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Assessment of eosinophil-neutrophil ratio, eosinophil-lymphocyte ratio and eosinophil-monocyte ratio in post-reproductive women

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Abstract

Post-reproductive (post-menopausal) changes can alter white blood cell composition, including changes in lymphocyte percentages which controls eosinophil-to-lymphocyte ratio. The eosinophil-to-neutrophil ratio, eosinophil-to-lymphocyte ratio and eosinophil-to-monocyte ratio are new haematological markers that give clinical understanding into conditions like autoimmune disorders, allergies, and cancers. This study aimed to assess eosinophil-to-neutrophil ratio (ENR), eosinophil-to-lymphocyte ratio (ELR) and eosinophil-to-monocyte ratio (EMR) in post-reproductive women. This case–control study was conducted at Enugu State University Teaching Hospital from September 2024 to August 2025, involving 43 post-reproductive women (aged 60–80 years) and 30 sex-matched healthy controls. Total and absolute differential white blood cell count (neutrophils, lymphocytes, monocytes, eosinophils, basophils) was measured using an automated analyzer. The ENR, ELR and EMR were calculated by dividing the eosinophil count by neutrophil count, eosinophil count by lymphocyte count, eosinophil count by monocyte count respectively. Post-reproductive women had significantly increased absolute neutrophil count (5.177 ± 3.640 × 109/L) and absolute monocyte count (0.692 ± 0.208 x 109/L) compared with control (3.327 ± 1.998 x 109/L and 0.449 ± 0.243 x 109/L). There was a positive correlation between absolute eosinophil count and ENR, ELR & EMR (p= < 0.001). In post-reproductive women above 60 years, there was significant increase in neutrophil count and monocyte count and with insignificant difference for the ENR, ELR, EMR, lymphocyte count, eosinophil count and basophil count when compared between case and control group. In addition, eosinophil count had a positive correlation with eosinophil-to-neutrophil ratio, eosinophil-to-lymphocyte ratio and eosinophil-to-monocyte ratio.

Keywords: *eosinophil-to-neutrophil ratio; eosinophil-to-lymphocyte; eosinophil-to-monocyte ratio, neutrophil count; lymphocyte count; monocyte count; eosinophil count; post-reproductive women*

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1.0 Introduction

Millions of women encounter health challenges beyond menopause globally, and a significant proportion of them reside in Africa. In Africa, Nigeria has the largest population. As of 2025, Nigeria counted over 237.5 million persons. 49.4% of women contribute to total population of Nigeria. Life expectancy at birth for females in Nigeria is projected to be 55.3 years, whereas the average age of menopause is 49 years [1]. So, there is urgent need to increase post-reproductive health, prevent diseases, reduce the mortality rates and improve quality of life in Nigeria women. The eosinophil-to-neutrophil ratio, eosinophil-to-lymphocyte ratio and eosinophil-to-monocyte ratio are new haematological markers that give clinical understanding into conditions like autoimmune disorders, allergies, and cancers. Autoimmune disorders are state of health in which the immune system is unable to differentiate between normal tissue and potentially damaging antigens [2]. In a healthy tissue, the immune system will attack the foreign cells and produce a response with respect to the cells. In the case of autoimmune diseases, the immune system is unable to differentiate between foreign cells and its own host cells [3]. There are over 100 different types of autoimmune diseases that mostly affect women. Around 80% of all patients diagnosed with autoimmune diseases are mainly women [2]. Autoimmune disorders and haematological parameters associated with it have rarely been reported among African and even in Nigeria but recent study in southern Nigeria had shown that Females comprised 93.3% of the autoimmune disease patients with a female to male ratio of 14:1 [4]. The ENR, ELR and EMR are new, cost-effective blood biomarker that is basically not used as a standalone diagnostic test. But they are used to assess systemic inflammation, evaluate immune balance, and estimate clinical outcomes in various allergic, autoimmune, and malignant diseases. The primary objective of this study was to determine the values of ENR, ELR, and EMR among post-reproductive women. In addition, we aimed to correlate these ratios between absolute differential counts.

2.0 Materials and Methods

This case-control study was conducted at the Haematology laboratory of Enugu State University Teaching Hospital (ESUTH) from September 2024 to August 2025. The study was approved by the ethical committee of the Enugu State University Teaching Hospital, and the participants were fully informed about the research before participation.

2.1 Inclusion and exclusion criteria:

Women who had stopped menstruation and aged 60-80 years were enrolled. Apparently healthy women who were having regular menstruation were included as control subjects. The age of the controls was 20–47 years. Women with lifestyle habits such as tobacco and smoking, surgically induced menopause or history of coagulopathies, and also medications known to affect the haematological and hormonal values were excluded from the study

2.2 Blood sample collection

Blood samples were collected from the post-menopausal women and collected in tubes with Ethylenediamine tetra-acetic acid (EDTA). The blood samples were analyzed for the hematological parameters: Total white blood cell count (TWBC), absolute differential white blood cell count (neutrophils, lymphocytes, monocytes, eosinophils, basophils). EDTA blood samples were processed by Mindray BC 5150 Auto hematology analyzer. The ENR, ELR and EMR were calculated by dividing the absolute eosinophil count by absolute neutrophil count, absolute eosinophil count by absolute lymphocyte count, absolute eosinophil count by absolute monocyte count respectively.

