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Neutrophil–lymphocyte ratio and platelet–lymphocyte ratio as predictors of MS severity: a retrospective cohort study

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Abstract

Background Multiple sclerosis (MS) is a disabling immune-mediated disease of the central nervous system. Ministry of Health and Population's statistics show that MS comprise 1.4% of all neurological diseases, putting into consideration, current economic crisis; it is needed to predict disease severity with an acceptable cost-effective method. Complete blood count (CBC) parameters are supposed to be cheap, and simple markers for the systemic inflammatory state. This study aims at evaluating role of neutrophil–lymphocyte ratio (NLR) and platelet–lymphocyte ratio (PLR) in predicting the severity of MS. Therefore, this retrospective cohort study was done on 150 MS patients attending MS clinic during year 2022. All patients were subjected to complete medical history. Estimation of the disability was done through the extended disability status scale (EDSS) and analysis of different parameters of baseline CBC before starting therapy.

Results A cutoff value of $NLR \geq 2.95$ and $PLR \geq 201.5$ could predict prognosis of MS. Risk factors of sever MS are high NLR, PLR, high body mass index and absence of disease-modifying therapy.

Conclusions Neutrophil/lymphocyte ratio and platelet/lymphocyte ratio are cheap valid useful predictors of increased relapse rate and severity in MS. Highlighting the role of both ratios at time of first diagnosis helps physicians to predict prognosis of patients in context of severity. Paying special attention to those with higher ratios can lead to improve patient outcome and reducing disease burden.

Keywords Complete blood count, Multiple sclerosis, Prognosis, Inflammation, Relapse, NLR, PLR, MLR, WBCs, Hemoglobin

Background

Multiple sclerosis (MS) is a changeable, complex often disabling central nervous system (CNS) demyelinating disease characterized by an abnormal response of the body immune system which is focused against the CNS destroying myelin sheath in the brain and spinal

cord causing functional disability [1]. It is more common in females than males between 20 and 40 years; its prevalence is progressively increasing due to increased awareness of the disease and improvement of diagnostic methods [2].

There are many MS subtypes; the most common of these is relapsing–remitting MS (RRMS). It is accounted for 85% of cases, manifested by recurrent neurological symptoms lasting from days to weeks. Clinical picture differs from mild symptoms to sever disability. These symptoms show partial or nearly complete recovery with treatment [3].

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Within 10–15 years of disease onset, if the patient is not treated adequately, the RRMS will convert into secondary progressive multiple sclerosis (SPMS) with increasing patient disability [4]. Progressed disability from the disease onset without relapses occurs in Primary progressive MS [5]. It is diagnosed by magnetic resonance imaging (MRI) and cerebrospinal fluid (CSF) oligoclonal bands and Ig G index [3].

Despite unclear etiology of MS, immunologic, infectious, inherited or environmental factors play an important role [6]. Chronic neurodegeneration caused by systemic inflammation plays a major remarkable role in MS pathogenesis through pro-inflammatory cytokines and the motivation of both adaptive and innate immune cells [7]. Multiple sclerosis is associated with many autoimmune diseases as type 1 diabetes mellitus and rheumatoid arthritis [8].

The pathophysiology of MS has two different hypotheses, the first is the inside–out that claimed that the inflammation starts inside CNS, the second is outside–in that postulated that T cells activated in the periphery and enter CNS through blood brain barrier (BBB) [9, 10].

The inflammatory process leads to destruction of myelin and production of CNS antigens. Persistence of inflammation leads to deterioration and disease progression [11].

MS affects hematological profile, hence, complete blood count (CBC) is routinely used by physicians to understand overall health of the patients [5]. The variable elements of complete blood count involving neutrophil–lymphocyte ratio, monocyte–lymphocyte ratio and platelet–lymphocyte ratio are considered as simple and effective markers of different branches of medicine as oncology [12], degenerative diseases [13, 14], autoimmune and inflammatory disorders including MS [15, 16].

There are metabolic instabilities red blood cell (RBC) membranes in MS. Impaired membrane fluidity also changes in the RBC profile, mainly in its oxygen-carrying capacity in MS [17].

