GLOBAL BURDEN OF TEMPOROMANDIBULAR DISORDER (TMD): A SYSTEMATIC REVIEW OF TMD PREVALENCE AND INCIDENCE (1990- January 2019)

Rashmi Mishra

A thesis

submitted in partial fulfillment of the

requirements for the degree of

Master of Science in Dentistry

University of Washington

2019

Committee:

Mark T. Drangsholt

Linda LeResche

Nicholas Kassebaum

Program Authorized to Offer Degree:

Oral Medicine

University of Washington

Abstract

Global Burden of TMD: A Systematic Review of TMD Prevalence and Incidence (1990- January 2019)

Rashmi Mishra

Chair of the Supervisory Committee:

Mark T. Drangsholt DDS, PhD

Department of Oral Medicine

Background: Temporomandibular disorder (TMD) is a common pain condition experienced mainly by young and middle-aged women. Depression, multiple pain conditions, and gender, along with bruxism, exogenous hormones, trauma, and hypermobility, appear to be associated with risk factors. The change in the proportion of persons complaining of TMD pain and seeking care over the last few decades is not known. TMD diagnostic systems that are reliable, accurate, and predictive are currently available, but the uncoordinated use of four or five different systems may have stymied research efforts. The TMD prevalence at the population level is still a matter of debate, owing to the heterogeneity in the diagnostic criteria adopted in different investigations. Therefore, this review

aims to summarize relevant findings and trends related to TMD pain according to different diagnostic systems and provide a summary of the global prevalence and incidence of TMD pain. This project will be the first step towards calculating the global burden for TMD pain, which, in turn, would be helpful in prevention and policies for the future. This has not been performed in a systematic way to date, but insights from recent rounds of the Global Burden of Disease study in relation to other common pain conditions such as low back pain and neck pain provide pointers to the steps that need to be taken to achieve this goal.

Aim: To summarize and systematically review the peer-reviewed literature on the TMD pain prevalence and incidence reported in studies adopting different diagnostic systems.

Methods: Papers were identified through a systematic search and review process. RDC/TMD Axis I criteria were considered as the reference definition for TMD pain. Studies that used other standards or interpretations that reported and or verified pain in the muscles of mastication and/or jaw pain were included. The studies included those in which TMD was diagnosed by a trained examiner or identified through questionnaires (either self-administered or by research staff). One senior graduate student in oral medicine (Ishraq Alshanqiti) was trained to assess the data and do the screening of articles based on inclusion

criteria after reaching interrater reliability of kappa=0.8 (between R.M. and I.A.). Differences among the two reviewers were resolved by discussion, rereading, and consultation with the orofacial pain expert (M.D.) when necessary.

The following data/information was recorded from each of the selected papers by R.M., with input from M.D., for analysis and discussion: sample size and demographic features (age, sex, population); prevalence of TMD pain, incidence of TMD pain, the diagnostic system utilized.

Results: Seventy-five (n =75) papers were included in the review, 67 dealing with prevalence on TMD pain and eight on the incidence of TMD pain. The most common diagnostic system used was RDC/TMD. Prevalence reports were highly variable across studies, even among those using the same diagnostic system. For children, the range of prevalence of TMD pain was 0.2% to 28%. In general, pain in the temporomandibular joint (TMJ) varied from 0.7% to 4%, depending upon the age. For adults, general prevalence estimates ranged from 2% to 8% for males and 4% to 15% for females. Myofascial pain was the most frequent diagnosis in TMD pain. The incidence of TMD pain was reported in a narrow range from 2.0% to 4.5% per year.

Conclusions: Although the range of prevalence was wide, TMD pain was shown to be a common pain condition in both children and adults. Descriptive

epidemiologic studies of TMD pain can be enhanced by following the usual methods in epidemiologic research, such as reporting age and gender-specific prevalence and establishing standardized self-report definitions.

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ACKNOWLEDGMENTS

Thank you is too small a word to acknowledge my committee members who have been my backbone throughout this entire study. I am thankful for my committee members, who met me promptly, made sure I understood the research process well, took the pains to meet me regularly, and motivated me throughout this period of study. They watched me grow as I learned a lot in this process. I want to thank my entire committee from the bottom of my heart. I enjoyed working on this project, and I attribute it to the support given by my committee members.

I would also like to thank Ms. Laura Kemmer of IHME for providing me with guidance for the search strategies for this study. Also, thanks to all the oral medicine faculty who accepted me into the Oral Medicine program at the UW and provided me a positive learning experience. I would also like to thank my co-residents for supporting me in every way in this project. There has been no better learning environment. I am incredibly thankful to work on this research project, and hopefully, this study will help in the future in estimating the global burden of orofacial conditions.

DEDICATION

To my husband, Vishal, and my parents, who have been pillars of support through the years without whom I could not have achieved this goal.

To my brothers, who continuously keep reminding me that they will always be there for me.

To my baby girl Rishika for enriching our life.

Chapter 1. Background

1.1History of Global Burden of Disease Study

Historically, the concept of the burden of disease has been linked to fatal diseases with limited life expectancy and high mortality rates. (1, 2) The concept of the burden of the disease includes the long and short-term consequences of health conditions. Data on long and short-term health outcomes are used to compare the health of different populations and provide empirical data, which in turn are helpful for decision making about resource allocation and health service planning.

