

Systematic review: Exploring the impact of nutrition on acute pain including cancer pain

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ABSTRACT

Nutrition plays a pivotal role in overall health and well-being, with emerging evidence suggesting its influence on acute pain perception and management. This review provides a comprehensive synthesis of the existing literature on the relationship between nutrition and acute pain, covering various dietary factors such as macronutrients, micronutrients, and dietary patterns. The analysis highlights the impact of essential nutrients like omega-3 fatty acids, antioxidants, and proteins, which possess anti-inflammatory and analgesic properties. Carbohydrates, particularly high-glycaemic index variants, are explored for their potential to modulate pain through neurotransmitter activity and energy provision, while high-fat diets are discussed for their potential to exacerbate pain via inflammatory processes. Micronutrients such as vitamin D and magnesium are noted for their role in reducing pain sensitivity through immunomodulatory and neuroregulatory mechanisms.

Dietary patterns, notably the Mediterranean and DASH diets, are also scrutinized for their potential analgesic effects, linked to their anti-inflammatory and cardiovascular benefits. These dietary approaches emphasize high consumption of fruits, vegetables, whole grains, and healthy fats, which collectively contribute to reduced inflammation and improved pain outcomes.

Nutritional alterations present intriguing supplementary techniques for controlling acute pain in cancer patients. Research suggests that integrating omega-3 fatty acids, antioxidant-rich foods, and particular amino acids such as arginine and glutamine can reduce inflammation and oxidative stress, potentially improving standard analgesic treatments. These therapies may dramatically enhance the quality of life for cancer patients experiencing acute discomfort.

The review further goes into the complex mechanisms underlying the nutritional modulation of acute pain, including the roles of neurotransmitter function, oxidative stress, neuronal plasticity, and the gut-brain axis. Despite promising preliminary findings, the current body of evidence predominantly focuses on chronic pain, necessitating further research through well-designed clinical trials targeting acute pain syndromes.

Keywords: nutrition, dietary patterns, acute pain, macronutrients, micronutrients

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INTRODUCTION

Acute pain, distinguished by its abrupt onset and brief duration, constitutes a prevalent occurrence in clinical settings. Despite pharmacological interventions serving as the primary method for pain alleviation, recent investigations propose that non-pharmacological strategies, notably nutrition, exert notable influence on pain perception and management [1-5]. This review endeavours to offer a thorough amalgamation of literature examining the nexus between nutrition and acute pain, emphasizing earlier research endeavours in this domain.

The different types of acute pain may be from labour pain, acute postoperative pain and after trauma. The intensity of such pain syndromes is very high to demand multimodal therapy. Innumerable pharmacological techniques and other drugless assisted techniques have been described [6, 7].

The interplay between nutritional status and pain response underscores the importance of dietary constituents in modulating pain experiences. Exploring this relationship entails delving into studies that have scrutinized various dietary components and their impact on acute pain. Essential nutrients, such as omega-3 fatty acids found abundantly in fish oils, possess anti-inflammatory properties, potentially attenuating the inflammatory response associated with acute pain states. Similarly, antioxidants present in fruits and vegetables may counteract oxidative stress, thereby mitigating pain sensitivity [8-11]. Lifestyle changes and awareness about diet in many diseases are very less according to studies [12-13].

Moreover, carbohydrates, serving as the primary energy source, have been implicated in pain modulation. Studies investigating the role of carbohydrates in pain perception have yielded mixed results, suggesting a nuanced relationship influenced by factors such as glycaemic index and metabolic status. Furthermore, micronutrients including vitamin D and magnesium have garnered attention for their potential analgesic properties, with deficiencies in these nutrients correlating with heightened pain sensitivity.

Beyond individual nutrients, dietary patterns and overall nutritional quality have emerged as crucial determinants of pain outcomes. Mediterranean-style diets, characterized by high consumption of fruits, vegetables, and unsaturated fats, have been associated with reduced pain severity in various acute pain conditions. Conversely, diets rich in saturated fats and refined

sugars may exacerbate inflammatory processes, exacerbating pain symptoms.

