A systematic review of the effectiveness of conservative therapy in the treatment and management of Temporomandibular Joint Disorders.

By

Samukelisiwe Nokulunga Hlongwane

Dissertation submitted in partial fulfilment of the requirements for the Masters of Health Sciences in Chiropractic in the Faculty of Health Sciences at The Durban University Of Technology

I, Samukelisiwe Nokulunga Hlongwane (student no. 21507383) do declare that this dissertation is entirely my own work in both conception and execution (except where acknowledgements indicate to the contrary)

[redacted] 31/07/2024

Samukelisiwe Nokulunga Hlongwane Date

Approved for final submission

01/08/24

Supervisor: Professor Peter McCarthy Date

01/08/2024

Co-supervisor: Dr Yasmeen Thandar Date

DEDICATION

It is with profound gratitude that I dedicate this dissertation to my beloved family: my parents Nelisiwe and Dingane, my sister Nontokozo, and my brothers Xolani, Celimpilo, and Mpumelelo, and to the youngest blessings of our family, Mandisa, Sinoxolo, Nkosingiphile, and Mvelo. Your unwavering support and love have guided me throughout this journey. This achievement is ours; your belief in me has been my strength. Forever grateful, MaNgwane.

ACKNOWLEDGEMENTS

First and foremost, I thank **God** for His guidance and strength.

I am deeply grateful to my supervisor, Professor Peter McCarthy, whose invaluable support and insights shaped this dissertation. I also appreciate my co-supervisor, Dr Thandar, for her guidance and constructive feedback.

To my parents, Nelisiwe and Dingane, my pillars of strength, your unwavering support and boundless love have been my bedrock. This achievement is a testament to the values you instilled in me.

To my sister, Nontokozo, my confidante and ally, your encouragement and understanding have been a source of great comfort and motivation. To my brothers, Xolani, Celimpilo, and Mpumelelo, my steadfast supporters, your constant belief in me has been a driving force throughout this journey.

To the youngest blessings of our clan, Mandisa, Sinoxolo, Nkosingiphile, and Mvelo, your joy and innocence have reminded me of the importance of perseverance and hope. I also want to acknowledge Zwelihle Nkosi for his support and encouragement throughout this process.

I am also thankful to all my reviewers, both local and international, for their invaluable feedback and expertise. Dr Charmaine Korporaal has my gratitude for her assistance. My best friend, Tiffany Grimett, has been with me from the start; your companionship and encouragement have been invaluable. I also want to acknowledge all my friends, the “nothing doers,” and my classmates for their camaraderie and support.

To Mrs. Amanda Makhonza who made my clinic and research journey memorable with her humour and encouragement, and Mrs. Twiggs, our clinic administrator, for providing efficient support and dedication.

To the DUT Health Sciences Library staff, you were instrumental with your assistance and resources.

Lastly, I want to express my appreciation to Lindani Miya for his friendship and belief in me.

ABSTRACT

Background: Temporomandibular disorders (TMD) encompass neuromusculoskeletal conditions affecting the temporomandibular joint (TMJ) and surrounding orofacial structures, particularly the muscles of mastication. Despite numerous treatment options, there is a dearth of evidence-based conservative interventions. This systematic review aims to evaluate the level of evidence for conservative TMD interventions to inform clinical practice guidelines.

Methods: A systematic search was conducted across databases including CINAHL, Cochrane Library, Medline, PubMed, ScienceDirect, Scopus, and Web of Science, supplemented by a hand search. The final search was completed on June 2022 and a supplementary search was performed in March 2023. Inclusion criteria encompassed studies evaluating conservative therapies for TMD in human subjects, while exclusion criteria included non-English studies, unavailable full texts, and studies not focused on conservative treatments. Risk of bias was assessed using the PEDro scale for RCTs, the Newcastle-Ottawa scale (NOS) for NRCTs, and the Liddle scale for case reports and series. Data were synthesized qualitatively. This review was registered in PROSPERO (CRD42023409560).

Results: From 4,148 records, 789 duplicates and 3 retracted articles were removed. Title screening excluded 3,141 articles, abstract screening excluded 172 articles, and full-text screening excluded 9 articles, leaving 31 eligible articles. An additional study identified through a hand search brought the total to 32, comprising 19 RCTs, 10 NRCTs, 1 case report, and 2 case series. The interventions evaluated included dry needling, exercise, physical therapy, ischemic compression, manipulation/mobilisation, and manual therapy. Strong evidence supports the effectiveness of dry needling, while moderate evidence was found for exercise, manual therapy, and multimodal interventions, such as cervical spine manipulation combined with other therapies. Limited evidence supports thoracic spine manipulation, myofascial techniques, physical therapy, and proprioceptive neuromuscular facilitation.

Conclusion: These findings highlight the potential benefits of conservative therapies in TMD management. Clinicians should prioritize dry needling, exercise, and manual

therapy, particularly in combination with other modalities, to optimize patient outcomes. Researchers should focus on conducting high-quality RCTs with standardized protocols and larger sample sizes to strengthen the evidence base, particularly for under-researched interventions such as thoracic spine manipulation and proprioceptive neuromuscular facilitation. Policymakers should consider integrating the strongest evidence-based interventions into clinical guidelines to improve accessibility and standardization of conservative TMD treatments.

Funding: This research received no external funding.

Keywords: TMD, temporomandibular joint, conservative therapy, systematic review, evidence-based practice, clinical guidelines.

TABLE OF CONTENTS

LIST OF TABLES

DEFINITIONS

Conservative therapy: a form of treatment or management intervention that does not involve surgical procedures and in this case does not involve any pharmacological and electro modalities intervention

External validity of a study: External validity concerns the generalizability of the study's findings to other populations, settings, and times (Andrade 2018).

Internal validity of a study: Internal validity refers to the degree to which the results of the study can be attributed to the interventions tested, free from the influence of external confounding factors (Andrade 2018).

Meta-analysis: A form of systematic review that includes the use of usually one, but sometimes more than one clinical outcome measure used in clinical studies that are included in a systematic review (Snyder 2019). This form of systematic review requires that the outcome measures are uniform (taken at similar intervals) and usually restricts the systematic review to RCT studies. This study is not a meta-analysis.

Non-invasive: a form of procedure that does not involve introducing an instrument that will penetrate the skin (*non-invasive procedure* 2012)

Non-randomize control trial: A non-randomized control trial is a study where subjects are assigned to different interventions without the use of random selection. Instead, the allocation is managed by the investigator, which can introduce bias into the trial's results (Sedgwick 2014)

Randomized control trial: A randomized control trial (RCT) is a scientific experiment designed to minimize bias when evaluating the effectiveness of new treatments. Subjects are randomly assigned to either a group receiving the intervention being tested or a control group receiving an alternative treatment. The outcomes of these groups are compared to determine any differences in the measured response. The results and subsequent analysis are used to assess the intervention's effectiveness (Kendall 2003).

Systematic review: This is a form of review that includes multiple different study types and considers to what extent each study provides evidence for a particular intervention (Snyder 2019). This data is then collated for several studies in respect of the invention using either GRADE or AGREE (Brouwers *et al.* 2010) to ascribe overall evidence.

Temporomandibular disorders: the term TMD is an umbrella term that refers to neuromusculoskeletal disorders (Macrì *et al.* 2022) that affect the temporomandibular joint (TMJ) and surrounding orofacial structures particularly the muscles of mastication and other associated soft tissue structures (Hanna *et al.* 2021).

ABBREVIATIONS

AI:	Asymmetry index
BDI-II:	Beck Depression Inventory
CCFT:	Craniocervical Flexion Test
CF-PDI:	Craniofacial Pain and Disability Inventory
CF-PDI:	Craniofacial Pain and Disability Inventory
CSM:	cervical spinal manipulation
DALRO:	Dramatic, Artistic and Literary Rights Organisation.
DDN:	Deep Dry Needling
DUT:	Durban University of Technology
EMG:	Electromyography
FoHS:	Faculty of Health Sciences
FRC:	Faculty Research Committee
GAD-7:	Generalized Anxiety Disorder 7-item scale
GCPS:	Graded Chronic Pain Scale
GPS:	Global Posture System
GROC:	Global Rating of Change
HIT-6:	Headache Impact Test
HPT:	Home physical therapy
HVLAT:	High-Velocity Low-Amplitude Thrust
ICT:	Ischaemic Compression Technique

JFLS-8:	8-item jaw functional limitation scale
MAMO:	Maximum Assisted Mouth Opening
MIO:	Maximum Interincisal Opening
MMO:	Maximum Mouth Opening
MT:	Manual Therapy
MAMO:	Maximum Assisted Mouth Opening
MIO:	Maximum Interincisal Opening
MMO:	Maximum Mouth Opening
MOU:	Memorandum of Understanding
MT:	Manual Therapy
NE:	Neck Exercise
NDI:	Neck Disability Index
NOS:	Newcastle Ottawa Scale
NRCT:	non-Randomized control trial
NRS/NPRS:	Numeric Pain Rating Scale
OHIP-14:	Oral Health Impact Profile-14
PE:	Patient Education
PMO:	Painless Mouth Opening
PPT:	Pressure Pain Thresholds
PNE:	Percutaneous Needle Electrolysis
PNF:	Proprioceptive Neuromuscular Facilitation

PRISMA:	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
PROSPERO:	International Prospective Register of Systematic Reviews
PT:	Physical Therapy
QoL:	Quality of Life
RCT:	Randomized control trial
RJM:	Rhythmic joint mobilization
ROM:	Range of motion
SM:	Sham Manipulation
sEMG:	Surface Electromyography
SF-12:	12-item Short Form Health Survey
SF-36:	Short Form 36
THI:	Tinnitus Handicap Inventory
TMD:	Temporomandibular Disorders
TMJ:	Temporomandibular Joint
TSK-11:	Tampa Scale for Kinesiophobia
VAS:	Visual Analogue Scale
VMO:	Vertical mouth opening

1 CHAPTER ONE: INTRODUCTION

1.1 Introduction

Temporomandibular joint disorders are a very common musculoskeletal health problem with about 70% of the population showing some signs of TMD (Lomas 2018). TMD causes the most common signs and symptoms such as limitations in mouth opening and jaw movements, pain over the TMJ area and surrounding structures, as well as popping, and cracking sounds in the TMJ (Chandak *et al.* 2017).

There does not appear to be a consensus among clinicians when it comes to management of TMD. This might reflect the overall lack of readily available literature with summarized evidence in support of conservative interventions used in the treatment and management of TMD (Li and Leung 2021). This research therefore aimed to identify and evaluate the evidence supporting the effectiveness of conservative interventions used in the treatment and management of TMD.

This chapter provides the introduction to the research by first discussing the background of TMD, followed by outlining the research problem, rationale, aims, objectives and the research question together with a discussion of the limitations of the study.

1.2 Rationale

The term TMD is an umbrella term that refers to neuromusculoskeletal disorders (Macrì *et al.* 2022) that affect the temporomandibular joint (TMJ) and surrounding orofacial structures particularly the muscles of mastication and other associated soft tissue structures (Hanna *et al.* 2021).

TMD causes a variety of symptoms which include TMJ clicking, pain and or tenderness over and around the TMJ area, pain on chewing, bruxism, decreased joint movement, facial asymmetry, and headaches (Chandak *et al.* 2017). TMD has also been linked to several otological symptoms such as tinnitus, deafness, dizziness, and ear fullness (Kusdra *et al.* 2018).

The Helkimo index (Rani *et al.* 2017) and the Research Diagnostic Criteria for TMD (RDC/TMD) (Schiffman *et al.* 2010a; Schiffman *et al.* 2010b; Schiffman *et al.* 2014) are popular tools used in the diagnosis of TMD however, literature tends to favour the RDC/TMD diagnostic tool (Harrison, Thorp and Ritzline 2014; Talaat, Adel and Al Bayatti 2018). MRI is said to be the gold standard for diagnosing TMD (Schiffman and Ohrbach 2016; Lomas 2018) and the use of both MRI and the RDC/TMD is a common practice when diagnosing TMD (Park *et al.* 2012; Michelotti, Vollaro and Cimino 2019). The RDC/TMD diagnostic tool classifies TMD into three groups which are muscle disorders, disc displacement and other common joint diseases namely osteoarthritis, osteoarthrosis and arthralgia (Schiffman *et al.* 2014).

Given this clinical presentation, literature seems to suggest that females have a higher prevalence of TMD compared to males. This may be attributed to the fact that studies to have a higher number of female subjects compared to males with female participation percentages ranging from 68,7% to 81,3% (Manfredini *et al.* 2010; Loster *et al.* 2017; Bueno *et al.* 2018; de Melo Júnior *et al.* 2019).

However, studies have looked at the possibility of females being diagnosed with TMD more than males, e.g., Manfredini *et al.* (2012) noting that more females were diagnosed using the RDC/TMD diagnostic tool. Additionally, a systematic review, Manfredini *et al.* (2011), suggested that more females tend to seek TMD treatment compared to males. It would be valuable to investigate whether the observed gender differences in TMD diagnosis persist when using other diagnostic tools and to explore if females are disproportionately favoured in the diagnostic process. Such studies could involve examining a general population with multiple diagnostic tools to determine any discrepancies in gender diagnosis rates.

In terms of age, TMD appears to be more prevalent in children and adolescents with age ranges from as young as 7 years to about 19 years of age (Look *et al.* 2010; Hongxing *et al.* 2016; de Melo Júnior *et al.* 2019; Hanna *et al.* 2021; Macrì *et al.* 2022). However, there are studies that have found a higher age prevalence in the adult population (Muthukrishnan and Sekar 2015) with a TMD prevalence of 55,1% in male subjects between the ages of 18-30 and 44,8% in female subjects between the ages of 31-50 years: however, this may have been a local phenomenon, the study was performed in Chennai, India, and awaits confirmation by studies from elsewhere. A

similarly high prevalence of TMD in older (45-65 years old) people was reported by Yadav *et al.* (2018). However, Scelza *et al.* (2022) noted that the prevalence was highest between the ages of 18 and 39 years in their questionnaire study performed on an Italian population. It is unclear whether the prevalence differences are methodological (e.g., sample recruitment, level of anonymity), or population types studied, or based on the definition and clinical presentation of TMD and its interpretation in the various studies.

These demographic variances may stem from the multifactorial aetiology of TMD which impacts the identification of the disorder and its reporting. Broadly, the aetiological factors can be classified as neuromuscular, biomechanical (Chisnoiu *et al.* 2015), psychosocial (Licini *et al.* 2009), and genetic (Melis and Giosia 2016). Dental occlusion has also been a factor linked to the development of TMD however, it has not been shown as a precipitating cause of TMD (Turp and Schindler 2012). Finally, parafunctions such as excessive chewing (e.g., chewing gum) and bruxism, trauma and head and neck posture have also been linked to the development of TMD (Tanti, Himawan and Kusdhany 2016).

Notwithstanding the variance in aetiology and the complex clinical presentation, there appears to be consensus regarding TMDs treatment goals, where a reduction of pain and improvement of the joint's range of motion are the main objectives (Gauer and Semidey 2015). TMD treatment is classified into non-invasive, minimally invasive, and fully invasive therapeutic interventions (Murphy et al. 2013; Cobo, et al. 2019). In this context, the non-invasive approach is widely preferred (Mohsin and Banduji 2020; Chu *et al.* 2023); however, treatment is symptomatic and is usually based on the aetiology and progression of TMD. This means that non-invasive therapeutic interventions tend to be preferred early in the disorder and should the TMD be recalcitrant, a more invasive approach is only taken later (Wieckiewicz *et al.* 2015). Fully invasive treatment procedures (e.g., surgical interventions) that carry a higher risk to the patient (e.g., facial nerve paralysis) are usually left as a last resort (Jewell, 2019).

Given that most non-invasive therapies are conservative interventions, they appear popular in the management of TMDs (Gauer and Semidey 2015). Clinically, Abouelhuda, Kim and Hegazy (2018b) and Cobo *et al*. (2019) concurred that physical therapy, medication (NSAID), and splint therapy or occlusal orthodontics are the most

popular and most used conservative therapies. Behavioural therapy (Iwasaki *et al.* 2018), physiotherapy (Grootel *et al.* 2017), and psychotherapy (Magesty *et al.* 2021) are other conservative therapies that have been used in the management of TMDs. These have shown varied success but are also used in the clinical practice (Butts et al. 2017).

Chiropractic and osteopathic manipulation, acupuncture, and Botox injections are gaining popularity however, have not been accepted as care pathways, probably due to a lack of evidence supporting their effectiveness (Butts et al. 2017; Dimitroulis 2018). This impacts significantly on the clinician (e.g. chiropractor) providing best evidence for the suggested interventions (Greenhalgh, Howick and Maskrey 2014), limits the patients ability to access all information required for a fully informed consent process (Hall, Prochazka and Fink 2012), does not underpin or allow for negotiation around patient preference (Alfandre 2016), and thus reduces the likelihoods of an optimal clinical outcome for the patient (Kazdin 2008; Chowdhury and Turin 2020).

Clinicians wade through this clinical quagmire by using a multidisciplinary approach ("throwing the book at the patient") to ensure best clinical outcomes in the conservative management of TMDs. (El-Tallawy et al. 2021). Therefore, a systematic review, that reviews and clearly delineates what is known in the literature would assist in addressing these concerns, improve clinical outcomes for patients and provide a reference point for further research in order to address gaps that exist in the clinical treatment (non-invasive conservative care domain) (Munn *et al.* 2018).

1.3 Research problem

The lack of a repository that reflects the current status of evidence with respect to non-invasive conservative interventions in the treatment of TMDs provides limitations to respecting patient preference (Brom *et al.* 2014), patient rights, and informed consent (Hall, Prochazka and Fink 2012; Hammami *et al.* 2014), as well as impacting on appropriate clinician decision making (Elwyn *et al.* 2012).

1.3.1 Objectives

1.3.1.1 To systematically identify relevant, appropriate, and current literature on conservative treatment forTMDs.

1.3.1.2 To determine the level of evidence that each article provides in terms of conservative therapy in the treatment and management of TMDs.

1.3.1.3 To determine the overall level of evidence for each intervention.

1.3.1.4 To provide clinical and research recommendations for future studies around TMDs.

1.3.2 Aim

The aim of the study was to determine the strength of evidence regarding the effectiveness of conservative therapy in the treatment and management of TMDs through evaluating currently available literature on the use of specific conservative therapies in the treatment and management of T MDs with possible implications for clinical practice guidelines.

1.3.3 Research question

What is the current state of evidence supporting the effectiveness of dry needling, exercise and physical therapy, ischemic compression, manipulation/mobilisation, and manual therapy as conservative therapies for the treatment and management of Temporomandibular Joint Disorders TMD?

1.4 Scope of review

The TMJ is an important joint in contributing to the patient being able to eat, drink, breath, and talk (Bordoni and Varacallo 2021), which are all functions essential in good health and social interaction (Yost, Liverman and English 2020). TMDs negatively impact these functions therefore, it is imperative that the available treatment options for all TMDs are evidence based, clinically impactful and respectful of patient preference (Kelly *et al.* 2015).

These elements of evidence-based practice are also essential for the practitioner in that it allows for obtaining appropriate informed consent and best practice evaluation of options available to the patient (Farrah *et al.* 2019). Both of these important parts of clinical practice in the South African context also underpin the rights of the patient as based on the Patient's Rights Charter (South Africa 1999) and the constitution of South Africa (South Africa 1996).

Most of the literature in terms of patient preference suggests that a non-invasive conservative approach to the treatment and management of TMDs is preferred (Abouelhuda, Kim and Hegazy 2018a). This seems to be supported in that patients prefer the least invasive and perceived safest alternatives to more invasive surgical interventions and the host of complications that are associated with surgery of the temporomandibular joint and surrounding orofacial structures (Tawfik *et al.* 2019b).

From an evidence-based and clinically impactful perspective, however, there is a lack of evidence available to guide both the clinicians (e.g. chiropractors) and patients in terms of the most appropriate and effective conservative therapies used in the treatment and management of TMDs.

Most literature on the conservative treatment and management of TMDs is contradictory and seems to lack consensus (Shun Li and Leung 2021). This could be the result of varying quality of studies providing information in this domain (Murphy *et al.* 2013; Butts *et al.* 2017b; Shun Li and Leung 2021).

Therefore, a composite, well-structured systematic review on non-invasive conservative therapy was necessary, to address the patient preference, the clinical impact need and to show that there was indeed information from which to draw effective informed consent decisions. In addition, a systematic review as proposed in this document, may also assist in providing clinical practice guidelines (Ferrillo *et al.* 2022) and improve consensus regarding the use of the most appropriate and effective conservative therapies for the treatment and management of TMDs (Gopalakrishnan and Ganeshkumar 2013).

1.5 Conclusion and outline of subsequent chapters.

In conclusion, this chapter provided an essential foundation for the research study by outlining its necessity, relevance, rationale, and limitations. The subsequent chapters will build on this foundation: Chapter Two will present a comprehensive literature review, detailing the anatomy of the TMJ and the pathologies affecting it and its surrounding soft tissue structures. Chapter Three will explain the research methodology, describing the systematic approach employed in this study. Chapter Four will present the results obtained from the collected data, and Chapter Five will offer a discussion and analysis of these findings. Finally, Chapter Six will conclude the study, offering recommendations for future research and practical applications of the reviewed interventions.

2 CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

Chapter two provides a comprehensive exploration of TMD, beginning with an examination of its intricacies and its relationship with soft tissue structures. It proceeds to analyse the various risk factors contributing to TMD and carefully examines its underlying pathophysiology. The chapter closely examines the clinical presentation of TMD, highlighting its nuanced aspects. Additionally, it explains the diverse diagnostic methodologies used in clinical practice. This chapter also discusses a range of treatment strategies, both established and emerging, aimed at alleviating the effects of TMD. Finally, a definition of a systematic review and what it entails is covered in this chapter, addressing the significance of systematic reviews in advancing our understanding of TMD and facilitating further research and clinical progress in this field.

2.2 Definition of TMD

The understanding of TMD has evolved significantly over time. Annandale's early medical description in 1887 identified mechanical issues with the TMJ disc, inadvertently leading to a traditional focus on the TMJ as the primary source of TMD discomfort. This view was expanded by Costen in 1934, who attributed TMJ discomfort to specific dental malocclusions and linked otologic pain symptoms to inadequate occlusal support of the jaw, thereby broadening the scope of factors considered in TMD.

As research progressed, Talley *et al.* (1990) redefined TMD to encompass a variety of clinical issues, such as myalgia, internal derangements, arthritic conditions, and craniofacial discomfort. This comprehensive definition marked a shift from a singular focus on the TMJ to a broader perspective that included various musculoskeletal and neuromuscular components. Similarly, Luther (1998) emphasized the wide range of TMJ-related signs and symptoms, integrating the bones, muscles, and other facial structures into the definition.

The understanding of TMD continued to evolve with Gauer and Semidey (2015), who described it as a diverse range of musculoskeletal and neuromuscular diseases affecting not just the TMJ complex but also other osseous and musculoskeletal structures. This broadened perspective was further refined by Ohrbach and Dworkin (2016), who distinguished between TMD and TMDs, noting that TMD refers to a specific type or component of an illness, while TMDs encompass a wide range of musculoskeletal problems.

More recent contributions by Hanna *et al.* (2021) and Macrì *et al.* (2022) describe TMD as a broad range of neuromusculoskeletal conditions impacting the muscles of mastication and other orofacial structures, in addition to the TMJ itself. Minervini *et al.* (2023) further elaborate on the complexity of TMD, highlighting the intricate disorders involving the TMJ, jaw muscles, including masticatory muscles, and the associated nerves. Additionally, factors affecting motor output and sensory perception, such as stress and psychological factors, can also initiate or exacerbate TMD issues, further emphasizing the complex interplay of physical and psychological components in TMD aetiology (Canfora *et al.* 2023). This progression in definitions reflects a growing recognition of the multifactorial nature of TMD, illustrating how advances in technology and a deeper understanding of musculoskeletal and neuromuscular interactions have shaped current perspectives.

2.3 Anatomy involved in TMD

2.3.1 The Temporomandibular Joint (TMJ)

The TMJ is an altered synovial hinge joint that is formed when the mandibular condyle articulates against the mandibular fossa of the temporal and tympanic bones at the base of the skull (Young 2015). An articular disc exists between the articulation points of the TMJ (mandibular head / condyle, mandibular fossa, and the articular tubercle of the temporal bone) and the synovial hinge nature of the TMJ is attributed to this unique mechanism (Moore, Dalley and Agur 2018). The articular disc is biconcave and is lined with fibrocartilaginous cartilage and the discs splits the joint into two parts of synovial cavities namely the superior and inferior articular cavities (Shaffer *et al.* 2014a).

The synovial hinge nature of the TMJ allows for translation, pivoting, elevation, and depression of the mandible to occur (Moore, Dalley and Agur 2018). The mandible moves in a hinge-like manner due to the TMJ, allowing for significant movement in a single plane (Moore, Dalley and Agur 2018). This motion opens the mouth to about half of its maximum. The lateral, protrusive, and retrusive movements, as well as the second half of the maximal mouth opening, are all made possible by the TMJ condyle's sliding action (Young 2015).

2.3.2 Muscles and related ligaments

The TMJ is a complex joint surrounded by a rich diversity of soft tissue structures, including muscles and ligaments. The primary muscles involved in TMD are the muscles of mastication: the masseter, temporalis, medial pterygoid, and lateral pterygoid and (Shaffer *et al.* 2014a) offer a comprehensive overview of these muscles' roles in TMD, providing valuable insights into the condition's underlying mechanisms.

Likewise, the TMJ has an array of accessary ligaments that stabilize the joint while allowing for movement within the normal range of motion of the joint (Cuccia, Caradonna and Caradonna 2011). However, like the muscles related to the TMJ not all the ligaments are involved in TMD. The accessory ligaments namely the sphenomandibular, stylomandibular, and pterygomandibular ligaments together with the temporomandibular / lateral ligament have been most associated with TMD (Cuccia, Caradonna and Caradonna 2011; Wilkie and Al-Ani 2022).

Table 2.1 Muscles of mastication

Muscles	**Origin**	**Insertion**	**Function**
Masseter	The masseter is a quadrangular shaped muscle that occupies the superficial layer of the face bilaterally. It originates from the inferior border of the	The masseter inserts in the mandible at the angle and lateral surface.	The masseter causes elevation of the mandible, which causes the mouth to close. It also facilitates the mandible's

	zygomatic arch and the maxillary process of the zygomatic arch.		protrusion, enabling the anterior movement of the mandible
Temporalis	The triangular shaped temporalis muscle originates from the floor of the temporal fossa.	This muscle inserts to the coronoid process of the mandible and the anterior border of the mandibular ramus.	This muscle causes the mandible to elevate and retract.
Medial pterygoid	This is a two headed quadrangular shaped muscle with two origins. The first head originates from lateral pterygoid plate on its medial surface. The second head originates from the tuberosity of the maxilla.	The medial pterygoid muscle has one insertion which is the medial surface of the mandibular ramus.	The medial pterygoid operates in concert with the masseter to elevate and protrude the mandible.
Lateral pterygoid	This is a two headed triangular shaped muscle. The lateral side of the lateral pterygoid plate is where the inferior head begins, while the infratemporal surface and crest of	The inferior head attaches to the pterygoid fovea on the condylar neck of the mandible anteromedially, while the superior head inserts at the joint	This muscle facilitates the mandible's protraction and the TMJ's anterior movement, which opens the mouth. The mandible can only be lowered because of

	the great wing of the sphenoid bone are the source of the superior head.	capsule and articular disc of the TMJ.	this one masticatory muscle as it is the only masticatory muscle causing depression of the jaw.

(Moore, Dalley and Agur 2018)

Table 2.2 accessory ligaments of the TMJ

Ligaments	**Origin**	**Insertion**	**Function**
Temporomandibular / lateral ligament	The lateral ligament, which is also referred to as the thickened lateral portion of the TMJ capsule, begins at the articular tubercle, which is the lateral surface of the temporal bone's articular eminence.	This ligament attaches to the posterior border of the condyle's neck.	This ligament's function, in addition to providing primary support for the joint, is to limit posterior and inferior movements of the mandible during retrusive and protrusive movements.
Sphenomandibular ligament	The sphenomandibular ligament begins at the spine of the sphenoid bone.	The attachment site of this ligament is the lingula of the mandible.	The purpose of this ligament is to stop the jaw from protruding excessively. It functions as the mandible's main

			passive support, acting as a fulcrum and check ligament to control the mandible's motion.
Stylomandibular ligament	When the fibrous capsule of the parotid gland thickens, this ligament forms. The ligament then emerges for the temporal bone's styloid process.	The mandible's posterior border and angle serve as the stylomandibular ligament's attachment points.	Given the uncertainty surrounding its function, the ligament makes a minimal contribution to the strength of the TMJ.
Pterygomandibular ligament / pterygomandibular raphe	As the buccopharyn-geal fascia thickens, this ligament develops. It is a slender band that originates from the medial pterygoid plate of the skull's hamulus.	The ligament attaches to the mandible's retromolar trigone at the posterior end	The main function of the raphe is to serve as the attachment site for the buccinator and superior pharyngeal constrictor muscles.

(Moore, Dalley and Agur 2018)

2.3.3 Blood supply of the TMJ

The TMJ sits in an area with a high level of blood flow and as a result, the TMJ has a rich and diverse arterial supply (Ângelo *et al.* 2022). The superficial temporal artery, a terminal branch of the external carotid artery, and the deep auricular artery, which

originates from the maxillary artery, provide most of the blood supply. Furthermore, the anterior tympanic artery, a branch of the maxillary artery, also supplies blood to the joint (Wilkie and Al-Ani 2022).

The superficial temporal artery mainly supplies the anterior and lateral aspects of the TMJ with the anterior portion specifically being supplied by the posterior deep temporal artery. The medial aspect of the TMJ is supplied by the anterior tympanic artery and the middle meningeal artery which are both branches of the maxillary artery (Wilkie and Al-Ani 2022).

2.3.4 Innervation of the TMJ

The innervation of joints is better understood mainly due to the work of John Hilton, who formulated Hilton's law. Hilton's law states that the sensory innervation of joints comes from the nerves that supply the muscles acting on the joint (Hilton 1863). This principle has enhanced our understanding of TMJ innervation, as the TMJ's sensory innervation is mostly supplied by branches of the trigeminal nerve's mandibular division (Demerjian, Barkhordarian and Chiappelli 2018), which also innervates all the muscles of mastication, the primary muscles acting on the TMJ (Moore, Dalley and Agur 2018).

The auriculotemporal branch of the third division of the trigeminal nerve which is the mandibular division innervates the TMJ predominantly, with supplementary innervation provided by the masseteric and posterior deep temporal nerves (Wilkie and Al-Ani 2022).

2.4 Risk factors

TMD is recognized as a multifaceted and intricate condition with biopsychosocial dimensions, precluding the identification of a singular causative factor in any given patient (Kapos *et al.,* 2020). The manifestation of painful TMD and accompanying symptoms is contingent upon the interplay of biological, psychological, and social susceptibilities with contextual and environmental stressors, occurring either with or without identifiable initiating events (Kapos *et al*., 2020). While numerous risk variables have been implicated in predicting the onset of TMD, there exists a paucity of research

investigating temporal variations in these risk factors and their respective contributions to TMD risk (Ohrbach *et al.* 2020).

2.4.1 Gender and Hormonal Factors

A conspicuous gender-based predilection is apparent in the heightened prevalence of TMD among females, as evidenced by studies conducted by Manfredini *et a*l. (2010), Loster *et al.* (2017), Bueno *et al.* (2018), and de Melo Júnior *et al.* (2019). This observed disproportion in incidence prompts an exploration into the plausible role of hormonal dynamics in contributing to manifestations of TMD. However, existing research has predominantly focused on the prospect of a greater prevalence of TMD diagnoses in females compared to males. For example, Manfredini *et al.* (2012) identified a higher incidence of TMD diagnoses in females utilizing the RDC/TMD diagnostic tool. Furthermore, Manfredini *et al*. (2011) posited that females exhibit a greater proclivity to seek TMD treatment compared to their male counterparts. Notably, reproductive phases such as menstruation and pregnancy, characterized by pronounced fluctuations in hormones such as oestrogen and progesterone, have been implicated as significant factors (Patil *et al.,* 2015; Ivković *et al*., 2018; Jedynak *et al.,* 2021). The intricate interplay between hormonal variations and TMD susceptibility is hypothesized to underlie the gender-specific prevalence patterns observed.

Additionally female hormones like oestrogen have significant effects on pain receptors and inflammatory processes (Dalewski *et al.* 2020). For instance, oestrogen fluctuations before puberty, during menstruation, during pregnancy and after menopause can impact pain thresholds and TMD-related pain (Minervini *et al.* 2024). High oestrogen levels tend to inhibit inflammatory processes, reducing TMD-related pain, while low levels can induce pro-inflammatory effects, increasing pain (Dalewski *et al.* 2020).

2.4.2 Age

Advanced age has emerged as a noteworthy risk factor in both the onset and progression of TMD, as delineated by studies conducted by Yadav *et al*. (2018) and Scelza *et al.* (2022). The aging process introduces a constellation of physiological changes within the TMJ and its associated structures, potentially rendering them more

susceptible to dysfunction (Yadav *et al*., 2018). Degenerative alterations in joint tissues, diminished cartilage resilience, and modifications in the biomechanical properties of the masticatory apparatus collectively contribute to the heightened vulnerability observed in older individuals (Alexiou, Stamatakis, and Tsiklakis, 2009; Chen *et al*., 2020; Zhou *et al.,* 2021). Furthermore, age-related changes in neuromuscular control and proprioception may further exacerbate the risk of TMD. Diminished muscle tone, coupled with a potential decline in adaptive capacities, may compromise the stability and coordination of jaw movements, thereby predisposing individuals to symptoms associated with TMD (Alexiou, Stamatakis, and Tsiklakis, 2009; Yadav *et al*., 2018; Chen *et al*., 2020).

Contrary to the prevailing notion that TMD predominantly affects individuals in advanced age, emerging evidence underscores the significance of youth as a potential risk factor for TMD susceptibility, as highlighted in studies conducted by Look *et al*. (2010), Hongxing *et al.* (2016), de Melo Júnior *et al*. (2019), Hanna *et al.* (2021), and Macrì *et al.* (2022). In the context of younger populations, several factors contribute to this vulnerability.

Firstly, anatomical and biomechanical considerations play a pivotal role (Suvinen *et al.,* 2005; Fernandes *et al.,* 2015). The developmental phase in early life involves ongoing growth and maturation of the TMJ and associated structures, and imbalances or irregularities during this formative period may predispose individuals to TMD (Hirsch, Hoffmann, and Türp, 2012; D'Ippolito *et al*., 2014). Additionally, the transition from deciduous to permanent dentition, accompanied by changes in occlusal relationships, may contribute to biomechanical stress on the TMJ, potentially influencing the development of TMD (Chisnoiu *et al.,* 2015; Bilgiç and Gelgör, 2017; Song, Yap, and Türp, 2018).

Secondly, lifestyle factors prevalent in youth, such as increased stress levels, participation in certain sports, and oral parafunctional habits like teeth clenching or grinding, may elevate the risk of TMD (Winocur *et al.,* 2006; van Selms *et al.,* 2013). Psychological stressors during adolescence and young adulthood can impact the neuromuscular and psychosocial aspects associated with TMD, manifesting as symptomatic expressions (Ostensjo *et al*., 2017; Natu *et al.,* 2018).

2.4.3 Genetics

Genetic predisposition stands out as a potential determinant, wherein certain individuals may manifest an inherent susceptibility to TMD (Smith *et al*., 2011), although the intricate genetic mechanisms remain complex and not entirely elucidated. The genetic influence on TMD is likely multifactorial, involving intricate interactions between genetic factors and environmental influences (Melis and Giosia, 2016). Specific genetic variations may impact the structure and function of the TMJ, the neuromuscular control of jaw movement, as well as the pain perception pathways, collectively contributing to the development of TMD (Melis and Giosia, 2016).

Furthermore, genetic factors may shape an individual's response to environmental stressors, such as trauma, psychological stress, or parafunctional habits, all recognized contributors to TMD (Gameiro *et al*., 2006; Ohrbach and Michelotti, 2018). Certain genetic variations may modulate the inflammatory response or tissue repair processes, thereby influencing the risk of developing TMD in the presence of environmental triggers (Fiamengui *et al*., 2020; Kapos *et al*., 2020).

2.4.4 Trauma or Injury

TMD may be precipitated by significant trauma or injury to the craniofacial region, imposing mechanical stress on the TMJ and resulting in pathological alterations, as observed in a study conducted by Yun and Kim (2005). Traumatic incidents, including facial injuries, motor vehicle accidents, whiplash (Epstein *et al.,* 2010; Montemurro *et al.*, 2023), or blows to the head and jaw, can apply substantial force to the TMJ and its associated structures, leading to anatomical and functional changes that may contribute to TMD (Häggman-Henrikson, Rezvani, and List, 2014).

Acute trauma has the potential to cause direct damage to the TMJ, encompassing fractures (primarily condylar fractures), dislocations, or soft tissue injuries, thereby initiating or exacerbating TMD symptoms (Giannakopoulos et al., 2009; He *et al*., 2016). Furthermore, the biomechanical forces exerted during trauma can induce alterations in the joint's structural integrity, potentially yielding long-term consequences for its functionality (Montemurro *et al.,* 2023). Chronic trauma, manifested through repetitive behaviours like teeth clenching, grinding (bruxism), or habitual jaw

clenching, also contributes to TMD (Oral *et al*., 2009). Prolonged exposure to these parafunctional habits may lead to overuse and strain on the TMJ and associated muscles, fostering the gradual development of TMD symptoms over time (Yadav *et al.,* 2020).

2.4.5 Biomechanical factors

Parafunctional habits, such as chronic bruxism characterized by habitual grinding or clenching of teeth, consistently impose biomechanical strain on the TMJ, thereby predisposing individuals to TMD, as observed in the research conducted by Manfredini *et al*. (2003). Prolonged gum chewing or unilateral chewing practices may introduce asymmetrical loading on the TMJ, thereby contributing to the development of TMD (Tabrizi *et al*., 2014). Malocclusion, denoting aberrations in dental occlusion, emerges as a contributory factor, as improper alignment may induce imbalances in TMJ biomechanics (Giannakopoulos *et al*., 2009). Degeneration of the TMJ may give rise to various forms of arthritis, including osteoarthritis (Kim, Wojczyńska, and Lee, 2016; Chung *et al.,* 2023), osteoarthrosis, and arthralgia, all implicated in the degeneration of the TMJ's articular surfaces, consequently augmenting susceptibility to TMD (Tanaka, Detamore, and Mercuri, 2008; Giannakopoulos *et al*., 2009).

2.4.6 Joint and Muscular factors

The hypermobility of the TMJ represents a condition in which the range of motion exceeds physiological norms, potentially resulting in heightened susceptibility to TMD, as highlighted in a study by Nosouhian *et al*. (2015). The intricate interplay between the structural components of the TMJ and its surrounding musculature emphasizes the significance of muscular dynamics in the aetology of TMD (Chisnoiu *et al*., 2015). Notably, muscular imbalances or inherent weaknesses within the muscles intricately linked to jaw movement emerge as pivotal factors that may substantially contribute to the manifestation of symptomatic expressions of temporomandibular TMD, as elucidated in the research by Maini and Dua (2023).

2.4.7 Psychosocial factors

Psychological determinants, particularly elevated stress and anxiety levels have been recognized as influential factors in both the genesis and exacerbation of symptoms

associated with TMD. Pesqueira *et al*. (2010) discuss the significant role these factors play in TMD. According to Canfora *et al*. (2023), the intricate interplay between psychological states and somatic manifestations underscores the nuanced nature of orofacial pain aetiology. Emotional distress, which can lead to conditions such as depression and other mood disorders, emerges as a notable contributor to the complexities of TMD manifestation, as outlined by Ye *et al*. (2022). Psychological factors significantly impact pain perception and coping mechanisms, thereby shaping the clinical landscape of TMD, as discussed by Fillingim *et al*. (2013).

2.4.8 Poor Posture

An association between poor posture, specifically in the cervical and thoracic regions, and TMD has been identified, highlighting the biomechanical ramifications of postural inadequacies on the musculature surrounding the TMJ, as discussed by Mannheimer and Rosenthal (1991) and Saito, Akashi, and Sacco (2009). The relationship between posture and TMD is intricate, involving the alignment of the head, neck, and upper body, all of which influence the biomechanics of the TMJ and associated structures, as explained by Garstka *et al.* (2022). Individuals with suboptimal posture may exhibit forward head posture or other misalignments, leading to increased strain on the muscles and ligaments supporting the TMJ, as highlighted by Minervini *et al.* (2023a). Prolonged periods of improper posture can contribute to muscle imbalances and fatigue, particularly in the muscles responsible for jaw movement, as further explored in the work by Minervini *et al.* (2023a). Their findings support the statement that poor posture can exacerbate TMD symptoms, although the effect size was modest and the sample size was relatively small, indicating the need for further research to confirm these results conclusively.

Furthermore, poor posture may disrupt the natural alignment of the spine, affecting the neuromuscular coordination of the entire musculoskeletal system, including the jaw, as highlighted by Carini *et al*. (2017). This disruption can lead to altered mechanics of the TMJ, potentially contributing to the onset or progression of TMD symptoms, as discussed by Petronis *et al.* (2023). Beyond its biomechanical implications, poor posture may also be associated with heightened levels of stress and tension, further exacerbating the risk of TMD, as noted by Ingawalé and Goswami (2012) and Karkazi and Özdemir (2020). The psychosocial impact of poor posture, encompassing

increased stress and muscle tension, can contribute to parafunctional habits such as teeth clenching or grinding, recognized as known risk factors for TMD, as outlined by Sarnu (2018) and Ohrbach and Sharma (2021).

2.5 Pathophysiology of TMD

TMD encompasses a spectrum of conditions affecting the TMJ, masticatory muscles, and associated soft tissues, leading to a pathophysiology that is intricate and diverse, frequently involving a combination of biological, psychological, and environmental components, as highlighted by Hanna *et al.* (2021) and Macrì *et al*. (2022). While specific mechanisms remain unknown, numerous significant factors contribute to the development and progression of TMD, as discussed by Oakley and Vieira (2008) and Wang *et al.* (2015).

The RDC/TMD classifies TMDs into three groups: TMJ disc displacement, degenerative joint diseases (e.g., osteoarthritis, osteoarthrosis, and arthralgia of the TMJ), and myofascial disorders, as outlined by Schiffman et al. (2014). However, the pathophysiology of TMD involves a combination of various factors, including myofascial pain and dysfunction, joint pathology, psychosocial factors, trauma and injury, inflammatory processes, structural anomalies, neuromuscular factors (Yin et al., 2020), and genetic predisposition (Cairns, 2010; Chisnoiu et al., 2015; Gauer and Semidey, 2015; Lund et al., 2020; Kalladka, Young, and Khan, 2021).

TMD is often associated with structural abnormalities within the TMJ, such as malocclusion, where misalignment of the teeth and jaws can contribute to TMD, although the relationship is complex and not fully understood, as mentioned by Macrì et al. (2022). Articular disc displacement, involving dislocation or displacement of the articular disc within the TMJ, can result in pain, clicking, or popping sounds during jaw movement, which may also lead to TMD, according to Ahmad and Schiffman (2016) and Poluha et al. (2019).

The TMJ, being a load-bearing joint, undergoes load bearing during mastication, and degenerative changes occur when the joint is overloaded, possibly caused by parafunctional activities such as teeth grinding/bruxism, jaw clenching, and excessive chewing, as discussed by Cairns (2010) and Barrientos *et al.* (2020). Overloading of

the TMJ results in the degradation of articular cartilage, leading to local bone remodelling and osteoarthritis of the TMJ (Barrientos *et al.*, 2020). Continued joint overloading eventually results in inflammation, progressing from osteoarthritis to osteoarthrosis and arthralgia, as found by Kalladka *et al.* (2014) and Gandhi *et al.* (2023).

