Evaluation of neutrophil-lymphocyte ratio and platelet-lymphocyte ratio as inflammatory markers in patients with insulin resistance and rheumatoid arthritis: A Pilot study

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ABSTRACT:

BACKGROUND: Rheumatoid arthritis (RA) is a chronic inflammatory disorder of unknown etiology associated with insulin resistance (IR) and additional cardiovascular threats. Both disorders have inflammation as a key factor in their development. The NLR and PLR have been identified along with other inflammation indices that may be important in elucidating RA and IR's disease activity and inflammatory processes.

Objective: This work evaluates the efficacy of NLR and PLR inflammatory markers in people with RA and IR and aims to establish the relationship between these ratios and disease activity in RA patients.

Methods: A cross-sectional study was conducted with 26 participants diagnosed with RA, out of which also had IR. Clinical measurements were recorded, including BMI, waist circumference, blood pressure, and laboratory tests such as fasting glucose, HbA1C, and lipid profiles. The NLR and PLR were calculated based on WBC and platelet counts, respectively. Disease activity was measured by the 28-jointed Disease Activity Score (DAS28).

RESULTS: In the present study, the NLR and PLR were higher in patients with RA associated with IR than the patients with RA alone. In the present study, NLR / PLR was high, with poor disease activity scores also identified, along with a correlation between a higher HOMA-IR and these biomarkers, specifically in RA, indicating a possible link between inflammation and insulin resistance in RA.

CONCLUSION: NLR and PLR are novel, feasible inflammation indices that can be used to assess disease activity in RA patients with IR. However, such functions require more clinical trials with extended groups of participants involved to determine their role in the practice.

Keywords: Rheumatoid Arthritis, Insulin Resistance, Neutrophil-Lymphocyte Ratio, Platelet-Lymphocyte Ratio, Inflammatory Markers, Disease Activity, HOMA-IR

1. INTRODUCTION:

Rheumatoid arthritis (RA) is a long-standing chronic inflammatory disease of unknown etiology involving the entire body, especially the joints, with considerable disability and lowered quality of life. In RA, inflammation seems to directly cause joint injury and also to drive several comorbidities including cardiovascular disease, metabolic syndrome, and IR and metabolic syndrome (Aletaha and Smolen, 2018). It is seen globally that there has been an increase in the burden of RA in the past decades. Global data as presented by WHO and Eze *et al.,* 2024 proved that 18 million populations globally have RA, 70% of which are women and 55% are above 55 years of age in 2019. It is equally important to note that the cases of RA are expected to increase in the future. The global prevalence of RA by 2050 was also estimated at 1 percent of the world's population thereby pointing to an 80.2 percent rise from the current population of afflicted people in 2020. In 2022, the age-adjusted prevalence of diagnosed arthritis in adults was 18.9%, with women (21.5%) more likely to have arthritis than men (16.1%) (Benavent *et al*., 2024; Clinical Trials Arena:Rheumatoid Arthritis in 2024; CDC, 2022).

This has been especially so given that insulin resistance, characteristic of type 2 diabetes mellitus, has been continually linked to chronic inflammation, which in turn complicates rheumatoid arthritis patient management (Nimura *et al.,* 2008). Insulin resistance (IR) is a metabolic abnormality in which body tissues fail to respond appropriately to insulin and allow itself an efficient enough to mobilize glucose from blood to muscles and other tissues. This impaired response contributes to raised blood glucose levels which over time may result in the development of T2DM and is linked with different metabolic disorders such as metabolic syndrome and NAFLD (Aktas *et al*., 2020). The molecular mechanism of insulin resistance entails a disruption of the basic tenet of molecular medicine, the signal transduction of insulin in target tissues. The major causative factors of IR include genetic makeup, obesity, lack of exercise, and aging. Notably, visceral adiposity appears to be important since adipose tissue produces pro-inflammatory cytokines that adversely affect insulin signaling and make insulin resistance worse (Takefuji, 2024).

The relationship between chronic inflammation and metabolic impairment in RA has been established with TNF-α and IL-6 playing a major role in joint degradation and IR (Hotamisligil, 2006). The simultaneous presence of inflammation and metabolic disturbances in RA patients requires reliable approaches for the early assessment and monitoring of the

activity of the disease as well as the disturbance of metabolism. The neutrophil-lymphocyte ratio (NLR) and platelet-lymphocyte ratio (PLR) are emerging as reliable, low-cost markers of systemic inflammation, calculated from routine complete blood counts. These markers have been extensively studied in various inflammatory conditions, including autoimmune diseases, cardiovascular disorders, and cancer (Templeton *et al.,* 2014; Hu *et al*., 2014). In RA, elevated NLR and PLR have been linked to disease activity and may serve as useful tools for monitoring inflammatory status (Koiwa *et al.,* 2016). Similarly, insulin resistance is thought to exacerbate systemic inflammation, raising the potential for these hematological markers to provide insight into both RA disease activity and metabolic dysfunction (Kaplan, 2006).