Along with inflammatory process, oxidative stress in CNS and periphery affects MS pathophysiology, dysfunction of erythrocyte antioxidant enzyme is due to decreased erythrocyte antioxidant capacity in MS patients. Appropriate antioxidant enzymes include superoxide dismutase (SOD) glutathione peroxidase (GPx) and catalase [18].

Erythrocytes in MS patients appear to have lower complement receptor 1 (CR1) expression. [19]. Erythrocyte CR1 clears immune-adherence inflammatory particles (apoptotic fragments, immune complexes and microbes). Subsequently, Reduction of CR1 may lead to

accumulation of inflammatory particles in the periphery, leading to some inflammatory destruction to the blood vessels and surrounding tissues [20].

Platelets are a non-nuclear cell within the blood stream and had been recently linked to inflammatory conditions as they control vascular microenvironment by secreting immune and inflammatory factors [21]. Platelet–lymphocyte ratio was used as a poor prognostic tool for cancer and COVID [22, 23]. Platelets were found to express different cytokines including IL-1 β which had a valuable role in inflammatory response regulation and some chemokines as CCL5, CCL3, in addition platelets can cross blood brain barriers through the broken endothelium to share in production of MS plaques [24].

Leukocytes contribute to the progression and deterioration of different inflammatory illnesses, such as MS [25, 26]. There are activated T-lymphocytes and cytokines at tissue damage site in addition to in the circulation in MS [27]. The lymphocytes enter the CNS parenchyma as it become adherent to endothelial cells of the cerebral blood vessels, transferred through the vessel walls [28]. Extravasation of T lymphocytes via the blood–brain barrier (BBB) is supposed to occur before the start of the demyelination process in the course of MS [29, 30].

Neutrophils are associated with occurrence of demyelination in MS as relapse occurs due to cellular infiltrations through the BBB [30]. In experimental autoimmune encephalomyelitis, neutrophil extracellular traps (NETs) which are an extracellular products of neutrophils have the major role in BBB breakdown through cytotoxicity, causing acute inflammation by influencing adaptive immune cell activation and presenting antigens. [31, 32].

Many conditions upregulate innate immune system, the main cell type of this system is neutrophils and it is the first cellular defense against external pathogens, neutrophil migration to the inflammatory site is an important step of inflammation, and presents as an increase production of neutrophil and quicken death of lymphocyte decreasing its counts [30, 33].

Increase NLR and MLR is associated with production of proinflammatory factors and adaptive immune system dysregulation, early stages of MS are associated with balance disruption between innate and acquired immune system leading to relevant increase in NLR and MLR [34].

Many disease-modifying drugs (DMTs) oral or injectable affect immune system by targeting leukocyte reduction or interference of lymphocyte production, activation, cytokine release or transportation across BBB [35, 36].

MS patients with immunosuppressive DMTs may have an increased global risk of infections due to changes of protective immune system [37]. These infections can be