Inflammation, as a standalone factor, can play a role in TMD by causing pain and joint dysfunction, as outlined by Gandhi et al. (2023). Infections, autoimmune reactions, or local discomfort can stimulate inflammatory processes, causing tissue damage and aggravating the disorder, as discussed by Gauer and Semidey (2015). Synovitis, inflammation of the synovial lining of the TMJ, may lead to pain and swelling, while capsulitis, inflammation of the joint capsule, can contribute to restricted jaw movement and cause pain and tenderness on palpation, as discussed by Maini and Dua (2023).

Myofascial pain in TMD refers to discomfort originating from trigger points within the muscles of the jaw and face, mainly the muscles of mastication (Golanska et al., 2021). Dysfunction in myofascial tissues can lead to muscle imbalances and altered biomechanics, contributing to pain and restricted jaw movement, while muscle hyperactivity or hypoactivity can cause imbalances in muscle activity and contribute to TMD, as discussed by Maini and Dua (2023).

Psychosocial factors, such as stress, anxiety, and emotional distress, play a significant role in TMD, as noted by Ye et al. (2022). Psychological stress can contribute to increased muscle tension, altered pain perception, and heightened sensitivity to jaw-related discomfort, as mentioned by Golanska et al. (2021). Emotional stress can contribute to muscle tension and bruxism, exacerbating TMD symptoms, and conditions such as depression or anxiety may influence pain perception and coping mechanisms (Golanska et al., 2021).

Physical trauma, such as direct injury to the TMJ and mandible, fractures, dislocations, or whiplash injuries, can also cause TMD development, possibly aided by microtrauma induced by recurrent stress on the TMJ, such as habitual clenching or grinding (Manfredini et al., 2003; Chisnoiu et al., 2015). Trauma can cause TMJ damage, muscular tension/strain, and altered mechanics, creating a risk of developing TMD symptoms, as noted by Ivković et al. (2018). Dislocation of the TMJ causing TMD can

be exacerbated by disruptions in the neuromuscular regulation of the TMJ and surrounding orofacial structures, as outlined by Sharma et al. (2015), Gauer and Semidey (2015), Małgorzata et al. (2020), and Marcelino et al. (2023).

Irritation or compression of nerves innervating the TMJ and surrounding muscles, such as diseases like trigeminal neuralgia, may also exacerbate TMD, as suggested by Khan et al. (2017) and Lomas (2018). There may be a hereditary component that increases susceptibility to TMD, although the specific genes involved are unclear, as discussed by Oakley and Vieira (2008) and Fillingim et al. (2012). However, genes such as serotonin transporter SLC6A4 and serotonin 2A receptor HTR2A and the serotonin metabolic enzyme tryptophan hydroxylase 1 TPH and oestrogen receptor-α (ESR1) in females have been suggested to be associated with TMD, as noted by Scariot et al. (2018) and Smith et al. (2013). The anatomical and functional properties of the TMJ, as well as an individual's vulnerability to inflammatory responses and pain perception, may be influenced by genetic factors, as outlined by Smith et al. (2011).

2.6 Clinical presentation

TMD manifest a diverse range of clinical presentations, presenting a spectrum of symptoms that significantly impact an individual's oral health and overall well-being (Crandall, 2018). A predominant indicator of TMD is pain, often localized to the TMJ and the surrounding muscles (Cairns, 2010). This pain may manifest intermittently or persistently, ranging in intensity from mild discomfort to debilitating agony (Maini and Dua, 2023). Patients commonly report discomfort during activities such as chewing, talking, or even at rest, underscoring the pervasive nature of TMD-related pain (Italia, 2018).

In conjunction with pain, individuals afflicted with TMD frequently encounter limitations in jaw movement. This constraint may manifest as trismus, characterized by difficulty fully opening the mouth, or challenges in executing lateral and protrusive movements smoothly (Klasser and Greene, 2009; Chandak et al., 2017). These limitations not only contribute to functional impairment but also emphasize the intricate biomechanics of the jaw as a focal point of TMD as a disorder (Chandak et al., 2017).

In addition to primary symptoms, TMD may precipitate secondary manifestations that affect the head and neck region (Shaffer et al., 2014a; Ferreira, Silva, and Felício, 2016). Patients often describe headaches, typically localized in the temporal or occipital regions, along with ear pain, tinnitus, or a sensation of fullness in the ears (Kusdra et al., 2018). These symptoms, extending beyond the confines of the oral cavity, necessitate a comprehensive understanding of the interplay between the temporomandibular joint and surrounding anatomical structures (Ferreira, Silva, and Felício, 2016).

Parafunctional habits, notably bruxism (clenching or grinding of the teeth), frequently co-occur with TMD (Chandak et al., 2017). These habits can exacerbate symptoms and contribute to the perpetuation of the disorder. The clinical presentation of TMD is multifaceted, encompassing pain, restricted jaw movement, and an array of secondary symptoms (Chisnoiu et al., 2015; Maini and Dua, 2023).

2.7 Diagnosing TMD

The diagnosis of TMD primarily relies on patient history and observations obtained through physical examinations (Li and Leung, 2021). The chief complaint serves as the initial point of contact, elucidating the primary reason motivating the patient to seek medical attention, whether it be pain, clicking sensations, or difficulties in jaw movement (Gauer and Semidey, 2015). In the history of the present illness, a comprehensive exploration of the onset, duration, and progression of symptoms is imperative to construct a nuanced understanding of the patient's condition (Schiffman et al., 2014; Slade et al., 2016). Pain assessment becomes pivotal, involving an evaluation of the nature, intensity, and precise location of pain (Li and Leung, 2021). Documenting the history of previous TMD treatments is indispensable, shedding light on the efficacy of prior interventions and their impact on the patient's condition (Yost et al., 2020a). Concurrently, noting the patient's current medications is essential, considering potential associations with TMD symptoms (Yost et al., 2020a).

The TMJ examination is a critical facet, encompassing an assessment of jaw range of motion, identification of joint sounds (such as clicking or popping), and evaluation of tenderness (Gauer and Semidey, 2015). Muscle examination involves a thorough evaluation of masticatory muscle function, tenderness, and the presence of trigger

points (Manfredini et al., 2011; Harrison, Thorp, and Ritzline, 2014; Kalladka, Young, and Khan, 2021). Additionally, occlusal examination plays a crucial role in the clinical assessment, focusing on the detection of malocclusion and dental abnormalities (Haralur, 2013; Nokar et al., 2018).

Incorporating imaging studies into the diagnostic process is essential. Panoramic radiographs, TMJ tomograms, or magnetic resonance imaging (MRI) scans provide valuable insights into the visualization of joint structures and the identification of any abnormalities. MRI is widely regarded as the gold standard for the diagnosis of TMD, as noted by Schiffman and Ohrbach (2016) and Lomas (2018). Beyond the physical aspects, a comprehensive assessment includes an exploration of stressors and psychological factors that may contribute to TMD (Ohrbach et al., 2010; Fillingim et al., 2013; Saccomanno et al., 2020). Understanding the psychosocial dimensions of the patient's experience can inform a holistic approach to the diagnosis of TMD (Nilsson et al., 2023).

The Helkimo index (Rani et al., 2017) and the Research Diagnostic Criteria for TMD (RDC/TMD) (SF 1992; Schiffman et al., 2010a; Schiffman et al., 2010b; Schiffman et al., 2014) are popular tools used in the diagnosis of TMD. However, the RDC/TMD holds favour among clinicians and healthcare professionals as a reliable tool for diagnosing TMD, ensuring a standardized and comprehensive approach to the diagnostic process (Harrison, Thorp, and Ritzline, 2014). The concurrent utilization of both MRI and the RDC/TMD is a prevailing approach in the diagnostic process for TMD, as established by Park et al. (2012) and further supported by Michelotti, Vollaro, and Cimino (2019).

The updated iteration of the RDC/TMD, denoted as the Diagnostic Criteria for TMD (DC/TMD), stands as an improved instrument for application (Schiffman *et al.*, 2014). This enhancement is attributable to the evidence-based nature of the DC/TMD Axis I and Axis II, rendering it a readily applicable assessment protocol in both clinical and research contexts (Schiffman *et al.*, 2014; Ahmad and Schiffman, 2016). Axis I focuses on the physical diagnoses of TMD, incorporating a robust screening questionnaire known for its validity and reliability in discerning pain-related TMD (Schiffman *et al.*, 2014; Ahmad and Schiffman, 2016). It includes diagnostic algorithms specifically designed for the most prevalent pain related TMD conditions, ensuring accurate

identification and classification (Schiffman *et al.*, 2014; Ahmad and Schiffman, 2016). Axis II addresses the psychosocial aspects, evaluating the impact of TMD on psychological status and pain-related disability, thus providing a comprehensive assessment of the patient's condition (Schiffman *et al.*, 2014; Ahmad and Schiffman, 2016). In contrast to its predecessor, the original RDC/TMD protocol, the DC/TMD offers an enhanced and holistic approach to TMD assessment.

2.8 Treatment and management

TMD is a multifaceted condition influenced by a range of factors, including myofascial disorders, joint pathology, psychological variables, trauma, inflammation, structural anomalies, neuromuscular factors, and genetic susceptibility (Chisnoiu *et al.* 2015). An understanding of these elements is crucial for developing comprehensive treatment approaches that acknowledge the complexity of the disorder (Palmer and Durham 2021). Treatment modalities for TMD include pain management, physical therapy, lifestyle adjustments, and, at times, dental procedures (Yost *et al.* 2020a; Giorgi 2023). A preference for a conservative therapeutic approach is advocated in the treatment of TMD and the multifaceted approach to treatment centred around the biopsychosocial model involves conservative measures, pharmacological interventions, dental procedures, psychological support, and systematic follow-up plans (Garstka *et al.* 2023). Given the dynamic nature of TMD, tailored interventions based on individual responses and evolving clinical findings are imperative (Kotiranta, Suvinen and Forssell 2014).

Occlusal dental interventions, including the use of splints and mouth guards, represent integral components of the therapeutic repertoire for TMD (Celakil *et al.* 2019). These interventions primarily focus on modifying the occlusal relationships and mitigating parafunctional habits to alleviate symptoms associated with TMD, such as jaw pain and dysfunction (Singh *et al.* 2017). Splints, commonly referred to as occlusal appliances, are custom-designed devices that aim to stabilize and realign the temporomandibular joint, facilitating optimal occlusion and reducing excessive forces during mastication (Singh *et al.* 2017). Mouth guards, on the other hand, serve as a protective barrier, particularly during sleep, shielding the teeth from the deleterious effects of bruxism and clenching (Dossey, Abasolo and Starr 2023).

The rationale behind occlusal interventions lies in their capacity to redistribute forces and provide a supportive environment for the temporomandibular joint and associated musculature (Kaur and Datta 2013; Singh *et al.* 2017). These interventions contribute to the reduction of stress on the joint, mitigating symptoms and promoting a more harmonious occlusal relationship (Singh *et al.* 2017). While occlusal dental interventions, splints, and mouth guards offer tangible benefits in symptom management, their long-term efficacy and impact on the natural course of TMD require ongoing research (Albagieh *et al.* 2023). The integration of these interventions into a comprehensive treatment plan, considering patient-specific factors and collaborative interdisciplinary approaches, underscores their significance in the holistic management of Temporomandibular Disorder (Brighenti *et al.* 2023).

Physical therapy stands as a pivotal intervention in the comprehensive management of TMD, offering a non-invasive and holistic approach to address the intricate biomechanical intricacies associated with this condition (Shaffer *et al.* 2014b; Aurora–Liliana 2021). Through a tailored regimen of exercises, manual techniques, and therapeutic modalities, physical therapy aims to alleviate pain, enhance joint mobility, and restore optimal function to the temporomandibular joint complex (Gil-Martínez *et al.* 2018; Fisch *et al.* 2021). Therapists employ a systematic evaluation to identify impairments in musculoskeletal function and design individualized treatment plans, often encompassing exercises to strengthen weakened muscles, stretches to improve flexibility, and manual techniques to address soft tissue restrictions (Aurora–Liliana 2021; Fisch *et al.* 2021). Physical therapy not only targets symptomatic relief but also seeks to rectify the underlying biomechanical dysfunctions contributing to TMD (Crăciun *et al.* 2022). Moreover, patient education regarding posture, ergonomics, and jaw-related habits is integral to the overall success of physical therapy interventions (Prodoehl and Kahnert 2022). As a non-pharmacological and non-surgical option, physical therapy holds considerable promise in the comprehensive management of TMD, emphasizing the importance of a multidisciplinary approach for optimal patient outcomes (Prodoehl and Kahnert 2022).

Pharmacotherapy plays a pivotal role in the comprehensive management of TMD, addressing various aspects of the condition such as pain, inflammation, and muscle dysfunction (Cairns 2010). Non-steroidal anti-inflammatory drugs (NSAIDs) are

commonly employed to alleviate pain and reduce inflammation within the temporomandibular joint complex (Hersh, Balasubramaniam and Pinto 2008; Cairns 2010; Gauer and Semidey 2015) . These medications, including diclofenac, ibuprofen and naproxen, act by inhibiting prostaglandin synthesis, thereby mitigating pain and swelling associated with TMD (Cairns 2010; Gauer and Semidey 2015; Wu *et al.* 2021). Muscle relaxants may also be prescribed to alleviate muscular tension and spasms commonly observed in TMD patients(Cairns 2010; Häggman-Henrikson, Alstergren and Davidson 2017). These medications, such as cyclobenzaprine or diazepam, work by modulating central nervous system activity to induce muscle relaxation (Cairns 2010; Häggman-Henrikson, Alstergren and Davidson 2017; Gil-Martínez *et al.* 2018).

In cases where TMD is associated with neuropathic pain, tricyclic antidepressants or anticonvulsants may be considered (Wu *et al.* 2021). These medications, such as amitriptyline or gabapentin, can help modulate pain signals and improve pain management (Wu *et al.* 2021). Additionally, corticosteroid injections may be utilized to deliver anti-inflammatory agents directly to the affected temporomandibular joint, providing targeted relief for localized inflammation and pain (Cairns 2010; Gauer and Semidey 2015). The choice of pharmacological agents is guided by the specific clinical presentation of the individual, and careful consideration of potential side effects and contraindications is essential in the treatment planning process (Pereira, Alves and Fiedler 2023). However, the efficacy of pharmacotherapy in treating TMD still presents a challenge as there is little evidence to support its efficacy and is rather largely empirical (Pereira, Alves and Fiedler 2023).

Ultrasound therapy has gained recognition as a viable adjunctive modality in the therapeutic armamentarium for TMD (Baker, Robertson and Duck 2001; Fouda 2014; Khairnar *et al.* 2019). This non-invasive intervention harnesses the mechanical vibrations of ultrasound waves to penetrate deep into the target tissues, thereby promoting tissue healing and alleviating pain associated with TMD (Fouda 2014; Khairnar *et al.* 2019) . The application of ultrasound therapy is predicated on its ability to generate thermal and non-thermal effects, facilitating increased blood flow, cellular metabolism, and collagen synthesis (Fouda 2014; Rai *et al.* 2016). By inducing these physiological responses, ultrasound therapy contributes to the reduction of

inflammation, muscle spasms, and joint stiffness commonly observed in TMD patients (Rai *et al.* 2016; Ba, Zhou and Yu 2021). However, the optimal parameters and protocols for ultrasound therapy in TMD warrant further investigation to refine its efficacy and establish evidence-based guidelines (Rai *et al.* 2012). In light of its non-invasiveness and potential benefits, ultrasound therapy holds promise as a valuable therapeutic modality in the multifaceted management of TMD (Budakoti *et al.* 2019; Mishra *et al.* 2022).

Laser therapy has emerged as a notable modality in the therapeutic landscape for the management of TMD (Maia *et al.* 2012). This treatment approach harnesses the unique properties of laser light to address the multifaceted nature of TMD, which encompasses pain, inflammation, and muscular dysfunction within the temporomandibular joint complex (Maia *et al.* 2012; Melis, Di Giosia and Zawawi 2012). The application of low-level laser therapy (LLLT) has shown promise in mitigating pain associated with TMD by exerting anti-inflammatory effects and promoting cellular regeneration (Herranz-Aparicio *et al.* 2013; Ahmad *et al.* 2021). Moreover, laser therapy exhibits a non-invasive nature, making it an appealing option for patients seeking alternatives to conventional interventions (Chan *et al.* 2022). The modulatory impact of laser therapy on tissue repair and its ability to modulate inflammatory pathways underscore its potential as a valuable adjunct treatment for TMD (Catão *et al.* 2013).

Transcutaneous Electrical Nerve Stimulation (TENS) emerges as a notable modality in the therapeutic repertoire for TMD, offering a non-invasive and neuromodulatory approach to manage pain and dysfunction associated with this condition (Shanavas *et al.* 2014). TENS involves the application of low-frequency electrical currents to the skin surface, targeting specific nerve pathways to induce analgesic effects and modulate pain perception (Shanavas *et al.* 2014). TENS is employed to alleviate muscular tension, reduce pain sensitivity, and enhance blood circulation within the temporomandibular joint complex (Gibson *et al.* 2019). By stimulating sensory nerve fibres, TENS disrupts pain signals and prompts the release of endorphins, contributing to pain relief and improved patient comfort (Gibson *et al.* 2019). Additionally, TENS may facilitate muscle relaxation, reducing the severity of symptoms related to muscular hyperactivity and spasm commonly observed in TMD patients (Ferreira *et*

al. 2017; Abe *et al.* 2020). The non-invasive nature of TENS and its ability to provide targeted relief make it an appealing modality, especially in cases where pharmacological interventions may be limited or contraindicated (Abouelhuda, Kim and Hegazy 2018b).

Manipulation and mobilization are manual therapy techniques that are frequently employed in the management of TMD (Fernández-de-Las-Peñas and Von Piekartz 2020). These interventions involve skilled hands-on techniques applied by trained healthcare professionals, such as physical therapists or chiropractors, to address joint dysfunction, improve range of motion, and alleviate pain associated with TMD (Fernández-de-las-Peñas and Bensen 2019). Manipulation involves a high-velocity, low-amplitude thrusting technique being applied to specific joints to improve joint mechanics and alleviate joint restrictions (Coronado, Bialosky and Cook 2010; Butts *et al.* 2017a). In the context of TMD, manipulation may target the temporomandibular joint and adjacent structures to improve joint function and reduce pain and this technique is often reserved for cases where joint restrictions or malalignment are identified (Butts *et al.* 2017a; Aurora–Liliana 2021). Mobilization, in contrast, involves slower and more controlled movements to stretch or manipulate soft tissues and joints as it is a gentler technique compared to manipulation and is often used to improve joint mobility, reduce muscle tightness, and enhance overall function (Shaffer *et al.* 2014b; Aurora–Liliana 2021).

Both manipulation and mobilization aim to restore optimal joint function, reduce pain, and improve the overall musculoskeletal dynamics of the temporomandibular joint complex (Shaffer *et al.* 2014b; Butts *et al.* 2017a; Asquini *et al.* 2022). The efficacy of manipulation and mobilization is substantiated by burgeoning research, underscoring the paramount significance of evidence-based practice in the management of this condition (Herrera-Valencia *et al.* 2020; Vieira *et al.* 2023). Nonetheless, further investigation is requisite to conclusively validate the effectiveness of manipulation and mobilization as integral modalities in the therapeutic approach to TMD in order to fortify the existing knowledge base and facilitate a more comprehensive understanding of the therapeutic potential inherent in these interventions (Armijo-Olivo *et al.* 2016; McComish 2023).

Dry needling and ischemic compression are therapeutic techniques commonly employed in the management of TMD to address muscular trigger points and alleviate associated pain and dysfunction (Vier *et al.* 2019). Dry needling involves the insertion of thin, solid needles directly into myofascial trigger points, which are hyperirritable spots within muscles and the goal is to elicit a localized twitch response and release tension in the affected muscle (Fernández-de-Las-Peñas and Nijs 2019). In the context of TMD, dry needling can be applied to the muscles around the temporomandibular joint, aiming to reduce muscle tightness, improve blood flow, and alleviate pain (Gonzalez-Perez *et al.* 2015; Vier *et al.* 2019). Ischemic compression, on the other hand, is a manual therapy technique that involves applying sustained pressure to specific trigger points to reduce local blood flow temporarily (Moraska *et al.* 2013). This pressure helps to release muscle tension and promote the relaxation of tight muscles and ischemic compression can be targeted at trigger points in the muscles involved in jaw movement and function (Lu *et al.* 2022).

Both dry needling and ischemic compression are intended to address myofascial pain and dysfunction associated with TMD and these techniques aim to release muscular tension, improve local blood circulation, and reduce pain, contributing to the overall management of TMD symptoms (Moraska *et al.* 2013). While initial studies suggest promising outcomes, there is a pressing need for more comprehensive research into the efficacy and safety of dry needling and ischemic compression as potential therapeutic interventions for TMD, ensuring a better understanding of their long-term benefits and potential side effects (Vier *et al.* 2019; Lu *et al.* 2022).

Behavioural adjustments or alterations in daily habits, commonly referred to as lifestyle modifications, are integral components of the comprehensive management of TMD (Ohrbach and Sharma 2021; Priyank *et al.* 2023). Cognitive-Behavioural Therapy (CBT) stands out as a pivotal intervention, addressing maladaptive cognitive patterns and behaviours that contribute to the perpetuation of TMD-related pain (Matsuoka *et al.* 2017). Furthermore, stress management techniques, relaxation training, and biofeedback emerge as noteworthy components of psychosocial treatments, acknowledging the substantial influence of emotional and environmental stressors on TMD symptomatology (Penlington *et al.* 2022). The incorporation of lifestyle modifications is recognized as an essential element in the multifaceted approach to

TMD management, acknowledging the interplay between lifestyle factors and the manifestation of temporomandibular joint symptoms (Prodoehl and Kahnert 2022).

Surgical interventions represent a category of therapeutic measures employed in the management of TMD, particularly in cases where conservative modalities have proven insufficient in addressing the severity of symptoms or when structural abnormalities necessitate more invasive interventions (Yost *et al.* 2020a). Surgical approaches may include Arthrocentesis, arthroscopy, open joint surgery such as arthroplasty and joint replacement procedures, each tailored to the specific pathophysiological characteristics of the individual's TMD presentation (Dimitroulis 2018; Yost *et al.* 2020a). These interventions are typically considered after a thorough assessment and diagnostic evaluation, weighing the potential risks and benefits, and when other non-surgical modalities have not yielded adequate outcomes (Yost *et al.* 2020a). The decision to pursue surgical intervention is contingent upon a comprehensive understanding of the underlying aetiology and the patient's overall health status, emphasizing the importance of individualized treatment planning in the realm of surgical management for Temporomandibular Joint Disorder (Dimitroulis 2018; Kumar, Murugesan and Hinaz 2021).

2.9 Impact of TMD

TMD exerts a substantial influence on diverse facets of an individual's life, thereby affecting not only physical but also psychological well-being (Eaves *et al.* 2015) This multifaceted impact encompasses a range of consequences, each contributing to the complex nature of TMD (Eaves *et al.* 2015). TMD frequently manifests as chronic or recurrent pain, presenting in the TMJ, facial muscles, and surrounding areas and the spectrum of discomfort varies from mild to severe, with exacerbation during activities like chewing, talking, or even mundane jaw movements (Maini and Dua 2023). The disorder is intricately linked to difficulties in jaw movement and functionality and manifestations such as limited jaw mobility, jaw locking, or audible clicking sounds during movement are commonplace (Ivković *et al.* 2018). These impairments extend beyond mere inconvenience, significantly affecting an individual's ability to perform fundamental activities like eating and speaking (Safour 2018). Chewing and eating difficulties stemming from TMD can impede an individual's nutritional intake. The

aversion to harder foods, driven by TMD-related discomfort, may limit dietary variety and nutritional value (Safour 2018).

The association between TMD and headaches, encompassing tension-type headaches and migraines, underscores the systemic impact of the disorder (Chandak *et al.* 2017). Pain and muscle tension originating in the jaw and face can radiate, contributing to the development and exacerbation of headaches (Chandak *et al.* 2017). The pain and discomfort associated with TMD can intrude upon sleep quality where difficulties in finding a comfortable sleeping position may lead to disrupted sleep patterns and subsequent fatigue, further compounding the challenges faced by individuals with TMD (Lee *et al.* 2022). The chronic nature of pain and functional limitations often gives rise to heightened emotional distress and TMD is frequently linked to increased stress, anxiety, and depression, forming a reciprocal relationship with pain sensitivity and symptom severity (Lei *et al.* 2021). The amalgamation of physical symptoms, pain, and emotional distress culminates in a diminished overall quality of life (Lei *et al.* 2021).

TMD disrupts various daily activities, leading to potential absenteeism from work or school and avoidance of social situations due to the discomfort associated with essential tasks like talking or eating (Yost *et al.* 2020b). TMD occasionally precipitates dental complications, including tooth wear, muscle spasms, and changes in bite alignment (Yost *et al.* 2020b). Addressing these issues may necessitate dental interventions to mitigate the consequences of TMD on oral health (Singh *et al.* 2017). The impact of TMD transcends its physical symptoms, extending to emotional, social, and daily life realms (Ilgunas *et al.* 2023).

2.10 Conclusion

In conclusion, this chapter has undertaken a thorough and comprehensive exploration of TMD, providing an in-depth understanding of its multifaceted dimensions. The elucidation commenced with a detailed definition of TMD, intricately intertwined with an examination of the soft tissue structures that underlie its manifestation. The subsequent analysis delved into the intricate web of risk factors influencing TMD, unravelling the complex pathophysiological mechanisms that govern its development.

A pivotal aspect of this chapter has been the meticulous exploration of the clinical presentation of TMD, unravelling the nuanced manifestations that clinicians encounter in practice. The diagnostic landscape of TMD was systematically examined, explaining the methodologies employed for accurate discernment in clinical settings. The latter part of this chapter shifted focus towards the therapeutic domain, where the treatment and management strategies for TMD were scrutinized with precision. By encompassing both established and emerging modalities, this analysis aimed to provide a comprehensive overview, shedding light on the complexities inherent in mitigating the effects of TMD.

3 CHAPTER THREE: METHODOLOGY

3.1 Introduction

This chapter outlines the research methodology used for the study. It includes a definition of the study design used, the steps used for data collection, extraction and analysis, the inclusion and exclusion criterion, and the literature review process and materials used. The validity and reliability of the materials used, and the ethical considerations are also outlined in this chapter.

3.2 Study design

This systematic review was conducted using a quantitative paradigm, as it primarily assessed the effectiveness of interventions through the analysis of randomized controlled trials (RCTs), non-randomized controlled trials (nRCTs), and Case series/report studies. The internal validity of included studies was evaluated using standardized numerical scoring systems appropriate for each study type (Liddle, Williamson, and Irwig 1996; PEDro 1999; Wells et al. 2003). External validity was assessed descriptively, focusing on the generalizability of findings. Given the structured approach to data collection and analysis, this study follows a quantitative systematic review design, integrating numerical data and structured assessments to synthesize evidence effectively (Gough 2015).

The inclusion of NRCTs and case reports/series in this review, while not challenging the established standard of systematic reviews or RCTs, serves to broaden the scope of current knowledge and highlight promising, yet underexplored, modalities for managing TMDs. While RCTs remain the gold standard for determining treatment efficacy, these additional study types provide valuable insights into less conventional or emerging treatment options that may not yet have the rigorous evidence required for large-scale trials. By including these studies, the review aims to inform future research directions, encouraging further exploration into these innovative approaches and identifying areas where RCTs can be more effectively designed. This approach ensures that a wider range of treatment modalities is considered, facilitating the

development of a more comprehensive and adaptable evidence base for TMD management

3.3 Permissions and approval

The research proposal for this study was approved at the FoHS research committee in February 2023, and permission to commence the systematic review was granted (Appendix A). PROSPERO registration (Appendix B) for this study was performed in April 2023 (registration no. CRD42023409560). The systematic review followed the PRISMA guidelines for methods and reporting (Page et al., 2021), ensuring consistency and transparency in the review process. This study involved identifying, sourcing, and reviewing appropriate literature to evaluate evidence and provide summarised, evidence-based literature on conservative therapies for the treatment and management of TMDs (Gopalakrishnan and Ganeshkumar, 2013).

A memorandum of understanding (MOU) was put in place to formalize the agreement between the researcher and the reviewers (Appendix C), and reviewers were required to sign it prior to their participation in the review process, which commenced in July 2023. Copyright permissions for 25 articles included in this study were obtained through DALRO (Appendix D) in May 2023. For the remaining seven articles that DALRO could not obtain copyright permissions for, an attempt to reach the authors directly via email was made. This was done prior to the distribution of all articles to reviewers.

3.4 Literature search strategy and databases used

A systematic literature search was conducted on multiple databases and search engines guided by specific keywords and index terms to make the search comprehensive. Boolean operators such as “AND” and “OR” were used to reach as many records as possible and Boolean operators such as “AND” and “NOT” were used to narrow and refine the search (Grewal, Kataria and Dhawan 2016). Truncations symbols such as *,?, !,and/ # were used as a technique to widen the search as they helped to include words that were spelled differently but meant the same thing and helped to search plural and singular terms simultaneously.

The Boolean operators were used in conjunction with the following search terms; “temporomandibular joint disorder/s”, “TMJD”, “TMD”, “TMJ pain”, “orofacial pain”, “myofascial pain”, “Jaw pain”, “TMJ clicking”, “conservative therapy/ies”, “manual therapy”, “physical therapy”, “manipulation”, “mobilisation”, “adjustment/s”, “rehabilitation/rehab”, “stress therapy”, “exercise”, “massage”, “dry needling” “compression”, “acupuncture”, “traditional Chinese medicine”.

A review of search terms was done after a trial search and only where it was necessary in order to maximise the efficacy of the search. Search terms such as “occlusal splints/splints”, “mouth guard”, “bite plate”, “night plate” “electro- modalities”, “ultrasound”, “TENS / transcutaneous electrical nerve stimulation”, “cryotherapy”, “low level laser therapy” and “activator” were included in the search strategies to ensure that relevant articles that might have been masked by these terms were not missed.

The search strategies for each database were modified in a way that best suited each specific database to maximise the efficacy of the search and this was then documented accordingly following the PRISMA guidelines (Page et al 2020) as indicated in the PRISMA flow diagram (Appendix E). Keywords were also combined into phrases and used in conjunction with Boolean and truncation symbols in each database. The truncation symbols may have varied across different databases and adjustments were made according to each database where it was necessary.

An additional hand search was conducted to ensure that no appropriate articles were missed when the databases and search engines were searched (Cooper *et al.* 2018). This was done also because a hand search is a necessity in systematic reviews as per the Cochrane guidelines (Higgins *et al.* 2022). All the notes for the search of the databases were documented to allow for transparency and reproducibility (Appendix F).

Databases searched for this research project were, CINAHL, Cochrane library, MEDLINE, PUBMED, Science Direct, Scopus and web of science (De Brun 2013). The selection of the above databases followed a review of literature that supported their effectiveness in finding healthcare related research articles/studies and publications.

3.5 Eligibility criteria

3.5.1 Inclusion criteria

1. Articles were required to be in English.
2. All publications were required to be in electronic format or convertible into an electronic format.
3. Article title had to contain the phrase “temporomandibular joint disorder/s or TMJD or TMD”.
4. The title/abstract had to contain one or more of the following keywords: “temporomandibular joint disorder/s”, “TMJD”, “TMD”, “TMJ pain”, “orofacial pain”, “myofascial pain”, “Jaw pain”, “TMJ clicking”, “conservative therapy/ies”, “manual therapy”, “physical therapy”, “manipulation”, “mobilisation”, “adjustment/s”, “rehabilitation/rehab”, “exercise”, “massage”, “dry needling”, “compression”, “acupuncture”.
5. Abstracts needed to recognise that conservative treatment/s and or management were being tested on patients with TMD.
6. Articles had to be the original publication with a study design limited to randomized controlled trials (RCTs), non-randomized controlled trials (nRCTs), case reports, and case series. Although observational studies were initially considered, only case reports and a case series met the inclusion criteria.
7. Articles needed to include adult humans only with minimum age of 18 years or older.

3.5.2 Exclusion criteria

1. Articles that were not available in full text format or were abstracts from conference proceedings or seminars.
2. Systematic reviews, meta-analysis, opinion papers and editorial publications.
3. Articles with medical interventions e.g., surgical, and pharmacological interventions for treating and managing TMD.
4. Animal studies or human paediatric studies (<18 years of age).

3.6 Appraisal tools for the review process (quality and risk of bias assessment)

For this study, the following appraisal tools or scales were selected: PEDro scale (PEDro 1999) for RCTs (Appendix G), Newcastle Ottawa scale (NOS) (Appendix H) for NRCTs (Wells *et al.* 2003), and Liddle scale (Appendix I) for case series and case report studies (Liddle, Williamson and Irwig 1996).

3.7 Validity and reliability of the research tools

3.7.1 Reliability and validity of scales for RCTs

The Delphi list (Olivo *et al.* 2008), the Downs and Blacks scale (Olivo *et al.* 2008), the Jadad scale (Clark *et al.* 1999) and the PEDro scale (Maher *et al.* 2003) tend to be considered the most frequently used scales for the review of RCTs (Olivo *et al.* 2008). The PEDro scale is by far the most commonly used (Macedo *et al.* 2010) and favoured scale for RCTs in physical therapy as it holds a fair reliability rating as indicated by (Macedo *et al.* 2010) as compared to the Jadad scale which carries low reliability (Clark *et al.* 1999). The Downs and Blacks scale has substantial evidence of reliability which would make it an ideal tool for RCTs according to O'Connor et al (20215) however, the scale was developed for public health, and this disqualifies it for this systematic review as it mainly focused on physical therapy interventions. The PEDro scale was used in study reported here not only because it was developed for use in the physical therapy field but also because it is supported by literature such as (Bhogal *et al.* 2005; Macedo *et al.* 2010; Zeng *et al.* 2015)

3.7.2 Reliability and validity of scales for nRCTs

The Newcastle Ottawa scale (NOS) (Zeng *et al.* 2015), ROBINS-I (Sterne *et al.* 2016) and MINORS (Slim *et al.* 2003) tools are the most frequently used tools for nRCTs Quigley *et al.* (2019). The Cochrane ROBINS-I tool has gained popularity amongst non-randomized control trials (nRCTs) and has been the tool of choice in risk of bias assessment in current systematic reviews in the health field. In a study done by Ma *et al.* (2020) that looked at the risk of assessment bias tools, they observed that the ROBINS-I tool was the most used for nRCTs of interventions in systematic reviews.

The ROBINS-I tool is also the preferred tool for nRCTs of interventions by the Cochrane collaboration guidelines (Higgins et al, 2022) but not necessarily a standard for nRCTs of interventions. However, according to Quigley *et al.* (2019) the reliability and validity of both the MINORS and ROBINS-I is unclear, and this has disqualified these scales for use in this study.

The NOS has been shown to be easier and less complicated to use than the other tools (Deeks *et al.* 2003; Margulis *et al.* 2014). Also, the validity and reliability of the NOS has been shown to be fair in more recent studies (Hartling *et al.* 2013; Quigley *et al.* 2019) even though these contradict previous studies (Stang 2010; Hartling *et al.* 2013). The NOS was utilised for this study despite this apparent contradiction because the more recent literature supports its use.

3.7.3 Reliability and validity of scales for case reports/series studies

Case reports/series studies have been neglected and mostly overlooked in systematic reviews resulting in lack of efforts in developing evaluation tools for such literature (Murad *et al.* 2018) . There are tools that are frequently used in evaluating grey case reports/series namely the Pierson criteria (Pierson 2009) the Bradford Hill criteria (Hill 1965) and the Liddle scale (Liddle, Williamson and Irwig 1996).

The Pierson criteria is hardly utilised and the reasons as to why are unclear (Murad *et al.* 2018), the Bradford Hill criteria is mainly utilized in the adverse drug reaction and in the public health fields (McDonald and Strang 2016). As such, both these tools were not considered suitable for use in this study. The Liddle scale has not only been used most commonly, it also has been proven to have a criterion that provides overall assessment of methodological quality of the study following sound epidemiological principles (Liddle, Williamson and Irwig 1996). Therefore, the Liddle scale was used for this study.

3.8 Study selection process

3.8.1 Searching of Literature.

A systematic search following the search strategy was performed on the different databases and search engines using the search terms stipulated in the search

strategy. EndNote 20 was used to manage the literature search. This made it easier to identify and remove duplicates and screen abstracts for inclusion and exclusion criteria. Once eligible literature was identified, the full text was then obtained. The PRISMA flow diagram (Appendix E) was used as a guide in documenting the search results from all the databases and the hand search.

Table 3.1 Databases with number of citations after initial search

Database	**Search date**	**No. of initial records found**
CINAHL	3 June 2022	217
Cochrane library	3 June 2022	37
Medline	3 June 2022	650
Pubmed	2 June 2022	155
ScienceDirect	3 June 2022	18
Scopus	8 June 2022	2,606
Web of Science	3 June 2022	465
Total number of citations after initial search		**4,148**
Total number of duplicates		**789**
Citations after duplicate removal		**3,359**

The initial search of the databases was conducted in June 2022 to identify relevant studies for inclusion. Following approval from the Faculty Research Office, a

supplementary search was performed in March 2023 to ensure that any newly published literature meeting the inclusion criteria was considered. This additional search helped maintain the relevance and comprehensiveness of the systematic review by capturing recent studies within the scope of the research.

3.8.2 Eligibility screening of citations and sourcing of full text articles

The database searches yielded 4,148 records after the initial search and screening of literature for eligibility was done in four different stages.

Stage one: Duplication occurred as a result of the same articles being picked up in more than one database during the search: 789 duplicates were identified and removed leaving 3,359 articles. A further three articles were removed due to the publications being retracted. This brought the number of articles to 3,356.

Stage two: this was the screening of article titles to identify if they contained the words temporomandibular disorders (TMD) or Myofascial pain as stipulated in the inclusion criteria. After this screening, 3,141 articles were excluded, and 215 articles were left for stage three of the screening for eligibility.

Stage three: this stage involved the screening of abstracts to see if they met the inclusion criteria: 215 abstracts were screened during this stage, 172 were excluded, 43 abstracts met the inclusion criteria and full text PDFs were sourced using Endnote 20, DUT library SUMMONS and Google scholar. Three additional abstracts had to be excluded because full texts could not be obtained, this brought the total number of articles to 40.

Stage four: this was the final stage which involved full text screening to identify whether the full text was eligible. Of the 40 full text articles, 9 were excluded (six were reviews and three were retracted publications). After this stage of screening, 31 articles met the inclusion criteria and were eligible for this study.

The eligibility screening process was initiated by the researcher alone, followed by a collaborative review involving six independent reviewers—three with PhD qualifications and three at the master's level. Each article was reviewed by a

combination of one PhD reviewer, one Master's reviewer, and the researcher herself to ensure a multifaceted evaluation. To further enrich the review process, the reviewers were invited to suggest additional articles they believed met the inclusion criteria, as outlined in the MOU. These recommended articles were then cross-checked with the researcher's selection, and any discrepancies were resolved through discussion and consensus.

This approach not only enhanced the robustness of the review but also allowed for a more comprehensive collection of relevant studies, ensuring a balanced and thorough examination of the available evidence.

3.8.3 Hand search

A hand search was also performed to ensure that any relevant literature that was missed during the database searches was reached. The journals that had the greatest number of articles were identified from the records obtained from the databases after stage three of screening. These were the Journal of Dental Anaesthesia and Pain Medicine, Journal of Oral Rehabilitation and Journal of Bodywork and Movement Therapies. These journals were then hand searched for articles that might have been missed during the initial database searches. Access to these journals was gained via the DUT online library with the help of the post graduate librarians.

One more article meeting the inclusion criteria was identified during the hand search and this brought the total number of eligible articles to 32. Therefore, this systematic review included a total of 32 articles.

3.8.4 Master list

A complete master list of all the literature publications was compiled (Appendix J) after the literature search was completed and all the articles that met the inclusion criteria were identified. This list was created in a table format where all authors, the year and date of the included publications were outlined.

Table 3.2 Articles grouped by study design

Study design	**Number of articles**

RCTs	19
nRCTs	10
Case series	3
Total number of articles	**32**

Table 3.3 Articles grouped by intervention

Intervention	**Number of articles**
Dry needling	6
Dry needling plus exercise	1
Exercise	5
Ischaemic compression	1
Manipulation	5
Manual therapy	5
Mobilization	2
Mobilization plus dry needling	1
Mobilization plus exercise	1
Myofascial techniques	2
Physical therapy	2
PNF	1
Total	**32**

3.8.5 Recruiting of reviewers

3.8.5.1 Characteristics of reviewers that were needed for this systematic review

Independent reviewers with Master's and PhD qualifications were recruited following the approval of the study by the Faculty Research Committee (FRC) and registration on the PROSPERO database. Reviewers were selected based on their clinical, research, and academic experience, as well as prior involvement in systematic reviews and/or publications (table 3.4). Their role in this review included study selection, appraisal of the methodological quality of the included studies, and overall quality assessment. The involvement of multiple reviewers helped enhance the reliability and validity of the review process by reducing bias and ensuring a thorough evaluation of the included studies.

3.8.5.2 Process of invitation of reviewers

The number of reviewers for this study was seven, this number depended on the number of articles that were included in this study. Multiple invitation emails were sent to potential reviewers that met the requirements of the study until the number of reviewers was met. Reviewers were asked to provide proof of their qualifications in a form of a bio sketch and if a reviewer had any involvement in the publication, then they were not allocated their own publication to review in order to prevent bias (Almeida and Goulart 2017).

The researcher was an active member of the reviewer group and participated in all aspects of the review process, including study selection, data extraction, quality assessment, and methodological appraisal. The researcher reviewed all 32 included articles, applying the same evaluation criteria as the independent reviewers to ensure consistency and accuracy in the review process.

Table 3.4 Reviewer qualifications and experience

Reviewers	PhD qualification	Masters qualification	Academic experience	Clinical experience	Research experience

Reviewer 1		X	X	X	X
Reviewer 2	X		X	X	X
Reviewer 3		X	X		X
Reviewer 4		X	X	X	X
Reviewer 5	X		X	X	X
Reviewer 6	X		X	X	X
Reviewer 7 (researcher)	-	-	-	-	-

3.8.5.3 Memorandum of Understanding

Once the reviewers agreed to participate in this study, they were asked to sign a memorandum of understanding (MOU) (Appendix C) before their services could be accepted. This was to ensure that the reviewers knew and understood their role in the study and what was expected from them (Martel 2020).

3.8.6 Article allocation to reviewers and review process

Full PDF articles in each respective article group were sent to the assigned reviewers via email. Along with the articles, the appropriate appraisal tools were also provided: the PEDro scale (Appendix G) for RCTs, the Newcastle-Ottawa Scale (Appendix H) for nRCTs, and the Liddle scale (Appendix I) for case series and case reports. Reviewers were given eight weeks to complete the reviews, with the duration depending on the number of articles allocated to each reviewer. This timeframe was agreed upon in the Memorandum of Agreement (MOA) that reviewers signed prior to participating in the study.

Table 3.5 Allocated articles per reviewer

Group A	Group B	Group C

Reviewer A1	Reviewer A2	Researcher	Reviewer B1	Reviewer B2	Researcher	Reviewer C1	Reviewer C2	Researcher
RCTs – PEDro scale Dunning et al 2022 Garrigos-Pedron 2018 Lopez-Martos et al 2018 Nagata 2019 Packer et al 2015 Patra et al 2020 nRCTs – Newcastle Ottawa scale Ergezen 2022 Kulesa-Mrowiecka 2021 Macias Hernandez 2022 Moleirinhoalves et al 2021 Case series – Liddle scale Gonzalez-Iglesias			RCTs – PEDro scale Corum et al 2018 Delgado dela sena et al 2020 Dib-Zakkour et al 2022 Patra 2021 Rajadurai 2011 Reynolds 2020 Rezaie 2022 nRCTs – Newcastle Ottawa scale Calixtre 2016 Calixtre 2021 Urbanski 2021 Case series – Liddle scale Asha et al 2015			RCTs – PEDro scale Bae et al 2013 Barbosa et al 2021 Calixtre 2019 Sahin 2021 Sen 2020 Tuncer 2013 nRCTs – Newcastle Ottawa scale Bageston et al 2019 Barone et al 2021 Henriksen 2018 Case series - Liddle scale Reynolds and Brown 2020		
Total: 11			**Total: 11**			**Total: 10**		

Each article was reviewed by three reviewers—two external reviewers (one Masters and one PhD reviewer) in addition to the researcher (table 3.5). The articles were critically analyzed according to the respective scale (PEDro, NOS, and Liddle). These reviews were conducted independently and sent to the supervisors, not the researcher, to allow the researcher to perform their own reviews without the influence of external reviews.

