Heliyon 10 (2024) e32075

Contents lists available at ScienceDirect

Heliyon

journal homepage: www.cell.com/heliyon

Research article

Efficacy of acupuncture on craniomandibular myofascial pain in temporomandibular disorder patients: A systematic review

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ARTICLE INFO

Keywords:
Temporomandibular disorders
Myofascial pain
Acupuncture
Systematic review

ABSTRACT

Background: This systematic review aimed to answer the question, "What is the efficacy of acupuncture treatment in patients with temporomandibular disorder (TMD) with myofascial pain?".
Data, sources, and study selection: This study followed PRISMA guidelines and was registered in PROSPERO. The electronic search strategy was applied to the Scopus, PubMed, Embase, and Science Direct databases. As inclusion criteria, were selected randomized clinical articles that evaluated patients with myofascial pain symptoms treated by acupuncture without the restriction of time and language.
Results: The search in the databases resulted in 286 articles, after removing the duplicates 251 were analyzed by title and abstract. Twenty were selected for full reading and 10 were included in the systematic review. The studies evaluated acupuncture treatments by puncture and laser, auriculotherapy by puncture and laser, and an occlusal device for treating myofascial TMD.
Conclusions: Comparing acupuncture with placebo acupuncture, it was observed that it is effective for subjective pain relief and palpation of orofacial structures with immediate results; it should be noted that there is still no specific protocol and that the duration of treatment must be personalized. When comparing it with the occlusal device, the associated treatment has enhanced the results. Future studies are suggested by the current literature gap that prevents the determination of clinical guidelines for effective acupuncture treatment in TMD patients with myofascial pain.
Practical implications: Laser and needle puncture acupuncture treatment and laser and needle puncture auriculotherapy have shown favorable results in short-term myofascial pain relief. The need for long-term studies to assess benefits and reduce possible biases is highlighted.
Clinical trial registry name: PROSPERO (CRD42021271505).

1. Introduction

Myofascial pain is a temporomandibular disorder (TMD) pathology that mainly affects the masseter muscle, characterized by pain, muscle spasms due to trigger points, sensitivity, limited joint movement, and muscle fatigue [1–3]. TMD etiology is multifactorial and may be related to occlusal disharmony, parafunctional habits, postural changes, orofacial trauma, psychological stress, and hormonal

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https://doi.org/10.1016/j.heliyon.2024.e32075
Received 25 January 2024; Received in revised form 11 May 2024; Accepted 28 May 2024
Available online 31 May 2024

changes [4–11]. These cause muscle fatigue in the temporomandibular region, headache, disturbances in mandibular movement, and joint sounds during the mouth's opening, closing, protrusion, retrusion, and laterality movements [7,9,12–14]. Overuse of the joint or adverse loading on it can cause degeneration or dysfunction of the temporomandibular joint (TMJ) and fatigue of the jaw muscles with consequent pain that can radiate to different regions, such as ears, temples, forehead, dental arches, occipital and cervical regions, being more pronounced in the neck [15,16]. With increased muscle tension and a decrease in local pH, muscles are injured due to decreased blood flow and oxygen level, with the consequent release of inflammatory mediators that result in local sensitivity, referred pain, stiffness, and limitation of the muscle movement [17–19].

25 %–33 % of the population may have some TMD-related symptoms. However, a small percentage seeks treatment [20,21]. TMD symptoms are reported with higher incidences in females [22–24]. The reasons behind gender are still unclear, but doctors suggest a hormonal influence [22–24].

The treatment of TMDs has several therapeutic approaches, including occlusal devices, occlusal adjustment, medications, jaw exercises, and complementary therapies such as acupuncture, auriculotherapy, and laser [7,25–28]. Myofascial pain is the most common symptomatology of the muscular temporomandibular disorder, and complementary therapies, such as acupuncture by laser and needle puncture acupuncture, and, laser and needle puncture auriculotherapy are used for the treatment [5,29,30]. The acupuncture treatment is the target of studies because it blocks painful stimuli [5,29,30].

Acupuncture is an efficient therapeutic method of Traditional Chinese Medicine for treating myofascial pain because it promotes muscle relaxation and restoring vascular nutrition [4,29–31]. Acupuncture stimulates a wide spectrum of nerve fibers promoting analgesia and muscle relaxation [14,30]. Although side effects are rare, they can occur, such as hematoma, hemorrhage, ecchymosis, fatigue, pain, local paresthesia, sweating, and dizziness [24,29,30,32–35].

The literature presents a possibility for the integrative therapy acupuncture treatment of myofascial pain and has shown favorable results. However, there is still a gap as to which treatment protocol, technique and duration is best for relieving myofascial pain in patients with muscular temporomandibular disorder. Therefore, this systematic review aimed to evaluate all randomized clinical studies that applied acupuncture treatment, without the use of medication, to avoid bias, regardless of the comparison group, placebo acupuncture, or occlusal device, to clarify the literature gap and answer the question "What is the efficacy of acupuncture treatment in patients with temporomandibular disorder (TMD) with myofascial pain?".

2. Material and methods

2.1. PICOS strategy

This systematic review followed PRISMA [36] guidelines and was registered in PROSPERO (CRD42021271505). The PubMed, Scopus, Science Direct, and Embase databases were searched on September 22nd, 2020, with no time restriction, with terms customized according to the search question (A. 1). The question was structured according to PICO P = adults with TMD myofascial pain, I = acupuncture treatment, C = patients without acupuncture treatment (control group), O = data on the efficacy of acupuncture treatment in adults with TMD myofascial pain collected from randomized experimental clinical trials.

2.2. Inclusion and exclusion criteria

As inclusion criteria, randomized clinical articles that evaluated acupuncture treatment for cases of myofascial pain were selected. And as exclusion criteria: a) lack of essential information (not specify the standard stomatognathic treatment), b) use of medication (analgesic, anti-inflammatory, or anesthesia), c) non-application of therapy in acupuncture points, d) another type of TMD, e) book chapter, conference, systematic review, observational studies, or a case report.

2.3. Selection process

The selection process was conducted in two stages. In the first, two reviewers read the title and abstract of the articles found in the databases, according to the inclusion and exclusion criteria, they selected the articles to be read in full in the second phase. Doubts and discrepancies were resolved with the third reviewer and the coordinator.

