

# **Integrated Multidisciplinary Approaches to Managing Chronic Inflammation: The Combined Impact of Biochemical, Nutritional, Pharmacological, and Physiotherapy Interventions**

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## **Abstract**

**Chronic inflammation is a key driver in several long-term diseases, requiring an integrated management approach. This study aimed to evaluate the efficacy of a multidisciplinary intervention combining biochemical monitoring, nutritional adjustments, pharmacotherapy, and physiotherapy in reducing inflammation, pain, and improving quality of life in patients with chronic inflammatory conditions. Conducted over 12 months in a tertiary hospital, 120 patients were divided into intervention and control groups. The intervention group showed significant reductions in inflammatory markers, including C-reactive protein (CRP) and interleukin-6 (IL-6), along with substantial improvements in pain levels and quality of life, compared to the control group, which received standard pharmacological treatment. These findings support the adoption of a comprehensive, multidisciplinary approach in managing chronic inflammation to achieve superior patient outcomes.**

**Keywords: Chronic inflammation, multidisciplinary approach, biochemical monitoring, pharmacotherapy, nutrition, physiotherapy, C-reactive protein, pain management, quality of life.**

## **Introduction**

Chronic inflammation is a key driver of numerous diseases, including rheumatoid arthritis, cardiovascular diseases, Crohn's disease, and diabetes. It is characterized by the prolonged activation of the immune system, which can lead to tissue damage and contribute to the progression of these conditions (Gabay, 2006). Traditional management of chronic inflammation often relies on pharmacological interventions, such as nonsteroidal anti-inflammatory drugs (NSAIDs) and corticosteroids, to reduce inflammation and relieve symptoms. However, there is growing evidence that a multidisciplinary approach, incorporating nutritional, pharmacological, physiotherapy, and biochemical interventions, may be more effective in managing chronic inflammation holistically (Calder, 2013).

Biochemical markers such as C-reactive protein (CRP), tumor necrosis factor-alpha (TNF-alpha), and interleukins (IL-6) play a crucial role in understanding the inflammatory process and monitoring the effectiveness of interventions. Monitoring these markers can help guide treatment adjustments and provide insight into the body's response to various therapeutic strategies (Pepys & Hirschfield, 2003). While

pharmacological therapies focus on modulating these inflammatory pathways, dietary interventions, such as an anti-inflammatory diet rich in omega-3 fatty acids, have been shown to complement medical treatments by reducing oxidative stress and inflammation (Calder, 2013).

Physiotherapy interventions, including exercise and manual therapy, have been found to further mitigate the effects of chronic inflammation by improving mobility, reducing pain, and enhancing overall function (Pedersen & Saltin, 2015). Physical activity has been shown to modulate inflammatory processes, making it an essential component of a multidisciplinary approach to managing chronic inflammation.

Despite the progress in understanding and treating chronic inflammation, there is still a need for more research into how these interventions can be integrated and tailored to individual patients. The aim of this study is to evaluate the effectiveness of a multidisciplinary approach—combining biochemical monitoring, dietary interventions, pharmacotherapy, and physiotherapy—in managing chronic inflammation and improving patient outcomes. By exploring the synergistic effects of these interventions, this research seeks to provide a more comprehensive understanding of how to optimize the management of chronic inflammatory conditions.

## Literature Review

### Chronic Inflammation Overview

Chronic inflammation is a prolonged and dysregulated immune response that persists in the body, contributing to the pathogenesis of various diseases, including rheumatoid arthritis, cardiovascular disease, inflammatory bowel disease, and metabolic disorders (Medzhitov, 2008). Inflammation is a natural protective response to infection or injury, but when it becomes chronic, it can cause tissue damage and promote disease progression. Chronic inflammation is driven by cytokines such as tumor necrosis factor-alpha (TNF- $\alpha$ ), interleukin-6 (IL-6), and C-reactive protein (CRP), which are often used as biomarkers to monitor inflammation levels in patients (Hunter & Jones, 2015). These biomarkers provide valuable insight into the effectiveness of therapeutic interventions and the progression of inflammatory diseases.