In cases of disparity or disagreement among the reviewers, a conflict resolution strategy was implemented. When a discrepancy in the assessment ratings occurred, the three reviewers collaboratively discussed the discrepancies to reach a consensus. If consensus could not be achieved, the final decision was made through arbitration by a senior expert in the field. This process ensured that the reviews remained as objective as possible while maintaining the integrity of the assessment.

3.9 Data extraction and analysis

3.9.1 Data extraction process

All articles included in this systematic review were evaluated for quality and risk of bias prior to the extraction of outcomes. This assessment was performed using appropriate tools—the PEDro scale for randomized controlled trials (RCTs), the Newcastle-Ottawa Scale (NOS) for non-randomized controlled trials, and the Liddle Scale case series/reports. Conducting these assessments before data extraction minimized the risk of bias influencing the interpretation of results and ensured that only studies meeting quality thresholds contributed to the synthesis of evidence

3.9.2 Risk of bias assessment

The risk of bias in the included studies was assessed independently by three reviewers using standardized tools appropriate for the study designs. To enhance reliability, the assessments from the three reviewers were compared. If agreement on a quality item did not reach 70%, discrepancies were resolved through discussion. Persistent disagreements were addressed by consulting the supervisor. This multi-reviewer approach helped mitigate individual biases and improved the robustness of the quality assessment process. Quality and risk of bias assessments were conducted prior to outcome extraction to minimize any potential biases in the interpretation of the results. While subjective judgments during this process could introduce bias, steps were taken to mitigate this by employing standardized scales and involving multiple reviewers.

3.9.3 Synthesis method

Given the heterogeneity of study designs, interventions, and outcome measures, a meta-analysis was not conducted. Instead, a narrative synthesis approach was employed to summarize the findings across studies. Data were extracted systematically and grouped according to intervention type, primary outcomes, and methodological quality. To provide a structured synthesis, studies were categorized based on their quality and risk of bias assessments. Findings from high-quality studies were prioritized in drawing conclusions, while lower-quality studies were acknowledged with appropriate caution. Trends, consistencies, and discrepancies in

the reported outcomes were analysed to identify patterns in the effectiveness of conservative therapies for TMD.

In addition, the studies were analyzed for their strengths and weaknesses, clinical outcomes, study biases, and heterogeneity. This helped evaluate the factors influencing the study results and overall validity. Biases, including selection and reporting biases, were assessed based on the methodological quality of each study, while heterogeneity was evaluated through the comparison of study designs, patient populations, and outcome measures. This analysis was essential in guiding the synthesis and understanding the overall patterns across the studies.

3.9.4 Criteria for Ranking Evidence

The quality of evidence in this systematic review was assessed using three distinct grading systems: the AGREE system (Dagenais and Haldeman, 2011), the GRADE system (Brozek, 2009), and the grading system proposed by Foley et al. (2003). Among these, the Foley and AGREE grading systems were chosen for their more straightforward classification, which provides greater clarity for healthcare professionals compared to the more complex GRADE system. While the GRADE system is designed for developing healthcare guidelines with consistency, its complexity makes it less practical for the purposes of this review.

The AGREE system (Dagenais and Haldeman, 2011) and the grading system by Foley et al. (2003) include categories that indicate whether evidence within a specific clinical domain is consistent or conflicting. This feature is particularly valuable when studies present contradictory findings, helping to clarify the context of evidence and allowing for more informed decision-making.

Application of AGREE and Foley Grading Systems

- **Strong Evidence**: Findings supported by two or more RCTs of at least fair/moderate quality.
- **Moderate Evidence**: Findings supported by at least one RCT of fair/moderate quality.

- **Limited Evidence**: Findings supported by a single non-experimental study (e.g., NRCT, CS, cohort study).

- **Consensus of Evidence**: In the absence of sufficient studies, expert consensus provides support for an intervention. While often regarded as weak evidence, consensus may indicate consistent findings across various studies for a specific intervention in a particular condition.

- **Conflicting Evidence**: Observed discrepancies in findings from at least two RCTs. The conclusion is drawn from the majority of studies unless one study of superior quality significantly alters the overall findings.

- **No Evidence**: Available studies are of low quality and offer no clear evidence to support a treatment regimen.

This grading approach (AGREE and Foley) was applied throughout the systematic review to assess the quality of evidence and guide the interpretation of findings.

3.9.5 Interpretation of the grading of evidence using the AGREE system and the grading by Foley et al. (2003)

Strong Evidence:

- Definition: The highest level of evidence is derived from multiple RCTs of at least 'fair/moderate' quality.

- Application: When reviewing studies, if one finds that two or more high-quality RCTs consistently support a particular finding or intervention, then the evidence is classified as strong. This level suggests a high confidence that the intervention is effective.

(Foley *et al.* 2003; Dagenais and Haldeman 2011)

Moderate Evidence:

- Definition: Supported by at least one RCT of 'fair/moderate' quality.

- Application: If there is only one RCT that is methodologically sound and shows a positive effect, the evidence is considered moderate. This level implies moderate confidence in the findings.

(Foley *et al.* 2003; Dagenais and Haldeman 2011)

Limited Evidence:

- Definition: Based on a single non-experimental study, which could include NRCTs, Case Series, or cohort studies.

- Application: When the evidence is drawn from a single case report/ series study or a weaker design than an RCT, it falls under limited evidence. This suggests low confidence in the findings due to the lack of rigorous testing.

(Foley *et al.* 2003; Dagenais and Haldeman 2011)

Consensus of Evidence:

- Definition: In the absence of empirical evidence, expert opinion converges on a recommended intervention. This can also mean consistent results across different studies for a specific condition.

- Application: When no strong or moderate quality studies are available, but experts agree on a treatment or intervention, it can still guide clinical practice. This is considered weaker evidence but can be valuable, especially in novel or under-researched areas.

(Foley *et al.* 2003; Dagenais and Haldeman 2011)

Conflicting Evidence:

- Definition: When findings from at least two RCTs are inconsistent. The resolution of these conflicts depends on the quality and quantity of the studies.

- Application: If different RCTs provide contradictory results, the overall evidence quality is assessed and the majority view is favoured unless a conflicting study

is of superior quality. This level indicates uncertainty and the need for further research.

(Foley *et al.* 2003; Dagenais and Haldeman 2011)

No Evidence:

- Definition: Studies are of low quality or fail to support a clear conclusion. This implies a lack of reliable data to recommend a particular intervention.
- Application: When available studies are methodologically weak or inconclusive, the evidence is classified as none. This suggests that no firm conclusions can be drawn, and caution is required in making recommendations.

(Foley *et al.* 2003; Dagenais and Haldeman 2011)

3.10 Ethical considerations

Reviewers were kept blinded to the identity of each other throughout the study and were expected to work confidentially and not discuss anything related to the study with anyone. Everything pertaining to the study such as rules and what was expected from the reviewers was outlined in the MOU that was signed prior to undertaking the study.

If the reviewer had authored or was part of any article to be reviewed as part of the study, they were asked to not review those articles. The reviewers were asked to declare a conflict of interest if they had any formal relationship with one of the authors of a paper they had been allocated. This was done to avoid bias in the review process. Once reviewers completed reviewing their allocated articles, they were instructed (which was outlined in the MOU) to send their reviews to the research supervisor and not to the researcher to ensure that the review process remained independent, and bias was minimised as the researcher was also reviewing the articles.

The reviewers may be revealed to each other as a consequence of publication, but only if they agreed to act as co-authors. No information was made available regarding who reviewed which articles.

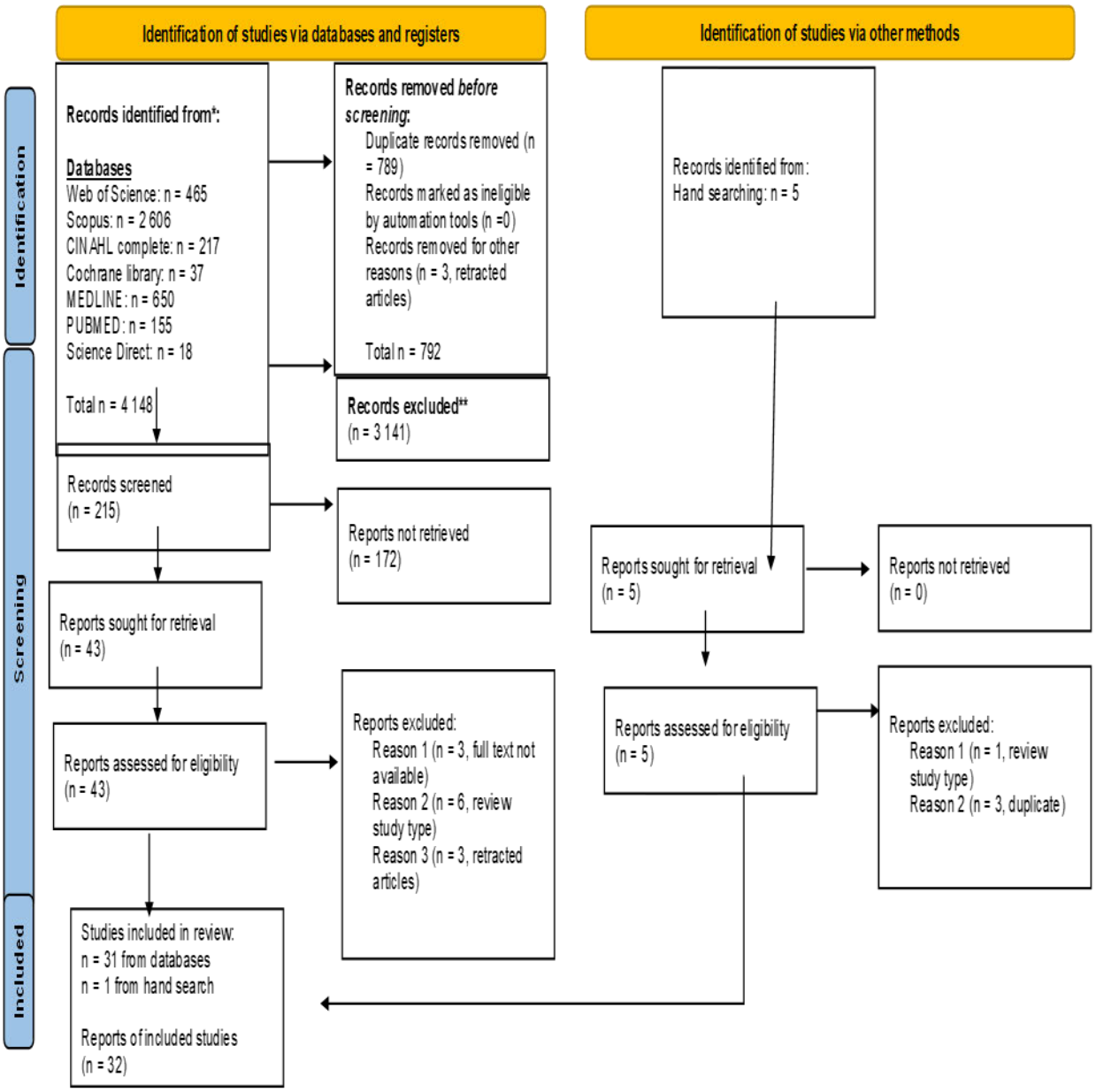
3.11 Conclusion

The methodology used in conducting this systematic review was described in this chapter. This chapter also provided an overview of the study's design and the methods taken throughout the literature search, including the selection of reviewers. The research tools, inclusion and exclusion criteria, and ethical issues were also reviewed, along with the data sample, data extraction, and data analysis.

4 CHAPTER FOUR: RESULTS

4.1 Study selection

The process of study selection for this systematic review is illustrated in the PRISMA flowchart below. The flowchart presents a step-by-step overview of the number of records identified, screened, assessed for eligibility, and included in the review. The selection process adhered to predefined inclusion and exclusion criteria, and reasons for exclusion are also noted.



4.2 Study characteristics

4.2.1 RCTs

Table 4.1 consolidates the PEDro scores for the included RCTs, ensuring clarity and compliance with PRISMA guidelines. It provides a clear comparison of study quality across multiple criteria.

Table 4.1: Consolidated PEDro score for included RCTs

Criterion	1. Eligibility criteria specified	2. Random allocation	3. Allocation concealment	4. Similar groups at baseline	5. Blinding of subjects	6. Blinding of therapists	7. Blinding of assessors	8. >85% outcome data obtained	9. Intention-to-treat analysis	10. Between-group comparisons reported	11. Point measures and variability reported	Total Score (/11)	Overall Agreement (%)
Bae & Park (2013)	Yes	Yes	No	Yes	No	No	No	Yes	Yes	Yes	Yes	7	88%
Barbosa et al. (2019)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	11	100%
Calixtre et al. (2019)	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes	Yes	10	94%
Corum et al. (2018)	Yes	Yes	No	Yes	No	No	No	Yes	Yes	Yes	Yes	7	91%
de la Serna et al. (2020)	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes	Yes	9	88%
Dib-Zakkour et al. (2022)	Yes	Yes	No	Yes	No	No	No	No	Yes	Yes	Yes	6	82%
Dunning et al. (2022)	Yes	Yes	No	Yes	No	No	Yes	Yes	Yes	Yes	Yes	9	88%
Garrigós-	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes	Yes	9	100%

Criterion	1. Eligibility criteria specified	2. Random allocation	3. Allocation concealment	4. Similar groups at baseline	5. Blinding of subjects	6. Blinding of therapists	7. Blinding of assessors	8. >85% outcome data obtained	9. Intention-to-treat analysis	10. Between-group comparisons reported	11. Point measures and variability reported	Total Score (/11)	Overall Agreement (%)
Pedrón et al. (2018)													
Lopez-Martos et al. (2018)	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes	Yes	10	85%
Nagata et al. (2019)	Yes	Yes	Yes	Yes	No	No	No	Yes	Yes	Yes	Yes	8	97%
Packer et al. (2015)	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	10	91%
Patra et al. (2020)	Yes	Yes	No	Yes	No	No	No	Yes	Yes	Yes	Yes	7	85%
Patra et al. (2021)	Yes	Yes	Yes	Yes	No	No	No	Yes	Yes	Yes	Yes	8	85%
Rajadurai (2011)	Yes	Yes	No	No	No	No	No	Yes	Yes	No	Yes	5	91%
Reynolds et al. (2020)	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	10	100%
Rezaie et al. (2022)	Yes	Yes	Yes	Yes	Yes	No	Yes	No	Yes	Yes	Yes	9	94%
Şahin et al. (2021)	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	10	88%
Şen et al. (2020)	Yes	Yes	Yes	Yes	Yes	No	Yes	No	Yes	Yes	Yes	9	91%
Tuncer et al. (2013)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	11	100%

4.2.2 NRCTs

Table 4.2: Summary of NRCT quality assessment

Author(s)	Year	Case Definition Adequate	Representative Cases	Selection of Controls	Definition of Controls	Comparability	Ascertainment of Exposure	Same Method of Ascertainment	Non-Response Rate	Total Score	Agreement (%)
Bagestson de Britto et al.	2019	Yes (100 %)	Yes (100%)	Yes (100 %)	Yes (100 %)	67%	0%	67%	67%	5/9	87.6%
Barone et al.	2021	Yes (100 %)	67%	0%	0%	0%	67%	0%	0%	2/9	91.75 %
Calixtre et al.	2016	Yes (100 %)	67%	0%	0%	67%	67%	0%	0%	3/9	87.62 %
Calixtre et al.	2021	Yes (100 %)	Yes (100%)	0%	0%	67%	67%	0%	0%	4/9	91.75 %
Ergezen et al.	2022	Yes (100 %)	Yes (100%)	0%	0%	0%	67%	0%	0%	3/9	95.87 %
Häggman-Henrikson et al	2018	Yes (100 %)	Yes (100%)	Yes (100 %)	Yes (100 %)	67%	Yes (100%)	Yes (100%)	Yes (100 %)	6/9	91.75 %
Kulesa-Mrowiecka, M., Piech, J. and Gaździk, T. S.	2021	Yes (67%)	Yes (100%)	Yes (100 %)	Yes (100 %)	67%	Yes (67%)	Yes (100%)	Yes (67%)	9/9	83.5%

Author(s)	Year	Case Definition Adequate	Representative Cases	Selection of Controls	Definition of Controls	Comparability	Ascertainment of Exposure	Same Method of Ascertainment	Non-Response Rate	Total Score	Agreement (%)
Macías-Hernández, S. I. et al.	2022	Yes (100%)	Yes (67%)	No (67%)	No (100%)	67%	Yes (100%)	No (67%)	Yes (100%)	7/9	83.5%
Moleirinho-Alves, P., Almeida, A., Exposto, F. G.	2021	Yes (100%)	Yes (100%)	No (67%)	No (67%)	67%	Yes (100%)	Yes (100%)	Yes (67%)	6/9	83.5%
Urbański, P., Trybulec, B. and Pihut, M.	2021	Yes (100%)	Yes (100%)	No (100%)	No (67%)	100%	Yes (67%)	Yes (100%)	Yes (67%)	5/9	87.6%

Notes:

- "Yes (100%)" indicates full agreement among reviewers.
- "67%" and "0%" indicate partial or no agreement.
- Total scores reflect the sum of criteria met out of 9.
- Agreement percentages represent the overall consensus among reviewers

4.2.3 Case series and case reports

Table 4.3: Summary of Case reports and Case series quality assessment

Author(s)	Year	Study Identification	Study Type Description	Intervention Implementation	Individual or Population	Outcomes Considered	Other Factors Affecting Outcome	Population & Study Setting	Groups/ Sites	Total Score
Asha et al.	2015	Yes (100%)	67%	67%	N/A (100%)	67%	67%	67%	100%	79.4%
González-Iglesias et al.	2013	Yes (100%)	100%	67%	67%	100%	67%	67%	67%	79.4%
Reynolds & Brown	2020	Yes (100%)	100%	67%	67%	67%	67%	67%	67%	75.2%

4.3 Risk of bias, Results of individual studies and syntheses and Reporting biases of included studies,

4.3.1 RCTs

RCT 1: Bae and Park (2013)

Risk of Bias in Studies

Bae and Park (2013) conducted a randomized controlled trial to assess the effects of relaxation exercises for the masticatory muscles on temporomandibular dysfunction (TMD). Although the study mentioned randomization, the process was not fully described, which increases the risk of selection bias. There was also no evidence of blinding, which introduces both performance and detection bias. The sample size was relatively small, with only 41 subjects, and the follow-up period was short (four weeks), limiting the generalizability of the findings and the ability to assess long-term effects. The study did not report how missing data or dropouts were handled, raising concerns about attrition bias. Furthermore, while paired t-tests and ANOVA were used appropriately for statistical analysis, the study did not specify whether corrections for multiple comparisons were applied, which could increase the risk of type I errors.

Results of Individual Studies

The study assessed several outcomes, including range of motion (ROM) of the temporomandibular joint (TMJ), deviation, occlusion, and pain. ROM was measured using goniometry, deviation was analysed with a digital camera and GPS software, and occlusion was assessed with a bite stick. Pain levels were recorded using a visual analogue scale (VAS), with measurements taken at baseline and after four weeks. Both active and relaxation exercises led to significant improvements in ROM, deviation, and pain reduction. Notably, relaxation exercises were more effective in reducing deviation compared to active exercises. The no-treatment group, consisting of 11 subjects, showed no significant improvements. However, the study did not provide confidence intervals or p-values, which limits the precision of the effect estimates and makes it difficult to assess the true magnitude of the effects.

Results of Syntheses

This study did not conduct a meta-analysis or statistical synthesis, and the results were presented narratively. The study highlighted the positive effects of relaxation exercises in improving ROM, deviation, and pain reduction, with relaxation exercises showing particular effectiveness in reducing deviation. The active exercise group also showed improvements, but to a lesser degree than the relaxation exercises group. The study did not explore heterogeneity between the groups or conduct any subgroup or

sensitivity analyses. As a result, there was no investigation into potential causes of variability in the study results or tests for the robustness of the findings.

Reporting Biases

The study did not address the handling of missing data or dropouts, which raises concerns about reporting bias. Without this information, it is unclear whether results were selectively reported or whether missing data could have affected the overall findings. The lack of transparency in dealing with missing data introduces the possibility of reporting bias, which may impact the completeness and reliability of the study's conclusions.

RCT 2: Barbosa et al. (2019)

Risk of Bias in Studies

Barbosa et al. (2019) conducted a randomized controlled trial to evaluate the effects of an 8-week endurance exercise protocol on masticatory muscle function in women with oro-facial pain and TMD. The study used randomization via the Research Randomizer website with a 1:1 allocation ratio. However, while randomization was mentioned, the study did not explicitly state whether blinding was maintained throughout, which raises concerns about performance and detection bias. Although the assessors were blinded to group allocation, the absence of explicit information on whether blinding was maintained throughout the study weakens the internal validity. The study had a 26% dropout rate, which may impact the results, introducing the potential for attrition bias. Additionally, the sample size (34 subjects) was relatively small, which could limit the power of the findings. The study also relied on self-reported pain measures, which can introduce measurement bias, and the 8-week duration may not be sufficient to assess long-term outcomes.

Results of Individual Studies

The study assessed pain using VAS, pressure pain threshold (PPT), bite force, and muscle endurance. Both groups showed pain reduction, but the intervention group had significantly lower VAS scores at 8 weeks. The intervention group also demonstrated improvements in muscle efficiency and endurance compared to the control group.

However, the study did not provide detailed summary statistics for each group, nor did it present the effect estimates with their corresponding confidence intervals, which limits the ability to assess the precision of the effect.

Results of Syntheses

This study did not conduct a meta-analysis or statistical synthesis of the results, as it was a single trial. The narrative results suggested that the endurance exercise protocol was effective in reducing pain and improving muscle efficiency, particularly in the intervention group. However, the study did not explore heterogeneity or conduct subgroup analyses to assess variability in treatment effects across different participant characteristics.

Reporting Biases

The study did not provide information on how missing data or dropouts were handled, which raises concerns about reporting bias. Without this information, it is unclear if any selective reporting of results or outcome measures occurred, particularly given the relatively high dropout rate. The lack of details on missing data management introduces the potential for reporting bias, which could affect the integrity of the findings.

RCT 3: Calixtre et al. (2019)

Risk of Bias in Studies

Calixtre et al. (2019) conducted a single-blind randomized controlled trial to evaluate the effects of upper cervical mobilization and craniocervical flexor training on orofacial pain, mandibular function, and headaches in women with TMD. Although the study used randomization and a 1:1 allocation ratio, the single-blind design introduces a risk of performance bias, as subjects were aware of the treatment they received. The sample was limited to women, which could reduce the generalizability of the findings to other populations. Additionally, the short duration of the study (5 weeks) limited the ability to assess long-term treatment efficacy. Self-reported measures for pain intensity and headache impact might have introduced bias due to recall bias or social desirability bias.

Results of Individual Studies

The primary outcomes included orofacial pain, headache impact, PPT of the masticatory muscles, and mandibular function. Results showed significant reductions in orofacial pain and headache impact in the intervention group. However, there was no significant improvement in masticatory muscle sensitivity or mandibular function. The study did not report specific effect estimates or confidence intervals for each outcome, limiting the ability to assess the precision of the results.

Results of Syntheses

This study did not conduct a meta-analysis or statistical synthesis, as it was a single trial. The results were presented narratively, showing that the intervention reduced orofacial pain and headache impact but did not improve masticatory muscle sensitivity or mandibular function. The study did not explore potential causes of heterogeneity or conduct any sensitivity analyses, which limits the ability to assess the robustness of the findings.

Reporting Biases

The study did not address how missing data or participant dropout were handled. This lack of information raises concerns about the potential for reporting bias, particularly if dropouts or missing data were not accounted for. Without transparency regarding these aspects, the completeness and reliability of the findings may be compromised.

RCT 4: Corum et al. (2018)

Risk of Bias in Studies

Corum et al. (2018) conducted a randomized controlled trial assessing spinal high-velocity low-amplitude manipulation combined with neck exercises in women with chronic TMD. While the study employed randomization using a computer-generated sequence, allocation concealment was not clearly described. A significant risk of bias arises from the absence of blinding for both assessors and subjects. This could have influenced subjective outcome measures such as pain intensity and quality of life, leading to detection bias. Furthermore, while the study used validated tools for pain intensity, pressure pain thresholds, and mouth opening, the lack of blinding increases

the risk of bias in subjective reporting. The study also did not consider confounding variables, such as comorbidities, which could have impacted the results.

Results of Individual Studies

The trial demonstrated significant improvements in pain intensity, pressure pain thresholds, pain-free maximum mouth opening, and quality of life in the cervical spinal manipulation group compared to the control groups. However, these improvements were less pronounced at the one-month follow-up, suggesting a potential reduction in treatment efficacy over time. Despite the promising short-term outcomes, the absence of a robust follow-up period limits the ability to assess long-term effectiveness.

Results of Syntheses

The combined approach of cervical spinal manipulation and neck exercises showed superior outcomes compared to both the sham manipulation and patient education groups. However, the study did not include a detailed synthesis of the data, nor did it explore the potential long-term benefits of the intervention. The observed effects on subjective outcomes such as pain intensity and quality of life were notable, but their sustainability was not fully addressed due to the limited follow-up.

Reporting Biases

The study did not adequately address potential reporting biases. There was no mention of how missing data were handled or whether the statistical analysis accounted for missing follow-ups or incomplete data. Additionally, ethical considerations were not explicitly stated in the study, including the protocols for informed consent or any measures to minimize participant risk. The lack of transparency around funding sources and conflicts of interest raises concerns regarding potential bias in the interpretation of results.

RCT 5: De la Serna et al. (2020)

Risk of Bias in Studies

De la Serna et al. (2020) conducted a randomized clinical trial to assess cervico-mandibular manual therapy in patients with TMD and somatic tinnitus. The study used

randomization with concealed allocation, and assessors were blinded, which mitigated detection bias. However, subjects and therapists were not blinded, which introduces performance bias, particularly in subjective measures such as pain and disability. Furthermore, the sample was drawn from private physiotherapy clinics, which limits the generalizability of the findings to a broader population. The absence of a control group that received no intervention also poses a risk of bias in determining the true effects of the treatment.

Results of Individual Studies

The study found significant improvements in TMD-related pain, tinnitus severity, disability, pressure pain sensitivity, and mandibular range of motion in the manual therapy group compared to the physiotherapy alone group. The intervention was shown to provide greater benefits across multiple outcome measures, and the sample size was appropriately powered to detect meaningful differences. However, the lack of a no-treatment control group means that the study cannot definitively rule out placebo effects as a contributing factor.

Results of Syntheses

The synthesis of the study's results indicated that the addition of manual therapy to a multimodal physiotherapy approach provided greater improvements in the severity of TMD and associated symptoms compared to the physiotherapy alone. While this finding is promising, it is important to interpret the results with caution, particularly due to the absence of a non-intervention group. This limitation prevents a clear understanding of whether the observed improvements were due to the intervention itself or other factors.

Reporting Biases

The study did not provide detailed information on how missing data were handled, which could impact the validity and generalizability of the results. Furthermore, the reliance on self-reported measures for outcomes such as tinnitus severity and disability introduces the possibility of bias, as these measures are subject to individual interpretation and recall bias. While statistical methods such as ANCOVA were used to control for baseline differences, the use of Bonferroni correction for multiple

comparisons may have reduced statistical power, potentially obscuring the true effect of the treatment.

RCT 6: Dib-Zakkour et al. (2022)

Risk of Bias in Studies

Dib-Zakkour et al. (2022) employed random allocation of subjects into either the experimental or control group, but the exact method of random sequence generation was not detailed, leaving some uncertainty regarding the potential for selection bias. The lack of clear information on allocation concealment further weakens the transparency of the randomization process and raises concerns about potential selection bias. Despite this, the study's double-blind design (both subjects and assessors were blinded) reduced the risk of performance and detection bias, making it a strength of the study. However, the absence of information on handling incomplete data or participant attrition increases the risk of attrition bias, as the effects of lost follow-ups on the results are unclear. Additionally, the study does not address confounding factors or disclose potential conflicts of interest, which raises concerns about the influence of external variables on the outcomes.

Results of Individual Studies

The study reported significant reductions in pain, muscle activity, and improved jaw movement patterns in the experimental group receiving dry needling compared to the control group. These findings suggest that dry needling may be effective in treating myogenous TMJ disorders. However, the lack of clear reporting on whether all prespecified outcomes were analyzed leaves uncertainty about the completeness of the data, and selective reporting cannot be ruled out.

Results of Syntheses

While the study showed improvements in several outcomes for dry needling, there was no synthesis of results across studies or treatment approaches. The absence of a clear methodology for handling missing data or non-reporting of confounding variables limits the interpretation of the findings. Furthermore, the study did not

compare dry needling to other interventions or include a placebo group, making it difficult to determine whether the observed effects were truly due to the intervention.

Reporting Biases

The study did not provide adequate information on how missing data were handled, raising concerns about the validity of the results. The potential for selective outcome reporting also exists, as the study did not specify whether all planned outcomes were reported. Moreover, the lack of discussion on potential conflicts of interest or confounding factors limits the transparency of the study, leaving room for concerns regarding reporting bias.

RCT 7: Dunning et al. (2022)

Risk of Bias in Studies

Dunning et al. (2022) used computer-generated randomization and allocation concealment through sealed opaque envelopes, which helped minimize selection bias. However, the study did not explicitly mention whether the assessors were blinded, which could introduce detection bias. The study design also lacked a placebo or no-treatment control group, which weakens the ability to draw conclusions about the efficacy of the experimental treatments (dry needling and upper cervical spinal manipulation). Additionally, the homogeneity of the therapists' backgrounds may have introduced treatment bias, affecting the generalizability of the findings. The reliance on subjective self-report measures for outcomes, such as the Visual Analog Scale (VAS), also increases the risk of measurement bias.

Results of Individual Studies

The trial demonstrated significant improvements in jaw pain intensity and active pain-free mouth opening for patients who received dry needling and upper cervical spinal manipulation compared to those receiving conventional treatments. These results suggest that the combined treatment may be an effective approach for TMD. However, the lack of a placebo or control group limits the ability to attribute these improvements solely to the interventions. Additionally, the use of self-reported measures introduces some subjectivity and potential for bias in assessing the outcomes.

Results of Syntheses

While the study provided valuable insights into the relative effectiveness of the two experimental interventions, it did not include a synthesis of these findings with other similar studies, nor did it offer a comparison to a placebo or no-treatment control. This omission limits the ability to generalize the findings to other populations or settings. The study did not address the potential for placebo effects or the influence of natural TMD progression, which could have affected the outcomes.

Reporting Biases

The study did not report on the handling of missing data or participant dropout, making it difficult to assess potential bias related to attrition. Although the study adhered to the intention-to-treat principle and used mixed-model ANCOVA for statistical analysis, it did not perform sensitivity analyses to evaluate the robustness of the results under different assumptions. The reliance on subjective self-report measures and the potential for bias due to therapist homogeneity also contribute to concerns about reporting bias.

RCT 8: Garrigós-Pedrón et al. (2018)

Risk of Bias in Studies

The study by Garrigós-Pedrón et al. (2018) included appropriate randomization and allocation concealment methods using sealed opaque envelopes, which minimized selection bias. Additionally, the assessors were blinded to group allocation, which reduced detection bias. However, the study did not mention whether subjects were blinded to their group allocation, potentially leading to bias in self-reported outcomes, particularly for subjective measures such as pain intensity and disability. There was no placebo control group, and the single-center design and small sample size limit the generalizability of the findings.

Results of Individual Studies

The study demonstrated that both treatment groups (cervical therapy and cervical + orofacial therapy) showed significant improvements in the Craniofacial Pain and Disability Inventory (CF-PDI), the Headache Impact Test-6 (HIT-6), and pain intensity.

The cervical and orofacial group (COG) showed more significant improvements, particularly in pressure pain thresholds (PPTs) in the trigeminal region and achieving pain-free maximum mouth opening (MMO). No significant differences were observed between groups in PPTs of the extratrigeminal region or the Tampa Scale of Kinesiophobia (TSK-11).

Results of Syntheses

Although the study showed positive results, the potential for bias, such as recall bias in self-reported outcomes and the lack of a placebo control, suggests that the results should be interpreted cautiously. The findings indicate that adding orofacial therapy to cervical physical therapy may lead to greater improvements in pain and function for patients with chronic migraine and TMD.

Reporting Biases

There was no significant loss to follow-up, and the study did not explicitly address the potential for missing data, which could result in attrition bias. Additionally, as the study relied heavily on self-reported measures of pain intensity and disability, there is a possibility of reporting bias, as patients may have interpreted or remembered their symptoms subjectively.

RCT 9: Lopez-Martos et al. (2018)

Risk of Bias in Studies

Lopez-Martos et al. (2018) implemented appropriate randomization using Epidat 4.0 software and blinded both the principal investigator and subjects to group allocation, effectively minimizing detection bias. However, the study excluded patients with comorbid conditions like fibromyalgia and depression, which limits the external validity. The reliance on subjective outcome measures, such as pain scales, may introduce measurement bias, as more objective assessments like electromyography (EMG) were not included.

Results of Individual Studies

The study demonstrated significant pain reduction and improved mandibular mobility in the PNE and DDN groups compared to the sham needling procedure (SNP). These outcomes were observed at multiple time points (baseline, day 28, day 42, and day 70). However, the therapeutic effects of the sham needling procedure might have influenced the results, particularly in terms of pain reduction.

Results of Syntheses

The findings of the study support the effectiveness of both PNE and DDN for managing temporomandibular myofascial pain compared to the sham procedure. Despite the robust statistical analyses and the multiple time points for outcome assessments, the lack of an intention-to-treat analysis and the exclusion of certain patient populations limit the generalizability of the results.

Reporting Biases

The study did not clearly report the reasons for the small dropout rate (approximately 5%), which raises concerns about potential attrition bias. Additionally, the reliance on self-reported measures introduces the possibility of reporting bias, as these measures could be influenced by the subjects' subjective interpretation of their symptoms. Furthermore, the sham needling procedure could have led to placebo effects that influenced the reporting of outcomes.

RCT 10: Nagata et al. (2019)

Risk of Bias in Studies

Nagata et al. (2019) employed a block randomization process and a computer-generated random number table for allocation, which minimized selection bias and ensured balanced distribution of subjects. While the study was single-blinded (subjects were unaware of treatment allocation), assessor blinding was not explicitly mentioned, which raises concerns about potential observer bias. The exclusion criteria and frequent clinic visits could introduce selection bias, limiting the external validity. The reliance on self-reported pain scales introduces the possibility of recall bias and subjective interpretation of symptoms. The lack of adjustments for multiple

comparisons may have increased the risk of type I errors. Missing data and loss to follow-up were not adequately addressed, which could further impact the reliability of the results.

Results of Individual Studies

The study found no significant differences between the intervention group (mandibular manipulation plus conventional treatment) and the control group (conventional treatment alone), except for short-term mouth-opening improvements following mandibular manipulation. This suggests that mandibular manipulation may provide only transient benefits. Therapeutic exercises produced comparable long-term outcomes, implying that the effect of mandibular manipulation may not be sustained.

Results of Syntheses

While the study provided useful insights into the effects of mandibular manipulation, the findings suggest that the treatment may have limited benefits beyond the short term. Given the lack of long-term differences, the study supports the idea that mandibular manipulation, when added to conventional treatment, offers only modest improvements in mouth opening. The findings emphasize the need for more robust studies with long-term follow-up to assess the true impact of the intervention.

Reporting Biases

Although the study did not report missing data or reasons for participant attrition, the potential for reporting bias remains a concern. The reliance on self-reported outcomes, particularly pain and mouth-opening distance, may lead to biased interpretations of results. The absence of assessor blinding may also affect the reporting of treatment effects, particularly for subjective measures like pain intensity.

RCT 11: Packer et al. (2015)

Risk of Bias in Studies

Packer et al. (2015) employed a block randomization process and opaque envelopes to ensure allocation concealment, reducing selection bias. The study used a placebo-controlled design with a sham intervention for the control group, which effectively

minimized the placebo effect. However, participant blinding was not feasible due to the nature of the intervention, potentially introducing performance bias. Missing data and loss to follow-up were not clearly reported, raising concerns about attrition bias. Outcome assessments were conducted by blinded assessors, which minimized detection bias, but the reliance on self-reported measures of pain and discomfort introduces potential recall bias.

Results of Individual Studies

The study found no significant differences in vertical mouth opening (VMO) or electromyographic (EMG) activity between the experimental and control groups. While isolated increases in muscle activity were observed post-manipulation, these effects were inconsistent and not sustained. The Cohen's d analysis revealed negligible clinical effects from the upper thoracic manipulation, suggesting that the intervention did not provide meaningful improvements in mouth opening or masticatory muscle activity

Results of Syntheses

The study's findings indicate that upper thoracic manipulation does not significantly impact mouth opening or masticatory muscle activity in women with temporomandibular disorder (TMD). Despite employing appropriate statistical methods, the study's small sample size and short follow-up period limited the ability to detect long-term or subtle clinical effects. These results highlight the need for further studies with larger sample sizes and extended follow-up periods to better understand the potential effects of upper thoracic manipulation.

Reporting Biases

The study did not clearly address missing data or reasons for participant attrition, which may contribute to attrition bias. Additionally, while assessors were blinded, the lack of participant blinding could have influenced the self-reported outcomes, introducing reporting bias. Given the small sample size and the inability to detect clinically significant differences, reporting bias may have played a role in the study’s outcomes, particularly in subjective measures such as pain and discomfort.

RCT 12: Patra et al. (2020)

Risk of Bias in Studies

Patra et al. (2020) randomized subjects into experimental and control groups using a lottery method, reducing selection bias. However, the study lacked blinding of assessors, which may have led to potential performance and detection bias. The use of self-reported outcomes via the SF-36 questionnaire introduces the possibility of recall bias, as subjects could subjectively report their health-related quality of life. The study's recruitment from a single outpatient department and its narrow age range (18 to 50 years) limit external validity, as the findings may not be generalizable to the broader TMD population, including older individuals or those with comorbidities. The absence of objective outcome measures also raises concerns about the comprehensiveness of the results. Although potential dropout was accounted for, the study did not fully report reasons for participant discontinuation, which affects the interpretation of treatment adherence and acceptability. The lack of adjustments for multiple comparisons further increases the risk of type I errors.

Results of Individual Studies

The study found that the combination of dry needling and cranial stabilization exercises significantly improved health-related quality of life in TMD patients, as measured by the SF-36 questionnaire. The results suggest that the intervention had a positive impact across various domains of health, but the study's limitations temper the strength of these conclusions.

Results of Syntheses

While the study demonstrates the potential benefits of dry needling combined with exercise in improving quality of life in TMD patients, the findings should be interpreted cautiously. The lack of blinding, the reliance on self-reported data, and the limitations in sample diversity may undermine the external validity of these results. Larger studies with objective outcome measures and longer follow-up periods are needed to validate the findings and refine treatment protocols.

Reporting Biases

Although the study did not report participant dropout reasons, the potential for reporting bias exists, particularly with self-reported outcomes such as the SF-36. The lack of blinding and potential performance bias may also have influenced the reporting of the outcomes, especially in subjective measures of health-related quality of life.

RCT 13: Patra et al. (2021)

Risk of Bias in Studies

Patra et al. (2021) employed a randomized controlled trial design with proper randomization using a lottery method and sealed envelopes, which minimized selection bias. However, the study did not mention blinding of the outcome assessors, which could introduce performance bias. While subjects were blinded, assessors' knowledge of group allocation may have influenced their interpretation of results, potentially skewing the findings. The study experienced a 15% dropout rate, which was accounted for in the power calculation but still introduces attrition bias. Uncontrolled confounding factors, such as prior treatments or comorbid conditions, could have contributed to residual confounding, further affecting the reliability of the results.

Results of Individual Studies

The study found that dry needling combined with muscular inhibition techniques showed some effectiveness in improving mouth function and health-related quality of life in patients with TMD. However, the presence of biases such as assessor unblinding and confounding factors limits the reliability of these findings.

Results of Syntheses

The findings from the study suggest potential benefits from dry needling combined with muscular inhibition techniques. However, the lack of assessor blinding and confounding variables make it difficult to draw definitive conclusions. The study’s

dropout rate and failure to control for prior treatments or comorbid conditions further complicate the interpretation of the results.

Reporting Biases

While the study appropriately accounted for dropout rates, the absence of a detailed explanation for participant attrition may indicate the possibility of reporting bias. Furthermore, the lack of assessor blinding could have influenced the reporting of results, particularly in the subjective outcomes, such as health-related quality of life and mouth function.

RCT 14: Rajadurai (2011)

Risk of Bias in Studies

Rajadurai (2011) conducted a randomized clinical trial on Muscle Energy Technique (MET) for Temporomandibular Joint (TMJ) dysfunction, but several critical issues raised concerns about the study's internal validity. The absence of a control group severely limits the ability to draw definitive conclusions about the effectiveness of MET, as there is no comparison to other treatment options. This lack of a control group introduces potential confounding variables, reducing internal validity. Additionally, the study did not employ blinding of subjects, assessors, or therapists, raising concerns about performance, detection, and measurement bias. Without blinding, both subjects and therapists may have influenced outcomes based on expectations or knowledge of the treatment, leading to biased reporting of pain intensity and improvements in mouth opening. The absence of blinding of assessors further complicates the situation, as their interpretations of outcome measures (e.g., VAS for pain and MMO for TMJ range of motion) may have been influenced by their expectations. The study also did not report any missing data or loss to follow-up, leaving room for potential attrition bias. The small sample size of 40 subjects further limits statistical power, and the absence of adjustments for multiple comparisons increases the risk of type I errors.

Results of Individual Studies

Due to the lack of a control group and blinding, the results of Rajadurai's study should be interpreted with caution. The findings suggest that MET may have some benefit for

TMJ dysfunction, but the study design limitations weaken the reliability of these conclusions.

Results of Syntheses

The study's design flaws, including the lack of a control group, absence of blinding, and small sample size, make it difficult to synthesize these results with other studies. Future research should include a control group, blinding, and a larger sample size to clarify the effects of MET for TMJ dysfunction and enhance the reliability of findings.

Reporting Biases

The lack of information on missing data and loss to follow-up raises concerns about potential reporting bias. Without proper reporting of these aspects, the study's findings may not fully reflect the true outcomes of the intervention, and the potential for bias in outcome assessment remains a significant concern.

RCT 15: Reynolds et al 2020

Risk of Bias in Studies

Reynolds et al 2020 involved randomization into two groups (cervical HVLAT and control) and was designed to minimize selection bias. However, the study did not blind treating clinicians, which introduces performance bias. While subjects and assessors were blinded, the inability to blind clinicians may have influenced treatment delivery and outcome interpretation. The lack of a placebo for other components of the intervention (such as behavioural education and soft tissue mobilization) presents a significant risk of confounding bias, as these additional treatments could have impacted the outcomes. The control group received a multimodal treatment, which makes it difficult to isolate the effect of cervical HVLAT alone. The psychometric properties of some of the outcome measures, such as the NPRS for TMD symptoms, were not fully reported, raising concerns about their reliability and validity. The absence of established minimal clinically important differences (MCID) for certain outcomes also limits the interpretation of clinical significance. Although the study had no dropouts, two subjects missed a visit due to illness, which may affect data

completeness. Additionally, statistical methods were appropriately chosen, but the lack of adjustments for multiple comparisons increases the risk of type I errors.

Results of Individual Studies

The results of the study indicate that both the cervical HVLAT and control groups showed improvement over time, with small differences between them. While the cervical HVLAT group exhibited some improvements in jaw function and fear of movement, these improvements were not consistent across all outcome measures. The inability to isolate the effect of cervical HVLAT due to the multimodal treatment protocol and the lack of clinician blinding reduce the internal validity of these findings.