To date, the most comprehensive, contemporary framework for measuring disease burden is the Global Burden of Diseases, Injuries, and Risk Factors Study (hereafter referred to as GBD). The distinguishing features of the GBD are that it is the only international burden of disease study to date that uses uniform, standardized measures across countries to assess the burden of conditions including a wide range of diseases and injuries and assesses the role of a set of cross-cutting, related risk factors. (3) On an annual basis, GBD generates a group of summary measures of population health, which include years of life lost (YLLs), years lived with disability (YLD), and Disability-Adjusted Life Years (DALYs).(4) YLLs assess the health loss due to premature death, YLDs quantify

the corresponding nonfatal burden, and DALYs are a sum of YLLs and YLDs. For each specific condition within a population, the estimate of YLD related to that condition is calculated from the number of people living with that disability multiplied by a disability weight. Disability weights for individual diseases and injuries are measured on a continuum of "health gap" anchored at 0 representing no disability or full health, and 1, which is equivalent to death. (4)

As populations live longer, the focus is appropriately shifting toward chronic diseases, and it has become critical to capture the burden of non-fatal disease. Nonfatal health loss is increasingly contributing to overall health loss, and while life expectancy is increasing, the years gained are often not lived in a state of "good" health.(5) Some of the non-fatal diseases that have been gaining attention in GBD in recent years are the common pain conditions, notably low back pain and neck pain. (6) The central attribute of each condition is persistent pain that drives treatment-seeking and becomes debilitating in a significant minority of cases. (7) Temporomandibular disorders (TMD) is another similar group of musculoskeletal pain conditions which share common features with other prevalent musculoskeletal disorders that include low back pain, headache, and fibromyalgia. (8)

1.2 Characterization of Temporomandibular Disorder

1.2.1 Anatomy of Temporomandibular Joint

The temporomandibular joint (TMJ) or mandibular joint is an ellipsoid variety of the synovial joint with the right and left joints forming a bicondylar articulation. The features of this joint that are common to other synovial joints include a fibrous capsule, a disk, synovial membrane, and adjacent ligaments. (9) The unique feature of the TMJ is that it acts as a fulcrum in which the movement is controlled both by the morphology of the joints and the dentition at the other end. During life, the components of the joint, including temporal, condylar, and discal articular surfaces undergo continuous remodeling. The synovium is an essential joint component that contributes to nourishment and lubrication of the avascular surfaces.(9) The lateral pterygoid muscle is anteriorly associated with the joint capsule. The articular disc has a very low coefficient of friction, and biomechanically it is stabilized between condyle and articular eminence by its thick rim, which has unique viscoelastic properties.(9) Mastication and speech are the two most critical functions of the TMJ.

1.2.2 Etiology and Clinical Presentation of Temporomandibular Disorders

The first known mention of disorder of the TMJ occurred in year 348 BC by Hippocrates, where he described a condition of dislocation of the temporomandibular joint.(10). Temporomandibular disorders (TMD) is often used as an umbrella term for pain and dysfunction involving the masticatory muscles and the temporomandibular joints. TMDs are a group of heterogeneous musculoskeletal disorders mainly characterized by regional pain in the facial and preauricular areas and or by limitation or interference in jaw movement.(11). TMD has multifactorial etiology, which includes biologic, environmental, social, emotional, and cognitive factors. Factors associated with TMD include other pain conditions (e.g., chronic headaches, fibromyalgia), autoimmune disorders, sleep apnea, and psychiatric illness.(12, 13) Besides, based on extensive prior research, TMD, like other musculoskeletal pain conditions, has been shown to fit within the multidimensional biopsychosocial model of pain which includes psychologic disabilities, such as depression, psychosocial dysfunction, inability to perform activities of daily living, susceptibility to medication abuse, and frequent treatment seeking. (14-18)

Numerous risk factors have been implicated, including: joint and muscle trauma, anatomical factors (e.g., skeletal and occlusal relationships), pathophysiological

factors (e.g., bone and connective tissue disorders, sensitization of peripheral and central nervous system pain processing pathways) and psychosocial factors (e.g., depression and anxiety, emotional and perceptual responses to psychological stressors).(19)

TMDs can be further subdivided into pain-related disorders, such as myofascial pain and arthralgia, and typically non-painful disorders associated with the TMJ, primarily disc displacement and degenerative joint disease. The most common signs and symptoms of TMD are temporomandibular joint sounds, impaired movement of the mandible, limitation in mouth opening, preauricular pain, facial pain, headaches and jaw tenderness on function. Clinical examination findings supporting the diagnosis of TMD may include—but are not limited to—abnormal mandibular movement, decreased range of motion, tenderness of masticatory muscles and/or TMJ's, pain with function, signs of bruxism, and neck or shoulder muscle tenderness.

1.2.3 Epidemiology and Health Care Needs

The available knowledge about TMD is not entirely clear, and the prevalence of TMD signs and symptoms, according to the literature, varies between 5% and

88%, depending on the studied population, signs, and symptoms studied and the diagnostic system used. The condition is most prevalent in adolescents and women during the reproductive years and falls off sharply with advancing middle age. A review done in 1999 found that the incidence of TMD pain meriting a diagnosis is 3.9% per annum and the population prevalence is 10% to 15%, with a sex ratio of approximately 2:1 (females: males).(20) Another large population based study, the 2002 National Health Interview Survey in USA, found that 5% of US adults reported TMD-type pain (6% of women, and 3% of men), while an examination-survey of a representative sample of females in New York City found that 10% had examiner-diagnosed TMD. (21, 22) Individuals in the community with TMD rate the intensity of its pain at 4.3, on average, using a 0–10 scale, which is comparable to the average intensity rating of 4.7 for back pain among people with that condition.(23, 24) While the natural history of TMD has not been well studied, TMD has been reported to remit over a 5-year observational period in 33% to 49% of diagnosed cases and to remain persistent or recurrent in the remainder.(25-27). Thus, it is reasonable to deduce that TMD pain has the potential to remit or persist and has the potential to debilitate in some cases.

