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Systematic review

Is chiropractic spinal manipulation effective for the treatment of cervicogenic, tension-type, or migraine headaches? A systematic review

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ABSTRACT

Introduction: Patients with headaches often seek complementary and alternative therapies, including chiropractic care. Chiropractic spinal manipulation is one of the most commonly used techniques for these patients; however, its effectiveness remains unclear. This systematic review aimed to evaluate the effectiveness of chiropractic spinal manipulation in reducing headache days, episode duration, episode intensity, and medication intake in patients with headaches.

Methods: MEDLINE (Pubmed), PEDro, SCOPUS, Cochrane Library and Web of Science databases were searched from inception to April 2024. PICO search strategy was used to identify randomized controlled trials applying chiropractic spinal manipulations versus sham manipulation, no additional intervention, or other conservative non-pharmacological interventions in patients with headaches. Eligible studies and data extraction were conducted independently by two reviewers. Quality of the studies was assessed with Physiotherapy Evidence Database scale, and risk of bias with Cochrane Collaboration tool. Certainty of the evidence was evaluated using GRADE approach.

Results: Eight studies ranging from low to high methodological quality were included in the synthesis without a meta-analysis. The results were categorized into three subgroups: chiropractic manipulation versus sham, chiropractic manipulation versus control, and chiropractic manipulation versus deep friction massage. Among the five studies comparing chiropractic manipulation to sham, two found a significant reduction in the number of headache days. Of the three studies comparing chiropractic manipulation to a control, one reported a decrease in headache episode duration. No significant differences were observed for any other variable across the subgroups. The certainty of evidence was downgraded to very low.

Conclusions: It is uncertain if chiropractic spinal manipulation is more effective than sham, control, or deep friction massage interventions for patients with headaches.

PROSPERO registration number: CRD42024518480

List of abbreviations: TTH, Tension-type headache; CH, Cervicogenic headache; NICE, National Institute for Health and Care Excellence; VA/dod, Department of Veterans Affairs and Department of Defense; IFOMPT, International Federation of Orthopaedic Manipulative Physical Therapists; pedro, Physiotherapy Evidence Database; WOS, Web of Science; mesh, Medical Subject Heading; MD, Mean difference; SD, Standard deviation; 95% CI, 95% confidence interval; GRADE, Grading of Recommendations Assessment, Development and Evaluation; VAS, Visual analogue scale; NRS, Numeric rating score.

This study design, protocol and consent forms were performed in accordance with the Helsinki Declaration of 1964 (revised in Fortaleza, 2013). The study protocol was submitted to PROSPERO before the start of the study and received a registration number (CRD42024518480).This manuscript is original and not previously published, nor it is being considered elsewhere until a decision is made as to its acceptability by the review board. Authors not declare conflicts of interest in this study. All the authors have been actively involved in the planning and enactment of the review, and have also assisted with the preparation of the submitted article. This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.**Level of evidence**: 1A

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1. Introduction

Headaches are one of the most common reasons for seeking medical attention worldwide. The International Headache Society classifies headaches into primary or secondary according to its clinical presentation and associated symptoms [1]. Among the most common primary headaches are migraine and tension-type headaches (TTH) [2], which are considered the result of dysfunctions or overactivity of pain-sensitive structures in the head without a clear underlying cause. Cervicogenic headache (CH) is the most diagnosed secondary headache, which is related to other conditions such as trauma, musculoskeletal, arthritic, or vascular disorders [1]. These three types of headaches are the most prevalent in the general population, showing a lifetime prevalence around 53 % in Europe [3].

The National Institute for Health and Care Excellence (NICE) [4] recommends pharmacological treatments as the first-line intervention for managing acute headache symptoms in patients with various headache types, whereas the Department of Veterans Affairs and Department of Defense (VA/DoD) recommends pharmacological treatments for prophylaxis in all cases [5]. However, the medications employed are not free of risks, and about one-third of the headache patients are unsatisfied with the pharmacological treatments [6]. Many thus turn to complementary and alternative therapies such as chiropractic [7,8]. Between 8 % to 15 % of all the patients consulting chiropractors in United States and Canada do so because of headaches [8,9], and one of five patients attending by chiropractors in Australia suffer from CH, TTH, or migraine [10].

Spinal manipulation techniques such as the Gonstead method or toggle-recoil technique are commonly used by chiropractors. Moore et al. reported that 82 % of chiropractors use these techniques for patients suffering migraine, 88 % for patients with TTH, and 91 % for patients with CH [10]. Like any spinal manipulation, chiropractic spinal manipulations entail risk of adverse events that range from mild and transient to severe and permanent. The latter category includes cervical edema, disc herniation, or vertebrobasilar artery dissection [11–15]. For this reason, the International Federation of Orthopaedic Manipulative Physical Therapists (IFOMPT) discourage the use of spinal manipulation for cervical spine disorders and suggest the use of other conservative approaches in which patients have greater control of the treatment [16, 17].

Five previous systematic reviews [18–21] and one meta-analysis [22] have investigated the efficacy and safety of spinal manipulations for treating headaches. However, none of these studies specifically considered the practitioner performing the treatment or the technique used. Therefore, it is particularly important to examine the effects of chiropractic spinal manipulation. The aim of this systematic review therefore is to evaluate the totality of the evidence from RCTs of chiropractic spinal manipulations as a treatment of patients diagnosed with CH, TTH, or migraine.

2. Methods

2.1. Study design

This systematic review was conducted following the PRISMA statement and the Cochrane recommendations [23] The protocol was prospectively registered in PROSPERO (identification number CRD42024518480).

