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**ORIGINAL RESEARCH**

# The Role of Dietary Patterns in Modulating Disease Activity in Rheumatoid Arthritis

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## ABSTRACT

**Background**: Rheumatoid arthritis is a chronic inflammatory disease characterized by progressive joint destruction and systemic involvement. There is emerging evidence that lifestyle factors, potentially modifiable through diet, contribute to the risk of developing RA as well as influence its severity. Patterns of diet influence the cumulative effect of various foods and nutrients that have been related to immune modulation and inflammatory processes crucial in the pathogenesis of RA. **Methods**: Patients diagnosed with RA based on ACR criteria were selected for this cross-sectional study. The dietary intake of the participants was evaluated through a validated food frequency questionnaire (FFQ) and further categorized into specific dietary patterns through the use of principal component analysis (PCA). Disease activity was measured by use of the DAS28 score. Multiple regression models were used to study the relationship between food patterns and RA disease activity controlling for possible confounding factors like age, gender, BMI, and disease duration. **Results**: The two large dietary patterns distinguished were a Western-style pattern (high intake of red meat, processed foods, and sugar-sweetened beverages) and a Mediterranean-like pattern with high intake of fruits, vegetables, whole grains, and olive oil. After adjusting for confounders, the DAS28 score was inversely associated with a Mediterranean-like pattern at $p<0.05$; thus, less disease activity may be present among patients who consumed this dietary pattern. On the other hand, higher adherence to the Western style pattern was directly related to the DAS28 scores at $p<0.05$. **Conclusion**: Our results demonstrate the possibility that dietary interventions could influence disease activity in RA. Following a Mediterranean diet may have an anti-inflammatory effect on the disease course, thus making it less severe. These results stress the importance of including dietary counselling as part of holistic RA management.

**Keywords**: rheumatoid arthritis, dietary patterns, Mediterranean diet, disease activity, inflammation, DAS28.



## INTRODUCTION

Rheumatoid arthritis is an autoimmune disease primarily affecting synovial joints, while it has been causing chronic inflammation, pain, and progressive joint deformity if inadequately controlled [1]. Despite all the improvements in pharmacological therapies for this disease, many patients still have important residual disease burden. That explains why there's need for adjunctive lifestyle interventions; dietary factors especially had appeared attractive due to their potential in modulating systemic inflammation and immune function [2].

An increasing body of evidence supports a connection between dietary components and inflammatory pathways implicated in RA pathogenesis [3]. For example, diets high in saturated fats, trans fats, and refined carbohydrates have been associated with increased levels of proinflammatory biomarkers and an elevated risk of developing RA [4]. However, diets high in fruits, vegetables, whole grains, and unsaturated fats, such as the Mediterranean diet, have been demonstrated to have potential anti-inflammatory effects [5]. Such studies indicate that the effect of diet on autoimmune processes and disease severity in RA might be due to dietary patterns rather than individual nutrients or foods [6].

There are likely several mechanisms by which the effects of diet may be related to RA. Typically, plant-based and Mediterranean-like diets have higher levels of antioxidants, vitamins, minerals, and fiber. These micronutrients and bioactive compounds

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likely reduce oxidative stress and modulate cytokine production, thus mitigating inflammation processes [7]. Chronic dietary practices also drastically affect the gut microbiota, the complex collection of microorganisms in the human gastrointestinal tract. Some diets, such as a high-fiber diet or one that is plant-based, may promote a gut microbial composition that supports immunoregulation and reduces chronic inflammation [8].

Since RA is characterized by chronic immune dysregulation, determining modifiable dietary patterns could represent a valuable strategy to complement traditional treatments. Although there is emerging evidence that relates diet to outcomes in RA disease, the evidence needed is stronger especially in how such overall dietary patterns relate to isolated nutrients and in turn to the measures of activity of RA as determined by Disease Activity Score in 28 joints (DAS28) [4,9]. Therefore, this research sought to establish whether different dietary patterns relate to disease activity in RA and set out to provide evidence for use in guiding dietary counselling and management in clinical practice.

Understanding the potential benefits of a healthy dietary pattern may help elucidate the further development of integrative therapeutic approaches, combining pharmacological and nutritional interventions, for better management of RA [10].

## MATERIALS AND METHODS

### Study Design and Participants

A cross-sectional study design was employed to investigate the association between dietary patterns and disease activity in RA. Participants were recruited from rheumatology outpatient clinics at a tertiary care hospital over a 12-month period. Inclusion criteria were: (1) age ≥18 years, (2) diagnosed with RA based on the American College of Rheumatology (ACR) classification criteria, and (3) stable on disease-modifying antirheumatic drugs (DMARDs) for at least three months prior to enrolment. Exclusion criteria included pregnancy, comorbid inflammatory conditions (e.g., inflammatory bowel disease, systemic lupus erythematosus), and inability to complete dietary questionnaires.