Severe temporomandibular joint disorders can cause unsymmetrical growth of the bilateral condyle, leading to maxillofacial deformities that potentially affect an

individual's physical and mental health. (28) TMDs also increase the difficulty in opening mouth, which restricts individuals' abilities to perform daily functions and decreases their quality of life. The scientific rationale for including TMD among chronic pain conditions rests on confirmed observations ranging from impairment of the masticatory system in TMD pain sufferers resulting in mild alterations in eating behaviors to profoundly disabling depression and substantial interference with activities of daily living.(17) All chronic pain conditions have the same effect in the psychosocial domain (e.g., depression, limitations in activities, increased health care utilization) while retaining unique physical characteristics like specific body site (e.g., headache, back pain) or specific pathophysiologic processes (e.g., postherpetic neuralgia, cancer).(29) However, TMD pain, like other musculoskeletal pain problems, lacks an objective gold standard, such as tissue biopsy, that can easily differentiate people with the condition from people without the disease.(20)

1.2.4 Diagnosis of TMD

The best substitute for a gold standard for the diagnosis of TMD is a comprehensive medical history, physical examination, and selective use of imaging for conditions affecting joint structures. (14) A question commonly asked during history-taking to ascertain if TMD pain and dysfunction exist is, "Do you have

pain in or around your jaw joint or in your ear when at rest?" Common clinical signs of TMD upon examination are pain upon palpation of the TMJ or muscles of mastication; decreased ability to open the mouth or move the jaw from side to side; and clicking or grating sounds in and around TMJ with jaw movement.
Several diagnostic systems have been proposed and are being reported in the literature include Helkimo's indices, the Craniomandibular Index, or CMI, and the TMJ scale, developed by Levitt and associates.(30-33) In 1992, Fonseca modified Helkimo's indices and developed his anamnestic questionnaire, classifying TMD as light, moderate, or severe, or non-TMD. (34, 35) The advantages of Fonseca's questionnaire include self-administration, short time of application, low cost, and less variability in the measures. However, the outcome is reported as dysfunction, which incorporates jaw joint noises, jaw pain, and muscle pain.

One of the diagnostic systems most widely accepted and used by researchers all over the world is the research diagnostic criteria for TMD (RDC/TMD). RDC/TMD was developed by a group of international investigators in the early 1990s. (11) The RDC/TMD led to more standardized diagnostic methods and a better understanding of TMD prevalence, incidence, and other characteristics in populations around the world. The RDC/TMD has been tested for reliability and clinical utility of the multi-axial system and has been widely used since the

1990s.(36, 37) Table 1 provides an overview of RDC/TMD diagnostic criteria for clinical subtypes of TMD.

Table 1.RDC/TMD Diagnostic Criteria (11, 38)

Group I: muscle disorders	*Group II: disc displacements*	*Group III: arthralgia, arthritis, arthrosis*
Ia. Myofascial pain: ● Report of pain or ache in the jaw, temples, face, preauricular area, or inside the ear at rest or during function; ● The pain reported by the subject in response to palpation of ≥3 of the following muscle sites (right side and left side count as separate sites for each muscle): posterior temporalis, middle temporalis, anterior temporalis, origin of masseter, body of masseter, insertion of masseter, posterior mandibular region, submandibular region, lateral pterygoid area, and tendon of the temporalis; ● At least one of the painful sites must be on the same side as the complaint of pain. **Ib. Myofascial pain with limited opening:** ● Myofascial pain as defined in Ia; ● Pain-free unassisted mandibular opening <40 mm; ● Maximum assisted opening (passive stretch) ≥5 mm greater than a pain-free unassisted opening.	**IIa. Disc displacement with reduction:** ● Reciprocal clicking in TMJ (click on both vertical opening and closing that occurs at a point ≥5 mm greater interincisal distance on opening than closing and is eliminated on protrusive opening), reproducible on 2 of 3 consecutive trials; or ● Clicking in TMJ on both vertical ranges of motion (either opening or closing), reproducible on 2 of 3 consecutive trials, and click during lateral excursion or protrusion, reproducible on 2 of 3 consecutive trials. **IIb. Disc displacement without reduction with limited opening:** ● History of significant limitation in opening; ● Maximum unassisted opening ≤ 35 mm; ● Passive stretch increases opening by ≤ 4 mm over maximum unassisted opening;● Contralateral excursion <7 mm and/or uncorrected deviation to ipsilateral side on opening; ● Absence of joint sound or presence of joint sounds not meeting criteria for disc displacement with reduction. **IIc. Disc displacement without reduction, without limited opening:** ● History of significant limitation of mandibular opening; ● Maximum unassisted opening >35 mm; ● Passive stretch increases opening by ≥5 mm over maximum	**IIIa. Arthralgia:** ● Pain in one or both joint sites (lateral pole and/or posterior attachment) during palpation; ● One or more of the following self-reports of pain: pain in the region of the joint, pain in the joint during maximum unassisted opening, pain in the joint during assisted opening, pain in the joint during lateral excursion ; ● For a diagnosis of simple arthralgia, coarse crepitus must be absent. **IIIb. Osteoarthritis of the TMJ:** ● Arthralgia as defined in IIIa; ● Either coarse crepitus in the joint or radiologic signs of arthrosis. **IIIc. Osteoarthrosis of the TMJ:** ● Absence of all signs of arthralgia; ● Either coarse crepitus in the joint or radiologic signs of arthrosis

	unassisted opening; ● Contralateral excursion ≥7 mm; ● Presence of joint sounds not meeting criteria for disc displacement with reduction; ● In those studies, allowing images, imaging conducted by either arthrography or magnetic resonance reveals disc displacement without reduction.	

