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# DIAGNOSING AND TREATING FACIAL PAIN IN RELATION TO TEMPOROMANDIBULAR JOINT

Structured literature review

Master´s thesis

Master of Healthcare, Naprapathy

2024

South-Eastern Finland
University of Applied Sciences

South-Eastern Finland University of Applied Sciences

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| Degree title | Master of Healthcare, Naprapathy |
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| Thesis title | Diagnosing and Treating Facial Pain in relation to temporomandibular joint |
| Commissioned by | South-Eastern Finland University of Applied Sciences |
| Year | 2024 |
| Pages | 51 pages, 10 pages of appendices |
| Supervisors | Salla Leinonen, Anita Näslindh-Ylispangar, Petteri Koski |


## ABSTRACT

The temporomandibular joint (TMJ) is a vital human body component, playing a crucial role in our daily activities. It is responsible for the movement of the jaw, the ability to speak, chew, and swallow, and overall well-being. Isolated symptoms can be found in 25-50 % of adult people. Women are affected more than men. Dysfunction in the TMJ can significantly impact individual health and societal dynamics.

The causes of temporomandibular disorders (TMD) are multifaceted, encompassing physical, neuromuscular, and psychological factors. Various examinations have been employed to investigate the etiology of TMD; however, a definite approach for assessing the disorder has yet to be established. Diagnostic imaging may be necessary in certain cases but should be carefully considered due to the potential risk of ionizing radiation.

This thesis aims to identify effective diagnostic methods for evaluating the etiology of pain in TMD and to determine which treatment modalities exhibit the strongest evidence. A meticulously structured literature review was conducted to comprehensively explore five relevant databases: Cinahl, Medline, SportDiscus, PubMed, and Web of Science. This review incorporated thirteen studies, revealing a notable absence of precise examination methods for clinicians despite thorough searches.

Notwithstanding the challenges in diagnostic clarity, the literature suggests that conservative treatments, including manipulation, mobilization, and exercises to enhance posture, have demonstrated efficacy in reducing pain associated with TMD.

**Keywords**: temporomandibular disorder (TMD), diagnosis, examination, manual therapy, systematic review

**CONTENTS**

Abbreviations with explanations:

DC/TMD- Diagnostic Criteria for Temporomandibular Disorders
DDwR- Disk Displacement with Reduction, the displaced disk returns to its proper place after movement. Associated with clicking or popping sounds.
DDwoR- Disk Displacement without Reduction, the disk remains displaced after movement. Often associated with limited jaw movement, pain, and other symptoms.
FM® - Fascial Manipulation
GRADE- Grading of Recommendations, Assessment, Development, and Evaluations
MMA- musculoskeletal manual approach
MRI- magnetic resonance imaging
M-TMD- myogenous TMD
NSAID- non-steroidal anti-inflammatory drug
QUADAS- Quality Assessment Tool for Diagnostic Accuracy Studies
RDC/TMD- Research Diagnostic Criteria for Temporomandibular disorders
SUCRA- Surface Under the Cumulative Ranking
TMD – Temporomandibular Disorder
TMJ – Temporomandibular Joint
VAS – Visual Analog Scale

# 1 INTRODUCTION

The temporomandibular joint (TMJ) is an essential component of the human body, responsible for the movement of the jaw, and the ability to speak, chew, and swallow. However, despite its vital role, the TMJ is also a source of significant pain and discomfort for millions of people worldwide. Studies suggest that isolated symptoms can be found in 25-50% of the adult population, with women being affected more than men. The female dominance is assumed to be related to the sex hormones estrogen. (Current Care Guidelines 2021; O'Kane & Barritt 2022).

While the exact causes of TMJ disorders remain unclear, both physiological and psychological factors have been identified as potential contributors. Temporomandibular disorder (TMD) can lead to a variety of symptoms, including jaw pain, headaches, earaches, and difficulty opening and closing the mouth. These symptoms can significantly impact a person´s quality of life (QoL), affecting their ability to eat, sleep, and engage in daily activities. (Current Care Guidelines 2021; Dalewski et al. 2019; Kuć et al. 2020; List & Jensen 2017; Nasri-Heir et al. 2016).

Given the prevalence and impact of TMD, it is crucial to understand the underlying causes, risk factors, and potential treatment options. This Master´s thesis aims to provide a comprehensive review of the current literature on TMD, with a particular focus on diagnosis, management, and the role of manual therapy in treatment. By synthesizing the latest research on this complex and multifaceted condition, this thesis aims to shed light on the challenges of pain in TMD and help improve the lives of those affected by this condition.

# 2 CENTRAL CONCEPTS AND THEORETCICAL FRAMEWORK

To gain a comprehensive understanding of pain associated with TMD, it is essential to grasp the central concepts that underlie this condition. In this regard, the terminology is critical to understand. Furthermore, a thorough comprehension

of the anatomical structures surrounding the TMJ is imperative to fully comprehend the nature and extent of the problem.

## 2.1 Anatomy and function

### 2.1.1 Temporomandibular joint (TMJ)

The TMJ is a synovial joint that is unique due to the presence of fibrocartilage. This type of cartilage is more resistant to wear than hyaline cartilage and can repair itself. (Ladeira et al. 2013 cited in Standring et al. 2021). During chewing, the joint is subjected to pressure, with the contralateral side from biting experiencing greater pressure. The TMJ capsule is a fibrous, collagenous sac that surrounds and encloses the TMJ, the joint that connects the mandible to the temporal bone. The capsule consists of an outer fibrous layer and an inner synovial layer. The fibrous layer is composed of dense connective tissue and provides support and stability to the joint. The synovial layer produces fluid, which lubricates the joint and makes sure that the disc gets its nutritional supply. The fluid consists of phospholipids and hyaluronic acid. (Standring et al. 2021.)

### 2.1.2 Ligaments surrounding the joint

The TMJ capsule also contains several ligaments that help to reinforce and stabilize the joint and suspend the mandible to the skull. These include the temporomandibular (lateral) ligament, which attaches to the temporal bone and the neck of the condyle, and the sphenomandibular ligament, which connects the sphenoid bone to the mandible. The stylomandibular ligament inserts into the styloid process and the posterior line of the mandible. This ligament does not participate in the movement of the jaw. (O'Kane & Barritt; 2022; Standring et al. 2021.)

### 2.1.3 Nerves connected to the TMJ

The trigeminal nerve (cranial nerve V) of the face divides into different branches. The three branches are mandibular, which is the largest branch, the maxillary, and the ophthalmic branch. The sensory part of these three nerves innervates

almost the whole face and the free nerve endings in the tissue can be activated by different stimuli: mechanical, thermal, or chemical stimuli. The activation gets more sensitized by different substances, such as substance P, prostaglandins, or bradykinin, found in the tissue. It is assumed that the pain transmission takes place via small-diameter unmyelinated C-fibers and myelinated Aδ fibers. In the area, there are also Aβ fibers, which react to mechanical stimulation, which need not be painful. The jaw-opening muscles lack spindle afferent nerve fibers, which means that the jaw does not have the same reflex control as other joints. (Kucukguven 2020; Fernandez-De-Las-Penas 2018.)

The mandibular nerve branches further into the auriculotemporal, lingual, and inferior alveolar nerves. The innervation of the TMJ comes from four main nerves. The most important is the auriculotemporal nerve (Figure 1). From different directions, other nerves also innervate the joint. The masseteric nerve is from the anterior side, and from the anteromedial side, we have the posterior deep temporal nerve. Looking from the medial side we have the TMJ branch from the mandibular nerve. This is not a very distinct innervation pattern; many variations are possible. (Kucukguven 2020; Fernandez-De-Las-Penas 2018.)

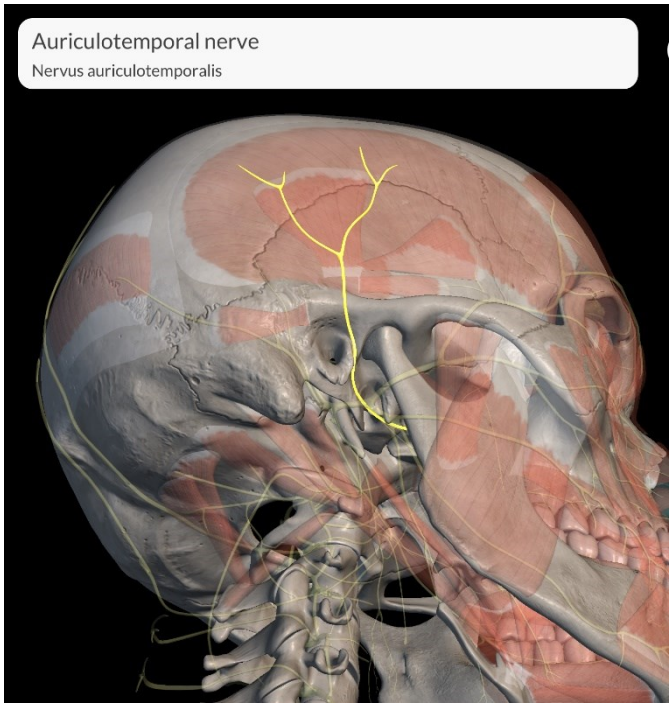


Figure 1. The auriculotemporal nerve highlighted (Anatomy 3D Atlas 2023).

Regarding the blood supply to the TMJ, four distinct branches of the external carotid artery are commonly mentioned, superficial temporal, maxillary, anterior tympanic, and deep auricular artery (O'Kane & Barritt 2022).

### 2.1.4 Muscles connected to TMJ

The movement of the jaw is primarily controlled by four pairs of muscles, the masseter, temporalis, medial pterygoid, and lateral pterygoid muscles. The masseter muscle, being the strongest and most superficial, plays a crucial role in mastication, requiring significant strength to break down food. On the other hand, the temporalis muscle, located on the lateral side of the skull, inserts its tendon onto the coronoid of the mandible. Both the masseter and temporalis muscles may also be inserted on the articular disc and assist in the closure of the mouth. Apart from their role in the mouth closure, the temporalis muscle participates in the lateral movement of the jaw. Mastication, the process of grinding and chewing, is the initial phase of digestion and is dependent on the coordinated action of these muscles. (Fernandez-De-Las-Penas 2018; Standring et al. 2021.)

The superior lateral pterygoid muscle (Figure 2), which inserts into the TMJ capsule, is a muscle that facilitates mouth opening. It achieves this by pulling the coronoid process of the mandible forward and downward. When used unilaterally, this muscle is responsible for the lateral movement of the jaw during mastication. (Fernandez-De-Las-Penas 2018; Standring et al. 2021.)

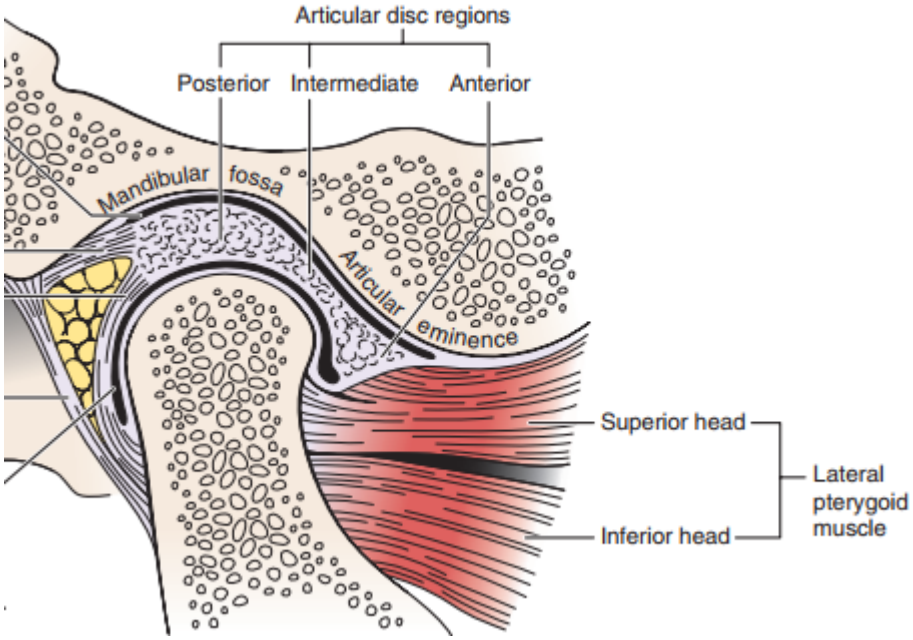


Figure 2. Close up of TMJ and the Lateral pterygoid muscle (Magee 2014).