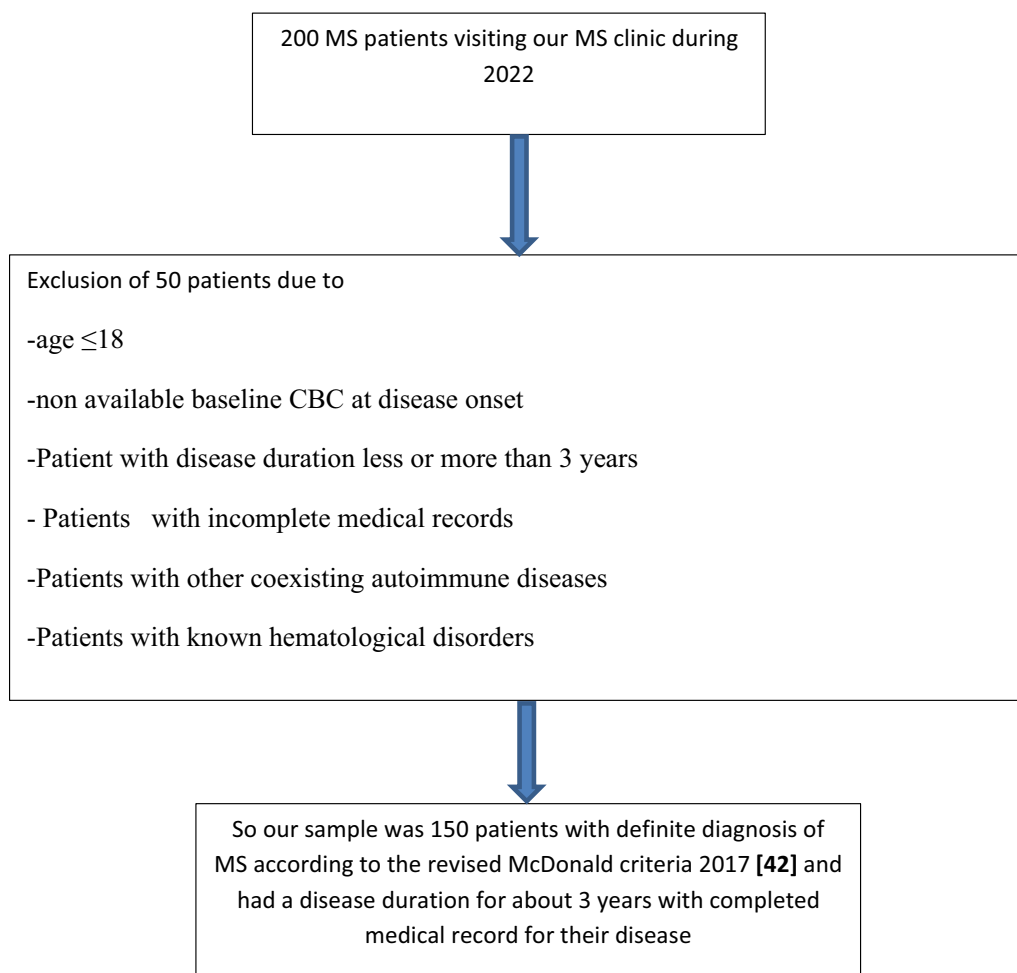
due to higher susceptibility of infection, reactivation of a latent infection or deteriorating of previously asymptomatic chronic infections, so we should give immunization to patients receiving DMTs [38].

Disease progression from relapsing to progressive MS is associated with conversion of innate to acquired immune system that is marked by increase NLR and MLR [39, 40]. Baseline CBC has important predictive value of disease activity, magnetic resonance imaging (MRI) disease burden, disability and brain atrophy [41].

The current economic crisis and the high cost of the disease-modifying drugs, in addition the increased prevalence rate of MS and social disability caused by MS, all these factors make the issue of finding a valid and cost benefit markers to predict disease severity and prognosis is vital condition. Therefore, this study aims at evaluating role of neutrophil–lymphocyte ratio (NLR) and platelet–lymphocyte ratio (PLR) in predicting the severity of multiple sclerosis.

Methods

Study design: this retrospective cohort study was performed via analysis of 200 MS patient data records who attended multiple sclerosis clinic during 2022 for their regular follow-up visits or having a new relapse, the included patients were older than 18 years with disease duration of about three years as it is a reasonable duration for assessing relapse rate and evaluating the disability and their medical record included CBC before steroid therapy. Patients were excluded if they met our exclusion criteria which were non-available baseline CBC at disease onset, patient with disease duration less or more than 3 years, patients with incomplete medical records, patients with other coexisting autoimmune diseases, and patients with known hematological disorders. Therefore, out of these 200 patients, only 150 met our inclusion and exclusion criteria, they were 60 (40%) male and 90 (60%) female, and their mean age was 33.1 ± 6.55.



Assessment of included patients was done as the following: complete medical history was obtainable including age of disease onset, number of relapses, use of disease-modifying therapy. Estimation of the disability was done through the Extended disability status scale (EDSS); the results were interpreted as mild disability with EDSS score ≤ 3.5 and moderate–severe disability with EDSS ≥ 4 [42].

