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# Non-pharmacological pain management strategies: a mini-review

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## ABSTRACT

Pain is an unpleasant sensory and emotional experience associated with actual or potential tissue damage. Non-pharmacological interventions offer several advantages, including reduced medical costs, increased accessibility, broader applicability, ease of use, and greater patient satisfaction. These strategies may also reduce the patients' pain levels while minimizing the adverse effects commonly associated with pharmacological treatments. However, non-pharmacological techniques have limitations concerning their applicability and efficacy. They are classified according to their mechanisms of action into four main categories: mind–body interventions, biological treatments, manipulative and body-based practices, and energy-based strategies. Common examples include the transcutaneous electrical nerve stimulation, heat therapy, massage therapy, light therapy, cognitive behavioural therapy, acupuncture, yoga, virtual reality therapy, Quran therapy, and aromatherapy. This mini-review provides an overview of the mechanisms through which these strategies alleviate pain, and highlights the advantages that contribute to their growing global appeal.

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## 1. Introduction

According to the International Association for the Study of Pain, pain is an unpleasant sensory and emotional experience associated with actual or potential tissue damage[1]. Pain negatively affects quality of life, economic status, and family well-being, often due to lost workdays, increased healthcare costs, and physical incapacity[2]. Millions of individuals worldwide suffer from pain both in hospital settings and at home. In acutely ill patients, pain is linked to adverse physiological and psychological outcomes[3].

Pain mechanisms involve three

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fundamental components: nociceptors (which identify pain stimuli), the spinal cord (which transmits and modulates signals), and the brain (which interprets and regulates the entire pain experience)[4]. Pain pathways are complex and dynamic, encompassing sensory, cognitive, and behavioural elements. These systems have evolved in order to coordinate appropriate reactions to noxious stimuli, ranging from primitive spinal reflexes to consciously experienced emotional responses[5].

Non-pharmacological treatments (including behavioural, cognitive, rehabilitative, and complementary therapies) can alleviate the stress associated with hospitalization, enhance the quality of life, and prevent physiological and behavioural changes in neonates. Techniques such as oral sweet solutions, sucking, positioning, skin-to-skin contact, and environmental adjustments reduce stress and may enhance medication efficacy or reduce reliance on pharmacological agents, thus mitigating drug-related side effects[6].

Non-pharmacological interventions are categorized by their mechanisms of action into four modalities: mind–body interventions, biologically based treatments, manipulative and body-based practices, and energy therapies. Examples include meditation, herbal and essential oil therapies, massage, and energy-based approaches such as reiki and therapeutic touch[7].

This mini-review aimed at describing the mechanisms of non-pharmacological pain management strategies across different types of pain, along with their limitations, their advantages over pharmacological treatments, and their potential for global implementation – not merely as adjunct therapies, but as viable primary options.

## 2. Advantages of non-pharmacological pain management strategies

Non-pharmacological strategies have demonstrated beneficial effects in reducing pain intensity and minimizing the side effects associated with pharmacological treatments[3]. These approaches can reduce or even replace the need for pharmacological intervention, thereby lowering harm and improving patients' quality of life. Major advantages include ease of application, increased safety, accessibility for millions of people, and ease of learning, making them globally implementable[8].

## 3. Some limitations of non-pharmacological pain management strategies

Some limitations include the need for a time-intensive application, the need for a long-term follow-up, and the reduced efficacy when used concurrently with pharmacological treatments for severe pain. Additionally, certain interventions may be culturally specific or context-dependent[7].

## 4. Non-pharmacological strategies for pain management and their underlying mechanisms

### 4.1. Transcutaneous electrical nerve stimulation

Studies suggest that this strategy influences the expression and activity of pain-related ion channels in the peripheral nervous system (including voltage-gated sodium channels and transient receptor potential, TRP, channels), thereby modulating nociceptive excitability and neurotransmission. It also increases endogenous opioid and serotonin levels in the brain, contributing to descending pain modulation.