The medial pterygoid muscle, which forms a sling around the mandible works together with the masseter muscle to bring about the occlusion of the teeth. These muscle works in unison to cause the protrusion of the mandible during mastication. In contrast, the two muscles located under the mandible, the digastric muscle and the geniohyoid muscle, play a crucial role in depressing the mandible. (Fernandez-De-Las-Penas 2018; Standring et al. 2021.)

Overall, an understanding of the function and interaction of these muscles is crucial to the effective functioning of the TMJ and the overall process of mastication.

### 2.1.5 Movement of TMJ

The function of the jaw is to chew food. The jaw moves in different planes, both vertically and laterally. The lateral movement involves a simultaneous rotation around the articular condyle, while the contralateral condyle slides back and forth. The mouth normally opens between 35 and 55 mm, while the lateral movement is smaller, 8-12 mm. The mouth opening starts as a hinge movement in the TMJ, and the condyle continues forward downward along the articular eminence. The

opening of the jaw is limited by the ligaments, as mentioned before. (Standring et al. 2021.)

The disc in the TMJ is located on the condyle in the glenoid fossa when the mouth is closed. The disc primarily consists of collagen type I, which provides high tensile strength. Additionally, glycosaminoglycans (GAGs) in the disc increase its stress tolerance and distribute the load. Removal of the disc for any reason increases the risk of osteoarthritis by two to three times. When the mouth is opened, the condyle moves forward, and the disc initially moves with it. At maximum mouth opening, the disc is left behind the condyle. The lateral pterygoid muscle pulls the condyle forward. The condyle is attached posteriorly by a ligament, which can move in front of the condyle limiting its movement. If the ligament is stretched to its maximum, it can snap back, producing a loud clicking sound. The limitation of jaw movement is released when the disc returns to its normal position, allowing the mouth to open. If the disc moves in front of the condyle, it is referred to as disc displacement with reduction. (Fernandez-De-Las-Penas 2018; Standring et al. 2021.)

## 2.2 Manual Medicine

In research, the terms ´manual medicine´, ´manual therapy´ and ´physical therapy´ are often used interchangeably, with the term ´therapy´ being part of ´manual medicine´. Manual medicine is a person-centered approach where the clinician uses various methods to influence a patient´s function and perception of pain. These methods can be active or passive, and most researchers agree that they include joint manipulation and mobilization, which are believed to affect biomechanical factors. Biomechanical factors, encompassing changes in mechanical and structural aspects of the body, include restoration of mobility and range of motion, alignment, tissue extensibility, release entrapment of joint menisci and muscle function. Mobilization is characterized as low amplitude thrust, whereas manipulation involves high amplitude thrust, in some surveys. The spinal tissues, including fascia, muscles, tendons, joints, ligaments, and intervertebral discs, are well innervated and provide afferent input to the central nervous system. Mechanoreceptors, such as type I and II, and free nerve

endings (type IV receptors) play a crucial role in conveying information about static joint position and movement to the central nervous system. With spinal mobilization/ manipulation, joint movement activates these receptors, providing afferent input to the spinal cord. (Bialosky et al. 2009; Bishop et al. 2015; Cook 2011; Olsson 2022; Roura et al. 2021.)

The afferent nerves from these receptors synapse in the dorsal horn of the spinal cord, conveying proprioceptive and nociceptive information. Spinal mobilization/ manipulation induces movement in the vertebral column, influencing multiple receptors and generation afferent input that ascends the spinal cord. The neuroanatomic basis creates a complex neurophysiologic response during manipulation, with additional interactions occurring in the cervical spine involving systems like vestibular and optic systems. According to the review of Bishop et al. (2015), manual medicine is believed to inhibit the spinal pain reflex, which is also claimed by Roura et al. (2021). At the central level, manual medicine is thought to decrease pain sensitivity. Different massage therapies, including trigger point massage, hot and cold therapies, neural dynamics, ultrasound, and acupressure can be added to the treatment. (Bialosky et al. 2009; Bishop et al. 2015; Cook 2011; Olson 2022; Roura et al. 2021.)

The treatment process is recognized as a dynamic interplay between the clinician and the patient. Psychological factors, including patient expectations, the treatment environment, and surrounding circumstances, play a significant role in shaping the treatment outcomes. It is important to note that the term ´therapy´ is not limited to manual interventions but also present in literature as ´exercise therapy´, ´therapy intervention, ´ and ´physiotherapy´. This nuanced understanding underscores the holistic nature of manual medicine, acknowledging both mechanical and psychological aspects that contribute to its therapeutic effects. (Olson 2022.)

Antinociception, the suppression of pain perception, is explained through a five-level model. This includes peripheral desensitization of nociceptive fibers (for example menthol), inhibitory effects of dorsal horn, a fast-acting neuronal

descending system involving specific brain regions, hormonal responses releasing endorphins, and the involvement of emotional and cortical aspects in pain perception. These levels illustrate the multifaceted neurophysiologic response to mobilization/ manipulation and contribute to understanding its effects on pain modulation and overall spinal function. (Olson 2022.)

# 3 TEMPOROMANDIBULAR DISORDER

TMD is a worldwide problem, and the prevalence number is estimated to be between 5 and 12 %. Isolated symptoms can be found in 25-50% of the adult population, with women being affected more than men. The difference is assumed to be due to the sex hormone estrogen. Symptoms occur in the TMJ, and the disorder affects the surrounding area and the masticatory muscles. A part of this disorder is referred pain, which does not always follow a certain pattern, due to a central sensitisation. However, Alstergren et al. (2010, cited in Fernandez-De-Las-Penas 2018,5) reported that, when glutamate was administered into the TMJ during testing, the referred pain remained localized. The definition of pain, according to the International Association for the Study of Pain is “an unpleasant sensory and emotional experience associated with actual or potential tissue damage or described in terms of such damage.” The literature on TMD has highlighted several symptoms with non-dental causes. Part of the symptoms is headaches, limited range of motion, muscle sensitivity, and joint crepitation. (Current Care Guidelines 2021; Dalewski et al.; 2019; IASP 2021; Kuć et al.; 2020; Melo et al. 2020.)

## 3.1 Causes of TMD

Research into TMD has a long history. In 1950s Travell and Rintzler (1952, 11, cited in Kuć 2020) already identified this problem but described it as a myofascial pain that was explained to be caused by trigger points. Researchers today agree that the problem consists of more than trigger points. The causes are multidimensional and can be divided into physical and neuromuscular factors. Physical factors influencing the joint can be myogenic or disk related. Hypermobility may lead to subluxation of the mandibular condyle, resulting in

pain. Trauma is often mentioned as well as postural problems and ergonomic traits, not to forget dental occlusion. In cases of joint inflammation, the cause is not always straightforward but can give rise to pain. For the neuromuscular factors, occlusal splints are often used. There is also evidence to imply that psychosocial impairments are a significant issue. Of the psychosocial factors, the authors underscore that stress greatly impacts the masticatory muscles and pain. Depression and anxiety are personal traits that amplify pain sensation and sleeping problems are found in many studies as an additional factor increasing the pain. (Dalewski et al 2019; Fernandez-De-Las-Penas 2018; Kuć et al. 2020; Melo et al. 2020; Moraes et al 2013.)

### 3.2 Diagnosis

TMD involves a multifaceted assessment. The Diagnostic Criteria for Temporomandibular Disorders (DC/TMD) method is considered by several researchers to be the ´Golden Standard. ´. The method demonstrates validity in identifying patients with TMD and detecting pain related to most TMD problems, with a sensitivity of ≥ 86 % and a specificity of ≥ 98 %. Sensitivity over 0,7 and specificity over 0,95 are considered acceptable. (Putri et al. 2021; Schiffman 2014). However, the ´Temporomandibular Etiology test, ´ is believed by Putri et al. (2021), to be better suited for clinical settings. Its sensitivity is 47,8 % and its specificity is 88,2 %, which is sufficient for reliable results in clinical settings. According to Stasiak et al. (2020), the Fonseca Anamnestic Index could be used as the first step in identifying TMD. This test has a high sensitivity, 97,2 %, but the specificity is low 26 %. The positive predictive value for the test is 84,96 % and the negative predictive value is 68,4 %, which means that the likelihood of showing TMD is high.

In contrast to Schiffman (2014) and Putri et al. (2021), Shan Shen et al. (2022) propose that MRI would be the ´Golden Standard´ for diagnosing TMD. This is because disc displacement is the most common cause of TMD, and it can be better visualized on MRI than diagnosed by the DC/TMD tool (Putri et al. 2021; Schiffman 2014.)

Mastering TMD is important because it affects the whole body (Walczyńska-Dragon 2014). The most common problems are local pain around the joint and face. But also pain in the ear, headache, and clicking sounds can be annoying, not to exclude nutritional problems. As TMD affects overall health and mental well-being, including QoL, it is obvious that the problem affects the health costs of society. (List & Jensen 2017; Nasri-Heir et al. 2016.)

### 3.3 Treatments of TMD

Research with decent quality on manual therapy and management of TMD is hard to find. A generic treatment strategy is that conservative treatments for pain reliving should be prioritized. One of the most studied treatment modalities is the occlusal splint (OS). A comparison study by Dalewski et al. (2019), combined the treatment with NSAID and dry needling. Dry needling is an old method used for pain relieving and even if acupuncture needles are used it is different from acupuncture treatment. Acupuncture is used for moving energy, whereas dry needling aims to treat myofascial trigger points, which are hyperalgesic in the muscles. In the study of Dalewski et al. (2019), it was not shown that dry needling would be better than NSAIDs for treating TMD.

Interestingly, another study made by Diracoglu et al. (2012, 25, cited in Dalewski et al., 2019), concluded that dry needling was superior to sham dry needling on pain pressure threshold. In a study by Gonzales-Perez et al. (2012, 17, cited in Dalewski et al., 2019) the needle was inserted in the external pterygoid muscle and their result on pain reduction was greater the worse the pain was from the starting point. Together these studies indicate that there is conflicting evidence for the use of dry needling.

As stated before, conservative treatments are the first-line treatment for TMD. The same was discussed in a study by Melo et al. (2020). They were also interested in the impact of including psychological treatments. Therefore, they examined what impact psychological treatments, through counselling, have on the other conservative treatments, such as manual therapy. Manual therapy was, in their study, defined as heat and cryotherapy and the exercises were massage

and stretching for masseter and temporal muscles. This research acknowledged the limited understanding of the effects of these non-invasive treatments on psychological factors like anxiety, citing conflicting results in existing literature due to heterogeneity, lack of strict criteria, and varying follow-up periods. Therefore, they tried to be more accurate in the inclusion criteria and used the screening method by RCD/TMD. They looked at the results after one month and pain relief was measured by the VAS scale. The study showed decreased pain sensation and anxiety levels, however, did not show any significant difference in pain sensation or anxiety between groups. (Melo et al. 2020.)

More specific pain, with mouth opening, was measured in a meta-analysis by Martins et al. (2015) and the results showed that MMA was an opportunity to diminish pain. In comparison to the study done by Melo et al. (2020), the manual treatments in this meta-analysis included manipulations of body tissues, muscles, and bones prior to heat and cryotherapy. Resting pain could not be affected in the study.

Comparable results were found in a study by, Craane et al. (2011). Physical therapy, including education, muscle stretching, and exercises was used to treat pain in TMD. They used VAS and the McGill Questionnaire to assess pain after 3, 6,12, 26, and 52 weeks, but the pain did not decrease significantly more than in the control group. Moraes et al. (2013) also used stretching and relaxation in their study and pointed out that a successful treatment could only be possible when the diagnosis was accurate.

Intraoral manual therapy is rare. Kalamir et al. (2011) examined if intraoral myofascial therapy combined with instruction and homework could positively affect TMD. They concluded that a combination of the treatments would have a better outcome than no treatment.

Sekito et al. (2022) had a different view of TMD, stating that TMD is multifactorial and has been treated with conventional treatments. They wanted to add the chronology to the clinical history and had a hypothesis that TMD could be a

problem of compensation for previous events. Instead of treating the tender area, they treated connected areas, highlighting the cervical and thoracic areas. Sekito et al. (2022) concluded that FM® is an effective, rapid, and cost-effective way of treating pain in TMD, even if more research must be conducted with a larger sample.

Because the origin of TMD is complex, choosing the accurate treatment strategy is not a simple task. As extracted from the introduction, there are a numerous treatment options available, each requiring careful consideration for an effective approach. A thorough examination of TMD is a prerequisite for a successful treatment. (Moraes 2013.)