Results of Syntheses

While the study contributes to the understanding of cervical HVLAT for TMD, the inability to blind clinicians, the multimodal nature of the intervention, and the potential issues with the outcome measures make it difficult to draw clear conclusions. Further research with stricter controls, larger sample sizes, and more robust outcome measures is needed to clarify the effectiveness of cervical HVLAT for TMD.

Reporting Biases

The study reported no dropouts, but the fact that two subjects missed a visit could impact the validity of the results. The study's limitations, including the lack of clinician blinding, the absence of a placebo for some components, and concerns about the psychometric properties of outcome measures, raise the possibility of reporting bias, particularly in the subjective outcomes such as pain intensity and jaw function.

RCT 16: Rezaie et al. (2022)

Risk of Bias in Studies

Rezaie et al. (2022) conducted a randomized controlled trial with single blinding of subjects and assessors. Randomization was performed using block balanced randomization and concealed allocation, which were strengths of the study design. However, therapist blinding was not possible due to the nature of the intervention, potentially introducing performance bias. The study utilized an appropriate control

group that received routine conservative treatment, including TENS, ultrasound, and gentle massage, which allowed for an assessment of the added benefit of manual therapy. Despite efforts to minimize bias, the lack of blinding for therapists remains a concern, particularly in the administration of the intervention. The sample size of 30 subjects (15 per group) is relatively small, limiting the generalizability of the findings. Additionally, the study was conducted at a single centre, and the inclusion/exclusion criteria may have resulted in a sample that does not represent the broader TMD population. The high dropout rate, with 8 patients in the intervention group and 7 in the control group discontinuing the study, further limits the study's internal validity. The absence of an intention-to-treat (ITT) analysis also weakens the study, as this method is essential for maintaining the integrity of randomized trials.

Results of Individual Studies

The study suggests that adding manual therapy to routine conservative treatment results in significant improvements in pain intensity, MMO, and cervical flexion ROM compared to the control group. However, the small sample size, high dropout rate, and lack of therapist blinding reduce the reliability of these results.

Results of Syntheses

While the intervention appears beneficial for treating TMD, the lack of therapist blinding, high dropout rate, and small sample size necessitate caution in interpreting the findings. The study would benefit from a larger sample size, longer follow-up, and complete blinding to confirm the results and improve generalizability.

Reporting Biases

The study did not explore the reasons for dropout, which could introduce bias, especially if subjects dropped out due to treatment-related issues. Moreover, the absence of an ITT analysis reduces the robustness of the findings and increases the risk of reporting bias. Further transparency in reporting dropout reasons and a more rigorous analysis would enhance the reliability of the conclusions.

RCT 17: Şahin et al. (2021)

Risk of Bias in Studies

Şahin et al. (2021) employed a strong study design, including randomization with allocation concealment and blinding of assessors. However, the lack of therapist blinding raises concerns about potential performance bias, as the therapist's knowledge of group allocation could influence the delivery of the interventions. The control group received exercise and postural exercises, while the intervention group also received ischaemic compression technique (ICT). Although the study utilized validated outcome measures such as the VAS, GCPS, and algometer, the use of self-reported measures (e.g., pain intensity) introduces subjectivity, which could affect the reliability of the results. The study did not include a no-treatment or sham control group, which could have helped to isolate the effect of the intervention and reduce bias. The small sample size (50 subjects) and short duration (4 weeks) may limit the generalizability and long-term applicability of the results. Furthermore, the dropout rate of 12 subjects could reduce statistical power, and the reasons for dropout were not thoroughly explored, leaving room for potential bias.

Results of Individual Studies

The study found no significant differences between the intervention and control groups at week 4. However, at week 1, there were significant differences in painless mouth opening (PMO) and maximum assisted mouth opening (MAMO), with small to medium effect sizes, suggesting that ICT combined with exercise may provide short-term benefits.

Results of Syntheses

While the intervention shows some short-term benefits, the lack of long-term follow-up, small sample size, and absence of a no-treatment or sham control group limit the strength of these conclusions. The study's short duration and potential subjectivity in self-reported measures mean that further research is needed to clarify the effectiveness and sustainability of the intervention for TMD.

Reporting Biases

The study did not provide detailed information on the reasons for participant dropout, which raises concerns about potential reporting bias. Furthermore, the absence of a more varied ICT frequency or long-term follow-up means that the results may not reflect the true long-term effects of the intervention. Transparency regarding funding sources and conflicts of interest would also strengthen the study's credibility.

RCT 18: Şen et al. (2020)

Risk of Bias in Studies

Şen et al. (2020) conducted a randomized controlled trial to investigate the effects of acupuncture on specific and non-specific points for treating TMD. The study employed randomization and blinding of assessors, which enhances its internal validity. Subjects were randomly assigned to two acupuncture groups, one for specific points based on traditional Chinese medicine (TCM) principles and the other for non-specific points. Despite efforts to control for placebo effects and patient expectations, the study lacked an a priori sample size calculation, potentially weakening the statistical power of the findings. The absence of a waiting list or placebo control group further limits the ability to account for natural changes in pain intensity or regression to the mean, introducing potential confounding. Additionally, the study had a dropout rate of 16%, and the reasons for dropout were not fully explored, raising concerns about selection bias. The primary outcome, characteristic pain intensity (CPI), was assessed through self-reported measures, which are susceptible to recall bias and patient expectations.

Results of Individual Studies

The study found that acupuncture, regardless of whether it targeted specific or non-specific points, significantly reduced pain intensity in TMD patients. However, there were no significant differences between the two acupuncture protocols, indicating that the point selection may not provide additional benefits.

Results of Syntheses

While acupuncture appears to reduce pain in TMD patients, the modest effect size and the lack of long-term follow-up limit the strength of the study's conclusions. The lack

of a placebo or waiting list control group and the use of subjective self-reported pain measures further reduce the reliability of the findings.

Reporting Biases

The lack of detailed dropout reasons and the use of self-reported outcomes suggest potential reporting bias. The absence of a control group and the small sample size limit the generalizability of the study's findings, emphasizing the need for further research with larger, more diverse samples and longer follow-up to confirm these results and explore the long-term effects of acupuncture on TMDs.

RCT 19: Tuncer et al. (2013)

Risk of Bias in Studies

Tuncer et al. (2013) evaluated the effectiveness of manual therapy (MT) combined with home physical therapy (HPT) compared to HPT alone for TMD. The study employed randomization, enhancing internal validity; however, the lack of blinding for assessors raises concerns about potential performance bias, particularly for subjective outcome measures like pain intensity. The study utilized self-reported measures of pain intensity (VAS) and pain-free maximum mouth opening (MMO), both of which are subjective and prone to reporting bias. While the study followed clear intervention protocols for both groups, the absence of a detailed description of the manual therapy and physical therapy techniques used reduces the clarity of the interventions. Additionally, the study did not report dropout rates or missing data, which affects the completeness of the findings.

Results of Individual Studies

The study concluded that manual therapy combined with home physical therapy (MTeHPT) was more effective than HPT alone in the short term for treating TMD. However, due to the small sample size and lack of long-term follow-up, the reliability of these findings is limited.

Results of Syntheses

While the study suggests that MTeHPT is more effective than HPT alone, its small sample size, absence of long-term follow-up, and methodological limitations weaken the strength and generalizability of the findings. Further research with larger sample sizes, long-term follow-up, and more transparent reporting is needed to confirm these results and assess the clinical applicability of the interventions.

Reporting Biases

The study's lack of dropout data and the absence of a placebo or sham group introduce potential reporting biases, making it unclear whether the observed effects were truly due to the interventions. Additionally, the lack of a power analysis and the absence of a detailed statistical analysis limit the ability to assess whether the sample size was adequate to detect clinically significant differences. More comprehensive reporting would improve the study's credibility.

4.3.2 NRCTs

NRCT 1: Bageston de Britto et al. (2019)

Risk of Bias in Studies

The study carries a high risk of bias due to its non-randomized design. Subjects were allocated based on diagnosis and selection criteria, introducing selection bias. Assessor blinding was not mentioned, increasing the risk of detection bias. The small sample size and lack of allocation concealment further contribute to potential bias. Additionally, the single-session intervention limits the ability to assess long-term effects.

Results of Individual Studies

Manual therapy techniques showed promise in reducing pain levels in TMD patients. Significant reductions in pain intensity were observed post-intervention, but electromyographic activity remained unchanged. The study employed factorial ANOVA to compare EMG variables, a dependent t-test for pain comparisons, and Bonferroni post hoc testing for significant ANOVA results.

Results of Syntheses

Findings suggest that manual therapy may offer short-term pain relief for TMD patients. However, given the small sample size, lack of blinding, and non-randomized design, the strength of the evidence is limited. The study's results align with previous findings indicating that manual therapy can provide temporary symptom relief but highlight the need for further research with stronger methodologies.

Reporting Biases

The study did not report details on allocation concealment, funding sources, or potential conflicts of interest. This omission raises concerns about transparency and possible reporting bias. Additionally, outcome reporting was limited to immediate effects, without long-term follow-up data to assess sustained benefits.

NRCT 2: Barone et al. (2021)

Risk of Bias in Studies

The one-group quasi-experimental design lacks a control group, limiting the ability to attribute observed improvements solely to the intervention. The use of convenience sampling introduces selection bias, and the absence of blinding for subjects and assessors increases the risk of performance and detection bias. Additionally, the study's short duration prevents an assessment of long-term effects.

Results of Individual Studies

Significant improvements were observed in pain intensity, pressure pain threshold, and mouth opening following the rhythmic joint mobilization (RJM) intervention. The study used SPSS for statistical analysis, with effect sizes calculated using Cohen's d. However, the lack of a control group limits the strength of these findings.

Results of Syntheses

The study provides preliminary evidence that RJM may offer immediate symptom relief in TMD patients. While statistical improvements were observed, the absence of a control group makes it difficult to determine whether these effects were due to the

intervention or other factors. The findings are consistent with prior research on RJM but should be interpreted with caution due to methodological limitations.

Reporting Biases

The study does not clarify whether blinding was attempted, which introduces a risk of reporting bias. Additionally, no information is provided on funding sources, conflicts of interest, or potential confounders such as concurrent treatments. These omissions reduce transparency and make it difficult to fully assess the reliability of the findings.

NRCT 3: Calixtre et al. (2016)

Risk of Bias in Studies

The study employed a single-group pre-post test design without randomization or a control group, increasing the risk of selection bias. Blinding of assessors and subjects was not specified, leading to potential performance and detection bias. The small sample size and lack of allocation concealment further limit the study's internal validity.

Results of Individual Studies

Significant improvements were observed in self-reported pain, jaw function (Mandibular Functional Impairment Questionnaire), maximum mouth opening, and pressure pain thresholds of the masseter and temporalis muscles. The study used ANOVA, Tukey test, and Friedman test for statistical analysis. However, the absence of a control group limits causal inferences.

Results of Syntheses

The study provides preliminary evidence that cervical mobilization and exercise may be beneficial for TMD patients. However, the non-randomized design, small sample size, and absence of a control group weaken the strength of these findings. The results align with prior research suggesting potential benefits, but more robust studies are needed.

Reporting Biases

The study did not specify whether blinding was implemented, which introduces a risk of reporting bias. Additionally, no details were provided on funding sources, conflicts of interest, or adherence to an intention-to-treat analysis. These omissions reduce transparency and reliability.

NRCT 4: Calixtre et al. (2021)

Risk of Bias in Studies

The study carries a high risk of bias due to its single-arm design, which lacks a control group and randomization. Without a control group, it is difficult to determine whether observed improvements were due to the intervention or other confounding factors. Additionally, the absence of blinding for both subjects and assessors increases the risk of performance and detection bias.

Results of Individual Studies

The study assessed pain pressure threshold (PPT), orofacial pain intensity, mandibular function, maximum mouth opening, and craniocervical flexor training (CCFT) performance. Significant improvements were reported for PPT over left masseter and temporalis muscles, pain intensity, mandibular function, and deep cervical muscle performance compared to baseline. Effect sizes ranged from moderate to large.

Results of Syntheses

The study provides preliminary evidence suggesting potential benefits of myofascial release and craniocervical flexor training in individuals with chronic myofascial TMD. However, the lack of a control group, small sample size, and absence of blinding weaken the strength of these findings. The results are consistent with prior studies that support the use of manual therapy and exercise for TMD, but further high-quality research is necessary.

Reporting Biases

The study did not include blinding, allocation concealment, or randomization, leading to a high risk of bias. Additionally, there were no details on funding sources, conflicts of interest, or adjustments for multiple comparisons, raising concerns about transparency and potential reporting bias.

Thanks for the clarification. Here's a refined approach with each of the four sections (Risk of Bias, Results of Individual Studies, Results Synthesis, and Reporting Bias) for NRCT 5, followed by NRCT 6, with each section covered in paragraphs.

NRCT 5: Ergezen et al (2022)

Risk of Bias in Studies:

This study's design is a pilot, non-randomized, quasi-experimental design, which introduces several risks of bias. The absence of a control group limits the ability to assess the intervention's effectiveness compared to no treatment or an alternative treatment. Without random assignment, selection bias may have occurred, with the subjects potentially differing in baseline characteristics in ways that could affect the outcomes. Furthermore, the lack of blinding introduces performance bias, as the knowledge of the treatment may have influenced both the subjects' and assessors' evaluations of the outcomes. The small sample size of only nine subjects further limits the study's power and raises concerns about the internal validity of the findings.

Results of Individual Studies:

The study found significant improvements in maximal mouth opening, pain intensity, and pain thresholds immediately following the proprioceptive neuromuscular facilitation (PNF) intervention. However, these results must be viewed cautiously due to the study’s methodological limitations, such as the lack of a control group and randomization. The absence of a control group means that we cannot be certain whether these improvements were due to the PNF exercises or other factors such as natural recovery or placebo effects. The small sample size also limits the ability to generalize these results to a larger population.

Results Synthesis:

Given the absence of other studies with a similar design and the study's methodological weaknesses, it is difficult to synthesize the results of this study with others in the field. The improvements in mouth opening and pain reduction observed in this study are promising but cannot be considered definitive without further rigorous trials. A synthesis of similar studies would require more robust methodologies, such as randomized controlled trials (RCTs) with larger sample sizes, control groups, and blinding, to draw more reliable conclusions about the effectiveness of PNF in TMD management.

Reporting Bias:

The study does not appear to report any selective outcome reporting or other types of bias. However, due to the pilot nature of the study, it's unclear whether all relevant outcomes were assessed and reported, particularly long-term effects or follow-up data, which could have provided a more comprehensive picture of the intervention's impact. The lack of a control group and randomization further complicates the interpretation of the results, as it cannot be determined whether the observed changes were due to the intervention or other external factors.

NRCT 6: Häggman-Henrikson et al. (2018)

Risk of Bias in Studies:

This non-randomized controlled trial also has several risks of bias, including the absence of randomization, which leads to selection bias. Subjects were not randomly assigned to the exercise intervention group, potentially influencing the comparability of the two groups. The study also did not mention blinding, which increases the likelihood of performance and detection bias. Moreover, the lack of detailed information on confounding factors such as prior treatments or comorbidities makes it difficult to assess the potential impact of these variables on the results. Additionally, the statistical analysis methods used, including the Wilcoxon matched pairs test and Mann–Whitney U-test, may not have been the most appropriate for the type of data and study design, introducing the risk of statistical bias.

Results of Individual Studies:

The results showed that subjects who underwent the supervised exercise program experienced reductions in jaw pain intensity, improved endurance during physical tasks, and better daily functioning. However, there were no significant differences observed between those with localized versus generalized pain, indicating that the exercise program may have had a similar effect on both groups. While these results suggest that supervised exercise may be beneficial for TMD, the study's methodological flaws, such as the lack of randomization and blinding, reduce the confidence in these findings. The subjective measures used, like pain intensity, are vulnerable to individual perceptions and biases.

Results Synthesis:

The findings of this study are consistent with the broader literature suggesting that exercise programs may alleviate TMD symptoms, particularly pain and functional limitations. However, the methodological issues in this study—such as non-randomization, lack of blinding, and inadequate statistical analysis—make it difficult to compare the results directly to other studies with more rigorous designs. To better synthesize these results, it would be essential to include data from higher-quality randomized controlled trials that minimize biases and provide stronger evidence for the effectiveness of exercise in managing TMD.

Reporting Bias:

While there is no clear evidence of selective reporting in this study, the lack of detail on some aspects, such as how the study accounted for confounding factors and the potential impact of participant expectations, may suggest some limitations in how outcomes were reported. Furthermore, the study does not provide information on potential dropouts or non-responders, which could affect the generalizability of the results. The reliance on subjective outcome measures, such as pain intensity and daily functioning, also introduces the possibility of reporting bias, as these measures are influenced by individual perceptions.

NRCT 7: Kulesa-Mrowiecka et al. (2021)

Risk of Bias

This study presents several limitations that affect its internal validity. The non-randomized design introduces selection bias because subjects were grouped based on the presence or absence of generalized joint hypermobility (HJS) rather than random allocation. This lack of randomization, combined with no mention of allocation concealment, increases the risk that baseline differences between groups could influence the outcomes. Additionally, the absence of blinding for subjects, caregivers, and outcome assessors introduces potential performance and detection biases, which are particularly problematic when subjective outcome measures, such as myofascial pain severity, are used. Furthermore, significant differences in baseline characteristics, notably age, between the two groups could confound the results. While the study initially recruited 322 patients, only 79 participated in the clinical portion, limiting the statistical power of the study. The 3-week intervention period, coupled with the lack of long-term follow-up, restricts our understanding of the sustainability of the observed improvements.

Results of Individual Studies

The study found a statistically significant improvement in both myofascial pain severity and mandibular coordination after the 3-week physiotherapy intervention for both the HJS and non-HJS groups. However, the findings should be interpreted cautiously, given the non-randomized nature of the study and the potential biases introduced by the lack of blinding and randomization. The improvements in both outcomes are promising but cannot be definitively attributed to the intervention alone.

Results of Syntheses

The results suggest that physiotherapy may be effective for TMD patients with or without generalized joint hypermobility, but the lack of a control group and the study's non-randomized design limit the ability to draw firm conclusions. While both groups showed improvements, these effects could be due to other factors or simply a result of the natural course of the condition, rather than the intervention itself.

Reporting Biases

The study lacks transparency regarding funding sources and potential conflicts of interest, which could have influenced the findings. The absence of allocation concealment and blinding increases the risk of reporting bias, as the knowledge of which subjects were in the intervention group might have affected the way outcomes were assessed or reported. Furthermore, without clear information on how missing data were handled, there is a concern about the completeness and reliability of the reported results.

NRCT 8: Macías-Hernández et al. (2022)

Risk of Bias

This study is also limited by several factors that affect its internal validity. The lack of a control group significantly hinders the ability to make causal inferences regarding the effects of the home-based exercise program. Without a control group, it is impossible to rule out other factors that could have contributed to the observed improvements in pain, functionality, and joint structure. Additionally, the study's non-randomized design introduces potential selection bias, as subjects were not randomly assigned to different groups, which could have resulted in unaccounted-for differences between individuals. The lack of blinding for both subjects and assessors further introduces the risk of performance and detection bias, as knowledge of the intervention may have influenced the expectations and reporting of outcomes. The study's small sample size—only 15 patients and 26 joints—also limits its statistical power and generalizability, raising concerns about the robustness of the findings. Moreover, the absence of allocation concealment in the study increases the likelihood of bias in participant selection.

Results of Individual Studies

The study reported significant improvements in pain, functionality, and joint structure following the home-based exercise intervention. Pain was measured using a visual analog scale (VAS), and functionality was assessed with the Helkimo index, while joint

structure was evaluated via ultrasound imaging. Despite these promising results, the lack of a control group makes it difficult to definitively attribute the observed changes to the exercise program alone. Other factors, such as concurrent treatments or the natural course of the condition, could have influenced the outcomes, limiting the ability to draw causal conclusions.

Results of Syntheses

While the results indicate potential benefits of the home-based exercise program for patients with temporomandibular joint osteoarthritis (TMJ OA), the absence of a control group and the non-randomized design limit the ability to synthesize these findings with other studies or draw definitive conclusions. Given the lack of a comparison group, it is difficult to determine whether the observed improvements are truly due to the intervention or if they could be attributed to other variables not accounted for in the study.

Reporting Biases

The study does not provide details on funding sources or potential conflicts of interest, which makes it challenging to assess whether these factors could have influenced the study design or results. The lack of blinding and the absence of a control group further exacerbate concerns about reporting bias, as the researchers or subjects may have been influenced by their expectations regarding the intervention’s effectiveness. Additionally, without clear information on how missing data were handled, there is a risk of bias in the reported outcomes.

NRCT 9: Moleirinho-Alves et al. (2021)

Risk of Bias in Studies

The study by Moleirinho-Alves et al. (2021) presents several methodological limitations that impact its internal validity. The main issue lies in the non-randomized design, which introduces potential selection bias. Subjects were assigned to groups through non-probabilistic convenience sampling, and although the outcome assessor was blinded, there was no blinding of subjects or intervention providers. This lack of

blinding could lead to performance and ascertainment biases, influencing the results. The potential for confounding factors is also a concern, as the study did not provide detailed baseline characteristics, such as pain severity or duration of TMD symptoms, making it challenging to assess comparability between the groups.

Results of Individual Studies

In terms of individual outcomes, the study observed significant reductions in pain and improvements in oral health-related quality of life in the groups that received therapeutic exercises, with the combined therapeutic and aerobic exercise group showing the most significant improvements. However, anxiety levels did not show significant changes across the groups. Despite the observed improvements in the primary outcomes, the study's non-randomized design and limited sample size hinder the reliability of these findings.

Results Synthesis

While the study suggests that therapeutic and combined therapeutic-aerobic exercise programs effectively reduce pain and improve quality of life in TMD patients, the methodological limitations prevent definitive conclusions. The lack of randomization and blinding, along with the small sample size, make it difficult to draw broad conclusions applicable to the wider TMD patient population.

Reporting Bias

The study does not provide information regarding funding sources or conflicts of interest, which could introduce reporting bias. Additionally, while the study reports the outcomes clearly, the limited sample size and potential bias reduce the confidence in the generalizability of the findings.

The study highlights the effectiveness of therapeutic exercise and combined therapeutic-aerobic exercise interventions in improving pain and quality of life for TMD patients. However, due to methodological limitations such as non-randomization, lack of blinding, and potential for bias, the results should be interpreted cautiously, and further research with rigorous randomization, larger sample sizes, and better blinding is needed.

NRCT 10: Urbański et al. (2021)

Risk of Bias in Studies

Urbański et al. (2021) conducted a non-randomized trial, which introduces selection bias as the allocation of subjects was done using an alternating method, not randomization. The study also lacked blinding for both subjects and assessors, increasing the risk of performance and detection biases. Potential confounders, such as prior treatments or comorbidities, were not controlled for, which could impact the results. Additionally, there was no explicit power calculation, raising concerns about the study's statistical power to detect clinically significant differences.

Results of Individual Studies

The individual outcomes of the study showed improvements in muscle activity and reductions in pain intensity in both treatment groups (post-isometric relaxation and myofascial release). However, the lack of randomization and blinding means the results may be influenced by biases, and the true effect of the interventions cannot be conclusively determined.

Results Synthesis

The study's findings suggest that both post-isometric relaxation and myofascial release methods are effective in improving TMD symptoms, particularly in reducing pain and improving muscle activity. However, due to the study's non-randomized design, lack of blinding, and potential confounders, the results cannot be synthesized with high confidence. Larger, well-conducted randomized trials are necessary to substantiate these findings.

Reporting Bias

There is a lack of transparency in the reporting of funding sources and conflicts of interest, which may introduce reporting bias. Furthermore, there is no mention of patient dropouts or adverse events, which limits the understanding of the study's conduct and potential biases.

The study provides valuable insights into the use of manual techniques like post-isometric relaxation and myofascial release for treating TMD. However, due to methodological limitations, including non-randomized allocation, lack of blinding, and potential confounding factors, the results should be interpreted with caution. Future research should focus on randomized trials with larger sample sizes and clear reporting of all relevant information.

4.3.3 Case series and Case reports

Case Report 1: Asha, V., Kannan, R., & Jacob, T. (2015)

Risk of Bias in Studies

The case report is descriptive in nature, involving only a single patient. There is no blinding of assessors, which could introduce potential bias as the healthcare providers were likely aware of the treatment administered. The absence of a control group or randomization further limits the internal validity. The study's small sample size (n=1) significantly reduces its generalizability, and the potential for confounding factors such as the patient's occupation and posture could influence the results. Furthermore, subjective measurements like pain scales and patient-reported outcomes could introduce variability and subjectivity into the results.

Results of Individual Studies

The case report provides a detailed assessment of the patient's response to dry needling, showing significant pain reduction, symptom improvement, and better functional outcomes. These results are promising for dry needling as a treatment for myofascial pain syndrome in the orofacial region, but they are based on a single participant, which limits the ability to generalize these findings.

Results Synthesis

Given that this is a single case report with no control group, it does not contribute to synthesizing evidence across studies. It offers insights into an individual's experience but cannot provide definitive conclusions on the overall effectiveness of dry needling for myofascial pain in a broader population.

Reporting Bias

There is no clear indication of reporting bias in this case report, but given the study's design, the findings may reflect the positive outcome of the single treatment provided, with less emphasis on potential negative effects or long-term results due to the short observational period.

Case Series 2: González-Iglesias, J., Cleland, J.A., Neto, F., Hall, T., & Fernández-De-Las-Peñas, C. (2013)

Risk of Bias in Studies

The study did not involve blinding of assessors, and subjects were not randomized, which increases the potential for bias. The absence of a control group makes it difficult to determine if improvements in symptoms were due to the treatment or the natural progression of the condition. The study also has a small sample size (n=15), which could introduce variability and limit the external validity of the results. Moreover, there is a potential risk of selection bias as the subjects were all recruited from one private clinic, potentially limiting the representativeness of the sample.

Results of Individual Studies

The study found significant improvements in pain intensity, maximal mouth opening, and disability following treatment. Effect sizes were large across all outcomes, suggesting a positive impact of the multimodal treatment approach (mobilization with movement, thoracic spine manipulation, and dry needling). However, the small sample size and lack of a control group limit the ability to attribute these improvements solely to the treatment, and the findings should be interpreted with caution.

Results Synthesis

This case series contributes to the understanding of multimodal treatments for TMD but cannot provide conclusive evidence on the efficacy of these interventions due to the study design limitations. The results suggest that these interventions may be beneficial for patients with myofascial TMD, but further research with controlled trials and larger samples is needed to confirm these findings and generalize them to a broader population.

Reporting Bias

The study does not provide evidence of significant reporting bias, but there is a possibility that the positive outcomes may be highlighted, while the lack of a control group and the small sample size limit the interpretation of these results. The study's short follow-up period also prevents a clear understanding of the long-term effectiveness of the interventions.

Case Series 3: Reynolds, B., & Brown, J.L. (2020)

Risk of Bias in Studies

The study's design as a prospective case series with a small sample size (n=5) and no randomization or blinding introduces the potential for bias. The lack of a control group further complicates attributing improvements to the intervention rather than other factors, such as natural progression or external influences. Additionally, the small sample size and convenience sampling reduce the generalizability of the findings.

Results of Individual Studies

The study found clinically meaningful improvements in pain ratings, jaw and cervical range of motion, and functional limitations, suggesting that cervical spine thrust joint manipulation, education, and home exercise may be effective in managing chronic TMD. However, the small sample size and lack of randomization mean that these findings should be interpreted with caution and further studies are needed to confirm the efficacy of this multimodal approach.

Results Synthesis

This case series suggests that the combination of cervical spine manipulation, education, and exercise could offer some benefit for TMD, but the evidence is limited by the small sample size and methodological weaknesses. The results provide some preliminary evidence but cannot establish a cause-effect relationship or offer definitive conclusions about the efficacy of this treatment approach in a broader population.

Reporting Bias

There is no clear evidence of reporting bias, but due to the small sample size and the design of the study, there is potential for the positive outcomes to be emphasized. The absence of long-term follow-up also limits the understanding of whether these improvements are sustained over time, which could affect the interpretation of the overall effectiveness of the interventions.

4.4 Certainty of evidence

Following the review of the 32 articles that met the inclusion criteria, the following interventions were identified as being used in the treatment and management of TMD:

Single intervention

- Dry needling
- Exercise
- Manipulation (thoracic spine)
- Manual therapy
- Mobilization
- Myofascial techniques
- Physical therapy
- PNF

Multi modal interventions

- Cervical spinal manipulation plus behavioural education plus soft tissue mobilization
- Cervical spinal manipulation plus exercise
- Cervical spine manipulation plus patient education plus exercise
- Dry needling plus cervical spinal manipulation

- Dry needling plus exercise
- Dry needling plus myofascial technique
- Ischemic compression plus exercise
- Mandibular manipulation plus conventional treatment
- Manual therapy plus exercise
- Manual therapy plus physiotherapy
- Mobilization plus exercise
- Mobilisation plus thoracic spine manipulation plus dry needling
- Myofascial technique plus exercise

4.4.1 Evidence of Single Interventions:

Table 4.4 Single Intervention: Level of Evidence for Dry Needling

Intervention: Dry needling				**Evidence rating per individual study**					
Author(s)	**Study type**	**Ranking of individual study**	**Internal and external validity**	**STRONG**	**MODERATE**	**LIMITED**	**NO EVIDENCE**	**CONFLICTED**	**CONSENSUS**
Dib-Zakkour *et al* (2022)	RCT	Moderate	**Moderate** internal validity and **Moderate** external validity		**X**				
Lopez-Martos *et al (2018)*	RCT	Excellent	**Good** internal validity and **Moderate** external validity.	**X**					
Sen *et al* (2020)	RCT	Good	**Good** internal validity and **Moderate** external validity.		**X**				

Asha *et al* 2015	Case report	Moderate	**Poor** internal validity and **Poor** external validity.			**X**			

Dib-Zakkour *et al.* (2022) conducted a randomized clinical trial evaluating the effectiveness of dry needling in treating myogenous TMD. The study demonstrates reasonable internal validity with a double-blind design, randomized allocation, and comprehensive outcome assessments. However, limitations include a small sample size, lack of details on allocation concealment, and limited generalizability due to single-centre recruitment and demographic restrictions. The external validity of the study is moderate, and the findings are relevant to clinical settings but may not generalize to diverse populations or settings without consideration of therapist expertise and protocol variations. The study adhered to intention-to-treat (ITT) principles in the statistical analysis, analysing subjects according to their randomized group regardless of adherence to treatment protocol or withdrawal from the study. This approach maintains the integrity of randomization and avoids overestimating treatment effects. While ITT analysis is robust, the study could have benefited from sensitivity analyses to assess the robustness of results under different assumptions or handling of missing data, which would enhance the interpretation of findings. Longer-term follow-up and replication studies in broader populations would strengthen the external validity and confirm the efficacy of dry needling for managing myogenous TMD.

The study by Lopez-Martos *et al.* (2018) offers valuable evidence on the comparative efficacy of deep dry needling versus a sham needling procedure for managing TMD. The study's strengths include rigorous randomization, double-blinding, and the use of both subjective and objective outcome measures. These elements bolster the internal validity of the findings. However, the study's limitations, such as the challenges in maintaining effective blinding with invasive procedures, reliance on subjective measures, and small sample size, warrant cautious interpretation. The absence of explicit ITT analysis and potential attrition bias due to dropouts also impact the study's robustness. Externally, the study's generalizability is constrained by its single-centre design, specific exclusion criteria, and small, homogeneous sample. While the findings are promising, further research with larger, more diverse populations and multi-centre

settings is necessary to validate and extend these results. Moreover, incorporating more objective measures and longer follow-up periods would enhance the understanding of the long-term efficacy and mechanisms of these interventions.

Şen *et al.* (2020) conducted a well-designed RCT comparing acupuncture on specific versus non-specific points for treating painful TMD. The study demonstrated good internal validity through randomization, blinding, and rigorous statistical analysis. However, limitations such as the lack of ITT analysis, absence of a placebo control, and relatively small sample size impact internal validity. External validity is moderately affected by the study's homogenous sample, short duration, and specific exclusion criteria. While the findings are valuable for understanding acupuncture's role in managing non-chronic TMD-related pain, further research with larger, more diverse samples and longer follow-up periods is recommended to confirm and extend these findings.

The case report by Asha, Kannan and Jacob (2015) presents an informative exploration of dry needling as a treatment for orofacial pain/TMD, highlighting its potential benefits in reducing pain and improving symptoms in a single patient. The detailed narrative provides valuable qualitative insights and practical considerations for clinicians. However, the internal validity is poor due to significant methodological limitations, including the single-case design, absence of randomization and blinding, and lack of control group. These factors limit the ability to draw causal inferences or generalize the results to a wider population.

For external validity, the report offers some relevance through its practical application and detailed procedural description but falls short in terms of broader applicability due to the focus on one patient and short-term observation. Future studies should involve larger sample sizes and include control groups to enhance the ability to generalize findings and draw causal inferences, implement randomization and blinding to reduce bias and strengthen the internal validity of the findings. Longer follow-up periods are necessary to evaluate the sustainability and long-term effects of dry needling for orofacial pain and including detailed information on potential adverse events, dropouts, and reasons for exclusion will provide a fuller picture of the intervention’s effectiveness and safety. Overall, the case report by Asha, Kannan and Jacob (2015) provides a valuable starting point for understanding dry needling's role in treating

orofacial pain, but more rigorous research is needed to confirm its efficacy and generalizability.

Overall, the collective evidence suggests that dry needling may be beneficial in managing myogenous TMD, particularly when considering the short-term effects observed in controlled settings. The studies reviewed provide **moderate** to **good** evidence of internal validity, indicating that the results are relatively robust and credible within the constraints of their designs. However, the **moderate** to **poor** external validity highlights the need for caution in generalizing these findings to broader, more diverse populations or clinical settings.

Table 4.5 Single Intervention: Level of Evidence for Exercise

Intervention: Exercise				**Evidence rating per individual study**					
Author(s)	**Study type**	**Ranking of individual study**	**Internal and external validity**	**STRONG**	**MODERATE**	**LIMITED**	**NO EVIDENCE**	**CONFLICTED**	**CONSENSUS**
Bae, Y. and Park, Y. (2013)	RCT	Moderate	Internal validity is moderate. Poor external validity		**X**				
Barbosa *et al* (2019)	RCT	Excellent	Internal validity is good. External validity is moderate		**X**				
Häggman-Henrikson *et al* (2018)	NRCT	Good	**Poor** internal validity and **Poor** external validity			**X**			
Macías-Hernández *et al* (2022)	NRCT	Moderate	**Poor** internal validity and **Poor** external validity			**X**			
Moleirinho-Alves *et al* (2021)	NRCT	Good	**Moderate** internal validity and **Moderate** external validity			**X**			

Bae and Park (2013) study provides valuable insights into the potential efficacy of relaxation exercises for TMD. The study indicates improvements in jaw movement and pain reduction. Internal validity is supported by the random allocation of subjects and the application of appropriate statistical analyses. However, several limitations are noted: the absence of blinding and a detailed randomization process, coupled with potential measurement biases, diminish confidence in the findings. In terms of external validity, the study's focus on a young, relatively homogenous population, a short follow-up duration, and a specific clinical setting restricts its applicability. Future research should address these issues by including diverse populations, extending follow-up periods, and replicating the interventions across varied real-world contexts. Overall, while the study lays a useful foundation for exploring exercise interventions for TMD, further research is necessary to confirm and broaden these findings.

Barbosa *et al.* (2019) conducted a robust investigation into the effects of masticatory muscle endurance exercises on women with TMD and orofacial pain. The study boasts strong internal validity, characterized by rigorous randomization, appropriate blinding, and comprehensive statistical analysis. However, concerns arise from a high dropout rate and the lack of explicit mention of an ITT analysis and sustained assessor blinding. Externally, the study's focus on a specific demographic and controlled clinical environment limits its generalizability. The short follow-up duration further constrains the applicability of the findings to long-term TMD management. Despite these limitations, Barbosa *et al.* (2019) offer valuable insights into the short-term efficacy of endurance exercises for TMD. Future studies should aim to include diverse populations, extend follow-up periods, and consider practical applications in varied clinical settings to strengthen the evidence base for these interventions.

Häggman-Henrikson, Wiesinger and Wänman (2018) provide preliminary evidence suggesting that supervised exercise programs may reduce jaw pain intensity and improve daily activities for TMD patients. However, the non-randomized design, lack of blinding, absence of a control group, and potential biases weaken the internal validity and limit the generalizability of their findings. These methodological shortcomings highlight the need for well-designed RCTs with larger, diverse samples and rigorous methodologies to validate the effectiveness and broader applicability of supervised exercise interventions for TMD.

The study by Macías-Hernández *et al.* (2022) explores the impact of a home-based exercise program on pain, functionality, and joint structure in patients with TMJ OA. The internal validity is compromised by the lack of a control group, absence of blinding, small sample size, and potential biases. External validity is similarly limited by the specific patient population, single-centre design, and short-term follow-up. Future research should focus on conducting RCTs with larger, more diverse samples, incorporating control groups, implementing blinding procedures, and extending follow-up periods. These improvements will help confirm the findings and enhance their applicability in broader clinical settings.

Moleirinho-Alves *et al.* (2021) investigated the potential benefits of therapeutic and aerobic exercise programs for patients with TMD. Despite offering valuable preliminary data, the non-randomized design and potential biases necessitate cautious interpretation of the results. Both the internal and external validity of the study are rated as moderate, indicating that while the findings are useful, more robust methodologies are needed to confirm their reliability and support their application in clinical practice. Future research should employ randomized designs, include larger and more diverse sample sizes, and ensure comprehensive reporting of baseline characteristics and potential confounders. These steps will enhance the internal and external validity and provide more conclusive evidence on the efficacy of exercise interventions for TMD patients.

The collective evidence from these studies suggests that various exercise interventions, including relaxation exercises, masticatory muscle endurance exercises, and both supervised and home-based exercise programs, show potential benefits in managing TMD. On average, the reviewed studies exhibit moderate internal validity, indicating a reasonable level of confidence in their findings within the confines of their methodologies. However, the moderate to poor external validity across these studies highlights significant limitations in generalizing the results to diverse and varied real-world populations.

Table 4.6 Single intervention: Level of Evidence for Manipulation (Thoracic spine)

Intervention: Thoracic spine manipulation	**Evidence rating per individual study**

Author(s)	Study type	Ranking of individual study	Internal and external validity	STRONG	MODERATE	LIMITED	NO EVIDENCE	CONFLICTED	CONSENSUS
Packer *et al* (2016)	RCT	Excellent	Internal validity is good and external validity is moderate		X				

The study by Packer *et al.* (2015) provides valuable data on the short-term effects of upper thoracic manipulation on TMD-related outcomes, specifically in women. The robust RCT design, use of objective and subjective measures, and blinding of assessors contribute to the study's internal validity. However, the limitations in terms of single-session intervention, short follow-up, and potential for performance bias due to the lack of participant blinding should be noted. The small sample size and specific demographic focus limit the generalizability of the findings. Externally, while the study's findings are applicable to similar clinical settings, broader applicability may be restricted due to the specific age and gender inclusion criteria and the university-based sample.

The study by Packer *et al.* (2015) provides significant evidence on the short-term effects of upper thoracic manipulation for TMD, especially in women. Its strong design and methodological rigor ensure good internal validity, suggesting that the findings are credible and can be trusted within the context of the study. However, the study's scope is limited by its short-term, single-session intervention and the lack of participant blinding, which introduces potential performance bias.

Externally, the findings are relevant to similar clinical settings but may not generalize well beyond the specific demographic and academic context in which the study was conducted. The limited sample size and focus on a particular age and gender group restrict the broader applicability of the results. This study by Packer *et al.* (2015) provides a good level of evidence for the short-term efficacy of thoracic manipulation in managing TMD symptoms in women. However, further research is required to confirm these findings over longer periods and in more diverse populations, which will strengthen the evidence base and support broader clinical applications.

Table 4.7 Single Intervention: Level of Evidence for Manual Therapy

Intervention: Manual Therapy				**Evidence rating per individual study**					
Author(s)	**Study type**	**Ranking of individual study**	**Internal and external validity**	**STRONG**	**MODERATE**	**LIMITED**	**NO EVIDENCE**	**CONFLICTED**	**CONSENSUS**
Bageston de Britto *et al* (2019)	NRCT	Moderate	**Poor** internal validity and **Poor** external validity			**X**			
Rezaie *et al* (2022)	RCT	Good	**Good** internal validity and **Moderate** external validity.		**X**				
Urbański *et al* (2021)	NRCT	Moderate	**Poor** internal validity and **Moderate** external validity.			X			

The study by Bageston de Britto, Bisi and Dhein (2019) provides valuable insights, however, its internal validity is constrained by several factors. The non-randomized design led to potential selection bias, as subjects were allocated based on their TMD diagnosis and selection criteria rather than random assignment. This raises concerns about the equivalence of the intervention and control groups. Additionally, the lack of blinding in the assessment of pain and EMG activity introduces measurement bias, potentially skewing the results. Despite employing appropriate statistical methods like factorial ANOVA and dependent t-tests, the study's design limitations hinder its ability to fully control for confounding variables, thereby affecting the reliability of the cause-and-effect relationship between manual therapy and the observed outcomes. The study’s internal validity is further weakened by its short-term, single-session intervention. This approach does not capture the long-term effects or sustainability of the improvements in pain and EMG activity observed immediately after the intervention. Without follow-up data, it is challenging to determine how these benefits evolve over time or if they persist beyond the initial session. The study attempted to

match subjects on basic characteristics such as age and gender, but this does not sufficiently control for other potential confounders that could influence the results.

The external validity of Bageston de Britto, Bisi and Dhein (2019) study's generalizability is limited. The small sample size, specific selection criteria, and controlled clinical setting restrict the applicability of the findings to broader TMD populations. The study included only 20 subjects, evenly split between TMD patients and healthy controls. While the age and gender matching helps to some degree, the narrow selection criteria and specific clinical environment may not represent the diverse contexts in which TMD treatments are applied. Furthermore, the manual therapy techniques used in the study might differ from those practiced in other clinical settings, which could limit the generalizability of the results. Despite these limitations, the study's findings are consistent with existing evidence that manual therapy can reduce pain in TMD patients. However, the lack of long-term follow-up, coupled with incomplete reporting on critical aspects like allocation concealment and potential conflicts of interest, raises questions about the study's transparency and broader applicability.

The study by Rezaie *et al.* (2022) investigated the efficacy of adding manual therapy to routine conservative treatment for TMD. The results indicated significant improvements in pain, MMO, and cervical ROM in the intervention group. The study employed robust randomization and single blinding, enhancing internal validity. However, limitations such as lack of therapist blinding, high dropout rates, and absence of ITT analysis impact the strength of the findings. The generalizability of the results is limited by the small sample size, specific patient population, and single-centre setting. Overall, the study provides promising evidence for manual therapy's role in managing TMD, but further research with larger, more diverse samples and rigorous study designs is needed to confirm these findings and expand their applicability.

The study by Urbański, Trybulec and Pihut (2021) offers valuable insights into the effectiveness of manual techniques, specifically post-isometric relaxation and myofascial release, as adjunctive therapies for temporomandibular joint disorders. However, the study's internal validity is compromised by its non-randomized design, lack of blinding, and failure to control for potential confounders. These factors suggest

that the findings should be interpreted with caution when considering causality. In terms of external validity, while the study's interventions are clearly described and relevant to clinical practice, the methodological limitations and short follow-up period limit the generalizability of the findings.

Manual therapy interventions, including techniques like post-isometric relaxation and myofascial release, show potential benefits for managing TMD. However, the reviewed studies highlight significant limitations in their design and generalizability. Bageston de Britto, Bisi and Dhein (2019) provides insights into immediate effects of manual therapy but lacks long-term data and robust methodological rigor. Rezaie *et al.* (2022) offers promising evidence for manual therapy as an adjunctive treatment with good internal validity but requires further exploration in larger and more diverse samples to strengthen external validity. Urbański, Trybulec and Pihut (2021) suggests potential benefits of specific manual techniques but suffers from methodological weaknesses and limited follow-up, reducing the reliability and generalizability of the findings. The evidence supports the potential utility of manual therapy in TMD management. However, the methodological limitations and issues with generalizability highlight the need for more rigorous and expansive research to confirm these findings and establish stronger, more generalizable evidence for clinical practice.

