# Blood Cell Indices in Ankylosing Spondylitis and Psoriatic Arthritis with Relation to the Disease Activity: A Cross-Sectional Study

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## ABSTRACT

**Background:** Red blood cell distribution width (RDW) and mean platelet volume (MPV) are influenced by autoimmune diseases as RA.

**Objective:** This study aimed to assess RDW, MPV levels and different hematological indices in ankylosing spondylitis (AS) and psoriatic arthritis (PsA) to investigate their relations with disease activity.

**Methods:** A total of 120 patients (60 AS and 60 PsA) were enrolled. Demographic data, disease activity scores, complete blood count (CBC), erythrocyte sedimentation rate (ESR) and C-reactive protein (CRP) levels were recorded. RDW, MPV and various ratios were measured.

**Results:** Patients mean age was $44.750 \pm 12.187S$ years were elevated in PsA and AS patients. RDW and MPV were significantly higher in patients with active PsA patients ($14.495 \pm 1.9$ and $8.903 \pm 1.166fl$) than in inactive ones ($11.975 \pm 0.5fl$ and $8.220 \pm 0.5$ fl, p value <0.001, 0.014 respectively). While in AS active patients RDW was elevated in patients with high bath ankylosing Spondylitis disease activity index (BASDAI) score. RDW% was positively correlated to disease activity among PsA and AS patients (r=0.614 p <0.001) and (r=0.567 p <0.001) respectively. In AS patients, RDW was at a criterion of 12.4, with sensitivity of 83.78% and specificity of 69.5% (p value < 0.001), while in PsA patients' RDW showed good metrics [p value < 0.001; Cutoff:13.2; sensitivity: 72.5%; specificity: 100%].

**Conclusion:** RDW and MPV were potentially elevated in active psoriatic patients and RDW were positively correlated with activity score of AS and PsA, which could be possible important index for disease activity.

**Key words:** Ankylosing spondylitis, Psoriatic arthritis, Mean platelet volume, Red cell distribution width.

## INTRODUCTION

Spondyloarthropathy (SPA) are immune-mediated disease characterized by systemic inflammation with functional affection of various organs including joints and others [1]. Chronic inflammatory arthritis is the predominate involvement of ankylosing spondylitis (AS) & psoriatic arthritis (PsA) [2].

These patients usually alternate activity with remission state along the disease course. Of determinant of disease activity and inflammatory milieu are the Disease Activity Score and usual laboratory markers like erythrocyte sedimentation rate (ESR) and C-reactive protein (CRP) [3].

A mass activation of the immune system leads to the autoantibodies overproduction, immune complexes, and inflammatory cytokines promition, which interplay to produce eventual disease commencement that can affect different peripheral blood cells and their indices as activated platelets can trigger sequences of physiological and pathological reactions, liberating different platelet-derived proteins, chemokines and growth factors, which might result into immune- inflammatory disorders [4-6]. Through that, they react with neutrophils allowing the release of inflammatory cytokines.

Mounting evidence that mean platelet volume (MPV), red blood cell distribution width (RDW) [7], and other parameters (e.g., neutrophil-to-lymphocyte ratio

[NLR]) are illustrated as reliable, accurate bio inflammatory markers in various autoimmune diseases [8]. Moreover, red blood cell distribution width-to-platelet ratio (RPR) has been presented as a surrogate and rapid index to predict morbidity and mortality in liver cirrhosis and acute pancreatitis.

The relations between blood indices and disease activity in spondyloarthropathy cases have not been widely investigated [9-10] yet the impact of those heamoparameters and ratios not extensively investigated among spondyloarthropathies that may give hand to structured model of different clinical and laboratory categories that may be used to assess disease activity and damage index in such diseases. Accordingly, this study aimed to assess the association between blood cell indices with the disease activity in AS and PsA, and to determine whether those indices can be used as a predictor of disease activity.

## MATERIALS AND METHODS

**Study design:** Observational study (cross- sectional) study. A convenient sample of patients were recruited from Outpatient Clinic of Internal Medicine Department and Rheumatology Department at Ain Shams and Kasr-Alainy hospitals.

**Study setting and sampling:** The study was conducted on 60 AS patients, 60 PsA patients. All AS patients were diagnosed according to the Assessment of Spondylarthritis International Society classification criteria for spondylarthritis [12] and PsA in line with Moll and Wright criteria for psoriatic arthritis [11].

**Exclusion criteria:**

Anyone who had other inflammatory, autoimmune diseases, infectious diseases, malignancies, diabetes mellitus, or liver/kidney diseases.

**Calculation of sample size:**

Based on evidence from prior study done on autoimmune disease. Epi-calc 2000 was used to calculate the sample size of this cross-sectional study. Assuming 80% power, 0.05 level of significance, 60% proportion of exposed individuals, to detect odds ratio OR= 2.5 Sample size will be = 110 participants). Considering drop-outs rate of 10%, therefore the final sample size was 120 participants.

**Methodology**

All patients were subjected to full medical history and clinical examination. Disease activity was assessed using Ankylosing Spondylitis Disease Activity Score (ASDAS) [13], where patients with ASDAS scores < 1.3 were considered as inactive and those >1.3 were considered as active patients. Whilst, psoriatic disease activity was evaluated by Disease Activity in Psoriatic Arthritis (DAPSA) Score [14]. Patients with score 0-4 were considered inactive while those with score > 4 were considered active patients.

**Laboratory investigations:** Blood samples were drawn and chemically analyzed within 2 hrs from time of collection. Complete blood cell (CBC) analysis was done by the Coulter Counter mode including total white blood cell (WBC), with differential of neutrophil and lymphocyte count, RDW%, MCV, MCH and platelet counts, MPV and PDW.

*Statistical analysis*
-Data were coded and entered using the statistical package SPSS version 24. For quantitative variables comparisons, nonparametric Kruskal-Wallis and Mann-Whitney tests were used. While, chi-square ($\chi^2$) test was performed for categorical data.

**Ethical consideration:**

The institutional ethical committee (Ain Shams University Hospitals) approved the study.An informed consents were taken from the patients with explaining the objectives and the methods of this study. Confidentiality was guaranteed on handling the data conformed to the revised biomedical ethics of Helsinki deceleration.

**RESULTS**

In 60 PsA patients, average age in years was 44.750 ± 12.187, 38 were females (63.33%), 22 were males (36.67%), 20(33.33%) patients had inactive disease while 40 (66.67%) were active (Table 1). Among 60 AS patients the mean age was 39.600 ± 12.048 years, 41 (68.33%) patients were males while 19 (31.67%) were females. Patients with active disease were 37 (61.67%) while 23 patients were inactive (38.33%) as shown in table (2).

