INTRODUCTION

Psychiatric disorders or mental illness is associated with relative changes or distress functioning in social, work, or family activities and characterized by alteration in behavior, emotion, and thinking. The neutrophil-to-lymphocyte ratio (NLR) is an inexpensive, reproducible test which can be obtained from the white blood cell count and has been considered as a new biomarker for systemic inflammatory response [1,2]. In some malignancies, increased mortality can be predicted by elevated levels of NLR as it is considered as an important inflammatory marker [3,4]. Depression is a complex disease associated with increased morbidity and is characterized by prominent disabilities, social burden, and reduced quality of life [5]. According to the World Health Organization in 2020, depression will account for the second leading cause for morbidity worldwide [6,7]. Certain studies show that pharmacotherapy for depression has the ability to normalize some of the disturbed indices of immunoreactivity and depression is related to a disturbance in central nervous system (CNS), immune response, and vascular reactivity [5,8].

Schizophrenia is a mental disorder without a satisfactory biological explanation characterized by well-defined symptoms and a lifelong course and by growing body of evidence whose pathophysiology is associated with immunological and inflammatory mechanisms [9,10]. The immunopathogenesis mechanism in schizophrenia is evident as several studies discuss the increased permeability of the blood–brain barrier which supports the penetration of T cells to fight an inflammatory CNS process [10].

"Bipolar disorder is a chronic, severe neuropsychiatric disorder with recurrence of mood exacerbation from major depressive episodes to manic episodes and vice versa" and whose lifetime prevalence approximately around 2% [11]. In 2001, Zahorec developed NLR as an easily measurable and readily available parameter to evaluate the intensity of stress and other systemic inflammations in patients with shock, multiple trauma, major surgery, or sepsis [12]. Bipolar disorder can be explained effectively as a multisystemic inflammatory disease without a proper biological mechanism [11]. The severity of diseases has been examined using scales such as Hamilton depression (HAM-D) for depression, Brief Psychiatric Rating Scale (BPRS) for schizophrenia, and both Young Mania Rating Scale (YMRS) for bipolar disorder. Depressive disorder touches and impairs all aspects of life and it is having a great risk in societal aspects of a human being. It also contributes more to the suicidal thoughts and risk of managing other comorbidities [13].

Most of the psychotropics are associated with dysfunction in sexually related activities, cardiac-related diseases such as arrhythmia, hypotension, and also cardiac death [14]. Leukopenia and agranulocytosis are occasionally noted as side effects of antipsychotic medications. This is particularly true of the antipsychotic medication clozapine, for which the incidence of agranulocytosis is approximately 1% [12]. According to a study reported by Cramlington, post regarding effects of treatment with carbamazepine monotherapy or in combination with lithium, on leukocyte count significant reductions in total leukocyte, neutrophil, and lymphocyte counts were found with carbamazepine monotherapy, whereas inclusion of lithium with carbamazepine shown marked increases in leukocyte and neutrophil counts but not lymphocyte counts [15].

Psychotropic drugs may also affect the immune system by direct action on immunocompetent cells or indirectly through hormonal secretions. There are no much studies available which assessed the hematological effects of psychotropic, especially the NLR in Indian psychotic patients. We aimed to analyse the effect of psychotropic medication on the NLR in Indian psychotic patients.
and bipolar disorder are admitted, respectively, was conducted after obtaining the ethical approval from IEC, AIMS, B. G Nagara. We considered only antipsychotic drug newer patients. Pediatric patients and patients with infection or other comorbidities were excluded from the study. The severity of disorder was calculated using BPRS, YMRS, and HAM-D scales.

Method
A total of 30 patients were included in the study. To access the NLR, blood samples were collected from patients and laboratory data were evaluated. The follow-up was done in the duration of 1 month to the patient after administering the medication and their NLR was assessed to evaluate the changes caused by psychotropic. Both the NLRs have been compared to assess the changes in NLR before and after the treatment.

Statistical analysis
Statistical Package for the Social Sciences (SPSS) acquired by IBM for Windows, Version 17.0. Released Chicago: SPSS Inc; 2009. were used for the development of a data entry sheet and statistical analysis. Descriptive statistics were conducted to demonstrate the demographic characteristics of the subjects. Paired t-test was applied to compare pre- and post-results in both groups. Spearman rank correlation was run to evaluate the correlation between NLR and severity of the disease.

RESULTS
The mean difference of NLR between baseline and follow-up was statistically significant for depression ($t=−9.920$, $p=0.001$; Fig 1a; Table 1a), schizophrenia ($t=−3.682$, $p=0.005$; Fig 1b; Table 1b), and bipolar disorder ($t=4.467$, $p=0.002$; Fig 1c; Table 1c).