### Pharmacological Interventions

Pharmacological treatments for chronic inflammation typically focus on reducing inflammation through the use of nonsteroidal anti-inflammatory drugs (NSAIDs), corticosteroids, and disease-modifying antirheumatic drugs (DMARDs). NSAIDs reduce inflammation by inhibiting cyclooxygenase (COX) enzymes, while corticosteroids suppress the immune response by interfering with multiple pro-inflammatory pathways (Rang et al., 2012). Biologic agents, such as TNF inhibitors, have also been developed to target specific cytokines involved in the inflammatory process, leading to more targeted and effective management of conditions like rheumatoid arthritis and Crohn's disease (Feldmann, 2008).

Pharmacists play a critical role in managing these therapies, ensuring proper dosing, minimizing side effects, and preventing drug interactions. They also monitor patients for therapeutic effectiveness, particularly by tracking inflammatory biomarkers such as CRP and erythrocyte sedimentation rate (ESR) to evaluate treatment success (Woodrick and Ruderman, 2011). However, pharmacotherapy alone may not fully address the multifaceted nature of chronic inflammation, underscoring the need for integrated approaches that also include dietary and physical interventions.

### Nutritional Interventions

There is a growing body of evidence suggesting that dietary factors can significantly influence chronic inflammation. Anti-inflammatory diets, particularly those rich in omega-3 fatty acids, antioxidants, and polyphenols, have been shown to reduce markers of inflammation and improve clinical outcomes in patients with inflammatory conditions (Calder, 2013). For instance, the Mediterranean diet, which emphasizes fruits, vegetables, whole grains, nuts, and healthy fats, has been associated with lower levels of CRP and IL-6, markers of systemic inflammation (Barbaresko et al., 2013). Omega-3 fatty acids, found in fatty fish and flaxseed, have demonstrated potent anti-inflammatory properties by reducing the production of pro-inflammatory cytokines (Calder, 2013).

Dietitians are integral to this process, helping patients adopt and adhere to anti-inflammatory dietary plans tailored to their specific health conditions. Research indicates that dietary interventions can complement pharmacological therapies, enhancing overall treatment outcomes. For example, a combination of omega-3 supplementation and pharmacotherapy has been shown to reduce inflammation more effectively than pharmacotherapy alone in patients with rheumatoid arthritis (Lee et al., 2012).

### Physiotherapy Interventions

Physiotherapy interventions, such as exercise and manual therapy, play a crucial role in managing chronic inflammation by improving mobility, reducing pain, and enhancing overall physical function. Exercise, in particular, has been shown to have a profound anti-inflammatory effect by reducing circulating levels of pro-inflammatory cytokines, such as TNF- $\alpha$  and IL-6, and increasing the production of anti-inflammatory molecules like interleukin-10 (Pedersen & Saltin, 2015). Regular physical activity also helps mitigate the risk of secondary complications, such as cardiovascular disease and osteoporosis, which are common in patients with chronic inflammatory conditions (Booth et al., 2012).

Physiotherapists work with patients to develop personalized exercise regimens that take into account their specific physical limitations and goals. Evidence suggests that both aerobic and resistance training can significantly reduce inflammation and improve quality of life in patients with conditions such as rheumatoid arthritis, chronic obstructive pulmonary disease (COPD), and fibromyalgia (Sharpe et al., 2003). Additionally, manual therapy techniques, including joint mobilization and soft tissue massage, can relieve pain and improve joint function, making physiotherapy a key component of a multidisciplinary approach to inflammation management.

### Biochemical Markers in Chronic Inflammation Management

Biochemical markers, including CRP, TNF- $\alpha$ , and IL-6, are essential tools for assessing the severity of inflammation and the efficacy of therapeutic interventions. CRP, an acute-phase protein produced by the liver, is widely used to monitor inflammation levels in clinical practice (Pepys & Hirschfield, 2003). Elevated CRP levels are associated with a higher risk of chronic diseases, including cardiovascular disease, and are used to evaluate treatment responses in inflammatory conditions (Libby et al., 2002). Similarly, cytokines such as TNF- $\alpha$  and IL-6 are key mediators of the inflammatory response and are often targeted by biologic therapies to reduce disease activity (Feldmann, 2008).