**Table (1):** Descriptive data of PSA patients

| PSA | | | | |
|---|---|---|---|---|
| **Age (Years)** | **Median** | 46 | | |
| | **IQR** | 38 | - | 53 |
| **DD (Years)** | **Median** | 10 | | |
| | **IQR** | 6 | - | 15 |
| | | **N** | | **%** |
| **Sex** | **Male** | 22 | | 36.67 |
| | **Female** | 38 | | 63.33 |
| **Peripheral affection** | **Yes** | 48 | | 80 |
| | **No** | 12 | | 20 |
| **Axial affection** | **Yes** | 43 | | 71.67 |
| | **No** | 17 | | 28.33 |
| **No Tender j** | **Median** | 18.5 | | |
| | **IQR** | 11 | - | 34 |
| **No Swollen j** | **Median** | 3 | | |
| | **IQR** | 2 | - | 5 |
| **DAPSA score** | **Median** | 21.8 | | |
| | **IQR** | 4 | - | 32 |
| **Disease Activity** | **Remission** | 20 | | 33.33 |
| | **Mild** | 0 | | 0 |
| | **Moderate** | 18 | | 30 |
| | **Severe** | 22 | | 36.67 |
| **Disease Activity** | **Inactive** | 20 | | 33.33 |
| | **Active** | 40 | | 66.67 |
| **WBCS (10⁹/L)** | **Mean ±SD** | 6.558 | ± | 1.131 |
| **Neutrophils (10⁹/L)** | **Mean ±SD** | 4.148 | ± | 1.58 |
| **Lymphocytes (10⁹/L)** | **Mean ±SD** | 1.993 | ± | 0.3 |
| **HCT (%)** | **Mean ±SD** | 37.088 | ± | 1.567 |
| **RBCs (10¹²/L)** | **Mean ±SD** | 4.793 | ± | 0.532 |
| **Hb (g/L)** | **Mean ±SD** | 12.6 | ± | 1.102 |
| **MCV( fL)** | **Mean ±SD** | 80.235 | ± | 7.156 |
| **MCH (pg)** | **Mean ±SD** | 24.933 | ± | 3.973 |
| **RDW%** | **Mean ±SD** | 13.655 | ± | 2.015 |
| **PLT(10⁹/L)** | **Mean ±SD** | 247.833 | ± | 7.786 |
| **MPV/fl** | **Mean ±SD** | 8.675 | ± | 1.027 |
| **PDW%** | **Mean ±SD** | 11.945 | ± | 2.513 |
| **Hb/PLT ratio** | **Mean ±SD** | 0.055 | ± | 0.017 |
| **RDW%/PLT ratio** | **Mean ±SD** | 0.059 | ± | 0.018 |
| **RBCs/PLT ratio** | **Mean ±SD** | 0.021 | ± | 0.006 |
| **Hb/RDW% ratio** | **Mean ±SD** | 0.941 | ± | 0.153 |
| **NLR ratio** | **Mean ±SD** | 2.091 | ± | 0.491 |
| **PLR ratio** | **Mean ±SD** | 133.302 | ± | 8.824 |
| **ESR (mm/h)** | **Mean ±SD** | 60.475 | ± | 7.728 |
| **CRP (mg/L)** | **Mean ±SD** | 14.667 | ± | 7.097 |
| **HLA B27** | **Positive** | 43 | | 71.67 |
| | **Negative** | 17 | | 28.33 |

SD: Standard Deviation, No: number, %: percentage, mm/h: millimeter per hour, mg/L: milligram per Liter, IU/ml: International unit per milliliter, U/L: Unit per liter, mg/dL: milligram per Deci Liter WBCs: White blood cells, HCT: Hematocrit, RBCs: Red blood cells, Hb: Hemoglobin, MCV: Mean corpuscular volume, MCH: Mean corpuscular Hemoglobin, RDW: Red cell distribution width, PLT: Platelets, MPV: Mean platelet volume, PDW: Platelet distribution width, Hb/PLT ratio: Hemoglobin/Platelet ratio, RDW/PLT ratio: Red cell distribution width/ Platelet ratio, RBCs/PLT ratio: Red blood cells/Platelet ratio, Hb/RDW ratio: Hemoglobin/ Red cell distribution width ratio, NLR: Neutrophil/Lymphocyte ratio, PLR: Platelet/Lymphocyte ratio, /mm³: Per cubic millimeter, %: percentage, g/dL: Gram per deci Liter, fl: femtoliter, pg: picogram, t: independent sample t test, P: probability value, *: p<0.05 is statistically significant, **: p ≤ 0.001 is statistically highly significant.
Median (IQR) for non-parametric data , Mean±SD for parametric data

**Table (2):** Descriptive data of AS patients

| AS | | | |
|---|---|---|---|
| **Age (Years)** | **Median** | 41 | |
| | **IQR** | 33 - | 46.5 |
| **DD (Years)** | **Median** | 6.5 | |
| | **IQR** | 3 - | 10 |
| | | **N** | **%** |
| **Sex** | **Male** | 41 | 68.33 |
| | **Female** | 19 | 31.67 |
| **Peripheral** | **Yes** | 38 | 63.33 |
| | **No** | 22 | 36.67 |
| **Axial** | **Yes** | 60 | 100 |
| | **No** | 0 | 0 |
| **Tender j** | **Median** | 5 | |
| | **IQR** | 2.5 - | 7 |
| **Swollen j** | **Median** | 2 | |
| | **IQR** | 1 - | 3 |
| **ASDAS score** | **Median** | 2.2 | |
| | **IQR** | 1.2 - | 3.5 |
| **Disease Activity** | **Remission** | 23 | 38.33 |
| | **Mild** | 0 | 0 |
| | **Moderate** | 7 | 11.67 |
| | **Severe** | 13 | 21.67 |
| | **Very severe** | 17 | 28.33 |
| **Disease Activity** | **Inactive** | 23 | 38.33 |
| | **Active** | 37 | 61.67 |
| **WBCS (10$^9$/L)** | **Mean ±SD** | 6.853 ± | 1.737 |
| **Neutrophils (10$^9$/L)** | **Mean ±SD** | 3.988 ± | 1.311 |
| **Lymphocytes (10$^9$/L)** | **Mean ±SD** | 2.443 ± | 0.792 |
| **HCT (%)** | **Mean ±SD** | 38.14 ± | 3.213 |
| **RBCs (10$^{12}$/L)** | **Mean ±SD** | 4.915 ± | 0.644 |
| **Hb (g/L)** | **Mean ±SD** | 12.978 ± | 1.639 |
| **MCV (fL)** | **Mean ±SD** | 78.268 ± | 7.214 |
| **MCH (pg)** | **Mean ±SD** | 25.397 ± | 3.914 |
| **RDW%** | **Mean ±SD** | 13.232 ± | 1.6 |
| **PLT (10$^9$/L)** | **Mean ±SD** | 309.65 ± | 21.259 |
| **MPV/fl** | **Mean ±SD** | 9.695 ± | 2.322 |
| **PDW%** | **Mean ±SD** | 11.457 ± | 2.739 |
| **Hb/PLT ratio** | **Mean ±SD** | 0.048 ± | 0.018 |
| **RDW%/PLT ratio** | **Mean ±SD** | 0.048 ± | 0.016 |
| **RBCs/PLT ratio** | **Mean ±SD** | 0.018 ± | 0.007 |
| **Hb/RDW% ratio** | **Mean ±SD** | 0.997 ± | 0.179 |
| **NLR ratio** | **Mean ±SD** | 1.786 ± | 0.4 |
| **PLR ratio** | **Mean ±SD** | 139.872 ± | 6.929 |
| **ESR (mm/h)** | **Mean ±SD** | 38.383 ± | 4.654 |
| **CRP (mg/L)** | **Mean ±SD** | 9.95 ± | 2.819 |
| **HLA B27** | **Positive** | 37 | 61.67 |
| | **Negative** | 23 | 38.33 |