Table 4.8 Single Intervention: Level of Evidence for Mobilization

Intervention: Mobilization				**Evidence rating per individual study**					
Author(s)	**Study type**	**Ranking of individual study**	**Internal and external validity**	**STRONG**	**MODERATE**	**LIMITED**	**NO EVIDENCE**	**CONFLICTED**	**CONSENSUS**
Barone *et al* (2021)	NRCT	Poor	Internal validity is poor and external validity is moderate			**X**			

The study by Barone *et al.* (2021) explored the immediate effects of rhythmic joint mobilization in the treatment of TMD. Internal validity is limited due to several factors. The one-group quasi-experimental design without a control group makes it challenging

to determine if the observed improvements in pain, PPT, and MO are due to RJM or other factors like placebo effects. Additionally, the use of convenience sampling introduces selection bias, which affects the representativeness of the findings. The lack of blinding for subjects and assessors likely introduces performance and detection bias, skewing the results in favour of RJM.

The sample size of 38 subjects may be too small to detect smaller, clinically significant effects, thus reducing the study's statistical power. The study's focus on the immediate effects of a single, brief RJM session does not provide insights into the long-term efficacy or potential benefits of repeated interventions, which are common in clinical practice for managing TMD (Busse *et al.* 2023). The study's findings may not be generalizable to other populations or settings. While the study suggests that RJM can provide immediate relief in TMD symptoms, the lack of a control group, the brief duration of the intervention, and the potential biases limit the strength and generalizability of these conclusions. The statistically significant results need to be interpreted cautiously, especially considering their clinical significance without a control for comparison.

The study by Barone *et al.* (2021) provides preliminary insights into the potential immediate benefits of RJM for TMD, suggesting that this intervention can offer short-term relief from symptoms such as pain and restricted mouth opening. However, the study's conclusions are tempered by several significant limitations. The current evidence supports the potential for RJM to provide immediate symptom relief in TMD patients, but due to significant methodological limitations and limited generalizability, the evidence is weak. Further rigorous research is needed to confirm these findings and establish stronger, more generalizable evidence for the long-term efficacy and broader application of RJM in TMD management.

Table 4.9 Single intervention: Level of Evidence for Myofascial Technique

Intervention: Myofascial Technique	**Evidence rating per individual study**

Author(s)	Study type	Ranking of individual study	Internal and external validity	STRONG	MODERATE	LIMITED	NO EVIDENCE	CONFLICTED	CONSENSUS
Rajadurai (2011)	RCT	Moderate	Internal validity is moderate and external validity is limited		X				

The study by Rajadurai (2011) suggests that MET may reduce TMJ pain and improve range of motion over a 5-week period. However, the findings should be interpreted cautiously due to methodological limitations including lack of blinding, absence of a control group, small sample size, and short duration. While randomization and measurement tools were appropriately used, the lack of blinding, potential for bias, and absence of a control group compromise the internal validity of the study resulting in moderate internal validity. The study's limitations in sample size, demographic diversity, and absence of a control group restrict broader applicability of findings resulting in limited external validity. The study by Rajadurai (2011) provides preliminary evidence suggesting that MET may reduce TMJ pain and improve range of motion over a short period. However, the study's conclusions are tempered by several notable limitations. While the current evidence supports the potential short-term benefits of MET in managing TMJ dysfunction, significant methodological limitations and restricted generalizability suggest that the evidence is weak. More rigorous and well-designed research is needed to confirm these findings and establish stronger, more generalizable evidence for the clinical efficacy of MET in treating TMJ dysfunction.

Table 4.10 Single Intervention: Level of Evidence for Physical Therapy

Intervention: Physical Therapy				Evidence rating per individual study					
Author(s)	Study type	Ranking of individual study	Internal and external validity	STRONG	MODERATE	LIMITED	NO EVIDENCE	CONFLICTED	CONSENSUS

Garrigós-Pedrón *et al* (2018)	RCT	Good	Internal and external validity is moderate		**X**				
Kulesa-Mrowiecka *et al* (2021)	NRCT	Excellent	Internal validity is poor to moderate and external validity is poor			**X**			

The study by Garrigós Pedrón *et al.* (2018) provides valuable evidence on the benefits of combined cervical and orofacial physical therapy for patients with chronic migraine and TMD. The study's strengths include a rigorous randomization process, blinding of outcome assessors, and a mix of subjective and objective outcome measures. However, the absence of a placebo control group and the lack of participant blinding present significant limitations. Additionally, the single-centre recruitment and small sample size limit the generalizability of the findings. The ITT analysis is a notable strength, maintaining the benefits of randomization and offering a realistic view of treatment effectiveness. Nonetheless, the study's failure to explicitly address the handling of missing data and the potential for bias due to non-blinding of subjects are critical issues that need consideration. Overall, while the study demonstrates positive effects of combined therapy on chronic migraine and TMD, its methodological limitations should be taken into account. Future research should aim to include placebo controls, larger and more diverse samples, and multi-centre designs to validate and extend these findings.

Kulesa-Mrowiecka, Piech and Gaździk (2021) suggest that physiotherapy can be effective in reducing myofascial pain and improving mandibular coordination for patients with TMD and generalized joint hypermobility syndrome. However, the study's non-randomized design, lack of blinding, small sample size, and potential biases limit its internal validity and generalizability. These methodological limitations underscore the need for future well-designed randomized controlled trials with larger, more representative samples, rigorous blinding procedures, and comprehensive outcome measures to validate the effectiveness of physiotherapy interventions for TMD across diverse patient populations and healthcare settings.

Overall, the evidence provided by Garrigós Pedrón *et al.* (2018) and Kulesa-Mrowiecka, Piech and Gaździk (2021) supports the potential short-term benefits of combined cervical and orofacial physical therapy for managing chronic migraine and TMD. However, significant methodological limitations and restricted generalizability suggest that the evidence is moderate to weak. More comprehensive and well-designed studies are needed to validate these preliminary findings and establish stronger, more generalizable evidence for the intervention's efficacy.

Table 4.11 Single Intervention: Level of Evidence for PNF

Intervention: PNF				**Evidence rating per individual study**					
Author(s)	**Study type**	**Ranking of individual study**	**Internal and external validity**	**STRONG**	**MODERATE**	**LIMITED**	**NO EVIDENCE**	**CONFLICTED**	**CONSENSUS**
Ergezen *et al* (2022)	NRCT	Poor	Internal validity is poor and external validity is limited.			**X**			

Ergezen, Atilgan and Kilicaslan (2022) provide initial evidence suggesting immediate benefits of PNF exercises on mouth opening, pain thresholds, and pain intensity in individuals with TMD, the study is constrained by its non-randomized design, lack of blinding, absence of a control group, and small sample size. These limitations introduce biases and hinder the ability to draw robust conclusions about the effectiveness of PNF exercises compared to alternative treatments or no intervention. Future research employing randomized controlled trials with larger, diverse samples and longer-term follow-up is warranted to validate these preliminary findings and assess the broader clinical implications of PNF exercises in managing TMD.

The study by Ergezen, Atilgan and Kilicaslan (2022) offers weak evidence due to significant methodological flaws, including non-randomization, lack of blinding, absence of a control group, and small sample size. The findings have limited generalizability, restricted by the study's specific clinical setting, homogeneous sample, and short-term focus. The preliminary evidence suggests potential immediate benefits of PNF exercises for TMD management. However, the significant limitations

in study design and generalizability indicate that these findings should be interpreted with caution. Comprehensive, well-designed RCTs are needed to validate and expand upon these initial results to provide more robust and generalizable evidence for the clinical application of PNF exercises in TMD treatment.

4.4.2 Evidence of Multi-Modal Interventions:

Table 4.12 Multi Modal Intervention: Level of Evidence for Cervical manipulation plus other interventions

Intervention: cervical manipulation, exercise, mobilization and patient education				**Evidence rating per individual study**					
Author(s)	**Study type**	**Ranking of individual study**	**Internal and external validity**	**STRONG**	**MODERATE**	**LIMITED**	**NO EVIDENCE**	**CONFLICTED**	**CONSENSUS**
Corum *et al* (2018)	RCT	Moderate	Internal and external validity is moderate		**X**				
Reynolds *et al* (2020)	RCT	Excellent	Internal and external validity is moderate		**X**				
Reynolds and Brown (2020)	Case series	Moderate	Internal validity is poor and external validity is moderate			**X**			

Corum *et al.* (2018) conducted a study to evaluate the effects of spinal high-velocity low-amplitude manipulation combined with exercise in women with chronic TMD. The study's internal validity is moderate, with strengths in randomization and detailed reporting of outcomes but weaknesses in blinding and follow-up duration. The lack of feasible blinding for subjects and therapists due to the nature of the interventions introduces potential performance bias. The external validity of the study by Corum *et al.* (2018) is moderate, with the study providing valuable insights into the efficacy of cervical manipulation and exercises for chronic TMD. However, the exclusive focus on female subjects and a single clinical setting limits the generalizability of the findings to

broader populations and varied clinical environments. The short-term follow-up period further restricts the understanding of the long-term effects of the interventions.

Overall, the study contributes to the evidence base for managing chronic TMD but highlights the need for future research to address its limitations, including longer follow-up periods, broader and more diverse populations, and enhanced blinding procedures. Such improvements will strengthen the evidence base for the effectiveness of these interventions in managing TMD in various clinical settings.

The study by Reynolds *et al.* (2020) evaluated the addition of cervical HVLAT to a multimodal treatment approach for TMD with myalgia. The results suggest that while there were improvements in both groups, the additive effect of HVLAT remains unclear. The study employed robust randomization and attempted blinding, enhancing its internal validity. However, the lack of blinding of treating clinicians, absence of a placebo component, and potential biases limit the strength of causal inferences. The findings are applicable within the context of the study sample but should be interpreted cautiously given the limitations in generalizability. Future research with larger, more diverse samples, extended follow-up periods, and more rigorous control conditions is warranted to validate and expand upon these preliminary findings.

The prospective case series by Reynolds and Brown (2020) investigates the effects of cervical spine thrust joint manipulation, education, and a home exercise program on individuals with TMD. The study by Reynolds and Brown (2020) reports improvements in jaw and cervical range of motion, pain ratings, and functional limitations among the five subjects. However, the internal validity of the study is poor due to significant methodological limitations, including the small sample size, lack of a control group, absence of blinding, and unspecified statistical analysis. These factors introduce potential biases and limit the ability to attribute observed improvements directly to the interventions. The external validity of the study by Reynolds and Brown (2020) is moderate, as the findings provide practical insights but are limited in their generalizability due to the small and specific sample and the short-term nature of the study.

Overall, the current evidence for HVLAT manipulation combined with exercise and multimodal approaches, is promising but varies in strength. The strength of the

evidence is weak to moderate. These interventions show consistent short-term benefits for TMD management across studies. However, improvements in study design, including longer follow-up, broader population samples, and better blinding protocols, are necessary to confirm these findings and establish their long-term efficacy and broader applicability. Although initial findings suggest that these approaches may be beneficial, the current evidence base is limited by methodological weaknesses. Future research should focus on rigorous, controlled studies to provide more definitive conclusions on their effectiveness.

Table 4.13 Multi Modal Intervention: Level of Evidence for Mandibular manipulation plus other interventions

Intervention: mandibular manipulation and conventional interventions				**Evidence rating per individual study**					
Author(s)	**Study type**	**Ranking of individual study**	**Internal and external validity**	**STRONG**	**MODERATE**	**LIMITED**	**NO EVIDENCE**	**CONFLICTED**	**CONSENSUS**
Nagata *et al* (2019)	RCT	Moderate	Internal and external validity is moderate		**X**				

Nagata *et al.* (2019) study provides valuable insights into the efficacy of mandibular manipulation combined with conventional treatment for patients with TMD experiencing mouth-opening limitations. The study's strengths include a rigorous single-blind RCT design, frequent and varied outcome assessments, and a clear comparison between the intervention and control groups. However, the internal validity is somewhat compromised by the lack of double-blinding, potential biases in self-reported measures, and unaddressed strategies for handling missing data. The absence of blinding for practitioners is a particular concern, as their knowledge of treatment allocation could influence the interaction and outcomes. Externally, the findings are relevant for clinical settings similar to the study's hospital environment. Yet, the limited generalizability due to specific patient demographics and exclusion criteria necessitates caution when applying these results to broader populations. Overall, The study by Nagata *et al.* (2019) offers preliminary evidence supporting the addition of mandibular manipulation to conventional treatment for TMD with mouth-

opening limitations. However, the conclusions should be interpreted with caution due to methodological limitations and the need for further research. Future studies with larger, more diverse samples, multi-centre designs, and extended follow-up are necessary to validate and expand upon these findings, providing more robust and generalizable evidence for clinical practice.

Table 4.14 Multi Modal Intervention: Level of Evidence for Dry needling plus other interventions

Intervention: dry needling, cervical spine manipulation, exercise and muscular inhibition technique				**Evidence rating per individual study**					
Author(s)	**Study type**	**Ranking of individual study**	**Internal and external validity**	**STRONG**	**MODERATE**	**LIMITED**	**NO EVIDENCE**	**CONFLICTED**	**CONSENSUS**
Dunning *et al* (2022)	RCT	Good	Internal validity is strong and external validity is good	**X**					
Patra *et al* (2020)	RCT	Moderate	Internal and external validity is moderate		**X**				
Patra *et al* (2020)	RCT	Moderate	Internal and external validity is moderate		**X**				

Dunning *et al.* (2022) study on the combined effects of dry needling and upper cervical spinal manipulation for TMD provides valuable insights into potential therapeutic options. The study boasts a strong internal validity framework with rigorous randomization, intention-to-treat analysis, and a combination of subjective and objective outcome measures. However, the absence of a placebo control group and potential biases related to the lack of assessor blinding and the homogeneity of therapists limit the conclusiveness of attributing observed benefits directly to the interventions. Externally, the study's results are promising and applicable to outpatient physical therapy settings, although caution is needed when generalizing to broader populations or different clinical contexts. Future research could enhance the robustness of these findings by including placebo controls, more diverse therapist

backgrounds, and expanded objective measures, which would further solidify the evidence for dry needling and spinal manipulation in the management of TMD.

The internal validity of the study by Patra, Kanungo and Mohanty (2020) is moderate. The strengths in randomization and intervention protocol are overshadowed by the lack of blinding and potential biases from self-reported measures and unaddressed confounders. The external validity of the study by Patra, Kanungo and Mohanty (2020) is moderate. While the interventions and outcome measures are replicable and relevant, the specific population, short duration, and convenience sampling limit the broader applicability of the findings.

The study by Patra, Kaur and Kanungo (2021) presents a well-conducted trial with a clear intervention and relevant outcomes for TMD treatment with moderate internal and external validity. While the internal validity is bolstered by good randomization practices, the lack of blinding for assessors, potential confounding factors, and incomplete reporting of the ITT analysis moderately impact confidence in the results. Similarly, the external validity is constrained by the sample's geographic and demographic limitations, the absence of long-term follow-up, and variations in clinical practice. The study's application of an ITT analysis provides a conservative estimate of treatment effects but requires further clarification in its execution and reporting.

The strength and quality of the evidence across these studies are moderate. Each study brings valuable insights into TMD management but is tempered by specific methodological and applicability concerns. To strengthen the evidence base, future research should focus on improving blinding, addressing confounders, including diverse populations, and expanding follow-up durations. This approach will enhance the robustness and generalizability of findings, providing a more solid foundation for clinical decision-making in TMD interventions (Arias, Rogus-Pulia and Kind 2022)

Table 4.15 Multi Modal Intervention: Level of Evidence for Ischaemic compression plus other interventions

Intervention: ischaemic compression and exercise	**Evidence rating per individual study**

Author(s)	Study type	Ranking of individual study	Internal and external validity	STRONG	MODERATE	LIMITED	NO EVIDENCE	CONFLICTED	CONSENSUS
Sahin *et al* (2021)	RCT	Good	Internal and external validity is moderate		X				

The study by Şahin *et al.* (2021) provides moderate-quality evidence for the use of the ischaemic compression technique combined with exercise in the short-term management of TMD. The robust methodological framework, including effective randomization and blinding, supports the internal validity of the findings. However, the lack of ITT analysis, high dropout rates, and potential performance biases temper the confidence in the causal inferences drawn from the results. Externally, the findings are limited by the study's short follow-up duration, single-centre setting, and specific patient demographics, suggesting that further research is needed to validate these outcomes across broader and more diverse populations. Future studies with larger sample sizes, longer follow-up periods, and more varied participant profiles are crucial to enhance the robustness and applicability of the evidence, thereby solidifying the role of ICT in TMD management.

Table 4.16 Multi Modal Intervention: Level of Evidence for Manual therapy plus other interventions

Intervention: manual therapy, exercise, physiotherapy, physical therapy				Evidence rating per individual study					
Author(s)	Study type	Ranking of individual study	Internal and external validity	STRONG	MODERATE	LIMITED	NO EVIDENCE	CONFLICTED	CONSENSUS
Calixtre *et al* (2019)	RCT	Excellent	Internal validity is good and external validity moderate	X					

de la Serna *et al* (2020)	RCT	Good	Internal validity is good and external validity moderate	**X**					
Tuncer *et al* (2013)	RCT	Excellent	Moderate internal validity and poor external validity		**X**				

Calixtre *et al.* (2019) conducted a well-designed study to assess the effects of upper cervical region mobilization and craniocervical flexor training on orofacial pain, headache, and mandibular function in women with TMD. The study's internal validity is strong, characterized by rigorous randomization, baseline comparability, and detailed reporting of outcomes. However, the lack of explicit details on concealed allocation, blinding of assessors, and the conduct of ITT analysis are areas of concern. The high reliance on self-reported outcomes also introduces potential subjectivity. In terms of external validity, the study's focus on a specific demographic (women) and controlled clinical environment limits its generalizability to broader populations and varied real-world settings. The short duration of follow-up restricts the applicability of the findings to long-term TMD management. Overall, the study provides valuable preliminary evidence supporting the efficacy of neck mobilization and flexor training in reducing TMD symptoms.

Delgado De La Serna *et al.* (2020) conducted a randomized clinical trial evaluating the effects of cervico-mandibular manual therapy in patients with temporomandibular pain disorders and associated somatic tinnitus. The study demonstrates strong internal validity with rigorous randomization, allocation concealment, and blinding of outcome assessors. However, limitations include the lack of blinding for subjects and therapists, potential performance bias, and the absence of ITT analysis. Externally, the study's findings are relevant to clinical settings but may be limited by demographic restrictions and variations in therapeutic expertise. Long-term follow-up assessments enhance the understanding of treatment durability. Overall, the study contributes valuable insights into multimodal physical therapy interventions for managing TMD and associated somatic tinnitus, highlighting the need for further research to enhance generalizability and confirm findings across diverse populations and settings.

Tuncer *et al.* (2013) conducted an RCT investigating the effectiveness of MT in conjunction with HPT compared to HPT alone for TMD. While the study design

included randomization and clear intervention protocols, it lacked blinding of outcome assessors and did not report on ITT analysis or power calculations. These factors may affect the reliability and generalizability of findings. The study's findings suggest potential short-term benefits of MT in conjunction with HPT for managing TMD, but caution is warranted in applying these results to diverse TMD populations or settings.

The collective evidence from these studies on interventions for TMD presents moderate quality. Each study contributes valuable insights yet is tempered by various methodological limitations and constraints on generalizability. The strength and applicability of the evidence is promising but not definitive. The combined findings underscore the need for future research with larger, more diverse samples, extended follow-up periods, and comprehensive methodologies, including ITT analysis and multi-centre trials. Such advancements will enhance the robustness and generalizability of the evidence, offering a more solid foundation for clinical decision-making in TMD interventions.

Table 4.17 Multi Modal Intervention: Level of Evidence for Mobilization plus other interventions

Intervention: mobilization, exercise, thoracic spine manipulation and dry needling				**Evidence rating per individual study**					
Author(s)	**Study type**	**Ranking of individual study**	**Internal and external validity**	**STRONG**	**MODERATE**	**LIMITED**	**NO EVIDENCE**	**CONFLICTED**	**CONSENSUS**
Calixtre *et al* (2016)	NRCT	Poor	Internal and external validity is poor			**X**			
González-Iglesias *et al* (2013)	Case series	Moderate	Internal validity is moderate to poor and external validity is moderate			**X**			

Despite observing improvements in mandibular function, pain-free MMO, and self-reported pain in the study by Calixtre *et al.* (2016) the study's design and methodological limitations significantly affect its internal validity. The single-group pre-post-test design without a control group means that it is difficult to attribute these

improvements solely to the intervention, as there are no comparative data to account for placebo effects or natural variations in TMD symptoms. Furthermore, the small sample size of 12 subjects reduces the statistical power and generalizability of the findings.

The absence of randomization and blinding in the study by Calixtre *et al.* (2016) introduces several biases. Without randomization, there is a higher risk of selection bias, and without blinding, both subjects and assessors might inadvertently influence the results due to expectations or preconceptions about the intervention's effectiveness. Additionally, the study relied heavily on subjective measures like self-reported pain, which are prone to measurement bias. Given the short follow-up period of just 3-5 days after the last session, the study does not provide insights into the long-term effects or sustainability of the intervention. The limited diversity of the sample, consisting only of female subjects, further restricts the applicability of the findings to broader populations or different demographic groups.

The prospective case series by González-Iglesias *et al.* (2013) explores the effects of a multimodal treatment approach involving mobilization with movement, thoracic spine manipulation, and dry needling for managing TMD. The study reports significant improvements in pain, disability, and maximal mouth opening among the 15 subjects, suggesting potential benefits from this combined intervention. However, the internal validity of the study is moderate to poor due to several methodological limitations, including the absence of a control group, lack of blinding, and a small sample size. These factors introduce biases and limit the ability to attribute observed improvements directly to the interventions. The external validity is also moderate, as the findings from a small, specific sample in a single clinic may not be generalizable to broader populations or different healthcare settings.

While these studies suggest potential short-term benefits of certain TMD interventions, the methodological limitations significantly constrain the strength and applicability of their conclusions. The evidence is preliminary and should be interpreted with caution. To build a stronger evidence base, future research should focus on employing more rigorous study designs, including RCTs with adequate sample sizes, control groups, and blinding, as well as considering long-term follow-up and diverse patient

populations. This approach will provide more robust and generalizable data to guide clinical practice in managing TMD.

Table 4.18 Multi Modal Intervention: Level of Evidence for Myofascial techniques plus other interventions

Intervention: myofascial technique and exercise				**Evidence rating per individual study**					
Author(s)	**Study type**	**Ranking of individual study**	**Internal and external validity**	**STRONG**	**MODERATE**	**LIMITED**	**NO EVIDENCE**	**CONFLICTED**	**CONSENSUS**
Calixtre *et al* (2021)	NRCT	Moderate	Internal validity is weak and external validity is limited			**X**			

The study by Calixtre *et al.* (2021) provides initial insights into the potential benefits of myofascial release and cranio-cervical flexor training for individuals with myofascial TMD, its methodological limitations significantly constrain internal validity. The study's internal validity is weak due to the absence of randomization, blinding, and a control group. These factors introduce multiple biases that undermine the reliability of attributing observed benefits directly to the interventions. The external validity is also limited, with a small sample size and narrow participant criteria restricting the generalizability of the findings to the broader population of TMD patients. Although the study by Calixtre *et al.* (2021) highlights the potential benefits of myofascial release and cranio-cervical flexor training in treating myofascial TMD, significant methodological weaknesses severely constrain the strength and applicability of its conclusions. Future research should prioritize randomized controlled trials with larger, more diverse samples, longer follow-up periods, and comprehensive outcome assessments to validate and extend these preliminary findings.

4.4.3 Summary of collective evidence for the interventions.

Table 4.19 Collective Evidence for all the Interventions Presented in Chapter 4

		Collective Evidence

Interventions that were reviewed for level of evidence of effectiveness in treating and managing TMD	Number of studies reviewed plus rating as per the AGREE system (Dagenais and Haldeman 2011) and the grading by Foley et al. (2003).	STRONG	MODERATE	LIMITED	NO EVIDENCE	CONFLICTED	CONSENSUS
Single Interventions							
Dry needling	Total of 4 studies: 2 RCTs: Moderate 1 RCT: Strong 1 Case report: limited	X					
Exercise	Total of 5 studies: 2 RCTs: Moderate 3 NRCTs: limited		X				
Manipulation (thoracic spine)	Total of study: 1 RCT: Moderate		X				
Manual therapy	Total of 3 studies: 1 RCT: Moderate 2 NRCTs: limited		X				
Mobilization	Total of 1 study: 1 NRCT: limited			X			
Myofascial techniques	Total of 1 study: 1 RCT: Moderate			X			
Physical therapy	Total of 2 studies: 1 RCT: Moderate 1 NRCT: limited			X			
PNF	Total of 1 study: 1 NRCT: limited			X			
Multi Modal Interventions							
Cervical spinal manipulation plus other interventions	Total of 3 studies: 2 RCT: Moderate 1 Case series: limited		X				

Dry needling plus other interventions	**Total of 3 studies:** **3 RCT: 1 Strong and 2 Moderate**	**X**					
Ischemic compression plus exercise	**Total of 1 study:** **1 RCT: Moderate**		**X**				
Mandibular manipulation plus conventional treatment	**Total of 1 study:** **1 RCT: Moderate**		**X**				
Manual therapy plus other interventions	**Total of 3 studies:** **3 RCT: 2 Strong, 1 Moderate**	**X**					
Mobilization plus other interventions	**Total of 2 studies:** **1 NRCT: limited** **1 Case series: limited**			**X**			
Myofascial technique plus exercise	**Total of 1 study:** **1 NRCTs: limited**			**X**			

In summary, the evaluation of both single and multi-modal interventions for the treatment and management of TMD reveals varying degrees of evidence supporting their effectiveness. This chapter synthesized findings from multiple studies to determine the strength of evidence for each intervention type.

5 CHAPTER FIVE: DISCUSSION

5.1 Interpretation and Implications

During the course of this systematic review, several contemporaneous reviews, including those by Menéndez-Torre et al. (2023) and González-Sánchez et al. (2023), explored conservative therapies for TMD. While these studies primarily focused on high-quality RCTs, their findings align with several conclusions of this dissertation. Menéndez-Torre et al. (2023) reported moderate evidence supporting physical therapy and occlusal splints, whereas González-Sánchez et al. (2023) emphasized strong evidence for manual therapy and exercise. In comparison, this review sought to provide a broader perspective by incorporating NRCTs, case series, and grey literature, thereby capturing additional clinical insights not always reflected in RCT-based reviews.

It is important to acknowledge that this systematic review is not superior to previous systematic reviews but rather complementary, as RCTs remain the gold standard for evaluating treatment efficacy. The inclusion of NRCTs and grey literature was not an attempt to challenge the hierarchy of evidence but rather to shed light on additional findings that may inform future research. This approach revealed strong evidence for dry needling and moderate evidence for exercise, manual therapy, and multi-modal interventions, such as cervical spine manipulation combined with other treatments. However, given the inherent limitations of NRCTs such as a higher risk of bias and methodological variability, these findings should be interpreted with caution.

By identifying promising but less rigorously studied interventions, this review underscores the need for well-designed RCTs to further investigate these treatment modalities. The findings reinforce the evolving nature of conservative TMD management and highlight the importance of continued research to bridge the gap between emerging evidence and clinical application.

The evaluation of both single and multi-modal interventions for the treatment and management of TMD reveals varying degrees of evidence supporting their effectiveness. Among single interventions, dry needling demonstrated strong support, with evidence from one high-quality RCT, two moderate-quality RCTs, and a case

report indicating its potential as an effective treatment option. Exercise interventions exhibited moderate evidence, supported by two RCTs and three NRCTs, suggesting promising but not yet definitive results. Thoracic spine manipulation had limited support, based on a single RCT, highlighting the need for more comprehensive studies. Similarly, manual therapy was backed by moderate evidence from one RCT and two NRCTs, whereas mobilization, myofascial techniques, physical therapy, and PNF had limited evidence due to the small number of supporting studies.

Findings from recent systematic reviews further reinforce these conclusions. Asquini et al. (2021) explored the effectiveness of manual therapy applied to craniomandibular structures and highlighted its potential benefits in TMD treatment. Another systematic review on the efficacy of manual therapy approaches confirmed significant improvements in pain and maximum mouth opening, particularly in the mid-term, further supporting the role of manual therapy in TMD management. Minervini et la (2023) similarly reported moderate to strong evidence for manual therapy, emphasizing its positive effects on pain and jaw function.

Multi-modal interventions, which combine different treatment approaches, demonstrated varying levels of support. Moderate evidence supported the combination of cervical spine manipulation with exercise, mobilization, and patient education, based on two RCTs and a case series. Dry needling combined with cervical spine manipulation, exercise, and muscular inhibition techniques had strong evidence from three RCTs, making it a robust option. The combination of ischemic compression with exercise had limited support from a single RCT, highlighting the need for further research. Similarly, mandibular manipulation combined with conventional therapy had limited evidence from one moderate-quality RCT. Strong evidence supported the combination of manual therapy with exercise, physiotherapy, and physical therapy, as demonstrated by two high-quality RCTs and one moderate-quality RCT. Finally, limited evidence supported mobilization combined with exercise, thoracic spine manipulation, and dry needling, as well as myofascial techniques combined with exercise, both requiring further investigation.

Overall, this systematic review highlights the effectiveness of various single and multi-modal interventions for TMD, reinforcing the need for continued high-quality research to establish definitive clinical recommendations.

5.2 Limitations of Evidence

This systematic review had several limitations that may have influenced the findings. One limitation was the inability to perform a meta-analysis due to significant heterogeneity in the included studies. The variability in study designs, interventions, and outcome measures meant that pooling data for a meaningful analysis was not feasible. While meta-analytic methods can sometimes be applied to specific subgroups of studies, the diversity of the studies included here made such an approach unfeasible.

Another limitation relates to **publication bias**, where studies with positive results are more likely to be published than those with negative outcomes (Song, Hooper & Loke, 2013). This bias can lead to the underreporting of studies with null or negative results, potentially skewing the evidence towards more favourable findings. Consequently, the level of evidence presented in this review may reflect a positive slant, which could overestimate the effectiveness of the interventions.

Language bias also impacted this review, as only studies published in English were included. Articles requiring translation were excluded, primarily due to concerns about translation bias, where important details could be lost or misinterpreted (Layton & Clarke, 2016). Additionally, as this was a Master's-level study without grant funding, the resources required to translate articles were not available. While exclusion of non-English studies due to language barriers is common practice in systematic reviews (Jackson et al., 2019), this did limit the scope of literature available for inclusion and potentially excluded relevant studies published in other languages.

Reviewer bias is another factor that may have influenced the review process. The level of expertise and experience of the reviewers could have impacted their assessment of the studies. To mitigate this, steps were taken to ensure that reviewers were not assigned articles they had authored (Section 3.8). Additionally, common scales and standardized explanations were provided to maintain consistency across reviews, and three independent reviewers were assigned to each article. This allowed for discrepancies to be identified and resolved through arbitration. However, bias could

not be completely eliminated due to external factors, such as reviewers potentially being familiar with the authors of the articles, which could influence their reviews.

Lastly, the **narrow scope** of this review, focused primarily on complementary and alternative medicine (CAM) interventions—such as manipulation/mobilization, dry needling, exercise/physical therapy, and ischemic compression—was another limitation. Pharmacological and surgical interventions were excluded from the review, as CAM interventions typically do not involve these treatments (Ng et al., 2022; Wieland, Manheimer & Berman, 2011). While this limitation was intentional and did not negatively impact the study, it means that conclusions are restricted to the selected interventions.

5.3 Strengths and Weaknesses of this Review

This systematic review offers several notable strengths, particularly in its comprehensive methodology and broad inclusion criteria. By incorporating NRCTs, case series, and grey literature alongside RCTs, this review provides a more inclusive perspective on conservative therapies for TMD. This approach allows for a more holistic understanding of available evidence, capturing insights that may not be present in RCT-based reviews alone. Additionally, the rigorous quality assessment using the PEDro scale for RCTs, the NOS for NRCTs, and the Liddle scale for case series ensures a transparent evaluation of study reliability, enhancing the validity of the findings.

However, this review also has inherent limitations. The inclusion of NRCTs and grey literature introduces a greater risk of bias and heterogeneity, as these study designs lack the rigorous controls of RCTs. While this approach broadens the scope of findings, it also means that some conclusions must be interpreted with caution. Additionally, publication bias and language restrictions may have limited the inclusion of relevant studies, as only English-language articles were considered. Another potential limitation is the variability in outcome measures across studies, which made direct comparisons challenging and may have influenced the ability to draw firm conclusions regarding treatment efficacy. Finally, while every effort was made to minimize bias in study selection, data extraction, and synthesis, the potential for subjective interpretation remains a consideration.

Despite these weaknesses, this review contributes valuable insights to the field of TMD management and highlights key areas for future research, particularly the need for high-quality RCTs to validate promising interventions identified in NRCTs and case series.

6 CHAPTER SIX: CONCLUSION

6.1 Implications and Contributions

The findings of this systematic review have significant implications for clinical practice, research, and the broader understanding of conservative TMD management. By evaluating a diverse range of single and multi-modal interventions, this review provides a comprehensive synthesis of current evidence, identifying both well-supported and emerging treatment strategies.

From a clinical perspective, the strong evidence supporting dry needling and the moderate evidence for manual therapy, exercise, and multi-modal interventions reinforce the importance of individualized treatment approaches. Clinicians can use these findings to guide treatment decisions, tailoring interventions based on the specific needs of TMD patients. The inclusion of multi-modal approaches, such as combining manual therapy with exercise or dry needling with cervical spine manipulation, underscores the potential benefits of integrative treatment strategies in achieving optimal patient outcomes.

In the research domain, this review highlights key gaps in the literature, particularly the need for high-quality RCTs to validate findings from NRCTs and case series. The identification of promising but under-researched interventions, such as thoracic spine manipulation, mobilization, and proprioceptive neuromuscular facilitation, provides a foundation for future studies to build upon. Additionally, the findings emphasize the necessity of standardized outcome measures and methodological rigor in future research to ensure consistency and reliability in evaluating treatment effectiveness.

The contributions of this review extend beyond synthesizing existing evidence by integrating insights from both high-quality trials and lesser-studied interventions. By including NRCTs and grey literature, this review broadens the scope of available evidence, offering a more nuanced perspective that complements existing systematic reviews focused solely on RCTs. This inclusive approach ensures that emerging treatment options are recognized, potentially influencing the direction of future clinical guidelines and best practice recommendations.

Ultimately, this systematic review contributes to the evolving discourse on TMD management, bridging the gap between research and clinical application. By providing a comprehensive assessment of available conservative therapies, this review serves as a valuable resource for clinicians, researchers, and policymakers, fostering evidence-based decision-making and promoting continued advancements in the field of TMD treatment.

REFERENCES

Abe, S., Miyagi, A., Yoshinaga, K., Matsuka, Y., Matsumoto, F., Uyama, E., Suzuki, Y., Oshima, M., Okura, K. and Tanaka, E. 2020. Immediate effect of masticatory muscle activity with transcutaneous electrical nerve stimulation in muscle pain of temporomandibular disorders patients. *Journal of clinical medicine*, 9 (10): 3330.

Abouelhuda, A. M., Kim, Y.-K. and Hegazy, S. A. 2018a. Non-invasive different modalities of treatment for temporomandibular disorders: review of literature. *Journal of the Korean Association of Oral and Maxillofacial Surgeons* 44(2): 43-51. Available: https://synapse.koreamed.org/articles/1092049 (Accessed 14 March 2022).

Abouelhuda, A. M., Kim, Y.-K. and Hegazy, S. A. 2018b. Non-invasive different modalities of treatment for temporomandibular disorders: review of literature. *Journal of the Korean Association of Oral and Maxillofacial Surgeons*, 44 (2): 43-51.

Ahmad, S. A., Hasan, S., Saeed, S., Khan, A. and Khan, M. 2021. Low-level laser therapy in temporomandibular joint disorders: a systematic review. *Journal of Medicine and Life*, 14 (2): 148.

Ahn, E. and Kang, H. 2018. Introduction to systematic review and meta-analysis. *Korean journal of anesthesiology*, 71 (2): 103-112.

Albagieh, H., Alomran, I., Binakresh, A., Alhatarisha, N., Almeteb, M., Khalaf, Y., Alqublan, A. and Alqahatany, M. 2023. Occlusal splints-types and effectiveness in temporomandibular disorder management. *The Saudi Dental Journal*, 35 (1): 70-79.

Alfandre, D. 2016. Clinical recommendations in medical practice: a proposed framework to reduce bias and improve the quality of medical decisions. *The Journal of Clinical Ethics*, 27 (1): 21-27.

Almeida, C. P. B. d. and Goulart, B. N. G. d. 2017. How to avoid bias in systematic reviews of observational studies. *Revista CEFAC*, 19: 551-555.

Andrade, C. 2018. Internal, external, and ecological validity in research design, conduct, and evaluation. *Indian journal of psychological medicine*, 40 (5): 498-499.

Ângelo, D. F., Nogueira, J., Pinheiro, C., Alves, G. and Cardoso, H. J. 2022. Temporomandibular joint arterial variability. *Journal of Cranio-Maxillofacial Surgery*, 50 (2): 150-155.

Arfè, A. and Corrao, G. 2015. Tutorial: strategies addressing detection bias were reviewed and implemented for investigating the statins–diabetes association. *Journal of clinical epidemiology*, 68 (5): 480-488.

Arias, F., Rogus-Pulia, N. and Kind, A. J. 2022. Appendix C Improving Representativeness in Clinical Trials and Research: Facilitators to Recruitment and Retention of Underrepresented Groups.

Armijo-Olivo, S., Pitance, L., Singh, V., Neto, F., Thie, N. and Michelotti, A. 2016. Effectiveness of manual therapy and therapeutic exercise for temporomandibular disorders: systematic review and meta-analysis. *Physical therapy*, 96 (1): 9-25.

Arroyave, W. D., Mehta, S. S., Guha, N., Schwingl, P., Taylor, K. W., Glenn, B., Radke, E. G., Vilahur, N., Carreon, T. and Nachman, R. M. 2021. Challenges and recommendations on the conduct of systematic reviews of observational epidemiologic studies in environmental and occupational health. *Journal of exposure science & environmental epidemiology*, 31 (1): 21-30.

Asha, V., Kannan, R. and Jacob, T. 2015. A novel case of orofacial pain treated by dry needling technique-A case report. *Dentistry*, 5 (319): 2161-1122.1000319.

Asquini, G., Pitance, L., Michelotti, A. and Falla, D. 2022. Effectiveness of manual therapy applied to craniomandibular structures in temporomandibular disorders: A systematic review. *Journal of oral rehabilitation*, 49 (4): 442-455.

Aurora–Liliana, C. 2021. Temporomandibular disorders and physical therapy intervention possibilities.

Ba, S., Zhou, P. and Yu, M. 2021. Ultrasound is effective to treat temporomandibular joint disorder. *Journal of Pain Research*: 1667-1673.

Bae, Y. and Park, Y. 2013. The effect of relaxation exercises for the masticator muscles on temporomandibular joint dysfunction (TMD). *Journal of physical therapy science*, 25 (5): 583-586.

Bageston de Britto, P., Bisi, M. A. and Dhein, W. 2019. Effect of manual therapy on pain and electromyographic activity of masticatory muscles in patients with temporomandibular disorders. *Manual Therapy, Posturology & Rehabilitation Journal*, 17: 0-0.

Baker, K. G., Robertson, V. J. and Duck, F. A. 2001. A review of therapeutic ultrasound: biophysical effects. *Physical therapy*, 81 (7): 1351-1358.

Barbosa, M. A., Tahara, A. K., Ferreira, I. C., Intelangelo, L. and Barbosa, A. C. 2019. Effects of 8 weeks of masticatory muscles focused endurance exercises on women with oro-facial pain and temporomandibular disorders: A placebo randomised controlled trial. *Journal of oral rehabilitation*, 46 (10): 885-894.

Barone, M., Imaz, F., Converso, G., Bordachar, D., Barbero, A., Trucco, M. and Intelangelo, L. 2021. Immediate effects of rhythmic joint mobilization of the temporomandibular joint on pain, mouth opening and electromyographic activity in patients with temporomandibular disorders. *Journal of Bodywork and Movement Therapies*, 28: 563-569.

Bhogal, S. K., Teasell, R. W., Foley, N. C. and Speechley, M. R. 2005. The PEDro scale provides a more comprehensive measure of methodological quality than the Jadad scale in stroke rehabilitation literature. *Journal of clinical epidemiology*, 58 (7): 668-673.

Blunt, C. 2015. Hierarchies of evidence in evidence-based medicine. London School of Economics and Political Science.

Bordoni, B. and Varacallo, M. 2021. *Anatomy, Head and Neck, Temporomandibular Joint*. Available: https://www.ncbi.nlm.nih.gov/books/NBK538486/ (Accessed 26 August 2022).

Boutron, I., Page, M. J., Higgins, J. P., Altman, D. G., Lundh, A., Hróbjartsson, A. and Group, C. B. M. 2019. Considering bias and conflicts of interest among the included studies. *Cochrane handbook for systematic reviews of interventions*: 177-204.

Brighenti, N., Battaglino, A., Sinatti, P., Abuín-Porras, V., Sánchez Romero, E. A., Pedersini, P. and Villafañe, J. H. 2023. Effects of an interdisciplinary approach in the management of temporomandibular disorders: a scoping review. *International Journal of Environmental Research and Public Health*, 20 (4): 2777.

Brom, L., Hopmans, W., Pasman, H. R. W., Timmermans, D. R., Widdershoven, G. A. and Onwuteaka-Philipsen, B. D. 2014. Congruence between patients' preferred and perceived participation in medical decision-making: a review of the literature. *BMC medical informatics and decision making*, 14 (1): 1-16.

Brouwers, M. C., Kho, M. E., Browman, G. P., Burgers, J. S., Cluzeau, F., Feder, G., Fervers, B., Graham, I. D., Hanna, S. E. and Makarski, J. 2010. Development of the AGREE II, part 1: performance, usefulness and areas for improvement. *Cmaj*, 182 (10): 1045-1052.

Brozek. 2009. Grading quality of evidence and strength of recommendations in clinical practice guidelines. *Allergy*, 64: 669-677.

Budakoti, A., Puri, N., Dhillon, M., Ahuja, U. S., Rathore, A., Choudhary, A. and Kour, M. 2019. A comparative evaluation of the effectiveness of low-level laser therapy, ultrasound therapy, and transcutaneous electric nerve stimulation in the treatment of patients with TMDs: a prospective study. *Lasers in Dental Science*, 3: 257-267.

Bueno, C., Pereira, D., Pattussi, M., Grossi, P. and Grossi, M. 2018. Gender differences in temporomandibular disorders in adult populational studies: a systematic review and meta-analysis. *Journal of oral rehabilitation*, 45 (9): 720-729.

Busse, J. W., Casassus, R., Carrasco-Labra, A., Durham, J., Mock, D., Zakrzewska, J. M., Palmer, C., Samer, C. F., Coen, M. and Guevremont, B. 2023. Management of chronic pain associated with temporomandibular disorders: a clinical practice guideline. *bmj*, 383

Butts, R., Dunning, J., Pavkovich, R., Mettille, J. and Mourad, F. 2017a. Conservative management of temporomandibular dysfunction: A literature review with implications for clinical practice guidelines (Narrative review part 2). *Journal of bodywork and movement therapies*, 21 (3): 541-548.

Butts, R., Dunning, J., Pavkovich, R., Mettille, J. and Mourad, F. 2017b. Conservative management of temporomandibular dysfunction: A literature review with implications for clinical practice guidelines (Narrative review part 2). *Journal of bodywork and movement therapies* 21(3): 541-548. Available: https://www.sciencedirect.com/science/article/abs/pii/S1360859217301213 (Accessed 29 April 2022).

Cairns, B. 2010. Pathophysiology of TMD pain–basic mechanisms and their implications for pharmacotherapy. *Journal of oral rehabilitation*, 37 (6): 391-410.