Analysis of baseline CBC which was done shortly after MS diagnosis before starting DMD as the following: red blood cell parameters including total red blood cells count and hematocrit level. White blood cell parameters involving total count, neutrophil/lymphocyte ratio (NLR) and monocyte/lymphocyte ratio (MLR) were calculated manually by dividing the neutrophils or monocytes counts over by the lymphocytes count, respectively [25]. Platelet parameters including platelet count and platelet/lymphocyte ratio (PLR) were manually calculated by dividing the platelet count over the lymphocytes count [30].

Statistical analysis: analysis of data was accomplished using Statistical Package for the Social Sciences (SPSS) version 26 software released 2019 [43]. Qualitative data were represented as number and percentage and compared using Chi-square test. Normality of data distribution was checked using Shapiro test. Normally distributed data were represented using mean \pm standard deviation and compared using student *t* test. Pearson correlation coefficient was utilized to assess correlation between two quantitative parameters. ROC curve was used to determine best cutoff of NLR and PLR in diagnosis of MS. Binary logistic regression analysis was used to determine odds of predictors of certain disease. *P* value is significant when <0.05 while $p \leq 0.001$ is considered highly significant.

Results

This study included 150 patients with age range from 20 to 48 years with female predominance. Largest percentage of our patients had relapsing–remittent course Table 1.

Table 2 shows the statistically significant positive correlation between number of relapse and all of BMI, NLR, PLR, platelet count, WBCs and EDSS.

There is statistically significant relation between disease severity and body mass index, NLR, white blood cells, PLR, platelet count, sex, DMT, and disease type, as demonstrated in Table 3.

High NLR, PLR, absence of DMT and primary progressive MS were found to significantly independently increase risk of severe MS by 17.91, 1.02, 148.38 and 29.65 folds, respectively (Table 4).

Table 1 Distribution of studied patients according to baseline data

	Mean \pm SD	Range
Age (year)	33.1 \pm 6.55	20–48
Age of onset (year)	29.21 \pm 6.07	18–42
EDSS	2.93 \pm 0.86	1.5–4
	n = 150	%
Sex		
Male	60	40%
Female	90	60%
BMI (kg/m ²)	28.65 \pm 4.75	20–34.5
DMT	100	66.7%
Type		
PPMS	10	6.7%
RRMS	140	93.3%
Relapse		
Two	40	28.6%
Three	50	35.7%
Four	20	14.3%
Five	30	21.4%
Hematocrit	40.34 \pm 2.78	36–44
NLR	2.69 \pm 0.43	2.0–3.4
WBCs	6.16 \pm 1.61	4.3–9.8
Platelet count	257.53 \pm 45.19	191–354
PLR	191.03 \pm 40.19	140–256
EDSS		73.3%
Mild	110	26.7%
Moderate and severe	40	
MLR	0.23 \pm 0.04	0.17–0.33

EDSS extended disability status scale, BMI body mass index, DMT disease-modifying therapy, PPMS primary progressive multiple sclerosis, RRMS relapsing–remittent multiple sclerosis, NLR neutrophil–lymphocyte ratio, WBCs white blood cells, PLR platelet–lymphocyte ratio, MLR monocyte–lymphocyte ratio

Table 2 Correlation between number of relapse and the studied parameters

	<i>r</i>	<i>p</i>
Age (year)	– 0.001	0.992
BMI (kg/m ²)	0.161	0.049*
Age of onset (year)	0.002	0.978
Hematocrit	0.04	0.631
NLR	0.394	< 0.001**
WBCs	0.096	0.243
Platelet count	0.103	0.21
PLR	0.519	< 0.001**
MLR	– 0.099	0.228

BMI body mass index, NLR neutrophil–lymphocyte ratio, WBCs white blood cells, PLR platelet–lymphocyte ratio, MLR monocyte–lymphocyte ratio

