Original article

Changes in Headache Pain Intensity and Perception Following Acupuncture Treatment

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Abstract

Aim of the study: The aim of this research was to investigate changes in pain intensity and pain perception in patients with headaches following acupuncture therapy, compared with baseline values.
Methods: The research was conducted at the Institute for Pain Management at KBC Osijek on 20 patients diagnosed with headaches who underwent a two-week course of acupuncture therapy. At the beginning of the therapy, each patient filled out an anamnestic questionnaire and rated their pain on a Numerical Rating Scale (NRS). Pain rating was repeated on the fifth day and at the end of the therapy. Additionally, they completed the Chronic Pain Acceptance Questionnaire (CPAQ-8), the Pain Detect Questionnaire (PDQ), and the Depression, Anxiety, and Stress Scale (DASS-14) before and after the therapy.
Results: The study sample consisted predominantly of women, with a median age of 46 years. Most of these patients use pharmacological therapy daily. Acupuncture did not significantly alter pain perception or intensity, except in those with a neuropathic pain component. Also, patients reported high levels of depression and anxiety, which were not significantly alleviated by acupuncture.
Conclusion: While acupuncture therapy reduced the intensity of pain and improved mental health for some individuals, there were no statistically significant differences in this study. Therefore, further research should be conducted on a larger sample size and over a longer period to assess the actual impact of acupuncture and why its efficacy differs among individuals.

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Introduction

Headaches are neurological disorders involving the central nervous system, characterized by recurrent painful episodes localized in the head region. Their impact extends across multiple domains of an individual's life, including occupational functioning, family dynamics, daily activities, and overall quality of life (1). Therefore, identifying and optimizing therapeutic approaches for each patient is essential.

Etiology and epidemiology

Headaches are subjective sensations of discomfort, pain, or pressure in the head region, often accompanied by autonomic symptoms such as nausea, vomiting, and photophobia (1). They are among the most prevalent chronic pain disorders, with pain perception being inherently individual and influenced by biological characteristics, psychological status, and social determinants (2). Globally, approximately 52% of the population experiences headaches annually, while 15.8% report daily symptoms. Notable sex-based differences in prevalence have been observed, with higher rates in women (57.8%) compared to men (44.4%) (3). Chronic headaches are known to significantly disrupt daily functioning and negatively impact mental health, often presenting with anxiety and depression, ultimately resulting in a reduced quality of life (4). While pharmacological strategies continue to dominate headache management, non-pharmacological approaches offer advantages such as avoidance of medication-related adverse effects, reduced healthcare costs, and suitability for patients who prefer to avoid pharmacotherapy, such as pregnant individuals or those with insufficient therapeutic response to medication (5).

Acupuncture

Acupuncture is one of the oldest therapeutic modalities, based on the traditional concept of vital energy (qi) circulating through meridians in the body. One of the most compelling contemporary hypotheses highlights the role of subcutaneous mast cells at acupuncture points. Mechanical stimulation during acupuncture induces collagen deformation and activation of transient receptor potential vanilloid (TRPV) channels on mast cell membranes, leading to the mast cell degranulation and increasing of bioactive mediators such as histamine, serotonin, and adenosine. These mediators subsequently activate peripheral nerve endings, contributing to analgesia (6,7). The central mechanism is mediated by neurotransmitters and neuromodulators, including opioids, serotonin, norepinephrine, orexin, and endocannabinoids. Furthermore, acupuncture has been shown to reduce levels of cyclooxygenase-2 (COX-2) and prostaglandin E2 (PGE2), both of which are implicated in pain pathways (8). It is particularly indicated for patients who exhibit an inadequate response or intolerance to conventional pharmacological therapies.

Materials and methods

Study design and participants

This research was designed as a prospective study and conducted at the Department of Pain Management, Department of Anesthesiology, Resuscitation and Intensive Care Medicine, University Hospital Centre Osijek. The study included 20 adult participants with a diagnosis of headache who were treated with acupuncture during the period from November 2023 to April 2024. Inclusion criteria required sufficient cognitive and literacy levels to understand the study procedures and independently complete the questionnaires. Prior to participation, all subjects were fully informed about the study and provided informed consent.