Moreover, a new comprehensive version of the RDC/TMD was developed in 2014, which is known as the Diagnostic Criteria for Temporomandibular Disorders (DC/TMD). (39) Another system that has been used was put forth by the American Academy of Orofacial Pain.(40) In recent literature, there has been increasing the use of validated 2Q/3Q questions designed in Sweden that are often used as pain screener.(41)

Table 2: TMD 3Q Questions (41)

Q1: 'Do you have pain in your temple, face, jaw or jaw joint once a week or more?';
Q2: 'Does it hurt once a week or more when you open your mouth or chew?'; and
Q3: 'Does your jaw lock or become stuck once a week or more?'

Although several epidemiologic studies have been done in the past using these classification systems, wide variations exist in measured prevalence and incidence of these conditions in both developed and emerging countries. TMD prevalence at

the population level is still a matter of debate, owing to the heterogeneity in the diagnostic criteria adopted in different investigations. (42)

Therefore, the objective of this project is to summarize relevant findings and trends related to TMD pain according to different diagnostic systems and provide a summary of the global prevalence and incidence of TMD. This thesis is based on the epidemiology of pain, as most patients with TMD seek care because of the pain they experience. (43) This will be the first step towards calculating the global burden for TMD pain, which in turn would be helpful in prevention and policies for the future. This has not been performed in a systematic way to date, but insights from recent rounds of the GBD in relation to other common pain conditions such as low back pain and neck pain provide pointers to the steps that need to be taken to achieve this goal. (6)

1.3 Research Aim

Aim: To summarize and systematically review the peer-reviewed literature on the TMD pain prevalence and incidence reported in studies adopting different diagnostic systems. The period covered by the review began in 1990, as is GBD protocol, and ended on January 31, 2019.

Chapter 2. Methods

The prevalence and incidence summaries for TMD pain were established through the following steps: (A) Establishing a case definition; B) Defining and executing search strategies; C) Developing inclusion criteria and exclusion criteria; D) Extracting and summarizing data by age, sex and diagnostic system.

2.1 Case Definition

For this review, RDC/TMD Axis I criteria, as shown in Table 1 were considered as the reference definition for TMD pain. Studies that used other criteria or definitions like DC/TMD, 2Q-TMD pain questions, AAOP or clinical exam or any other diagnostic system that reported and or verified pain in the muscles of mastication and/or jaw pain separately from non-painful jaw dysfunction were included. The purpose of the case definition is to not to exclude any studies, but as per GBD protocol to crosswalk with other definitions in the future. The studies included were those in which TMD was diagnosed by a trained examiner or identified through questionnaires (either self-administered or by research staff). Since pain is a subjective phenomenon, self-report-based studies were also included in the review.

2.2 Search Strategies

Multiple databases of the scientific literature were electronically searched using the following text-words: *temporomandibular*, *craniomandibular,* and *facial pain.* Searches were also made using the text-words and MeSH subheadings *epidemiology, cohort, prevalence, and incidence.* All English and foreign language articles with an English abstract with these subheadings were retrieved and read to determine eligibility. Specifically, PubMed via MEDLINE and EMBASE via Elsevier were electronically searched. Additionally, we supplemented our electronic search with hand searches of reference lists of all relevant publications, textbooks, web pages of government health departments, and international health organizations and national surveys whenever possible. All article abstracts meeting the search criteria were retrieved and read to determine eligibility. The search string is included in Table 3.

Table 3: PubMed Search String

Search string: TMJ Disorders [mh] OR TMJ Diseases[mh] OR TMJ Dysfunction[mh]) ORFacial pain[mh] OR(TMD[TiAb] OR "Temporomandibular Disorder"[TiAb] OR "Temporomandibular Disorders"[TiAb] OR "Temporo-mandibular Disorder"[TiAb] OR "Temporo-mandibular Disorders"[TiAb] OR “Temporo-mandibular disease”[TiAb] OR “Temporo-mandibular diseases”[TiAb] OR “Craniomandibular disorder”[TiAb] OR "Craniomandibular Disorders"[TiAb]

ORTMJ[TiAb] OR “TMJ Disorders”[TiAb] OR “TMJ Disorder”[TiAb] OR "Temporomandibular Joint disorder"[TiAb] OR "Temporomandibular Joint disorders"[TiAb]) OR "Temporo-mandibular Joint disorder"[TiAb] OR "Temporo-mandibular Joint disorders"[TiAb] OR “TMJ pain”[TiAb])AND (prevalen*[TiAb] OR inciden*[TiAb] OR epidem*[TiAb) AND (1990[PDat] : 2019/1/3[PDat])

2.3 Inclusion and Exclusion Criteria

Inclusion criteria were: 1) the authors reported the outcome measure as the prevalence of TMD pain or the incidence of TMD pain; 2) Population-based studies; 3) Studies on humans; 4) Studies from 1990-2019 (Jan); 5) Studies of any region or country of the world; 6) Studies of urban and/or rural populations ;7) Studies of males and/or females; 8) Studies of any age group; and 9) Studies published in any language.