SD: Standard Deviation, No: number, %: percentage, mm/h: millimeter per hour, mg/L: milligram per Liter, IU/ml: International unit per milliliter, U/L: Unit per liter, mg/dL: milligram per Deci Liter WBCs: White blood cells, HCT: Hematocrit, RBCs: Red blood cells, Hb: Hemoglobin, MCV: Mean corpuscular volume, MCH: Mean corpuscular Hemoglobin, RDW: Red cell distribution width, PLT: Platelets, MPV: Mean platelet volume, PDW: Platelet distribution width, Hb/PLT ratio: Hemoglobin/Platelet ratio, RDW/PLT ratio: Red cell distribution width/ Platelet ratio, RBCs/PLT ratio: Red blood cells/Platelet ratio, Hb/RDW ratio: Hemoglobin/ Red cell distribution width ratio, NLR: Neutrophil/Lymphocyte ratio, PLR: Platelet/Lymphocyte ratio, /mm$^3$: Per cubic millimeter, %: percentage, g/dL: Gram per deci Liter, fl: femtoliter, pg: picogram, t: independent sample t test, P: probability value, *: p<0.05 is statistically significant, **: p≤0.001 is statistically highly significant. Median (IQR) for non-parametric data , Mean±SD for parametric data

Patients then were divided into active group and inactive group, comparison between both groups was done regarding the different blood cell indices. On comparing the different blood cell indices in active and non-active psoriatic patients, we demonstrated significantly higher RDW% (p<0.001) and MPV (p<0.014) and significantly lower HB/RDW% ratio (p<0.001) in patients who are active as opposed to inactive one (Table 3). However, active AS patients had significantly higher RDW% (p<0.001) and lower Hb/RDW% ratio (p<0.003) compared to inactive patients (Table 4).

**Table (3):** Comparison between active & inactive PsA patients as regard WBCs, RBCs and platelet indices

| PSA | Disease Activity | | | | | | T-Test | |
|---|---|---|---|---|---|---|---|---|
| | Inactive | | | Active | | | | |
| | Mean | ± | SD | Mean | ± | SD | t | P-value |
| NEUT($10^9$/L) | 4.120 | ± | 1.630 | 4.163 | ± | 1.575 | -0.097 | 0.923 |
| HCT (%) | 37.060 | ± | 1.338 | 37.103 | ± | 1.686 | -0.098 | 0.922 |
| RBCs($10^{12}$/L) | 4.772 | ± | 0.506 | 4.804 | ± | 0.550 | -0.220 | 0.827 |
| Hb(g/L) | 12.550 | ± | 0.805 | 12.625 | ± | 1.233 | -0.246 | 0.806 |
| MCV( fL) | 80.575 | ± | 4.835 | 80.065 | ± | 8.124 | 0.258 | 0.797 |
| MCH (pg) | 24.805 | ± | 3.067 | 24.998 | ± | 4.392 | -0.175 | 0.861 |
| RDW% | 11.975 | ± | 0.587 | 14.495 | ± | 1.951 | -5.629 | <0.001* |
| MPV/fl | 8.220 | ± | 0.562 | 8.903 | ± | 1.132 | -2.536 | 0.014* |
| PDW% | 11.480 | ± | 2.081 | 12.178 | ± | 2.698 | -1.014 | 0.315 |
| NEUT/Lympho ratio | 2.132 | ± | 0.563 | 2.070 | ± | 0.457 | 0.455 | 0.651 |
| | Inactive | | | Active | | | Mann-Whitney test | |
| | Median | IQR | | Median | IQR | | Z | P-value |
| WBCS | 6.000 | 4.150 - | 8.250 | 6.300 | 5.250 - | 7.400 | 0.660 | 0.509 |
| Lympho | 2.100 | 1.450 - | 2.450 | 1.900 | 1.500 - | 2.100 | 0.024 | 0.981 |
| PLT | 216.000 | 208.000 - | 240.000 | 235.000 | 215.000 - | 276.500 | 1.359 | 0.174 |
| Hb/PLT ratio | 0.060 | 0.050 - | 0.060 | 0.050 | 0.040 - | 0.060 | 1.074 | 0.283 |
| RDW%/PLT ratio | 0.055 | 0.050 - | 0.060 | 0.060 | 0.050 - | 0.070 | 1.407 | 0.159 |
| RBCs/PLT ratio | 0.020 | 0.020 - | 0.030 | 0.020 | 0.020 - | 0.020 | 0.659 | 0.510 |
| Hb/RDW% ratio | 1.045 | 0.975 - | 1.100 | 0.845 | 0.750 - | 0.995 | 3.831 | <0.001* |
| PLT/Lympho ratio | 139.855 | 90.950 - | 154.315 | 132.110 | 91.355 - | 160.000 | 0.031 | 0.975 |