Research protocol

Acupuncture treatment was administered by physicians trained in acupuncture at the Pain Management Clinic, following a standardized protocol incorporating points: DM20, DM14, LI4, LI11, PC1, PC2, GB14, ST1, ST2 and ST8. Each participant underwent a cycle of 10 acupuncture sessions, with each session lasting 20 minutes.

At baseline, participants completed a medical history questionnaire and assessed pain intensity using Numeric Rating Scale (NRS). Pain intensity was re-evaluated on the fifth day of treatment and at the end of the two-week treatment period. In addition, the following standardized questionnaires were administered at baseline and upon completion of the acupuncture protocol: the Chronic Pain Acceptance Questionnaire-8 (CPAQ-8), the PainDetect Questionnaire (PDQ), and the Depression, Anxiety and Stress Scale-14 (DASS-14). Acupuncture was the sole non-pharmacological intervention implemented during the study. Pre-existing pharmacological treatment prescribed by the participant' physicians was not altered during the study.

Instruments

Numeric Rating Scale (NRS)

Pain intensity was evaluated using a Numeric Rating Scale ranging from 0 to 10, where 0 indicated "no pain" and 10 represented "the worst imaginable pain". Assessments were conducted at baseline, on the fifth day of treatment, and upon completion of acupuncture treatment.

PainDetect Questionnaire (PDQ)

The PDQ was used to assess the presence of a neuropathic pain component. Based on their scores, participants were categorized according to the presence, absence, or unclear status of a neuropathic pain component.

Chronic Pain Acceptance Questionnaire-8 (CPAQ-8)

The CPAQ-8 was used to assess chronic pain acceptance. The questionnaire covers two primary domains: Pain Willingness and Activity Engagement, as well as an overall pain acceptance score.

Depression, Anxiety and Stress Scale-14 (DASS-14)

The DASS-14 was used to evaluate symptoms of depression, anxiety, and stress. Results were analysed according to severity categories before and after acupuncture treatment.

Ethical considerations

The study was conducted in accordance with the ethical principles of the Declaration of Helsinki. Ethical approval was granted by the Ethics Committee of the Faculty of Medicine Osijek (Ref. No. 641-01/24-01/04). All participants provided written informed consent prior to the commencement of the study, and all data were anonymized to ensure confidentiality.

Statistical Analysis

Categorical data are presented as absolute and relative frequencies. Differences in categorical variables between measurements were tested using the McNemar–Bowker test and, when appropriate, the test of marginal homogeneity. The normality of distribution for numerical variables was assessed using the Shapiro–Wilk test; since the distribution did not follow normality, data are described by the median and interquartile range. Differences in values before and after therapy were analysed using the Wilcoxon test (with the Hodges–Lehmann median difference and 95% confidence interval) or the Friedman test. All p-values are two-sided. The level of significance was set at alpha = 0.05. Data analysis was performed using MedCalc® Statistical Software version 22.018 (MedCalc Software Ltd, Ostend, Belgium; https://www.medcalc.org; 2024).

Results

The study was conducted on 20 subjects, of whom 19 (95%) were female. The median age of participants was 46 years (interquartile range from 33 to 58 years), ranging from 18 to 62 years.

Table 1. General characteristics of participants

	Number (%) of participants
Sex	
Male	1 (5)
Female	19 (95)
Age	
< 30 years	4 (20)
30 – 44 years	7 (35)
45 – 60 years	6 (30)
>60 years	3 (15)
Medications that were prescribed by a doctor:	
I take my medications regularly as prescribed	9 (45)
I only take medications occasionally when I feel stronger pain	10 (50)
I take the following pain medications:	
Tramadol or tramadol-containing medications	3 (15)
Co-analgesics: pregabalin, duloxetine	2 (10)
Nonsteroidal anti-inflammatory drugs (NSAIDs)	11 (55)
Paracetamol	7 (35)
Other	4 (20)