The risk of bias in the studies was assessed by Rob II [37] independently by two reviewers.

2.4. Data tabulation

The first and second reviewers independently tabulated the data in an Excel spreadsheet (Tables 1–4).

3. Results

3.1. Selection process result

Fig. 1 shows the selection process, and A.2 the excluded articles.

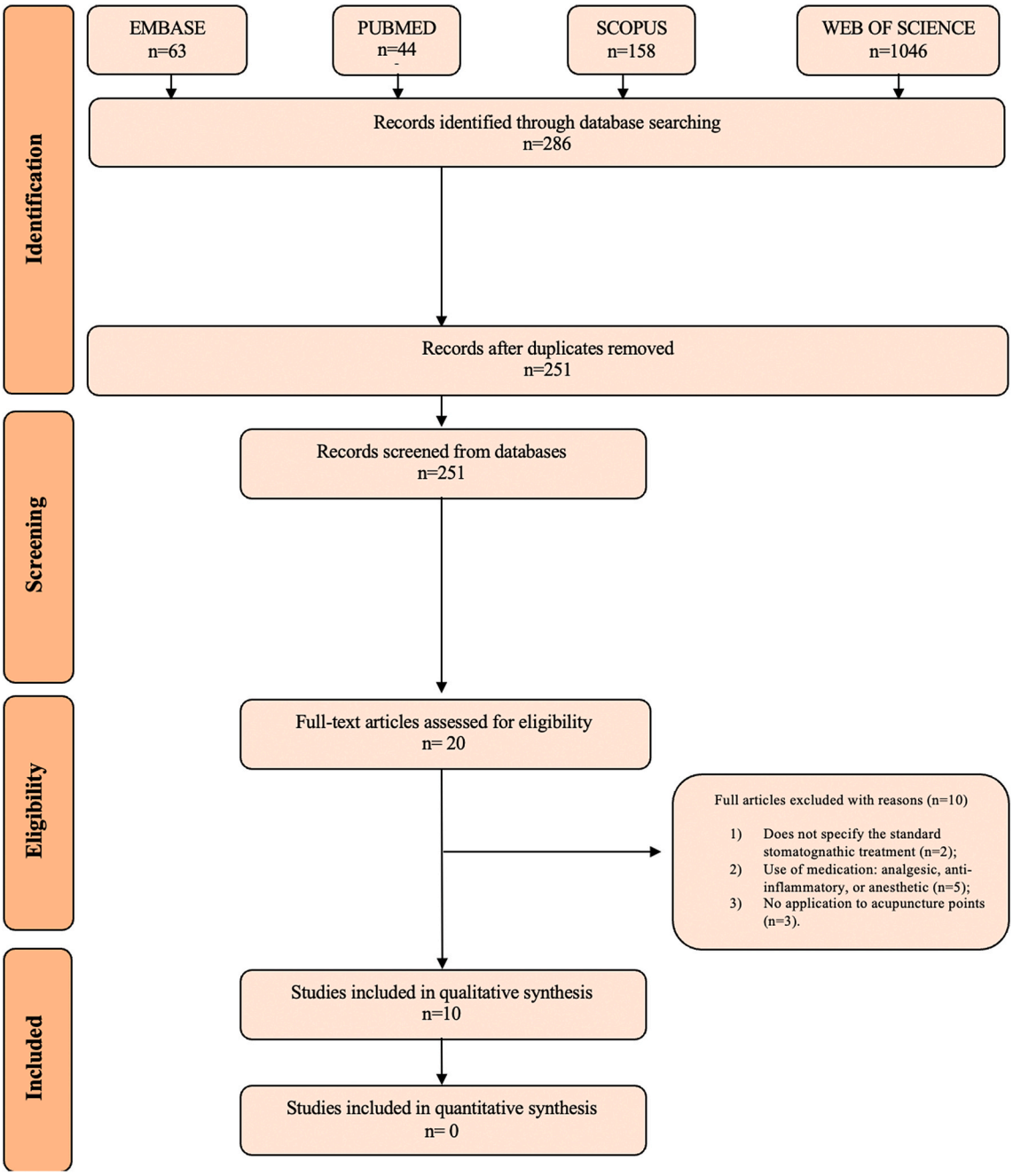

Fig. 1. Flow diagram of article selection.

3.2. Qualitative analysis

The 10 included studies were divided into two groups according to control, active and placebo.

A) Acupuncture X Control (Active)

Although in Table 1 occlusal device is classified as an active control group, it can not be considered a realistic control/placebo group for acupuncture treatments, and it is not consistent with the review's objective, which is to evaluate the effectiveness of acupuncture treatment in patients with TMD who have myofascial pain. But, the 4 [2,4,26,30] studies that compared acupuncture with the occlusal device were included in this systematic review because the occlusal device is the treatment most indicated by dentists to promote disocclusion and consequent muscle relaxation in patients with myofascial pain. So the comparison with occlusal devices is

Table 1
Simplified table of studies that compared acupuncture treatment with an active control group.

Author, year	Experimental group	Control Group	Result
Barrero et al., 2012	Needle puncture acupuncture	Occlusal device	Both groups promoted improvements in pain relief on palpation in orofacial areas. Greater relief was provided in the experimental group. How much the pain improved on the VAS scale was not reported.
Ferreira et al., 2013	Occlusal device and laser acupuncture.	Occlusal device and placebo laser acupuncture.	Both groups promoted significant improvements in subjective pain relief and palpation in orofacial areas. Greater relief (10-7) was provided in the experimental group according to VAS.
Ferreira et al., 2015	Occlusal device and needle puncture auricular acupuncture.	Occlusal device	Both groups showed significant improvements in pain relief on palpation in orofacial areas. Greater relief (9-6) was provided in the experimental group according to VAS.
Rodrigues et al., 2019	Auricular laser acupuncture.	Occlusal device	Both groups promoted improvements in pain relief on palpation in orofacial areas, how much pain improved on the VAS scale was not reported, and on mouth opening, but they were similar. The control group promoted greater increase in mouth opening (1.46 mm).

Table 2
Table of characteristics of studies that compared acupuncture treatment with an active control group.