Monitoring these biochemical markers allows healthcare professionals to track the effectiveness of interventions over time. In addition to pharmacological treatments, lifestyle modifications such as diet and exercise have been shown to lower levels of inflammatory biomarkers. For example, a study by Petersen

and Pedersen (2005) demonstrated that regular exercise reduces levels of CRP and IL-6 in patients with metabolic syndrome, suggesting that physical activity can modulate the biochemical pathways involved in inflammation. Integrating biochemical monitoring into a multidisciplinary approach helps ensure that all interventions are optimized to achieve the best possible patient outcomes.

### The Need for a Multidisciplinary Approach

While each of these interventions—pharmacology, nutrition, and physiotherapy—has demonstrated efficacy in managing chronic inflammation, emerging research highlights the importance of a multidisciplinary approach that combines these strategies. A study by Bianchini et al. (2013) found that combining pharmacological treatment with dietary and exercise interventions significantly improved inflammatory markers and overall patient outcomes in individuals with metabolic syndrome. Similarly, a review by Calder (2013) emphasized the synergistic effects of combining anti-inflammatory diets with pharmacotherapy and exercise in reducing chronic inflammation.

By integrating the expertise of biochemists, dietitians, physiotherapists, and pharmacists, healthcare teams can offer a more comprehensive approach to managing chronic inflammation. This multidisciplinary strategy not only addresses the biochemical underpinnings of inflammation but also improves patients' physical function and overall well-being.

## Methodology

### Study Design

This research was conducted as a prospective cohort study in a tertiary hospital with a multidisciplinary team of healthcare professionals, including physiotherapists, biochemists, dietitians, and pharmacists. The study aimed to evaluate the effectiveness of an integrated approach combining biochemical monitoring, nutritional interventions, pharmacological treatments, and physiotherapy in managing chronic inflammation. The study was conducted over a 12-month period.

### Study Setting and Population

The study was conducted in a tertiary hospital with a well-established multidisciplinary care unit. A total of 120 adult patients with a confirmed diagnosis of chronic inflammatory conditions, including rheumatoid arthritis, Crohn's disease, and cardiovascular disease, were recruited from the hospital's outpatient clinic. Patients were eligible for inclusion if they:

- Were between the ages of 30 and 70.
- Had elevated inflammatory biomarkers (e.g., CRP, IL-6, TNF- $\alpha$ ).
- Were on stable pharmacological therapy for at least 3 months prior to enrollment.
- Were able to participate in a structured physiotherapy program.

Patients were excluded if they:

- Had an acute infection or other conditions that could confound inflammatory markers.
- Were unable to participate in regular exercise or follow dietary plans due to physical or cognitive limitations.
- Were receiving experimental treatments for inflammation.

Participants were divided into two groups:

1. Intervention Group (n=60): Received a comprehensive treatment plan involving pharmacotherapy, dietary modifications, physiotherapy, and regular biochemical monitoring.

2. Control Group (n=60): Continued their standard pharmacological treatment without the additional multidisciplinary interventions.

### Interventions

#### 1. Biochemical Monitoring:

Biochemical markers of inflammation, including C-reactive protein (CRP), interleukin-6 (IL-6), and tumor necrosis factor-alpha (TNF- $\alpha$ ), were measured at baseline, 6 months, and 12 months. Blood samples were collected and analyzed in the hospital's biochemistry lab. These markers were used to assess the degree of inflammation and the effectiveness of the multidisciplinary interventions.

#### 2. Nutritional Intervention:

A dietitian provided personalized anti-inflammatory dietary plans for patients in the intervention group. The plan emphasized the Mediterranean diet, including high intake of fruits, vegetables, whole grains, nuts, and omega-3-rich foods (e.g., fatty fish). Patients attended monthly dietary consultations to assess adherence and make adjustments as needed. Nutritional compliance was monitored through dietary recall assessments and food frequency questionnaires.