**Table (4):** Comparison between active and inactive AS patients as regard WBCs, RBCs and platelet indices

| AS | Disease Activity | | | | | | T-Test | |
|---|---|---|---|---|---|---|---|---|
| | Inactive | | | Active | | | | |
| | Mean | ± | SD | Mean | ± | SD | t | P-value |
| HCT (%) | 38.896 | ± | 3.064 | 37.670 | ± | 3.255 | 1.450 | 0.153 |
| RBCs($10^{12}$/L) | 5.048 | ± | 0.733 | 4.833 | ± | 0.578 | 1.262 | 0.212 |
| Hb(g/L) | 13.091 | ± | 1.759 | 12.908 | ± | 1.581 | 0.418 | 0.678 |
| MCV (fL) | 78.235 | ± | 9.023 | 78.289 | ± | 5.961 | -0.028 | 0.978 |
| MCH (pg) | 25.291 | ± | 3.731 | 25.462 | ± | 4.074 | -0.163 | 0.871 |
| RDW% | 12.270 | ± | 1.365 | 13.830 | ± | 1.449 | -4.144 | <0.001* |
| MPV/fl | 9.683 | ± | 2.605 | 9.703 | ± | 2.166 | -0.032 | 0.974 |
| | Inactive | | | Active | | | Mann-Whitney test | |
| | Median | IQR | | Median | IQR | | Z | P-value |
| WBCS | 6.000 | 4.800 - | 8.400 | 7.300 | 6.400 - | 8.300 | 1.217 | 0.223 |
| NEUT | 3.200 | 2.400 - | 4.800 | 3.600 | 3.500 - | 4.700 | 1.204 | 0.229 |
| Lympho | 2.000 | 1.500 - | 2.950 | 2.700 | 2.000 - | 3.100 | 1.767 | 0.077 |
| PLT | 288.000 | 201.000 - | 387.500 | 255.000 | 240.000 - | 365.000 | 0.152 | 0.879 |
| PWD | 10.100 | 9.750 - | 11.650 | 11.000 | 9.900 - | 11.700 | 0.822 | 0.411 |
| Hb/PLT ratio | 0.050 | 0.030 - | 0.060 | 0.050 | 0.030 - | 0.060 | 0.139 | 0.889 |
| RDW%/PLT ratio | 0.040 | 0.030 - | 0.060 | 0.050 | 0.040 - | 0.060 | 1.307 | 0.191 |
| RBCs/PLT ratio | 0.020 | 0.010 - | 0.020 | 0.020 | 0.010 - | 0.020 | 0.312 | 0.755 |
| Hb/RDW% ratio | 1.100 | 0.960 - | 1.255 | 0.980 | 0.800 - | 1.070 | 2.792 | 0.005* |
| NEUT/Lympho ratio | 1.470 | 1.380 - | 2.105 | 1.440 | 1.240 - | 1.970 | 0.548 | 0.584 |
| PLT/Lympho ratio | 166.000 | 84.780 - | 210.670 | 124.140 | 70.000 - | 185.240 | 1.886 | 0.059 |

No: number, %: percentage, mm/h: millimeter per hour, mg/L: milligram per Liter, IU/ml: International unit per milliliter, U/L: Unit per liter, mg/dL: milligram per Deci Liter WBCs: White blood cells, HCT: Hematocrit, RBCs: Red blood cells, Hb: Hemoglobin, MCV: Mean corpuscular volume, MCH: Mean corpuscular Hemoglobin, RDW: Red cell distribution width, PLT: Platelets, MPV:

Mean platelet volume, PDW: Platelet distribution width, Hb/PLT ratio: Hemoglobin/Platelet ratio, RDW/PLT ratio: Red cell distribution width/ Platelet ratio, RBCs/PLT ratio: Red blood cells/Platelet ratio, Hb/RDW ratio: Hemoglobin/ Red cell distribution width ratio, NLR: Neutrophil/Lymphocyte ratio, PLR: Platelet/Lymphocyte ratio, /mm$^3$: Per cubic millimeter, %: percentage, g/dL: Gram per deci Liter, fl: femtoliter, pg: picogram, t: independent sample t test, P: probability value, *: p<0.05 is statistically significant, **: p≤0.001 is statistically highly significant

      Correlation of different blood cell indices with disease activity clinical and laboratory parameters showed that among psoriatic patients, RDW% was positively correlated with the number of tender and swollen joint, disease activity score, ESR and the C-RP titer. Hb/RDW% ratio was negatively correlated with all same parameters. While, the MCV was negatively correlated with the number of tender joints, swollen joint and ESR (Table 5).

Regarding patients, results yielded that RDW% was positively correlated to disease activity score and tender joints. While, the Hb/RDW% ratio was inversely correlated to same parameters (Table 6).

**Table (5):** Correlation between the WBCs, RBCs, Platelets indices and parameters of disease activity in PsA

| PSA | Tender j | | Swollen j | | Activity score | | ESR | | CRP | |
|---|---|---|---|---|---|---|---|---|---|---|
| | r | P-value | r | P-value | r | P-value | r | P-value | r | P-value |
| WBCS (10⁹/L) | -0.161 | 0.219 | -0.153 | 0.266 | -0.042 | 0.750 | -0.125 | 0.342 | 0.110 | 0.402 |
| NEUT (10⁹/L) | -0.186 | 0.154 | -0.197 | 0.150 | -0.102 | 0.436 | -0.191 | 0.144 | 0.052 | 0.694 |
| Lympho(10⁹/L) | -0.247 | 0.057 | -0.239 | 0.078 | -0.119 | 0.366 | -0.196 | 0.134 | 0.083 | 0.526 |
| HCT (%) | -0.025 | 0.847 | -0.022 | 0.873 | 0.021 | 0.873 | 0.057 | 0.667 | -0.093 | 0.480 |
| RBCs(10¹²/L) | 0.054 | 0.680 | 0.067 | 0.627 | 0.108 | 0.413 | 0.154 | 0.241 | -0.024 | 0.858 |
| Hb(g/L) | 0.084 | 0.523 | 0.050 | 0.716 | 0.058 | 0.662 | -0.041 | 0.755 | -0.043 | 0.742 |
| MCV (fL) | -0.250 | 0.054* | -0.347 | 0.009* | -0.213 | 0.102 | -0.266 | 0.040* | -0.186 | 0.155 |
| MCH (pg) | -0.205 | 0.117 | -0.205 | 0.133 | -0.130 | 0.321 | -0.165 | 0.209 | -0.001 | 0.995 |
| RDW% | 0.529 | <0.001* | 0.380 | 0.004* | 0.614 | <0.001* | 0.433 | 0.001* | 0.388 | 0.002* |
| PLT (10⁹/L) | 0.039 | 0.770 | 0.004 | 0.978 | 0.050 | 0.707 | -0.040 | 0.764 | 0.039 | 0.768 |
| MPV/fl | 0.263 | 0.042 | 0.172 | 0.210 | 0.196 | 0.134 | 0.187 | 0.153 | 0.172 | 0.188 |
| PDW% | 0.099 | 0.452 | -0.054 | 0.694 | 0.037 | 0.779 | -0.070 | 0.596 | -0.040 | 0.760 |
| Hb/PLT ratio | 0.044 | 0.738 | 0.100 | 0.466 | -0.007 | 0.959 | 0.095 | 0.472 | -0.053 | 0.685 |
| RDW%/PLT ratio | 0.233 | 0.074 | 0.204 | 0.135 | 0.241 | 0.063 | 0.219 | 0.092 | 0.107 | 0.415 |
| RBCs/PLT ratio | -0.024 | 0.855 | 0.061 | 0.660 | -0.057 | 0.668 | 0.093 | 0.480 | -0.050 | 0.705 |
| Hb/RDW% ratio | -0.426 | 0.001* | -0.316 | 0.019* | -0.525 | <0.001* | -0.410 | 0.001* | -0.366 | 0.004* |
| NLR ratio | -0.002 | 0.987 | -0.061 | 0.661 | -0.063 | 0.633 | -0.107 | 0.415 | -0.067 | 0.612 |
| PLR ratio | 0.148 | 0.258 | 0.127 | 0.355 | 0.053 | 0.685 | 0.043 | 0.743 | -0.097 | 0.460 |