Exclusion criteria were: 1) Studies that were not population-based, e.g., specialty clinic-based studies (like pain clinics); 2) Studies based on high-risk populations like patients receiving orthodontic treatment or patients with facial injuries; 3) Studies that provided no prevalence or incidence data, e.g., only risk factor analysis; 4) Studies reporting outcome other than TMD pain, e.g. TMD dysfunction; 5) Studies with no full-text available; and 6) Reviews.

A log of all those studies considered, and their fate was created so that a flow diagram of the studies could be created. One senior graduate student in oral medicine (Ishraq Alshanqiti) along with R.M. was trained to assess the data and do the screening of articles based on inclusion criteria after reaching interrater reliability of kappa=0.8 (between R.M. and I.A.). All the differences between the reviewers were resolved by discussion, rereading, and consultation with the orofacial pain expert (M.D.) when necessary.

2.4 Data Extraction

The following data/information was recorded from each of the selected studies by R.M. and any uncertainties were discussed with the orofacial pain expert (M.D): diagnostic system, size and demographic features of the sample (sex, sample size, sample population), outcome in terms of prevalence and/or incidence of TMD pain.

Chapter 3: Results

The database search resulted in 2196 citations, as depicted in Figure 1. Removing duplicates yielded 1620 unique citations. After screening titles and abstracts, 1425 citations were removed as clearly irrelevant to this study, leaving 209 for full-text review. Next, 134 publications were excluded following the inclusion/exclusion criteria, and finally, 75 studies were included in the final evaluation. A significant challenge in synthesizing these data was the extent of between-study methodological heterogeneity, particularly relating to the prevalence period and case definition, namely the minimum episode duration, the anatomical location, and whether cases had to experience activity limitation. As an initial attempt to deal with these heterogeneities, the effort is to include all prevalence and incidence studies that reported TMD pain either in masticatory muscles or jaw. In the future, these prevalence data can be cross-walked, and burden of disease can be calculated. There were two studies for which we could not get the full text and two studies that used repetitive data. The exclusion criteria, along with the frequency of reasons for exclusion, are listed in Table 4 below. Two studies were excluded as they used repeat data. In this review, prevalence data were synthesized and compared by two age groups (3-19 years and 20 years and above), sex, and diagnostic system.