Author, year	Population (Age, Sex, and Geographic location)	Signs and Symptoms	Intervention	Comparison	Outcome
Barrero et al., 2012	20 patients females and males between 18 and 58 years. Department of Stomatology and Oral and Maxillofacial Surgery of the Hospital Insular de Gran Canaria, Spain.	Pain on palpation of the TMJ or muscles of mastication; restriction or deviation of mandibular movement; headache; or joint noise were present for at least 3 months.	**Treatment protocol:** needle puncture acupuncture; **Acupoints:** **Local:** EX-HN5, SJ 21, GB 2, SJ 17, ST 6. **Distal:** LI 4, ST 36, SJ5, and GB34. **Frequency and duration:** 15 sessions of 30 min for 5 weeks.;	**Treatment protocol:** decompression splints; **Characteristics splint:** Stable occlusion with a maximum number of contacts, Canine guidance, Absence of contacts on the nonworking side. **Frequency and duration:** Only overnight for 5 weeks.	**Assessment method:** Sensitivity to pressure on areas: preauricular, masseter, temporal, and trapezius muscles by algometer by VAS. **Follow-up:** no. **Palpation pain before treatment:** NS. **Palpation pain after treatment:** NS. Patients treated with acupuncture showed a significant reduction in pain on muscle palpation before and after treatment ($P < 0.05$) in the short term. Different from patients treated with decompression splints who showed subjective improvement without statistical significance.
Ferreira et al., 2013	40 patients females between 20 and 40 years. Diagnostic and Guidance Center for Patients with Temporomandibular Disorders of the Federal University of Juiz de Fora, Brazil.	Myofascial pain and arthralgia were present for at least 6 months.	**Treatment protocol:** reversible occlusal splint and laser acupuncture; **Characteristics splint:** NS. **Acupoints:** **Local:** EX-HN3, SI 19, ST 6, GB 20. **Distal:** TE 3, LI 4, LR 3, GB 34. **Laser intensity:** wavelength of 780 nm and 50 mW. **Frequency and duration:** 12 sessions of 90 s at each point and OD at night for 12 weeks.	**Treatment protocol:** reversible occlusal splint and laser placebo; **Characteristics splint:** NS. **Acupoints:** **Local:** EX-HN3, SI 19, ST 6, GB 20. **Distal:** TE 3, LI 4, LR 3, GB 34. **Laser intensity:** no radiation. **Frequency and duration:** 12 sessions of 90 s at each point and OD at night for 12 weeks.	**Assessment method:** Pain intensity and pain on palpation on areas: temporal, masseter, stylohyoid and posterior digastric; medial pterygoid, suprahyoid, and anterior digastric; lateral pole of the mandibular condyle; posterior attachment of the TMJ; lateral pterygoid; and tendon of temporalis by VAS (0-10); **Follow-up:** no. **Subjective pain and palpation pain before treatment:** CG and EG: 7–10 VAS. **Subjective pain and palpation pain after treatment:** CG: 1–4 VAS, EG: 0 VAS. There was a reduction in both groups ($P < 0.001$). LA and OD treatment promoted pain remission attributed to the effects of acupuncture.

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Table 2 (*continued*)

Author, year	Population (Age, Sex, and Geographic location)	Signs and Symptoms	Intervention	Comparison	Outcome
Ferreira et al., 2015	20 patients females between 18 and 56 years. School of Dentistry of the Federal University of Juiz de Fora, Brazil.	Pain in at least four orofacial structures and/or eccentric bruxism for at least 6 months.	**Treatment protocol:** occlusal splint and needle puncture auricular acupuncture; **Characteristics splint:** just informed that it was acrylic. **Auricular acupoints:** Shen Men, Mouth, Kidney, Liver, Spleen; Maxillary and Jaw regions; and San Jiao. **Frequency and duration:** 5 sessions one per week for 50 min and OD at night for 5 weeks.	**Treatment protocol:** occlusal splint; **Characteristics splint:** just informed that it was acrylic. **Frequency and duration:** at night for 5 weeks.	**Assessment method:** Pain intensity after palpation (2.0 kg force in muscle and 1.5 kg in joint) on orofacial areas: medial and lateral pterygoid, masseter, and temporal muscles; and retrodiscal and lateral pole of the condyle joint; by VAS (0-10). **Follow-up:** no. **Palpation pain before treatment:** CG: 8-4 VAS and EG: 9-4 VAS. **Palpation pain after treatment:** CG: 6-1 VAS, EG: 3-0 VAS Pain reduced in both groups ($P < 0.05$). The AA and OD treatment promoted greater pain reduction in a shorter time.
Rodrigues et al., 2019	**20 patients females ≥18 years. Western State University of Paraná, Brazil.**	**TMD with myofascial pain**	Treatment protocol: **auricular laser acupuncture;** Auricular acupoints: **Shen Men (1-C), TMJ (43-E), heart (60-CL).** Laser intensity: **wavelength of 904 nm and 50 mW.** Frequency and duration: **8 sessions one per week for 24s each point.**	Treatment protocol: **occlusal splint;** Characteristics splint: **just informed that it was adjusted after 48 h and 7 days.** Frequency and duration: **8 h daily (overnight) for 8 weeks.**	Assessment method: **Pain intensity after palpation (dynamometer) on orofacial areas: masseter, temporal, style hyoid, digastric, medial pterygoid, and suprahyoid; palpation manually lateral pterygoid and temporal tendon; and articular region (lateral pole of jaw and posterior ligament); by VAS. And vertical extension of the jaw by unassisted oral opening without pain, assisted mouth opening without pain, and assisted mouth opening with pain.** Follow-up: **no.** Palpation pain before treatment: **CG and EG: NS.** Palpation pain after treatment: **CG and EG: NS.** Mouth opening before treatment: **CG: 47.54 ± 8.59 and EG: 47.70 ± 6.60.** Mouth opening after treatment: **CG: 49.00 ± 6.93 and EG: 48.10 ± 3.90.** **Both groups showed improvements, with no differences between them. The parameters that showed significant improvements in pain were for CG (right temporal, right and left masseter, left joint, and left intraoral) and EG (left masseter, right and left joint, and right and left intraoral). And improves mouth opening.**

AA, auricular acupuncture; CG, control group; EG, experimental group; LA, laser acupuncture; NS, not specified; OD, occlusal device; VAS, visual analogue pain scale.

justified for the need to provide an overview of treatments that have already been compared to acupuncture in the literature.