* *p* < 0.05 is statistically significant

** *p* \leq 0.001 is statistically highly significant *r* Pearson correlation coefficient

Table 3 Relation between disease severity and the studied parameters

	Mild Mean ± SD	Moderate and severe Mean ± SD	t	p
Age (year)	33.66 ± 6.17	31.55 ± 7.36	1.759	0.081
BMI	27.9 ± 4.25	30.74 ± 5.45	- 2.981	0.004*
Age of onset (year)	29.68 ± 5.44	27.93 ± 7.47	1.361	0.179
Hematocrit	40.64 ± 2.57	39.53 ± 3.2	1.976	0.053
NLR	2.57 ± 0.31	3.03 ± 0.52	- 5.206	< 0.001**
WBCs	5.36 ± 0.82	5.6 ± 1.28	- 1.124	0.173
Platelet count	251.19 ± 34.15	262.48 ± 57.29	- 1.172	0.247
PLR	175.19 ± 27.94	234.6 ± 36.52	- 10.571	< 0.001**
MLR	0.23 ± 0.04	0.23 ± 0.05	- 0.025	0.98
	n = 110 (%)	n = 40 (%)	χ²	p
Sex				
Male	57 (51.8%)	3 (7.5%)	24.006	< 0.001**
Female	53 (48.2%)	37 (92.5%)		
DMT	95 (86.4%)	5 (12.5%)	72.017	< 0.001**
Type				
PPMS	1 (0.9%)	9 (22.5%)	Fisher	< 0.001**
RRMS	109 (99.1%)	31 (77.5%)		

BMI body mass index, NLR neutrophil–lymphocyte ratio, WBCs white blood cells, PLR platelet–lymphocyte ratio, MLR monocyte–lymphocyte ratio DMT disease-modifying therapy, PPMS primary progressive multiple sclerosis, RRMS relapsing–remitting multiple sclerosis

* p < 0.05 is statistically significant

** p ≤ 0.001 is statistically highly significant χ² Chi square test t independent sample t test

Table 4 Multivariate regression analysis of predictors of MS severity

	β	p	AOR	95% C.I	
				Lower	Upper
NLR	2.885	0.037*	17.911	1.18	271.30
PLR	0.021	0.049*	1.021	1.00	1.04
No DMT	- 5.000	< 0.001**	148.38	11.32	1945.58
PPMS	- 3.389	0.032*	29.65	1.35	653.78

NLR neutrophil–lymphocyte ratio, PLR platelet–lymphocyte ratio, No DMT no-disease-modifying therapy, PPMS primary progressive multiple sclerosis

AOR adjusted odds ratio CI confidence interval

*p < 0.05 is statistically significant

**p ≤ 0.001 is statistically highly significant

Table 5 and Fig. 1 illustrate that the best cutoff of NLR in prediction of severe MS was ≥ 2.95 with are under curve 0.735, sensitivity 70%, specificity 88.2% and overall accuracy 83.3%. For PLR, values ≥ 201.5 had sensitivity 87.5%, specificity 88.2%, and overall accuracy 88% in predicting severe MS.

Apart from PLR and NLR which had been proved as valid tools that can be used to stratify risk of developing severe disease among patients with MS, other CBC markers lack this significance. In addition high BMI and absence of DMT show significant roles in predicting MS severity.

Table 5 Performance of PLR and NLR in diagnosis of severe MS

	AUC	Cutoff	Sensitivity (%)	Specificity	PPV (%)	NPV (%)	Accuracy (%)	p
NLR	0.735	≥ 2.95	70	88.2	68.3	89	83.3	< 0.001**
PLR	0.877	≥ 201.5	87.5	88.2	72.9	95.1	88	< 0.001**

NLR neutrophil–lymphocyte ratio, PLR platelet–lymphocyte ratio

**p ≤ 0.001 is statistically highly significant AUC area under curve PPV positive predictive value NPV negative predictive value