### 3.4 Diagnostic Imaging

TMD can include a broad variety of symptoms. To ensure an accurate diagnosis, diagnostic imaging may be necessary in certain cases, such as when differential diagnoses need to be ruled out. However, the necessity of such imaging should be carefully considered due to the potential risk associated with X-ray and computed tomography (CT) scans, including exposure to ionizing radiation for personnel and patients. Alternatives include CT, MRI, or ultrasound imaging. CT may be preferred in cases of suspected issues related to prior surgeries or implant complications. In the case of carcinoma, either CT or MRI may be employed, with MRI being the preferred option in cases where surgery is planned or nerve compression due to tumors needs to be assessed. Ultrasound is useful for evaluating soft tissue problems, glands, and swellings. (Zakrewska 2009.)

## 4 RESEARCH QUESTIONS

The thesis is dedicated to addressing two main research questions:

- What diagnostic methods are effective in identifying the etiology of pain in temporomandibular disorders?
- What is the efficacy of manual treatments for temporomandibular disorders?

This thesis aims to provide a comprehensive overview of the available information regarding pain with TMD. Specifically, the aim is to elucidate the proper diagnostic procedures for TMD and to explore the potential efficacy of manual therapy. With this knowledge, one should be able to enhance the QoL for those affected by this condition. After in-depth exploration of existing research, the hypothesis arises that patients with TMD who receive manual therapy are likely to experience more significant pain reduction compared to those who do not receive treatments.

In addition, the aim of this Master´s thesis goes beyond to academic knowledge: it seeks to deepen the knowledge base regarding TMD with the ultimate purpose of influencing practical applications. By promoting a better understanding of TMD, this research strives to establish a basis for well-informed decision-making in various contexts, potentially even contributing to the improvement of education.

# 5 RESEARCH METHOD

## 5.1 Literature Review Methodology

To answer the research questions in the thesis, a structured literature review was conducted, more specifically with a quantitative approach. The quantitative approach aims to immerse, explain, rank, and establish connections between a range of factors. The study design is shown in Table 1. The method is based on the design of a systematic literature review. A step-by-step procedure is specific to this method, with the first step delimiting and defining the question. In this thesis, the aim was to answer the questions about the effectiveness of diagnostic methods identifying the etiology of pain in TMD and the efficacy of manual treatments in TMD. To chart the research conducted on pain related to TMD and reported outcomes, the PICO (Population, Intervention, Comparison, and Outcomes) method was utilized. The characteristic of a good question is a clear and specific formulation. Similarly, the characteristic of a good, structured review can be generalized and reproduced by others interested of the same topic. (Finnish Center for evidence-based health care n.d.; Forsberg & Wengström 2015; Karolinska Institutet 2023; Sarajärvi & Tuomi 2018.)

Table 1. Explanation of study design.

| | STUDY DESIGN |
|---|---|
| **1** | Central Concepts |
| **2** | Research questions and hypothesis |
| **3** | Research Method<br>Inclusions and Exclusions<br>Preliminary Searches and Final Search |
| **4** | Article Selection |
| **5** | Processing Results |
| **6** | Discussion, conclusion |
| | |

## 5.2 Search strategy for the study databases

The test searches were conducted in the PubMed and PEDro databases. PubMed was used because it is a vast database with associated citations and abstracts from the field of biomedicine, as indicated on the South-Eastern Finland University of Applied Science´s web pages (Xamk Kaakkuri n.d.). Pedro complemented the search within the physiotherapeutic evidence, broadening the scope within the relevant area.

For the test search, the following terms were used: “Temporomandibular joint disorders” (MeSH) for PubMed, and “temporomandibular treatment” for PEDro. Initially, the PEDro search started with “temporomandibular rehabilitation,” but it did not yield suitable results for the purpose. Other appropriate MeSH terms and keywords were chosen from articles in these databases, which were adapted for use in other databases.

The first question focused on establishing an accurate diagnosis for TMD. The most relevant systematic reviews or meta-analyses, written in English were identified in PubMed. After trying different combinations, the search terms used were ´temporomandibular disorder* AND Diagnos*. ´ A total of 40 systematic reviews or meta-analyses were identified. The other combinations were

´temporomandibular joint, ´ ´TMJ, ´ assessing, ´ ´screening´, ´examination´, ´clinical examination´ ´investigation´, ´protocol´, ´diagnostic criteria´, and ´detection´. Web of Science produced some hits with the search terms ´temporomandibular joint´ or temporomandibular disorder*´ and ´clinical examination´ OR diagnos* OR investigation. ´ A total of 40 systematic reviews or meta-analyses were identified. The exact search details are found in Table 2.

Table 2. Data search for diagnosis.

| Database | Keywords | | | Results |
|---|---|---|---|---|
| Pubmed | Temporomandibular disorder* | AND | Diagnos* | 40 |
| Web of Science | Temporomandibular joint or temporomandibular disorder* | AND | Clinical examination or diagnos* or investigation | 40 |

The other question concerned pain in TMD and associated manual treatment. Initially, Pedro and the Ebsco database were explored, but it became evident that Cinahl, Medline, SportDiscus, PubMed, and Web of Science provided more relevant results. CINAHL was chosen because it contains health-related articles for research purposes. Medline was chosen because it covers medicine, dentistry, and health care. SportDiscus was chosen because it contains physiotherapy reviews. Web of Science is a database that includes multidisciplinary abstracts and citations and the articles included are all peer-reviewed. (Xamk Kaakkuri n.d.)

After narrowing down the search to include peer-reviewed English language publications, systematic reviews, or meta-analyses conducted on the adult population, a total of 29 reviews were identified, as shown in Table 3. The search terms used were ´temporomandibular disorder´ or TMD AND ´manual therapy´ or ´mobilisation´ or

´manipulation´ OR ´exercise therapy´ or ´physical therapy´ or ´physiotherapy´ or ´exercise intervention´ or ´low amplitude thrust. ´ In addition to the database search, references to the included systematic reviews were checked and, one more systematic review was included. The retrieval of the last systematic review included was made possible through the assistance from the school´s library staff.

Table 3. Data search, TMD treatments

| **Database** | **Keywords** | | | **Result** |
|---|---|---|---|---|
| **Cinahl** | ´Temporomandibular disorder´ or tmd | AND | ´manual therapy´ or ´exercise therapy´ | 2 |
| **Medline** | ´temporomandibular disorders´ or tmd | AND | ´manual therapy´ or manipulation or ´exercise therapy´ or ´physical therapy´ or physiotherapy or ´exercise intervention´ | 10 |
| **SportDiscus** | ´temporomandibular disorders´ or tmd | AND | ´manualt therapy´ or manipulation or ´exercise therapy´ | 6 |
| **PubMed** | ´temporomandibular disorder´ or tmd | AND | ´physiotherapy´ or ´exercise therapy´ or ´low amplitude thrust´ or ´physical therapy´ | 4 |
| **Web of Science** | ´temporomandibular disorder*´ | AND | ´manual therapy´ or mobilisation or manipulation or ´physical therapy´ or ´exercise therapy´ | 7 |

### 5.3 Inclusion and exclusion criteria

In this review, the following inclusion criteria were used: systematic reviews and meta-analyses about diagnosing TMD, manual treatments for TMD, pain related to TMD, and consistently addressing the questions posed. The aim was to include adult people, but in the process, it became evident that a nuanced approach was necessary for the inclusion of articles, deviating from the initially

planned age category. This adjustment was made to ensure the comprehensive incorporation of relevant information. Consequently, systematic reviews with a younger population are included. Manual treatments included the following: manual therapy, mobilization, manipulation, exercise therapy, physical therapy, physiotherapy, exercise intervention, and low amplitude thrust. Only English-language articles were included, and the articles were not more than 10 years old (31 August 2013- 31 August 2023). The articles were all peer-reviewed. A detailed explanation of the inclusion and exclusion criteria is presented in Table 4. To ensure the validity of the literature review, studies with high evidence were referenced. As shown in Figure 3, systematic reviews and meta-analyses are high in the hierarchy pyramid and these publications were of choice. The higher the hierarchy the better the quality of evidence, and the lower the risk of bias. (Yetley et al. 2016.)

Table 4. Table of inclusion and exclusion criteria.

| Inclusion criteria | Exclusion criteria |
|---|---|
| Systematic reviews and meta-analyses about diagnosing or treating TMD | Surgery |
| Manual treatments for TMD (manual therapy, mobilization, manipulation, exercise therapy, physical therapy, physiotherapy, exercise intervention, and low amplitude thrust | Genetic factors |
| Pain related to TMD | Psychological causes |
| Regardless of age | Oral splints |
| English language | Medication and botulinum toxin |
| Not more than 10 years old | |

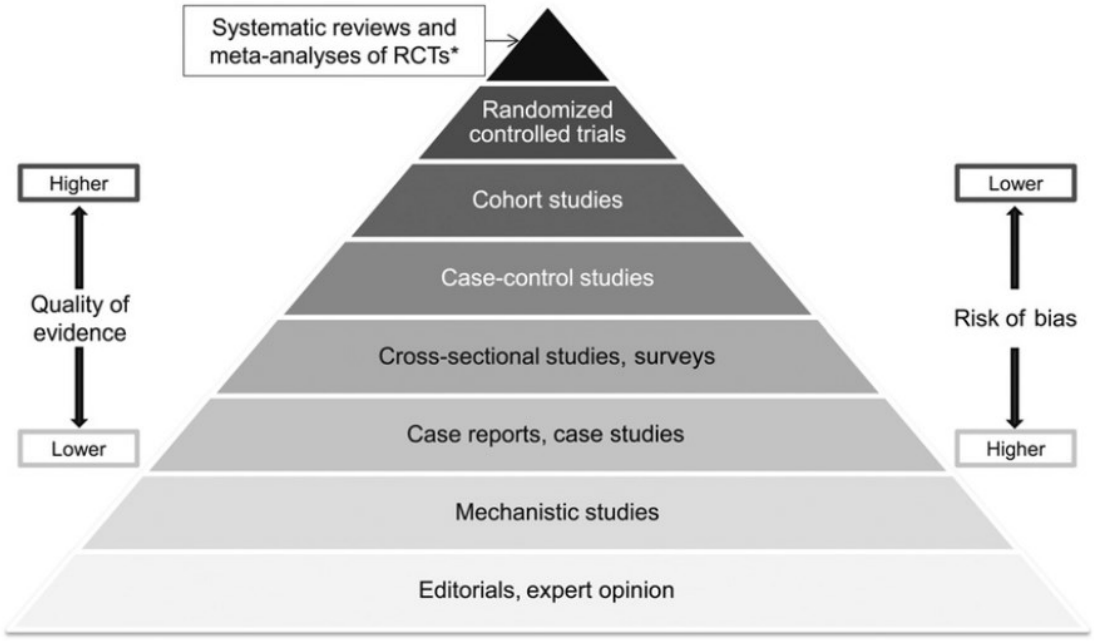


Figure 3. Screenshot of the evidence pyramid (Yetley et al. 2016).

In this review, the focus was on manual methods. Methods excluded, such as medication, oral splints, botox, and surgery. These methods are used by medical doctors, dentists, or bite physiologists. Genetic factors and psychological causes were beyond the scope of this Master´s thesis, as were the rheumatic problems. Serious illnesses need to be noted and patients need to be referred to further medical evaluation.

### 5.4 Quality Assessment

The objective was to present the best available evidence on the subject comprehensively and objectively. However, it is important to recognize the limitations that various factors may cause. A limiting factor was that the quality assessment of the articles, according to a specific model, has been omitted. This was in accordance with the instructions provided by the supervisor. Nevertheless, the articles have been compared in terms of sample, intervention methods, and results. The sample sizes ranged from 213 to 17611. The interventions used exhibited considerable diversity, with an explanation for each approach. The analysis also includes a review of factors that may have potentially influenced the results, blinding participants being one of the main problems. (University of Oxford, n.d.)

# 6 RESULT

## 6.1 Study selection

In conducting this structured literature review, the Covidence Systematic Review Tool was employed. Covidence facilitated the screening and selection phases of the work, enhancing the efficiency and transparency of the methodology. Additionally, the PRISMA flow chart (Appendix 2), a key component of the process illustrates the study selection and screening workflow. This was generated by using the functionalities provided by Covidence. The selection of systematic reviews was done in different phases. In phase I 109 systematic reviews were identified, from five different databases (Web of Science, PubMed, Medline, SportDiscus, and Cinahl). After the removal of duplicates, 88 reviews were left. The cause of exclusion is seen on the PRISMA flowchart. 1 systematic review was found through citation searching. After reading the title and abstracts, 20 reviews were left. A comprehensive assessment of the full text was conducted on these 20 remaining systematic reviews to confirm their eligibility for inclusion in the study. An additional step was taken to ensure a comprehensive approach. The reference list of the included systematic reviews was examined manually to identify relevant studies that might have been missed during the initial process. Additionally, one more study met the inclusion criteria. Furthermore, it is noteworthy that the reference list of Martins et al. (2015) was checked before excluding the systematic review. Thirteen systematic reviews were finally included.