2.2. Search strategy

The bibliographical searches were carried out in PubMed (MEDLINE), Physiotherapy Evidence Database (PEDro), Cochrane Library, Web of Science (WOS), from inception to April 2024. Medical Subject Heading (MeSH) terms and grey terms were used as keywords in the search strategy: “spinal manipulation”, “chiropractic manipulation”, “high-velocity low-amplitude” and “headache” among others. The search strategy used in each database is shown in Appendix A. The reference lists of the included studies and the above-mentioned previous systematic reviews were hand-searched.

2.3. Eligibility criteria and study selection

Studies were eligible if they included patients diagnosed with CH, TTH, or migraine; applied a spinal manipulation by a chiropractor as intervention; compared the chiropractic intervention to a sham or placebo technique, non-pharmacological conservative intervention, pharmacological treatment prescribed prior to the study, or no intervention; reported variables related days with headache, duration of the episode, intensity of the episode and medication intake; were designed as RCT or cross-over. Studies were excluded if they: included only healthy participants; applied spinal manipulation using a non-chiropractic technique (i.e. translatoric manipulation) or if the intervention was not performed by a chiropractor (authors were contacted by email in case this information was not declared); included spinal manipulation in a multimodal intervention or comparator in which the effects of the spinal manipulation could not be extrapolated; reported no clinical outcomes or the outcome measures were not quantified using validated instruments.

The reference lists retrieved from each database were exported to Mendeley to remove duplicates. Two authors (L.C-L. and A.C-U.) independently reviewed the title and abstract of each retrieved study to determine their potential eligibility. The studies that met the eligibility criteria were assessed in full text by the same authors. A third author (S. J-B.) was consulted in case of discrepancies.

2.4. Data extraction

The data extraction was performed independently by two reviewers (L.C-L. and A.C-U.) using a predetermined sheet adapted from the Cochrane Collaboration. The data extracted were the characteristics of the population (mean age, diagnosis), type of interventions (session duration, sessions per week, and total number of sessions), outcome variables, and results. Data were analyzed using synthesis without meta-analysis due to the high heterogeneity of the studies selected.

2.5. Risk of bias assessment and methodological quality

The risk of bias was assessed using the Cochrane risk-of-bias-tool 2 (RoB2) and the methodological quality was assessed using the PEDro scale. The same authors performed independently the assessment.

The RoB2 was used to determine the potential risk of bias in RCTs and consist of five domains that cover all types of bias that can affect the results: bias arising from the randomization process (domain 1), bias due to deviations from the intended interventions (domain 2), bias due to missing outcome data (domain 3), bias in measurement of the outcome (domain 4), and bias in selection of the reported result (domain 5). For each domain the tool comprises a series of signaling questions that can be responded as “yes”, “probably yes”, “probably no”, “no”, or “no information” and the algorithm maps responses and judge about risk of bias as “low”, “unclear” or “high” for each domain. The official instructions from the Cochrane Collaboration were used to ensure the answer to each question. A study is judged to be low risk of bias if all criteria were met, a study was considered as unclear risk of bias when at least one item presented some concerns, and a study was judged to be high risk of bias when at least one item was considered as high risk [24]. RoB 2 assessments were conducted exclusively for patient-reported outcomes, which were considered the main result.

The PEDro scale was used to determine the methodological quality of the RCTs included and consist of an 11-item checklist. A study is judged to be high methodological quality when at least seven criteria were met, fair methodological quality when five or six items were met, and a study

was considered as low methodological quality when four or less items were met [25].

2.6. Data synthesis and analysis

For the synthesis without meta-analysis, the groups were divided based on interventions (chiropractic spinal manipulation vs. sham; chiropractic spinal manipulation vs. control; chiropractic spinal manipulation vs. deep friction massage) and outcome variables (days with headache, duration of the episode, intensity of the episode, and medication intake).

Data synthesis and analysis were conducted following the methodology of Campell et al. [26] for systematic reviews without meta-analysis. The mean difference (MD) and standard deviation (SD) were used as intragroup measures of effect size. For studies that did not report these values but provided sufficient data, MD and SD were calculated following the Cochrane Handbook for systematic reviews with meta-analysis [27]. Between-group comparisons were reported as MD with a 95 % confidence interval (95 % CI). In case the studies presented insufficient data, corresponding authors were contacted via email to request raw data. Statistical significance was set at <0.05. The data were compiled in tables and categorized by intervention type, outcome variables and results.

The quantitative synthesis of results (meta-analysis) using forest plots was not possible due to the high heterogeneity observed among the studies included.

2.7. Certainty of evidence

The certainty of evidence was assessed by the Grading of Recommendations Assessment, Development and Evaluation (GRADE) approach by the same independent reviewers. Prior to the independent evaluation, criteria for downgrading the certainty of evidence were established to the following domains: risk of bias, inconsistency, indirectness, imprecision, and other considerations. The categories of evidence were classified as “high”, “moderate”, “low”, or “very low”, to help researchers and clinicians on the importance of the results [28].