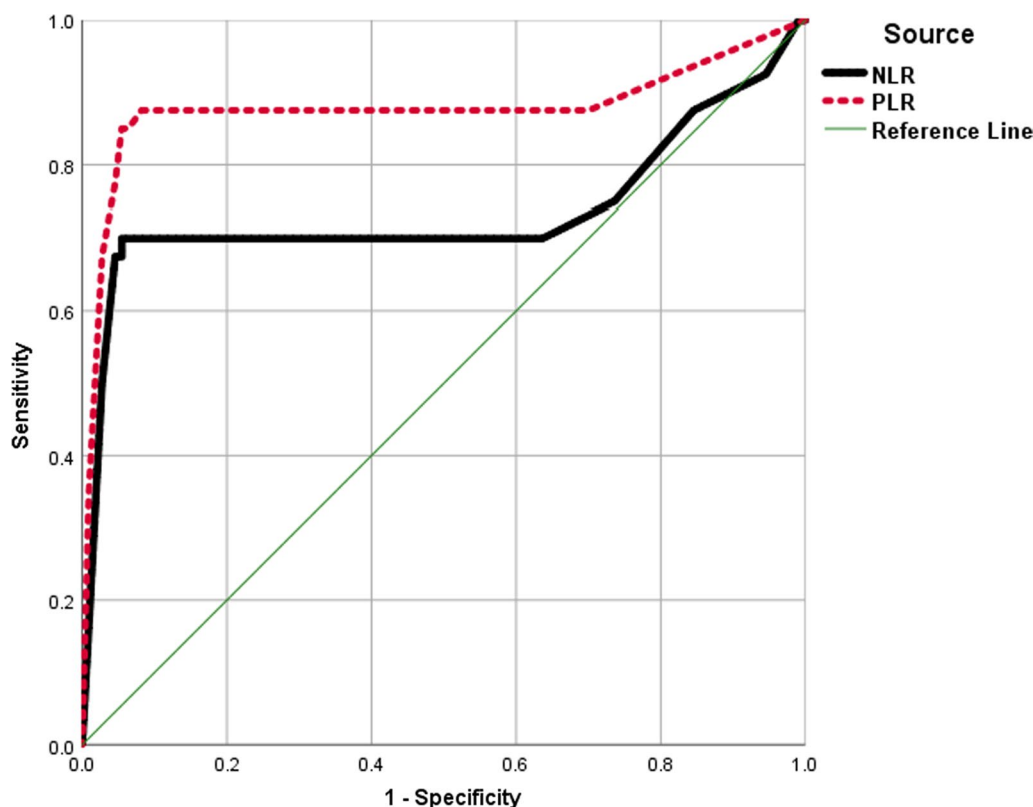


Fig. 1 ROC showing performance of PLR and NLR in diagnosis of severe MS

Discussion

Multiple sclerosis (MS) is a disabling chronic immune-mediated neurodegenerative disease affecting central nervous system and present in over two million individual worldwide [44]. It has a variable clinical manifestations and a variety of clinical courses ranging from benign (relapsing–remitting) to severe progressive (primary progressive) [45], so there is a great need for reliable markers that help in disease detection, staging and predicting prognosis and aid in for the decision-making about the best therapy to improve prognosis especially there is a great advance in highly effective disease-modifying therapy [46]. Hence most of the recent MS studies are targeting the discovery of reliable biomarkers that can predict the different disease characters including disease course, progression and severity [5].

Different biomarkers are used to assess disease progression and course, including radiological and immunological markers detected in either serum or cerebrospinal fluid; they can evaluate the inflammatory state, immune system activation, demyelination and remyelination, neuronal loss and gliosis [47, 48]. Several previous studies tried the use of inflammatory markers to early predict the disease severity aiming to delay transition to the progressive disease forms, they start to investigate traditional

markers of the acute phase response (ESR and CRP) but an opposing results were obtained, some reported them as a valuable markers [49–51], and others had declined this relationship [52–54].

Complete blood count panel is usually used as a routine investigation to measure the overall health of a patient and characterized by being easily available, non-expensive and can measure the inflammatory response [55]. NLR, MLR and PLR are recent predictors of different autoimmune inflammatory diseases, they all share the same calculation variant (lymphocyte ratio) [56]. There were a few previous studied including analysis of all CBC markers as predictors of MS severity and disability but all these studied were either cross section studies or case control studies not taking the role of steroid therapy or MS disease-modifying therapies on these inflammatory markers level, so we designed this retrospective cohort study on 150 MS patients fulfilling our inclusion and exclusion criteria in order to evaluate the role of different parameters of CBC as predictors for MS progression. Estimation of hemoglobin level, WBCs, NLR, MLR and PLR of all patients was done, in addition to EDSS. Higher relapse rate among MS patients with high NLR and PLR were the main results of our study, so NLR and PLR could be utilized as a simple, rapid, and inexpensive

inflammatory marker of MS disability and activity, and hence, a deep look on patient's first CBC is advised.