Table 1 shows the studies that compared acupuncture with an active control group. It demonstrates that the investigations by Barrero et al., 2012 [2], Ferreira et al., 2013 [4], Ferreira et al., 2015 [30], and Rodrigues et al., 2019 [26] were heterogeneous regarding the treatments applied in the experimental and control groups.

The parameters evaluated by the studies were improvement in pain on palpation of orofacial areas [2,26,30], subjective pain and palpation of orofacial areas [4], and improvement in mouth opening [26]. However, the last parameter does not assess myofascial pain, it is reported because it is directly affected by myofascial pain improvement. Although it is essential to note the improvement size of these evaluated parameters to verify how much the proposed treatments promoted progress, it can be seen from Tables 1 and 2 that only the studies by Ferreira et al., 2013 [4] and Ferreira et al., 2015 [30] reported them according to the VAS scale for pain relief on palpation of orofacial areas and Rodrigues et al., 2019 [26] reported quantitative data of mouth opening improving.

B) Acupuncture x Control (placebo).

Table 3 shows the studies that compared acupuncture with a placebo control group. And it demonstrates that the investigations by Kletschaka et al., 2010 [38], Schmid-Schawap et al., 2006 [39], and Simma et al., 2009 [40] compared needle puncture acupuncture with placebo laser acupuncture; Sales-Neto et al., 2020 [29] and Smith et al., 2007 [5] compared needle puncture acupuncture and placebo needle puncture acupuncture; and Madani et al., 2020 [41] compared laser acupuncture in two ways with placebo laser acupuncture.

The parameters evaluated by the studies were improvement in pain on palpation of orofacial areas [40,41], improvement in mouth opening [5,38,39,41], and mandibular function [29]. The improvement size of these evaluated parameters is shown in Tables 3 and 4.

3.3. Risk of bias analysis

The risk of bias analyzed Rob II resulted in seven studies with a low risk of bias [4,5,29,30,40,41,39], one with a moderate risk of bias [38], and two with a high risk of bias [2,26] (Fig. 2).

The increased risk of bias in Simma-Kletschka et al., 2010 [38] was due to domain one not informing if the randomization sequence was random and if the allocation was hidden until the participants were selected and assigned to the respective interventions, and attributed to domain five because the article did not demonstrate whether the data were analyzed according to some predetermined plan before the results were available.

The study by Barrero et al., 2012 [2] had its classification of high risk of bias due to domain two, as it did not inform whether the interventions were balanced between the experimental groups since it needed to be made clear whether all patients adhered to the intervention, and attributed to domain five because the article did not demonstrate whether the data were analyzed according to some predetermined plan before the results were available.

Although Ferreira et al., 2015 [30] study was classified as low risk, domain five was classified with some concerns because it needs to demonstrate whether the data that produced the results were analyzed according to the predetermined planning before the results were available.

Rodrigues et al., 2019 [26] study was classified as a high risk of bias because, in domain two, the non-protocol interventions were not balanced between the intervention groups, in domain four because the treatments differed, so the methods of measure too, and in domain five since was not demonstrated whether the data were analyzed according to some predetermined plan before the results were available.

Table 3
Simplified table of studies that compared acupuncture treatment with a placebo control group.

Author, year	Experimental group	Control Group	Result
Kletschaka et al., 2010	Needle puncture acupuncture	Placebo laser acupuncture	Both groups promoted improvements in subjective pain relief. Greater relief was provided in the experimental group (19.1 ± 11.9). And slight improvement in mouth opening without significance when compared to the control group.
Schmid-Schawap et al., 2006	Needle puncture acupuncture	Placebo laser acupuncture	Both groups promoted improvements in subjective pain relief. Greater relief was provided in the experimental group (19.1 ± 11.9). And slight improvement in mouth opening without significance when compared to the control group.
Simma et al., 2009	Needle puncture acupuncture	Placebo laser acupuncture	Both groups promoted improvements in subjective pain relief and palpation. Greater subjective pain relief (≅ 24) and palpation (≅ 14.5) for the experimental group.
Sales-Neto et al., 2020	Needle puncture acupuncture	Placebo needle puncture acupuncture	Both groups promoted improvements in subjective pain relief and mouth opening. Greater subjective pain relief (≅ 5.5) and mouth opening (≅ 5) for the experimental group.
Smith et al., 2007	Needle puncture acupuncture	Placebo needle puncture acupuncture	Puncture acupuncture treatment promoted significant improvements before and after treatment. With relief for subjective pain (3.31) and increased mouth opening (3.2).
Madani et al., 2020	Laser acupuncture in two ways.	Placebo laser acupuncture	Both groups showed improvements in pain on palpation and mouth opening. Greater pain relief on muscle palpation (5.1) and mouth opening (≅ 7) for experimental group 1.

Table 4
Table of characteristics of studies comparing acupuncture treatment with a placebo control group.