3. Results

Our searches retrieved 420 hits. After eliminating the 197 duplicates, 223 titles and abstracts were reviewed, 18 RCTs were selected for full-text review, and eight were finally included in the review. Five studies were excluded because were not carried out by chiropractors or not applied chiropractic manipulations [29–33]. Five studies applied chiropractic interventions but Witthingam et al., [34] did not present

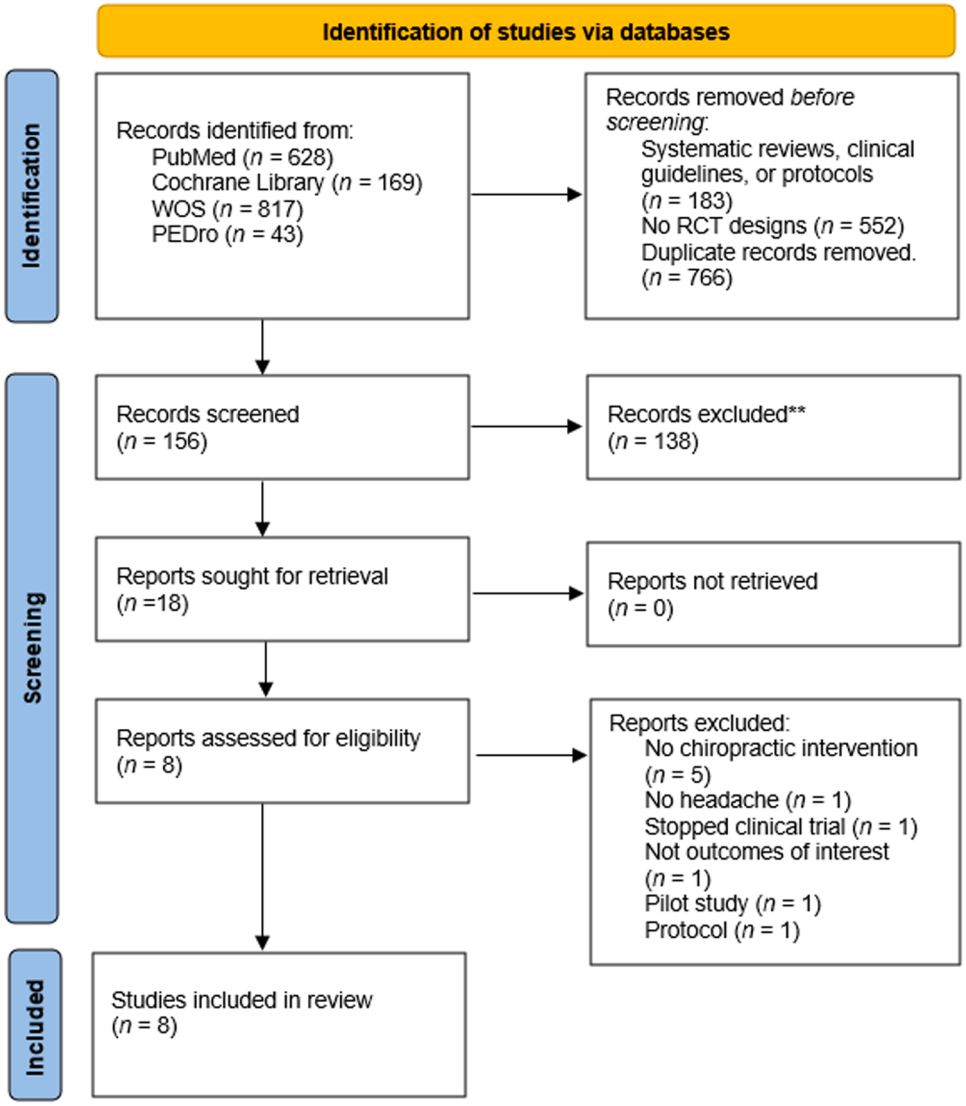

Fig. 1. Flowchart diagram.

the outcomes of interest, Vernon et al. [35] stopped the clinical trial before finishing it, Walker et al., [36] did not include patients with headaches, Wayne et al. [37] published a protocol of a RCT, and Nilsson et al., [38] published a pilot study before the definitive study of 1997. The description of the selection process is shown in the PRISMA flow-chart diagram (Fig. 1).

The characteristics of the included studies are shown in the Table 1. The results were categorised into the three subgroups described in the methods section (chiropractic vs. sham; chiropractic vs. control; and chiropractic vs. deep friction massage). The included RCTs were published between 1987 and 2021. All the RCTs followed parallel group design. The total sample size of all the studies was 655 patients, 337 receiving chiropractic manipulation, and 318 control interventions.

All the interventions were delivered by chiropractors and were based on chiropractic manipulations, only for studies described the specific technique applied [39–42]. Chaibi et al., [39,40] used the Gonstead method and Bove & Nilsson [41,42] used the toggle-recoil technique. The control groups received sham techniques [39,40,43,44], oscillatory mobilizations [39,40,44], or soft tissue techniques such as deep friction massage and trigger point therapy [41,42], or the continuation of the previously prescribed pharmacological intervention. All the studies allowed the participants the medication intake during the study process.

The outcome variables were days with headache (frequency), the duration of the headache episodes, the pain intensity, and the medication intake. These outcome variables were registered as the number of days with headache per week (0–7) or per month (0–30), the duration of the episode was registered in hours, the intensity was assessed using a visual analogue scale (VAS) or a numeric rating score (NRS), and the medication intake was registered as the number of pills per day, per week or per month.

3.1. Methodological quality and risk of bias assessment

The overall risk of bias was considered to be high for four studies, and four studies showed some concerns. The Fig. 2 showed in detail the Cochrane risk-of-bias 2 tool results. The methodological quality assessed using the PEDro scale classified four studies as high quality, two studies as fair quality, and two as low quality (Table 2). In both scales, concerns arise from the lack of random and/or concealed allocation and blinding of examiners. The Risk of bias also showed some concerns due to the possibility of selective reporting bias in five of the included studies.