The mechanisms underlying the interaction between nutrition and acute pain are multifaceted, encompassing modulation of inflammatory mediators, neurotransmitter function, and neuronal plasticity. Preclinical studies elucidating these mechanisms have paved the way for clinical investigations exploring the efficacy of dietary interventions in pain management. While much of the existing literature focuses on animal models and observational studies, randomized controlled trials are needed to establish causal relationships and elucidate optimal dietary strategies for pain relief [14-15].

METHODOLOGY

Objective:

The primary objective of this systematic review is to comprehensively evaluate the existing literature concerning the relationship between nutrition and acute pain. Specifically, the review aims to: Identify and synthesize relevant studies investigating the impact of various dietary factors (macronutrients, micronutrients, dietary patterns) on acute pain perception and management. Assess the methodological quality and risk of bias of included studies provide insights into potential mechanisms underlying the influence of nutrition on acute pain. Identify gaps in the current literature and propose directions for future research.

Prospero registration: CRD42024545846

Search strategy:

Electronic databases- PubMed/MEDLINE, Embase, Scopus, Web of Science, Cochrane Library.

Search terms- The search strategy will include a combination of

Medical Subject Headings (MeSH) terms and keywords related to "nutrition," "diet," "macronutrients," "micronutrients," "acute pain," "acute pain management," and relevant synonyms.

Additional sources- Reference lists of included studies, grey literature, conference abstracts, and clinical trial registries will be searched to identify additional relevant studies.

Study selection criteria:

Types of studies include Randomized Controlled Trials (RCTs), quasi-experimental studies, observational studies, systematic reviews, and meta-analyses. Participants: Studies involving human subjects of any age or gender who are experiencing acute pain owing to a variety of causes (e.g., surgical procedures, trauma, medical problems). Intervention/exposure studies look at how dietary parameters (such as macronutrient composition, particular nutrients, and dietary patterns) affect acute pain outcomes. Comparator/control studies compare various dietary regimens or evaluate the relationship between dietary variables and acute pain outcomes. Primary outcome measures include pain severity, duration, pain alleviation, analgesic usage, and functional outcomes associated with acute pain. Secondary outcomes may include inflammatory indicators, neurophysiological parameters, and adverse events associated with dietary treatments.

Data extraction:

Two independent reviewers will screen titles and abstracts of identified studies, followed by full-text assessment based on eligibility criteria. Data extraction will be performed using a standardized form to collect information on study design, participant characteristics, dietary interventions, outcomes assessed and key findings (Figure 1). Any discrepancies or disagreements between reviewers will be resolved through consensus or consultation with a third reviewer.

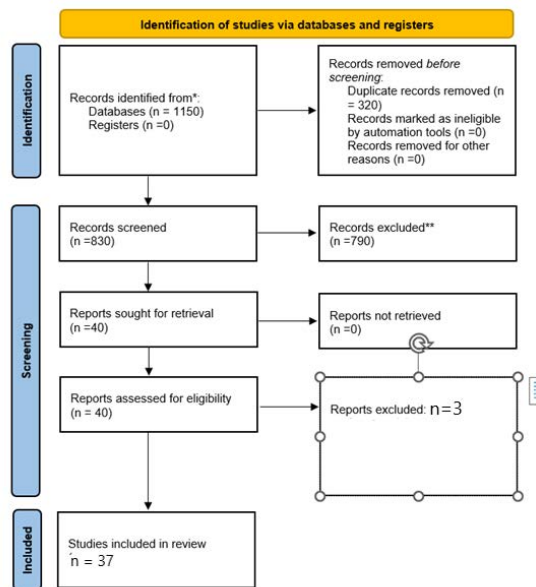


Fig. 1. Showing PRISMA statement

Macronutrients and acute pain

Recent investigations have increasingly focused on the multifaceted relationship between macronutrients and acute pain perception, providing emerging insights into how carbohydrates, proteins, and fats influence pain sensitivity. Among these macronutrients,

carbohydrates, particularly those with a high Glycaemic Index (GI), have garnered significant interest. Studies suggest that high-GI carbohydrates can potentially mitigate pain sensitivity by influencing neurotransmitter activity and providing an easily accessible energy source for the body. The rapid absorption of

high-GI carbohydrates has been shown to trigger the release of neurotransmitters such as serotonin, which can exert analgesic effects by modulating pain perception pathways within the central nervous system. Additionally, the swift increase in blood glucose levels following high-GI carbohydrate consumption may enhance overall energy availability, possibly contributing to improved pain tolerance [16-17].