Author, year	Population (Age, Sex, and Geographic location)	Signs and Symptoms	Intervention	Comparison	Outcome
Kletschaka et al., 2010	23 patients females between 18 and 65 years. Vienna University Dental Clinic, Austria.	Craniomandibular pains	**Treatment protocol:** needle puncture acupuncture; **Acupoints**: **Local:** Maxilla and Mandible retromolar and vestibulars; **Distal:** LI 4 and SI 3; ear and sternum. **Frequency and duration:** 1 session of 20 min.	**Treatment protocol:** placebo laser acupuncture; **Acupoints**: **Local:** Maxilla and Mandible retromolar and vestibulars; **Distal:** LI 4 and SI 3; ear and sternum. **Laser intensity:** no radiation. **Frequency and duration:** 15s each point for 20 min.	**Assessment method:** Subjective Pain by VAS (0–100) and mouth opening in mm. **Follow-up:** no. **Subjective pain before treatment:** CG: 34,1 ± 22,7 and EG: 44,0 ± 23,3. **Subjective pain after treatment:** CG: 27,8 ± 16,2 and EG: 24,9 ± 22,2. **Mouth opening before treatment:** CG and EG: NS. **Mouth opening after treatment:** CG and EG: NS. Puncture acupuncture treatment promoted immediate significant improvement in subjective pain (P = 0.03) with relief of (19.1 ± 11.9) and slight improvement in mouth opening without significance when compared to sham laser acupuncture.
Schmid-Schawap et al., 2006	23 female patients 17 and 68 years. Unit for Dysfunction at the University Clinic of Dentistry, Austria.	TMJ pain and tenderness on pressure of the craniomandibular musculature.	**Treatment protocol:** needle puncture acupuncture; **Acupoints**: **Local:** Maxilla and Mandible retromolar and vestibulars; **Distal:** LI 4, SI 2, SI3, ear and sternum. **Frequency and duration:** 1 session of 20 min.	**Treatment protocol:** placebo laser acupuncture; **Acupoints**: **Local:** Maxilla and Mandible retromolar. **Distal:** SI 2, SI 3, and ear. **Laser intensity:** no radiation. **Frequency and duration:** 15s each point for 20 min.	**Assessment method:** subjective pain by VAS (0–100); mouth opening in mm. **Follow-up:** no. **Subjective pain before treatment:** CG: 34.1 ± 22.7 and EG: 44.0 ± 23.3. **Subjective pain after treatment:** CG: 27.8 ± 16.2 and EG: 24.9 ± 22.2. **Mouth opening before treatment:** CG: 36.2 ± 11.7 and EG: 40.4 ± 9.6. **Mouth opening after treatment:** CG: 37.2 ± 12.1 and EG: 45.4 ± 7.6. Puncture acupuncture treatment promoted immediate significant improvement in subjective pain (P = 0.03) with relief of 19.1 ± 11.9 and slight improvement in mouth opening when compared to sham laser acupuncture.
Simma et al., 2009	23 female patinets between 18 and 64 years. Department of Prosthetic Dentistry of the Medical University of Vienna, Austria.	Dysfunction and pain in the stomatognatic system not attributable to a known underlying disease or disorder.	**Treatment protocol:** needle puncture acupuncture; **Acupoints**: **Local:** Maxilla and Mandible retromolar and vestibulums. **Distal:** LI 4, SI 2, SI3, ear, sternum, adler large points and others. **Frequency and duration:** 1 session of unspecified duration.	**Treatment protocol:** placebo laser acupuncture; **Acupoints**: **Local:** Maxilla and Mandible retromolar and vestibulums. **Distal:** LI 4, SI 2, SI3, ear, sternum, adler large points and others. **Laser intensity:** no radiation. **Frequency and duration:** 1 session and each point for 2 min.	**Assessment method:** Subjective pain by VAS; Pain intensity after palpation on orofacial areas: atlanto-occipital junction and muscles: temporal (anterior, mediali, and posterior), cranio-mandibular junction, pterygoid, masseter, digastricus, and sternocleidomastoideus by sum of pain ratings (0–3). **Follow-up:** no. **Subjective pain before treatment:** CG: 41,0 (34,0) and EG: 40,5 (34,0). **Subjective pain after treatment:** CG: 30,0 (28,5) and EG: 16,5 (33,0). **Palpation pain before treatment:** CG: 19.0

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Table 4 (*continued*)

Author, year	Population (Age, Sex, and Geographic location)	Signs and Symptoms	Intervention	Comparison	Outcome
					(15.0) and EG: 22.5 (7.8). **Palpation pain after treatment:** CG: 16.0 (20.0) and EG: 8.0 (10.0). Treatment with immediate needle acupuncture was shown to significantly reduce subjective pain ($P = 0.031$) and muscle pain ($P < 0.001$) when compared to sham laser.
Sales-Neto et al., 2020	32 Female patients between 18 and 60 years. Orofacial Pain Service of the Clinics Hospital of UFMG in Belo Horizonte, Brazil	Masticatory myofascial pain and pain intensity ≥4 VAS for at least three months.	**Treatment protocol:** needle puncture acupuncture; **Acupoints**: large intestine 4 (Hegu), gall bladder 34 (Yanglingquan), stomach 36 (Zusanli), small intestine 18 (Quanliao), small intestine 19 (Tinggong), stomach 6 (Jiache), stomach 7 (Xiaguam), gall bladder 20 (Fengchi). **Frequency and duration:** 5 sessions one per week for 20 min.	**Treatment protocol:** placebo needle puncture acupuncture; **Acupoints**: large intestine 4 (Hegu), gall bladder 34 (Yanglingquan), stomach 36 (Zusanli), small intestine 18 (Quanliao), small intestine 19 (Tinggong), stomach 6 (Jiache), stomach 7 (Xiaguam), gall bladder 20 (Fengchi). **Frequency and duration:** 5 sessions one per week for 20 min.	**Assessment method:** Subjective pain by VAS (0-10) and mandibular function by MOPDS. **Follow-up:** no. **Subjective pain before treatment:** CG: 5 (0–10) and EG: 6.5 (3–10). **Subjective pain after treatment:** CG: 3.5 (0–6) and EG: 1(0–9). **Mandibular function before treatment:** CG: 11.9 (9.2) and EG: 12.9 (7.8). **Mandibular function after treatment:** CG: 8.9 (7.9) and EG: 8 (6.1). Both groups showed improvements for subjective pain and jaw function, without statistical significance when comparing them. Being higher for EG with subjective pain relief (≅5.5) and mandibular function (≅5).
Smith et al., 2007	27 patients females and males between 40,5 (13,63) years. TMD Clinic, at the School of Dentistry, The University of Manchester, United Kingdom.	Pain on palpation of the associated muscles; limitation or deviation of mandibular movement; intermittent joint sounds such clicking or cracking (but not crepitus); headache; were present for at least 6 months.	**Treatment protocol:** needle puncture acupuncture; **Acupoints**: ST7. **Frequency and duration:** 3 sessions one per week for 20 min.	**Treatment protocol:** placebo needle puncture acupuncture; **Acupoints**: ST7. **Frequency and duration:** 3 sessions one per week for 20 min.	**Assessment method:** Subjective pain by VAS (0-10); and maximum mouth opening in mm by Vernier style bite gauge. **Follow-up:** no. **Subjective pain before treatment:** CG: 1.41 and EG: 6.21. **Subjective pain after treatment:** CG: 1.33 and EG: 2.89. **Maximum mouth opening before treatment:** CG: 40.75 and EG: 36.06. **Maximum mouth opening after treatment:** CG: 39.25 and EG: 39.26. Both groups promoted improvements in Subjective pain with greater relief for EG (3.31). And there was an improvement in mouth opening (3.2) for EG.
Madani et al., 2020	**45 patients females and males between 15 and 71 years. Occlusion and TMD Department of Mashhad Dental School, Mashhad University of Medical Sciences, Iran.**	**Limited mouth opening or function and the presence of pain in masticatory muscles and/or TMJs, either in clenching or in jaw movements**	Treatment protocol: **laser acupuncture;** **G1: LLLT** Points: **posterior and superior of the mandibular condyles, Inside the external acoustic meatus, and on tender muscle points.**	Treatment protocol: **laser acupuncture;** Points: **posterior and superior of the mandibular condyles, Inside the external acoustic meatus, and on tender muscle points.** Laser intensity: **off.**	Assessment method: **Pain intensity after palpation (1.0 kg force in external muscle and 0.5 kg in intra-oral muscle) on orofacial areas: masseter, tendon of temporal, insertion of internal pterygoid and TMJ by VAS (0–10); and maximum mouth opening by digital caliper in mm;**