Fig 1. PRISMA flowchart for selection of studies

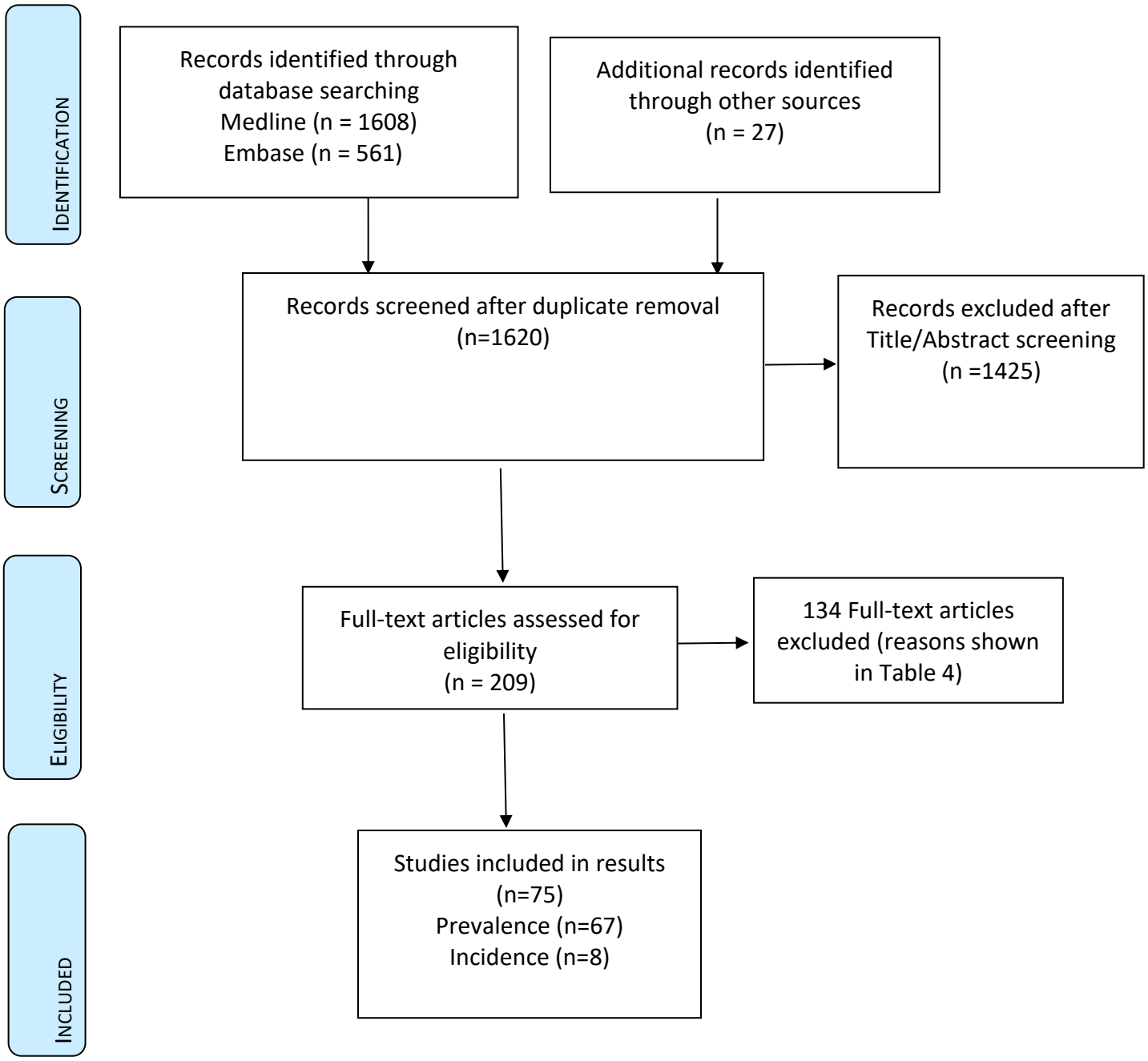


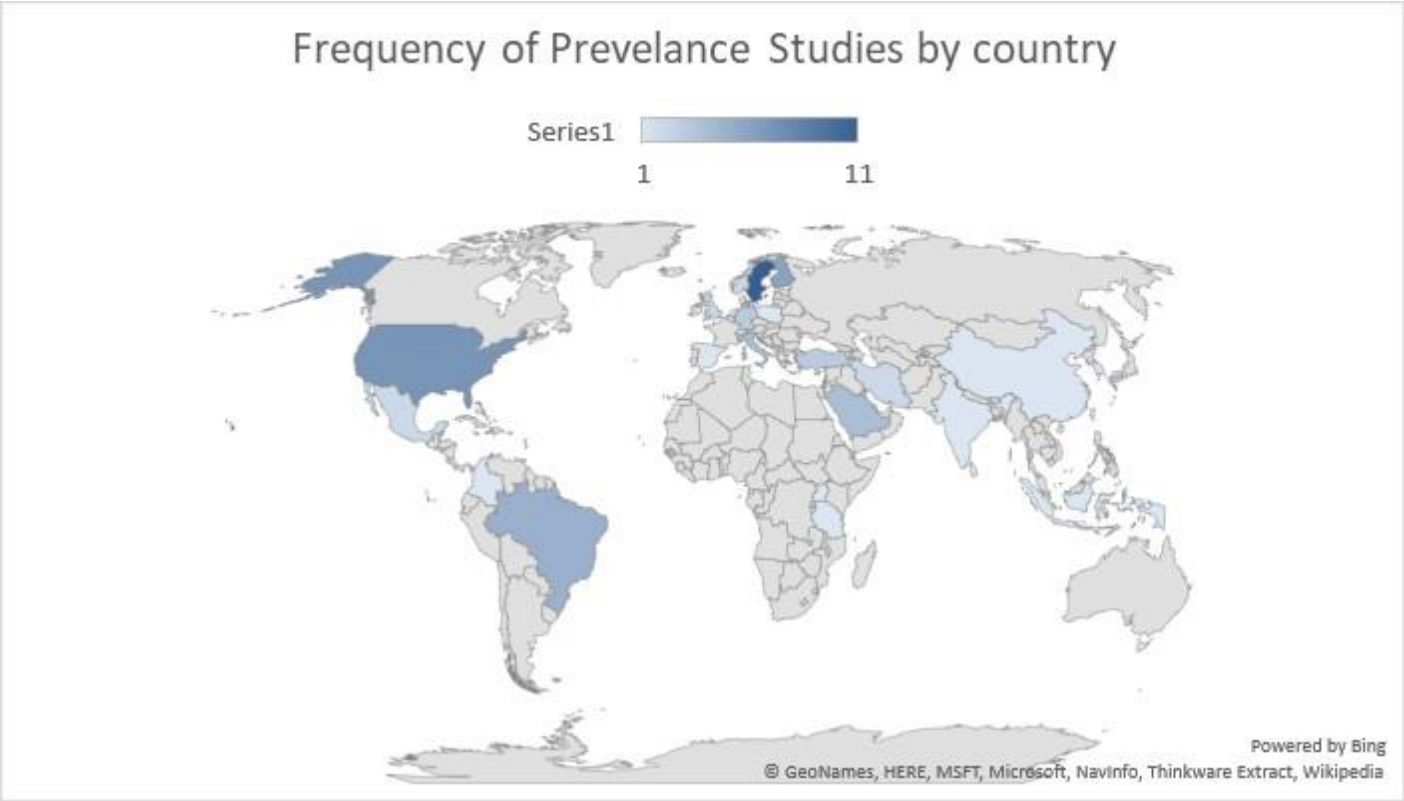
Table 4: Exclusion Criteria and their frequency

Exclusion criteria	Frequency (total 134)
A: Studies that were not population-based, e.g., specialty clinic-based studies like pain clinic;	25
B: Studies based on high-risk populations like patients receiving orthodontic treatment or facial pain injuries;	33
C: Studies that provided no prevalence or incidence data, e.g., risk factor analysis	18
D: Studies reporting outcome other than TMD pain (Jaw or muscle pain), e.g., TMD dysfunction, orofacial pain prevalence	60
E. Reviews (full text not available + repeat data)	6(4)

3.1 Studies on the Prevalence of TMD Pain

We located 67 published articles from 1990 to 2019 on the prevalence of TMD pain. The two countries producing most of the studies were Sweden, followed by the United States. Figure 2 shows the distribution of studies across the world.