In case of patients with depression, when compared to the NLR-baseline, NLR-follow-up was found to be increased, and on Spearman’s correlation, NLR-baseline and HAM-D-baseline are negatively correlated with $r=−0.438$ and $p=0.206$ (Table 2a), whereas NLR-follow-up and HAM-D-follow-up are positively correlated with $r=0.049$ and $p=0.894$ (Table 2b) which are not statistically significant. For patients with schizophrenia, NLR-follow-up was higher when compared to NLR-baseline up, and on Spearman’s correlation, NLR-baseline and BPRS-baseline are positively correlated with $r=0.231$ and $p=0.521$ (Table 2c), but NLR-follow-up and BPRS-follow-up are negatively correlated with $r=−0.219$ and $p=0.544$ (Table 2d) which are not statistically significant.

In contradiction to the above two groups of patients, NLR-follow-up was lower when compared to NLR-baseline in patients with bipolar disorder. On Spearman’s correlation, NLR-baseline and YMRS-follow-up were positively correlated with $r=0.244$ and $p=0.391$ (Table 2e), whereas NLR-follow-up and YMRS-follow-up were negatively correlated with $r=−0.257$ and $p=0.344$ (Table 2f) which are not statistically significant.

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>Comparison</th>
<th>Mean±SD</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depression</td>
<td>NLR-B</td>
<td>1.60110±0.340423</td>
<td>−9.920</td>
<td>0.001***</td>
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<tr>
<td></td>
<td>NLR-F</td>
<td>2.36830±0.262317</td>
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</tbody>
</table>

SD: Standard deviation, NLR-B: Neutrophil-lymphocyte ratio baseline, NLR-F: Neutrophil-lymphocyte ratio follow-up

Table 1b: Comparison of changes in neutrophils and lymphocyte ratio in patients with schizophrenia, before and after the treatment

<table>
<thead>
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<th>Comparison</th>
<th>Mean±SD</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Schizophrenia</td>
<td>NLR-B</td>
<td>1.86170±0.342614</td>
<td>−3.682</td>
<td>0.005*</td>
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<td></td>
<td>NLR-F</td>
<td>2.07800±0.202820</td>
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</table>

SD: Standard deviation, NLR-B: Neutrophil-lymphocyte ratio baseline, NLR-F: Neutrophil-lymphocyte ratio follow-up

Table 1c: Comparison of changes in neutrophils and lymphocyte ratio in patients with bipolar disorder, before and after the treatment

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>Comparison</th>
<th>Mean±SD</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bipolar disorder</td>
<td>NLR-B</td>
<td>3.30830±0.835098</td>
<td>4.467</td>
<td>0.002**</td>
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<td></td>
<td>NLR-F</td>
<td>2.20120±0.128456</td>
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<td></td>
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</tbody>
</table>

SD: Standard deviation, NLR-B: Neutrophil-lymphocyte ratio baseline, NLR-F: Neutrophil-lymphocyte ratio follow-up

Fig. 1: (a) NLR changes in patients with depression. (b) NLR changes in patients with schizophrenia. (c) NLR changes in patients with bipolar disorder. NLR-B – Neutrophil-lymphocyte ratio baseline. NLR-F – Neutrophil-lymphocyte ratio follow-up
In some of the earlier studies, in case of depression, it has been observed that there was no significant difference between the groups based on sociodemographic characteristics such as age, gender, marital status, income level, smoking, and employment. Mean NLR value was 1.58 ± 0.59 in the patient group, and it was 2.05 ± 0.89 in the control group. The difference between these mean values was statistically significant (p=0.007) [16]. However, the mean ± standard deviation NLR of patients with schizophrenia was significantly higher than that of healthy controls (2.6 ± 1.0 vs. 1.9 ± 0.7, respectively, p<0.001) [9]. In bipolar disorder, the NLR was higher in male patients than in female comparison subjects (3.2 ± 2.2 vs. 1.7 ± 0.4) (p<0.001). Furthermore, compared with the healthy male subjects, the male patients had significantly higher NLR (3.3 ± 2.4 vs. 2.0 ± 0.7) (p<0.001) [17].

The present study showed that there is a significant increase in the NLR of patients with depression after treatment with psychotropics (p=0.001). In the case of schizophrenia, there is a slight increase in the NLR of psychiatric patients after treatment with psychotropics (p=0.005). However, in bipolar disorder, there is a significant decrease in the NLR of psychiatric patients after treatment with psychotropics (p=0.002). The study has shown that NLR is not significantly correlated with the severity of the diseases in patients with depression, schizophrenia, and bipolar disorder. Although the study includes a lesser number of subjects when compared to related studies, it might obtain certain preliminary data regarding the effects of psychotropic in NLR. However, the study has not carried out for more number of psychotropic.

In the case of schizophrenia, there is a slight increase in the NLR of psychiatric patients after treatment with psychotropics (p=0.005).