Calixtre, L. B., Grüninger, B. L. d. S., Haik, M. N., Alburquerque-Sendín, F. and Oliveira, A. B. 2016. Effects of cervical mobilization and exercise on pain, movement and function in subjects with temporomandibular disorders: a single group pre-post test. *Journal of Applied Oral Science*, 24 (3): 188-197.

Calixtre, L. B., Oliveira, A. B., de Sena Rosa, L. R., Armijo-Olivo, S., Visscher, C. M. and Alburquerque-Sendín, F. 2019. Effectiveness of mobilisation of the upper cervical region and craniocervical flexor training on orofacial pain, mandibular function and headache in women with TMD. A randomised, controlled trial. *Journal of oral rehabilitation*, 46 (2): 109-119.

Calixtre, L. B., Rezende, M. A., Kamonseki, D. H. and de Oliveira, A. B. 2021. Effects of myofascial release applied to neck muscles and craniocervical flexor training in patients with chronic myofascial TMD: A single arm study. *International Journal of Osteopathic Medicine*, 41: 4-10.

Callaham, M. L., Wears, R. L., Weber, E. J., Barton, C. and Young, G. 1998. Positive-outcome bias and other limitations in the outcome of research abstracts submitted to a scientific meeting. *Jama*, 280 (3): 254-257.

Canfora, F., Ottaviani, G., Calabria, E., Pecoraro, G., Leuci, S., Coppola, N., Sansone, M., Rupel, K., Biasotto, M. and Di Lenarda, R. 2023. Advancements in Understanding and Classifying Chronic Orofacial Pain: Key Insights from Biopsychosocial Models and International Classifications (ICHD-3, ICD-11, ICOP). *Biomedicines*, 11 (12): 3266.

Catão, M. H. C. d. V., Oliveira, P. S. d., Costa, R. d. O. and Carneiro, V. S. M. 2013. Evaluation of the efficacy of low-level laser therapy (LLLT) in the treatment of temporomandibular disorders: a randomized clinical trial. *Revista CEFAC*, 15: 1601-1608.

Celakil, T., Muric, A., Gökcen Roehlig, B. and Evlioglu, G. 2019. Management of pain in TMD patients: Bio-oxidative ozone therapy versus occlusal splints. *CRANIO®*, 37 (2): 85-93.

Chan, N. H. Y., Ip, C. K., Li, D. T. S. and Leung, Y. Y. 2022. Diagnosis and treatment of myogenous temporomandibular disorders: a clinical update. *Diagnostics*, 12 (12): 2914.

Chandak, R. M., Pandhripande, R. M., Sonule, S., Chandak, M. G. and Rawlani, S. S. 2017. To assess the prevalence of signs and symptoms of temporomandibular disorders in Vidarbha population by Fonseca's questionnaire.

Journal of Oral Research & Review 9(2). Available: https://web.p.ebscohost.com/ehost/pdfviewer/pdfviewer?vid=3&sid=9a4767e5-cec2-4e62-88e0-49555ca737bc%40redis (Accessed 11 August 2023).

Chisnoiu, A. M., Picos, A. M., Popa, S., Chisnoiu, P. D., Lascu, L., Picos, A. and Chisnoiu, R. 2015. Factors involved in the etiology of temporomandibular disorders-a literature review. *Clujul medical*, 88 (4): 473.

Chowdhury, M. Z. I. and Turin, T. C. 2020. Variable selection strategies and its importance in clinical prediction modelling. *Family medicine and community health*, 8 (1)

Chu, E. C.-P., Lee, W. T., Chau, C., Wong, E., Cheng, H. Y. and Wong, E. W. 2023. Temporomandibular disorder treated with chiropractic therapy. *Cureus*, 15 (3)

Clark, H. D., Wells, G. A., Huët, C., McAlister, F. A., Salmi, L. R., Fergusson, D. and Laupacis, A. 1999. Assessing the quality of randomized trials: reliability of the Jadad scale. *Controlled clinical trials*, 20 (5): 448-452.

Cook, C. E. and Thigpen, C. A. 2019. *Five good reasons to be disappointed with randomized trials*: Taylor & Francis. Available: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6484499/ (Accessed

Cooper, C., Booth, A., Varley-Campbell, J., Britten, N. and Garside, R. 2018. Defining the process to literature searching in systematic reviews: a literature review of guidance and supporting studies. *BMC medical research methodology* 18(1): 1-14. Available: https://bmcmedresmethodol.biomedcentral.com/articles/10.1186/s12874-018-0545-3 (Accessed 4 March 2022).

Coronado, R. A., Bialosky, J. E. and Cook, C. E. 2010. The temporal effects of a single session of high-velocity, low-amplitude thrust manipulation on subjects with spinal pain. *Physical Therapy Reviews*, 15 (1): 29-35.

Corum, M., Basoglu, C., Topaloglu, M., Dıracoglu, D. and Aksoy, C. 2018. Spinal high-velocity low-amplitude manipulation with exercise in women with chronic temporomandibular disorders. *Manuelle Medizin*, 56 (3): 230-238.

Costen, J. B. 1934. I. A syndrome of ear and sinus symptoms dependent upon disturbed function of the temporomandibular joint. *Annals of Otology, Rhinology & Laryngology*, 43 (1): 1-15.

Cousins, S., Blencowe, N. S. and Blazeby, J. M. 2019. What is an invasive procedure? A definition to inform study design, evidence synthesis and research tracking. *BMJ open* 9(7): e028576. Available: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6678000/pdf/bmjopen-2018-028576.pdf (Accessed 10 September 2022).

Crăciun, M. D., Geman, O., Leuciuc, F. V., Holubiac, I. Ş., Gheorghiţă, D. and Filip, F. 2022. Effectiveness of Physiotherapy in the Treatment of Temporomandibular Joint Dysfunction and the Relationship with Cervical Spine. *Biomedicines*, 10 (11): 2962.

Cuccia, A. M., Caradonna, C. and Caradonna, D. 2011. Manual therapy of the mandibular accessory ligaments for the management of temporomandibular joint disorders. *Journal of Osteopathic Medicine*, 111 (2): 102-112.

Dagenais, S. and Haldeman, S. 2011. *Evidence-based management of low back pain*. Elsevier Health Sciences.

Dalewski, B., Kamińska, A., Białkowska, K., Jakubowska, A. and Sobolewska, E. 2020. Association of estrogen receptor 1 and tumor necrosis factor α polymorphisms with temporomandibular joint anterior disc displacement without reduction. *Disease Markers*, 2020 (1): 6351817.

Dawadi, S., Shrestha, S. and Giri, R. A. 2021. Mixed-methods research: A discussion on its types, challenges, and criticisms. *Journal of Practical Studies in Education*, 2 (2): 25-36.

De Brun, C. 2013. *Useful databases*. Available: https://www.england.nhs.uk/wp-content/uploads/2017/02/tis-evidence-wrkshp-caroline-de-brun.pdf (Accessed 2 March 2022).

de Melo Júnior, P. C., Aroucha, J. M. C. N. L., Arnaud, M., Lima, M. G. d. S., Gomes, S. G. F., Ximenes, R., Rosenblatt, A. and Caldas Jr, A. d. F. 2019. Prevalence of TMD and level of chronic pain in a group of Brazilian adolescents. *PloS one*, 14 (2): e0205874.

Deeks, J. J., Dinnes, J., D'Amico, R., Sowden, A. J., Sakarovitch, C., Song, F., Petticrew, M., Altman, D., Group, I. S. T. C. and Group, E. C. S. T. C. 2003. Evaluating non-randomised intervention studies. *Health technology assessment (Winchester, England)*, 7 (27): iii-173.

Delgado De La Serna, P., Plaza-Manzano, G., Cleland, J., Fernández-De-Las-Peñas, C., Martín-Casas, P. and Díaz-Arribas, M. J. 2020. Effects of Cervico-mandibular

manual therapy in patients with temporomandibular pain disorders and associated somatic tinnitus: a randomized clinical trial. *Pain Medicine*, 21 (3): 613-624.

Demerjian, G. G., Barkhordarian, A. and Chiappelli, F. 2018. Neuroanatomy of the Trigeminal Nerve and Proximal Innervation of the TMJ. *Temporomandibular Joint and Airway Disorders: A Translational Perspective*: 3-15.

Dib-Zakkour, J., Flores-Fraile, J., Montero-Martin, J., Dib-Zakkour, S. and Dib-Zaitun, I. 2022. Evaluation of the effectiveness of dry needling in the treatment of myogenous temporomandibular joint disorders. *Medicina*, 58 (2): 256.

Dimitroulis, G. 2018. Management of temporomandibular joint disorders: A surgeon's perspective. *Australian dental journal*, 63: S79-S90.

Dossey, C. A., Abasolo, E. S. and Starr, I. A. 2023. Bruxism Biofeedback Device.

Dunning, J., Butts, R., Bliton, P., Vathrakokoilis, K., Smith, G., Lineberger, C., Eshleman, N., Fernández-de-Las-Peñas, C. and Young, I. A. 2022. Dry needling and upper cervical spinal manipulation in patients with temporomandibular disorder: A multi-center randomized clinical trial. *CRANIO®*: 1-14.

Eaves, E. R., Nichter, M., Ritenbaugh, C., Sutherland, E. and Dworkin, S. F. 2015. Works of Illness and the Challenges of Social Risk and the Specter of Pain in the Lived Experience of TMD. *Medical anthropology quarterly*, 29 (2): 157-177.

Elwyn, G., Frosch, D., Thomson, R., Joseph-Williams, N., Lloyd, A., Kinnersley, P., Cording, E., Tomson, D., Dodd, C. and Rollnick, S. 2012. Shared decision making: a model for clinical practice. *Journal of general internal medicine*, 27: 1361-1367.

Ergezen, G., Atilgan, E. and Kilicaslan, A. 2022. Immediate effect of proprioceptive neuromuscular facilitation on pain and maximal mouth opening in temporomandibular dysfunction: A pilot study. *Rawal Medical Journal*, 47 (1): 125-125.

Evans, D. 2003. Hierarchy of evidence: a framework for ranking evidence evaluating healthcare interventions. *Journal of clinical nursing*, 12 (1): 77-84.

Farrah, K., Young, K., Tunis, M. C. and Zhao, L. 2019. *Risk of bias tools in systematic reviews of health interventions: an analysis of PROSPERO-registered protocols*. Available: https://systematicreviewsjournal.biomedcentral.com/articles/10.1186/s13643-019-1172-8 (Accessed 2 March 2022).

Fernández-de-las-Peñas, C. and Bensen, K. 2019. Adjunctive Therapies for Temporomandibular Disorders. *Contemporary Management of Temporomandibular Disorders: Non-Surgical Treatment*: 169-197.

Fernández-de-Las-Peñas, C. and Nijs, J. 2019. Trigger point dry needling for the treatment of myofascial pain syndrome: current perspectives within a pain neuroscience paradigm. *Journal of pain research*: 1899-1911.

Fernández-de-Las-Peñas, C. and Von Piekartz, H. 2020. Clinical reasoning for the examination and physical therapy treatment of temporomandibular disorders (TMD): a narrative literature review. *Journal of Clinical Medicine*, 9 (11): 3686.

Ferreira, A. P. d. L., Costa, D. R. A. d., Oliveira, A. I. S. d., Carvalho, E. A. N., Conti, P. C. R., Costa, Y. M. and Bonjardim, L. R. 2017. Short-term transcutaneous electrical nerve stimulation reduces pain and improves the masticatory muscle activity in temporomandibular disorder patients: a randomized controlled trial. *Journal of Applied Oral Science*, 25: 112-120.

Ferrillo, M., Ammendolia, A., Paduano, S., Calafiore, D., Marotta, N., Migliario, M., Fortunato, L., Giudice, A., Michelotti, A. and Sire, A. d. 2022. Efficacy of rehabilitation on reducing pain in muscle-related temporomandibular disorders: A systematic review and meta-analysis of randomized controlled trials. *Journal of Back and Musculoskeletal Rehabilitation* (Preprint): 1-16

Fisch, G., Finke, A., Ragonese, J., Dugas, L. and Wrzosek, M. 2021. Outcomes of physical therapy in patients with temporomandibular disorder: A retrospective review. *British Journal of Oral and Maxillofacial Surgery*, 59 (2): 145-150.

Foley, N. C., Teasell, R. W., Bhogal, S. K. and Speechley, M. R. 2003. An evidence-based review of stroke rehabilitation. *Topics in stroke Rehabilitation*, 10 (1): 29-58.

Fouda, A. 2014. Ultrasonic therapy as an adjunct treatment of temporomandibular joint dysfunction. *J Oral Maxillofac Surg*, 117 (April): 238-248.

Gagnier, J. J., Kienle, G., Altman, D. G., Moher, D., Sox, H., Riley, D. and group, C. 2014. The CARE guidelines: consensus-based clinical case report guideline development. *Journal of clinical epidemiology*, 67 (1): 46-51.

Garrigós Pedrón, M., La Touche Arbizu, R., Desentre, N., Gracia Naya, M. and Segura Ortí, E. 2018. Effects of a physical therapy protocol in patients with chronic migraine and temporomandibular disorders: a randomized, single-blinded, clinical trial. *Journal of Oral & Facial Pain and Headache, vol. 32 (2018), n. 2.*,

Garstka, A. A., Kozowska, L., Kijak, K., Brzózka, M., Gronwald, H., Skomro, P. and Lietz-Kijak, D. 2023. Accurate diagnosis and treatment of painful temporomandibular disorders: a literature review supplemented by own clinical experience. *Pain Research and Management*, 2023

Gauer, R. L. and Semidey, M. J. 2015. Diagnosis and treatment of temporomandibular disorders. *American family physician*, 91 (6): 378-386.

Gibson, W., Wand, B. M., Meads, C., Catley, M. J. and O'Connell, N. E. 2019. Transcutaneous electrical nerve stimulation (TENS) for chronic pain-an overview of Cochrane Reviews. *Cochrane Database of Systematic Reviews*, (4)

Gil-Martínez, A., Paris-Alemany, A., López-de-Uralde-Villanueva, I. and La Touche, R. 2018. Management of pain in patients with temporomandibular disorder (TMD): challenges and solutions. *Journal of pain research*: 571-587.

Giorgi, A. 2023. *Treatments for TMJ*. Available: https://www.verywellhealth.com/tmj-treatment-7152871 (Accessed 15 January 2024).

González-Iglesias, J., Cleland, J. A., Neto, F., Hall, T. and Fernández-De-Las-Peñas, C. 2013. Mobilization with movement, thoracic spine manipulation, and dry needling for the management of temporomandibular disorder: a prospective case series. *Physiotherapy theory and practice*, 29 (8): 586-595.

Gonzalez-Perez, L.-M., Infante-Cossio, P., Granados-Nunez, M., Urresti-Lopez, F.-J., Lopez-Martos, R. and Ruiz-Canela-Mendez, P. 2015. Deep dry needling of trigger points located in the lateral pterygoid muscle: efficacy and safety of treatment for management of myofascial pain and temporomandibular dysfunction. *Medicina oral, patologia oral y cirugia bucal*, 20 (3): e326.

González-Sánchez, B., García Monterey, P., Ramírez-Durán, M. d. V., Garrido-Ardila, E. M., Rodríguez-Mansilla, J. and Jiménez-Palomares, M. 2023. Temporomandibular Joint dysfunctions: a systematic review of treatment approaches. *Journal of Clinical Medicine*, 12 (12): 4156.

Gopalakrishnan, S. and Ganeshkumar, P. 2013. Systematic reviews and meta-analysis: understanding the best evidence in primary healthcare. *Journal of family medicine and primary care* 2(1): 9. Available: https://doi.org/10.4103/2249-4863.109934 (Accessed 29 April 2022).

Gough, D. 2015. *Qualitative and mixed methods in systematic reviews*. Available: https://link.springer.com/article/10.1186/s13643-015-0151-y (Accessed 26 February 2022).

Greenhalgh, T., Howick, J. and Maskrey, N. 2014. Evidence based medicine: a movement in crisis? *Bmj*, 348

Grewal, A., Kataria, H. and Dhawan, I. 2016. Literature search for research planning and identification of research problem. *Indian journal of anaesthesia* 60(9): 635. Available: https://doi.org/10.4103/0019-5049.190618 (Accessed 29 April 2022).

Grootel, R. J. v., Buchner, R., Wismeijer, D. and Glas, H. W. v. d. 2017. Towards an optimal therapy strategy formyogenous TMD, physiotherapy comparedwith occlusal splint therapy in an RCT withtherapy-and-patient-specific treatmentdurations. 18 (78)

Häggman-Henrikson, B., Alstergren, P. and Davidson, T. 2017. Högestä tt ED, Ostlund P, Tranaeus S, et al. Pharmacological treatment of oro-facial pain—health technology assessment including a systematic review with network meta-analysis. *J Oral Rehabil*, 44 (10): 800-826.

Häggman-Henrikson, B., Wiesinger, B. and Wänman, A. 2018. The effect of supervised exercise on localized TMD pain and TMD pain associated with generalized pain. *Acta Odontologica Scandinavica*, 76 (1): 6-12.

Hall, D. E., Prochazka, A. V. and Fink, A. S. 2012. Informed consent for clinical treatment. *Canadian Medical Association Journal*, 184 (5): 533-540.

Hammami, M. M., Al-Gaai, E. A., Al-Jawarneh, Y., Amer, H., Hammami, M. B., Eissa, A. and Qadire, M. A. 2014. Patients' perceived purpose of clinical informed consent: Mill's individual autonomy model is preferred. *BMC Medical Ethics*, 15 (2)

Hanna, K., Nair, R., Amarasena, N., Armfield, J. M. and Brennan, D. S. 2021. Temporomandibular dysfunction experience is associated with oral health-related quality of life: an Australian national study. *BMC Oral Health*, 21 (1): 1-13.

Harrison, A. L., Thorp, J. N. and Ritzline, P. D. 2014. A proposed diagnostic classification of patients with temporomandibular disorders: implications for physical therapists. *journal of orthopaedic & sports physical therapy*, 44 (3): 182-197.

Hartling, L., Milne, A., Hamm, M. P., Vandermeer, B., Ansari, M., Tsertsvadze, A. and Dryden, D. M. 2013. Testing the Newcastle Ottawa Scale showed low reliability between individual reviewers. *Journal of clinical epidemiology*, 66 (9): 982-993.

Herranz-Aparicio, J., Vázquez-Delgado, E., Arnabat-Domínguez, J., España-Tost, A. and Gay-Escoda, C. 2013. The use of low level laser therapy in the treatment of temporomandibular joint disorders. Review of the literature. *Medicina oral, patologia oral y cirugia bucal*, 18 (4): e603.

Herrera-Valencia, A., Ruiz-Muñoz, M., Martin-Martin, J., Cuesta-Vargas, A. and González-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.

Hersh, E. V., Balasubramaniam, R. and Pinto, A. 2008. Pharmacologic management of temporomandibular disorders. *Oral and maxillofacial surgery clinics of North America*, 20 (2): 197-210.

Higgins, J., Thomas, J., Chandler, J., Cumpston, M., Li, T., Page, M. and Welch, V. 2022. *Cochrane Handbook for Systematic Reviews of Interventions version 6.3*. Available: www.training.cochrane.org/handbook. (Accessed 5 September 2022).

Hill, A. B. 1965. *The environment and disease: association or causation?* : Sage Publications.

Hilton, J. 1863. *On the Influence of Mechanical and Physiological Rest in the Treatment of Accidents and Surgical Diseases, and the Diagnostic Value of Pain: a Course of Lectures*.

Hongxing, L., Astrøm, A., List, T., Nilsson, I. M. and Johansson, A. 2016. Prevalence of temporomandibular disorder pain in Chinese adolescents compared to an age-matched Swedish population. *Journal of oral rehabilitation*, 43 (4): 241-248.

Ilgunas, A., Fjellman-Wiklund, A., Häggman-Henrikson, B., Lobbezoo, F., Visscher, C. M., Durham, J. and Lövgren, A. 2023. Patients' experiences of temporomandibular disorders and related treatment. *BMC oral health*, 23 (1): 653.

Ivković, N., Racic, M., Lecic, R., Bozovic, D. and Kulic, M. 2018. Relationship Between Symptoms of Temporomandibular Disorders and Estrogen Levels in Women With Different Menstrual Status. *Journal of Oral & Facial Pain & Headache*, 32 (2)

Iwasaki, S., Shigeishi, H., Akita, T., Tanaka, J. and Sugiyama, M. 2018. Efficacy of cognitive-behavioral therapy for patients with temporomandibular disorder pain-systematic review of previous reports. *Int J Clin Exp Med*, 11 (2): 500-509.

Kamei, F., Pinto, G., Wiese, I., Ribeiro, M. and Soares, S. 2021. What evidence we would miss if we do not use grey literature? In: Proceedings of *Proceedings of the 15th ACM/IEEE International Symposium on Empirical Software Engineering and Measurement (ESEM)*. 1-11.

Kapos, F. P., Exposto, F. G., Oyarzo, J. F. and Durham, J. 2020. Temporomandibular disorders: a review of current concepts in aetiology, diagnosis and management. *Oral Surgery*, 13 (4): 321-334.

Kaur, H. and Datta, K. 2013. Prosthodontic management of temporomandibular disorders. *The Journal of Indian Prosthodontic Society*, 13: 400-405.

Kazdin, A. E. 2008. Evidence-based treatment and practice: new opportunities to bridge clinical research and practice, enhance the knowledge base, and improve patient care. *American psychologist*, 63 (3): 146.

Kelly, M., Heath, I., Howick, J. and Greenhalgh, T. 2015. *The importance of values in evidence-based medicine*. Available: https://bmcmedethics.biomedcentral.com/articles/10.1186/s12910-015-0063-3#citeas (Accessed 29 August 2022).

Khairnar, S., Bhate, K., SN, S. K., Kshirsagar, K., Jagtap, B. and Kakodkar, P. 2019. Comparative evaluation of low-level laser therapy and ultrasound heat therapy in reducing temporomandibular joint disorder pain. *Journal of dental anesthesia and pain medicine*, 19 (5): 289.

Khan, A., Liu, S. and Tao, F. 2024. Mechanisms Underlying Sex Differences in Temporomandibular Disorders and Their Comorbidity with Migraine. *Brain Sciences*, 14 (7): 707.

Khan, K. S., Daya, S. and Jadad, A. R. 1996. The importance of quality of primary studies in producing unbiased systematic reviews. *Archives of Internal Medicine*, 156 (6): 661-666.

Kirkham, J. J., Altman, D. G., Chan, A.-W., Gamble, C., Dwan, K. M. and Williamson, P. R. 2018. Outcome reporting bias in trials: a methodological approach for assessment and adjustment in systematic reviews. *bmj*, 362

Kolaski, K., Romeiser Logan, L. and Ioannidis, J. 2023. Guidance to best tools and practices for systematic reviews 1. *Journal of Pediatric Rehabilitation Medicine*, 16 (2): 241-273.

Kotiranta, U., Suvinen, T. and Forssell, H. 2014. Tailored treatments in temporomandibular disorders: where are we now? A systematic qualitative literature review. *Journal of Oral & Facial Pain & Headache*, 28 (1)

Kulesa-Mrowiecka, M., Piech, J. and Gaździk, T. S. 2021. The effectiveness of physical therapy in patients with generalized joint hypermobility and concurrent temporomandibular disorders—a cross-sectional study. *Journal of clinical medicine*, 10 (17): 3808.

Kumar, M., Murugesan, K. and Hinaz, N. 2021. Surgical treatment modalities in the management of temporomandibular joint disorders. *Int J Dentistry Oral Sci*, 8 (9): 4168-4179.

Kunisch, S., Denyer, D., Bartunek, J. M., Menz, M. and Cardinal, L. B. 2023. Review research as scientific inquiry. *Organizational Research Methods*, 26 (1): 3-45.

Kusdra, P. M., Stechman-Neto, J., Leao, B. L. C. d., Martins, P. F. A., Lacerda, A. B. M. d. and Zeigelboim, B. S. 2018. Relationship between Otological Symptoms and TMD. *International Tinnitus Journal* 22(1): 30-34. Available: https://www.tinnitusjournal.com/articles/relationship-between-otological-symptoms-and-tmd.pdf (Accessed 11 August 2023).

Layton, D. M. and Clarke, M. 2016. Lost in translation: review of identification bias, translation bias and research waste in dentistry. *Dental Materials* 32(1): 26-33. Available: https://www.sciencedirect.com/science/article/abs/pii/S010956411500398X (Accessed 5 September 2022).

Lee, Y.-H., Auh, Q.-S., An, J.-S. and Kim, T. 2022. Poorer sleep quality in patients with chronic temporomandibular disorders compared to healthy controls. *BMC Musculoskeletal Disorders*, 23 (1): 246.

Lei, J., Yap, A. U., Zhang, M. and Fu, K. Y. 2021. Temporomandibular disorder subtypes, emotional distress, impaired sleep, and oral health-related quality of life in Asian patients. *Community Dentistry and Oral Epidemiology*, 49 (6): 543-549.

Li, D. T. S. and Leung, Y. Y. 2021. Temporomandibular Disorders: Current Concepts andControversies in Diagnosis and Management. *Diagnostics* 11(3): 459. Available: https://doi.org/10.3390/diagnostics11030459 (Accessed 11 September 2023).

Licini, F., Nojelli, A., Segù, M. and Collesano, V. 2009. Role of psychosocial factors in the etiology of temporomandibular disorders: relevance of a biaxial diagnosis. *Clujul Medical* Europe (11): 557-566. Available: https://europepmc.org/article/med/20027126 (Accessed 9 September 2023).

Liddle, J., Williamson, M. and Irwig, L. 1996. *Method for evaluating research & guideline evidence*. NSW Department of Health.

Lomas, J. 2018. Temporomandibular dysfunction. *Australian journal of general practice*, 47 (4): 212-215.

Look, J. O., Schiffman, E. L., Truelove, E. L. and Ahmad, M. 2010. Reliability and validity of Axis I of the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD) with proposed revisions. *Journal of oral rehabilitation*, 37 (10): 744-759.

Lopez-Martos, R., Gonzalez-Perez, L.-M., Ruiz-Canela-Mendez, P., Urresti-Lopez, F.-J., Gutierrez-Perez, J.-L. and Infante-Cossio, P. 2018. Randomized, double-blind study comparing percutaneous electrolysis and dry needling for the management of temporomandibular myofascial pain. *Medicina oral, patologia oral y cirugia bucal*, 23 (4): e454.

Loster, J. E., Osiewicz, M. A., Groch, M., Ryniewicz, W. and Wieczorek, A. 2017. The prevalence of TMD in Polish young adults. *Journal of Prosthodontics*, 26 (4): 284-288.

Lu, W., Li, J., Tian, Y. and Lu, X. 2022. Effect of ischemic compression on myofascial pain syndrome: a systematic review and meta-analysis. *Chiropractic & Manual Therapies*, 30 (1): 34.

Luther, F. 1998. Orthodontics and the temporomandibular joint: where are we now? Part 1. Orthodontic treatment and temporomandibular disorders. *The Angle Orthodontist*, 68 (4): 295-304.

Ma, L., Wang, Y., Yang, Z., Huang, D., Weng, H. and Xeng, X. 2020. *Methodological quality (risk of bias) assessment tools for primary and secondary medical studies: what are they and which is better?* Available: https://mmrjournal.biomedcentral.com/articles/10.1186/s40779-020-00238-8 (Accessed 2 March 2022).

Macedo, L. G., Elkins, M. R., Maher, C. G., Moseley, A. M., Herbert, R. D. and Sherrington, C. 2010. There was evidence of convergent and construct validity of Physiotherapy Evidence Database quality scale for physiotherapy trials. *Journal of clinical epidemiology*, 63 (8): 920-925.

Macías-Hernández, S. I., Morones-Alba, J. D., Tapia-Ferrusco, I., Vélez-Gutiérrez, O. B., Hernández-Diaz, C., Nava-Bringas, T. I., Cruz-Medina, E., Contreras-del Toro, L. and de los Angeles Soria-Bastida, M. 2022. A home-based exercise program for temporomandibular joint osteoarthritis: pain, functionality, and joint structure. *Journal of the Korean Association of Oral and Maxillofacial Surgeons*, 48 (1): 50-58.

Macrì, M., Murmura, G., Scarano, A. and Festa, F. 2022. Prevalence of temporomandibular disorders and its association with malocclusion in children: a transversal study. *Frontiers in Public Health*, 10: 860833.

Magesty, R. A., da Silva, M. A. M., Simões, C. A. S. C., Falci, S. G. M., Douglas-de-Oliveira, D. W., Gonçalves, P. F. and Flecha, O. D. 2021. Oral health-related quality of life in patients with disc displacement with reduction after counselling treatment versus counselling associated with jaw exercises. *Journal of Oral Rehabilitation*, 48 (4): 369-374.

Maher, C. G., Sherrington, C., Herbert, R. D., Moseley, A. M. and Elkins, M. 2003. Reliability of the PEDro scale for rating quality of randomized controlled trials. *Physical therapy*, 83 (8): 713-721.

Maia, M. L. d. M., Bonjardim, L. R., Quintans, J. d. S. S., Ribeiro, M. A. G., Maia, L. G. M. and Conti, P. C. R. 2012. Effect of low-level laser therapy on pain levels in patients with temporomandibular disorders: a systematic review. *Journal of Applied Oral Science*, 20: 594-602.

Maini, K. and Dua, A. 2023. Temporomandibular syndrome. In: *StatPearls [Internet]*. StatPearls Publishing.

Makarova, E. A. and Makarova, E. L. 2014. Culturally-Based and Culturally-Biased Aspects of Knowing the Other. *Universal Journal of Educational Research*, 2 (2): 181-187.

Manfredini, D., Arveda, N., Guarda-Nardini, L., Segù, M. and Collesano, V. 2012. Distribution of diagnoses in a population of patients with temporomandibular disorders. *Oral surgery, oral medicine, oral pathology and oral radiology*, 114 (5): e35-e41.

Manfredini, D., Guarda-Nardini, L., Winocur, E., Piccotti, F., Ahlberg, J. and Lobbezoo, F. 2011. Research diagnostic criteria for temporomandibular disorders: a systematic review of axis I epidemiologic findings. *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology*, 112 (4): 453-462.

Manfredini, D., Piccotti, F., Ferronato, G. and Guarda-Nardini, L. 2010. Age peaks of different RDC/TMD diagnoses in a patient population. *Journal of Dentistry* 38(5): 392-399. Available: https://www.sciencedirect.com/science/article/abs/pii/S0300571210000205?casa_token=zLFR2TXvjN8AAAAA:ItxO4jtnEWEpki-qUm_KjblWdAtgYGebHecMcY-SZAQRIxd4w-LXa1HMBU1ZCOEPLxFXUykhvg (Accessed 12 August 2023).

Margulis, A. V., Pladevall, M., Riera-Guardia, N., Varas-Lorenzo, C., Hazell, L., Berkman, N. D., Viswanathan, M. and Perez-Gutthann, S. 2014. Quality assessment of observational studies in a drug-safety systematic review, comparison of two tools: the Newcastle–Ottawa scale and the RTI item bank. *Clinical epidemiology* 6: 359. Available: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4199858/ (Accessed 30 April 2022).

Martel, A. 2020. *Guide for Research Partnership Agreements.* Available: https://idl-bnc-idrc.dspacedirect.org/bitstream/handle/10625/58810/58953.pdf (Accessed 4 March 2022).

Mathes, T., Klaßen, P. and Pieper, D. 2017. Frequency of data extraction errors and methods to increase data extraction quality: a methodological review. *BMC medical research methodology*, 17 (1): 1-8.

Matsuoka, H., Chiba, I., Sakano, Y., Toyofuku, A. and Abiko, Y. 2017. Cognitive behavioral therapy for psychosomatic problems in dental settings. *BioPsychoSocial medicine*, 11 (1): 1-7.

McComish, N. 2023. The role of manual therapy for osteopaths in the management of temporomandibular disorders: A qualitative study.

McDonald, R. and Strang, J. 2016. Are take-home naloxone programmes effective? Systematic review utilizing application of the Bradford Hill criteria. *Addiction*, 111 (7): 1177-1187.

Melis, M., Di Giosia, M. and Zawawi, K. H. 2012. Low level laser therapy for the treatment of temporomandibular disorders: a systematic review of the literature. *CRANIO®*, 30 (4): 304-312.

Melis, M. and Giosia, M. D. 2016. The role of genetic factors in the etiology of temporomandibular disorders: a review. *The Journal of Craniomandibular & Sleep Practice*, 34 (4): 43-51.

Memon, M. A., Khan, S., Alam, K., Rahman, M. M. and Yunus, R. M. 2021. Systematic reviews: understanding the best evidence for clinical decision-making in health care: pros and cons. *Surgical Laparoscopy Endoscopy & Percutaneous Techniques*, 31 (2): 234-240.

Menéndez-Torre, Á., Pintado-Zugasti, A. M., Zaldivar, J. N. C., García-Bermejo, P., Gómez-Costa, D., Molina-Álvarez, M., Arribas-Romano, A. and Fernández-Carnero,

J. 2023. Effectiveness of deep dry needling versus manual therapy in the treatment of myofascial temporomandibular disorders: a systematic review and network meta-analysis. *Chiropractic & Manual Therapies*, 31 (1): 46.

Michelotti, A., Vollaro, S. and Cimino, R. 2019. Diagnosis of Temporomandibular Disorders Using DC/TMD Criteria. *Contemporary Management of Temporomandibular Disorders: Fundamentals and Pathway to Diagnosis*: 205-227.

Minervini, G., Franco, R., Marrapodi, M. M., Fiorillo, L., Cervino, G. and Cicciù, M. 2023. Prevalence of temporomandibular disorders in children and adolescents evaluated with Diagnostic Criteria for Temporomandibular Disorders: A systematic review with meta-analysis. *Journal of Oral Rehabilitation*, 50 (6): 522-530.

Minervini, G., Marrapodi, M. M., La Verde, M., Meto, A., Siurkel, Y., Ronsivalle, V. and Cicciù, M. 2024. Pregnancy related factors and temporomandibular disorders evaluated through the diagnostic criteria for temporomandibular disorders (DC/TMD) axis II: a cross sectional study. *BMC Oral Health*, 24 (1): 226.

Mishra, N., Barapatre, P., Pandey, M., Bagde, H., Randhawa, G. S., Balani, A., Paiwal, K. and Makkad, R. S. 2022. Data on ultrasound therapy as an adjuvant pain control method among Indian TMDS patients. *Bioinformation*, 18 (9): 774-779.

Moher, D., Shamseer, L., Clarke, M., Ghersi, D., Liberati, A., Petticrew, M., Shekelle, P., Stewart, L. A. and Group, P.-P. 2015. Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015 statement. *Systematic reviews*, 4: 1-9.

Mohsin, N. W. and Banduji, F. T. 2020. Temporomandibular joint dysfunction: A non-invasive approach towards the management of a long-standing condition. *International Journal of Pharmaceutical Research (09752366)*,

Moleirinho-Alves, P. M. M., Almeida, A. M. C. S. d., Exposto, F. G., Oliveira, R. A. N. d. S. and Pezarat-Correia, P. L. C. d. 2021. Effects of therapeutic exercise and aerobic exercise programmes on pain, anxiety and oral health-related quality of life in patients with temporomandibular disorders. *Journal of oral rehabilitation*, 48 (11): 1201-1209.

Moons, P., Goossens, E. and Thompson, D. R. 2021. Rapid reviews: the pros and cons of an accelerated review process. *European Journal of Cardiovascular Nursing*, 20 (5): 515-519.

Moore, K. L., Dalley, A. F. and Agur, A. M. 2018. *Clinically oriented anatomy*. Wolters kluwer india Pvt Ltd.

Moraska, A. F., Hickner, R. C., Kohrt, W. M. and Brewer, A. 2013. Changes in blood flow and cellular metabolism at a myofascial trigger point with trigger point release (ischemic compression): a proof-of-principle pilot study. *Archives of physical medicine and rehabilitation*, 94 (1): 196-200.

Munn, Z., Peters, M. D., Stern, C., Tufanaru, C., McArthur, A. and Aromataris, E. 2018. Systematic review or scoping review? Guidance for authors when choosing between a systematic or scoping review approach. *BMC medical research methodology*, 18: 1-7.

Murad, M. H., Sultan, S., Haffar, S. and Bazerbachi, F. 2018. Methodological quality and synthesis of case series and case reports. *BMJ evidence-based medicine*,

Murphy, M. K., MacBarb, R. F., Wong, M. E. and Athanasiou, K. A. 2013. Temporomandibular joint disorders: a review of etiology, clinical management, and tissue engineering strategies. *The International journal of oral & maxillofacial implants* 28(6): e393. Available: https://doi.org/10.11607/jomi.te20 (Accessed 30 April 2022).

Muthukrishnan, A. and Sekar, G. S. 2015. Prevalence of temporomandibular disorders in Chennai population. *Journal of Indian Academy of Oral Medicine and Radiology* 27(4): 508-515. Available: https://journals.lww.com/aomr/Fulltext/2015/27040/Prevalence_of_temporomandibular_disorders_in.2.aspx (Accessed 18 August 2023).

Nagata, K., Hori, S., Mizuhashi, R., Yokoe, T., Atsumi, Y., Nagai, W. and Goto, M. 2019. Efficacy of mandibular manipulation technique for temporomandibular disorders patients with mouth opening limitation: a randomized controlled trial for comparison with improved multimodal therapy. *Journal of prosthodontic research*, 63 (2): 202-209.

Newman, M. and Gough, D. 2020. Systematic reviews in educational research: Methodology, perspectives and application. *Systematic reviews in educational research: Methodology, perspectives and application*: 3-22.

Ng, J., Dhawan, T., Dogadova, E., Taghi-Zada, Z., Vacca, A., Wieland, S. and Moher, D. 2022. Operational defnition of complementary, alternative, and integrative medicine derived from a systematic search. *BMC Complementary Medicine and Therapies* 22(1). Available: https://doi.org/10.1186/s12906-022-03556-7 (Accessed 05 March 2023).

non-invasive procedure. 2012. Available: https://medical-dictionary.thefreedictionary.com/non-invasive+procedure (Accessed 10 September 2022).

Noyes, J., Booth, A., Flemming, K., Garside, R., Harden, A., Lewin, S., Pantoja, T., Hannes, K., Cargo, M. and Thomas, J. 2018. Cochrane Qualitative and Implementation Methods Group guidance series—paper 3: methods for assessing methodological limitations, data extraction and synthesis, and confidence in synthesized qualitative findings. *Journal of clinical epidemiology*, 97: 49-58.

Ohrbach, R. and Dworkin, S. 2016. The evolution of TMD diagnosis: past, present, future. *Journal of dental research*, 95 (10): 1093-1101.

Ohrbach, R. and Sharma, S. 2021. Behavioral therapy for temporomandibular disorders. *Frontiers of Oral and Maxillofacial Medicine*, 3: 37-37.

Ohrbach, R., Slade, G. D., Bair, E., Rathnayaka, N., Diatchenko, L., Greenspan, J. D., Maixner, W. and Fillingim, R. B. 2020. Premorbid and concurrent predictors of TMD onset and persistence. *European Journal of Pain*, 24 (1): 145-158.

Olivo, S. A., Macedo, L. G., Gadotti, I. C., Fuentes, J., Stanton, T. and Magee, D. J. 2008. Scales to assess the quality of randomized controlled trials: a systematic review. *Physical therapy*, 88 (2): 156-175.

Packer, A. C., Pires, P. F., Dibai-Filho, A. V. and Rodrigues-Bigaton, D. 2015. Effect of upper thoracic manipulation on mouth opening and electromyographic activity of

masticatory muscles in women with temporomandibular disorder: a randomized clinical trial. *Journal of manipulative and physiological therapeutics*, 38 (4): 253-261.

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A. and Brennan, S. E. 2021a. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *International journal of surgery*, 88: 105906.

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M. and Moher, D. 2021b. Updating guidance for reporting systematic reviews: development of the PRISMA 2020 statement. *Journal of clinical epidemiology*, 134: 103-112.

Page, M. J., Moher, D., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A. and Brennan, S. E. 2021c. PRISMA 2020 explanation and elaboration: updated guidance and exemplars for reporting systematic reviews. *bmj*, 372

Palmer, J. and Durham, J. 2021. Temporomandibular disorders. *BJA education*, 21 (2): 44-50.

Park, J., Song, H., Roh, H., Kim, Y. and Lee, J. 2012. Correlation between clinical diagnosis based on RDC/TMD and MRI findings of TMJ internal derangement. *International journal of oral and maxillofacial surgery*, 41 (1): 103-108.

Parums, D. V. 2021. Review articles, systematic reviews, meta-analysis, and the updated preferred reporting items for systematic reviews and meta-analyses (PRISMA) 2020 guidelines. *Medical science monitor: international medical journal of experimental and clinical research*, 27: e934475-934471.

Patra, R. C., Kanungo, B. and Mohanty, P. 2020. Dry needling followed by 4 weeks of cranial stabilization exercise on health-related quality of life in patients with temporomandibular disorders: An experimental study. *Journal of International Oral Health*, 12 (6): 540-545.

Patra, R. C., Kaur, S. and Kanungo, B. 2021. Dry Needling in Combination with Muscular Inhibition Technique on Mouth Function and Health-Related Quality of Life in Patients with Temporomandibular Disorders: A Randomized Control trial. *Health Sciences*, 10 (2): 1-7.

PEDro. 1999. *PEDro scale*. Available: https://pedro.org.au/english/resources/pedro-scale/ (Accessed 27 August 2023).

Penlington, C., Bowes, C., Taylor, G., Otemade, A. A., Waterhouse, P., Durham, J. and Ohrbach, R. 2022. Psychological therapies for temporomandibular disorders (TMDs). *Cochrane Database of Systematic Reviews*, (8)

Pereira, B. L. d. S., Alves, B. P. and Fiedler, F. P. 2023. The knowledge of prescription and the pharmacological role in temporomandibular disorders for dental surgeons: literature review. *BrJP*,

Petersen, J. M., Ranker, L. R., Barnard-Mayers, R., MacLehose, R. F. and Fox, M. P. 2021. A systematic review of quantitative bias analysis applied to epidemiological research. *International journal of epidemiology*, 50 (5): 1708-1730.

Pierson, D. J. 2009. How to read a case report (or teaching case of the month). *Respiratory care*, 54 (10): 1372-1378.

Pigott, T. D. and Polanin, J. R. 2020. Methodological guidance paper: High-quality meta-analysis in a systematic review. *Review of Educational Research*, 90 (1): 24-46.

Priyank, H., Prasad, R. S., Shivakumar, S., Abdul, N. S., Patak, A., Cervino, G., Cicciù, M. and Minervini, G. 2023. Management protocols of chronic orofacial pain: A review. *The Saudi Dental Journal*,

Prodoehl, J. and Kahnert, E. 2022. Physical therapy for temporomandibular disorders: evidence-based improvements and enhancements for diagnosis and management. *Frontiers of Oral and Maxillofacial Medicine*, 4

Quigley, J. M., Thompson, J. C., Halfpenny, N. J. and Scott, D. A. 2019. Critical appraisal of nonrandomized studies—a review of recommended and commonly used tools. *Journal of Evaluation in Clinical Practice*, 25 (1): 44-52.

Rai, S., Kaur, M., Goel, S., Panjwani, S. and Singh, S. 2012. Prospective utility of therapeutic ultrasound in dentistry—Review with recent comprehensive update. *Advanced biomedical research*, 1

Rai, S., Ranjan, V., Misra, D. and Panjwani, S. 2016. Management of myofascial pain by therapeutic ultrasound and transcutaneous electrical nerve stimulation: A comparative study. *European journal of dentistry*, 10 (01): 046-053.

Rajadurai, V. 2011. The effect of muscle energy technique on temporomandibular joint dysfunction: a randomized clinical trial. *Asian J Sci Res*, 4 (1): 71-77.

Rani, S., Pawah, S., Gola, S. and Bakshi, M. 2017. Analysis of Helkimo index for temporomandibular disorder diagnosis in the dental students of Faridabad city: A cross-sectional study. *The Journal of the Indian Prosthodontic Society*, 17 (1): 48.