Despite the emerging clinical data on the value of NLR and PLR as indicators of inflammation in RA and metabolic disorders, there are surprisingly few research investigations that address the usefulness of these parameters in RA patients with IR. At best, definitions of disease activity that incorporate these markers and an understanding of the association between these markers, disease activity, and IR could indeed prove illuminating to the pathophysiology of RA and enable better patient management. The purpose of this study would be to assess the prognostic and clinical utility of both NLR and PLR for the identification of inflammation in RA patients with elevated IR and to interconnect with disease activity and metabolic derangement.

2. Materials and Methods

This section describes in detail the types of materials used, and the set principles and methods for assessing NLR and PLR as inflammation biomarkers of patients with IR and RA. The study involved correspondingly adhering to the principles of ethics and the research was approved by the IRB. Participants were first given informed consent before they were considered for the study.

2.1 Study Design and Participants:

This is a cross-sectional study done between [14.08.2024] and [10.09.2024] at [IMS & SUM Hospital, Bhubaneswar SOA[Deemed to be University].Twenty-six clients of various age ranges of 23 to 71 years responded to the study. All participants had RA and a subgroup of them had IR, as assessed according to clinical criteria. Inclusion criteria for the study were as follows:

1. Diagnosed with RA as per the 2010 ACR/EULAR classification criteria for RA (Aletaha *et al.,* 2010).

2. Identification of insulin resistance by HOMA-IR with values derived from the formula of Matthews *et al*. (1985).
3. Age 18 years or older.

Exclusion criteria included:

1. Pregnancy or breastfeeding.
2. Severe, life-threatening systemic illnesses or diseases in combination with severe systemic infections, for example, severe pneumonia.
3. There are also other conditions characterized by inflammation apart from RA.

Participants were divided into two groups: those with RA only as one group and those with both RA and IR as the other group.

2.2 Clinical Measurements (Aletaha *et al.,* 2010)

Clinical measurements were recorded for all participants as mentioned:

- **Height** (using a stadiometer height measured in meters).
- **Weight** (using a calibrated scale weight measured in kilograms).
- **Body Mass Index (BMI)** was calculated using the formula: BMI = weight in kg/height in square meters).
- Using a standard sphygmomanometer (mmHg) **Blood Pressure** was checked.
- At the halfway between the lower rib and the iliac crest (cm),**the Waist Circumference** was measured.
- By dividing waist circumference in cm by hip circumference in cm, the **Waist-to-Hip Ratio (WHR)** was calculated.

2.3 Laboratory Measurements (Matthews et al., 1985)

2.4 Venous blood was drawn at least 12 hours after the last meal and only fasting blood was used in the study. The following laboratory tests were performed:

- **Fasting Blood Glucose (FBG)**: By using the glucose oxidase method (mg/dl).
- **HbA1C**: Expressed as malondialdehyde content and determined with high-performance liquid chromatography (HPLC).
- **Fasting Insulin**: Measured by using enzyme-linked immunosorbent assay (ELISA).
- **HOMA-IR Score**: Using the Homeostatic Model Assessment of Insulin Resistance (HOMA-IR) formula; HOMA-IR = fasting insulin (μU/mL) × fasting glucose (mg/dL)//405; (Matthews *et al.*, 1985).

- **Lipid Profile**: Serum levels of total cholesterol, triglycerides (TG), high-density lipoprotein (HDL), and Low-density lipoprotein (LDL) were determined by using the enzymatic colorimetric method.
- **Inflammatory Markers**: The WBC, ESR, and CRP levels were obtained for the patients from the routine blood test performed in the laboratory.

2.4 STATISTICAL ANALYSIS:

The data was analyzed using the Statistical Package for the Social Sciences software, SPSS 25.0 (IBM Corp., Armonk, NY, USA). To categorize the participants' demographic and clinical data descriptive statistics were applied. Systolic and diastolic blood pressure HbA1C% and other quantitative variables including age, BMI, fasting blood glucose, and inflammatory indices were described using mean and standard deviation (SD). Categorical variables such as gender and ethnicity were presented as frequencies and percentages.To evaluate the relationship between NLR, PLR, and clinical parameters (such as disease activity, insulin resistance, and inflammatory markers), Pearson's correlation coefficient (r) was used for normally distributed continuous variables. A p-value of <0.05 was considered statistically significant. Additionally, independent t-tests were used to compare mean values between groups (RA vs. RA with IR).

2.5 Ethical Considerations:

The study has been conducted by the principles of the Declaration of Helsinki and was approved by the Institutional Ethics Committee [IMS & SUM Hospital, SOA [Deemed to be University, Bhubaneswar]. As conducted with research participants, informed consent was acquired from all the participants to join the study.