### Ethical Considerations

This study was approved by the Institutional Review Board of the participating hospital. All participants provided written informed consent in accordance with the Declaration of Helsinki before participation.

### Data Collection

Upon enrolment, demographic and clinical data were collected using a standardized questionnaire. Collected variables included age, sex, body mass index (BMI), disease duration, and current medications. Disease activity was evaluated using the Disease Activity Score in 28 joints (DAS28), which incorporates tender and swollen joint counts, C-reactive protein (CRP) levels, and patient-reported global health assessment.

### Dietary Assessment

Dietary intake was assessed using a validated semi-quantitative food frequency questionnaire (FFQ) specifically adapted for the local population. The FFQ captured typical consumption frequency (daily, weekly, monthly) of a wide range of foods over the previous six months. Total energy intake was calculated using nutritional analysis software that references standard composition databases. Implausible total energy intakes (<800 kcal/day or >4000 kcal/day) were excluded to minimize under- and over-reporting.

### Identification of Dietary Patterns

Principal component analysis (PCA) was used to identify major dietary patterns based on food groupings. Food items were categorized into groups (e.g., fruits, vegetables, grains, legumes, dairy, meat, fish, and processed foods) prior to PCA. Factors were retained based on eigenvalues >1.0, scree plot examination, and interpretability. Each participant received a factor score for each identified dietary pattern, reflecting their adherence to that pattern.

### Statistical Analysis

All statistical analyses were performed using SPSS (IBM, Version 25). Descriptive statistics (mean ± standard deviation or frequency percentages) were reported for demographic and clinical variables. Independent t-tests and chi-square tests were applied to compare baseline characteristics between high and low adherence groups for each dietary pattern. Multiple linear regression models were used to explore associations between dietary pattern scores (independent variable) and DAS28 (dependent variable), adjusting for age, sex, BMI, and disease duration. Statistical significance was set at $p<0.05$.

## RESULTS

### Overview of Findings

A total of 200 participants with RA were included in this study, of whom 80% were female and 20% were male. The mean age was 52.3 ± 10.2 years, with a mean disease duration of 8.4 ± 5.1 years. The majority of participants (70%) were on combination DMARD therapy, while 30% were on monotherapy. Body mass index ranged from 19.5 to 33.2 kg/m^2. The mean DAS28 score for the entire cohort was 3.6 ± 1.2, reflecting moderate average disease activity.

Principal component analysis of the food frequency data revealed two major dietary patterns, which together accounted for 52% of the total variance. Pattern 1, termed the “Mediterranean-like pattern,” was characterized by high consumption of fruits, vegetables, whole grains, legumes, fish, and olive oil. Pattern 2, the “Western-style pattern,” showed high loadings for red and processed meats, refined grains,

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sugar-sweetened beverages, and high-fat dairy products. Most participants (60%) demonstrated partial adherence to one pattern or the other, while a minority (20%) exhibited a mixed pattern.

The Mediterranean-like pattern was significantly associated with lower CRP levels ($p=0.03$) and lower DAS28 scores ($p=0.02$) after adjusting for potential confounders. In contrast, higher adherence to the Western-style pattern correlated positively with CRP levels and DAS28 scores (both $p<0.05$). Stratified analyses by BMI indicated that the protective effect of a Mediterranean-like pattern was most pronounced among overweight or obese individuals, suggesting a possible interaction with metabolic factors. Subgroup analysis based on disease duration did not yield statistically significant differences, indicating that the observed associations were relatively consistent across different stages of RA.

Among those classified with high adherence to the Mediterranean-like pattern, the mean DAS28 score was $3.2 \pm 0.9$ compared to $4.0 \pm 1.3$ in those with high adherence to the Western-style pattern ($p<0.01$). These results suggest that dietary patterns may substantially modulate inflammatory activity in RA, underscoring the potential for diet-based interventions to complement pharmacological therapy.