Fig 2: Frequency of TMD Pain Prevalence studies.



3.1.1 Prevalence of TMD Pain in Children and Adolescents (3-19 Years).

Twenty-seven studies reported the prevalence of TMD pain for the population under the age of 20, as shown in Table 5. The range of prevalence estimates for self-reported pain was between a low of 0.2% for ‘severe pain’ in the TMJ in 11-

16-year olds to 28.1% in a study done in Uganda. (44) Symptoms and signs increase with age or with an increase in parafunctional habits like bruxism, but signs and symptoms of TMD are present even in early ages, in a small number of children.(45) It was found that for TMD pain, the highest rate is in the deciduous (primary) dentition, the rate decreases in the mixed dentition and rises again in the permanent dentition. This could be due to extensive masticatory parafunctional oral activity which is significantly related to TMD pain.

One large study found that the prevalence of self-reported overall weekly TMD pain was 2.0% for males and 2.7% for females at the age of 12, whereas corresponding levels at the age of 19 were 2.9% and 7.9%, respectively. (46) In general, the sex prevalence ratios varied between 0.50 to 2.0, indicating no consistent relationship in the report of TMD pain between male and female children and adolescents, however, in some studies myalgia was higher in females compared to males.(47). In another study comparing Chinese and Swedish adolescents, TMD pain in the Chinese sample was significantly higher than in the Swedish. Females had significantly more TMD pain than males in both the Chinese and Swedish samples.(48)

Table 5: Prevalence of TMD Pain in Children and Adolescents (3-19 Years)

Reference (author year)	Sample Size (n)	Diagnostic System	Country	Source of Sample	Age(Yrs.)	Prevalence in Males	Prevalence in Females	Total Prevalence
Bonjardim LR, et al. (2003)(45)	99	Clinical exam	Brazil	Random populations	3-5	ns	ns	TMJ pain=4.04%
Deng YM, et al. (1995)(49)	3105	Clinical exam	China	School children	3-19	ns	ns	TMJ pain=0.6%
Wu N, et al. (2010)(50)	Germany=561 China=497	RDC/TMD Axis 1	China Germany	Random populations from schools in Germany and China	13-18	ns	ns	Germany (gp1=0.4 %, gp 3=1.4%) China (gp 1=0.8, gp3=5.2%)
Hongxing L, et al. (2016)(48)	China=5524 Sweden=17015	2Q TMD-P Question	China Sweden	China- School children, Sweden- Public dental service clinic	15-19	Sweden=1.5% China=6.34%	Sweden=3.67% China=7.97%	Sweden=5.1% China=14.8%
Thilander B, et al. (2002)(51)	4724	Clinical exam	Colombia	Population that attended the Dental Health Service	5-17	TMJ pain=3.4% Muscle pain=5.2%	TMJ pain=4.6% Muscle pain=6.7%	TMJ pain=4.0%, Muscle pain=6.2%
Vierola A, et al. (2012)(52)	483	Modified RDC/TMD questions (past 3 months)	Finland	Primary school children	6-8	ns	ns	Pain in masticatory system=7.3% Pain in TMJ=3.7% Pain in mandible movement=5%

Reference (author year)	Sample Size (n)	Diagnostic System	Country	Source of Sample	Age	Prevalence in Males	Prevalence in Females	Total Prevalence
Ostensjo V, et al. (2017)(53)	562	RDC/TMD Clinical Exam and 2Q TMD-P Question	Norway	Four clinics representative of the county, two in urban areas and two in rural areas .	13-19	Myalgia=1.4% Arthralgia=0.17% Myalgia and Arthralgia=0.17%	Myalgia=2.3% Arthralgia=1.4% Myalgia and Arthralgia=1.4%	Myalgia=1.8% Arthralgia=0.5% Myalgia and Arthralgia = 0. 5%
Graue AM, et al. (2016)(54)	167	DC/TMD and 2Q TMD-P Question	Norway	Children and adolescents up to 19 years through a public dental health service (PDHS).	12-19	ns	ns	Self-Report=7% Myalgia=3% Myalgia and Arthralgia=1.2% Arthralgia and Headache=0.6%
Loster JE, et al. (2017)(55)	260	RDC/TMD	Poland	Volunteers were students from three randomly selected high schools in Krakow, Poland.	18	ns	ns	Gp1 a=20%. Gp 3a=4.2%
Al-Khotani A, et al. (2016)(56)	456	RDC/TMD	Saudi Arabia	School children	10-18	ns	ns	Gp1a=15.56% Gp1b=3.41% Gp3a=4.8%
Farsi NM, et al. (2003)(57)	1976	Clinical exam and questions	Saudi Arabia	School children	3-15	Primary dentition=7.5% Mixed dentition=8.3% Permanent dentition=6.7%	Primary dentition=8.3% Mixed dentition=4.5% Permanent dentition=3.1%	Primary dentition=8% Mixed dentition=3% Permanent dentition=4.7%
Alamoudi N, et al. (1998)(58)	502	Clinical Exam	Saudi Arabia	School children	3-7	ns	ns	Myalgia=6.77% Jaw pain=2.59%