**Table (6):** Correlation between the WBCs, RBCs, Platelets indices and parameters of disease activity in AS

| AS | Tender j | | Swollen j | | Activity score | | ESR | | CRP | |
|---|---|---|---|---|---|---|---|---|---|---|
| | r | P-value | r | P-value | r | P-value | r | P-value | r | P-value |
| WBCS(10⁹/L) | 0.246 | 0.071 | 0.005 | 0.978 | 0.204 | 0.118 | 0.100 | 0.447 | 0.368 | 0.004* |
| NEUT(10⁹/L) | 0.114 | 0.408 | -0.019 | 0.906 | 0.148 | 0.260 | 0.364 | 0.004* | 0.355 | 0.005* |
| Lympho(10⁹/L) | 0.285 | 0.035* | -0.004 | 0.978 | 0.150 | 0.253 | -0.085 | 0.521 | 0.193 | 0.139 |
| HCT (%) | -0.180 | 0.188 | -0.164 | 0.313 | -0.099 | 0.451 | -0.017 | 0.899 | 0.084 | 0.522 |
| RBCs(10¹²/L) | -0.110 | 0.425 | -0.331 | 0.037* | -0.060 | 0.647 | 0.092 | 0.483 | 0.235 | 0.070 |
| Hb(g/L) | -0.237 | 0.082 | -0.150 | 0.354 | -0.056 | 0.671 | -0.224 | 0.085 | -0.073 | 0.578 |
| MCV( fL) | -0.178 | 0.193 | 0.492 | 0.001* | 0.069 | 0.603 | 0.015 | 0.907 | -0.157 | 0.232 |
| MCH (pg) | -0.188 | 0.170 | 0.205 | 0.203 | -0.019 | 0.884 | -0.182 | 0.164 | -0.357 | 0.005* |
| RDW% | 0.551 | <0.001* | 0.101 | 0.533 | 0.460 | <0.001* | 0.090 | 0.493 | 0.140 | 0.285 |
| PLT(10⁹/L) | -0.060 | 0.666 | 0.182 | 0.261 | -0.056 | 0.673 | 0.266 | 0.040* | 0.223 | 0.087 |
| MPV/fl | -0.020 | 0.886 | -0.188 | 0.244 | -0.128 | 0.330 | -0.313 | 0.015* | -0.244 | 0.061 |
| PDW% | -0.004 | 0.979 | -0.278 | 0.082 | -0.036 | 0.782 | -0.278 | 0.031* | 0.055 | 0.675 |
| Hb/PLT ratio | -0.027 | 0.844 | -0.314 | 0.048* | -0.066 | 0.614 | -0.319 | 0.013* | -0.161 | 0.220 |
| RDW%/PLT ratio | 0.219 | 0.108 | -0.243 | 0.131 | 0.103 | 0.434 | -0.272 | 0.036* | -0.210 | 0.107 |
| RBCs/PLT ratio | 0.020 | 0.885 | -0.553 | <0.001* | -0.101 | 0.443 | -0.269 | 0.038* | -0.037 | 0.777 |
| Hb/RDW% ratio | -0.543 | <0.001* | -0.166 | 0.306 | -0.364 | 0.004* | -0.189 | 0.148 | -0.137 | 0.297 |
| NLR ratio | -0.172 | 0.208 | 0.081 | 0.619 | 0.033 | 0.803 | 0.300 | 0.020* | 0.087 | 0.509 |
| PLR ratio | -0.305 | 0.023* | 0.175 | 0.279 | -0.127 | 0.332 | 0.208 | 0.111 | -0.031 | 0.812 |

SD: Standard Deviation, No: number, %: percentage, mm/h: millimeter per hour, mg/L: milligram per Liter, IU/ml: International unit per milliliter, U/L: Unit per liter, mg/dL: milligram per Deci Liter WBCs: White blood cells, HCT: Hematocrit, RBCs: Red blood cells, Hb: Hemoglobin, MCV: Mean corpuscular volume, MCH: Mean corpuscular Hemoglobin, RDW: Red cell distribution width, PLT:

Platelets, MPV: Mean platelet volume, PDW: Platelet distribution width, Hb/PLT ratio: Hemoglobin/Platelet ratio, RDW/PLT ratio: Red cell distribution width/ Platelet ratio, RBCs/PLT ratio: Red blood cells/Platelet ratio, Hb/RDW ratio: Hemoglobin/ Red cell distribution width ratio, NLR: Neutrophil/Lymphocyte ratio, PLR: Platelet/Lymphocyte ratio, /mm$^3$: Per cubic millimeter, %: percentage, g/dL: Gram per deci Liter, fl: femtoliter, pg: picogram, t: independent sample t test, P: probability value, *: p<0.05 is statistically significant, **: p≤0.001 is statistically highly significant.

The following ratios, regarding PSA patients, were statistically significant with + ve   HLA B27 test such as Hb/PLT ratio, Hb/RDW% ratio and PLT/Lympho ratio with p< 0.025, <0.002 and <0.012 respectively as shown in table (7). While the AS patient all ratios were statistically insignificant as shown in table (8).