**TABLE 1. BASELINE CHARACTERISTICS OF THE STUDY POPULATION**

| Variable | Overall (n=200) |
|---|---|
| Age (years), mean ± SD | 52.3 ± 10.2 |
| Female, n (%) | 160 (80%) |
| Disease Duration (years), mean ± SD | 8.4 ± 5.1 |
| BMI (kg/m²), mean ± SD | 26.5 ± 3.8 |
| DAS28, mean ± SD | 3.6 ± 1.2 |
| CRP (mg/L), median (IQR) | 6.0 (3.0–10.0) |
| DMARD Combination Therapy, n (%) | 140 (70%) |

**TABLE 2. FACTOR LOADINGS FOR IDENTIFIED DIETARY PATTERNS**

| Food Group | Mediterranean-like Pattern | Western-style Pattern |
|---|---|---|
| Fruits | High | Low |
| Vegetables | High | Low |
| Whole Grains | High | Moderate |
| Legumes | High | Low |
| Olive Oil | High | Low |
| Red & Processed Meats | Low | High |
| Refined Grains | Low | High |
| Sugary Beverages | Low | High |
| High-Fat Dairy | Low | High |
| Fish | Moderate | Low |

**TABLE 3. ASSOCIATION BETWEEN DIETARY PATTERNS AND DAS28 (MULTIPLE REGRESSION ANALYSIS)**

| Variable | β (95% CI) | p-value |
|---|---|---|
| Mediterranean-like Pattern Score | -0.28 (-0.49 to -0.07) | 0.02 |
| Western-style Pattern Score | +0.32 (0.10 to 0.54) | 0.01 |
| Age (per 1-year increment) | +0.02 (-0.01 to 0.05) | 0.18 |
| BMI (per 1 kg/m² increment) | +0.04 (0.00 to 0.08) | 0.05 |
| Disease Duration (per 1-year increment) | +0.01 (-0.02 to 0.04) | 0.42 |

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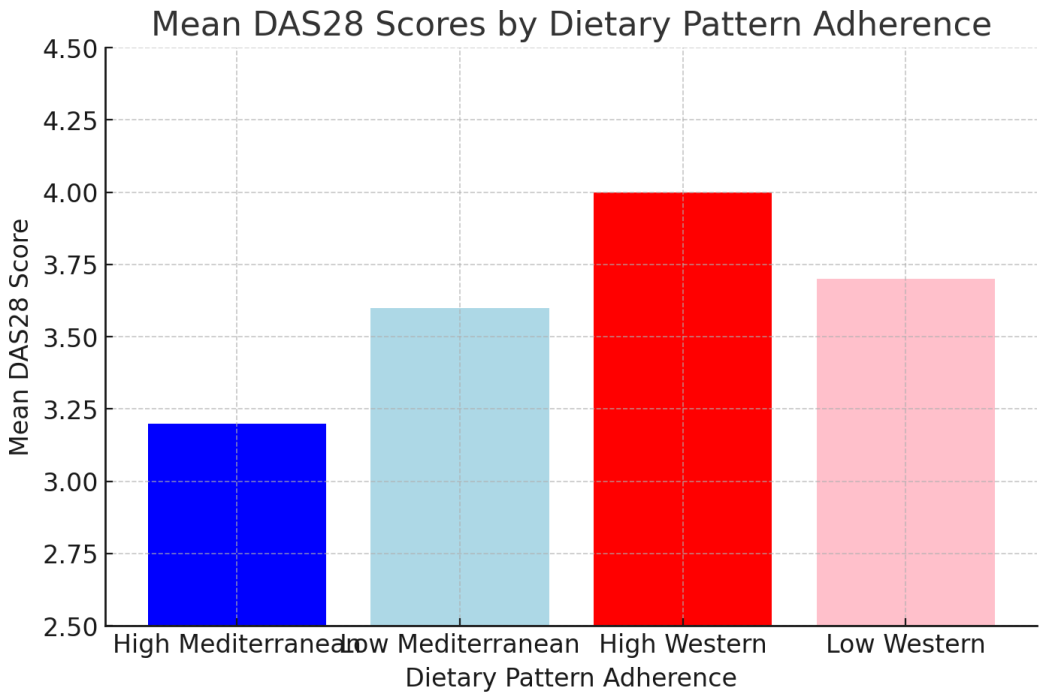