3. Results:

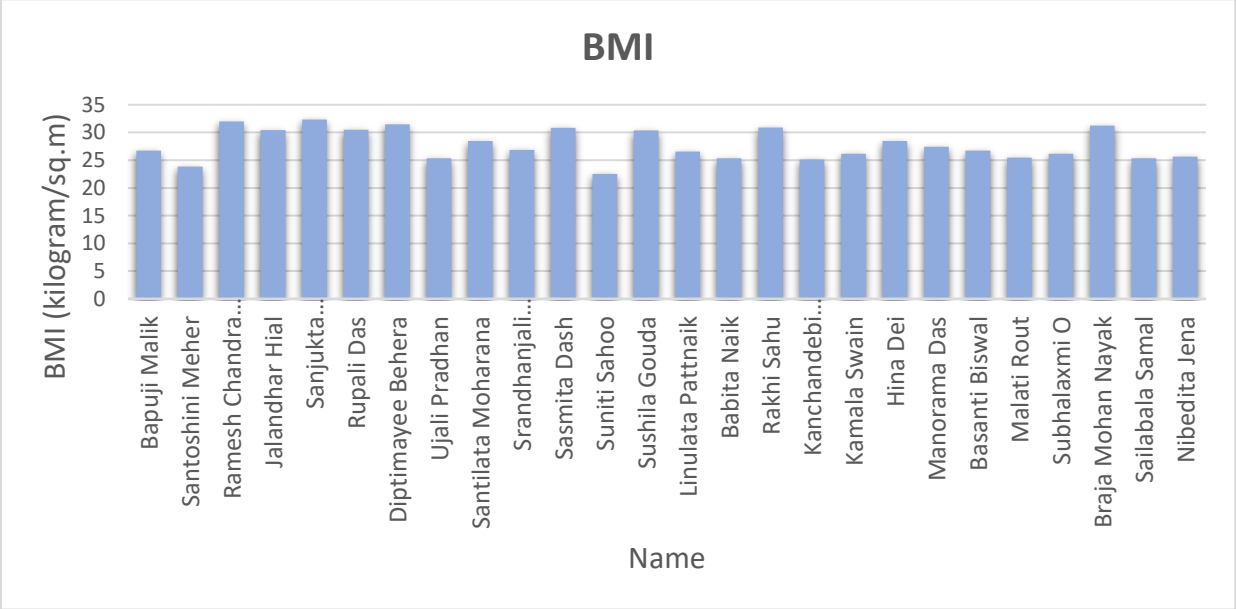
The research sample recruited 26 participants, distributed by gender; 10 males (38.46%) and females (61.54%). The participants were between 23 and 71 years and this brought in a good variety of the adult age group which would help explain variations in any of these health metrics among different age groups of adults. The age difference may cause different risk factors related to metabolic disorders individuals older in age are at higher risk.

3.1 Clinical Measurements

3.1.1 Height, Weight and BMI:

The participants were on average 1.66 meters tall and weighed about 61.5 kilograms, with an average BMI of 27.3 kilogram/sq.m, which is considered to be overweight most of the participants by present-day BMI standards. A BMI in this range is considered to contribute to lifestyle diseases such as insulin resistance, type 2 diabetes, and cardiovascular diseases.