**Table (7): R**elation of HLA B27 test in PSA patients

| PSA | HLA B27 | | | | | | T-Test | |
|---|---|---|---|---|---|---|---|---|
| | Positive | | | Negative | | | | |
| | Mean | ± | SD | Mean | ± | SD | t | P-value |
| WBCS | 6.207 | ± | 1.513 | 7.447 | ± | 1.094 | -2.088 | 0.041* |
| HCT | 37.072 | ± | 1.659 | 37.129 | ± | 1.351 | -0.127 | 0.900 |
| RBCs | 4.713 | ± | 0.533 | 4.994 | ± | 0.487 | -1.882 | 0.065 |
| Hb | 12.398 | ± | 0.939 | 13.112 | ± | 1.333 | -2.346 | 0.022* |
| MCV | 77.970 | ± | 5.643 | 85.965 | ± | 7.522 | -4.488 | <0.001* |
| MCH | 24.019 | ± | 4.069 | 27.247 | ± | 2.610 | -3.026 | 0.004* |
| RDW% | 14.002 | ± | 2.111 | 12.776 | ± | 1.463 | 2.190 | 0.033* |
| MPV/fl | 8.607 | ± | 0.921 | 8.847 | ± | 1.271 | -0.814 | 0.419 |
| PWD | 11.858 | ± | 2.153 | 12.165 | ± | 2.324 | -0.423 | 0.674 |
| NEUT/Lympho ratio | 2.073 | ± | 0.12 | 2.135 | ± | 0.445 | -0.436 | 0.665 |
| | Positive | | | Negative | | | Mann-Whitney Test | |
| | Median | IQR | | Median | IQR | | Z | P-value |
| WBCS | 6.100 | 5.200 - | 7.050 | 7.300 | 4.300 - | 9.200 | 1.232 | 0.218 |
| NEUT | 4.000 | 2.850 - | 4.800 | 5.100 | 3.200 - | 6.100 | 1.380 | 0.168 |
| Lympho | 1.800 | 1.500 - | 2.100 | 2.100 | 1.600 - | 2.700 | 1.855 | 0.064 |
| PWD | 11.900 | 10.100 - | 13.300 | 10.800 | 10.000 - | 13.100 | 0.296 | 0.767 |
| Hb/PLT ratio | 0.050 | 0.040 - | 0.060 | 0.060 | 0.050 - | 0.070 | 2.626 | 0.009* |
| RDW%/PLT ratio | 0.060 | 0.050 - | 0.060 | 0.060 | 0.050 - | 0.070 | 1.286 | 0.198 |
| RBCs/PLT ratio | 0.020 | 0.020 - | 0.020 | 0.020 | 0.020 - | 0.030 | 1.700 | 0.089 |
| Hb/RDW% ratio | 0.920 | 0.760 - | 1.020 | 1.050 | 0.960 - | 1.100 | 3.022 | 0.003* |
| PLT/Lympho ratio | 145.330 | 118.155 - | 155.770 | 80.000 | 77.620 - | 134.380 | 2.840 | 0.005* |

Parametric data represented by mean SD   -Non parametric data represented by median (IQR)

**Table (8):** Relation of HLA B27 test in AS patients.

| AS | HLA B27 | | | | | | T-Test | |
|---|---|---|---|---|---|---|---|---|
| | Positive | | | Negative | | | | |
| | Mean | ± | SD | Mean | ± | SD | t | P-value |
| HCT | 38.146 | ± | 3.146 | 38.130 | ± | 3.391 | 0.018 | 0.986 |
| RBCs | 4.959 | ± | 0.749 | 4.846 | ± | 0.434 | 0.657 | 0.514 |
| Hb | 12.973 | ± | 1.582 | 12.987 | ± | 1.763 | -0.032 | 0.975 |
| MCV | 78.327 | ± | 7.160 | 78.174 | ± | 7.460 | 0.079 | 0.937 |
| MCH | 25.376 | ± | 4.430 | 25.430 | ± | 2.995 | -0.052 | 0.959 |
| RDW% | 13.241 | ± | 1.713 | 13.217 | ± | 1.437 | 0.054 | 0.957 |
| PLT | 322.568 | ± | 16.804 | 288.870 | ± | 41.543 | 1.047 | 0.299 |
| Hb/RDW% ratio | 0.997 | ± | 0.178 | 0.996 | ± | 0.186 | 0.029 | 0.977 |
| | Positive | | | Negative | | | Mann-Whitney Test | |
| | Median | IQR | | Median | IQR | | Z | P-value |
| WBCS | 6.900 | 5.000 - | 8.300 | 7.500 | 5.450 - | 8.600 | 0.723 | 0.470 |
| NEUT | 3.600 | 2.800 - | 4.700 | 4.400 | 3.200 - | 4.850 | 0.541 | 0.588 |
| Lympho | 2.500 | 1.800 - | 2.900 | 2.400 | 1.600 - | 3.300 | 0.099 | 0.921 |
| PLT | 312.000 | 245.000 - | 373.000 | 253.000 | 201.000 - | 300.000 | 1.666 | 0.096 |
| MPV/fl | 9.200 | 8.600 - | 10.200 | 9.300 | 8.700 - | 10.900 | 0.891 | 0.373 |
| PWD | 10.100 | 9.800 - | 11.400 | 11.000 | 9.900 - | 12.600 | 1.485 | 0.138 |
| Hb/PLT ratio | 0.050 | 0.030 - | 0.060 | 0.050 | 0.050 - | 0.060 | 1.821 | 0.069 |
| RDW%/PLT ratio | 0.040 | 0.030 - | 0.060 | 0.050 | 0.040 - | 0.065 | 1.384 | 0.166 |
| RBCs/PLT ratio | 0.020 | 0.010 - | 0.020 | 0.020 | 0.020 - | 0.020 | 1.602 | 0.109 |
| NEUT/Lympho ratio | 1.440 | 1.290 - | 1.750 | 1.440 | 1.250 - | 2.105 | 0.221 | 0.825 |
| PLT/Lympho ratio | 133.330 | 92.590 - | 201.720 | 141.480 | 76.065 - | 190.955 | 0.844 | 0.399 |

WBCs: White blood cells, HCT: Hematocrit, RBCs: Red blood cells, Hb: Hemoglobin, MCV: Mean corpuscular volume, MCH: Mean corpuscular Hemoglobin, RDW: Red cell distribution width, PLT: Platelets, MPV: Mean platelet volume, PDW: Platelet distribution width, Hb/PLT ratio: Hemoglobin/Platelet ratio, RDW/PLT ratio: Red cell distribution width/ Platelet ratio, RBCs/PLT ratio: Red blood cells/Platelet ratio, Hb/RDW ratio: Hemoglobin/ Red cell distribution width ratio, NLR: Neutrophil/Lymphocyte ratio, PLR: Platelet/Lymphocyte ratio, /mm$^3$: Per cubic millimeter, %: percentage, g/dL: Gram per deci Liter, fl: femtoliter, pg: picogram, t: independent sample t test, P: probability value, *: p<0.05 is statistically significant, **: p≤0.001 is statistically highly significant.

**Diagnostic role of RDW to predict disease activity**

The ROC curve revealed that the best RDW% cut-off value for disease activity prediction in AS was >12.4. The sensitivity was 83.78% and the specificity was 69.57% with positive predictive value of 81.6%.