3.2. Clinical effectiveness of chiropractic manipulation vs sham

Five studies were included in the synthesis without meta-analysis, comparing chiropractic manipulation to sham. Lynge et al. [45] and Borusiak et al. [43] conducted trials in children and adolescents with non-specific headaches. Only Lynge et al. [45] reported a statistically significant reduction in headache days compared to sham manipulation (−0.40 [−0.77; −0.05]). Chaibi et al. [39] included adults with CH and found a statistically significant reduction in pain intensity (−2.30 [−4.54; −0.06]); however, it is important to note the wide 95 % confidence interval (CI) and the small sample size of only four patients per group. Tuchin et al. [46] and Chaibi et al. [40] included adults with migraines. Only Tuchin et al. [46] found a statistically significant reduction in migraine days in favor of chiropractic manipulation (−2.60

Table 1
Characteristics of the included studies.

Author (year)	Participants Mean age (SD)	Population	Diagnosis	Intervention Chiropractic manipulation group	Control group	Session duration	Frequency (sessions/week)	Total number of sessions
Chiropractic vs Sham								
Lynge et al. 2021 [45]	EG:10.9 (2.1) CG:10.7 (2.0)	Children and adolescents	Non-specific headache	Chiropractic manipulation (n = 99)	Sham manipulation (n = 100)	NR	2 first week 1 the following 2 weeks 1 each 2 weeks for 2 weeks 2 with 4 weeks apart	8 (4 months)
Borusiak et al. 2009 [43]	11.6 (2.3)	Children and adolescents	Non-specific headache	Chiropractic manipulation (n = 24)	Sham manipulation (n = 28)	NR	1	1
Chaibi et al. 2017 A [39]	EG:36.0 (12.8) CG:49.8 (12.3)	Adults	CH	Chiropractic manipulation (n = 4)	Sham manipulation (n = 4)	NR	1	12 (3 months)
Tuchin et al. 2000 [46]	EG:39.6 CG:37.8	Adults	Migraine	Chiropractic manipulation (n = 83)	Sham (n = 40)	NR	2	16 (2 months)
Chaibi et al. 2017 C [40]	EG:41.0 (11.3) CG:39.6(9.8)	Adults	Migraine	Chiropractic manipulation (n = 31)	Sham manipulation (n = 28)	15m	1	12 (3 months)
Chiropractic vs control								
Chaibi et al. 2017 B [39]	EG:36.0 (12.8) CG:49.8 (12.3)	Adults	CH	Chiropractic manipulation (n = 4)	Control (n = 4)	NR	1	12 (3 months)
Chaibi et al. 2017 D [40]	EG:41.0 (11.3) CG:38.7 (11.1)	Adults	Migraine	Chiropractic manipulation (n = 31)	Control (n = 24)	15m	1	12 (3 months)
Parker et al. 1978 [44]	EG:40 (5) CG:41(3)	Adults	Migraine	Chiropractic manipulation (n = 30)	Control (n = 28)	NR	2	16 (2 months)
Chiropractic vs DFM								
Bove et al. 1998 [41]	EG:37 CG:38	Adults	TTH	Chiropractic manipulation + DFM (n = 38)	DFM (n = 37)	15m	4	8 (2 weeks)
Nilsson et al. 1997 [42]	EG:42 CG:35	Adults	CH	Chiropractic manipulation (n = 28)	DFM (n = 25)	NR	2	6 (3 weeks)

EG: experimental group; CG: control group; CH: cervicogenic headache; TTH: tension-type headache; DFM: deep friction massage.

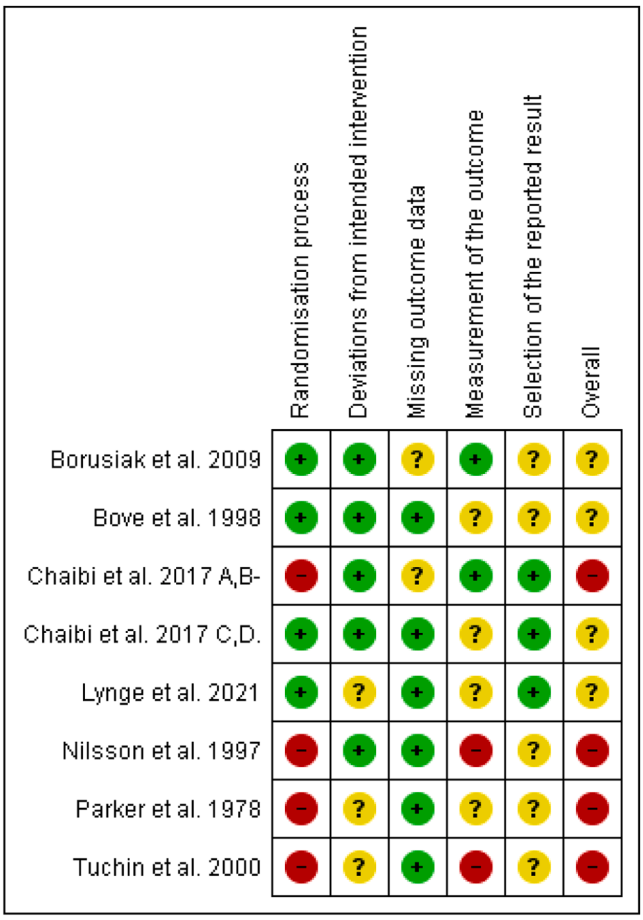

Fig. 2. Risk of bias of the included studies.