In the presentation of the results of this structured literature review (Appendix 1), it becomes evident, that there is a limited number of systematic reviews specifically addressing the Golden Standard DC/TMD. The number of hits regarding examination or the diagnostic methods identifying the etiology of pain in TMD was limited, only two meta-analyses were included in this structured literature review. Among the included systematic reviews, some incorporate meta-analysis or network meta-analysis to compare various modalities for managing TMD-related pain. A significant trend towards positive outcomes is

apparent, although variations exist among the findings. Notably, manual therapy emerges as the most frequently employed method; however, the specific techniques included in the studies exhibit diversity. The included studies were conducted in different countries (USA, Spain, Brazil, Switzerland, Portugal, Yemen, and China) and the number of participants varied from 213 to 17611. Not every study mentions the number of participants, just the number of RCTs. This synthesis underscores the need for further comprehensive investigations, particularly in the context of the Golden Standard DC/TMD and examination of TMD.

The obtained results are grounded in information derived from adhering to the principles outlined for conducting a structured literature review. The elucidation of these principles is clarified in section five.

### 6.1.1 Meta-analyses of Diagnosis and Examinations

Meta-analyses can be used when more than one study is available. This is to combine multiple treatment effects and obtain an overall estimate of the effect in the target population. (Dias & Caldwell 2019). In Pupo et al.´s meta-analyses (2016) (table 5), clinical examination protocols for intracapsular TMD – specifically RDC/ TMD, DC/ TMD, and CCD for TMD (cervical spine dysfunction) – were compared with MRI in adults aged 18-72 years. Six databases, specified in Appendix 1 were checked, and additional gray literature was included. To minimize bias three reviewers independently assessed the articles identified by the databases. The included articles were assessed by the QUADAS tool. Quantitative synthesis included seven studies, and findings pointed out to poor validity of clinical examinations. The systematic review included meta-analyses which displayed a notable degree of diversity, as indicated by high heterogeneity. On average, there was a moderate risk of bias. The inconsistency index ($I^2$), measuring the variability among the studies included, ranged from 85.10 % to 95.90 %. The pooled sensitivity and specificity for various selected studies were 48 % and 55 %, respectively.

While the meta-analyses of Pupo et al. (2016) examined the intracapsular TMD, the meta-analyses of Barros et al. (2020) shifted the focus to a completely different examination. In this separate study, including 738 individuals from twelve studies, researchers delved into muscle activity using electromyography, specifically examining the masticatory muscles. Seven databases were checked, and the PRISMA guidelines for systematic reviews and meta-analysis were followed. Two independent reviewers assessed the articles found. In the meta-analyses, they used a checklist for assessing the methodology, from an earlier study. The checklist included parts from STROBE and ISAK (Strengthening the Reporting of Observational Studies in Epidemiology statement and International Society in Epidemiology and Kinesiology). The methodological quality of the included articles was good in ten of twelve studies, but the capturing, processing, and analysis methods of the different EMG signals were a limiting factor. Blinding was not described in the included articles. The results indicated no significant differences in the activity of masticatory muscles between healthy individuals and those with TMD, aligning consistently with findings from similar studies.

In summary, the meta-analyses explored different diagnostic approaches for TMD, with Pupo et al. (2016) focusing on clinical examinations and Barros et al. (2020) investigating masticatory muscle activity through EMG. Both studies highlighted challenges and limitations in the diagnostic processes, contributing valuable insights to the understanding of TMD etiology. However, the answer to the first question in this structured literature review, regarding diagnostic methods for TMD problems remains unclear.

Table 5. Examinations of TMD. Disk displacement with reduction (DDwR), disk displacement without reduction (DDwoR).

| **Examination** | **Study authors** | **Outcome** |
|---|---|---|
| RDC/TD, DC/TMD and CCD for TMD compared with MRI for DDwR and DDwoR | Pupo et al. (2016) | In adults with intracapsular TMD, clinical examination protocols (RDC/TD, DC/ TMD, and CDD for TMD) demonstrate poor validity in diagnosing DDwR or |

| | | |
|---|---|---|
| | | DDwoR compared to MRI. Using MRI is recommended to enhance diagnostic accuracy, especially when examination results could impact treatment protocols. |
| Electromyographic activity of the masticatory muscles | Barros et al. (2020) | No significant differences in the electromyographic activity were found between people with or without TMD. |

### 6.1.2 Manual Therapy for TMD

According to the included systematic reviews, manual therapy encompasses a variety of hands-on treatments performed by physiotherapists. These treatments aim to enhance strength, coordination, and mobility while alleviating pain. The approaches include interventions such as mobilization, and manipulation. Mobilization involves low-velocity movements on cervical segments and manipulation involves high-velocity and low amplitude treatment on a cervical segment. Manual therapy interventions may also encompass a range of other techniques such as massage, myofascial release, muscle energy techniques, and passive stretching, according to these specific systematic reviews. The focus might extend to addressing poor posture, cervical muscle spasms, or pain. Different studies use slightly varied definitions or components within the term manual therapy. (Armijo-Olivo et al. 2015; La Touche et al. 2020; Liberato et al. 2022.)

Manual therapy strategies were categorized into mobilization, manipulation, exercise therapy, and physiotherapy, as shown in Table 6 below (p 35). In the systematic review by Dickerson et al. (2017), including a meta-analysis, the effectiveness of mobility, motor control, postural education, and a mixed approach in alleviating TMD pain was investigated. The PRISMA guidelines for systematic reviews were followed and two databases were checked. Two independent reviewers assessed the articles found. The mobility component

involved mobilization techniques. Motor control was addressed through prescribed exercises aimed at enhancing mandibular control, and the program for postural education incorporated therapeutic interventions. A mixed treatment protocol was employed, and comparisons were made with both a placebo group and another intervention group. To assess the risk of bias the Cochrane Risk of Bias Tool was used. Mean differences (MD) or standard mean differences (SMD) with a 95 % CI for different measurement scales, were calculated. SMD for the effect of exercise therapy on pain was calculated to be 0.824. The variables MD or SMD (when MD is not possible) are often used in research with quantitative approaches (Forsberg & Wengström 2015). The study comprised 152 participants, a relatively modest number compared to similar investigations, all of whom were assessed for pain. Self-reported pain assessments were conducted both at rest and during movement. The intervention groups demonstrated favorable outcomes, with no discernible difference observed between the intervention groups. The Short Form Survey Instrument (SF-36) was utilized for data collection.

If the systematic review by Dickerson et al. (2017) compared mobility, motor control, postural education, and a mixed approach in alleviating pain, the next systematic review was to compare mobilization and high-velocity manipulation. La Touche et al. (2020) conducted a systematic review with a meta-analysis involving 163 patients, wherein mobilization and high-velocity manipulations were incorporated. Three databases and the Web Search Engine Google Scholar were used, and two independent reviewers checked the included RCTs. The primary objective was to compare the efficacy of manual therapy (encompassing both mobilization and manipulation) on the cervico-craniomandibular region with that on the cervical region. Control groups received either a placebo or sham mobilization/ manipulation, coupled with prescribed exercises. Additionally, there was a cohort receiving manual therapy in conjunction with exercises and self-care counseling. The quality assessment of the systematic review was conducted using the Cochrane assessment tool. The studies included in the meta-analyses had a low risk of selection bias but had a higher or unclear risk of performance bias in blinding of participants and therapists. The SMD for pain intensity

reduction was -1.49, and the corresponding 95 % CI for the effect size was calculated between -2.45 and -54. The quality of the systematic review was moderate to low. The effect size of the meta-analysis showed that cervical manual therapy was more effective in decreasing pain intensity than placebo manual therapy or minimal intervention, with moderate evidence.

On the other hand, Al-Moraissi et al. (2021) chose to conduct a systematic review with a network meta-analysis. A network meta-analysis is done when there is a network of interventions with varying degrees of direct evidence and researchers want to make comparisons between interventions that have not been directly studied together (Dias & Caldwell 2019). Five databases were used, and two independent reviewers assessed the articles. A special data extraction form was used for this network meta-analyses and the risk for bias was assessed using Cochrane guidelines. Mobilization, and manipulation of the soft tissue, in addition to exercises, were included in the manual therapy. MD or SMD were calculated for the effect size and GRADE (Grading of Recommendations Assessment, Development and Evaluation) was used to summarize the evidence. GRADE is a widely adopted framework for transparently summarizing evidence and systematically making clinical practice recommendations (BMJ Best Practice 2023). In this study the SUCRA curve and mean ranking were employed as analytical tools. A total of 52 RCTs on adult people were included in the analysis. The findings and the treatment rankings revealed that manual therapy demonstrated the most significant decrease in pain compared to placebo. However, no statistically significant difference was observed between the intervention groups that exhibited an effect on M-TMD.

Similarly, Liberato et al. (2022), conducted a systematic review on manual therapy. The PRISMA guidelines for systematic reviews were followed and six databases were checked. Two independent reviewers assessed the articles found. The manual therapy (mobilization, manipulation, or massage) was applied to the cervical joints to reduce pain with TMD. The orofacial region and the neck share a common neural connection, suggesting the potential for influencing orofacial issues through neck interventions. 213 adult people (90 % women) with

TMD pain ranging from 6 months to 6 years were investigated and got treatments over 4 weeks. They had either a control group with no intervention or a placebo group. In the meta-analysis MD and the SMD were calculated, and the $I^2$ percentage was employed as a measure to quantify the degree of heterogeneity among the included studies. The overall effect size was estimated to be -1.8 cm on a scale (95 % CI: -2.8 to -0.9). When the effect was stratified by pain duration the individuals with < 12 months of pain duration experience a larger reduction in pain intensity (MD: -2.7 cm, 95 % CI: -3.3 to -2.1). Those with pain duration > 12 months still experience reduction in pain intensity, though to a lesser extent (MD: -1.1 cm; 95 % CI: 1.8 to 0.4). The GRADE was used to summarize the evidence. Blinding of participants and therapists was a limiting factor, as the participants were not blinded in 80 % of the trials, and the therapists were not blinded in any trial. The effect was clinically relevant; however, the quality of the evidence was low.

The table below (Table 6, page 35) illustrates a range of optional techniques available for treating TMD. A new systematic review with meta-analysis, conducted by Arribas-Pascual (2023), was conducted on adults and the aim was to find out the evidence on different physiotherapeutic interventions. A huge umbrella systematic review included 17611 participants. Five databases were searched, and three independent reviewers assessed the first phase of the article search. Different techniques were used in the articles and different kinds of TMD causes were investigated. This could, according to the authors, have affected the outcomes, which showed a moderate effect for manual therapy in reducing pain with TMD. Researchers used the kappa coefficient for the reliability of the study. The information from the study was displayed on a map. The Heges´ *g* was employed to measure the effect size, and the calculated value was statistically significant with an SMD of 0.51 (CI 95 % 0.23 to 0.8). This measurement corrects for bias in small sample sizes. Cochrane´s Q helped the researchers to assess the consistency of the study results. The AMSTAR was used as a measurement tool to evaluate the methodological quality of the study and the scores ranged from low to critically low, for the 31 included systematic reviews. The risk of bias ranged from high to low, assessed by the ROBIS tool (Risk of Bias in Systematic

Reviews). Apart from other studies, the risk of central sensitization was discussed. The frequency and number of treatments affects the result and was discussed in some studies. The exercises were performed two to six times daily, with sessions occurring between 0.5 to five times per week, and treatments were administered over durations ranging from one week to one year.

Equally, Vieira et al. (2023) were interested in the efficiency of manual therapy on pain in TMD. Six databases were searched and the Cochrane guidelines for systematic reviews were used. The PEDRO scale was used to assess bias and two independent reviewers assessed the included trials. Here the manual therapy (mobilization, manipulation, massage, soft tissue mobilization, muscle energy techniques, and stretching) was applied to the cervical joints to reduce pain with TMD. This closely resembled the research by Liberato et al. (2022), however they included massage as part of the manual therapy intervention. MDs with a 95 % CI or SMDs were presented in the analysis. The MD for the immediate effect was -0.88 points (scale 0-10), with the CI -1.57 to -0.19. The effect size for short-term and long-term effect was not mentioned. However, the CI for short term effect was -3.46 to -0.20, and for long term the calculated CI was -1.33 to 1.13. The GRADE system was used to summarize the evidence. The findings correspond to previous studies. 20 studies and 1084 individuals of various age groups indicated that neck treatments incorporating joint manipulation were effective in addressing orofacial issues, this evidence had a moderate quality. Combining two or more manual therapies as additional treatments showed a small impact. It is important to also consider the healthcare professionals´ expertise and the preferences of the patients. The quality of evidence for the studies included ranged from high to very low. The effect sizes were small for this systematic review and may not have significant clinical importance.