In PsA patients, the best RDW% cut-off value for disease activity prediction was >13.2 with specificity of 100.0% and sensitivity of 72.50% with 100.0% positive predictive value. While, the best MPV cut-off value for predicting disease activity was > 8.4 with specificity of 70.0% and sensitivity of 67.50% with positive predictive value is 81.8% (**Figures 1 & 2).**
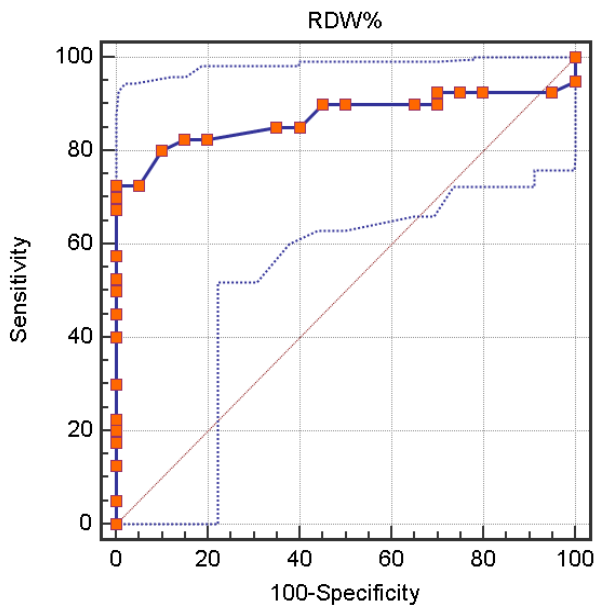


**Fig (1)** ROC curve showed the validity of RDW for disease activity prediction in PsA patients
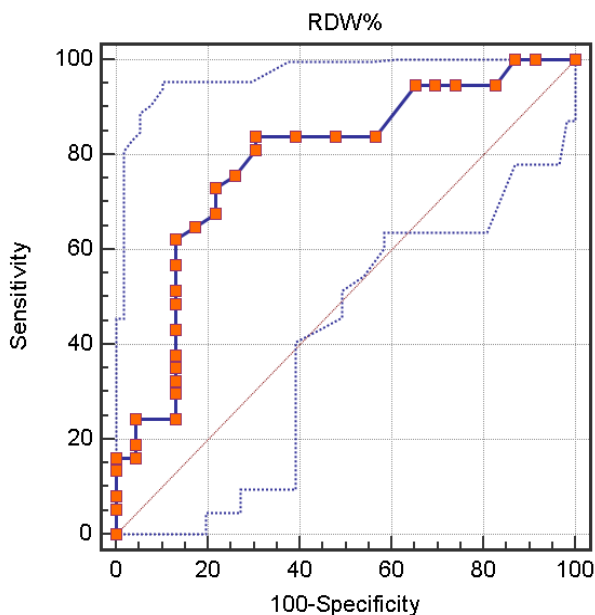


**Fig (2)** ROC curve showed the validity of RDW for disease activity prediction in AS patients

**DISCUSSION**

The etiopathogenesis of spondyloarthropathy is the result of interplay between genetic, immunoregulatory, ethnic, factors, and several key points of these multifactorial connections are still unclear [15], with summit of inflammatory status, which influence the disease severity.

MPV and RDW could reflect the extent of heterogeneity of circulating erythrocytes volume and platelets, which are influenced in inflammatory conditions [16]. Despite a great amount of evidence about the relations between MPV, RDW, platelet count and other hematological parameters in rheumatic diseases has been elucidated, but controversial results have been found [17]. However, disease activity relation in either PsA or AS and various blood cell indices has not been fully demonstrated yet [18].

In current study, trying to assess the relation between the various blood cell indices and the clinical, laboratory parameters of disease activity. In psoriatic patients we demonstrated significantly lower HB/RDW% ratio (p<0.001) and significantly higher RDW% (p<0.001) among patients who are active vs those who are not. Also, the number of tender joints, swollen joints, disease activity score, ESR and the CRP titer were positively correlated with RDW%, while they were negatively correlated with Hb/RDW% ratio. The MCV was negatively correlated with the number of tender joints, swollen joints and ESR. That may reflect the significance of these indices as indicators of disease activity and inflammation. This is similar to the results of **Gisondi** [19] who revealed that RDW is elevated in psoriatic patients, but unsimilarly, RDW did not seem to be associated with disease severity. Moreover, **Ozisler and Sandikci** [20] concluded that increased RDW found in active disease and it may be indicator of the inflammation similar to the CRP and ESR. And that RDW could be a biomarker of disease activity in PsA.

Although MPV (p < 0.014) was significantly higher in active patients but MPV was not correlated to activity score. This is matching with a previous study where the correlation was not significant between PASI values and MPV level [21, 22, 23]. This contradiction might be attributed to different ethnic population and sample size.

Regarding AS, active patients had significantly higher RDW% (p<0.001) and lower Hb/RDW% ratio (p<0.003) compared to inactive patients. Also, RDW% was positively correlated to the number of tender joints and disease activity score. While, the Hb/RDW% ratio was inversely correlated to same parameters. This agrees with **Melek and Coworkers** [24] who found RDW showed higher significancy in AS patients than in the controls. They had detected that RDW differed significantly in active compared to non-active patients. In line with

current study, activity score of AS was positively related to RDW and not related to MPV, other studies found MPV was not correlated to BSDAI [24, 25]. In contrast to the above-mentioned results, according to certain research, AS with active AS had lower MPV compared to inactive patients [26, 27]. this may be attributed to super production of acute reactants and pro-inflammatory cytokines that reduce the size of platelets [28].

RDW and MPV has been shown to be strongly associated with CRP and ESR in a various inflammatory disease as RA, IBD. Moreover, CRP has been observed to be linearly related to elevated RDW and MPV in prior studies [29-31] and these results partially disagree with ours as we didn't find correlation between MPV, CRP and RDW values although there was negative correlation of MPV to the ESR.

On evaluation of the performance validity of heamoparameters, the current study concluded that RDW% higher specificity with good sensitivity for prediction of psoriatic activity, while among AS, RDW showed good sensitivity with fair specificity inconsistent with another study that showed RDW and MPV were more specific than sensitive for disease activity [24].

Chronic inflammation can adversely influence, in view of these results, thrombopoiesis erythropoiesis through variable routs such as cell apoptosis and increased oxidative stress. Thus, inflammation may lead to anisocytosis and change in platelet maturation and size in spondyloarthropathy patients. Once CBC is cheap and easy to be done, blood cell indices could be used as tool for detection and following the activity of the disease.

Regarding the HLA-B 27, PSA patients with + ve HLA B27 test had lower Hb/PLT ratio, with higher Hb/RDW% ratio and PLR, while there was no significant difference between the AS patients in both HLA B27 groups.

The current study has some shortcomings: It is cross-sectional in design, small sized sample and no accessible information about the nutritional status or nutritional elements as levels of vitamin B12, folic acid or iron, which may result in change in CBC parameters.

## CONCLUSION
The current study has suggested that blood cell indices were related to both clinical and laboratory parameter of the disease activity in both AS and PsA. Also, the RDW% was the most related index to the disease activity score and inflammatory markers and it may be used to distinguish between active from inactive disease with best cut-off value >13.2 and >12.4 in PsA and AS respectively.