[−5.10; −0.10]) and a significant improvement in pain intensity in favor of the sham intervention (0.60 [0.12; 1.26]). No statistically significant between-group differences were observed for episode duration (in hours), headache index (HI), or medication intake (Table 3). The certainty of evidence was downgraded to very low. The detailed explanation for each outcome variable is shown in Table 4.

3.3. Clinical effectiveness of chiropractic manipulation vs control

Three studies were included in the synthesis without meta-analysis, comparing chiropractic manipulation to a control. All studies allowed the continuation of medication intake, which was recorded as an outcome measure. Consequently, in all three cases, the control group consisted of continued pharmacological treatment. Chaibi et al. [39] reported no between-groups differences in any outcome variable in adults with CH. Chaibi et al. [40] and Parker et al. [44] conducted their trials in adults with migraines and only Chaibi et al. [40] found a statistically significant improvement in duration of the episode in hours compared to a control intervention. No statistically significant between-group differences were observed for days with headaches, pain intensity, HI, or medication intake (Table 3). The certainty of evidence was downgraded to very low. The detailed explanation for each outcome variable is shown in Table 4.

3.4. Clinical effectiveness of chiropractic manipulation vs deep friction massage

Two studies were included in the synthesis without meta-analysis, comparing chiropractic manipulation to deep friction massage, trigger point therapy and low-power laser therapy in patients with TTH and CH [41,42]. No statistically significant differences between groups were found in duration of the episode (in hours), pain intensity, or medication intake (Table 3). The certainty of evidence was downgraded to very low. The detailed explanation for each outcome variable is shown in Table 4.

3.5. High versus low quality studies

Six out of eight studies ranging from high to low methodological quality did not demonstrate statistically significant differences in favor to the chiropractic spinal manipulation group in the days with headache, duration of the headache, intensity of the headache, or medication intake [39,41–44,47]. Only two studies with high methodological quality and unclear risk of bias showed statistically significant improvements after chiropractic manipulation in days with headaches [45] and the duration of the episode [40]. Two studies with fair and poor methodological quality and high risk of bias showed statistically significant improvements after chiropractic manipulation in pain intensity [39] and days with migraine [46].

3.6. Adverse events

Five studies did not mention adverse events [41,42,44–46]. Three studies reported minor adverse events such as hot skin, dizziness, local tenderness, and tiredness immediately after spinal manipulation [39, 43]. Borusiak et al. [43] reported cases of hot skin (6 patients after chiropractic manipulation and 9 after placebo technique) dizziness (7 patients after chiropractic manipulation and 4 after placebo technique), and an increase in headache intensity and frequency for up to 4 days (8 patients after chiropractic manipulation and 6 after placebo technique). Chaibi et al. [40] found that adverse events were more frequent following chiropractic manipulation than after the placebo intervention. Local tenderness, tiredness, and pain after spinal manipulation were reported by 11.3 %, 8.5 % and 2.0 % of participants, respectively. In

Table 2
PEDro scale scores.

Autor	Items											Total
	1	2	3	4	5	6	7	8	9	10	11	
Borusiak et al. [43]	Y	Y	Y	Y	Y	N	Y	N	N	Y	Y	7/10
Chaibi et al. A,B [39]	Y	Y	N	Y	Y	N	Y	N	N	N	Y	5/10
Lynge et al. [45]	Y	Y	Y	Y	N	N	N	Y	Y	Y	Y	7/10
Chaibi et al. C,D [40]	Y	Y	Y	Y	Y	N	Y	Y	N	Y	Y	8/10
Parker et al. [44]	N	Y	N	Y	N	N	N	Y	N	Y	N	4/10
Tuchin et al. [46]	Y	N	N	Y	N	N	N	Y	N	Y	N	4/10
Bove et al. [41]	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	8/10
Nilsson et al. [42]	Y	Y	N	Y	N	N	Y	Y	N	Y	Y	6/10

1, eligibility criteria 2, random allocation; 3, concealed allocation; 4, similarity at baseline; 5, blinding of participants; 6, blinding of therapists; 7, blinding of assessors; 8, measures of at least one key outcome from at least 85 % of participants initially allocated to groups; 9, intention to treat analysis; 10, between-group comparison; 11, point measures and measures of variability.
1= Yes (1 point), 0 = No (0 point), maximum score = 10 (criterion 1 is not included in scores).

Table 3
Description of the interventions and clinical effectiveness.