Reyes, R. P., Dieste, O. and Juristo, N. 2020. Publication bias: A detailed analysis of experiments published in ESEM. In: Proceedings of *Proceedings of the 24th International Conference on Evaluation and Assessment in Software Engineering*. 130-139.

Reynolds, B. and Brown, J. L. 2020. Cervical spine thrust joint manipulation, education, and a home exercise program for the management of individuals with temporomandibular disorder: A prospective case series. *Internet Journal of Allied Health Sciences and Practice*, 18 (4): 10.

Reynolds, B., Puentedura, E. J., Kolber, M. J. and Cleland, J. A. 2020. Effectiveness of cervical spine high-velocity, low-amplitude thrust added to behavioral education, soft tissue mobilization, and exercise for people with temporomandibular disorder with myalgia: a randomized clinical trial. *Journal of Orthopaedic & Sports Physical Therapy*, 50 (8): 455-465.

Rezaie, K., Amiri, A., Takamjani, E. E., Shirani, G., Salehi, S. and Alizadeh, L. 2022. The efficacy of neck and temporomandibular joint (TMJ) manual therapy in comparison with a multimodal approach in the patients with TMJ dysfunction: a blinded randomized controlled trial. *Medical Journal of the Islamic Republic Of Iran*, 36

Rutgers-University-library. 2022. *Systematic Reviews in the Health Sciences*. Available: https://libguides.rutgers.edu/c.php?g=337288&p=2269575 (Accessed 6 September 2022).

Safour, W. 2018. *Understanding the Influence of Changes to Diet on Individuals Living with Temporomandibular Disorder (TMD): An Interpretive Phenomenological Study*. McGill University (Canada).

Şahin, D., Kaya Mutlu, E., Şakar, O., Ateş, G., İnan, Ş. and Taşkıran, H. 2021. The effect of the ischaemic compression technique on pain and functionality in temporomandibular disorders: A randomised clinical trial. *Journal of Oral Rehabilitation*, 48 (5): 531-541.

Scelza, G., Amato, A., Rongo, R., Nucci, L., D'Ambrosio, F. and Martina, S. 2022. Changes in COVID-19 Perception and in TMD Prevalence after 1 Year of Pandemic in Italy. *European Journal of Dentistry*. Available: https://www.thieme-connect.com/products/ejournals/html/10.1055/s-0042-1755192 (Accessed 18 August 2023).

Schiffman, E. and Ohrbach, R. 2016. Executive summary of the Diagnostic Criteria for Temporomandibular Disorders for clinical and research applications. *The Journal of the American Dental Association*, 147 (6): 438-445.

Schiffman, E., Ohrbach, R., Truelove, E., Look, J., Anderson, G., Goulet, J.-P., List, T., Svensson, P., Gonzalez, Y. and Lobbezoo, F. 2014. Diagnostic criteria for temporomandibular disorders (DC/TMD) for clinical and research applications: recommendations of the International RDC/TMD Consortium Network and Orofacial Pain Special Interest Group. *Journal of oral & facial pain and headache*, 28 (1): 6.

Schiffman, E. L., Ohrbach, R., Truelove, E. L., Feng, T., Anderson, G. C., Pan, W., Gonzalez, Y. M., John, M. T., Sommers, E. and List, T. 2010a. The revised research diagnostic criteria for temporomandibular disorders: methods used to establish and validate revised axis I diagnostic algorithms. *Journal of orofacial pain*, 24 (1): 63.

Schiffman, E. L., Truelove, E. L., Ohrbach, R., Anderson, G. C., John, M. T., List, T. and Look, J. O. 2010b. The Research Diagnostic Criteria for Temporomandibular Disorders. I: overview and methodology for assessment of validity. *Journal of orofacial pain*, 24 (1): 7.

Schulz, K. F., Altman, D. G. and Moher, D. 2010. CONSORT 2010 statement: updated guidelines for reporting parallel group randomised trials. *Journal of Pharmacology and pharmacotherapeutics*, 1 (2): 100-107.

Şen, S., Orhan, G., Sertel, S., Schmitter, M., Schindler, H. J., Lux, C. J. and Giannakopoulos, N. N. 2020. Comparison of acupuncture on specific and non-specific points for the treatment of painful temporomandibular disorders: A randomised controlled trial. *Journal of oral rehabilitation*, 47 (7): 783-795.

Shaffer, S. M., Brismée, J.-M., Sizer, P. S. and Courtney, C. A. 2014a. Temporomandibular disorders. Part 1: anatomy and examination/diagnosis. *Journal of manual & manipulative therapy*, 22 (1): 2-12.

Shaffer, S. M., Brismée, J.-M., Sizer, P. S. and Courtney, C. A. 2014b. Temporomandibular disorders. Part 2: conservative management. *Journal of Manual & Manipulative Therapy*, 22 (1): 13-23.

Shanavas, M., Chatra, L., Shenai, P., Rao, P. K., Jagathish, V., Kumar, S. P. and Naduvakkattu, B. 2014. Transcutaneous electrical nerve stimulation therapy: An adjuvant pain controlling modality in TMD patients—A clinical study. *Dental research journal*, 11 (6): 676.

Shun Li, D. and Leung, Y. 2021. Temporomandibular Disorders: Current Concepts and Controversies in Diagnosis and Management. *Diagnostics* 11(3): 459. Available: https://mdpi-res.com/d_attachment/diagnostics/diagnostics-11-00459/article_deploy/diagnostics-11-00459-v2.pdf?version=1615964507

Singh, B. P., Jayaraman, S., Kirubakaran, R., Joseph, S., Muthu, M. S., Jivnani, H., Hua, F. and Singh, N. 2017. Occlusal interventions for managing temporomandibular disorders. *The Cochrane Database of Systematic Reviews*, 2017 (11)

Slim, K., Nini, E., Forestier, D., Kwiatkowski, F., Panis, Y. and Chipponi, J. 2003. Methodological index for non-randomized studies (MINORS): development and validation of a new instrument. *ANZ journal of surgery*, 73 (9): 712-716.

Smith, L. H. 2020. Selection mechanisms and their consequences: understanding and addressing selection bias. *Current Epidemiology Reports*, 7: 179-189.

Snyder, H. 2019. Literature review as a research methodology: An overview and guidelines. *Journal of business research* 104: 333-339. Available: https://www.sciencedirect.com/science/article/pii/S0148296319304564 (Accessed 6 September 2022).

Song, F., Hooper, L. and Loke, Y. K. 2013. Publication bias: what is it? How do we measure it? How do we avoid it? *Open Access Journal of Clinical Trials*: 71-81.

Stang, A. 2010. Critical evaluation of the Newcastle-Ottawa scale for the assessment of the quality of nonrandomized studies in meta-analyses. *European journal of epidemiology*, 25: 603-605.

Stern, C. and Kleijnen, J. 2020. *Language bias in systematic reviews: you only get out what you put in*: LWW.

Sterne, J. A., Hernán, M. A., Reeves, B. C., Savović, J., Berkman, N. D., Viswanathan, M., Henry, D., Altman, D. G., Ansari, M. T. and Boutron, I. 2016. ROBINS-I: a tool for assessing risk of bias in non-randomised studies of interventions. *bmj*, 355

Talaat, W. M., Adel, O. I. and Al Bayatti, S. 2018. Prevalence of temporomandibular disorders discovered incidentally during routine dental examination using the Research Diagnostic Criteria for Temporomandibular Disorders. *Oral surgery, oral medicine, oral pathology and oral radiology*, 125 (3): 250-259.

Talley, R. L., Murphy, G. J., Smith, S. D., Baylin, M. A. and Haden, J. L. 1990. Standards for the history, examination, diagnosis, and treatment of temporomandibular disorders (TMD): a position paper. *CRANIO®*, 8 (1): 60-77.

Tanti, I., Himawan, L. S. and Kusdhany, L. 2016. Etiology of Temporomandibular Disorders Index. *Journal of International Dental and Medical Research*, 9: 299-305.

Tawfik, G. M., Dila, K. A. S., Mohamed, M. Y. F., Tam, D. N. H., Kien, N. D., Ahmed, A. M. and Huy, N. T. 2019a. A step by step guide for conducting a systematic review and meta-analysis with simulation data. *Tropical medicine and health*, 47 (1): 1-9.

Tawfik, G. M., Dila, K. A. S., Mohamed, M. Y. F., Tam, D. N. H., Kien, N. D., Ahmed, A. M. and Huy, N. T. 2019b. A step by step guide for conducting a systematic review and meta-analysis with simulation data. *Tropical medicine and health* 47(1): 1-9. Available: https://tropmedhealth.biomedcentral.com/articles/10.1186/s41182-019-0165-6 (Accessed 30 April 2022).

Tuncer, A. B., Ergun, N., Tuncer, A. H. and Karahan, S. 2013. Effectiveness of manual therapy and home physical therapy in patients with temporomandibular disorders: A randomized controlled trial. *Journal of bodywork and movement therapies*, 17 (3): 302-308.

Turp, J. C. and Schindler, H. 2012. The dental occlusion as a suspected cause for TMDs: epidemiological and etiological considerations. *Journal of oral rehabilitation*, 39 (7): 502-512.

Urbański, P., Trybulec, B. and Pihut, M. 2021. The application of manual techniques in masticatory muscles relaxation as adjunctive therapy in the treatment of temporomandibular joint disorders. *International journal of environmental research and public health*, 18 (24): 12970.

Vieira, L. S., Pestana, P. R. M., Miranda, J. P., Soares, L. A., Silva, F., Alcantara, M. A. and Oliveira, V. C. 2023. The efficacy of manual therapy approaches on pain, maximum mouth opening and disability in temporomandibular disorders: a systematic review of randomised controlled trials. *Life*, 13 (2): 292.

Vier, C., de Almeida, M. B., Neves, M. L., Dos Santos, A. R. S. and Bracht, M. A. 2019. The effectiveness of dry needling for patients with orofacial pain associated with temporomandibular dysfunction: a systematic review and meta-analysis. *Brazilian journal of physical therapy*, 23 (1): 3-11.

Von Elm, E., Altman, D. G., Egger, M., Pocock, S. J., Gøtzsche, P. C. and Vandenbroucke, J. P. 2007. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. *The lancet*, 370 (9596): 1453-1457.

Wells, G., Shea, B., O'Connell, D., Peterson, J., Welch, V., Losos, M. and Tugwell., P. 2003. The NewcastleOttawa Scale (NOS) for assessing the quality of nonrandomised studies in meta-analyses.

Whiting, P., Savović, J., Higgins, J. P., Caldwell, D. M., Reeves, B. C., Shea, B., Davies, P., Kleijnen, J. and Churchill, R. 2018. ROBIS: a new tool to assess risk of bias in systematic reviews was developed. *Recenti Progressi in Medicina*, 109 (9): 421-431.

Wieckiewicz, M., Boening, K., Wiland, P., Shiau, Y.-Y. and Paradowska-Stolarz, A. 2015. Reported concepts for the treatment modalities and pain management of temporomandibular disorders. *The journal of headache and pain*, 16 (1): 1-12.

Wieland, L. S., Manheimer, E. and Berman, B. 2011. Development and classification of an operational definition of complementary and alternative medicine for the Cochrane collaboration. *Alternative therapies in health and medicine*, 17 (2): 50.

Wilkie, G. and Al-Ani, Z. 2022. Temporomandibular joint anatomy, function and clinical relevance. *British Dental Journal*, 233 (7): 539-546.

Wormald, R. and Evans, J. 2018. *What makes systematic reviews systematic and why are they the highest level of evidence?* : Taylor & Francis.

Wu, M., Cai, J., Yu, Y., Hu, S., Wang, Y. and Wu, M. 2021. Therapeutic agents for the treatment of temporomandibular joint disorders: progress and perspective. *Frontiers in Pharmacology*, 11: 596099.

Yadav, S., Yang, Y., Dutra, E. H., Robinson, J. L. and Wadhwa, S. 2018. Temporomandibular joint disorders in older adults. *Journal of the American Geriatrics*

Society 66(6): 1213-1217. Available: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6699643/pdf/nihms946837.pdf (Accessed 15 August 2023).

Yost, O., Liverman, C. and English, R. 2020. *Temporomandibular Disorders: Priorities for Research and Care.* Available: https://www.ncbi.nlm.nih.gov/books/NBK557995/ (Accessed 29 August 2022).

Yost, O., Liverman, C. T., English, R., Mackey, S., Bond, E. C., National Academies of Sciences, E. and Medicine. 2020a. Caring for Individuals with a TMD. In: *Temporomandibular Disorders: Priorities for Research and Care*. National Academies Press (US).

Yost, O., Liverman, C. T., English, R., Mackey, S., Bond, E. C., National Academies of Sciences, E. and Medicine. 2020b. Individual and Societal Burden of TMDs. In: *Temporomandibular Disorders: Priorities for Research and Care*. National Academies Press (US).

Young, A. L. 2015. Internal derangements of the temporomandibular joint: A review of the anatomy, diagnosis, and management. *The Journal of the Indian Prosthodontic Society*, 15 (1): 2.

Zawacki-Richter, O., Kerres, M., Bedenlier, S., Bond, M. and Buntins, K. 2020. *Systematic reviews in educational research: Methodology, perspectives and application*. Springer Nature.

Zeng, X., Zhang, Y., Kwong, J. S., Zhang, C., Li, S., Sun, F., Niu, Y. and Du, L. 2015. The methodological quality assessment tools for preclinical and clinical studies, systematic review and meta-analysis, and clinical practice guideline: a systematic review. *Journal of evidence-based medicine*, 8 (1): 2-10.

APPENDIX A: FOHS APPROVAL LETTER

3 October, 2023

Ms SN Hlongwane
Student No: 21507383

PO Box 3182
Ladysmith
3370

Dear Ms Hlongwane

MASTER OF TECHNOLOGY: CHIROPRACTIC

I am pleased to advise that:

1. The Faculty Research Committee approved the following:

    (i) Your research proposal and dissertation title, being:

A systematic review of the effectiveness of conservative therapy in the treatment and management of Temporomandibular Joint Disorders.

Please note: ANY PROPOSED CHANGES in the DISSERTATION TITLE require the approval of your supervisor and the Faculty Research Committee.

    (ii) Supervisor – **Prof P McCarthy**
    Co-supervisor – **Dr C Korporaal**

2. Your request for funding totalling **R 8 000.00** subject to any literature referred to in Section A of the PG 4a form being accessioned by this University, and any equipment purchased shall become the property of the department.

NOTE: - This funding is not paid directly to you but is controlled by the Faculty Office. Any proposed changes to this funding allocation needs the approval of your supervisor, and Faculty Research Committee

The University Research Committee has stipulated that:

(a) Ownership of any patent registered in respect of the results of your Master's studies is retained by you as the initiator of the project;

(b) Should you make any drift from the results of your Master's studies, you will be required to repay pro rata, the **R 8 000.00** investment which the University Research Committee has made in approving your request for funding;

(c) If the Durban University of Technology provided the equipment/materials for the creation of artefacts, this cost would be refunded to the University if such artefacts were sold and

(d) Durban University of Technology is given first refusal in respect of any possible future sale by you of any patent that may be registered in respect of your said project.

(e) All journal articles, referenced in your dissertation, are to accompany your ring-bound copies when submitting for examination purposes.

Should you experience any problems relating to your research studies, your supervisor must be informed as soon as possible. If the difficulty persists, you must then approach your Head of Department and thereafter the Executive Dean of the Faculty.

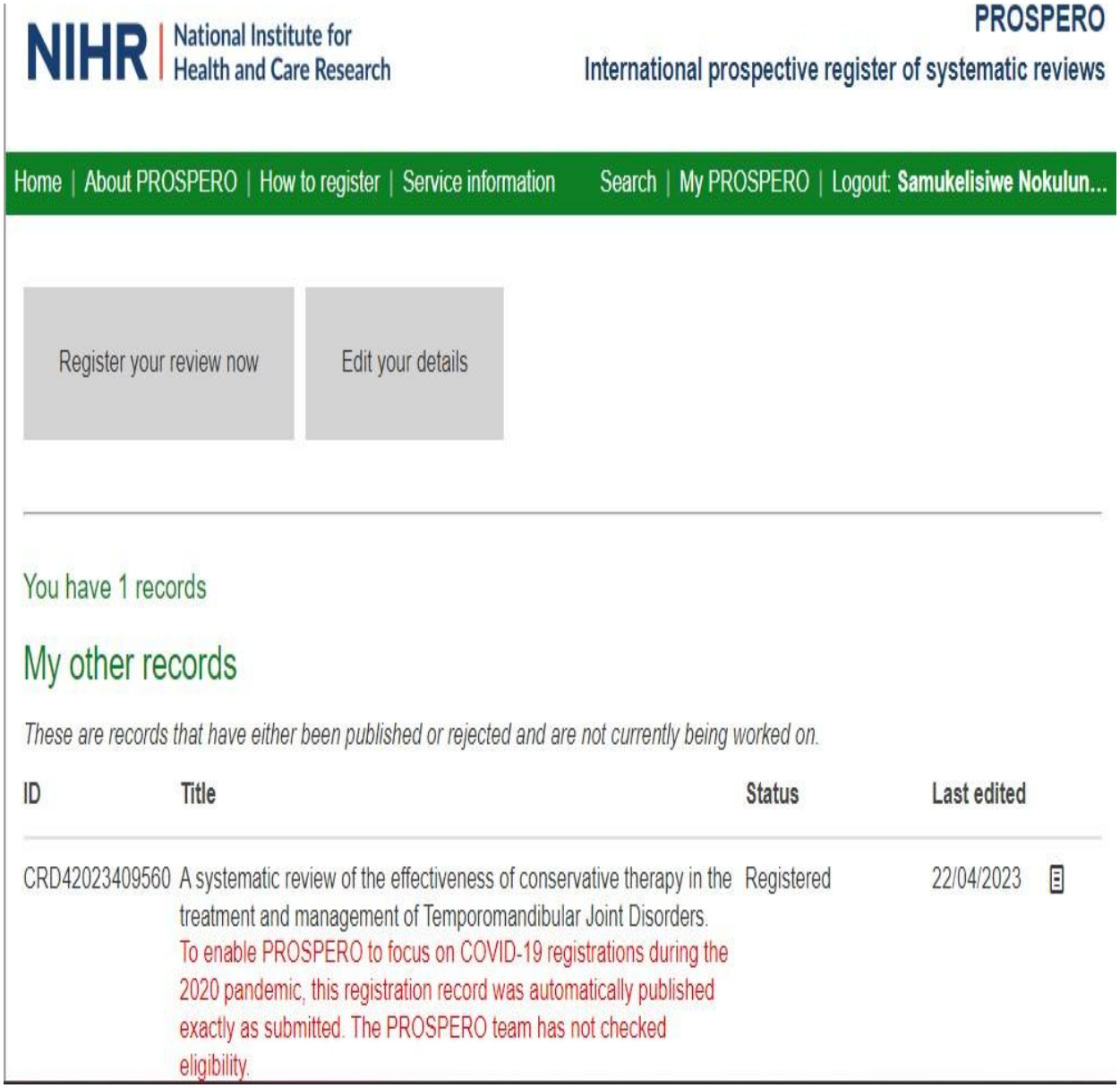
Yours sincerely

Ms S Perumal
FACULTY RESEARCH OFFICER

Student's signature in acceptance of the conditions contained herein.

Date:

APPENDIX B: PROSPERO REGISTRATION



NIHR | National Institute for Health and Care Research

PROSPERO
International prospective register of systematic reviews

Home | About PROSPERO | How to register | Service information Search | My PROSPERO | Logout: **Samukelisiwe Nokulun...**

Register your review now Edit your details

You have 1 records

My other records

These are records that have either been published or rejected and are not currently being worked on.

ID	Title	Status	Last edited
CRD42023409560	A systematic review of the effectiveness of conservative therapy in the treatment and management of Temporomandibular Joint Disorders. To enable PROSPERO to focus on COVID-19 registrations during the 2020 pandemic, this registration record was automatically published exactly as submitted. The PROSPERO team has not checked eligibility.	Registered	22/04/2023

APPENDIX C: MOU

Memorandum of Understanding

Study tittle: A systematic review of the effectiveness of conservative therapy in the treatment and management of Temporomandibular Joint Disorders.

Principal investigator: Samukelisiwe Hlongwane (researcher) BHSc: chiropractic

Co-investigators: Professor Peter McCarthy (supervisor) PhD Neuropharmacology and Neurophysiology and DR Charmaine Korporaal (collaborator) M.Tech: chiropractic

Brief introduction and description of the study

This is a systematic review study looking at the effectiveness of manual conservative therapies mainly physical therapy, manipulation, mobilization, dry needling, ischemic compression and exercise therapies in the treatment and management of temporomandibular joint disorders (TMD). The researcher will be using online databases to collect articles for the research study. Randomized control clinical trials, non-randomize clinical trials and case reports/series studies that meet the inclusion criteria will be included in the study.

Outline of procedure

Articles meeting the inclusion criteria will be grouped according to study types mainly Randomised clinical trials, non-randomised clinical trials, and case reports studies. These will then be sent to reviewers together with the corresponding rating scale sheets and explanation sheets for each scale. Scales will be used as follows, PEDro scale for randomised clinical trials, Newcastle-Ottawa scale for non-randomised clinical trials and Liddle scale for case reports studies. Reviewers will individually be required to rate their allocated articles using their corresponding scales and using rating sheets that will be provided. Rating sheets will then be collected for statistical analysis after a time period agreed upon for the review of each group of articles has been reached.

Reviewer requirements

A bio-sketch or CV indicating the reviewer's qualifications and experience will be attained from each reviewer when they agree to participate in the study. The purpose of the bio-sketch or CV is to provide evidence to support the proposed guidelines with respect to reviewer recruitment for record keeping.

Benefits

Publication of the study: should this study be published, all persons participating in the study will be included in the publication as the author. Should the reviewer wish to be exempted from this, please strike through the paragraph and initial alongside.

Remuneration

An honorarium of R1, 000.00 will be awarded to each reviewer in appreciation of their time and dedication to this project. This amount will be paid at the end of the study once submission for final marking has been made.

Contact persons

(a) Ms. Samukelisiwe Hlongwane (researcher)

Cellphone no: 078 669 7604
Email address: snokulunga55@gmail.com

(b) Prof. Peter McCarthy (main supervisor)
Email address: peter.mccarthy@southwales.ac.uk

(c) Dr. Charmain Korporaal (collaborator)
Tel: 031 373 2611
Cellphone no: 083 246 3562
Email address: charmak@dut.ac.za

Statement of agreement to participate in the research study

I …….. (Subject's full name),

…… (Identity / passport number), have read this document in its entirety and understand its contents. Where I have had any questions or queries, these have been explained to me by ……. to my satisfaction. Furthermore, I voluntarily agree to participate in this study as a reviewer.

Reviewer's name: ……

Reviewer's Signature: ……

Date: ……..

Supervisor's name: ……

Supervisor's signature: ……

Date: ……

Collaborator's name: ……..

Collaborator's signature: ……

Date: ……

Researcher's name: ……

Researcher's signature: ……..

Date: ……

APPENDIX D: COPYRIGHTS

DRAMATIC, ARTISTIC and LITERARY
RIGHTS ORGANISATION (Pty) LIMITED

Landline: +27 (0)10 822 7469
Fax: +27 (0)86 649 1136
Email: dalro@dalro.co.za
Website: www.dalro.co.za
Address: Waverley Office Park; Building 1;
15 Forest Road; Bramley; Gauteng; 2090
Postal Address: PostNet Suite #018;
Private Bag X9951; Sandton; 2146
Reg No: 1967/005018/07
Vat Number: 4390106815

TO: DURBAN UNIVERSITY OF TECHNOLOGY

Intellectual Property
Durban University of Technology
P O Box 1334
DURBAN

Dear COPYRIGHT SPECIALISTS,

REPROGRAPHIC REPRODUCTION RIGHTS QUOTATION FOR (H.SC : CHIROPRACTIC/RESEARCH (RPCR521)/KORPORAAL C /N/A) (0000014588/01):

DALRO hereby grants permission for the reprographic reproduction of extract(s) from the publication(s) as per the schedule following. The reproduction royalties are indicated next to the title(s).

Please note that this permission is subject to the following conditions:

1. The copied extract(s) may only be distributed by the licensing entity identified on the schedule, and only to persons enrolled for the specific course of study at the licensing entity.
2. Should the licensing entity decide to sell the copied extract(s) to the persons enrolled for the course of study, the selling price per unit shall not exceed the cost per unit incurred by the licensing entity.
3. The copied extract(s) may only be distributed from a point which is under the direct control of, and staffed by, the licensing entity, and no external entity or concern, whether commercial or non-commercial, may act as distributor.

Only upon acceptance, in writing, of this quotation will a Tax Invoice be issued. Please let us know if this reproduction will not be going ahead at all to enable us to cancel the quotation. Should the information on which the quotation is based, have changed, the new information need to be supplied to enable us to prepare a revised quotation.

Yours sincerely

RIGHTS ADMINISTRATION

REPROGRAPHIC REPRODUCTION RIGHTS QUOTATION: 17/05/2023

QUOTATION NUMBER: 0000014588/01

LICENSING ENTITY: DURBAN UNIVERSITY OF TECHNOLOGY
REFERENCE: N/A
LECTURER: KORPORAAL C
DEPARTMENT: H.SC : CHIROPRACTIC
COURSE: RESEARCH (RPCR521)
DISSEMINATION: TRANSIENT ELECTRONIC COPY
USAGE PERIOD: 01/01/2023 - 30/06/2023

Item	Title	Units	Pages	Copies	Rate	VAT Excl.	VAT	VAT Incl.
001/001	JOURNAL OF PHYSICAL THERAPY SCIENCE EFFECT OF RELAXATION EXERCISES FOR THE MASTICATOR MUSCLES ON TEMPOROMANDIBULAR JOINT DYSFUNCTION (TMD), THE (BAE Y., PARK Y.) 169906	2	4	8	R1.24	R49.71 *	R7.46	R57.17

002/002	JOURNAL OF ORAL REHABILITATION EFFECTS OF 8 WEEKS OF MASTICATORY MUSCLES FOCUSED ENDURANCE EXERCISES ON WOMEN WITH ORO-FACIAL PAIN AND TEMPOROMANDIBULAR DISORDERS: A PLACEBO RANDOMISED CONTROLLED TRIAL (BARBOSA M.A. (et al)) 169908	2	10	20	R1.24	R49.71 *	R7.46	R57.17
003/003	JOURNAL OF BODYWORK AND MOVEMENT THERAPIES IMMEDIATE EFFECTS OF RHYTHMIC JOINT MOBILIZATION OF THE TEMPOROMANDIBULAR JOINT ON PAIN, MOUTH OPENING AND ELECTROMYOGRAPHIC ACTIVITY IN PATIENTS WITH TEMPOROMANDIBULAR DISORDERS (BARONE M. (et al)) 169909	2	7	14	R1.24	R49.71 *	R7.46	R57.17

Item	Title	Units	Pages	Copies	Rate	VAT Excl.	VAT	VAT Incl.
004/004	JOURNAL OF ORAL REHABILITATION EFFECTIVENESS OF MOBILISATION OF THE UPPER CERVICAL REGION AND CRANIOCERVICAL FLEXOR TRAINING ON OROFACIAL PAIN, MANDIBULAR FUNCTION AND HEADACHE IN WOMEN WITH TMD. A RANDOMISED, CONTROLLED TRIAL (CALIXTURE L.B.) 169911	2	11	22	R1.24	R49.71 *	R7.46	

005/ 005	INTERNATIONAL JOURNAL OF OSTEOPATHIC MEDICINE EFFECTS OF MYOFASCIAL RELEASE APPLIED TO NECK MUSCLES AND CRANIOCERVICAL FLEXOR TRAINING IN PATIENTS WITH CHRONIC MYOFASCIAL TMD: A SINGLE ARM STUDY (CALIXTRE L.B. (et al)) 169912	2	7	14	R1.24	R49.71 *	R7.46	
006/ 006	MANUELLE MEDIZIN SPINAL HIGH-VELOCITY LOW-AMPLITUDE MANIPULATION WITH EXERCISE IN WOMEN WITH CHRONIC TEMPOROMANDIBULAR DISORDERS: A RANDOMIZED CONTROLLED TRIAL COMPARING TO PATIENT EDUCATION (CORUM M. (et al)) 169914	2	9	18	R1.24	R49.71 *	R7.46	
007/ 007	PAIN MEDICINE EFFECTS OF CERVICO-MANDIBULAR MANUAL THERAPY IN PATIENTS WITH TEMPOROMANDIBULAR PAIN DISORDERS AND ASSOCIATED SOMATIC TINNITUS: A RANDOMIZED CLINICAL TRIAL (DE LA SEMA P.D. (et al)) 169915	2	12	24	R1.24	R49.71 *	R7.46	
008/ 008	MEDICINA EVALUATION OF THE EFFECTIVENESS OF DRY NEEDLING IN THE TREATMENT OF MYOGENOUS TEMPOROMANDIBULAR JOINT DISORDERS (DIB0ZAKKOUR J. (et al)) 169916	2	1	2	R1.24	R49.71 *	R7.46	
009/ 009	CRANIO DRY NEEDLING AND UPPER CERVICAL SPINAL MANIPULATION IN PATIENTS WITH TEMPOROMANDIBULAR DISORDER: A MULTI-CENTER RANDOMIZED CLINICAL TRIAL (DUNNING J. (et al)) 169918	2	15	30	R1.24	R49.71 *	R7.46	

Item	Title	Units	Pages	Copies	Rate	VAT Excl.	VAT	VAT Incl.
010/ 010	JOURNAL OF ORAL & FACIAL PAIN AND HEADACHE EFFECTS OF A PHYSICAL THERAPY PROTOCOL IN PATIENTS WITH CHRONIC MIGRAINE AND TEMPOROMANDIBULAR DISORDERS: A RANDOMIZED, SINGLEBLINDED, CLINICAL TRIAL (GARRIGÓS-PEDRÓN M. (et al)) 169919	2	14	28	R1.24	R49.71 *	R7.46	
011/ 011	ACTA ODONTOLOGICA SCANDINAVICA EFFECT OF SUPERVISED EXERCISE ON LOCALIZED TMD PAIN AND TMD PAIN ASSOCIATED WITH GENERALIZED PAIN, THE (HAGGMAN-HENRIKSONA B., WIESINGERIA B., WANMANA A.) 169921	2	7	14	R1.24	R49.71 *	R7.46	
012/ 012	JOURNAL OF CLINICAL MEDICINE EFFECTIVENESS OF PHYSICAL THERAPY IN PATIENTS WITH GENERALIZED JOINT HYPERMOBILITY AND CONCURRENT TEMPOROMANDIBULAR DISORDERS - A CROSS-SECTIONAL STUDY, THE (KULESA-MROWIECKA M., PIECH J., GAŹDZIK T.S.) 169923	2	1	2	R1.24	R49.71 *	R7.46	
013/ 013	MEDICINA ORAL, PATOLOGIA ORAL Y CIRUGIA BUCAL RANDOMIZED, DOUBLE-BLIND STUDY COMPARING PERCUTANEOUS ELECTROLYSIS AND DRY NEEDLING FOR THE MANAGEMENT OF TEMPOROMANDIBULAR MYOFASCIAL PAIN (LOPEZ-MARTOS R. (et al)) 169924	2	9	18	R1.24	R49.71 *	R7.46	
014/ 014	JOURNAL OF ORAL REHABILITATION EFFECTS OF THERAPEUTIC EXERCISE AND AEROBIC EXERCISE PROGRAMMES ON PAIN, ANXIETY AND ORAL HEALTH-RELATED QUALITY OF LIFE IN PATIENTS WITH TEMPOROMANDIBULAR DISORDERS (MOLEIRINHO-ALVES P. (et al)) 169926	2	9	18	R1.24	R49.71 *	R7.46	

015/ 015	JOURNAL OF PROSTHODONTIC RESEARCH EFFICACY OF MANDIBULAR MANIPULATION TECHNIQUE FOR TEMPOROMANDIBULAR DISORDERS PATIENTS WITH MOUTH OPENING LIMITATION: A RANDOMIZED CONTROLLED TRIAL FOR COMPARISON WITH IMPROVED MULTIMODAL THERAPY (NAGATA K. (et al)) 169927	2	8	16	R1.24	R49.71 *	R7.46	

Item	Title	Units	Pages	Copies	Rate	VAT Excl.	VAT	VAT Incl.
016/ 016	JOURNAL OF MANIPULATIVE AND PHYSIOLOGICAL THERAPEUTICS EFFECT OF UPPER THORACIC MANIPULATION ON MOUTH OPENING AND ELECTROMYOGRAPHIC ACTIVITY OF MASTICATORY MUSCLES IN WOMEN WITH TEMPOROMANDIBULAR DISORDER: A RANDOMIZED CLINICAL TRIAL (PACKER A.C. (et al)) 169929	2	9	18	R1.24	R49.71 *	R7.46	
017/ 017	JOURNAL OF INTERNATIONAL ORAL HEALTH DRY NEEDLING FOLLOWED BY 4 WEEKS OF CRANIAL STABILIZATION EXERCISE ON HEALTHRELATED QUALITY OF LIFE IN PATIENTS WITH TEMPOROMANDIBULAR DISORDERS: AN EXPERIMENTAL STUDY (PATRA R.C., KANUNGO B., MOHANTY P.) 169930	2	6	12	R1.24	R49.71 *	R7.46	
018/ 018	INTERNATIONAL JOURNAL OF MEDICAL RESEARCH AND HEALTH SCIENCES DRY NEEDLING IN COMBINATION WITH MUSCULAR INHIBITION TECHNIQUE ON MOUTH FUNCTION AND HEALTH-RELATED QUALITY OF LIFE IN PATIENTS WITH TEMPOROMANDIBULAR DISORDERS: A RANDOMIZED CONTROL TRIAL (PATRA R.C., KAUR S., KANUMGO B.) 169932	2	7	14	R1.24	R49.71 *	R7.46	

019/ 019	INTERNET JOURNAL OF ALLIED HEALTH SCIENCES AND PRACTICE, THE CERVICAL SPINE THRUST JOINT MANIPULATION, EDUCATION, AND A HOME EXERCISE PROGRAM FOR THE MANAGEMENT OF INDIVIDUALS WITH TEMPOROMANDIBULAR DISORDER: A PROSPECTIVE CASE SERIES (REYNOLDS B., BROWN J.L.) 169934	2	1	2	R1.24	R49.71 *	R7.46	
020/ 020	INTERNET JOURNAL OF ALLIED HEALTH SCIENCES AND PRACTICE, THE CERVICAL SPINE THRUST JOINT MANIPULATION, EDUCATION, AND A HOME EXERCISE PROGRAM FOR THE MANAGEMENT OF INDIVIDUALS WITH TEMPOROMANDIBULAR DISORDER: A PROSPECTIVE CASE SERIES (REYNOLDS B., BROWN J.L.) 169934	2	11	22	R1.24	R49.71 *	R7.46	
021/ 021	JOURNAL OF ORAL REHABILITATION EFFECT OF THE ISCHAEMIC COMPRESSION TECHNIQUE ON PAIN AND FUNCTIONALITY IN TEMPOROMANDIBULAR DISORDERS: A RANDOMISED CLINICAL TRIAL, THE (SAHIN D. (et al)) 169939	2	11	22	R1.24	R49.71 *	R7.46	
Item	Title	Units	Pages	Copies	Rate	VAT Excl.	VAT	VAT Incl.
022/ 022	JOURNAL OF ORAL REHABILITATION COMPARISON OF ACUPUNCTURE ON SPECIFIC AND NON-SPECIFIC POINTS FOR THE TREATMENT OF PAINFUL TEMPOROMANDIBULAR DISORDERS: A RANDOMISED CONTROLLED TRIAL (SEN S, (et al)) 169940	2	13	26	R1.24	R49.71 *	R7.46	
023/ 023	JOURNAL OF ORAL REHABILITATION EFFECTS OF EXERCISE THERAPY ON PAINFUL TEMPOROMANDIBULAR DISORDERS (SHIMADA A. (et al)) 169941	2	7	14	R1.24	R49.71 *	R7.46	

024/ 024	JOURNAL OF BODYWORK AND MOVEMENT THERAPIES EFFECTIVENESS OF MANUAL THERAPY AND HOME PHYSICAL THERAPY IN PATIENTS WITH TEMPOROMANDIBULAR DISORDERS: A RANDOMIZED CONTROLLED TRIAL (A.B. (et al)) 169942	2	7	14	R1.24	R49.71 *	R7.46	
025/ 025	INTERNATIONAL JOURNAL OF ENVIRONMENTAL RESEARCH IN PUBLIC HEALTH APPLICATION OF MANUAL TECHNIQUES IN MASTICATORY MUSCLES RELAXATION AS ADJUNCTIVE THERAPY IN THE TREATMENT OF TEMPOROMANDIBULAR JOINT DISORDERS, THE (URBANSKI P., TRYBULEC B., PIHUT M.) 169943	2	15	30	R1.24	R49.71 *	R7.46	
		50	211	422		R1,242.75	R186.50	R1,

* MINIMUM FEE PER TRANSACTIONAL CLEARANCE (R49.71 + VAT)

PLEASE NOTE: DALRO reserves the right to adjust the number of pages copied from a publication in all quotations if the calculation as per the application is found to be incorrect.

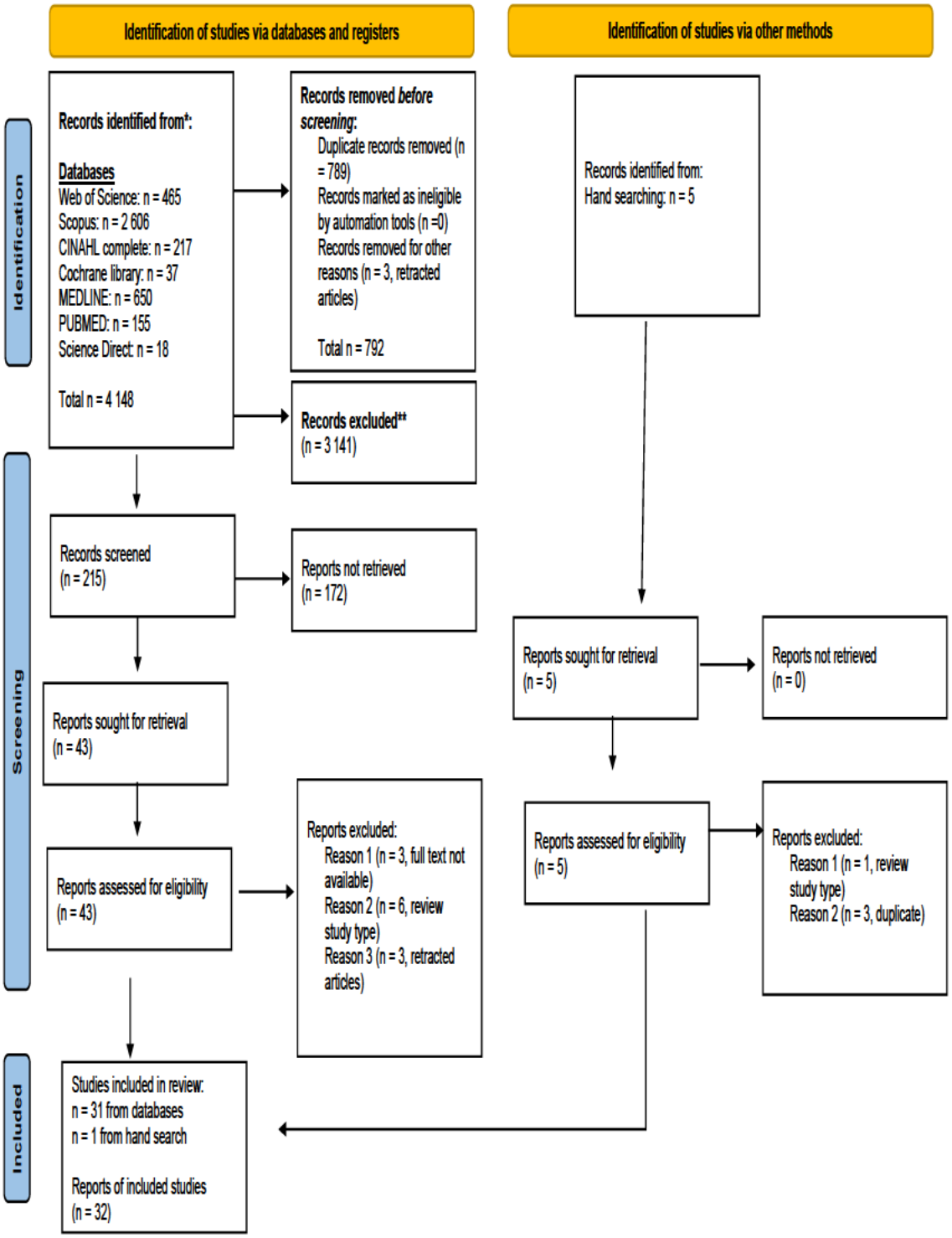
ITEM(S) FOR WHICH REPROGRAPHIC REPRODUCTION RIGHTS CANNOT BE CLEARED THROUGH DALRO

Item	Title	Reason	Comments
001/ 001	Manual therapy, posturology and rehabilitation Journal Effect of manual therapy on pain and electromyographic activity of masticatory muscles in patients with temporomandibular disorders	DALRO DOES NOT CONTROL COPYRIGHT IN WORK	NO AGREEMENT WITH TERRITORY
002/ 002	Journal of applied oral science Effects of cervical mobilization and exercise on pain, movement and function in subjects with temporomandibular disorders: a single group pre-post test	DALRO DOES NOT CONTROL COPYRIGHT IN WORK	NO AGREEMENT WITH TERRITORY

003/ 003	Romanian Journal of Oral Rehabilitation Conservative treatment of temporomandibular disorder using physical therapy	DALRO DOES NOT CONTROL COPYRIGHT IN WORK	NO AGREEMENT WITH TERRITORY
004/ 004	Rawal Medical Journal IMMEDIATE EFFECT OF PROPRIOCEPTIVE NEUROMUSCULAR FACILITATION ON PAIN AND MAXIMAL MOUTH OPENING IN TEMPOROMANDIBULAR DYSFUNCTION: A PILOT STUDY	DALRO DOES NOT CONTROL COPYRIGHT IN WORK	NO AGREEMENT WITH TERRITORY
005/ 005	Journal of the Korean Association of Oral and Maxillofacial Surgeons HOME-BASED EXERCISE PROGRAM FOR TEMPOROMANDIBULAR JOINT OSTEOARTHRITIS: PAIN, FUNCTIONALITY, AND JOINT STRUCTURE, A	DALRO DOES NOT CONTROL COPYRIGHT IN WORK	NO AGREEMENT WITH TERRITORY
006/ 006	Asian Journal of Scientific Research The effect of muscle energy technique on temporomandibular joint dysfunction: A randomized clinical trail	DALRO DOES NOT CONTROL COPYRIGHT IN WORK	NO AGREEMENT WITH TERRITORY
007/ 007	Medical Journal of the Islamic Republic of Iran The Efficacy of Neck and Temporomandibular Joint (TMJ) Manual Therapy in Comparison With a Multimodal Approach in the Patients with TMJ Dysfunction: A Blinded Randomized Controlled Trial	DALRO DOES NOT CONTROL COPYRIGHT IN WORK	NO AGREEMENT WITH TERRITORY

This Quotation is valid for 90 days.

APPENDIX E: PRISMA FLOW CHART



APPENDIX F: SEARCH STRATEGY AND DATABASES

Notes on search strategy for the systematic review

Date: 8 June 2022

Topic: A systematic review of the effectiveness of conservative therapy in the treatment and management of Temporomandibular Joint Disorders.