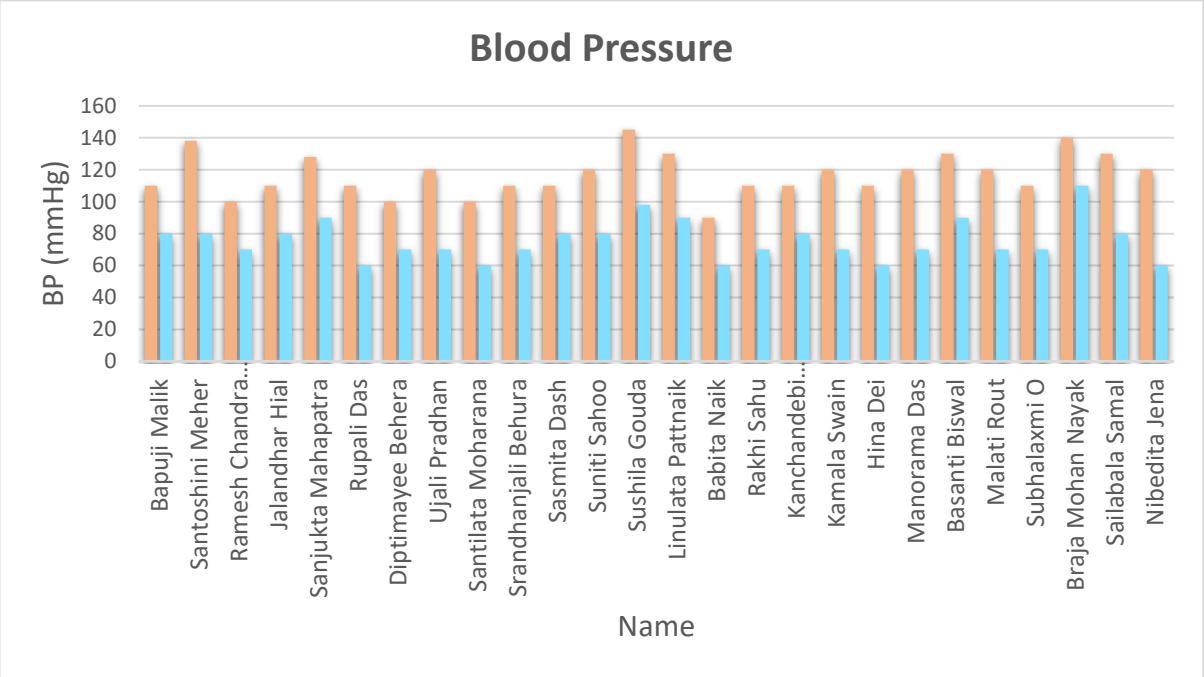
Figure 1: BMI of Participants



3.1.2 Blood Pressure:

Their average blood pressure is 113/77 mmHg and therefore it can be stated that the blood pressure level is typical for most of the population. However, this does not exclude hypertension completely for any consumers and this should be made with caution that blood pressure varies and may require follow-up spot check on the particular persons with other risks.

Figure 2: Blood Pressure of Participants



1.3 Waist Circumference and Waist-to-Hip Ratio:

The average waist circumference is 114.5 cm, which exceeds the threshold for abdominal obesity (generally 102 cm for males and 88 cm for females). This finding may be associated with increased visceral fat, which is a key risk factor for both insulin resistance and cardiovascular disease.The average WHR of 0.9 also indicates this as this measure is often used to find out those persons who are at higher cardiovascular risk especially if WHR is above 0.85 in women and 0.90 in men.

3.2 Laboratory Results

3.2.1 Fasting Blood Glucose:

The average fasting blood glucose was 100 mg/d, which is in the range of the preceding stage of diabetes – prediabetes The normal level is below 100 mg/d, while the level of prediabetes ranges from 100 to 125 mg/d. Certain participants also take levels of up to 200mg/dL, which may indicate that the participants have diabetes that has not been diagnosed or poorly controlled diabetes.

3.2.2 HbA1C:

The HbA1C ranges from 5.1% to 7.5%, with the average potentially indicating an elevated risk for diabetes. An HbA1C value of 5.7%-6.4% is considered prediabetes, while values above 6.5% confirm the diagnosis of diabetes. Monitoring these levels is important for assessing the risk of progression to diabetes.

3.2.3 Fasting Insulin and HOMA IR Score:

The fasting insulin levels recorded in the study vary widely with a value ranging from 3.9 to 83.59 µU/mL Fasting insulin tends to be elevated in the context of insulin resistance and levels toward the high end of this range may indicate a significant amount of such resistance. The HOMA-IR (Homeostasis Model Assessment of Insulin Resistance) score then adds numerical value to the finding. The calculated values varied between 0.16 and 22.8 and higher numbers suggest impaired glucose tolerance and a high probability of the development of VP2DM.Low IR: HOMA-IR < 2.5 (indicative of normal insulin sensitivity) and High IR: HOMA-IR ≥ 2.5 (indicative of insulin resistance or prediabetes/diabetes risk). Patients with Low IR where the individuals exhibit normal insulin sensitivity and have a lower risk of developing metabolic disorders such as Type 2 diabetes and cardiovascular diseases. Regular monitoring is still essential to ensure insulin function remains stable. The Patients with High IR where elevated HOMA-IR scores suggest insulin resistance, which is a risk factor for conditions such as metabolic syndrome, Type 2 diabetes, hypertension, and cardiovascular diseases. Those with very high values (e.g., Santilata Moharana - 25.1, Sanjukta Mahapatra - 18.6, Nibedita Jena - 17.7) require immediate medical attention and lifestyle modifications to manage IR effectively.

3.3 Cholesterol Levels

3.3.1 Total Cholesterol:

The total cholesterol ranges from 145 to 308 mg/dL, with some participants exceeding the recommended threshold of 200 mg/dL. Elevated cholesterol levels, particularly above 240 mg/dL, can increase the risk of atherosclerosis and cardiovascular events.