Author (year)	Intervention: Chiropractic manipulation group	Intervention: Control group	Outcome (tool)	Intragroup results MD (SD)	Between groups MD (95 %CI)
Chiropractic vs sham					
Lynge et al. 2021 [45]	HVLA Chiropractic manipulation	Sham manipulation consisted of non-specific contact, low-velocity, low-amplitude sham push manoeuvre	Days with headache	CMG: −0.8 (1.24) CG: −0.4 (1.24)	0.40 (−0.77;−0.05)*
			Intensity (NRS)	CMG: −0.5 (1.59) CG: −0.5 (1.59)	0.01 (−0.43;0.46)
			Medication intake	CMG: −0.1 (0.35) CG: −0.03 (0.35)	0.07 (−0.16;0.03)
Borusiak et al. [43]	HVLA Chiropractic manipulation with a force of 50Nm infants and 350Nm in adults	Sham manipulation consisted of light touch of specific spinal segments without HVLA thrust	Days with headache	CMG: −9.7 (30.86) CG: −9.4 (28.40)	0.30 (−16.52;15–92)
			Duration in hours	CMG: −7.5 (35.39) CG: −6.6 (21.93)	0.90 (17.30;15.50)
			Intensity (VAS)	CMG: −0.3 (1.78) CG: −0.1 (0.63)	0.20 (−0.95;0.55)
			Medication intake	CMG: −1.8 (19.41) CG: −1 (11.25)	0.80 (−8.01;9.61)
Chaibi et al. 2017 A [39]	HVLA Chiropractic manipulation using the Gonstead method	Sham manipulation consisted of non-specific contact, low-velocity, low-amplitude sham push manoeuvre	Days with headache	CMG: −6.0 (8.12) CG: −8.2 (14.97)	−2.20(−14.44;18.84)
			Duration in hours	CMG: −2.6 (5.92) CG: −3.5 (6.65)	−1.00 (−7.71;9.73)
			Intensity (NRS)	CMG: −2.2 (1.68) CG: 0.1 (1.55)	−2.30 (−4.54;−0.06)*
			HI	CMG: −581.7 (810.67) CG: −52.2 (589.82)	633.20 (349.21;1615.61)
Tuchin et al. [46]	HVLA Chiropractic manipulation	Sham intervention consisted of detuned interferencial thersapy	Days with migraine	CMG: −3.0 (6.76) CG: −0.4 (6.56)	2.60 (−5.10;−0.10)*
			Duration in hours	CMG: −8.5 (24.42) CG: −2.8 (23.24)	5.70 (−3.21;14–61)
			Intensity (VAS)	CMG: −1.0 (1.61) CG: −1.69 (1.47)	0.69 (0.12;1.26)#
			Medication intake	CMG: −0.38 (21.91) CG: −0.13 (21.91)	−0.25 (−8.52;8.02)
Chaibi et al. 2017 C [40]	HVLA Chiropractic manipulation using the Gonstead method	Sham manipulation consisted of non-specific contact, low-velocity, low-amplitude sham push manoeuvre	Days with headache	CMG: −2.6 (3.20) CG: −4.2 (5.65)	1.60 (−0.78;3.98)
			Duration in hours	CMG: −2.5 (5.85) CG: −3.6 (5.96)	1.10 (−1.92;4.12)
			Intensity (VAS)	CMG: −1.0 (2.31) CG: −1.1 (2.42)	0.10 (−1.11;1.31)

(*continued on next page*)

Table 3 (*continued*)

Author (year)	Intervention Chiropractic manipulation group	Control group	Outcome (tool)	Intragroup results MD (SD)	Between groups MD (95 %CI)
			HI	CMG: −262 (406.89) CG: −432.4 (620.92)	170.40 (−100.54;441.34)
			Medication intake		
Chiropractic vs control					
Chaibi et al. [39]	HVLA Chiropractic manipulation using the Gonstead method	Control consisted of usual pharmacological management	Days with headache	CMG: −6.0 (8.12) CG: 0 (1.41)	−6 (−14.15;2.15)
			Duration in hours	CMG: −2.6 (5.92) CG: −1.45 (1.34)	−1.15 (−7.10;4.80)
			Intensity (NRS)	CMG: −2.2 (1.68) CG: −0.35 (1.21)	−1.85 (−3.83;0.13)
			HI	CMG: −581.7 (810.67) CG: −200.2 (356.50)	−380.80 (−1248.67;487.07)
Chaibi et al. D [40]	HVLA Chiropractic manipulation using the Gonstead method	Control consisted of usual pharmacological management	Days with migraines	CMG: −2.6 (3.20) CG: −1.7 (5.95)	−0.90 (−3.22;1.42)
			Duration in hours	CMG: −2.5 (5.85) CG: 2 (6.25)	−4.50 (−7.14;−1.86) *
			Intensity (VAS)	CMG: −1.0 (2.31) CG: 0.1 (2.25)	−1.10 (−2.26;0.06)
			HI	CMG: −262 (406.89) CG: −34 (642.39)	−228.0 (−505.73;49.73)
			Medication intake		
Parker et al. [44]	HVLA Chiropractic manipulation beyond normal limitations	Control consisted of mobilizations defined as oscillatory joint movements within normal limitations	Duration in hours	CMG: −11.1 CG: −3	ND
			Intensity (VAS)	CMG: −2.1 CG: −0.8	ND
			Disability (0–5)	CMG: −1.0 CG: −0.6	ND
Chiropractic vs DFM					
Bove et al. [41]	HVLA Chiropractic manipulation using the toggle-recoil technique and diversified technique + DFM of trapezius muscle and trigger point therapy if indicated.	DFM of trapezius muscle including trigger point therapy and low-power laser therapy	Duration in hours	CMG: −1.5 (10.69) CG: −1.9 (14.90)	0.40 (−5.48;6.28)
			Intensity (VAS)	CMG: −3.8 (2.64) CG: −3.4 (2.34)	−0.40 (−1.53;0.73)
			Medication intake	CMG: −0.38 (3.59) CG: −0.59 (6.46)	−0.21 (−2.58;2.16)
Nilsson et al. [42]	HVLA Chiropractic manipulation using the toggle-recoil technique and diversified technique	DFM including trigger point therapy with low-power laser therapy	Duration in hours	CMG: −3.2 (3.71) CG: −1.6 (3.68)	−1.60 (−3.55;0.35)
			Intensity (VAS)	CMG: −1.6 (3.25) CG: −0.5 (1.68)	−1.10 (−2.46;0.26)
			Medication intake	CMG: −0.7 (0.81) CG: −0.3 (2.19)	−0.40 (−1.28;0.48)

MD: mean difference; SD: standard deviation; HVLA: high-velocity low-amplitude; VAS: visual analogue scale; CMG: chiropractic manipulation group; CG: control group;.