The general characteristics of the participants are presented in Table 1. All participants underwent acupuncture therapy for headache treatment. Medications prescribed by a physician were regularly taken by 9 (45%) participants. The most commonly used therapies were non-steroidal anti-inflammatory drugs (NSAIDs), used by 11 (55%) participants, and paracetamol, used by 7 (35%) participants. During the study period, all participants received a two-week course of acupuncture as the sole non-pharmacological intervention. Pain intensity was assessed at baseline, on the fifth day, and at the end of treatment using the Numeric Rating Scale (NRS), where pain intensity was rated on a scale from 0 (indicating no pain) to 10 (indicating the most severe pain imaginable).

Analysis revealed no statistically significant differences in pain intensity across the three assessment time points (Table 2).

Table 2. Differences in pain intensity across the three assessment points

	Median (interquartile range)			*p**
	Baseline	Day 5 of Treatment	End of treatment	
Pain intensity (1 – 10) NRS	4 (3 – 8)	5.5 (4 – 7)	3 (1.3 – 5)	0.28

*Friedman test

Additionally, no significant changes were observed in the description of pain (Table 3). Among participants who screened positive for a neuropathic pain component, pain intensity decreased significantly across all follow-up measurements compared with pre-therapeutic baseline values (Friedman test, $p < 0.001$). Furthermore, this subgroup demonstrated the highest baseline pain scores, with a median of 8 compared with a median of 3 in patients without neuropathic pain symptoms (Table 4). Pain acceptance, functional status, and behavioural flexibility were evaluated using the CPAQ-8 questionnaire, which comprises two domains: Pain Willingness and Activity Engagement.

Table 3. Distribution of participants according to pain description before and after therapy

Description of pain	Number (%) of participants by pain description		*p**
	Baseline	Post-treatment	
Continuous pain with fluctuations	5 (25)	6 (30)	0.32
Continuous pain with paroxysms	5 (25)	5 (25)	
Paroxysmal pain without interictal pain	7 (35)	7 (35)	
Frequent painful attacks with interictal pain	3 (15)	2 (10)	

*McNemar – Bowker test

Table 4. Distribution of participants based on screening for the neuropathic pain component

Neuropathic pain screening	Median (interquartile range) pain intensity (0–10) on the NRS pain scale across measurements			*p**
	Baseline	Day 5 of treatment	Post-treatment	
Negative	3 (1.5 – 7)	6 (4.5 – 8)	3 (1 – 4)	0.42
Unclear	3 (2.3 – 3)	5 (2 – 6)	3 (2.3 – 6)	0.79
Positive	8 (7 – 9)	6 (4 – 7)	4 (3 – 6)	**<0.001‡**

*Friedman test (post hoc Conover)
‡ All values differ significantly at $p < 0.05$

No statistically significant differences were observed in either individual subscale scores or the total CPAQ-8 score between baseline and post-treatment assessments (Table 5). Examining the clinical severity categories of the DASS-14, a trend toward improvement in both anxiety and depression symptoms was noted after therapy. However, these changes did not reach statistical significance (Table 6).

Table 5. Differences in CPAQ-8 domains and total score before and after therapy

	Median (interquartile range)		Difference (95% confidence interval)	*p**
	Baseline	Post-treatment		
Activity Engagement	14 (9 – 20)	14 (10 – 19)	0 (-0.5 to 0.5)	0.89
Pain Willingness	19 (15 – 21)	19 (14 – 21)	-0.5 (-1 to 0)	0.09
Pain Acceptance	34 (29 – 37)	34 (28 – 36)	-0.5 (-1.5 to 0.5)	0.32

*Wilcoxon test

Table 6. Distribution of participants according to the severity of depression and anxiety before and after therapy