#### 3. Pharmacological Management:

The hospital pharmacists monitored and optimized patients' pharmacological treatments. Pharmacotherapy included the use of nonsteroidal anti-inflammatory drugs (NSAIDs), corticosteroids, or disease-modifying antirheumatic drugs (DMARDs), as per clinical guidelines for each condition. Pharmacists ensured proper dosing, monitored for side effects, and adjusted medications based on the patient's clinical progress and inflammatory marker levels. Any medication adjustments were documented, and adherence was tracked through pill counts and patient interviews.

#### 4. Physiotherapy Intervention:

Patients in the intervention group participated in a structured physiotherapy program designed by hospital physiotherapists. The program included aerobic exercise (e.g., walking, cycling) and resistance training tailored to individual fitness levels and limitations. Patients attended two supervised physiotherapy sessions per week, with additional home exercises prescribed. Progress was evaluated using functional outcome measures, including the Visual Analogue Scale (VAS) for pain, joint mobility assessments, and quality of life questionnaires (e.g., the SF-36).

### Outcome Measures

#### 1. Primary Outcome:

The primary outcome was the reduction in inflammatory biomarkers (CRP, IL-6, TNF- $\alpha$ ) from baseline to 12 months. These markers were analyzed using enzyme-linked immunosorbent assays (ELISA) in the hospital's biochemistry lab.

#### 2. Secondary Outcomes:

- Pain and Function: Measured using the Visual Analogue Scale (VAS) and joint mobility assessments (e.g., goniometry for range of motion).
- Quality of Life: Evaluated using the SF-36 Health Survey, which measures physical function, bodily pain, and overall well-being.

- Nutritional Adherence: Assessed through dietary recall and food frequency questionnaires at baseline, 6 months, and 12 months.
- Pharmacotherapy Effectiveness: Monitored through medication adjustments, patient-reported outcomes on side effects, and adherence.

### Statistical Analysis

All data were analyzed using SPSS version 25. Descriptive statistics were used to summarize patient demographics, baseline characteristics, and adherence to interventions. Continuous variables (e.g., CRP, IL-6, VAS scores) were compared between the intervention and control groups using paired t-tests for within-group comparisons and independent t-tests for between-group comparisons. Repeated measures ANOVA was used to assess changes in inflammatory markers, pain, and functional outcomes over time. A p-value <0.05 was considered statistically significant.

### Ethical Considerations

The study was approved by the hospital's Ethics Committee. All participants provided written informed consent prior to enrollment, and the study adhered to the principles of the Declaration of Helsinki. Participants were informed of their right to withdraw from the study at any time without consequences to their ongoing treatment.

### Findings

The study demonstrated that the multidisciplinary approach, which included biochemical monitoring, dietary interventions, pharmacological treatments, and physiotherapy, significantly improved outcomes in patients with chronic inflammation. The following sections provide a detailed analysis of inflammatory markers, pain scores, and quality of life changes between the intervention and control groups.

#### 1. Reduction in Inflammatory Markers

##### - CRP (C-reactive protein):

- Intervention Group: CRP levels decreased from 10.2 mg/L at baseline to 3.2 mg/L after 12 months, reflecting a reduction of 7.0 mg/L.
- Control Group: CRP levels showed a smaller decrease, from 9.8 mg/L to 8.7 mg/L, representing a reduction of 1.1 mg/L.

##### - IL-6 (Interleukin-6):

- Intervention Group: IL-6 levels dropped from 45.6 pg/mL to 25.3 pg/mL, indicating a reduction of 20.3 pg/mL.
- Control Group: IL-6 levels decreased marginally from 44.1 pg/mL to 41.9 pg/mL, a reduction of 2.2 pg/mL.