* : statistically significant changes in favour to the CMG;.

: statistically significant changes in favour to the CG.

Table 4
Summary of treatment effects and evidence certainty for chiropractic spinal manipulation compared to sham, control and deep friction massage.

Number of studies and population	Certainty of evidence
Chiropractic manipulation vs sham	
Outcome variables: days with headache and pain intensity	
5 RCTs (441 patients)	Very low, due to risk of bias*, indirecteness#,†, and imprecision‡
Outcome variable: duration of the episode	
4 RCTs (242 patients)	Very low, due to risk of bias§, indirecteness#,¶ and imprecision‡
Outcome variable: medication intake	
4 RCTs (433 patients)	Very low, due to risk of bias*, indirecteness#,†, and imprecision‡
Chiropractic vs control	
Outcome variable: days with headache	
2 RCTs (63 patients)	Very low, due to risk of bias§, indirecteness#, imprecision‡,∫
Outcome variables: duration of the episode and pain intensity	
3 RCTs (121 patients)	Very low, due to risk of bias*, indirecteness#, imprecision‡,∫
Outcome variable: medication intake	
1 RCT (55 patients)	Very low, due to risk of bias§, indirecteness#, imprecision‡,∫
Chiropractic vs deep friction massage	
Outcome variables: duration in hours, pain intensity and medication intake	
2 RCTs (128 patients)	Very low, due to risk of bias§, indirecteness#, imprecision‡,∫

§ : one study presented high risk of bias;.
* : two studies presented high risk of bias;.
# : patients received uncontrolled pharmacological treatment;.
¶ : one study included patients with non-specific headaches;.
† : two studies included patients with non-specific headaches;.
‡ : confidence intervals are wide;.
∫ : small sample sizes.

contrast, 6.9 %, 1.4 %, and 0.3 % of participants in the placebo group reported tenderness, tiredness and pain, respectively. None of the three studies reported serious adverse events [39,40,43].

4. Discussion

This systematic review was aimed at determining whether chiropractic spinal manipulations are clinically effective in patients with headaches. Eight studies were included and most of them showed that chiropractic spinal manipulation was not more effective than sham, control, or deep friction massage interventions. The certainty of evidence was downgraded to very low.

In the synthesis without meta-analysis, six of eight studies showed no statistically significant changes in the days with headache, duration of the headache, intensity of the headache, or medication intake. Statistically significant results were only found in isolation. Lynge et al. [45] and Tuchin et al. [46] showed a reduction in headache days compared to a sham technique. Both Tuchin et al. [46] and Chaibi et al. [39] reported a reduction in pain intensity. The findings of the study conducted by Tuchin et al. [46] favored the placebo group, whereas the findings of the study of Chaibi et al. favored the chiropractic manipulation group. Chaibi et al. [40] found a reduction in the duration of the episodes after chiropractic manipulation compared to a control.

Concerning the sham and control interventions described in the included studies, it is important to note that sham interventions were likely not inert, as most studies involved different manual contacts. The lack of statistical differences between chiropractic manipulation and sham manual techniques may be attributed to additional factors that play a significant role in clinical practice, such as contextual factors and non-specific effects [48]. These factors should be considered in the design of future clinical trials and in clinical practice [49]. Regarding the control groups, all studies permitted medication intake during the study, but this was not considered a confounding factor; rather, it was treated as a secondary outcome. Consequently, medication use may not be regarded as a true control condition.

The studies by Lynge et al. [45] and Chaibi et al. [40] demonstrated high methodological quality with an uncertain risk of bias, primarily due to the lack of an intention-to-treat analysis and the blinding of participants and examiners. The study by Chaibi et al. [39], despite being classified as having fair methodological quality, presents the major issue of including only four patients per group, the inclusion of such small sample sizes can easily lead to false positives. In the study of Tuchin et al. [46] the randomization process was not clearly described; the allocation was not concealed, the patients and the examiners were not blinded even though the authors affirmed otherwise because there is no explanation about the blinding process, the masking of the placebo technique was not evaluated, and the outcomes were self-registered by patients instead of by blinded examiners. The study presented four dropouts but were not associated to any of both groups and no intent-to-treat analysis was performed. Despite that, two drop-outs occurred because of soreness sensation and due to an increase of migraine after the chiropractic manipulation.

On the other hand, when comparing the current evidence with other non-pharmacological conservative interventions, recent systematic reviews with meta-analyses have shown that certain physical therapy modalities can be effective in managing patients with headaches. Kamonseki et al. [50] found low to moderate quality of evidence suggesting that high-velocity low-amplitude manipulations were not superior to no treatment on improving pain intensity and pain frequency. But found low-quality evidence supporting soft tissue interventions and moderate-quality evidence supporting dry needling for reducing pain intensity and frequency in patients with TTH compared to control interventions. In addition, Bini et al. [51] reported moderate evidence suggesting that manual therapy combined with exercise therapy significantly reduces headache frequency and pain intensity in patients with CH compared to sham and control interventions.