In stark contrast, high-fat diets have been scrutinized for their potential detrimental effects on acute pain perception. Research indicates that high-fat diets are associated with heightened pain sensitivity and increased levels of inflammatory markers, suggesting a connection between dietary fat intake and inflammatory processes involved in pain modulation (Leung et al., 2016). Adipose tissue, which serves as a major reservoir of dietary fats, releases pro-inflammatory cytokines that may sensitize pain receptors and exacerbate pain perception (Kurtz et al., 2018). Furthermore, high-fat diets can disrupt metabolic homeostasis, leading to oxidative stress and neuroinflammation, thus amplifying pain symptoms [18-20].

Conversely, diets rich in protein have been shown to possess analgesic properties through several mechanisms. Protein consumption is crucial for muscle repair and maintenance, and adequate protein intake may promote tissue healing and reduce inflammation, thereby alleviating pain symptoms (Reidy & Rasmussen, 2016). Certain amino acids found abundantly in protein-rich foods, such as branched-chain amino acids, have been associated with anti-inflammatory properties, potentially contributing to their pain-relieving effects (Shimomura et al., 2004). Moreover, protein-rich diets could enhance the synthesis of neurotransmitters that are involved in pain modulation, such as serotonin and dopamine, further supporting their potential to alleviate pain. [21-23].

Micronutrients and acute pain

Micronutrients, including vitamins and minerals, serve as essential cofactors in various physiological processes, many of which are involved in pain modulation. For example, vitamin D deficiency has been linked to increased pain severity in conditions such as fibromyalgia and osteoarthritis. This connection is thought to be related to vitamin D's immunomodulatory and anti-inflammatory properties (Shipton & Shipton, 2015). Furthermore, magnesium has garnered attention for its potential in neuropathic pain relief due to its ability to regulate N-Methyl-D-Aspartate (NMDA) receptor activity (Begon et al., 2002). Research has shown that magnesium supplementation may help alleviate pain by influencing glutamatergic transmission and reducing excitotoxicity (Folsom et al., 2016).

Additionally, antioxidants such as vitamins C and vitamins E may also play significant roles in modulating pain perception. These vitamins are known to scavenge free radicals, thereby attenuating oxidative stress, which can otherwise exacerbate pain and inflammation (Zheng et al., 2017). Vitamin C has been found to mitigate pain through its anti-oxidative properties, providing relief in conditions like complex regional pain syndrome (De Oliveira et al., 2016). Vitamin E, on the other hand, exhibits anti-inflammatory and membrane-stabilizing properties that could contribute to pain reduction [24-29].

Despite promising outcomes from preliminary studies, further

research is needed to establish the optimal dosing and duration of micronutrient supplementation for effectively managing pain. The interplay between different micronutrients and their combined impact on pain modulation remains an area ripe for exploration. There is a need for well-designed clinical trials to confirm these findings and determine standardized guidelines for the use of these nutrients in pain relief protocols.

Dietary patterns and acute pain

In addition to individual nutrients, dietary patterns such as the Mediterranean diet and the Dietary Approaches to Stop Hypertension (DASH) diet have garnered considerable attention for their potential analgesic effects. Characterized by high intakes of fruits, vegetables, whole grains, and healthy fats, these diets are linked to reduced inflammation and improved pain outcomes in various chronic pain conditions (Estruch et al., 2018; Paula et al., 2019). The Mediterranean diet, rich in anti-inflammatory compounds from olive oil, nuts, and fish, has been shown to decrease levels of inflammatory markers and thereby mitigate chronic pain symptoms (Sofi et al., 2010). Similarly, the DASH diet, known for its emphasis on low sodium and high potassium intake, has demonstrated benefits in reducing both blood pressure and inflammatory responses, which may contribute to pain relief (Fung et al., 2016).