Obesity was found to be associated with greater disability and higher relapse rate, this was previously mentioned in other studies [57–59]. This was attributed to multiple theories including obesity is usually associated with dyslipidemia causing a state of chronic inflammation, mitochondrial dysfunction mediated by impaired insulin signaling and production of extra reactive oxygen species. These mechanisms are supposed to enhance MS progression but are not necessarily showed by T2-weighted imaging, number of contrast-enhancing lesions or clinical relapses [60].

In the current study, we revealed a non-significant role of red blood cells count and hematocrit level in predicting the relapse rate and severity of MS was noticed. In the same line Peng and colleagues revealed that hemoglobin levels were lower in MS compared with the controls but this difference possess a non-statistically significant value but red blood cells width was higher in MS patients without treatment and reduced in MS patients undergoing treatment and referred these changes to the reduction of polyunsaturated fatty acids from red blood cell membranes causing changes in erythrocyte deformability in MS patients [61].

On the contrary, Hon and colleagues announced that hemoglobin level is inversely correlated with EDSS; this was later on supported by Kasprzycka and coworkers.

In this study, total WBCs count was within the normal range for our patients and had no significant role in predicting the relapse rate and disease severity and this was in accordance with Huang and colleagues. In the same point, Kasprzycka and coworkers demonstrated a significant difference of WBCs count among different MS patients with highest levels among patients with primary progressive MS and the lowest levels among patients with relapsing–remitting MS; this was suggested by the fact that neutrophils considered as mediators for both the start and maintenance of autoimmune neuroinflammation being able to generate extracellular traps, which can be proinflammatory and provide a potential source of autoantigens triggering autoimmunity [31]. Many studies identify a relevant contribution of neutrophils to neuroinflammatory processes in MS and suggest a role in blood–brain and blood–spinal cord barrier disruption [32, 54]. Moreover, neutrophils have been shown to encourage the maturation of microglia and monocytes [64]. The difference in our results could be attributed to the methodological differences as our CBC was done very early in the disease course.

In the current study, high initial NLR was found to be associated with increased relapse rate during 3 year follow-up and subsequent increased disease severity

as measured by EDSS, these results were obtained by other several previous studies [15, 25, 34, 51–53, 56, 62]. Therefore, NLR has been suggested as marker for systemic inflammatory states because of its simplicity and economic feasibility compared to other inflammatory cytokines, such as Interleukin-6, Interleukin-1 β and Tumor Necrosis Factor- α [15].

Several explanations could explain these findings as NLR represents the balance between neutrophil and lymphocyte levels, increased neutrophil count in MS patients could be linked to increased expression of toll-like receptor 2 (TLR2), cluster of differentiation 43 (CD43) and relevant phenotypic changes for formyl peptide receptor 1 (FPR1) [63]. In addition, reduced lymphocyte count is a marker for immunological and inflammatory diseases [63]. All these theories were used to support the results gotten by Fahmi and colleagues in their case control study which revealed that MS patients tend to have a higher NLR compared with controls and the highest values were recorded in progressive disease course.

On the other hand, Yetkin and colleagues in their prospective study that involved 3 year follow-up of MS patients revealed that increased NLR was not associated with increased relapses; however, they recommended escalation therapy for patients with high NLR [64]. In addition, Bisgaard and colleagues demonstrated that NLR ratio was elevated in patients with MS compared with healthy controls but it is not related to disease progression [65].

A multivariate analysis was done to better predict the factors associated with increased MS severity revealed that NLR is one of these factors and then ROC curve demonstrated that NLR at level of ≥ 2.95 can predict MS severity with 70% sensitivity and a specificity of 88.2%. Meanwhile other studies demonstrated other values as Fahmi and colleagues suggested NLR value of 3.12 can best predict disease severity, also NLR value of 3.90 was obtained by Demirci and associates.