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Table 4 (*continued*)

Author, year	Population (Age, Sex, and Geographic location)	Signs and Symptoms	Intervention	Comparison	Outcome
			Laser intensity: **wavelength of 810 nm and 200 mW.** Frequency and duration: **2 times a week for 10 weeks for 30s each point.** **G2: LAT** Acupoints: **ST6, ST7, and LI4.** Laser intensity: **wavelength of 810 nm and 200 mW.** Frequency and duration: **2 times a week for 10 weeks for 30s each point.**	Frequency and duration: **2 times a week for 10 weeks for 30s each point.**	Follow-up: **one month.** Palpation pain before treatment: **CG, G1 and G2: 6,1 a 6,5 VAS.** Palpation pain after treatment: **CG: 5,06, G1: 1,40, and G2: 1,77.** Mouth opening before treatment**: CG: 33.1 ± 12,80, G1: 34.6 ± 9.78, and G2: 39.2 ± 7.18.** Mouth opening after treatment: **CG: 38.6 ± 7.72, G1: 41.57 ± 8.21, and G2: 40.82 ± 8.97.** **For pain on palpation, there were significant improvements in the 3 groups among them, with the greatest relief being for G1 (5.1) and it continued to be significant after one month of the last application. For mouth opening there were improvements, but not significant among them, being the greatest for G1 (≅7).**

CG, control group; EG, experimental group; LA, laser acupuncture; LAT, laser acupuncture therapy; LLLT, low-level laser therapy; MOPDS, Manchester Orofacial Pain Disability Scale; NS, not specified; OD, occlusal device; TMJ, temporomandibular joint; VAS, visual analogue pain scale.

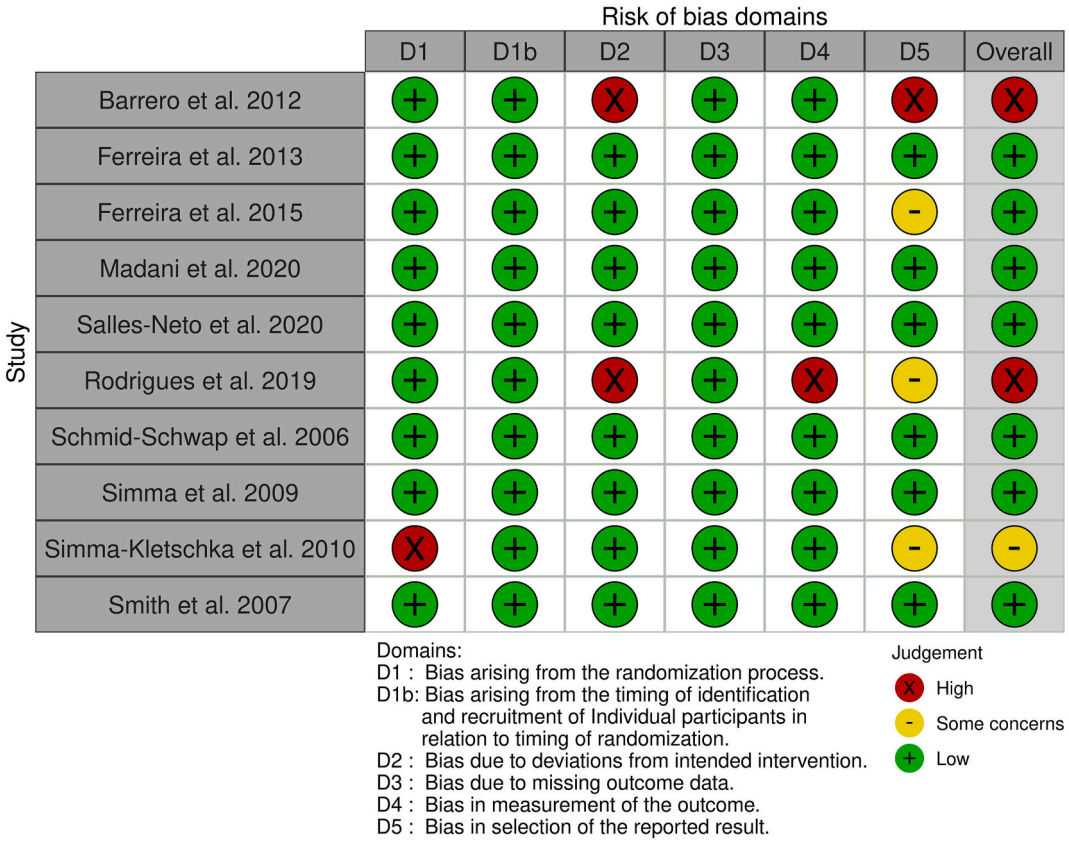

Fig. 2. Analysis of risk of bias by Rob 2.