	Number of participants (%)		*p**
	Baseline	Post-treatment	
Depression Severity			
Normal	11 (55)	13 (65)	0,09
Mild	2 (10)	3 (15)	
Moderate	3 (15)	3 (15)	
Severe	1 (5)	0	
Extremely severe	3 (15)	1 (5)	
Anxiety Severity			
Normal	11 (55)	15 (75)	0.39
Mild	5 (25)	2 (10)	
Moderate	3 (15)	2 (10)	
Extremely severe	1 (5)	1 (5)	

*Marginal homogeneity test

Discussion

Of the 20 participants included in this study, 19 (95%) were women, and the median age was 46 years. Although the predominance of women in this sample aligns with population-based studies showing a higher prevalence of headache disorders among women (3,9), the study's small convenience sample from a single pain clinic prevents drawing broader conclusions about headache prevalence by sex or age. All enrolled patients received acupuncture as their non-pharmacological treatment. Although the true effect of acupuncture would be most accurately assessed when administered as a sole treatment, most patients were also receiving specific pharmacological medication for chronic headaches. As expected, non-steroidal anti-inflammatory drugs (NSAIDs) were the most commonly used medications for acute pain relief, followed by paracetamol in seven patients, while three patients were on opioid therapy. Due to the chronic nature and high frequency of attacks, nine patients regularly used symptomatic relief medication. Daily use of analgesics can paradoxically increase headache frequency and the risk of developing medication-overuse headache (MOH) (10), as well as gastrointestinal and cardiovascular complications. Thus, these patients represent ideal candidates for acupuncture therapy. Living with chronic pain, such as headaches, can disrupt daily activities and social life, often triggering depression and anxiety, and vice versa. Using the marginal homogeneity test to categorise the patients' psychological states, three patients were classified in the severe or extremely severe depression group before therapy. Following acupuncture therapy, an apparent improvement in their psychological state was observed, which coincided with a reduction in pain intensity in these patients after treatment. The main aim of this study was to investigate the impact of acupuncture on pain intensity and pain perception in patients with headaches. The CPAQ-8 questionnaire was used to evaluate pain acceptance. The results indicated that participants demonstrated a relatively good baseline attitude toward their pain, despite reduced functionality and the need to avoid activities that could exacerbate their symptoms. However, this level of acceptance was not associated with the acupuncture treatment itself. As higher pain acceptance in chronic illness is linked to reduced daily

limitations, a decrease in the frequency and intensity of headache attacks would be expected to contribute to a reduction in these limitations (11). Until an optimal therapeutic outcome is achieved, it is worth considering psychological interventions effective in chronic pain management. Practicing mindfulness has been shown to reduce pain intensity and frequency, as well as anxiety and depression symptoms, while simultaneously improving quality of life in patients with migraines (12). Pain intensity was measured using the Numeric Rating Scale (NRS). The median score at the beginning of therapy was 4 (moderate pain), which decreased to 3 at the end of treatment. Although this represents an improvement from baseline, it did not reach statistical significance. While positive changes were observed in individual patients, future studies should include larger sample sizes to determine whether these trends achieve statistical significance, consistent with larger studies which demonstrate that acupuncture reduces the duration and frequency of attacks while improving quality of life (13). A recent meta-analysis encompassing 2296 patients evaluated the effects of acupuncture on headache frequency and intensity, providing evidence for its superior prophylactic efficacy compared with pharmacotherapy (14). The most favourable outcomes were observed with a regimen comprising 16 acupuncture sessions with a frequency of 3 sessions per week over a two-month treatment course (15). In contrast, a meta-analysis on 577 participants with headaches undergoing acupuncture treatment did not show any statistically significant effects (16). Significant differences were observed only after long-term monitoring of these patients. Therefore, future research should not only include larger sample sizes but also incorporate longer follow-up periods, ideally up to one year, to obtain more reliable data on the effects of acupuncture on pain intensity and quality of life. The presence of a neuropathic pain component was assessed using the PainDetect Questionnaire (PDQ). Although changes in pain perception and quality were monitored before and after therapy, baseline pain characteristics remained unchanged. Comparative analysis of PDQ and Numeric Rating Scale (NRS) data using the Friedman test revealed a statistically significant reduction in pain intensity; however, this effect was observed only in patients with a confirmed neuropathic component. This finding is crucial for treatment optimization, as neuropathic pain often responds poorly to standard analgesic therapy. Consequently, it suggests the potential role of acupuncture as a targeted intervention, offering a more favourable safety profile compared with pharmacotherapy.