In this way, it is important to note that spinal manipulations are used by osteopaths, physical therapists, and physicians, we included only studies carried out by chiropractors. Our reason was that not all the spinal manipulation techniques are similar or comparable, and the ones used by chiropractors tend to differ from those used by other healthcare professionals provoking the highest numbers of adverse events [12]. Numerous approaches to spinal manipulation have been described in the literature such as high-velocity low-amplitude rotatory or translatoric manipulations, using large-lever or short lever, in open-packed position, mid-range or maximum range of the cervical spine [16,17,29,31–33,52–54]. High-velocity low-amplitude rotatory techniques in mid-range positions and high-velocity low-amplitude translatoric techniques in open-packed positions have been recently studied by physical therapist in different populations with neck disorders and headaches [52–58] because they appear to present less risk than rotatory manipulations following the recommendations of the International Federation of Orthopaedic Manipulative Physical Therapists (IFOMPT) [16]. The studies included referenced high-velocity low-amplitude rotatory techniques, four did not specified the specific technique or position in which the manipulation was performed, two applied chiropractic spinal manipulation based on the Gonstead method and two applied the toggle-recoil technique. So, the risk related to the type of spinal manipulation used is unclear.

Only three studies mentioned adverse effects; they reported only minor events. Five studies ignored adverse events completely. Inadequate reporting of adverse events remains a persistent issue in many clinical studies, highlighting the need to improve the quality of adverse event reporting in non-pharmacological clinical trials. However, it should be taken into consideration that the rate of serious adverse events reported in the literature from cervical manipulation is substantially higher for chiropractors compared to other practitioners [12].

From a clinical perspective, the findings of this systematic review found mixed results. Whilst some benefits were reported, the overall

trend suggested that chiropractic spinal manipulation may be no more effective than alternative, potentially safer interventions for patients suffering from headaches. Although the rate of cervical arterial disorders following any type of cervical manipulations is low (estimated 2.6 to 2.9 per 100.000 [12]), it is not negligible, and the outcome can be catastrophic. Given these risks, best practice recommendations include undertaking a thorough clinical evaluation to identify risk factors for neurovascular pathology and balancing the potential risk against likely clinical benefits from cervical manipulation, which in this case is possibly very low. Patient preferences should also be considered and informed consent obtained before proceeding [16].

This systematic review has several limitations. First, even though our literature searches were thorough, we can never be absolutely sure that no relevant studies have been missed. Second, considerable heterogeneity exists across the included RCTs in terms of diagnosis, treatment duration, and outcome variables. Third, methodological quality and the risk of bias assessments showed many potential biases across all the included studies, which can limit the validity of the results found in our synthesis.

5. Conclusion

The certainty of evidence was downgraded to very low due to concerns with study risk of bias, small sample sizes, wide confidence intervals, and the concomitant use of pharmacological interventions that confounded the assessment of the stand-alone effects of chiropractic manipulation. Further research that addresses these concerns is required to resolve the uncertainty in the evidence.

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Declaration of generative AI and AI-assisted technologies in the writing process

Nothing to disclose.

CRediT authorship contribution statement

Luis Ceballos-Laita: Methodology, Formal analysis, Data curation, Conceptualization. **Edzard Ernst:** Writing – original draft, Visualization, Validation, Supervision, Methodology, Conceptualization. **Andoni Carrasco-Uribarren:** Writing – original draft, Supervision, Software, Methodology, Conceptualization. **Daniel García-García:** Writing – original draft, Supervision, Methodology. **Sandra Jiménez-del-Barrio:** Writing – original draft, Validation, Supervision, Methodology, Investigation, Conceptualization.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:

The authors Luis Ceballos-Laita, Andoni Carrasco-Uribarren, Sandra Jiménez-del-Barrio, and Daniel García-García are physiotherapists dedicated to teaching and clinical practice focused on manual therapy and therapeutic exercise. Dr. Ernst is a physician and researcher specializing in the study of complementary and alternative medicine who has published books and given lectures on these topics, including chiropractic.

Data availability

Not applicable. All data are presented in the manuscript.

Appendix A. Search strategy used in each database

PUBMED

(chiropractic [Mesh] OR manipulation, chiropractic [Mesh] OR "spinal manipulation" OR "high velocity low amplitude" OR "chiropractic manipulation" OR "chiropractic treatment" OR "chiropractic care" OR chiro* OR "toggle-recoil" OR gonstead) AND (headache [Mesh] "Headache Disorders, Secondary"[Mesh] AND "Headache Disorders, Primary"[Mesh] AND "Headache Disorders"[Mesh] OR headache OR cervicogenic headache OR tension-type headache OR migraine)

Date: 24/04/2024

Retrieved: 628

PEDro chiropractic AND headache

Date: 24/04/2024

Retrieved: 19

Chiropractic AND migraine

Date: 24/04/2024

Retrieved: 6

Chiropractic AND tension-type headache

Date: 24/04/2024

Retrieved: 6

Chiropractic AND cervicogenic headache

Date: 24/04/2024

Retrieved: 4

Chiropractic AND primary headache

Date: 24/04/2024

Retrieved: 6

Chiropractic AND secondary headache

Date: 24/04/2024

Retrieved: 2

Cochrane library

(chiropractic OR "spinal manipulation" OR "high velocity low amplitude" OR "chiropractic manipulation" OR "chiropractic treatment" OR "chiropractic care" OR chiro* OR "toggle-recoil" OR gonstead) AND (headache OR "Headache Disorders, Secondary" AND "Headache Disorders, Primary" AND "Headache Disorders" OR cervicogenic headache OR tension-type headache OR migraine)

Date: 24/04/2024

Retrieved 169

Web of Science

(chiropractic OR "spinal manipulation" OR "high velocity low amplitude" OR "chiropractic manipulation" OR "chiropractic treatment" OR "chiropractic care" OR chiro* OR "toggle-recoil" OR gonstead) AND (headache OR "Headache Disorders, Secondary" AND "Headache Disorders, Primary" AND "Headache Disorders" OR cervicogenic headache OR tension-type headache OR migraine)

Date: 24/04/2024

Retrieved: 817

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