Additionally, Calixtre et al. (2015) shared a similar interest, focusing on treatments targeting the upper cervical region for managing TMD. Five different databases were checked for RCTs, and two independent reviewers assessed the articles found. Eight RCTs, with seven of them demonstrating high methodological quality, were included. The study involved adult people, mostly

females with a minimum age of 18. Manual therapy encompassed hands-on treatments administered by physiotherapists, involving joint movements, stretching, and selected soft tissue techniques. This demonstrates the diversity within the category of manual therapy. Similarly, this systematic review showed that manual therapy on the cervical region may affect the TMD, as shown in an RCT by La Touche et al. (2020). The evidence supporting this was of high quality, summarized using the GRADE framework. Before drawing any larger conclusions, it is essential to unify the techniques. No meta-analyses were conducted due to heterogeneity.

In summary, various systematic reviews and meta-analyses investigated the effectiveness of manual therapy for TMD pain. Findings consistently suggest moderate effects of manual therapy, particularly joint manipulation, and mobilization, in reducing TMD-related pain. Despite some variations in methodologies and techniques, the overall evidence supports the efficacy of manual therapy as a treatment option for TMD.

### 6.1.3 Exercise Therapy for TMD

As mentioned earlier, the vocabulary varies when discussing treatments for TMD. In the following reviews, the term ´exercise therapy´ is used. Armijo-Olivo et al. (2015) focused on evaluating the quality of studies comparing manual therapy or exercise therapy with a placebo, control group, or standard care. Six databases were searched for RCTs, and the articles were assessed by two independent reviewers. The systematic review concluded that various interventions, including exercises for posture correction, demonstrated positive effects in treating adult people (more than 18 years of age) with TMD. Similarly, manual therapy targeting the orofacial region and cervical spine may have positive effects on TMD symptoms. Moreover, a combination of treatments for the neck and orofacial region resulted in improved pain. A total of forty-eight studies were included, and the kappa coefficient for inter-rater reliability was 0.98. Regarding the effect size for manual therapy applied to the orofacial region significantly reduced pain intensity compared to botulinum toxin or waiting list (MD 1.35 cm; 95 % CI: 0.91, 1.78). Mobilization of the cervical spine significantly decreased pain intensity and

pain sensitivity, with clinically relevant effect sizes (28.75 points and 1.12 kg/ cm², respectively). The risk of bias, assessed by the PEDro scale, ranged from unclear to high. The quality assessment followed the Cochrane Collaboration guidelines. One limiting factor was the blinding of participants, however, as discussed in the quality section of this systematic review, blinding in these kinds of studies is difficult.

Unlike the earlier mentioned systematic reviews, Idáñez-Robles et al. (2023) focused on assessing the effectiveness of mandibular exercise therapy in managing TMD-associated pain. Likewise, more women were included in the comparison and the number of participants was 812 across sixteen studies, identified from six databases. This systematic review, which incorporated a meta-analysis, revealed a medium effect size of exercise therapy in managing pain associated with TMD. The meta-analysis employed SMD to calculate effect sizes, with an SMD -0.58 (95 % CI -1.01 to -0.12) presented in the analysis. The GRADE framework was utilized to summarize the overall evidence, and the risk of bias across studies was assessed using PEDro scale. Additionally, the $I^2$ percentage was employed as a measure to quantify the degree of heterogeneity among included studies.

In summary, the findings indicate that exercise aimed at posture has a positive effect in treating TMD. Additionally, manual therapy, especially when combining treatments for the neck and orofacial region, was found to enhance pain relief. Idáñez-Robles et al. (2023) noted a medium effect of mandibular exercise therapy in managing pain associated with TMD.

### 6.1.4 Physiotherapy for TMD

In this Master´s thesis, different modalities for treating TMD and associated pain were compared. It is important to note that the inclusion of specific studies was based on predefined criteria. The term ´physiotherapy´ served as one of the inclusion criteria to ensure a focused review of relevant interventions. It is worth noting that the scope of what constitutes physiotherapy can vary and is not always clear. The quality of studies is paramount. Paço et al. (2016), conducted a

systematic review, based on seven studies, aiming to find out the methodological quality of RCTs and to summarize the findings related to physiotherapy in TMD management. The study involved a comprehensive search among three databases and two independent reviewers assessed the articles. All age groups were encompassed, and physiotherapy was explained to include manual therapy, dry needling, and exercise therapy. The mean duration of the interventions was 5 weeks. Different types of pain were assessed. In reviews comparing ´pain at rest, ´ the consensus was that there existed a statistically significant difference in the outcomes, suggesting an impact on TMD-related pain. In this systematic review the quality was assessed with the Cochrane Risk of Bias tool, the PEDro scale, and the 5-point Jadad scale. The effect size was calculated with SMD (= -0.63; 95 % CI: -0.95 to -0.31) and $I^2$ percentage was employed to quantify the degree of heterogeneity.

The last study included, was a network meta-analysis conducted by Feng et al. (2019). The meta-analysis included 12 RCTs involving adult people. The systematic review adhered to PRISMA guidelines, with an examination of three databases. Two independent reviewers assessed the articles. Different treatment modalities were compared, including physiotherapy, and they highlighted that the participants were predominantly women. MDs or standard deviation of median difference were calculated to summarize the measurements. The rankogram shows the differences among the interventions, ranking physiotherapy as the second most effective in network meta-analysis. The results were further visualized using a plot. Additionally, as in the network meta-analysis of Al-Moraissi et al. (2021) a SUCRA curve was employed to assess the effectiveness of the various interventions. It was shown that physiotherapy may contribute to pain management in TMD, although no significant difference was observed when compared to placebo. A significant confounding element, as mentioned in the study, is the ´human factors´ and the proficiency of the therapists.

In summary, the findings indicate that different types of physiotherapy suggest an influence on pain in TMD, but as stated by Feng et al. (2019) there is no significant difference when compared to placebo.

Table 6. Various manual techniques.

| **Manual therapy method** | **Study authors** | **Outcome (Impact factor)** |
|---|---|---|
| Mobilization | Dickerson et al. (2017) | Therapeutic exercise, including mobilization, has an impact on reducing pain, but could not show a difference between groups. |
| | La Touche et al. (2020) | Cervical mobilization showed significant improvements in pain compared with controls, in TMD problems. |
| | Al-Moraissi et al. (2021) | Manual therapy including mobilization and manipulation was considered the most effective treatment for M-TMD. |
| | Liberato et al. (2022) | Manual therapy, including mobilization and manipulation applied to the cervical joint, reduced orofacial pain. |
| | Arribas-Pascual et al. (2023) | Mobilization/ manipulation of the TMJ and the upper cervical spine showed positive effects on patients with TMD. |
| Manipulation | Calixtre et al. (2015) | Manipulation and mobilisation of the upper cervical region shows effect on TMD pain, but the technique must be specified before drawing larger conclusions. |
| | Al-Moraissi et al. (2021) | Manual therapy including mobilization and manipulation was considered the most effective treatment for M-TMD. |

| | | |
|---|---|---|
| | Arribas-Pascual et al. (2023) | Thrust manipulation of C7-T1 showed low evidence or non-significant results on pain with TMD. (3,9) |
| | Vieira et al. (2023) | Manual therapy, such as manipulation affects pain in TMD, but the choice of technique should rely on the expertise of the health care professional. (3,2) |
| Exercise therapy | Armijo-Olivo et al. (2015) | Exercise programs that correct head and neck postures and active and passive oral exercises can be effective in reducing pain. (3,8) |
| | Idáñez-Robles et al. (2023) | Exercise therapy showed an advantage in treating pain with TMD. |
| | Vieira et al. (2023) | |
| Physiotherapy | Paço et al. (2016) | Physiotherapy, including manual therapy, dry needling, and exercise therapy seems to decrease pain. |
| | Feng et al. (2019) | Physiotherapy showed no advantage over placebo. |

### 6.1.5 Evaluation of study outcomes

The evaluation of study outcomes can be approached from various angles. Examining and interpreting results require a comprehensive understanding of the data, and considering different perspectives is crucial in gaining insights into the implications and significance of findings.

One approach to evaluating study outcomes is through the ranking of journals where the articles are published. The Impact Factor of a journal serves as an

indicator of its influence in the respective field, with higher Impact Factors signifying greater influence. Impact Factors for journals are available on their official websites. (Global Research Club 2023.)

Among studies included, the Journal of Clinical Medicine holds the highest Impact Factor at 3.9. (Table 7). This journal contributed to the systematic review titled ´Effects of physiotherapy on pain and mouth opening in Temporomandibular disorders: an umbrella and mapping systematic review with meta-meta-analysis´. This systematic review stated that manual therapy and exercises would have an impact on pain within TMD. Following closely is the Journal of Physical Therapy, having an Impact Factor of 3.8, associated with the systematic review titled ´Effectiveness of Manual Therapy and Therapeutic Exercise for Temporomandibular Disorders: Systematic Review and Meta-Analysis´. The results suggest that posture correction and oral exercises may reduce pain in TMD. The third-highest Impact Factor belongs to the journal Life, with an Impact Factor of 3.2 and it is linked to the systematic review titled ´The Efficacy of Manual Therapy Approaches on Pain, Maximum Mouth Opening and Disability in Temporomandibular Disorders: A Systematic Review of Randomized Controlled Trials´. This supports the prior results, which indicate that manipulation decreases pain in TMD. (MDPI 2023; PTJ 2023.)

Table 7. Impact factor of journals.

| **Journal** | **Systematic review** | **Impact factor** |
|---|---|---|
| Clinical Medicine | Effects of physiotherapy on pain and mouth opening in Temporomandibular disorders: an umbrella and mapping systematic review with meta-meta-analysis | 3,9 |
| Journal of Physical Therapy | Effectiveness of Manual Therapy and Therapeutic Exercise for Temporomandibular | 3,8 |

| | | |
|---|---|---|
| | Disorders: Systematic Review and Meta-Analysis | |
| Life | The Efficacy of Manual Therapy Approaches on Pain, Maximum Mouth Opening and Disability in Temporomandibular Disorders: A Systematic Review of Randomized Controlled Trials | 3,2 |

### 6.1.6 Risk of bias/ limitations

The results of this study should be interpreted considering certain limitations. The quality of the included reviews varied. One source of bias was the allocation concealment, which is crucial for internal validity. This could result in selection bias and affect the outcomes. Other sources of bias were random sequence generation bias and blinding of outcome data. However, the nature of the interventions in this kind of study made it particularly difficult to achieve blinding. (Armijo-Olivo et al 2015; Dickerson et al 2017.)

Another limitation could be the inherent natural capacity for change in the human body, which can affect the course of pain and impair the generalizability of the results. One limitation lies in the potential for variations in the interpretation of terms within the defined categories. For instance, the meaning of manual therapy in the studies included varied. This may influence the precision of the results and the readers should exercise caution when comparing the findings. There was also a limitation regarding the sample size and number of the studies included. (Al-Moraissi et al. 2021; Dickerson et al. 2017; La Touche et al. 2020; Pupo et al. 2016.)

# 7 VALIDITY, RELIABILITY AND ETHICS

The validity of this study is established through the congruence of the findings with the research questions, ensuring that the results and conclusions align with the specific objectives outlined. It is acknowledged, however, that external validity, about generalizability, is compromised due to constraints such as heterogeneity, limited sample size, and concerns about the quality of employed measurement methods. Generalizability is also impaired by the inherent natural capacity for change in the human body, as mentioned in Chapter 6.

The Master´s thesis, presented as a structured literature review, is a publicly accessible document subject to scrutiny by all. Ensuring research integrity is paramount, requiring a well-constructed, transparent, and honest framework. In adherence to the principles of the responsible conduct of research, this study prioritizes ethical considerations, transparency, and accuracy. The study design is delineated in Chapter 5.1 and presented in the ´Study Design´ table page 19. To maintain accuracy and honesty, the author has meticulously reviewed research methodologies from diverse sources, adhering to the guidelines of the Research Ethics Advisory Integrity (2023) (in Finnish: Tutkimuseettinen neuvottelukunta, TENK) (Forsberg, C. & Wengström, Y. 2015 & Jacobsen 2012; Sarajärvi & Tuomi 2018.)

