, J., Alice Russell, L., Zhang, M., Mirza, S., Pearce-Fisher, D., Orange, D. E., Figgie, M. P., Sculco, P. K., & Goodman, S. M. (2022). Factors Associated with Increasing Length of Stay for Rheumatoid Arthritis Patients Undergoing Total Hip Arthroplasty and Total Knee Arthroplasty. HSS journal: the musculoskeletal journal of Hospital for Special Surgery, 18(2), 196–204. https://doi.org/10.1177/15563316221076603
41. Padjen, I., Öhler, L., Studenic, P., Woodworth, T., Smolen, J., & Aletaha, D. (2017). Clinical meaning and implications of serum hemoglobin levels in patients with rheumatoid arthritis. Seminars in arthritis and rheumatism, 47(2), 193–198. https://doi.org/10.1016/j.semarthrit.2017.03.001