NLR was found to meet the criteria of an ideal biomarker for prediction of MS progression as it correlate with disease activity, such as relapse or progression, respond to treatment; in addition, it is non-invasive, safe, accurate, simple, cheap, easily detectable and reflect the systemic inflammatory state in MS patients [66].

As regards the MLR, there were no significant association with relapse rate and disease severity and this was in accordance with Kasprzycka and coworkers, but these findings were not consistent with many previous studies [25, 56]. They attributed their findings by the increased monocytes during MS course with its phagocytic properties and cytokine production. Hemond and colleagues demonstrated that high MLR in MS patients is associated

with higher brain lesions burden and brain atrophy. Our different findings may be related to the different methodology as we included patients early in their disease course. In addition, Gokce and colleagues reported increased MLR ratio in MS patients with active brain lesions.

Platelet–lymphocyte ratio had been recently introduced as an inflammatory marker and elevated PLR ratio is considered marker of poor prognosis of cancers and reflects also the need of intensive care in COVID patients [22, 23]. Our results concluded that PLR is significantly associated with relapse rate and MS severity. This comes in hand with Gokce and colleagues who reported that elevated PLR in MS could be used as a marker of high EDSS.

These findings could be attributed to the emerging role of platelets in immune response as it is responsible for a variety of platelet-derived inflammatory mediators and the possible interactions between platelets and other inflammatory cells [66]. However Carnero Contentti and colleagues reported that high PLR could predict worse outcomes in patients with neuromyelitis optica spectrum disorder rather than MS. We also recorded that $PLR_{level} \geq 201.5$ can significantly predict poor MS outcome with 87.5% and specificity of 88.2%. On the other hand Kasprzycka and coworkers reported that PLR was not associated with disease severity and disability when measured by EDSS.

Limitations: we are aware that this study had some limitations as, first, it is a single center study, second, we had to compare these biomarkers with other ones either radiological or serological, third, we did not study the effect of different DMD on NLR, PLR ratios, but we presented a cheap, available and easily applicable biomarker especially when the other ones are not available and this could be used to improve MS treatment and management in clinical settings, potentially leading to better outcomes for patients.

Conclusion

We must keep in mind that: both NLR and PLR are valid cost-effective tools that can be used to stratify disease severity. Measuring both ratios at time of first diagnosis help physicians predict future of patients in context of severity. Paying special attention to those with higher ratios of NLR above 2.95 and PLR above 201.5 can lead to improve patient outcome and reducing disease burden which is both useful for patient and community overall in terms of increasing productivity, and decrease expenditures on advanced drugs or hospital admissions. Here we are introducing a highly effective, cheap and easily applicable two biomarkers that can help in early detection of

MS course, relapse rate and disability so early better control of neuroinflammation and subsequent neurodegeneration. But we still are recommending a detailed review article involving different methodological studies including retrospective and prospective and multicenter studies in order to strengthen the role of these biomarkers.

Abbreviations

MS	Multiple sclerosis
CBC	Complete blood count
WBCs	White blood cells
NLR	Neutrophil–lymphocyte ratio
MLR	Monocyte–lymphocyte ratio
PLR	Platelet–lymphocyte ratio
EDSS	Extended disability status scale

Acknowledgements

The authors would like to appreciate all participants and their families as well as the hospital staff who contributed to the study.

Author contributions

SF, AA and RH carried out this work. AA designed the study and had done the statistical analysis. SF, and RH collected the patients, gathered clinical data and wrote the manuscript. All authors were involved in drafting the article or revising it critically for important.

Funding

This study was not supported by any source of finding.

Availability of data and materials

Data and materials supporting the results of this article are included within the article.

Declarations

Ethics approval and consent to participate

The study was approved from the Institutional Ethics Committee of the Faculty of Medicine, Zagazig University (ZU-IRB #10116/4–12-2022). Written informed consent was obtained from all study participants after explaining the details and benefits as well as risks to them. Surrogate consent from the patient's legal guardian or designated health proxy was permitted in cases where the patient did not have decision-making capacity.

Consent for publication

Not applicable.

Competing interests

The authors declared that they have no conflicts of interest with respect to the authorship and/or publication of this article.

Received: 27 January 2023 Accepted: 6 February 2024

Published online: 29 February 2024

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