In the domain of academic research, meticulous referencing is essential, adhering to guidelines established by South-Eastern Finland University of Applied Sciences. Proper citation of sources not only upholds scholarly standards but also acknowledges contributions to the body of knowledge. Clear and well-defined research questions guided the study. The foundation of this review rests exclusively on systematic reviews and meta-analyses and the appropriateness of selected search terms was verified by the school´s library staff. Peer-reviewed sources, not more than 10 years old, providing the most reliable information, have been employed. The included systematic review and meta-analyses were carefully restricted based on specific inclusion and exclusion criteria. The databases were selected to be appropriate for the study. The outcome summarized the evidence from the reviewed systematic reviews in an objective

way, without incorporating the author´s personal opinions. (Forsberg, C. & Wengström, Y. 2015 & Jacobsen 2012; Sarajärvi & Tuomi 2018.)

The chosen subject matter holds not only contemporary significance, but also global relevance, impacting millions of people worldwide, irrespective of age, race, or socioeconomic status.

Acknowledging limitations transparently reflects the nuanced research material in diagnosing TMD, emphasizing the need for continued advancements in future investigations.

## 8 DISCUSSION

The implementation of Covidence, a screening and data extraction tool, helped in the initial screening process, by efficiently removing duplicates, resulting in time savings. The utilization of the PRISMA flowchart, a standard tool for reporting systematic reviews, further enhanced transparency and visualized the structured workflow, seamlessly integrated with Covidence.

The limited number of systematic reviews regarding the diagnosis of TMD indicates a deficiency in the existing literature, emphasizing the need for further investigation into this topic. Despite an extensive systematically structured review, no systematic review tailored for clinicians was identified, leaving a gap in the current knowledge accessible to manual therapists. Both Pupo et al. (2016) and Barros et al. (2020) examined methods not accessible to clinicians. Clinicians require proprietary assessments, and results and conclusions should be comparable with evidence-based practice. By incorporating RCTs into the investigation of examination of TMD, the result could have been different.

However, this structured literature review has confirmed that it is possible to affect pain caused by issues in the temporomandibular joint. This finding corroborates the results of previous studies, which have concluded that various manual therapy modalities alleviate pain with TMD. Mobilization techniques are employed in various studies (Arribas-Pascual et al. 2023; Calixtre 2015; Liberato

et al. 2022, La Touche et al. 2020), all demonstrating positive effects in the treatment of TMD. However, each study adopts a slightly different approach. Calixtre et al. (2015), emphasize the treatment of ligaments, fascia, and muscles, aspects not explicitly mentioned in the other investigations. Liberato et al. (2022) also approve of massage, incorporating it within the realm of manual therapies. La Touche et al. (2020) explore mobilization treatments of craniofacial areas, while the others specifically highlight upper neck regions. Lastly, as underscored by the Arribas-Pascual et al. (2023) study, it is worth noting that incorporating counselling into the treatment significantly enhances the outcomes.

Considering this insight, it is essential to accept that comparability of the results is challenging due to various factors and also because etiopathogenesis and assessment of TMD differ. This could be avoided with subclassifications of the causes and a more standardized evaluation protocol.

A topic, discussed in many included systematic reviews, is heterogeneity, which can be defined as the variability among included studies (Fletcher 2007). This can be referred to as clinical, methodological, or statistical heterogeneity, and in the presence of significant heterogeneity, one may opt to refrain from presenting the results of a meta-analysis. Alternatively, the results can be depicted using a forest plot, albeit displaying the pooled effect (Booland 2017).

The sample size is crucial for the generalizability and reliability of the findings and a small sample size may limit the power of the analysis. For example, the study by Liberato et al. (2022) included just 213 participants, and the meta-analyses by Dickerson et al. (2016) included 152 participants when assessing the effects of exercise therapy on pain. According to Boland (2017), small studies are less accurate, and meta-analyses with a small sample should be given less weight. For the future, larger sample sizes would be recommendable and for the studies with the smallest sample, a new study with a more diverse sample would be indicated. Moreover, what must be considered is that most of the studies are conducted on women, which means that the results are not directly transferable to men, this can also be considered in future studies.

The positive risks of bias in the reviews included are considered a limitation and a potential concern in the study. This risk of bias suggests that the study´s result may not accurately reflect the actual relationship between variables due to methodological flaws. In this area, the researchers should strive to minimize bias to ensure that their findings are valid and can confidently be applied to the broader population. (Viswanathan 2018). Another concern is the issue of funding, as illustrated by Arribas-Pascual et al. (2023). Funding is an important factor in conducting research and research may require support, however, the funding can significantly impact the overall reliability and scope of the findings. In the included systematic reviews, sources are seldom clarified.

One method of comparing the included articles is by considering the Impact Factor of the journal. A higher Impact Factor signifies a greater reputation and increased trust in a journal, contributing to enhanced credibility for the systematic review. On the other hand, journals focusing on areas closely related to the topics in this review may be particularly relevant. For instance, notable publications such as the Journal of Oral Rehabilitation, Physical Therapy, Clinical Rehabilitation, and Journal of Oral & Facial Pain can be cited as relevant sources.

A notable limitation of this structured literature review is that it was conducted by a single author. While the review strives for rigor and impartiality, the absence of multiple contributors may introduce a potential bias in the selection and interpretation of the literature. Collaborative efforts involving multiple authors contribute to a more comprehensive analysis and minimize individual biases. Readers should approach results with caution, considering the potential influence of a singular perspective on the review process. For future research in this area, a team-based approach would enhance the objectivity and validity of the structured review.

On the other hand, the thesis had also strong aspects. The chosen topic was well selected and is relevant within the healthcare domain. People suffer from TMD

problems, leading to impairments regarding QoL, but also leading to significant societal costs, as highlighted in the ´Diagnosis´-chapter. The background theory was well-researched, and the choice of methodology was appropriate for this structured literature review. The databases selected were suitable for the subject area, and the search methods were thoroughly considered. While the inclusion criteria could have been more restrictive to facilitate better result comparisons, the broader perspective obtained allows for a comprehensive view of the subject. To the author´s delight, there are numerous methods available for exploration in this area.

The acknowledgment of the existing gap, regarding the examination of the TMD, specifically for clinicians, a proposal for a different research approach could be considered. This could give a more nuanced understanding of TMD examinations for clinicians and researchers alike. The improvement of clinical investigation methods is crucial for future studies, necessitating meticulous research with sufficiently large samples. This structured literature review has been unable to demonstrate one treatment better than another, for treating TMD. However, the findings show that it is worth treating with conservative methods, such as manipulation, mobilization, and exercises to improve posture.

## 8.1 Conclusion

The prevalence of TMD, affecting millions of individuals worldwide, underscores the importance of accurate diagnosis. While many databases were searched, no conclusive evidence for clinicians or manual therapists regarding the investigation of TMD was found. With a different approach, the results on this matter could have been different. For now, adhering to the Golden Standard DC/TMD is advisable as no superior alternative has been identified. In the future, investigations are needed to solve the problem regarding the diagnosis of TMD for clinicians.

In future studies, it may be beneficial to consider not only specified treatments but also the implementation of more tailored and nuanced sampling approaches. For example, exploring interventions such as mobilization or manipulation treatments

specifically tailored for musicians could provide valuable insights into the efficacy of targeted therapeutic strategies within a specified population. It may also be of interest to consider the potential divergence in outcomes between specific home exercises and supervised practice sessions. Understanding whether the effectiveness of exercise therapy is dependent upon self-administered routines, or the guidance of supervised sessions may offer meaningful perspectives for optimizing rehabilitation protocols.

To assess collaboration across borders, one could examine the potential outcomes of speech therapy in conjunction with mobilization or manipulation. This approach would enable a closer investigation of synergies and possible advantages arising from the combination of these therapeutic methods. Such a study could contribute to a deeper understanding of how various treatment modalities may complete each other, offering insights for future integrated and effective therapeutic approaches.

Nevertheless, despite the challenges in comparing the results in this review, regarding treatments, a notable trend suggests favorable outcomes for conservative manual therapies in treating TMD (Figure 4). Consequently, manual therapists need to practice their skills in mobilization, manipulation, and other exercise modalities when managing TMD. This can help millions of people worldwide to get a better QoL. The treatment modalities can range from diverse types of manual therapy such as spinal interventions, and treatments for the craniofacial area to postural exercises for the jaw or neck. It is also good to remember that treatment options may vary due to the therapist´s individual expertise and style.

The author of this Master´s thesis has gained valuable insights during the project. It became evident that precision is paramount when conducting any review. Thorough utilization of “to-do” lists and checklists is essential. Inclusion criteria require careful consideration, and the effectiveness of the methodology is significantly enhanced when carefully planned before any other undertaking. The support of other students and the supervisors was invaluable and the patience at

home was priceless. The course in Academic Writing for Master´s Thesis provided valuable advice both regarding writing skills and English language proficiency. Many things will be done differently next time and manual expertise concerning TMD issues continues.

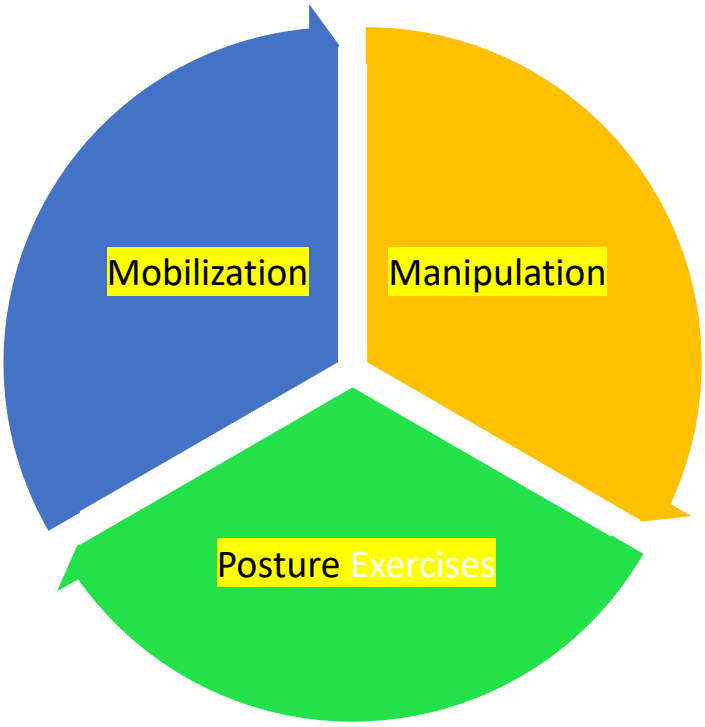


Figure 4. Recommended conservative treatments for TMD.

REFERENCES

Al-Moraissi, E., Conti, P., Alyahya, A., Alkebsi, K., Elsharkawy, A. & Christidis N. 2022. The hierarchy of different treatments for myogenous temporomandibular disorders: a systematic review and network meta-analysis of randomized clinical trials. *Oral and Maxillofacial Surgery,* 26: 519-533. Available at: https://doi.org/10.1007/s10006-021-01009-y [Accessed 20 September 2023].

Anatomy 3D Atlas. 2023. Version 5.1.0. Mobile application software. Available at: https://anatomy3datlas.com [Accessed 26 December 2023].

Armijo-Olivo, S., Pitance, L., Singh, V., Neto, F., Thie, N. & Michelotti, A. 2016. Effectiveness of Manual therapy and therapeutic Exercise for temporomandibular Disorders: Systematic Review and Meta-Analysis. *Physical Therapy*, *96*(1), 9–25. Available at: https://doi.org/10.2522/ptj.20140548 [Accessed 20 September 2023].

Arribas-Pascual, M., Hernández-Hernández, S., Jiménez-Arranz, C., Grande-Alonso, M., Angulo-Díaz-Parreño, S., La Touche, R., & París-Alemany, A. 2023. Effects of Physiotherapy on Pain and Mouth Opening in Temporomandibular Disorders: An Umbrella and Mapping Systematic Review with Meta-Meta-Analysis. *Journal of Clinical Medicine*, 12(3), 788. Available at: https://doi.org/10.3390/jcm12030788 [Accessed 20 September 2023].

Barros, B., Biasotto-Gonzalez, D., Bussadori, S., De Paula Gomes, C. & Politti, F. 2020. Is there a difference in the electromyographic activity of the masticatory muscles between individuals with temporomandibular disorder and healthy controls? A systematic review with meta-analysis. *Journal of Oral Rehabilitation*, *47*(5), 672–682. https://doi.org/10.1111/joor.12941 [Accessed 20 September 2023].

BMJ Best Practice. 2023. Web page. Available at: https://bestpractice.bmj.com/info/toolkit/learn-ebm/what-is-grade/ [Accessed 29 November 2023].

Bialosky, J., Bishop, M., Price, D., Robinson, M. & George, S. 2009. E-journal. The mechanisms of manual therapy in the treatment of musculoskeletal pain: a comprehensive model. *Manual therapy*, *14*(5), 531–538. Available at: https://doi.org/10.1016/j.math.2008.09.001[Accessed 21 March 2023].

