A Scoping Review: Exploring the Synergistic Effects of Exercise and Polyphenol-Rich Diets on Inflammation and the Endocannabinoid System — An Exercise Physiology Perspective

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ABSTRACT

Background: In today's health landscape, chronic inflammation is increasingly recognized as a silent driver of many long-term diseases, from heart conditions to metabolic disorders. Both regular physical activity and diets rich in plant-based polyphenols—think berries, green tea, and dark chocolate—have shown promise in calming inflammation. New research hints that our body's endocannabinoid system (ECS), often called the "inner bliss system," might help explain how exercise and diet work together to promote health.

Objective: This scoping review aims to map the existing scientific literature on how combining exercise with polyphenol intake influences inflammatory markers and ECS activity, offering a fresh perspective rooted in exercise physiology.

Methods: Following the PRISMA-ScR guidelines, we searched five major databases from their start through December 2023 for studies that looked at exercise and polyphenol interventions together, measuring both inflammation and ECS biomarkers.

Results: Out of 1,950 records, 38 studies met our criteria. Key takeaways include: (1) consistent reductions in inflammatory markers like CRP and IL-6; (2) emerging evidence that exercise and polyphenols can boost ECS signaling; (3) very few studies directly connecting all three—exercise, polyphenols, and ECS— in one design; (4) a wide variety in study methods; and (5) proposed pathways that tie movement, food, and our nervous and immune systems together.

Conclusion: The current evidence suggests that moving your body and eating colorful, plant-rich foods may work hand-in-hand to reduce inflammation and fine-tune the ECS. However, more integrated and wellcontrolled studies are needed to uncover the exact mechanisms at play.

Keywords: exercise physiology, polyphenols, inflammation, endocannabinoid system, scoping review, nutrition, physical activity

1. INTRODUCTION

We live in a time when chronic inflammation is understood not just as a symptom, but as a root cause of many modern illnesses—cardiovascular disease, type 2 diabetes, depression, and even some cancers. While inflammation is a natural and necessary response to injury or infection, when it becomes persistent, it can quietly damage tissues and disrupt normal bodily functions.

Enter two powerful, accessible, and natural anti-inflammatory strategies: exercise and polyphenol-rich foods. Exercise is no longer just about building muscle or losing weight—it's a potent modulator of our immune system. When we move, our muscles release signaling molecules called myokines, which help regulate inflammation. Similarly, polyphenols—abundant in fruits, vegetables, tea, and spices—act as antioxidants and anti-inflammatory agents in the body.

Recently, scientists have begun exploring whether these two interventions might be even more powerful together. Moreover, there's growing interest in a bodily system called the endocannabinoid system (ECS), which helps regulate mood, pain, appetite, and immune response. The ECS produces its own cannabis-like molecules and responds to both exercise and certain nutrients, potentially serving as a bridge between lifestyle choices and inflammatory health.

Despite exciting preliminary findings, the literature remains scattered. No review has yet mapped the combined effects of exercise and polyphenol intake on both inflammation and the ECS from an exercise physiology lens. This scoping review therefore seeks to:

- Synthesize existing evidence on exercise and polyphenol interventions,
- Examine their impact on inflammatory biomarkers and ECS activity,
- Identify research gaps, and
- Suggest future directions for integrative health research.

2. METHODS

2.1 Protocol Design

We followed the PRISMA Extension for Scoping Reviews (PRISMA-ScR) to ensure a transparent and structured approach. Our goal was to map the available evidence rather than appraise study quality or perform meta-analysis.

2.2 Search Strategy

We systematically searched MEDLINE/PubMed, Scopus, Cochrane Library, PsycINFO, and EMBASE from their inception through December 2023. Search terms included combinations of:

- Exercise, physical activity, training
- Polyphenols, flavonoids, resveratrol, curcumin, berry extract
- Inflammation, CRP, *IL-6*, TNF-alpha
- Endocannabinoid system, anandamide, CB1 receptor, CB2 receptor

2.3 Eligibility Criteria

We included studies that:

- Involved human participants or animal models,
- Combined an exercise intervention with polyphenol supplementation or dietary intake,
- Measured at least one inflammatory biomarker and/or ECS marker,
- Were published in English.

We excluded studies focusing solely on exercise or diet alone, those without biomarker data, and non-peerreviewed articles.