## REFERENCES
1. **Duffield S, Miller N, Zhao S, Goodson N (2018):** Concomitant fibromyalgia complicating chronic inflammatory arthritis: a systematic review and meta-analysis. Rheumatology (Oxford), 57 (8): 1453–1460.
2. **Lee J, Sinnathurai P, Buchbinder R *et al*. (2018):** Biologics and cardiovascular events in inflammatory arthritis: a prospective national cohort study. Arthritis Res Ther., 20 (1): 171.
3. **Larsson I. (2017):** Patients' conceptions of their own influence on good treatment response to biological therapy in chronic inflammatory arthritis. Patient Prefer Adherence,11: 1057–1067.
4. **Fu H, Qin B, Hu Z *et al*. (2015):** Neutrophil- and platelet-to-lymphocyte ratios are correlated with disease activity in rheumatoid arthritis. Clin Lab., 61: 269
5. **Uslu A, Küçük A, Sahin A *et al*. (2015):** Two new inflammatory markers associated with Disease Activity Score-28 in patients with rheumatoid arthritis: neutrophil-lymphocyte ratio and platelet-lymphocyte ratio. Int J Rheum Dis., 18: 731–5.
6. **Qin B, Ma N, Tang Q *et al*. (2016):** Neutrophil to lymphocyte ratio (NLR) and platelet to lymphocyte ratio (PLR) were useful markers in assessment of inflammatory response and disease activity in SLE patients. Mod Rheumatol., 26: 372–6
7. **Kisacik B, Tufan A, Kalyoncu U *et al*. (2008):** Mean platelet volume (MPV) as an inflammatory marker in ankylosing spondylitis and rheumatoid arthritis. Joint Bone Spine,75: 291–4.
8. **Cetinkaya E, Senol K, Saylam B *et al*. (2014):** Red cell distribution width to platelet ratio: new and promising prognostic marker in acute pancreatitis. World J Gastroenterol., 20: 14450–4
9. **Siyan X, Xuejie Ch (2018):** Red blood cell distribution width-to-platelet ratio as a disease activity-associated factor in systemic lupus erythematosus. Medicine, 97: 39
10. **Zhongwei Z, Hongmei Ch, Huixiang J *et al*. (2018):** Platelet indices in patients with chronic inflammatory arthritis: a systematic review and meta-analysis. https://www.tandfonline.com /loi/iplt20
11. **Moll J, Wright V (1973):** Psoriatic arthritis (review). Semin Arthritis Rheum., 3: 55–78
12. **Sieper J, Rudwaleit M, Baraliakos X *et al*. (2009):** The Assessment of SpondyloArthritis international Society (ASAS) handbook: a guide to assess spondyloarthritis. Ann Rheum Dis., 68: 1-44
13. **Lukas C, Landewé R, Sieper J *et al*. (2009):** Development of an ASAS-endorsed disease activity score (ASDAS) in patients with ankylosing spondylitis. Annals of the Rheumatic Diseases,68 (1): 18-24
14. **Mulder M, Broeder A, Ginneken B *et al*. (2019):** Implementing Psoriatic Arthritis Disease Activity Score-guided treat-to-target in psoriatic arthritis routine clinical practice: impossible? Rheumatology, 58: 2330-1
15. **Braun J, Sieper J (2007):** Ankylosing spondylitis. Lancet,369:1379-90.
16. **Lippi G, Mattiuzzi C, Cervellin G (2016):** Learning more and spending less with neglected laboratory parameters:

the paradigmatic case of red blood cell distribution width. Acta Biomed., 87 (3): 323–8.

17. **Kisacik B, Tufan A, Kalyoncu U** *et al.* **(2008):** Mean platelet volume (MPV) as an inflammatory marker in ankylosing spondylitis and rheumatoid arthritis. Joint Bone Spine,75: 291–4.

18. **ErkoliNal  E, İsmihan S, Şadiye S** *et al.* **(2015):**May Neutrophil-Lymphocyte and Platelet-Lymphocyte Ratios Indicate Disease Activity in Ankylosing Spondylitis? Arch Rheumatol,30(2):130-137                 doi: 10.5606/ArchRheumatol.,2015:4837

19. **Gisondi P, Geat D, Lippi G,  Montagnana M** *et al.* **(2021):** Increased red blood cell distribution width in patients with plaque psoriasis. J Med Biochem.,  40(2): 199-201. doi: 10.5937/jomb0-27237

20. **Ozisler C and Sandikci S (2020):**  Evaluation of red blood cell distribution width in patients with psoriatic arthritis. The Egyptian Rheumatologist,  42 (4): 309-31. doi.org/10.1016/j.ejr.2019.06.001.

21. **Raghavan V, Radha R, Rao R, Kuberan A (2017):** A Correlative Study between Platelet Count, Mean Platelet Volume and Red Cell Dis- tribution Width with the Disease Severity Index in Psoriasis Pa- tients. J Clin Diagn Res.,11: EC13–6.

22. **Canpolat F, Akpinar H, Eskioğlu F (2010):** Mean platelet volume in psori- asis and psoriatic arthritis. Clin Rheumatol., 29: 325–8.

23. **Özkur  E, Şeremet S, Afşar F** *et al.* **(2018):** Mean platelet volume    in    psoriasis    patients    .doi: 10.14744/SEMB.2018.69370

24. **Melek S, Duygu T, Arzu K** *et al.* **(2017):** Serum RDW and MPV in Ankylosing Spondylitis: Can they show the disease activity? Clinical Hemorheology and Microcirculation, 65: 1–10 DOI 10.3233/CH-162067

25. **Gasparyan A, Ayvazyan L, Mikhailidis D** *et al.***(2011):** Mean platelet volume: A link between thrombosis and inflammation? Curr Pharm Des., 17: 47–58

26. **Kisacik B, Tufan A, Kalyoncu U** *et al.* **(2008):** Mean platelet volume (MPV) as an inflammatory marker in ankylosing spondylitis and rheumatoid arthritis, Joint Bone Spine, 75(3):291-4.doi: 10.1016/j.jbspin.2007.06.016.

27. **Balta I, Balta S, Koryurek O** *et al.* **(2014):** Mean platelet volume is associated with aortic arterial stiffness in patients with Behcet's disease without significant cardiovascular involvement, J Eur Acad Dermatol Venereol., 28: 1388–1393

28. **Threatte  G  (1993):**Usefulness  of  the  mean  platelet volume, Clin Lab Med .,13 ,937–950

29. **Lippi G, Targher G, Montagnana M** *et al.* **(2009):** Relation between red blood cell distribution width and inflammatory biomarkers in a large cohort of unselected outpatients, Arch Pathol Lab Med .,133 , 628–632.

30. **Montagnana M, Cervellin G, Meschi T** *et al.* **(2011):** The role of red blood cell distribution width in cardiovascular and thrombotic disorders, Clin Chem Lab Med., 50: 635–641

31. **Zalawadiya S, Veeranna V, Niraj A** *et al.***(2010): Red** cell distribution width and risk of coronary heart disease events, Am J Cardiol., 106: 988–993