##### - TNF- $\alpha$ (Tumor Necrosis Factor-Alpha):

- Intervention Group: TNF- $\alpha$  levels decreased from 60.1 pg/mL to 30.4 pg/mL, a reduction of 29.7 pg/mL.
- Control Group: TNF- $\alpha$  levels decreased from 59.8 pg/mL to 55.5 pg/mL, a reduction of 4.3 pg/mL.

## 2. Pain Reduction (VAS Scores)

- Intervention Group: Pain scores on the Visual Analogue Scale (VAS) decreased from 7.8 at baseline to 3.2 at 12 months, representing a 4.6-point reduction.
- Control Group: Pain scores decreased from 7.5 to 6.9, a reduction of 0.6 points.

## 3. Quality of Life (SF-36 Scores)

- Intervention Group: SF-36 scores, which measure quality of life, increased significantly from 45 to 80, reflecting an improvement of 35 points.
- Control Group: SF-36 scores increased modestly from 46 to 50, an improvement of 4 points.

## Summary of Results

Indicator	Intervention Group (Baseline)	Intervention Group (12 Months)	Change (Intervention)	Control Group (Baseline)	Control Group (12 Months)	Change (Control)
CRP (mg/L)	10.2	3.2	-7.0	9.8	8.7	-1.1
IL-6 (pg/mL)	45.6	25.3	-20.3	44.1	41.9	-2.2
TNF- $\alpha$ (pg/mL)	60.1	30.4	-29.7	59.8	55.5	-4.3
VAS (Pain Score)	7.8	3.2	-4.6	7.5	6.9	-0.6
SF-36 (Quality of Life)	45	80	+35	46	50	+4

## Analysis

The data shows that the intervention group, which received the multidisciplinary treatment, experienced significantly greater reductions in inflammatory markers (CRP, IL-6, TNF- $\alpha$ ) and pain (VAS scores) than the control group. Additionally, the intervention group reported a substantial improvement in their quality of life (SF-36), with a 35-point increase, compared to only a 4-point increase in the control group.

These results suggest that the integrated approach combining diet, exercise, pharmacotherapy, and biochemical monitoring provides a more effective treatment for managing chronic inflammation, reducing pain, and improving overall patient outcomes.

## Discussion

The findings from this study highlight the significant impact of a multidisciplinary approach in managing chronic inflammation, incorporating biochemical monitoring, dietary interventions, pharmacological treatments, and physiotherapy. The results demonstrate that this integrated model is more effective in reducing inflammation, alleviating pain, and improving patients' quality of life compared to standard pharmacological treatment alone.

### 1. Reduction in Inflammatory Markers

The marked reduction in inflammatory markers, particularly C-reactive protein (CRP), interleukin-6 (IL-6), and tumor necrosis factor-alpha (TNF- $\alpha$ ), in the intervention group underscores the importance of a comprehensive treatment strategy. CRP, a key marker of systemic inflammation, decreased by 7.0 mg/L in the intervention group compared to just 1.1 mg/L in the control group. This significant reduction is consistent with findings from previous studies, which suggest that a combination of pharmacotherapy, diet, and physical activity can have a synergistic effect on reducing inflammation (Calder, 2013).

IL-6 and TNF- $\alpha$ , both pro-inflammatory cytokines, also saw substantial reductions in the intervention group, further supporting the hypothesis that dietary and physical interventions, in combination with pharmacological treatments, can downregulate key inflammatory pathways. The marginal reduction in the control group indicates that pharmacotherapy alone is insufficient in managing chronic inflammation, especially for long-term conditions like rheumatoid arthritis and Crohn's disease. These findings align with the literature that emphasizes the importance of lifestyle modifications, such as an anti-inflammatory diet and regular exercise, in managing chronic inflammatory diseases (Pedersen & Saltin, 2015).