Bishop, M., Torres-Cueco, R., Gay, C., Lluch-Girbés, E., Beneciuk, J. & Bialosky, J. 2015. What effect can manual therapy have on a patient's pain experience? *Pain management*, 5(6), 455–464. https://doi.org/10.2217/pmt.15.39 [Accessed 21 March 2023].

Boland, A., Cherry, G. and Dickson, R. 2017. Doing a Systematic Review: A Student's Guide. 2nd edition. Thousand Oaks, Canada: SAGE Publications. [Accessed 9 February 2023].

Calixtre, L., Moreira, R., Franchini, G., Alburquerque-Sendín, F., & Oliveira, A., 2015. Manual therapy for the management of pain and limited range of motion in subjects with signs and symptoms of temporomandibular disorder: a systematic review of randomised controlled trials. *Journal of Rehabilitation* 42, 847-861. https://doi.org/10.1111/joor.12321 [Accessed 27 November 2023].

Magee, D. 2014. *Orthopedic physical assessment*. 6th edition. E-book. Elsevier Health Sciences.

Cook, C. 2011. Immediate effects from manual therapy: much ado about nothing? *The Journal of manual & manipulative therapy*, 19(1), 3–4. Editorial. Available at: https://doi.org/10.1179/106698110X12804993427009 [Accessed 21 March 2023].

Covidence systematic review software, Veritas Health Innovation, Melbourne, Australia. 2023. Available at: https://www.covidence.org/ [Accessed 20 September 2023].

Craane, B., Dijkstra, P., Stappaerts K. & De Laat, A. 2012. Physical therapy for masticatory muscle pain. *EJP*, 16(5) 737-747. E-journal. Available at: https://doi.org/10.1002/j.1532-2149.2011.00038.x [Accessed 22 February 2023].

Dalewski, B., Kamińska, A., Szydłowski, M., Kozak, M. & Sobolewska, E. 2019. Comparison of Early Effectiveness of Three Different Intervention Methods in Patients with Chronic Orofacial Pain: A Randomized, Controlled Clinical Trial. *Pain research & management*. 2019. E-journal. Available at: https://doi.org/10.1155/2019/7954291 [Accessed 15 February 2023].

Dias, S., & Caldwell, D. M. 2018. Network meta-analysis explained. *Archives of Disease in Childhood-fetal and Neonatal Edition*, *104*(1), F8–F12. Available at: https://doi.org/10.1136/archdischild-2018-315224 [Accessed 27 November 2023].

Dickerson, S. M., Weaver, J. M., Boyson, A. N., Thacker, J. A., Junak, A. A., Ritzline, P. D., & Donaldson, M. 2016. The effectiveness of exercise therapy for temporomandibular dysfunction: a systematic review and meta-analysis. *Clinical Rehabilitation*, *31*(8), 1039–1048. Available at: https://doi.org/10.1177/0269215516672275 [Accessed 20 September 2023].

Ethical recommendation for thesis writing at universities of applied science. n.d. Web page. Available at: https://www.arene.fi/wp-content/uploads/Raportit/2020/ETHICAL%20RECOMMENDATIONS%20FOR%20THESIS%20WRITING%20AT%20UNIVERSITIES%20OF%20APPLIED%20SCIENCES_2020.pdf?_t=1578480382 [Accessed 19 March 2023].

Feng, J., Luo, M., Ma, J., Tian, Y., Han, X., & Bai, D. 2019. The treatment modalities of masticatory muscle pain a network meta-analysis. *Medicine*, *98*(46), e17934. Available at: https://doi.org/10.1097/md.0000000000017934 [ Accessed 20 September 2023].

Finnish center for evidence-based health care. n.d. Web page. Available at: https://www.hotus.fi/tutkimustiedon-hakeminen/ [Accessed 1 April 2023].

Fletcher, J. 2007. What is heterogeneity and is it important? *BMJ*, 334(7584), 94–96. Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1767262/ [Accessed 7 December 2023].

Forsberg, C. & Wengström Y. 2015 Att göra systematiska litteraturstudier: värdering, analys och presentation av omvårdnadsforskning. 4th edition. Natur & Kultur, Stockholm.

Global Research Club. 2023. Web page. Available at: https://globalresearcherclub.org/what-is-a-journal-impact-factor-and-why-is-it-important/ [Accessed 3 December 2023].

Herrera-Valencia, A., Ruiz-Muñoz, M., Martín-Martín, J., Cuesta-Vargas, A., & Gónzalez-Sánchez, M. 2020. Efficacy of Manual Therapy in Temporomandibular Joint Disorders and its Medium-and Long-Term Effects on Pain and Maximum Mouth Opening: A Systematic Review and Meta-Analysis. *Journal of Clinical Medicine*, *9*(11), 3404. Available at: https://doi.org/10.3390/jcm9113404 [Accessed 21 November 2023].

IASP Terminology. 2021. Web page. Available at: https://iasp-pain.org/resources/terminology/ [Accessed 6 September 2023].

Idáñez-Robles, A., Obrero-Gaitán, E., Lomas-Vega, R., Osuna-Pérez, M., Cortés-Pérez, I. & Zagalaz-Anula, N. 2022. Exercise therapy improves pain and mouth opening in temporomandibular disorders: A systematic review with meta-analysis. *Clinical Rehabilitation*, *37*(4), 443–461. Available at: https://doi.org/10.1177/02692155221133523 [Accessed 20 September 2023].

Jacobsen, D. 2012. *Förståelse, beskrivning och förklaring: introduktion till samhällsvetenskaplig metod för hälsovård och socialt arbete*.

Kalamir, A., Bonello, R., Graham, P., Vitiello, A. & Pollard, H. 2012. Intraoral Myofascial Therapy for Chronic Myogenous Temporomandibular Disorder: A Randomized Controlled Trial. *Journal of Manipulative and Physiological Therapeutics.* 35(1) 26-37. E-journal. Available at: https://doi.org/10.1016/j.jmpt.2011.09.004 [Accessed 22 February 2023].

Karolinska Institutet, 2023. Structured literature reviews- A guide for students. Web page. Available at: https://kib.ki.se/en/search-evaluate/systematic-reviews/structured-literature-reviews-guide-students [Accessed 11 March 2023].

Kuć, J., Szarejko, K. & Gołębiewska, M. 2020. Evaluation of Soft Tissue Mobilization in Patients with Temporomandibular Disorder-Myofascial Pain with Referral. *International journal of environmental research and public*

*health*, *17*(24), 9576. E-journal. Available at: https://doi.org/10.3390/ijerph17249576 [Accessed 15 February 2023].

La Touche, R., García, S., García, B., Acosta, A., Juárez, D., Pérez, J., Angulo-Díaz-Parreño, S., Cuenca-Martínez, F., París-Alemany, A., & Suso-Martí, L. 2020. Effect of Manual Therapy and Therapeutic Exercise Applied to the Cervical Region on Pain and Pressure Pain Sensitivity in Patients with Temporomandibular Disorders: A Systematic Review and Meta-analysis. *Pain Medicine*, *21*(10), 2373–2384. Available at: https://doi.org/10.1093/pm/pnaa021 [ Accessed 20 September 2023].

Liberato, F., Silva, T., Santuzzi, C., De Oliveira Ferreira, N. & Nascimento, L. 2023. Manual Therapy Applied to the Cervical Joint Reduces Pain and Improves Jaw Function in Individuals with Temporomandibular Disorders: A Systematic Review on Manual Therapy for Orofacial Disorders. *Journal of Oral and Facial Pain and Headache*, *37*(2), 101–111. Available at: https://doi.org/10.11607/ofph.3093 [Accessed 20 September 2023].

List, T. & Jensen, R. 2017. Temporomandibular disorders: Old ideas and new concepts. *Cephalalgia: an international journal of headache*, 37(7), 692–704. Available at: https://doi.org/10.1177/0333102416686302 [Accessed 18 March 2023].

Martins, W., Blasczyk, J., De Oliveira, M., Gonçalves, K., Bonini-Rocha, A., Dugailly, P. & De Oliveira, R. 2015. Efficacy of musculoskeletal manual approach in the treatment of temporomandibular joint disorder: A systematic review with meta-analysis. *Manual Therapy*, *21*, 10–17. Available at: https://doi.org/10.1016/j.math.2015.06.009 [Accessed 19 February 2023].

MDPI, *Life*. 2023. Web page. Available at: https://www.mdpi.com/journal/life [Accessed 3 December 2023].

MDPI, *Journal of Clinical Medicine*. 2023. Web page. Available at: https://www.mdpi.com/journal/jcm [Accessed 3 December 2023].

Melo, R., de Resende, C., de Figueiredo Rego, C., Bispo, A., Barbosa, G. & de Almeida, G. 2020. Conservative therapies to treat pain and anxiety associated with temporomandibular disorders: a randomized clinical trial. *International Dental Journal.* 70(4) 245-253. E-journal. Available at: https://doi.org/10.1111/idj.12546 [Accessed 15 February 2023].

Moraes, A., Sanches, M., Ribeiro, E. & Guimarães, A. 2013. Therapeutic exercises for the control of temporomandibular disorders. *Dental Press J Orthod*. 18(5):134-9. E-journal. Available at: https://www.scielo.br/j/dpjo/a/7hktPcYMLb9b3PLd9h3gR7C/?format=pdf&lang=en [Accessed 22 February 2022].

Nasri-Heir, C., Epstein, J. B., Touger-Decker, R. & Benoliel, R. 2016. What should we tell the patients with painful temporomandibular disorders about what

to eat? *Journal of the American Dental Association* 147(8), 667–671. Available at: https://doi.org/10.1016/j.adaj.2016.04.016 [Accessed 23 March 2023].

Olson, K. A. 2022. *Manual Physical Therapy of the Spine*. 3rd edition. Elsevier Health Sciences.

Paço, M., Peleteiro, B., Duarte, J. & Pinho, T. 2016. The Effectiveness of Physiotherapy in the management of temporomandibular Disorders: A Systematic review and meta-analysis. *Journal of Oral and Facial Pain and Headache*, *30*(3), 210–220. Available at: https://doi.org/10.11607/ofph.1661 [Accessed 20 September 2023].

PTJ, Physical Therapy & Rehabilitation Journal. 2023. Web page. Available at: https://academic.oup.com/ptj [Accessed 3 December 2023].

Pupo, Y., Pantoja, L., Veiga, F., Stechman-Neto, J., Zwir, L., Farago, P., De Luca Canto, G., & Porporatti, A. 2016. Diagnostic validity of clinical protocols to assess temporomandibular disk displacement disorders: a meta-analysis. *Oral Surgery, Oral Medicine, Oral Pathology, and Oral Radiology*, *122*(5), 572–586. Available at: https://doi.org/10.1016/j.oooo.2016.07.004 [Accessed 20 September 2023]

Roura, S., Álvarez, G., Solà, I. & Cerritelli, F. 2021. Do manual therapies have a specific autonomic effect? An overview of systematic reviews. *PloS one*, 16(12). Available at: https://doi.org/10.1371/journal.pone.0260642 [Accessed 21 March 2023].

Sarajärvi, A., & Tuomi, J. 2018. *Laadullinen tutkimus ja sisällönanalyysi: Uudistettu laitos*. Tammi. E-book. [Accessed 15 December 2023].

Sekito, F., Pintucci, M., Pirri, C., Ribeiro de Moraes Rego, M., Cardoso, M., Soares Paixão, K., Ribeiro da Silva, V. & Stecco, A. 2022. Facial Pain: RCT between Conventional Treatment and Fascial Manipulation® for Temporomandibular Disorders. *Bioengineering*, 9(7): 279. Available at: https://doi.org/10.3390/bioengineering9070279 [Accessed 22 February 2023].

Search start page. Xamk Kaakkuri. n.d. Web page. Available at: https://kaakkuri.finna.fi/ [Accessed 12 March 2023].

Standring, S. 2021. Gray´s Anatomy. The Anatomical Basis of Clinical Practice. 42nd edition. Elsevier Health Sciences. E-book. [Accessed 1 March 2023].

University of Oxford. n.d. Center for Evidence Based Medicine. Web page. Available at: https://www.cebm.ox.ac.uk/resources/ebm-tools/critical-appraisal-tools [Accessed 12 March 2023].

Viswanathan, M., Patnode, C., Berkman, N., Bass, E., Chang, S., Hartling, L., Murad, M., Treadwell, J., & Kane, R. 2018. Recommendations for assessing the risk of bias in systematic reviews of health-care interventions. Journal of Clinical

Epidemiology, 97, 26–34. Available at: https://doi-org.ezproxy.xamk.fi/10.1016/j.jclinepi.2017.12.004 [Assessed 9 December 2023].