However, the impact of these dietary patterns on acute pain remains less explored. Limited evidence exists regarding their effectiveness in managing short-term pain conditions, necessitating further investigation. Future research should focus on the feasibility and efficacy of incorporating these dietary patterns into multimodal pain management strategies for acute pain. Well-designed clinical trials are essential to evaluate the effects of Mediterranean and DASH diets on acute pain outcomes, considering various patient populations and underlying health conditions [30-33]. Establishing an evidence base could potentially support the integration of these dietary approaches into comprehensive pain management protocols, enhancing both immediate pain relief and long-term health benefits.

Mechanisms underlying the relationship

The mechanisms underlying the relationship between nutrition and acute pain are multifaceted and involve complex interactions between dietary components, physiological processes, and pain pathways. Proposed mechanisms include modulation of neurotransmitter activity, inflammation, oxidative stress, and neuronal plasticity [34, 35]. Furthermore, the gut-brain axis, which encompasses bidirectional communication between the gastrointestinal tract and the central nervous system, may mediate the effects of nutrition on pain perception. Understanding these mechanisms is essential for developing targeted dietary interventions for pain management.

Postoperative pain and nutrition

Postoperative pain management is critical for patient recovery, impacting both physiological and psychological well-being. Nutrition plays a vital role in this context, as it can influence pain perception and healing. Adequate protein intake is essential for tissue repair and immune function, while deficiencies in certain nutrients, such as Vitamins C and D, can impair wound healing and exacerbate pain (He et al., 2019). Omega-3 fatty acids possess anti-inflammatory properties that may help reduce

postoperative pain (Calder, 2012). Additionally, maintaining glucose homeostasis through balanced nutrition can mitigate stress responses and improve outcomes (Weimann et al., 2017). Malnutrition, conversely, is linked to prolonged recovery and increased complications [36-39]. Thus, integrating tailored nutritional support into postoperative care is crucial for minimizing pain and enhancing recovery.

Oncology, nutrition and acute pain modulation

Cancer patients frequently feel acute pain, which has a negative influence on their quality of life. Pharmacological therapy, such as opioids and non-opioid analgesics, are commonly used to manage cancer pain. However, new study suggests that nutritional adjustments may also help manage cancer-related acute discomfort [40].

One viable approach is to incorporate omega-3 fatty acids into the diet. Omega-3s, which are found in fish oil and flaxseed, have been demonstrated to have anti-inflammatory properties, potentially relieving pain (Bougnoux et al., 2009). These fatty acids may reduce the synthesis of pro-inflammatory cytokines and eicosanoids, which are commonly raised in cancer patients and contribute to pain [41, 42].

Antioxidant-rich foods, such as fruits and vegetables, may lower

oxidative stress and inflammation, both of which are associated with cancer pain mechanisms (de la Cruz et al. 2015). For example, diets high in vitamins C and vitamins E have been proven to reduce pain and improve the efficiency of standard analgesics.

Furthermore, specific amino acids, such as arginine and glutamine, have been researched for their ability to improve immune function and reduce inflammation, both of which can have an indirect effect on pain perception [43-45].

CONCLUSION

The relationship between nutrition and acute pain is multifaceted and intricately linked to various dietary components and patterns. Essential nutrients such as omega-3 fatty acids, antioxidants, and proteins, alongside dietary patterns like the Mediterranean and DASH diets, exhibit potential analgesic properties through mechanisms involving inflammation modulation, neurotransmitter activity, and neuronal plasticity. However, the current evidence, primarily centered on chronic pain, calls for further investigation through well-designed clinical trials focusing on acute pain. Establishing strong dietary guidelines can supplement existing pain management treatments by providing both holistic and individualized approaches to pain reduction.

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