2.2.1Statistical Analysis

Statistical Package for Social Sciences (SPSS) version 25 was used to perform the statistical analyses. The data were expressed as mean±SD. The mean values were tested for significance using an independent T-test. Pearson's correlation coefficients were used to determine the relationship between absolute differential count and blood biomarkers. Value of $p<0.05$ was accepted as statistically significant.

3.0 Results

The total white blood cell count (TWBC), absolute differential count, ENR, ELR and EMR were compared with post-menopausal women and control. Absolute neutrophil count and absolute monocyte count in post-menopausal were found to be significantly higher compared to control ($p<0.05$). No significant differences were observed in lymphocytes, eosinophils, basophils, ENR, ELR and EMR ($P>0.05$) (Figure 3.1).

Table 3.1: total white blood cell count (TWBC), absolute differential count and blood biomarkers observed for post-reproductive women and control

Parameters	case (N=43)	control (N=30)	p-value
TWBC (10^9/L)	8.020 ± 4.206	6.667 ± 3.363	0.132
Neutrophils (10^9/L)	5.177 ± 3.640	3.327 ± 1.998	0.014*
Lymphocytes (10^9/L)	2.479 ± 1.379	2.600 ± 1.379	0.711
Monocytes (10^9/L)	0.692 ± 0.208	0.449 ± 0.243	0.022*
Eosinophils (10^9/L)	0.110 ± 0.107	0.146 ± 0.103	0.324
Basophils (10^9/L)	0.010 ± 0.003	0.010 ± 0.001	0.289
ENR	0.035 ± 0.018	0.046 ± 0.038	0.222
ELR	0.044 ± 0.043	0.058 ± 0.051	0.213
EMR	0.258 ± 0.222	0.355 ± 0.342	0.289

Among post-reproductive women, neutrophils, eosinophils, and basophils were found positively correlated with ELR, ENR and EMR (*r=0.350, 0.800, 0.470, 0.536, 0.599*). While monocytes were found negatively correlated with EMR (*r= - 0.362*). No significant correlation was observed among TWBC, lymphocytes and blood markers ($p > 0.05$) (Table 3.2).

Table 3.2: Pearson's correlations (r) of TWBC, absolute count and blood biomarkers among post-reproductive women

	ENR	ELR	EMR
Parameters	r (*p*-value)	r (*p*-value)	r (*p*-value)
TWBC	0.029 (0.856)	0.294 (0.058)	-0213 (0.173)
Neutrophils	- 0.130 (0.405)	0.350 (0.023)*	-0.209 (0.178)

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Lymphocytes	0.300 (0.051)	-0.110 (0.488)	0.034 (0.829)
Monocytes	0.151 (0.334)	-0.028 (0.860)	-0.362 (0.017)*
Eosinophils	0.800 (<0.001)**	0.536 (<0.001)**	0.599 (<0.001)**
Basophils	0.470 (0.001)**	0.036 (0.820)	0.160 (0.305)

Discussion

The ENR, ELR and EMR are new emerging, cost-effective blood biomarkers used to determine systemic inflammation and immune system dysfunction. Though, it is not widely used as a standalone diagnostic tool, it provides predictive and prognostic value for monitoring disease severity, tissue damage, and treatment response in autoimmune conditions. In addition, the lower ratios of the blood biomarkers often correlate with worse clinical outcomes in cardiovascular and pulmonary conditions [5]. We found that eosinophil count and eosinophil hematologic ratios were decreased in post-reproductive women compared to controls. This is in line with previous study that found significantly decreased ENR level in the acute ischemic stroke patients compared with the healthy controls [6]. Furthermore, patients with decrease ENR levels are more likely to develop cardioembolic stroke and severe symptoms [6]. Our study is also in agreement with previous study that found no statistically significant result in the ELR of ten (10) bullous pemphigoid patients. Bullous pemphigoid (BP) is an autoimmune blistering disease that develops in elderly patients older than 60 years [7]. The benefit of the ELR was also evidenced in *immediate hypersensitivity* to nonsteroidal anti-inflammatory drugs (NSAIDs) and *assessment of severity of atopic dermatitis [8, 9]*. Additionally, ELR was also found to correlate with pruritus severity in atopic dermatitis and NSAID-exacerbated respiratory disease [8, 9]. The present study also slightly agrees with previous studies which observed that low EMR levels correlate with increased in-hospital mortality and severe disease [10]. Also, in pulmonary embolism, decrease EMR levels predict poor long-term outcomes [11]. Moreover, decreased EMR values are connected to increased mortality rates in patients with ST-elevation myocardial infarction undergoing percutaneous coronary intervention. [12, 13]. Eosinophils take part in local immune and inflammatory responses. Eosinophilia has been commonly believed to be a prothrombotic condition [14]. Because these new haematological markers are inexpensive, affordable, and consistent in normal clinical settings with little resources, they may be useful in improving patient management.

Conclusion

In post-reproductive women above 60 years, there was significant increase in neutrophil count and monocyte count and with insignificant difference for the ENR, ELR, EMR, lymphocyte count, eosinophil count and basophil count when compared between case and control group. In addition, eosinophil count had a positive correlation with eosinophil-to-neutrophil ratio, eosinophil-to-lymphocyte ratio and eosinophil-to-monocyte ratio.

Conflict of interests

Authors declared that no competing interests exist

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