### 4.2. Heat therapy and cryotherapy

These involve applying heat or cold to the affected body areas for pain relief. Heat sources include hot packs, paraffin wax, and infrared radiation for superficial or deep heating. Heat therapy improves blood flow, relaxes muscles, and activates thermosensitive TRP channels, thereby modulating peripheral sensitivity and central thermal regulation. Clinical trials suggest its efficacy in reducing neuropathic pain in conditions such as diabetic neuropathy, chemotherapy-induced peripheral neuropathy, and post-spinal cord injury pain.

Cryotherapy uses agents such as ice packs, cold

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compresses, and refrigerant sprays to lower tissue temperature. It inhibits inflammation and slows nerve conduction velocity *via* vasoconstriction and reduced release of serotonin and glutamate.

4.3. Massage therapy

Massage is increasingly recognized as effective in managing chronic pain. Although its mechanisms are not fully understood, the gating control theory posits that massage activates spinal interneuron inhibition, thereby suppressing pain signal transmission. Massage may also normalize sensory input, improve circulation, reduce muscle tension and trigger points, and restore descending inhibition, thereby preventing central sensitization.

4.4. Light therapy

Infrared light and laser-based approaches may enhance nitric oxide production and mitochondrial function, thereby modulating neuronal pathways relevant to analgesia. Specific wavelengths – such as far infrared and therapeutic laser – promote tissue healing and pain reduction. Applied either transcranially or to painful skin regions, light therapy operates through mechanisms involving retinal photoreceptors, mitochondrial activation, anti-inflammatory effects, and neural modulation.

4.5. Cognitive behavioural therapy

Cognitive behavioural therapy enhances the expression of endogenous opioid β-endorphin and reduces pro-inflammatory cytokines such as interleukin-6 (IL-6) and tumour necrosis factor-alpha (TNF-α), yielding both analgesic and anti-inflammatory effects.

4.6. Acupuncture

Traditional stimulation of acupoints *via* manual or electrical methods enhances activity of Aδ and C fibers and stimulates release of enkephalins, endorphins, and dynorphins. These bind to opioid receptors in the peripheral and the central nervous systems in order to suppress pain perception.

4.7. Yoga and tai chi

These modalities increase anti-inflammatory cytokines such as IL-10 and IL-4, while reducing pro-inflammatory mediators such as TNF-α, IL-6, and IL-1β.

4.8. Virtual reality therapy

Virtual reality-based approaches modulate neuronal plasticity and affect brain regions related to anxiety and pain. They may interrupt or reverse central sensitization; a key factor in the transition from acute to chronic pain.

4.9. Mindfulness strategies

These employ top-down regulation from the prefrontal cortex and anterior cingulate cortex in order to inhibit pain signalling. Studies suggest mindfulness enhances modulatory neurotransmitters (such as endogenous opioids, cannabinoids, and serotonin) while downregulating inflammatory gene and protein expression. This dual effect reduces both peripheral and central sensitization[4].

4.10. Quran therapy

This method reduces labor pain *via* three interrelated mechanisms. First, the rhythmic recitation of murottal Quran stimulates the neuroendocrine system, inducing a calming haemodynamic effect similar to music therapy. Second, murottal Quran-listening provides a distraction from pain, allowing patients to focus and relax. Third, the spiritual component supports emotional resilience and addresses psychosocial challenges associated with illness[9].

4.11. Aromatherapy

Aromatherapy activates the limbic system *via* inhalation and olfactory pathways, modulates neuro-

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transmitter levels, and provides anti-inflammatory benefits. It also diverts attention from pain, thereby promoting relaxation and pleasant sensory experiences[10].

## 5. Conclusion

Non-pharmacological pain management strategies encompass a broad range of approaches and are classified based on their physiological mechanisms. These strategies offer considerable benefits over pharmacological treatments by reducing analgesic dependence and providing cost-effective, culturally adaptable alternatives. Their growing potential as primary pain management tools underscores the importance of ongoing research to fully realize their benefits and minimize their limitations.

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## Conflicts of interest

None exist.

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