Search terms:

"Temporomandibular joint disorder*" **OR** "TMJ dysfunction" **OR** TMJD **OR** TMD **OR** TMJ pain **OR** "orofacial pain" **OR** "myofascial pain" **OR** "Jaw pain" **OR** "TMJ clicking"

AND

"Conservative therapy" **OR** "manual therapy" **OR** "physical therapy" OR "exercise" **OR** manipulation **OR** mobilization **OR** adjustment OR Dry needling OR ischemic compression **OR** compression **OR** acupuncture

AND

"Occlusal splints" **OR** splints **OR** "mouth guard" **OR** "bite plate" **OR** "night plate" **OR** rehab* **OR** "stress therapy" **OR** exercise **OR** massage **OR** "electro modalities" **OR** ultrasound **OR** TENS **OR** cryotherapy **OR** "low level laser therapy" **OR** activator **OR** "Traditional Chinese medicine"

Field of search: all fields

Search limits:

- Scholarly and peer-reviewed articles
- Language
- Custom range: 2010 - 2022

Initial Search:

Database 1 – Web of Science (1994 – present)

"Temporomandibular joint disorder*" OR "TMJ dysfunction" OR TMJD OR TMD OR TMJ pain OR "orofacial pain" OR "myofascial pain" OR "Jaw pain" OR "TMJ clicking" (All Fields) and **"Conservative therapy" OR "manual therapy" OR "physical therapy" OR manipulation OR mobilization OR adjustment*** (All Fields) and **"Occlusal splints" OR splints OR "mouth guard" OR "bite plate" OR "night plate" OR rehab* OR "stress therapy" OR exercise OR massage OR "electro modalities" OR ultrasound OR TENS OR cryotherapy OR "low level laser therapy" OR activator OR compression OR acupuncture**

OR "Traditional Chinese medicine" (All Fields) and **2010** or **2011** or **2012** or **2013** or **2014** or **2015** or **2016** or **2017** or **2018** or **2019** or **2020** or **2021** or **2022** (Publication Years) and **Articles** or **Review Articles** or **Early Access** (Document Types) and **English** (Languages)

Search date: 3 June 2022 (465 records found)

Database 2 – Scopus

"Temporomandibular joint disorder*" OR "TMJ dysfunction" OR tmjd OR tmd OR tmj AND pain OR "orofacial pain" OR "myofascial pain" OR "Jaw pain" OR "TMJ clicking " AND "Conservative therapy" OR "manual therapy" OR "physical therapy" OR manipulation OR mobilization OR adjustment* AND "Occlusal splints" OR splints OR "mouth guard" OR "bite plate" OR "night plate" OR rehab* OR "stress therapy" OR exercise OR massage OR "electro modalities" OR ultrasound OR tens OR cryotherapy OR "low level laser therapy" OR activator OR compression OR acupuncture OR "Traditional Chinese medicine" AND (LIMIT-TO (PUBYEAR , 2022) OR LIMIT-TO (PUBYEAR , 2021) OR LIMIT-TO (PUBYEAR , 2020) OR LIMIT-TO (PUBYEAR , 2019) OR LIMIT-TO (PUBYEAR , 2018) OR LIMIT-TO (PUBYEAR , 2017) OR LIMIT-TO (PUBYEAR , 2016) OR LIMIT-TO (PUBYEAR , 2015) OR LIMIT-TO (PUBYEAR , 2014) OR LIMIT-TO (PUBYEAR , 2013) OR LIMIT-TO (PUBYEAR , 2012) OR LIMIT-TO (PUBYEAR , 2011) OR LIMIT-TO (PUBYEAR , 2010)) AND (LIMIT-TO (DOCTYPE , "ar") OR LIMIT-TO (DOCTYPE , "re")) AND (LIMIT-TO (LANGUAGE , "English")) AND (LIMIT-TO (SRCTYPE , "j"))

Search date: 8 June 2022 (2 606 records found)

Database 3 – Ebscohost for CINAHL complete (1961 – present)

("Temporomandibular joint disorder*" OR "TMJ dysfunction" OR TMJD OR TMD OR TMJ pain OR "orofacial pain" OR "myofascial pain" OR "Jaw pain" OR "TMJ clicking") AND ("Conservative therapy" OR "manual therapy" OR "physical therapy" OR manipulation OR mobilization OR adjustment*) AND ("Occlusal splints" OR splints OR "mouth guard" OR "bite plate" OR "night plate" OR rehab* OR "stress therapy" OR exercise OR massage OR "electro modalities" OR ultrasound OR TENS OR cryotherapy OR "low level laser therapy" OR activator OR compression OR acupuncture OR "Traditional Chinese medicine")

Search date: 3 June 2022 (217 records found)

Database 4 – Cochrane library

37 Cochrane Reviews matching **"Temporomandibular joint disorder*" OR "TMJ dysfunction" OR TMJD OR TMD OR TMJ pain OR "orofacial pain" OR "myofascial pain" OR "Jaw pain" OR "TMJ clicking" in All Text AND "Conservative therapy" OR "manual therapy" OR "physical therapy" OR manipulation OR mobilization OR adjustment* in All Text AND "Occlusal splints" OR splints OR "mouth guard" OR "bite plate" OR "night plate" OR rehab* OR "stress therapy" OR exercise OR massage OR "electro modalities" OR ultrasound OR TENS OR cryotherapy OR "low level laser therapy" OR activator OR compression OR acupuncture OR "Traditional Chinese medicine" in All Text - (Word variations have been searched)**

Search date: 3 June 2022 (37 records found)

Database 5 – PubMed (1996 – present)

(("Temporomandibular joint disorder*" OR "TMJ dysfunction" OR TMJD OR TMD OR TMJ pain OR "orofacial pain" OR "myofascial pain" OR "Jaw pain" OR "TMJ clicking") AND ("Conservative therapy" OR "manual therapy" OR "physical therapy" OR manipulation OR mobilization OR adjustment*)) AND ("Occlusal splints" OR splints OR "mouth guard" OR "bite plate" OR "night plate" OR rehab* OR "stress therapy" OR exercise OR massage OR "electro modalities" OR ultrasound OR TENS OR cryotherapy OR "low level laser therapy" OR activator OR compression OR acupuncture OR "Traditional Chinese medicine") Filters: **Full text, Clinical Trial, Randomized Controlled Trial, English, from 2010/1/1 - 2022/12/31**

Search date: 2 June 2022 (155 records found)

Database 6 – Ebscohost for Medline

"Temporomandibular joint disorder*" OR "TMJ dysfunction" OR TMJD OR TMD OR TMJ pain OR "orofacial pain" OR "myofascial pain" OR "Jaw pain" OR "TMJ clicking") AND ("Conservative therapy" OR "manual therapy" OR "physical therapy" OR manipulation OR mobilization OR adjustment*) AND ("Occlusal splints" OR splints OR "mouth guard" OR "bite plate" OR "night plate" OR rehab* OR "stress therapy" OR exercise OR massage OR "electro modalities" OR ultrasound OR TENS OR cryotherapy OR "low level laser therapy" OR activator OR compression OR acupuncture OR "Traditional Chinese medicine")

Search date: 3 June 2022 (650 records found)

Database 7 – ScienceDirect

Conservative therapy in the treatment and management of Temporomandibular Joint Disorders (TMJDs). All text, custom range:2010-2022 **Search date: 3 June 2022 (18 records found)**

Results

Total number of records found = 4 148

Duplicate records = 789

Total number of records after duplicates have been removed = 3 359

Retracted articles = 3, reasons for retractions:

- Error in analysis
- Error in methods
- Unreliable results

Total number of records after retracted articles were removed = 3 356

APPENDIX G: PEDRO SCALE

PEDro scale

---

1. eligibility criteria were specified no yes where:

2. subjects were randomly allocated to groups (in a crossover study, subjects were randomly allocated an order in which treatments were received) no yes where:

3. allocation was concealed no yes where:

4. the groups were similar at baseline regarding the most important prognostic indicators no yes where:

5. there was blinding of all subjects no yes where:

6. there was blinding of all therapists who administered the therapy no yes where:

7. there was blinding of all assessors who measured at least one key outcome no yes where:

8. measures of at least one key outcome were obtained from more than 85% of the subjects initially allocated to groups no yes where:

9. all subjects for whom outcome measures were available received the treatment or control condition as allocated or, where this was not the case, data for at least one key outcome was analysed by "intention to treat" no yes where:

10. the results of between-group statistical comparisons are reported for at least one key outcome no yes where:

11. the study provides both point measures and measures of variability for at least one key outcome no yes where:

The PEDro scale is based on the Delphi list developed by Verhagen and colleagues at the Department of Epidemiology, University of Maastricht (*Verhagen AP et al (1998). The Delphi list: a criteria list for quality assessment of randomised clinical trials for conducting systematic reviews developed by Delphi consensus. Journal of Clinical Epidemiology, 51(12):1235-41*). The list is based on "expert consensus" not, for the most part, on empirical data. Two additional items not on the Delphi list (PEDro scale items 8 and 10) have been included in the PEDro scale. As more empirical data comes to hand it may become possible to "weight" scale items so that the PEDro score reflects the importance of individual scale items.

The purpose of the PEDro scale is to help the users of the PEDro database rapidly identify which of the known or suspected randomised clinical trials (ie RCTs or CCTs) archived on the PEDro database are likely to be internally valid (criteria 2-9), and could have sufficient statistical information to make their results interpretable (criteria 10-11). An additional criterion (criterion 1) that relates to the external validity (or "generalisability" or "applicability" of the trial) has been retained so that the Delphi list is complete, but this criterion will not be used to calculate the PEDro score reported on the PEDro web site.

The PEDro scale should not be used as a measure of the "validity" of a study's conclusions. In particular, we caution users of the PEDro scale that studies which show significant treatment effects and which score highly on the PEDro scale do not necessarily provide evidence that the treatment is clinically useful. Additional considerations include whether the treatment effect was big enough to be clinically worthwhile, whether the positive effects of the treatment outweigh its negative effects, and the cost-effectiveness of the treatment. The scale should not be used to compare the "quality" of trials performed in different areas of therapy, primarily because it is not possible to satisfy all scale items in some areas of physiotherapy practice.

Last amended June 21st, 1999 **Notes on administration of the PEDro scale:**

All criteria	**Points are only awarded when a criterion is clearly satisfied**. If on a literal reading of the trial report it is possible that a criterion was not satisfied, a point should not be awarded for that criterion.
Criterion 1	This criterion is satisfied if the report describes the source of subjects and a list of criteria used to determine who was eligible to participate in the study.
Criterion 2	A study is considered to have used random allocation if the report states that allocation was random. The precise method of randomisation need not be specified. Procedures such as coin-tossing and dice-rolling should be considered random. Quasi-randomisation allocation procedures such as allocation by hospital record number or birth date, or alternation, do not satisfy this criterion.
Criterion 3	*Concealed allocation* means that the person who determined if a subject was eligible for inclusion in the trial was unaware, when this decision was made, of which group the subject would be allocated to. A point is awarded for this criteria, even if it is not stated that allocation was concealed, when the report states that allocation was by sealed opaque envelopes or that allocation involved contacting the holder of the allocation schedule who was "off-site".
Criterion 4	At a minimum, in studies of therapeutic interventions, the report must describe at least one measure of the severity of the condition being treated and at least one (different) key outcome measure at baseline. The rater must be satisfied that the groups' outcomes would not be expected to differ, on the basis of baseline differences in prognostic variables alone, by a clinically significant amount. This criterion is satisfied even if only baseline data of study completers are presented.
Criteria 4, 7-11	*Key outcomes* are those outcomes which provide the primary measure of the effectiveness (or lack of effectiveness) of the therapy. In most studies, more than one variable is used as an outcome measure.
Criterion 5-7	*Blinding* means the person in question (subject, therapist or assessor) did not know which group the subject had been allocated to. In addition, subjects and therapists are only considered to be "blind" if it could be expected that they would have been unable to distinguish between the treatments applied to different groups. In trials in which key outcomes are self-reported (eg, visual analogue scale, pain diary), the assessor is considered to be blind if the subject was blind.
Criterion 8	This criterion is only satisfied if the report explicitly states *both* the number of subjects initially allocated to groups *and* the number of subjects from whom key outcome measures were obtained. In trials in which outcomes are measured at several points in time, a key outcome must have been measured in more than 85% of subjects at one of those points in time.
Criterion 9	An *intention to treat* analysis means that, where subjects did not receive treatment (or the control condition) as allocated, and where measures of outcomes were available, the analysis was performed as if subjects received the treatment (or control condition) they were allocated to. This criterion is satisfied, even if there is no mention of analysis by intention to treat, if the report explicitly states that all subjects received treatment or control conditions as allocated.

Criterion 10 A *between-group* statistical comparison involves statistical comparison of one group with another. Depending on the design of the study, this may involve comparison of two or more treatments, or comparison of treatment with a control condition. The analysis may be a simple comparison of outcomes measured after the treatment was administered, or a comparison of the change in one group with the change in another (when a factorial analysis of variance has been used to analyse the data, the latter is often reported as a group × time interaction). The comparison may be in the form hypothesis testing (which provides a "p" value, describing the probability that the groups differed only by chance) or in the form of an estimate (for example, the mean or median difference, or a difference in proportions, or number needed to treat, or a relative risk or hazard ratio) and its confidence interval.

Criterion 11 A *point measure* is a measure of the size of the treatment effect. The treatment effect may be described as a difference in group outcomes, or as the outcome in (each of) all groups. *Measures of variability* include standard deviations, standard errors, confidence intervals, interquartile ranges (or other quantile ranges), and ranges. Point measures and/or measures of variability may be provided graphically (for example, SDs may be given as error bars in a Figure) as long as it is clear what is being graphed (for example, as long as it is clear whether error bars represent SDs or SEs). Where outcomes are categorical, this criterion is considered to have been met if the number of subjects in each category is given for each group.

APPENDIX H: NOS SCALE

NEWCASTLE - OTTAWA QUALITY ASSESSMENT SCALE
NON-RANDOMIZED CONTROL STUDIES

Non-Randomised Studies

The Newcastle-Ottawa is composed of eight questions that pertain to the following three categories: selection, comparability and exposure.

For the selection and exposure sections, one response per question is required (a, b, or c, etc.) For the comparability section, multiple or no responses can be made.

One star can be presented per question, except comparability, where two stars may be awarded. The maximum amount of stars that a study can be awarded is nine stars.

Should a study contain only one group of subjects, comparability cannot be done, and should be omitted from the scale.

Reference:

Stang, A.2010.Critical evaluation of the Newcastle-Ottawa scale for the assessment of the quality of nonrandomized studies in meta-analyses. European Journal of Epidemiology. 25(9): 603-605.

Reviewer:	
Article Title:	

Note: A study can be awarded a maximum of one star for each numbered item within the Selection and Exposure categories. A maximum of two stars can be given for Comparability.

Selection

1) Is the case definition adequate?

a) yes, with independent validation ★
b) yes, eg record linkage or based on self reports
c) no description

2) Representativeness of the cases

a) consecutive or obviously representative series of cases ★
b) potential for selection biases or not stated

3) Selection of Controls

a) community controls ★
b) hospital controls
c) no description

4) Definition of Controls

a) no history of disease (endpoint) ★
b) no description of source

Comparability

1) Comparability of cases and controls on the basis of the design or analysis

a) study controls for _____ (Select the most important factor.) ★
b) study controls for any additional factor ★ (This criteria could be modified to indicate specific control for a second important factor.)

Exposure

1) Ascertainment of exposure

a) secure record (eg surgical records) ★
b) structured interview where blind to case/control status ★
c) interview not blinded to case/control status
d) written self report or medical record only
e) no description

2) Same method of ascertainment for cases and controls

a) yes ★
b) no

3) Non-Response rate

a) same rate for both groups ★
b) non respondents described
c) rate different and no designation

APPENDIX I: LIDDLE SCALE

Liddle scale checklist 2 of 5 composed of three sections to be completed by the reviewer:

Section one: descriptive information regarding the study

Include authors and publication year, study intervention, outcomes, study population and groups in the study (Liddle, Williamson and Irwig 1996).

Section two: evaluation criteria

Include main study components, study quality evaluation, guidelines, risk factors, accuracy of diagnostic tests and guideline recommendations. Codes for the evaluation criteria to be used are outlined in table two. The codes are descriptive and not necessarily a quantitative scoring system (Liddle, Williamson and Irwig 1996).

Section three: Overall assessment of the study

Assess and code the overall quality of the study using the codes in Table 3. For study quality code as A, B1, B2, C as these codes are proposed to be compatible with those of the Cochrane Collaboration (Liddle, Williamson and Irwig 1996).

Table 1: Coding for evaluation criteria

Evaluation criteria are coded according to the extent to which the criteria are fulfilled	**Code**
Criterion entirely fulfilled A	A
Criterion mostly fulfilled	b 1
Criterion mostly not fulfilled	b 2
Criterion not at all fulfilled	C

Criterion not described adequately to classify as	a, b1, b2 or c
Criterion not applicable	n/a

Table 2: Codes for overall assessment of quality of study checklists

Low risk of bias	A	All or most evaluation criteria from the checklist are fulfilled. Where evaluation criteria are not fulfilled, the conclusions of the study or review are thought very unlikely to alter.
Low to moderate risk of bias	B1	Some evaluation criteria from the checklist are fulfilled. Where evaluation criteria are not fulfilled or are not adequately described, the conclusions of the study or review are thought unlikely to alter.
Moderate to high risk of bias	B2	Some evaluation criteria from the checklist are fulfilled. Where evaluation criteria are not fulfilled or are not adequately described, the conclusions of the study or review are thought likely to alter.
High risk of bias	C	Few or no evaluation criteria fulfilled. Where evaluation criteria are not fulfilled or are not adequately described, the conclusions of the study or review are thought very likely to alter.

Table 3: The effect of interventions

Reviewer	
Article	

DESCRIPTIVE INFORMATION	NOTES	DESCRIPTION	CODE OPTIONS a, b1, b2, c, ?, n/a
Study Identification	Include author, title, reference and year of publication (if available) and the study timeframe.		
How is the study type described?	Randomised Controlled Trials (RCT), Non-Randomised Control Trials (N1RCS), Cohorts, Before and After Studies (BAS) with/without controls, Case Control Studies (C-CS) - define whether population- or hospital- based case control study.		
What interventions are considered and how are they implemented?			
Is the intervention aimed at individuals or populations?	For example, drug trial (for individuals), mass media campaign (for populations)		
What outcomes are considered?	I.e., benefits and harms		
What factors other than the intervention could affect the outcome?	Include potential confounding factors, differences in baseline characteristics between intervention and control groups.		

What are the characteristics of the population and study setting?	Population characteristics, e.g., age, sex, disease characteristics of the population, disease prevalence. Study setting, e.g., rural, urban, hospital inpatient or outpatient, general practice, community.		
How many groups/sites in the study?			

Adapted from Checklist 2 - Studies assessing the effect of interventions (Liddle, Williamson and Irwig 1996)

APPENDIX J: MASTER LIST

	Author/s	Year	Title	Reference	Study type
1	Asha, V., Kannan, R. and Jacob, T.	2015	A Novel Case of Orofacial Pain Treated by Dry Needling Technique - A Case Report	Asha, V., Kannan, R. and Jacob, T. 2015. A novel case of orofacial pain treated by dry needling technique-A case report. *Dentistry*, 5 (319): 2161	Case report
2	Bae, Y. and Park, Y.	2013	The Effect of Relaxation Exercises for the Masticator Muscles on Temporomandibular Joint Dysfunction (TMD)	Bae, Y. and Park, Y. 2013. The Effect of Relaxation Exercises for the Masticator Muscles on Temporomandibular Joint Dysfunction (TMD). *Journal of Physical Therapy Science*, 25 (5): 583-586.	RCT
3	Bageston de Britto, P., Bisi, M. A. and Dhein, W.	2019	Effect of manual therapy on pain and electromyographic activity of masticatory muscles in patients with temporomandibular disorders.	Bageston de Britto, P., Bisi, M. A. and Dhein, W. 2019. Effect of manual therapy on pain and electromyographic activity of masticatory muscles in patients with temporomandibular disorders. *Manual Therapy, Posturology & Rehabilitation Journal*, 17: 1-7.	NRCT
4	Barbosa, M. A., Tahara, A. K., Ferreira, I. C., Intelangelo, L. and Barbosa, A. C.	2019	Effects of 8 weeks of masticatory muscles focused endurance exercises on women with oro-facial pain and temporomandibular disorders: A placebo randomised controlled trial	Barbosa, M. A., Tahara, A. K., Ferreira, I. C., Intelangelo, L. and Barbosa, A. C. 2019. Effects of 8 weeks of masticatory muscles focused endurance exercises on women with oro-facial pain and temporomandibular disorders: A placebo randomised controlled trial. *Journal of Oral Rehabilitation* 46(10): 885-894. Available: https://onlinelibrary.wiley.com/doi/epdf/10.1111/joor.12823 (Accessed 22 September 2022).	RCT
5	Barone, M., Imaz, F., Converso, G., Bordachar, D., Barbero, A., Trucco, M. and Intelangelo, L.	2021	Immediate effects of rhythmic joint mobilization of the temporomandibular joint on pain, mouth opening and electromyographic activity in patients with temporomandibular disorders.	Barone, M., Imaz, F., Converso, G., Bordachar, D., Barbero, A., Trucco, M. and Intelangelo, L. 2021. Immediate effects of rhythmic joint mobilization of the temporomandibular joint on pain, mouth opening and electromyographic activity in patients with temporomandibular disorders. *Journal of Bodywork and Movement Therapies*, 28: 563-569.	NRCT
6	Calixtre, L. B., Gruninger, B. L. D., Haik, M. N., Alburquerque-	2016	Effects of cervical mobilization and exercise on pain, movement and function in subjects with	Calixtre, L. B., Gruninger, B. L. D., Haik, M. N., Alburquerque-Sendin, F. and Oliveira, A. B. 2016. Effects of cervical mobilization and exercise on pain, movement and function in subjects with temporomandibular	NRCT

	Sendin, F. and Oliveira, A. B		temporomandibular disorders: a single group pre-post test.	disorders: a single group pre-post test. *Journal of Applied Oral Science*, 24 (3): 188-197.	
7	Calixtre, L. B., Oliveira, A. B., de Sena Rosa, L. R., Armijo-Olivo, S., Visscher, C. M. and Alburquerque-Sendín, F.	2019	Effectiveness of mobilisation of the upper cervical region and craniocervical flexor training on orofacial pain, mandibular function and headache in women with TMD. A randomised, controlled trial	Calixtre, L. B., Oliveira, A. B., de Sena Rosa, L. R., Armijo-Olivo, S., Visscher, C. M. and Alburquerque-Sendín, F. 2019. Effectiveness of mobilisation of the upper cervical region and craniocervical flexor training on orofacial pain, mandibular function and headache in women with TMD. A randomised, controlled trial. *J Oral Rehabil*, 46 (2): 109-119.	RCT
8	Calixtre, L. B., Rezende, M. A., Kamonseki, D. H. and de Oliveira, A. B.	2021	Effects of myofascial release applied to neck muscles and craniocervical flexor training in patients with chronic myofascial TMD: A single arm study.	Calixtre, L. B., Rezende, M. A., Kamonseki, D. H. and de Oliveira, A. B. 2021. Effects of myofascial release applied to neck muscles and craniocervical flexor training in patients with chronic myofascial TMD: A single arm study. *International Journal of Osteopathic Medicine*, 41: 4-10.	NRCT
9	Corum, M., Basoglu, C., Topaloglu, M., Diracoglu, D. and Aksoy, C.	2018	Spinal high-velocity low-amplitude manipulation with exercise in women with chronic temporomandibular disorders. A randomized controlled trial comparing to patient education	Corum, M., Basoglu, C., Topaloglu, M., Diracoglu, D. and Aksoy, C. 2018. Spinal high-velocity low-amplitude manipulation with exercise in women with chronic temporomandibular disorders. A randomized controlled trial comparing to patient education. *Manuelle Medizin*, 56 (3): 230-238.	RCT
10	de la Serna, P. D., Plaza-Manzano, G., Cleland, J., Fernandez-de-las-Penas, C., Martin-Casas, P. and Diaz-Arribas, M. J.	2020	Effects of Cervico-Mandibular Manual Therapy in Patients with Temporomandibular Pain Disorders and Associated Somatic Tinnitus: A Randomized Clinical Trial.	de la Serna, P. D., Plaza-Manzano, G., Cleland, J., Fernandez-de-las-Penas, C., Martin-Casas, P. and Diaz-Arribas, M. J. 2020. Effects of Cervico-Mandibular Manual Therapy in Patients with Temporomandibular Pain Disorders and Associated Somatic Tinnitus: A Randomized Clinical Trial. *Pain Medicine*, 21 (3): 613-624.	RCT
11	Dib-Zakkour, J., Flores-Fraile, J., Montero-Martin, J., Dib-Zakkour, S. and Dib-Zaitun, I.	2022	Evaluation of the Effectiveness of Dry Needling in the Treatment of Myogenous Temporomandibular Joint Disorders.	Dib-Zakkour, J., Flores-Fraile, J., Montero-Martin, J., Dib-Zakkour, S. and Dib-Zaitun, I. 2022. Evaluation of the Effectiveness of Dry Needling in the Treatment of Myogenous Temporomandibular Joint Disorders. *Medicina (Lithuania)*, 58 (2)	RCT
12	Dunning, J., Butts, R., Bliton, P., Vathrakokoilis, K., Smith, G.,	2022	Dry needling and upper cervical spinal manipulation in patients with temporomandibular	Dunning, J., Butts, R., Bliton, P., Vathrakokoilis, K., Smith, G., Lineberger, C., Eshleman, N., Fernández-de-Las-Peñas, C. and Young, I. A. 2022. Dry needling and upper cervical spinal manipulation in	RCT

	Lineberger, C., Eshleman, N., Fernández-de-Las-Peñas, C. and Young, I. A.		disorder: A multi-center randomized clinical trial.	patients with temporomandibular disorder: A multi-center randomized clinical trial. *Cranio: the journal of craniomandibular practice*: 1-14.	
13	Ergezen, G., Atilgan, E. and Kilicaslan, A.	2022	Immediate effect of proprioceptive neuromuscular facilitation on pain and maximal mouth opening in temporomandibular dysfunction: A pilot study	Ergezen, G., Atilgan, E. and Kilicaslan, A. 2022. Immediate effect of proprioceptive neuromuscular facilitation on pain and maximal mouth opening in temporomandibular dysfunction: A pilot study. *Rawal Medical Journal*, 47 (1): 125-128.	NRCT
14	Garrigós-Pedrón, M., Touche, R. L., Navarro-Desentre, P., Gracia-Naya, M. and Segura-Ortí, E.	2018	Effects of a physical therapy protocol in patients with chronic migraine and temporomandibular disorders: A randomized, single-blinded, clinical trial.	Garrigós-Pedrón, M., Touche, R. L., Navarro-Desentre, P., Gracia-Naya, M. and Segura-Ortí, E. 2018. Effects of a physical therapy protocol in patients with chronic migraine and temporomandibular disorders: A randomized, single-blinded, clinical trial. *Journal of Oral and Facial Pain and Headache*, 32 (2): 137-150.	RCT
15	González-Iglesias, J., Cleland, J.A., Neto, F., Hall, T. and Fernández-De-Las-Peñas, C.	2013	Mobilization with movement, thoracic spine manipulation, and dry needling for the management of temporomandibular disorder: A prospective case series	González-Iglesias, J., Cleland, J.A., Neto, F., Hall, T. and Fernández-De-Las-Peñas, C., 2013. Mobilization with movement, thoracic spine manipulation, and dry needling for the management of temporomandibular disorder: a prospective case series. *Physiotherapy theory and practice*, *29*(8), pp.586-595.	Case series
16	Häggman-Henrikson, B., Wiesinger, B. and Wänman, A.,	2018	The effect of supervised exercise on localized TMD pain and TMD pain associated with generalized pain	Häggman-Henrikson, B., Wiesinger, B. and Wänman, A., 2018. The effect of supervised exercise on localized TMD pain and TMD pain associated with generalized pain. *Acta Odontologica Scandinavica*, *76*(1), pp.6-12.	NRCT
17	Kulesa-Mrowiecka, M., Piech, J. and Gaździk, T. S.	2021	The effectiveness of physical therapy in patients with generalized joint hypermobility and concurrent temporomandibular disorders—A cross-sectional study.	Kulesa-Mrowiecka, M., Piech, J. and Gaździk, T. S. 2021. The effectiveness of physical therapy in patients with generalized joint hypermobility and concurrent temporomandibular disorders—A cross-sectional study. *Journal of Clinical Medicine*, 10 (17)	NRCT
18	Lopez-Martos, R., Gonzalez-Perez, L. M., Ruiz-Canela-Mendez, P., Urresti-Lopez, F. J.,	2018	Randomized, double-blind study comparing percutaneous electrolysis and dry needling for the management of	Lopez-Martos, R., Gonzalez-Perez, L. M., Ruiz-Canela-Mendez, P., Urresti-Lopez, F. J., Gutierrez-Perez, J. L. and Infante-Cossio, P. 2018. Randomized, double-blind study comparing percutaneous electrolysis and dry needling for the management of temporomandibular myofascial pain. *Medicina Oral Patologia Oral y Cirugia Bucal*, 23 (4): e454-e462.	RCT

	Gutierrez-Perez, J. L. and Infante-Cossio, P.		temporomandibular myofascial pain.		
19	Macías-Hernández, S. I., Morones-Alba, J. D., Tapia-Ferrusco, I., Vélez-Gutiérrez, O. B., Hernández-Diaz, C., Nava-Bringas, T. I., Cruz-Medina, E., Toro, L. C. and Soria-Bastida, M.	2022	A home-based exercise program for temporomandibular joint osteoarthritis: pain, functionality, and joint structure	Macías-Hernández, S. I., Morones-Alba, J. D., Tapia-Ferrusco, I., Vélez-Gutiérrez, O. B., Hernández-Diaz, C., Nava-Bringas, T. I., Cruz-Medina, E., Toro, L. C. and Soria-Bastida, M. 2022. A home-based exercise program for temporomandibular joint osteoarthritis: pain, functionality, and joint structure. *Journal of the Korean Association of Oral and Maxillofacial Surgeons*, 48 (1): 50-58.	NRCT
20	Moleirinho-Alves, P., Almeida, A., Exposto, F. G., Oliveira, R. and Pezarat-Correia, P. L.	2021	Effects of therapeutic exercise and aerobic exercise programmes on pain, anxiety and oral health-related quality of life in patients with temporomandibular disorders.	Moleirinho-Alves, P., Almeida, A., Exposto, F. G., Oliveira, R. and Pezarat-Correia, P. L. 2021. Effects of therapeutic exercise and aerobic exercise programmes on pain, anxiety and oral health-related quality of life in patients with temporomandibular disorders. *Journal of Oral Rehabilitation*, 48 (11): 1201-1209.	NRCT
21	Nagata, K., Hori, S., Mizuhashi, R., Yokoe, T., Atsumi, Y., Nagai, W. and Goto, M.	2019	Efficacy of mandibular manipulation technique for temporomandibular disorders patients with mouth opening limitation: a randomized controlled trial for comparison with improved multimodal therapy.	Nagata, K., Hori, S., Mizuhashi, R., Yokoe, T., Atsumi, Y., Nagai, W. and Goto, M. 2019. Efficacy of mandibular manipulation technique for temporomandibular disorders patients with mouth opening limitation: a randomized controlled trial for comparison with improved multimodal therapy. *J Prosthodont Res*, 63 (2): 202-209.	RCT
22	Packer, A. C., Pires, P. F., Dibai-Filho, A. V. and Rodrigues-Bigaton, D.	2015	Effect of upper thoracic manipulation on mouth opening and electromyographic activity of masticatory muscles in women with temporomandibular disorder: a randomized clinical trial	Packer, A. C., Pires, P. F., Dibai-Filho, A. V. and Rodrigues-Bigaton, D. 2015. Effect of upper thoracic manipulation on mouth opening and electromyographic activity of masticatory muscles in women with temporomandibular disorder: a randomized clinical trial. *J Manipulative Physiol Ther*, 38 (4): 253-261.	RCT
23	Patra, R., Kanungo, B. and Mohanty, P.	2020	Dry needling followed by 4 weeks of cranial stabilization exercise on health-related quality of life in patients with	Patra, R., Kanungo, B. and Mohanty, P. 2020. Dry needling followed by 4 weeks of cranial stabilization exercise on health-related quality of life in patients with temporomandibular disorders: An experimental study. *Journal of International Oral Health*, 12 (6): 540-545.	RCT

			temporomandibular disorders: An experimental study.		
24	Patra, R. C., Kaur, S. and Kanungo, B.	2021	Dry Needling in Combination with Muscular Inhibition Technique on Mouth Function and Health-Related Quality of Life in Patients with Temporomandibular Disorders: A Randomized Control trial.	Patra, R. C., Kaur, S. and Kanungo, B. 2021. Dry Needling in Combination with Muscular Inhibition Technique on Mouth Function and Health-Related Quality of Life in Patients with Temporomandibular Disorders: A Randomized Control trial. *International Journal of Medical Research & Health Sciences*, 10 (2): 1-7.	RCT
25	Rajadurai, V.	2011	The effect of muscle energy technique on temporomandibular joint dysfunction: A randomized clinical trail.	Rajadurai, V. 2011. The effect of muscle energy technique on temporomandibular joint dysfunction: A randomized clinical trail. *Asian Journal of Scientific Research*, 4 (1): 71-77.	RCT
26	Reynolds, B. and Brown, J. L.	2020	Cervical Spine Thrust Joint Manipulation, Education, and a Home Exercise Program for the Management of Individuals with Temporomandibular Disorder: A Prospective Case Series.	Reynolds, B. and Brown, J. L. 2020. Cervical Spine Thrust Joint Manipulation, Education, and a Home Exercise Program for the Management of Individuals with Temporomandibular Disorder: A Prospective Case Series. *Internet Journal of Allied Health Sciences and Practice*, 18 (4): 13.	Case series
27	Reynolds, B., Puentedura, E. J., Kolber, M. J. and Cieland, J. A.	2020	Effectiveness of Cervical Spine High- Velocity, Low-Amplitude Thrust Added to Behavioral Education, Soft Tissue Mobilization, and Exercise for People With Temporomandibular Disorder With Myalgia: A Randomized Clinical Trial.	Reynolds, B., Puentedura, E. J., Kolber, M. J. and Cieland, J. A. 2020. Effectiveness of Cervical Spine High- Velocity, Low-Amplitude Thrust Added to Behavioral Education, Soft Tissue Mobilization, and Exercise for People With Temporomandibular Disorder With Myalgia: A Randomized Clinical Trial. *Journal of Orthopaedic & Sports Physical Therapy*, 50 (8): 455-465.	RCT
28	Rezaie, K., Amiri, A., Takamjani, E. E., Shirani, G., Salehi, S. and Alizadeh, L.	2022	The Efficacy of Neck and Temporomandibular Joint (TMJ) Manual Therapy in Comparison With a Multimodal Approach in the Patients with TMJ Dysfunction: A Blinded Randomized Controlled Trial.	Rezaie, K., Amiri, A., Takamjani, E. E., Shirani, G., Salehi, S. and Alizadeh, L. 2022. The Efficacy of Neck and Temporomandibular Joint (TMJ) Manual Therapy in Comparison With a Multimodal Approach in the Patients with TMJ Dysfunction: A Blinded Randomized Controlled Trial. *Medical Journal of the Islamic Republic of Iran*, 36 (1)	RCT
29	Şahin, D., Kaya Mutlu, E., Şakar, O.,	2021	The effect of the ischaemic compression technique on pain	Şahin, D., Kaya Mutlu, E., Şakar, O., Ateş, G., İnan, Ş. and Taşkıran, H. 2021. The effect of the ischaemic compression technique on pain and	RCT

	Ateş, G., İnan, Ş. and Taşkıran, H.		and functionality in temporomandibular disorders: A randomised clinical trial.	functionality in temporomandibular disorders: A randomised clinical trial. *Journal of Oral Rehabilitation*, 48 (5): 531-541.	
30	Şen, S., Orhan, G., Sertel, S., Schmitter, M., Schindler, H. J., Lux, C. J. and Giannakopoulos, N. N.	2020	Comparison of acupuncture on specific and non-specific points for the treatment of painful temporomandibular disorders: A randomised controlled trial.	Şen, S., Orhan, G., Sertel, S., Schmitter, M., Schindler, H. J., Lux, C. J. and Giannakopoulos, N. N. 2020. Comparison of acupuncture on specific and non-specific points for the treatment of painful temporomandibular disorders: A randomised controlled trial. *Journal of Oral Rehabilitation* 47(7): 783-795.	RCT
31	Tuncer, A. B., Ergun, N., Tuncer, A. H. and Karahan, S.	2013	Effectiveness of manual therapy and home physical therapy in patients with temporomandibular disorders: A randomized controlled trial	Tuncer, A. B., Ergun, N., Tuncer, A. H. and Karahan, S. 2013. Effectiveness of manual therapy and home physical therapy in patients with temporomandibular disorders: A randomized controlled trial. *J Bodyw Mov Ther*, 17 (3): 302-308.	RCT
32	Urbański, P., Trybulec, B. and Pihut, M.	2021	The Application of Manual Techniques in Masticatory Muscles Relaxation as Adjunctive Therapy in the Treatment of Temporomandibular Joint Disorders	Urbański, P., Trybulec, B. and Pihut, M. 2021. The Application of Manual Techniques in Masticatory Muscles Relaxation as Adjunctive Therapy in the Treatment of Temporomandibular Joint Disorders. *Int J Environ Res Public Health*, 18 (24)	NRCT

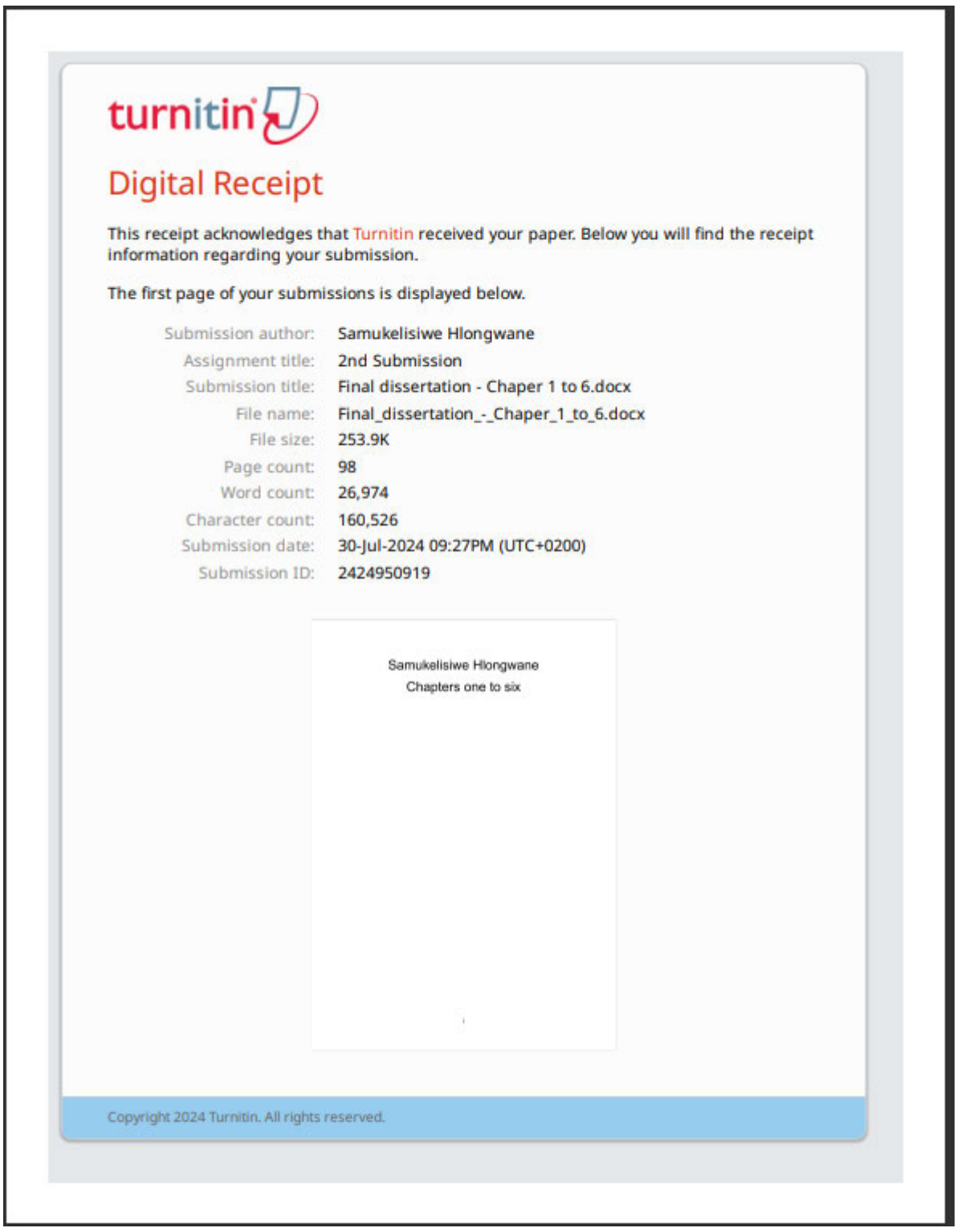
APPENDIX K: PRISMA CHECKLIST

Section and Topic	Item #	Checklist item	Location where item is reported
TITLE			
Title	1	Identify the report as a systematic review.	
ABSTRACT			
Abstract	2	See the PRISMA 2020 for Abstracts checklist.	
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	
Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	
METHODS			
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	
Information sources	6	Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.	
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used.	
Selection process	8	Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process.	
Data collection process	9	Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process.	
Data items	10a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which results to collect.	
	10b	List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information.	
Study risk of bias assessment	11	Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process.	
Effect measures	12	Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results.	
Synthesis methods	13a	Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)).	
	13b	Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions.	

Section and Topic	Item #	Checklist item	Location where item is reported
	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.	
	13d	Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used.	
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression).	
	13f	Describe any sensitivity analyses conducted to assess robustness of the synthesized results.	
Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases).	
Certainty assessment	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.	
RESULTS			
Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram.	
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.	
Study characteristics	17	Cite each included study and present its characteristics.	
Risk of bias in studies	18	Present assessments of risk of bias for each included study.	
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots.	
Results of syntheses	20a	For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies.	
	20b	Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.	
	20c	Present results of all investigations of possible causes of heterogeneity among study results.	
	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.	
Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.	
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.	
DISCUSSION			
Discussion	23a	Provide a general interpretation of the results in the context of other evidence.	
	23b	Discuss any limitations of the evidence included in the review.	

Section and Topic	Item #	Checklist item	Location where item is reported
	23c	Discuss any limitations of the review processes used.	
	23d	Discuss implications of the results for practice, policy, and future research.	
OTHER INFORMATION			
Registration and protocol	24a	Provide registration information for the review, including register name and registration number, or state that the review was not registered.	
	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.	
	24c	Describe and explain any amendments to information provided at registration or in the protocol.	
Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review.	
Competing interests	26	Declare any competing interests of review authors.	
Availability of data, code and other materials	27	Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review.	

PLAGIARISM REPORT



turnitin

Digital Receipt

This receipt acknowledges that Turnitin received your paper. Below you will find the receipt information regarding your submission.

The first page of your submissions is displayed below.

Submission author:	Samukelisiwe Hlongwane
Assignment title:	2nd Submission
Submission title:	Final dissertation - Chaper 1 to 6.docx
File name:	Final_dissertation_-_Chaper_1_to_6.docx
File size:	253.9K
Page count:	98
Word count:	26,974
Character count:	160,526
Submission date:	30-Jul-2024 09:27PM (UTC+0200)
Submission ID:	2424950919

Samukelisiwe Hlongwane
Chapters one to six

Final dissertation - Chaper 1 to 6.docx

ORIGINALITY REPORT

4%	3%	2%	2%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	elaw.org Internet Source	1%
2	"Evidence-based Paediatrics", Wiley, 2004 Publication	<1%
3	(7-17-15) http://196.21.61.18/bitstream/handle/10321/1109/HARI sequence=1&isAllowed=y Internet Source	<1%
4	listens.online Internet Source	<1%
5	Greg Wilkie, Ziad Al-Ani. "Temporomandibular joint anatomy, function and clinical relevance", British Dental Journal, 2022 Publication	<1%
6	Shawn Marshall, Robert Teasell, Nestor Bayona, Corbin Lippert et al. "Motor impairment rehabilitation post acquired brain injury", Brain Injury, 2009 Publication	<1%
7	ia902908.us.archive.org Internet Source	