3.3.2 Triglycerides:

The total cholesterol is within the normal range of 125-200 mg/dL and HDL cholesterol is slightly low as compared to the male control group The triglyceride level is between 35-201mg/dl and this indicates that some of the participants present with high levels of triglycerides which are associated with metabolic syndrome and insulin resistance. High triglycerides are usually related to other lipid abnormalities and are considered enhancers of CVD.

3.3.3 HDL and LDL:

HDL is between 25.1 and 83.59 mg / dL. Lipoprotein HDL is the so-called "good" cholesterol, which means that high levels are protective against cardiovascular diseases. It is found very interesting that lower-density lipoproteins may represent a risk factor for heart disease. LDL is from 35 to 150 mg/dL: the numbers higher than that is considered a significant risk for coronary artery disease. For a significant number of people in this sample, their LDL cholesterol levels may be above the stated target and put them at risk of cardiovascular diseases.

3.4 Autoimmune Markers

3.4.1 Rheumatoid Factor (RF)

RF is an autoantibody mainly identifying the body's own IgG and is mostly seen in autoimmune diseases including Rheumatoid Arthritis (RA). It is therefore essential to note that increased levels of RF are there suggestive of RA but can also be present in other diseases. An antibody that gives a clue of autoimmunity, more so in rheumatoid arthritis is defined by the acronym RA. Typically, normal values are below 15–20 IU/mL. High RF Levels (>70): Patients like Jalandhar Hial (112), Rupali Das (110), and Kamala Swain (92.6) are likely to have active RA. Normal RF levels are typically below 15–20 IU/mL. Elevated RF levels suggest autoimmune activity and inflammation, but they are not specific to RA alone (can be seen in conditions like Sjogren's syndrome, systemic lupus erythematosus, or chronic infections).

3.4.2 Anti-CCP (Anti-Cyclic Citrullinated Peptide):

Anti-CCP antibodies target citrullinated proteins, which are highly specific for RA. The presence of anti-CCP antibodies is a more reliable and specific indicator of RA, often appearing before clinical symptoms. A marker is specific to RA. Elevated levels often indicate RA and predict its severity. Normal levels are generally below 20 U/mL. Values above 20 U/mL are considered positive for RA. Elevated Anti-CCP Levels (>200) were Seen in most patients, with extremely high values in Kamala Swain (500), Sasmita Dash (467), and Bapuji Malik (435), strongly indicating RA and predicting severe joint damage.