Walczyńska-Dragon, K., Baron, S., Nitecka-Buchta, A. & Tkacz, E. 2014. Correlation between TMD and cervical spine pain and mobility: is the whole-body balance TMJ related? *BioMed research international*. https://doi.org/10.1155/2014/582414 [Accessed 18 March 2023].

Zakrzewska, J. 2009. *Orofacial pain*. E-book. Oxford; New York: Oxford University Press. Available at: https://kaakkuri.finna.fi/ [Accessed 17 September 2022].

Yetley, E., MacFarlane, A., Greene-Finestone, L., Garza, C., Ard, J., Atkinson, S., Bier, D., Carriquiry, A., Harlan, W., Hattis, D., King, J., Krewski, D., O'Connor, D., Prentice, R., Rodricks, J., Wells, G. 2016. Options for basing Dietary Reference Intakes (DRIs) on chronic disease endpoints: report from a joint US-/Canadian-sponsored working group. *American Journal of Clinical Nutrition.* E-journal. Available at: https://www.researchgate.net/figure/Hierarchy-of-evidence-pyramid-The-pyramidal-shape-qualitatively-integrates-the-amount-of_fig1_311504831 [Accessed 4 April 2023].

Appendix 1/1

Table of included research. Confidence Interval (CI), Physical Therapy (PT), Manual Therapy (MT), mean difference (MD), maximum mouth opening (MMO), standardized mean difference (SMD) TMD with muscular origin (M-TMD), network meta-analysis (NMA).

| Study | Study authors, year, journal | Purpose of the study | Included studies and participants | Data collection and analysis method | Main results |
|---|---|---|---|---|---|
| The hierarchy of different treatments for myogenous temporomandibular disorders: a systematic review and network meta-analysis of randomized clinical trials | Al-Moraissi, E., Conti, P., Alyahya, A., Alkebsi, K., Elsharkawy, A., Christidis, N. Yemen. 2022. Oral Maxillofacial Surgery. | To identify the best treatment for adult patients with M-TMD. | RCTs, which compared two or more of the following treatment modalities in patients with M-TMD: counseling therapy; occlusal appliances; manual therapy; laser therapy; dry needling; intramuscular injection of LA or BTX- | Database search: MEDLINE, EMBASE, CINAHL, CENTRAL, Scopus, and articles from additional sources. SMD analyzed the data. | Manual therapy can be considered the most effective treatment for M-TMD. However, considering the limitations of the studies included, and the scarce of strong evidence, the findings should be interpreted cautiously |

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| | | | A; muscle relaxants; hypnosis/ relaxation therapy; oxidative ozone therapy; and placebo or no treatment. 52 RCTs, number of participants unclear. | | |
| Is there a difference in the electromyographic activity of the masticatory muscles between individuals with temporomandibular disorder and healthy controls? A systematic review with meta-analysis | Barros, B., Biasotto-Gonzalez, D., Bussadori, S., Gomes, C. & Politti, F. Brazil. 2020. Journal of Oral Rehabilitation. | To determine whether there is a difference in the electromyographic activity of masticatory muscles between individuals with TMD and healthy controls. | Cross-sectional studies, crossover studies, and RCTs evaluated the EMG activity of the masseter and anterior temporal muscles. Altogether 738 participants. | Database search: Science Direct, EMBASE, MEDLINE, PEDro, SciELO, CINAHL and LILAC. MD and 95 % CI were calculated. | The results showed no evidence of differences in EMG signals by TMD patients compared to healthy controls. |
| Effectiveness of | Armijo- | To assess and | RCTs | Database | MT alone or |

| | | | | | |
|---|---|---|---|---|---|
| Manual Therapy and Therapeutic Exercise for Temporomandibular Disorders: Systematic Review and Meta-Analysis | Olivo, S., Pitance, L., Singh, V., Neto, F., Thie, N. & Michelotti, A. USA. 2016. Physical Therapy | summarize RCTs investigating the efficacy of MT and therapeutic exercise interventions in treating TMD. The focus was on evaluating methodological quality and comparing these interventions with other active treatments or standard care. | involving adults with TMD that compared any type of MT intervention or exercise therapy with a placebo intervention, controlled comparison intervention, or standard care were included. Altogether 1945 participants. | search: MEDLINE, EMBASE, Cochrane Library and Best Evidence, Web of Science, EBM reviews-Cochrane Central Register Trials, CINAHL, in addition to a manual search. The data were analyzed by MD and SMD with 95% CI. | in combination with exercises at the jaw or cervical level showed promising effects on reducing pain. |
| Exercise therapy improves pain and mouth opening in temporomandib | Idáñez-Robles, A., Obrero-Gaitán, E., Lomas-Vega, R., | To analyze the effectiveness of exercise therapy in improving pain and active or | RCTs evaluated the effect of exercise therapy on pain and | Database search: PubMed Medline, Web of Science, | Therapeutic exercise was an effective therapy to reduce pain |

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|---|---|---|---|---|---|
| ular disorders: A systematic review with meta-analysis | Osuna-Pérez, M., Cortés-Pérez, I. & Zagalaz-Anula, N. Spain. 2023. Clinical Rehabilitation. | passive maximum mouth opening in patients with TMD. | on active and passive maximum mouth opening in patients with TMDs. Altogether 812 participants. | Scopus, CINAHL Complete, and PEDRO in addition to a manual search. The data were analyzed by Cohen´s SMD and their 95 % CI. | in TMDs. |
| The effectiveness of exercise therapy for temporomandibular dysfunction: a systematic review and meta-analysis | Dickerson, S., Weaver, J., Boyson, A., Thacker, J., Junak, A., Ritzline, P. & Donaldson, M. USA. 2017. Clinical Rehabilitation | To investigate the effectiveness of exercise therapy on pain, function, and mobility outcomes in patients with TMJ dysfunction. | RCTs involving participants with TMJ dysfunctions, not post-surgical, were conducted. The exercise intervention was compared with another type of | Database search: Pub Med (two search strategies) and CINAHL, in addition to a manual search. MD or SMD analyzed the data with 95 % | Exercise therapy provides moderate short-term and varying long-term benefits in the reduction of pain. |

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|---|---|---|---|---|---|
| | | | treatment or placebo. 152 participants in the pain group. 419 participants in the whole study. | CI. | |
| Manual therapy applied to the cervical joint reduces pain and improves jaw function in Individuals with temporomandibular disorders: a systematic review on manual therapy for orofacial disorders | Liberato, F., da Silva, T., Santuzzi, C., de Oliveira, N. & Nascimento, L. Brazil. 2022. Journal of Oral & Facial Pain and Headache. | To examine the effect of manual therapy applied to the cervical joint for reducing pain and improving mouth opening and jaw function in people with TMDs. | RTCs on adults diagnosed with TMDs. The intervention was compared to no intervention/ placebo. Altogether 213 participants. | Database search: Medline, AMED, Embase, Cochrane, Global Health, and PEDro, in addition to a manual search. Mean and SD analyzed the data. | Manual therapy applied to the cervical joint had short-term benefits for reducing pain intensity. |
| Effects of physiotherapy on pain and mouth opening in Temporomandibular disorders: | Arribas-Pascual, M., Hernández-Hernández, S., | To assess the current evidence regarding the effect of PT interventions | Systematic reviews on adults, with or without a meta-analysis of RCTs, | Database search: PubMed, PEDro, Scielo, LILIACS and | It was shown that manual therapy and exercise interventions, |

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|---|---|---|---|---|---|
| an umbrella and mapping systematic review with meta-meta-analysis | Jiménez-Arranz, C., Grande-Alonso, M., Angulo-Díaz-Parreño, S., La Touche, R. & Paris-Alemany, A. Switzerland. 2023. Journal of Clinical Medicine | on pain and functional variables in temporomandibular disorders TMD. | controlled clinical trials, or a combination of both, given that they were primary studies from which useful information could be extracted. No language restrictions. Altogether 17611 participants. | EBSCOhost in addition to manual search. SMD analyzed the data with 95 % CI. | were effective in the reduction of pain intensity. |
| The effectiveness of physiotherapy in the management of temporomandibular disorders: a systematic review and meta-analysis | Paço, M., Peleteiro, B., Duarte, J. & Pinho, T. Portugal. 2016. Journal of oral & facial pain and headache | To analyze the methodologic quality, summarize the findings, and perform a meta-analysis of the results from randomized controlled trials that assessed the | RCTs assessed the effects of physiotherapy treatment regardless of blinding, age, gender, or race. Altogether | Database search: PubMed, EBSCO, and Science Direct in addition to manual search. SMD analyzed | Physiotherapy seemed to decrease pain. |

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| | | effects of physiotherapy management of temporomandibular disorders. | 329 participants. | the data with 95 % CI. | |
| Diagnostic validity of clinical protocols to assess temporomandibular disk displacement disorders: a meta-analysis | Pupo, Y., Pantoja, L., Veiga, F., Stechman-Neto, J., Zwir, L., BParm, P., Canto, G. &Porporatti, A. Brazil. 2016. Oral Medicine. | To evaluate the diagnostic validity of clinical examination protocols compared with MRI in adults with TMJ disk displacement disorders. | Studies that evaluated the diagnostic accuracy of clinical protocols to assess TMJ disorders in adults. No language or time restrictions. Altogether 730 participants. | Database search: Cochrane, LILACS, PubMed, Science Direct, SCOPUS, and Web of Science in addition to manual search. | Clinical examination protocols have poor validity in diagnosing DDwR and DDwoR compared with MRI. |
| The treatment modalities of masticatory muscle pain a network meta-analysis | Feng, J., Luo, M., Ma, J., Tian, Y., Han, X. & Bai, D. China. 2019. Medicine | To compare the treatment efficacy of more than 2 competing treatments in TMD. | RCTs compared treatment efficacy in TMD patients with masticatory muscle pain. Adult | Medline, Embase, and Cochrane Library Central in addition to manual search. | Complementary therapy seemed to be slightly more effective than the remaining treatment modalities |

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| | | | people with a diagnosis of masticatory muscle pain by DC/ TMD axis I or RDC/TMD axis I. | MD analyzed the data with CI. | for pain reduction in TMD patients. Physiotherapy showed no advantage over placebo. |
| Effect of manual therapy and therapeutic exercise applied to the cervical region on pain and pressure sensitivity in patients with temporomandibular disorders: a systematic review and meta-analysis | La Touche, R., García, S., García, B., Acosta, A., Juárez, D., Pérez, J., Angulo-Díaz-Parren o, S., Cuenca-Martınez, F., Paris-Alemany, A. & Suso-Martí, L. Spain. 2020. Pain Medicine. | To assess the effectiveness of cervical MT in patients with TMD and to compare cervico-craniomandibular MT treatment vs cervical treatment. | RCTs regarding the study's question and objectives. Adult people with chronic symptoms for> 3 months. 163 patients. | PubMed, Embase, PEDro, and Google Scholar. SMD analyzed the data with 95 % CI. | Cervical MT was more effective in decreasing pain intensity than placebo MT or minimal intervention. |
| The Efficacy of Manual Therapy Approaches on Pain, Maximum Mouth Opening and Disability in | Vieira, L., Pestana, P., Miranda, J., Soares, L., Silva F., | To investigate the effects of manual therapy on pain intensity, MMO, and disability in | RCTs regarding the study´s questions, included people of | Medline, Cochrane , Embase, Amed, Psychinfo | The results showed positive effects of manual therapy on |

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| Temporomandibular Disorders: A Systematic Review of Randomised Controlled Trials | Alcantara, M. & Oliveira, V. Brazil. 2023. Life. | TMD. | both sexes, regardless of age, with a TMD diagnosis. 1084 participants | , and Pedro. MDs and SMDs analyzed the data with 95 % CI. | pain both in and long term. |
| Manual therapy for the managment of pain and limited range of motion in subjes with signs and symptoms of temporomandibular disorder: a systematic review of randomized controlled trials | Calixtre, L., Moreira, R., Franchini, G., Alburquerque-Sendín, F., & Oliveira, A. Brazil. 2015. Journal of Oral Rehabilitation. | To synthesize how MT specifically impacts the pain in TMD. | RCTs regarding MT intervention versus placebo or control group. Measures regarding pain. No language restrictions. 8 studies on adult people were included. | Medline, Cochrane, Web of Science, SciELO, and Embase. SMD analyzed. | The results showed the strongest evidence for upper cervical manipulation or mobilization, and a mixed form of MT for pain in TMD. |

Appendix 2

Prisma Flowchart