Conclusion

The study sample consisted predominantly of middle-aged women; however, these findings reflect the characteristics of this specific sample and should not be interpreted as estimates of headache prevalence in the general population. Patients suffering from chronic headaches often present with symptoms of anxiety and depression, and acupuncture appears to be partially effective in these cases. In contrast to the latest meta-analyses, overall pain intensity following acupuncture treatment did not demonstrate a statistically significant change compared with baseline, except in patients with a positive neuropathic pain component. Furthermore, no statistically significant effect of acupuncture on pain perception and pain acceptance was observed.

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Disclosure

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Competing interests. None to declare.

References

1. Migraine and other headache disorders [Internet]. [cited 2026 Apr 9]. Available from: https://www.who.int/news-room/fact-sheets/detail/headache-disorders

2. Fillingim RB. Individual Differences in Pain: Understanding the Mosaic that Makes Pain Personal. Pain. 2017 Apr;158(Suppl 1):S11–8. doi:10.1097/j.pain.0000000000000775 PubMed PMID: 27902569; PubMed Central PMCID: PMC5350021.

3. Stovner LJ, Hagen K, Linde M, Steiner TJ. The global prevalence of headache: an update, with analysis of the influences of methodological factors on prevalence estimates. J Headache Pain. 2022 Apr 12;23(1):34. doi:10.1186/s10194-022-01402-2 PubMed PMID: 35410119; PubMed Central PMCID: PMC9004186.

4. López-Medina DC, Arboleda-Ramírez A, Ríos-Díaz S, Zambrano-Cruz R, Arboleda-Jaramillo A, Betancur-Henao C, et al. Cognition, mental health, and quality of life in patients with chronic and episodic migraine during the interictal period. BMC Neurol. 2025 Mar 14;25:108. doi:10.1186/s12883-025-04122-7 PubMed PMID: 40087647; PubMed Central PMCID: PMC11907823.

5. Haghdoost F, Togha M. Migraine management: Non-pharmacological points for patients and health care professionals. Open Med (Wars). 2022 Nov 23;17(1):1869–82. doi:10.1515/med-2022-0598 PubMed PMID: 36475060; PubMed Central PMCID: PMC9691984.

6. Li Y, Yu Y, Liu Y, Yao W. Mast Cells and Acupuncture Analgesia. Cells. 2022 Mar 2;11(5):860. doi:10.3390/cells11050860 PubMed PMID: 35269483; PubMed Central PMCID: PMC8909752.

7. Huang M, Wang X, Xing B, Yang H, Sa Z, Zhang D, et al. Critical roles of TRPV2 channels, histamine H1 and adenosine A1 receptors in the initiation of acupoint signals for acupuncture analgesia. Sci Rep. 2018 Apr 25;8(1):6523. doi:10.1038/s41598-018-24654-y

8. Lin JG, Kotha P, Chen YH. Understandings of acupuncture application and mechanisms. Am J Transl Res. 2022;14(3):1469–81. PubMed PMID: 35422904; PubMed Central PMCID: PMC8991130.

9. Husøy AK, Yu S, Liu R, Herekar AA, Ahmed B, Herekar AD, et al. The global prevalence of headache disorders of public-health importance: a meta-analysis of population-based individual participant data from 41,614 adults from 17 countries. J Headache Pain. 2025 Oct 7;26(1):204. doi:10.1186/s10194-025-02142-9 PubMed PMID: 41057756; PubMed Central PMCID: PMC12502191.

10. Fischer MA, Jan A. Medication-Overuse Headache. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024 [cited 2024 May 18]. Available from: http://www.ncbi.nlm.nih.gov/books/NBK538150/ PubMed PMID: 30844177.