Figure 3: Rheumatoid Factor (RF) of Participants

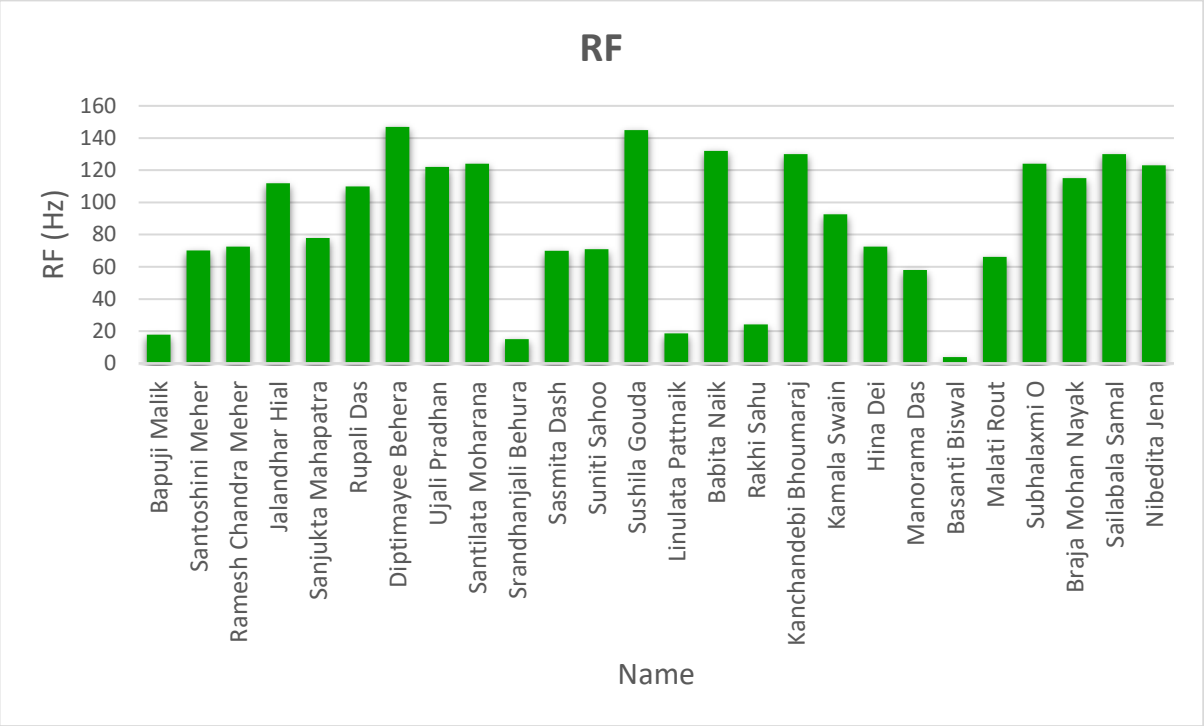
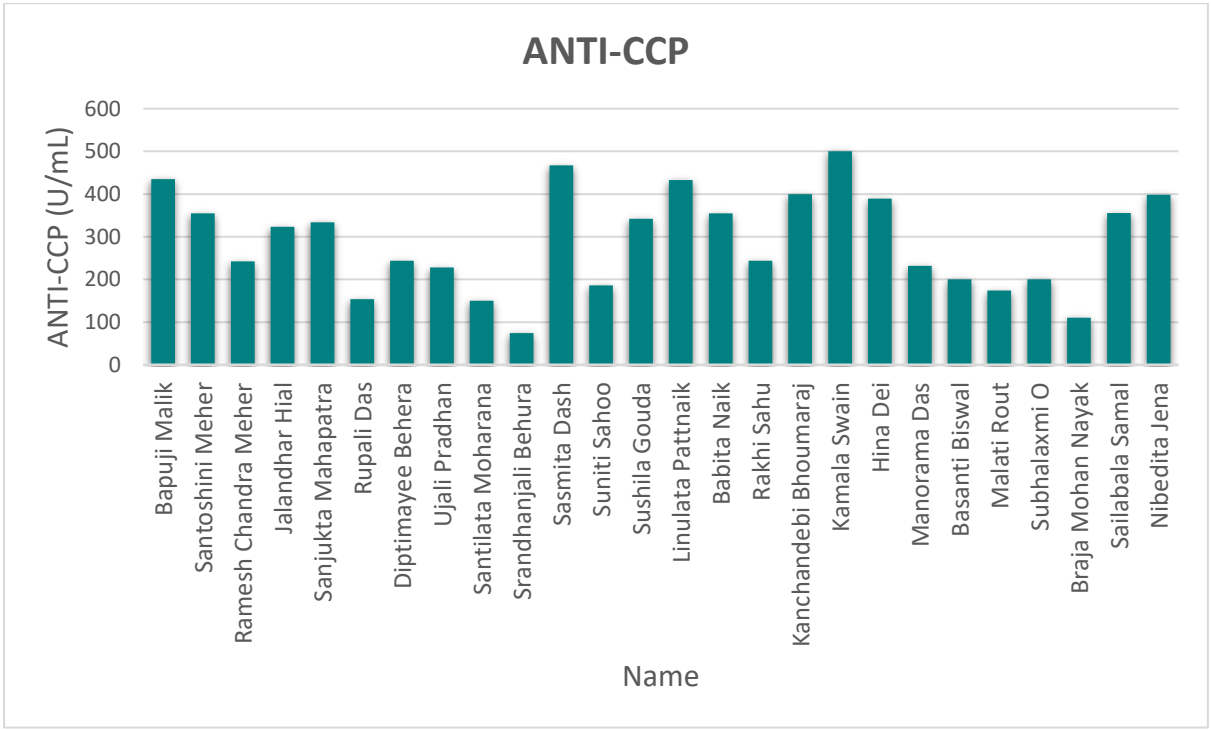


Figure 4: ANTI-CCP of Participants



3.5 Inflammatory Markers

3.5.1 WBC Count: The ANC values are also within normal levels for most of the study participants, though slightly higher than normal levels in some participants may be indicators

of active inflammation. Low-grade inflammation is well understood in patients with metabolic dysfunction, including insulin resistance and obesity.

3.5.2 ESR and CRP Levels: ESR and CRP levels increase in individuals with systemic inflammation and are usually seen in those with insulin resistance and metabolic syndrome. Both insulin resistance and cardiovascular disease involve inflammation as their core pathogenesis.

3.6 Neutrophil-to-Lymphocyte Ratio (NLR) and Platelet-to-Lymphocyte Ratio (PLR)

The Neutrophil-to-Lymphocyte Ratio (NLR) and Platelet-to-Lymphocyte Ratio (PLR) are important inflammatory biomarkers that help assess systemic inflammation, immune response, and potential disease risk. Most patients (16 out of 26) have NLR values within the normal range (<3), indicating low inflammation. Mild inflammation (NLR 3-5) is seen in six patients (e.g., Santoshini Meher, Babita Naik, Sasmita Dash). Moderate inflammation (NLR 5-9) is observed in four patients, including Rupali Das, Ujali Pradhan, Santilata Moharana, and Malati Rout. These patients might need closer monitoring for underlying conditions. No patients exceed the threshold of NLR >9, which would indicate severe inflammatory conditions. PLR values are within the normal range for all patients, suggesting that there is no strong platelet-driven inflammatory response. For patients with mild or moderate inflammation (NLR ≥3): Monitor for signs of systemic inflammation or infection. Consider lifestyle modifications, including a balanced diet and exercise. Further clinical investigations may be required if symptoms persist. For patients with normal NLR (<3) and PLR (<100): No immediate concerns; continue regular health checkups.