4. Discussion

Acupuncture has been used to relieve painful symptoms for over 2000 years [40]; with the scientific development of the study of pain, this therapy is expected to be indicated for the relief and treatment of patients suffering from myofascial pain. For muscle TMD, inconclusive evidence of acupuncture treatment motivated this systematic review to carefully evaluate the randomized clinical studies in the literature that reported its effectiveness in relieving myofascial pain. After a systematic methodology to answer "What is the efficacy of acupuncture treatment in patients with temporomandibular disorder (TMD) with myofascial pain?" it was found that ten studies were included in this review and evaluated the treatments of acupuncture by puncture and laser, auriculotherapy by puncture and laser, and an occlusal device for treating muscle TMD. The heterogeneity of the methodology and consequent results made possible a discussion on topics 1) Acupuncture x active control group; 2) Acupuncture x placebo control group; 3) Acupuncture points; 4) Duration of treatment; and 5) Final considerations.

1) Acupuncture x active control group

Muscle TMD derives from causal factors arising from dysfunctions of the stomatognathic system, which, depending on the diagnosis, can be treated with occlusal devices to control parafunction and TMD [2,4,26,30]. Occlusal device induces reduction of muscle hyperactivity, protection of tooth structure, relief of muscle pain, replacement of the condyle in a stable position, and redistribution of occlusal force [2,4,26,30].

Although occlusal devices are widely used to treat muscular TMD, this is multifactorial. The effectiveness of its treatment depends on a multi-professional approach that includes neurophysiological, pharmacological, and psycho-emotional knowledge for the relief of pain and discomfort of patients, which makes integrative therapies, such as acupuncture, a complementary treatment option as demonstrated in the studies by Barrero et al., 2012 [2], Ferreira et al., 2013 [4], Ferreira et al., 2015 [30], and Rodrigues et al., 2019 [26] that evaluated improvements in isolated treatment [2,26] or associated with acupuncture [4,30], for pain relief on palpation of orofacial areas [2,4,26,30] and mouth opening [26].

For pain on palpation of orofacial areas, Tables 1 and 2 show that treatment with acupuncture associated with the occlusal device reduced pain in a shorter time according to Ferreira et al., 2013 [4] and Ferreira et al., 2015 [30] which the treatments were applied alone, for Barrero et al., 2012 [2] acupuncture treatment showed more significant pain reduction, and for Rodrigues et al., 2019 [26] no differences. Thus, the results found in this review infer that despite the heterogeneity of studies, the association of occlusal devices

with acupuncture **is** beneficial due to its synergistic and potentiating action in reducing pain.

Parafunctional habits such as bruxism and occlusal discrepancies are also important predisposing factors for TMD. The authors of the articles included in this review present different acupuncture treatment protocols to improve pain when these are present. Regarding the effectiveness of treating myofascial pain, Barrero et al., 2012 [2] demonstrated significant improvement in pain on palpation of orofacial areas only when treated with needle puncture acupuncture (Tables 1 and 2), the authors of this review reinforce that when the etiological conditions of TMD are not controlled, such as cases of parafunction, bruxism, occlusal devices should not be dispensed, corroborating with Ferreira et al., 2013 [4].

For mouth opening, acupuncture results were not as promising when compared to the occlusal device [26], possibly attributed to the reduction of muscle hyperactivity by this device by repositioning the condyle and improving the distribution of occlusal forces, unlike auriculotherapy, which only blocks the pain stimulus by releasing opioids endogenous.

Having highlighted the myofascial effects of pain reduction obtained by acupuncture through the release of endogenous opioids, it is important to highlight that symptoms that improve the quality of life of patients, such as improved mouth opening, were only achieved by the use of the occlusal device, which allows us to infer that the use combination of therapies is the best indication, according to what was observed in the article by Rodrigues et al., 2019 [26].

The characteristics of the occlusal devices can be seen in Table 2, which can interfere with the patient's occlusion and central nervous system (CNS) response. As for the type of occlusal device, the most used vary in manufacturing, customized or prefabricated; material, acrylic or silicone; and arc, upper or lower. The authors of this review point out that regardless of the type of occlusal device, they must follow the specific use protocol for each device with the observation of the CNS response because if the patient is not supervised, the return of muscle hyperactivity or worsening of symptoms may occur. In addition, the time of use of the occlusal device depends on the pathology, whether for parafunction control or TMD.

2) Acupuncture x placebo control group

Studies [5,29,38–41] show the effect of acupuncture in treating myofascial pain through comparison with the control group demonstrated in Tables 3 and 4 The efficacy of acupuncture was evidenced in all studies [5,29,38–41] that analyzed, needle puncture acupuncture compared to placebo laser acupuncture [40,38,39], needle puncture acupuncture compared to placebo needle puncture acupuncture [5,29] and laser acupuncture in two ways compared to placebo laser acupuncture [41], demonstrated by improvement in the experimental group with greater effect size in the evaluated parameters, subjective pain relief [5,29,40,38,39], pain on palpation of orofacial structures [40,41], gain in mouth opening [5,38,39,41] and mandibular function [29] when compared to the placebo group, so these results show the physiological effect of acupuncture and differ from studies [42–44] which infer the non-influence or limited influence of acupuncture when compared to placebo. Although there is a need to understand the mechanism of action to understand these results, the articles above do not describe it clearly, because the results found are descriptive and attribute the improvement in symptoms to the feeling of comfort and security for receiving treatment, in addition to the fact that palpation can function as an aid to muscle relaxation [40,41].

The findings of this review corroborate with Turk et al., 2008 [45] and Sales-Neto et al., 2020 [29] that therapies for pain syndromes should not be evaluated only for statistical significance but also for their effect size so that the reduction of painful symptoms above 50 % can be considered as a success.

3) Acupuncture points

Acupuncture stimulates acupoints that activate myelinated nerve fibers in the muscles and block the nociceptive synapse in the central and peripheral nervous system, promoting analgesia by releasing serotonin, cortisol, dopamine, and endorphin [2,16,30,46–54]. There are two types of acupuncture, the systemic one, in which the reflexes are analogous to the meridian, and the microsystemic one, in which an organ such as the auricle has points representing all the organs [30].

Acupuncture is considered a safe, non-invasive technique; however, it can have side effects when stimulated by needles, such as puncture pain, hematoma, patient fear, and infection [4–8,41,55]. To control the side effects of needle therapy, low-intensity laser light can be used because it is painless and requires less time for acupoint stimulation [41,56–58]. It is noteworthy that for the success of laser therapy, the parameters of intensity and energy density, correct positioning of acupuncture points, and the number of sessions must be customized according to the pathology [41].