11. Salamon KS, Dutta RA, Hildenbrand AK. Improved pain acceptance and interference following outpatient interdisciplinary pediatric chronic pain treatment. Psychol Health. 2023;38(11):1482–93. doi:10.1080/08870446.2021.2024540 PubMed PMID: 35049389.

12. Liao YC, Chen WS, Restya WPD, Liao YC, Lin YC, Lin RT. Effectiveness and influence of mindfulness-based intervention on migraine patients: A systematic review and meta-analysis. Journal of Psychosomatic Research. 2025 Oct 1;197:112366. doi:10.1016/j.jpsychores.2025.112366

13. Lu T, Yang Y, Li J, Lu L, Liu J. Acupuncture improves migraine and quality of life in patients with migraine: a systematic review with meta-analysis. Systematic Reviews. 2025 Nov 11;14. doi:10.1186/s13643-025-02977-y

14. Liu AR, Zhu Q, Li J, Cao Y, Pei T, Shi L. Efficacy of Acupuncture and Pharmacotherapy for Migraine Prophylaxis: A Systematic Review and Meta-Analysis. J Pain Res. 2025;18:2521–40. doi:10.2147/JPR.S519846 PubMed PMID: 40406034; PubMed Central PMCID: PMC12095863.

15. Yang C, Wu M, Luo Q, Xu G, Huang L, Tian H, et al. Acupuncture for migraine: A systematic review and meta-regression of randomized controlled trials. Complementary Therapies in Medicine. 2024 Nov 1;86:103076. doi:10.1016/j.ctim.2024.103076

16. Kolokotsios S, Stamouli A, Koukoulithras I, Plexousakis M, Drousia G. The Effectiveness of Acupuncture on Headache Intensity and Frequency in Patients With Tension-Type Headache: A Systematic Review and Meta-Analysis. Cureus. 13(4):e14237. doi:10.7759/cureus.14237 PubMed PMID: 33948422; PubMed Central PMCID: PMC8087950.

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Analysis and interpretation of data: DLĆ, OKT, DB
Conception and design: DLĆ, OKT, DB
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Učinak akupunkture na intenzitet i percepciju boli kod glavobolje

Sažetak

Cilj: Ispitati promjene u intenzitetu i percepciji boli kod pacijenata s glavoboljom nakon terapije akupunkturom u odnosu na početne vrijednosti.

Ispitanici i metode: Istraživanje je provedeno u Zavodu za liječenje boli KBC-a Osijek na 20 pacijenata s dijagnozom glavobolje koji su prošli terapiju akupunkture u trajanju od dva tjedna. Na početku terapije ispitanici su popunili anamnestički upitnik i ocijenili svoju bol na numeričkoj ljestvici boli (NRS). Zatim su svoju bol ocijenili petog dana i nakon provedene terapije. Osim toga, ispunjavali su upitnik o prihvaćanju kronične boli (CPAQ-8), upitnik o boli (PDQ) te upitnik za procjenu depresije, anksioznosti i stresa (DASS-14) prije i nakon provedene terapije.

Rezultati: U ovom je istraživanju pretežito zastupljen ženski spol, uz medijan dobi od 46 godina. Svakodnevna primjena farmakološke terapije raširena je među ovim pacijentima. Nema statistički značajne promjene u percepciji boli nakon akupunkturnog liječenja. Isto vrijedi i za intenzitet boli, osim za one pacijente kod kojih postoji neuropatska komponenta boli. Pacijenti s glavoboljom imaju visoku razinu depresije i anksioznosti na koju akupunktura nije imala učinka.

Zaključak: Terapija akupunkturom može pomoći pojedincima u smanjenju intenziteta boli, ali u ovom istraživanju nije zabilježena statistički značajna razlika. Stoga bi trebalo provesti daljnja istraživanja na većem uzorku i tijekom duljeg razdoblja kako bi se utvrdio stvarni učinak akupunkture, te zašto je djelotvorna kod nekih osoba, a kod drugih nije.

Ključne riječi: akupunktura; glavobolja; bol