Table 1: Patient NLR and PLR Data

S. No	Name	NLR Ratio	PLR Ratio	NLR Interpretation	PLR Interpretation
1	Bapuji Malik	2	7.36	Normal	Normal
2	Santoshini Meher	3	9.44	Mild Inflammation	Normal
3	Ramesh Chandra Meher	2	7.08	Normal	Normal
4	Jalandhar Hial	2	5.42	Normal	Normal
5	Sanjukta Mahapatra	3	12.09	Mild Inflammation	Normal
6	Rupali Das	8	22.8	Moderate Inflammation	Normal
7	Diptimayee Behera	2	4.73	Normal	Normal

8	Ujali Pradhan	5	22.79	Moderate Inflammation	Normal
9	Santilata Moharana	6	19.1	Moderate Inflammation	Normal
10	Srandhanjali Behura	2	6.29	Normal	Normal
11	Sasmita Dash	3	6.29	Mild Inflammation	Normal
12	Suniti Sahoo	3	18.24	Mild Inflammation	Normal
13	Sushila Gouda	1	3.13	Normal	Normal
14	Linulata Pattnaik	2	9.2	Normal	Normal
15	Babita Naik	3	14.37	Mild Inflammation	Normal
16	Rakhi Sahu	6	18.59	Moderate Inflammation	Normal
17	Kanchandebi Bhoumaraj	2	6.57	Normal	Normal
18	Kamala Swain	2	10.56	Normal	Normal
19	Hina Dei	2	6.29	Normal	Normal
20	Manorama Das	1	3.13	Normal	Normal
21	Basanti Biswal	3	6.29	Mild Inflammation	Normal
22	Malati Rout	7	22.79	Moderate Inflammation	Normal
23	Subhalaxmi O	2	9.2	Normal	Normal
24	Braja Mohan Nayak	2	7.09	Normal	Normal
25	Sailabala Samal	3	12.09	Mild Inflammation	Normal
26	Nibedita Jena	2	9.44	Normal	Normal

3.7 Family History and Ethnicity

3.7.1 Ethnicity: All participants are of Indian ethnicity, this group is hypothesized to have higher insulin resistance and diabetes due to genetics, diet, and other lifestyle factors.

3.7.2 Family History: The presence of a family history of diabetes in some participants further elevates their risk of developing insulin resistance and type 2 diabetes. Family history is a strong risk factor for metabolic disorders.

The data suggests a high prevalence of risk factors associated with insulin resistance, type 2 diabetes, and cardiovascular diseases. The participants, with their elevated BMI, high waist circumference, abnormal glucose and lipid profiles, and inflammatory markers, exhibit signs of metabolic dysfunction. These findings highlight the importance of targeted health interventions, including lifestyle changes like improved diet, physical activity, and weight

management, which could help mitigate the risk of progression to more serious health conditions such as diabetes and cardiovascular diseases.

4. DISCUSSION:

The information received from 26 respondents relates to the basic health parameters that are linked with metabolic disorders like IR, obesity, dyslipidemia, and inflammation. They emphasize the dependent relationship of those factors and reveal the need for the further increased targeted prevention of further chronic diseases amplitude such as type 2 diabetes and cardiovascular diseases.

4.1 Insulin Resistance and Metabolic Dysfunction

Many participants exhibit an elevated BMI and a slightly higher waist circumference indicating a high proportion of abdominal obesity, a complication that increases the risk of insulin resistance-related complications (NCD Risk Factor Collaboration, 2016). Adipose tissue particularly, visceral fat releases pro-inflammatory cytokines that reduce insulin signaling pathways, hence leading to IR (Lumeng & Saltiel 2011; Zhang *et al* 2025). The HOMA-IR score according to which the obtained results were estimated varied from 0.16 to 22.8 in the study, it is an efficient marker of the severity of IR. Elevated HOMA-IR is associated with a raised risk of Type 2 diabetes and cardiovascular diseases (Kahn, 2003). Due to these high values in some participants, those persons are at risk of acquiring metabolic syndrome and diabetes, and therefore the necessity of managing insulin correction through changes in the life setting appropriately.

The relationship between elevated fasting blood glucose levels and HbA1C values further corroborates the presence of glucose dysregulation in many participants. HbA1C values ranging from 5.1% to 7.5% indicate varying degrees of glucose intolerance, with some participants falling within the prediabetes range (American Diabetes Association, 2020). These findings align with previous studies indicating that insulin resistance is a major contributor to the pathogenesis of type 2 diabetes (Guan*et al*., 2022).