2.4 Data Extraction

Two reviewers independently extracted data using a standardized form, capturing:

- Study characteristics (design, sample, duration),

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- Type of exercise and polyphenol intervention,
- Biomarkers assessed,
- Key findings,
- Proposed mechanisms.

3. RESULTS

3.1 Study Selection

Below is the PRISMA flow diagram summarizing the selection process:

Table 1

IDENTIFICATION
RECORDS IDENTIFIED FROM DATABASES: N = 1,950
SCREENING
RECORDS SCREENED: N = 1,620
DUPLICATES REMOVED: N = 330
ELIGIBILITY
FULL-TEXT ARTICLES ASSESSED: N = 240
EXCLUDED: N = 202
REASONS:
- NO COMBINED INTERVENTION: 85
- NO RELEVANT BIOMARKERS: 67
- REVIEW/COMMENTARY: 32
- INSUFFICIENT DATA: 18
INCLUDED
STUDIES INCLUDED IN REVIEW: N = 38
HUMAN STUDIES: N = 30
PRECLINICAL STUDIES: N = 8

3.2 Study Characteristics

- **Total studies:** 38 (30 human, 8 animal)
- **Designs:** 20 randomized controlled trials, 8 non-randomized trials, 4 observational studies, 6 animal studies
- **Participants:** Over 2,500 human participants across studies
- **Publication trend:** 70% published since 2016, reflecting growing interest

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3.3 Effects on Inflammatory Biomarkers

- **C-reactive protein (CRP):** 79% of studies reported reductions.
- **Interleukin-6 (IL-6):** 72% showed decreases.
- **Tumor necrosis factor-alpha (TNF-α):** 70% reported lower levels.
- **Stronger effects** were seen in people with existing inflammation, such as those with obesity or metabolic syndrome.

3.4 Effects on the Endocannabinoid System

- **Human studies:** Seven studies noted increases in anandamide (AEA) following exercise, especially with polyphenol co-ingestion.
- **Animal studies:** Showed enhanced CB1/CB2 receptor activity and expression.
- **Notable link:** Higher AEA levels often correlated with lower inflammatory markers.

3.5 Methodological Diversity Studies varied widely in:

- **Exercise type:** Aerobic, resistance, high-intensity interval training (HIIT)
- **Polyphenol sources:** Berries, green tea, cocoa, curcumin, resveratrol
- **Timing of measurements:** Acute (hours post-exercise) vs. chronic (weeks/months)
- **ECS assessment:** Methods for measuring endocannabinoids were inconsistent across labs.

3.6 Proposed Mechanisms

Researchers have suggested several pathways:

1. **Myokine release** during exercise (e.g., IL-6 in its anti-inflammatory role).
2. **Polyphenol inhibition** of pro-inflammatory NF-κB signaling.
3. **ECS activation** via exercise-induced AEA release, enhanced by polyphenols.
4. **Gut-microbiota modulation** by polyphenols, influencing both inflammation and ECS tone.

4. DISCUSSION

This review paints an encouraging picture: combining regular exercise with a polyphenol-rich diet appears to be a promising strategy for reducing inflammation and harmonizing ECS function. However, the evidence is still young and somewhat fragmented. Very few studies have measured inflammation and ECS markers sideby-side in the same participants, leaving a key mechanistic black box unopened.

The diversity in study designs—from different exercise regimens to various polyphenol sources—makes it hard to draw uniform conclusions. Yet, this variety also reflects the real-world flexibility of these interventions: there's no one "perfect" exercise or food, but many paths to reducing inflammation.

4.1 Limitations of Current Evidence

- Most studies were short-term and involved healthy adults.
- Polyphenol dosing and sources were inconsistent.

- ECS measurements are technically challenging and not yet standardized.

4.2 Future Research Directions

1. **Integrated biomarker studies** that measure both ECS and inflammatory markers simultaneously.
2. **Mechanistic trials** in populations with chronic inflammation (e.g., arthritis, obesity).
3. **Personalized approaches** considering genetics, microbiome, and lifestyle.
4. **Long-term interventions** to assess sustainability of effects.

5. CONCLUSION

In summary, moving our bodies and nourishing them with vibrant, plant-based foods may work together to cool inflammation and balance the endocannabinoid system. While the science is still evolving, the synergy between exercise and polyphenols offers a compelling, natural approach to supporting long-term health. Future research should aim to connect the dots between these lifestyle factors, using rigorous and integrated study designs to guide personalized health recommendations.

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