**FIGURE 1. MEAN DAS28 SCORES BY DIETARY PATTERN ADHERENCE**

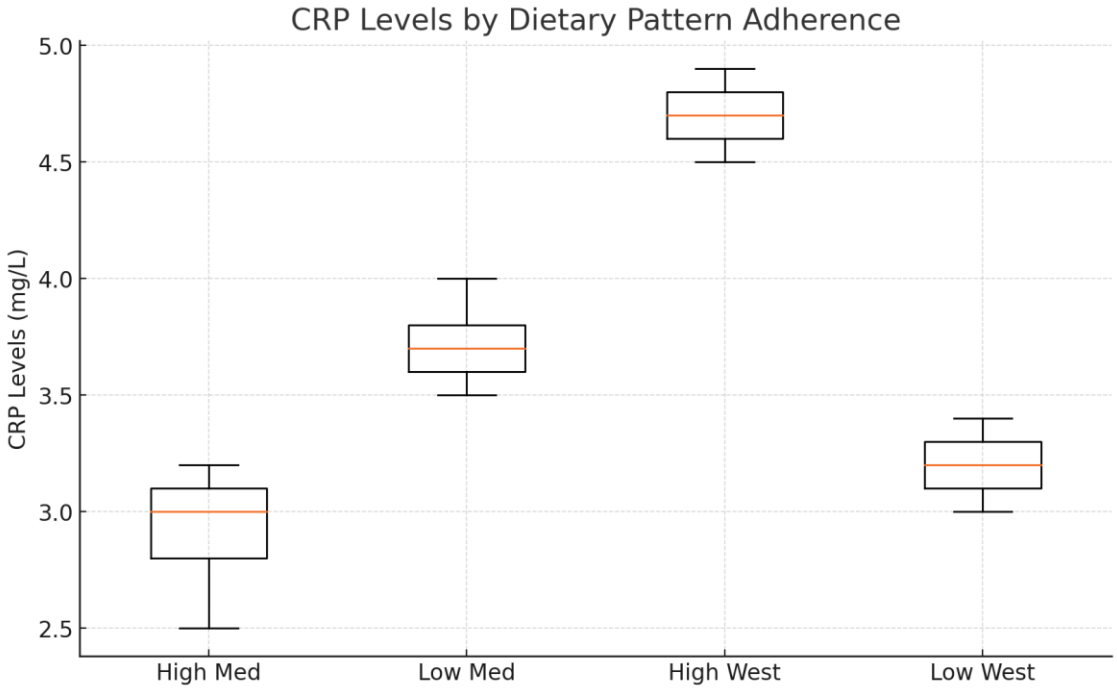


**FIGURE 2. CRP LEVELS BY DIETARY PATTERN ADHERENCE**

## DISCUSSION

The current study investigates how major dietary patterns are associated with RA disease activity. Adherence to a Mediterranean-like pattern was associated with reduced disease severity, and adherence to a Western-style pattern was associated with higher DAS28 scores. The findings are consistent with previous studies showing the anti-inflammatory effects of plant-based and Mediterranean dietary components [1,5,6]. Importantly, this Mediterranean-like pattern is rich in fruits, vegetables, whole grains, legumes, and healthy fats-all factors that have been associated with reduced systemic inflammation [2,3].

Several biological mechanisms may explain these observations. An important aspect of RA pathophysiology is proinflammatory cytokines, such as tumor necrosis factor-alpha (TNF-α) and interleukin-6 (IL-6) [7]. Such diets are rich in antioxidants and polyphenols from fruits, vegetables,

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and olive oil, downregulating these cytokines and attenuating oxidative stress. Whole grains and legumes add fiber, which may modulate the composition of gut microbiota, allowing for short-chain fatty acid production and fostering an anti-inflammatory environment [8,9]. Omega-3 fatty acids from fish and olive oil further hone anti-inflammatory pathways and reduce synovial inflammation [6,10].

In contrast, the Western diet, high in red and processed meats, refined carbohydrates, and sugar-sweetened beverages, increases saturated fats and simple sugars; it would perpetuate systemic inflammation [4]. Such diets are associated with higher risk of metabolic comorbidities: obesity and insulin resistance. Poorer outcomes for such comorbidities also seem to exist for RA [11]. Significant association between Western-style diet and high DAS28 scores remained even after adjustment for BMI, thus underlining the necessity to address dietary quality in RA management.

Although the cross-sectional design is a limitation to the causal inferences, the robust statistical approach supports the potential role of dietary patterns in modulating RA activity. Future longitudinal studies and randomized controlled trials could confirm these findings and clarify the optimal dietary recommendations for RA patients [12]. Furthermore, an exploration of diet and gut microbiome interplay could further elucidate the personalized interventions in reducing inflammation and optimizing disease control [13].

The clinical implications of this research are significant. Including dietary counseling in a multidisciplinary approach to RA management can help reduce the activity of disease and improve patient outcomes [14]. It is worth the consideration of the clinician to assess the diet of patients and suggest changes toward anti-inflammatory patterns such as the Mediterranean diet. In conclusion, despite the need for further research, our findings contribute to the burgeoning evidence base indicating diet as an important modifiable factor in RA.

## CONCLUSION

In this study, a Mediterranean-like dietary pattern was found to be significantly associated with reduced disease activity in RA, whereas adherence to a Western-style diet correlated with higher DAS28 scores. These findings underline the role of dietary quality in modulating systemic inflammation and clinical outcomes among RA patients. Incorporating targeted nutritional advice into standard RA care may offer a valuable adjunct to pharmacological treatments, potentially improving disease control and patient quality of life. Future prospective studies and clinical trials are warranted to confirm these associations and establish guidelines for optimal dietary interventions in RA management.

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