According to the acupuncture treatment protocol, the points to be stimulated can be local or distal to the target area [5,40,59,60]. As for promoted analgesia, local points are believed to promote more effective responses by promoting direct inhibition at the spinal cord level [5,40,59,60]. Local points often coincide with trigger points; in addition, in many patients, according to the literature, stimulation of distal points does not produce responses attributed to failures in their regulatory systems [5,40,59,60].

In this review, the acupuncture treatments studied varied in terms of location and type of technique (Tables 2 and 4). Among the studies that evaluated puncture acupuncture [2,5,29,40,38,39], local [5], distal [29], and local and distal [2,40,38,39] points were used; for laser acupuncture at local and distal points [4,41]; and considering the application technique for auriculoacupuncture, puncture [30], and laser [26] techniques were used. It is noteworthy that in no study that used the same acupuncture technique were the points used the same.

The acupuncture manual by Wong, 1999 [61] points out that one should always opt for fewer points to treat a given pathological condition to discern their effectiveness for suppressing symptoms. For myofascial pain in the orofacial region, the literature still needs to present an exact treatment protocol due to the large number of points for the treatment of this region and the different existing

techniques [4]. In the studies discussed in this review, the authors recommended ST7, ST6, and LI4 [41], and ST7, SI18, GV20, GB20, BL10, and LI4 [4].

Although there is a scientific need for an effective point protocol for the use of acupuncture, regardless of the puncture or laser technique, the literature survey carried out did not allow a differentiation between the size of the effect on orofacial pain considering the points evaluated by the included studies, however, Tables 2 and 4 show which points were effective in the included studies. An essential piece of information found in the study by Smith et al., 2007 [5] was that for immediate pain relief, the very-point technique could be used [40,62]; this was one of the cases in which the point used (ST7) coincided with the trigger-point of the masseter muscle and promoted considerable improvements for subjective pain and mouth opening (Table 4).

4) Duration of treatment

The authors Ferreira et al., 2013 [4] and Ferreira et al., 2015 [30] justified using acupuncture to promote lasting analgesia with cumulative effects. To verify this inference, the studies that compared acupuncture with placebo acupuncture were evaluated regarding the duration of treatment to cautiously infer the minimum time to produce relief from painful symptoms and whether the effects were cumulative. As for the time to have effects, it was observed that it promoted analgesia compared to the placebo group with more significant relief (Tables 3 and 4) when applied in a single session [40,38,39] and used for 3 [5], 5 [29], and 10 [41] weeks. About cumulative effects, the only study that analyzed one month of follow-up after the last intervention was that of Madani et al., 2020 [41], which demonstrated that the painful symptomatology did not present significant recurrence.

The heterogeneity of the studies regarding treatment time allows the authors of this review to infer that acupuncture treatment promotes immediate effects, as observed in the studies by Kletschaka et al., 2010 [38], Schmid-Schawap et al., 2006 [39], and Simma et al., 2009 [40]. The cumulative effects of acupuncture were observed by Madani et al., 2020 [41]. As for the ideal treatment time, it was possible to infer that this should be planned according to the patient's clinical conditions in a personalized protocol.

5) Final considerations

The objective of this systematic review was to verify the influence of acupuncture treatment for the remission of painful symptoms in patients with muscle TMD through the research question, "What is the efficacy of acupuncture treatment in patients with temporomandibular disorder (TMD) with myofascial pain?". The analysis of the included studies showed that it is effective in relieving subjective pain and pain on palpation of orofacial structures, as observed when comparing the group treated with acupuncture versus the placebo acupuncture group, with immediate relief of pain symptoms, thus not just a therapy, which acts by the placebo effect. In addition, this can enhance the treatment with occlusal devices by acting synergistically and thus reducing the time for pain relief.

It is known that age is a predisposing factor and can interfere with TMD symptoms. In the studies included, according to the eligibility criteria for carrying out this review, the authors presented a wide range of ages, between 15 and 71 years, and the 10 articles included, although reporting the age of the patients, did not mention its influence on the efficacy of acupuncture treatments, so this factor was not explored in this systematic review.

It is noteworthy that the added data on mouth opening and treatment duration are complementary to the main outcome and bring to this review beneficial inferences for clinicians who use it on how acupuncture is a synergistic treatment to the most used one (occlusal device) and that this does not should be dispensed with in cases of parafunction, as there are still no clinical guidelines on the best acupuncture method, points, and duration. Therefore, this review encourages further studies given the existing literature gap so that it is possible to determine a clinical protocol for acupuncture for myofascial pain in patients with TMD.

As a limitation of this systematic review, the authors emphasize the heterogeneity of the included studies in terms of treatment, acupuncture points used, frequency, and duration, in addition to the fact that the samples were small despite being randomized clinical studies. Thus, it is suggested to carry out investigations with similar methodologies, with a larger sample size and follow-up time after treatment, to determine the best acupuncture protocol regarding the type of acupuncture (puncture or laser) and location of the points (local or local and distal) for the treatment of muscular TMD.

Although acupuncture is now a widely accepted treatment by the World Health Organization (WHO) practiced and taught in teaching institutions and clinics, studies about its safety and side effects are required to determine clinical guidelines for its clinical use (risk/benefit ratio). This systematic review shows that few studies report on its effectiveness by presenting only four valid studies that compared acupuncture versus placebo acupuncture, demonstrates how this area lacks studies with systematic and controlled methodologies so that a systematic review can be carried out to determine clinical guidelines that will benefit both the professional and the patient with TMD who needs treatment for myofascial pain.

5. Conclusion

Laser and needle puncture acupuncture treatment and laser and needle puncture auriculotherapy have shown favorable results in short-term myofascial pain relief. The need for long-term studies to assess benefits and reduce possible biases is highlighted.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Data availability statement

This is a systematic review, so the data were detailed in the manuscript.

CRediT authorship contribution statement

Juliana Dias Corpa Tardelli: Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Bruna Gubitoso:** Writing – review & editing, Writing – original draft, Visualization, Methodology, Investigation, Formal analysis. **André Luís Botelho:** Writing – review & editing, Writing – original draft, Visualization. **Mariana Lima da Costa Valente:** Writing – review & editing, Writing – original draft, Visualization. **Andréa Cândido dos Reis:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Project administration, Methodology, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.heliyon.2024.e32075.

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