### 2. Pain Reduction

Pain reduction, as measured by the Visual Analogue Scale (VAS), was significantly greater in the intervention group, with a 4.6-point decrease compared to a 0.6-point reduction in the control group. This suggests that combining physiotherapy with pharmacological treatments provides superior pain management. Physiotherapy likely played a crucial role in this reduction, as exercise has been shown to have both anti-inflammatory effects and the ability to improve physical function, which contributes to pain relief (Sharpe et al., 2003). In contrast, the control group, which only received pharmacological interventions, experienced less notable improvements in pain, reinforcing the need for an integrated approach that includes physical rehabilitation.

### 3. Quality of Life Improvements

The improvement in quality of life, as reflected by the SF-36 scores, was profound in the intervention group, increasing by 35 points, compared to just 4 points in the control group. This improvement can be attributed to the combination of interventions that not only reduced inflammation and pain but also improved patients' physical function and overall well-being. The SF-36 score improvements highlight the role of physiotherapy and dietary interventions in enhancing patients' ability to carry out daily activities, thus contributing to a better quality of life.

Previous research has demonstrated that improving mobility and reducing pain can significantly enhance psychological well-being and overall health perception in patients with chronic conditions (Booth et al., 2012). Furthermore, nutritional interventions, particularly those involving anti-inflammatory diets, have been linked to better mood and energy levels, further contributing to the improvement in quality of life (Barbaresko et al., 2013). The modest improvement in the control group suggests that pharmacotherapy alone is not sufficient to address the broader psychosocial aspects of chronic inflammation management.

### 4. Implications for Clinical Practice

The findings from this study support the growing body of evidence that a multidisciplinary approach is essential in managing chronic inflammation effectively. Pharmacotherapy, while important, is not sufficient on its own to address the multifaceted nature of chronic inflammatory diseases. Incorporating



physiotherapy, dietary interventions, and biochemical monitoring not only helps in reducing inflammation but also addresses other critical aspects such as pain, mobility, and quality of life.

For clinical practice, this suggests that healthcare providers should consider implementing more comprehensive treatment plans for patients with chronic inflammation. Dietitians, physiotherapists, pharmacists, and biochemists can work together to tailor treatments that go beyond pharmacological management, focusing on holistic patient care. Regular biochemical monitoring of inflammatory markers can help in adjusting treatments more precisely, ensuring better outcomes for patients.

#### 5. Study Limitations

While the study provides valuable insights, there are several limitations to consider. First, the sample size, though sufficient for detecting significant differences, was relatively small, and future studies with larger populations are needed to confirm these findings. Additionally, the study was conducted in a single tertiary hospital, which may limit the generalizability of the results to other settings. Future research should explore the effectiveness of this multidisciplinary approach in different healthcare environments, such as primary care or community-based settings.

Another limitation is the potential for variability in adherence to the dietary and physiotherapy interventions. While efforts were made to ensure compliance, individual patient differences in following prescribed diets and exercise regimens could have influenced the outcomes. More rigorous monitoring of adherence, perhaps using wearable technology or dietary logs, could provide more accurate assessments of the impact of these interventions.

#### 6. Future Research Directions

The promising results from this study suggest several avenues for future research. One important area is the long-term sustainability of the multidisciplinary approach in managing chronic inflammation. Studies could assess whether patients maintain the improvements in inflammatory markers, pain, and quality of life beyond the 12-month period. Additionally, future research could explore specific subgroups of patients, such as those with more severe inflammation or comorbidities, to determine whether certain populations benefit more from integrated interventions.

Further exploration of the individual components of the intervention (i.e., the specific contribution of diet, physiotherapy, and pharmacotherapy) could help refine and optimize treatment plans for chronic inflammation. Moreover, the role of newer technologies, such as telemedicine or digital health monitoring, in supporting adherence and providing real-time feedback for biochemical monitoring could also be explored in future studies.

#### Conclusion

This study demonstrates that a multidisciplinary approach combining pharmacological management, dietary interventions, physiotherapy, and biochemical monitoring is significantly more effective in reducing chronic inflammation, pain, and improving quality of life compared to standard care alone. These findings highlight the importance of integrated healthcare models in managing complex, chronic conditions and underscore the need for further research to explore the long-term benefits and optimization of these approaches.

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