4.2 Dyslipidemia and Cardiovascular Risk

The lipid profile results showed some symptoms; total cholesterol score and triglyceride and LDL cholesterol were high in some participants. These lipid derangements are seen in patients with insulin resistance and are fundamental to the definition of metabolic

syndrome (Eckel *et al.,* 2005). Higher than-normal values of triglycerides and LDL are closely correlated with the presence of atherosclerosis and cardiovascular diseases (Patel *et al.,* 2024). Additionally, low levels of HDL cholesterol detected in some participants worsen cardiovascular disease risk because HDL is globally regarded as a vessel protecting against bio-film formation in arteries (Froldi, 2024). Abnormal levels of triglyceridaemia, elevated LDL, and low HDL render subjects to develop a pro-atherogenic lipid profile thus implying that prospective treatments must enhance lipid profile.

4.3 Inflammatory Markers and Systemic Inflammation

Some of the other parameters like C-reactive protein (CRP) and erythrocyte sedimentation rate (ESR) showing higher levels in some of the participants prove that insulin resistance and metabolic syndrome, (Brogan *et al*., 2024). They also appreciate that Low-grade inflammation has also been established to be a strong player in the continued perpetration of insulin resistance, arising from the suppression of the insulin signal transduction in muscle, liver, and adipose tissue (Shoelson *et al.,* 2006). Moreover, those few participants with a high level of WBC count can signify an inflammation within the body. This complements prior studies documenting cross-sectional serendipity between SIS and metabolic diseases, where inflammation increases insulin resistance and vice versa (Hotamisligil, 2006).

4.4 Gender and Age-related Differences

According to the demographics of the study, 61.5% of the client preferring the service are female, and the age is between 23 and 71 years. Past research has shown that metabolic ailments closely correlate with gender as well as age. For example, women in the postmenopausal period are more likely to have insulin resistance and obesity than men users, mainly because of hormonal shifts. In the same case, older adults are also significantly vulnerable to metabolic diseases owing to changes in metabolism as well as increased obesity among elderly people (Chia *et al.,* 2018). Such perturbations may partly account for the high levels of metabolic disorder evident in this study.

4.5 Family History and Ethnicity

One of the most common antecedents of poor fasting glucose and insulin resistance mentioned by the participants of the study is diabetes in the family (Grarup *et al.,* 2014). Diabetes is a disease that a person inherits from his or her parents and it affects insulin signals,

when the genotype is combined with an unfavorable environment like an unhealthy diet and sedentary lifestyle, the risk of developing metabolic diseases (Crook & Edison, 2024). Further, the Indian people are insulin resistant, obese, and have tendencies of Type-2 diabetes when compared with other ethnic groups, as studies by Wang *et al*., 2024.

4.6 Limitations and Future Directions:

However, there are some implications of this study, which are worth considering. One of the primary issues is the small sample size, so it will NOT be appropriate to generalize the results to the rest of the population. Moreover, the paper's cross-sectional research design means that the directionality of relationships cannot be determined. They should also enroll far greater and more heterogeneous groups of patients and use longitudinal designs as the next step to evaluate the evolution of insulin resistance about risks of acquiring type 2 diabetes and cardiovascular diseases. However, it would have provided valuable knowledge on the management of these conditions to examine by how much specific interventions including lifestyle changes and pharmacotherapies in the management of these conditions enhance these indices.

5. CONCLUSION:

This study underscores the importance of regular health assessments in individuals with risk factors for insulin resistance and metabolic dysfunction. The majority of the patients (16 out of 26) have normal NLR values (<3), suggesting a stable immune response with no significant systemic inflammation. Six patients exhibit mild inflammation (NLR 3-5), while four patients show moderate inflammation (NLR 5-9), indicating potential underlying inflammatory or stress-related conditions. These individuals may require monitoring or further clinical assessment. No patients have severe inflammation (NLR >9), which suggests the absence of critical inflammatory disorders in this group. PLR values remain within the normal range for all patients, indicating no significant platelet-driven inflammatory response. Patients with elevated NLR (≥3) may benefit from additional diagnostic evaluations, lifestyle modifications, or medical interventions to manage possible low-grade inflammation. The high prevalence of elevated BMI, glucose dysregulation, dyslipidemia, and inflammatory markers in this cohort emphasizes the need for early interventions. Lifestyle changes embracing dietary

modifications, exercise, and diets as well as weight loss can go a long way in reducing the overall prevalence of metabolic disorders and delaying the occurrence of type 2 diabetes and cardiovascular diseases. More studies are required to determine the chronic consequences of insulin resistance and the best ways of treating these diseases.

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