Reference (author year)	Sample Size(n)	Diagnostic system	Country	Source of Sample	Age	Prevalence in Males	Prevalence in Females	Total Prevalence
Nilsson IM, et al. (2005)(46)	28,899	2Q TMD-P Question	Sweden	Public dental services	12-19	2.7%	6.0%	4.2%
List T, et al (1999)(59)	862	RDC/TMD questions	Sweden	Public dental services	12-18	ns	na	TMD pain=7%
Marpaung C, et al. (2018)(60)	4235	Modified (RDC/TMD) questions	Netherlands	Dutch secondary schools	12-18	TMD pain=17.6%	TMD pain=26.1%	TMD pain=21.6%
Wahlund, et al. (2003)(61)	864	RDC/TMD	Sweden	Public dental clinic	13-19	ns	ns	TMD pain=7%
Sonmez H, et al. (2001)(62)	394	Clinical exam based on Gazi et al. and WHO	Turkey	School children	9-14	Myalgia=21.25% TMJ pain=27.50%	Myalgia=24.7% TMJ pain=24.17%	Myalgia=22.9% TMJ pain=25.8%
Moyaho-Bernal A, et al. (2010)(63)	235	RDC/TMD	Mexico	School Children	8-12	Jaw pain=0%, Myalgia=5%	Jaw pain=0.8%, Myalgia=3.9%	Jaw pain=0.4%, Myalgia=4.3%
Friedman Rubin P, et al. (2018)(44)	153	RDC/TMD clinical exam and questions	Uganda	Orphanage	6-17	Myalgia=34.9% Arthralgia=39.7	Myalgia=23.3% Arthralgia=27.8%	Myalgia=28.1% Arthralgia=26.8%
Inglehart MR, et al. (2016)(64)	8302	TMDP screening question, self-report	USA	35 schools	4-12	Pain on chewing=21.2% Pain on opening wide=17.1%	Pain on chewing=25.9% Pain on opening wide=20.4%	Pain on chewing=23.6% Pain on opening wide=18.8%
Widmalm SE, et al. (1995)(65)	2013	Exam by CMD method	USA	Preschool and kindergarten	4-6	3.3%	9.7%	6.7%

Q1: 'Do you have pain in your temple, face, jaw or jaw joint once a week or more?'; Q2: 'Does it hurt once a week or more when you open your mouth or chew?' Gp Ia-Myofascial pain without limited mouth opening, GpIIb Myofascial pain with limited mouth opening, III a Arthralgia, ns-not stated, na-not applicable

3.1.2 Prevalence of TMD Pain in Adults (20 years and above)

Forty studies assessing TMD prevalence in adults aged 20 years and older met inclusion criteria and are listed in Table 6. The prevalence of TMD pain in adults was variable as per the definitions and questions to assess pain and diagnostic systems. RDC/TMD Axis 1 diagnostic system led to the prevalence of muscle pain=29.5% and arthralgia=16% in a study in Brazil.(66) Another large study assessed the prevalence of self-reported temporomandibular joint and muscle disorders (TMJMD)-type pain in the 2002 U.S. National Health Interview Survey (NHIS). The overall prevalence of TMJMD-type pain was 4.6%, with 6.3% for women and 2.8% for men.(21) Five extensive cross-sectional, stratified, population-based studies carried out in Spain from 1993 to 2015 revealed the prevalence of temporomandibular pain and dysfunction increased over time in both adults and seniors.(67) The prevalence appeared to systematically vary between men and women, with prevalence generally about 2 to 8 percent for males and 4 to 15 percent for females. The female to male gender prevalence ratio varied, but most studies reported a ratio of about 2 to 1. Schmitter et al. found that the younger population in their study (18-44 yrs.) compared to the older population (65-76 yrs.) suffered more from both TMJ and muscle pain.(68)

Table 6: Prevalence of TMD Pain in Adults (20 years and above)

Reference (author year)	Sample size(n)	Diagnostic system	Country	Source of Sample	Age	Prevalence in Males	Prevalence in Females	Total Prevalence
Progiante PS, et al. (2015) (66)	1643	RDC/TMD Axis 1	Brazil	Public health database	20-65	ns	ns	gp 1a=19.0%, gp1b=10.5%, gp3a=16%
Goncalves DA, et al. (2010)(69)	1230	AAOP Questions	Brazil	Stratified sampling from census	15-65	TMJ pain=10.4%. Myalgia=10.7%	TMJ pain=21.8%, Myalgia=19.9%	TMJ pain=16.3%, Myalgia=15.4%
Jussila P, et al. (2017)(70)	1962	Modified DC/TMD and 2Q TMD-P Question in last 30 days	Finland	Northern Finland Birth Cohort 1966 (NFBC 1966)	46	Myalgia=2.2%, Arthralgia=2%	Myalgia=7.4%, Arthralgia=8.2%	Myalgia=5.0%, Arthralgia=5.3%
Miettinen O, et al. (2017(71))	13,819	Questionnaire developed in the Institute of Dentistry, University of Oulu, Finland (facial pain or jaw pain in last 1 year)	Finland	Finnish Defense Forces	18-20	Facial pain=13.6%, TMJ pain=25.3%	Facial pain=14.9%, TMJ pain33.8%	Facial Pain=14.25%, TMJ pain=29.5%
Huhtela OS, et al. (2016) (72)	4403	2Q TMD-P Question	Finland	Finnish Student Health Survey 2012	19-25	TMJ pain=11.4%	TMJ pain=25.9%	TMJ pain=20.6%
Tuuliainen L, et al. (2015)(73)	6155	Modified RDC/TMD	Finland	Cluster sampling from national health survey database(2000-2001)	30-75	Myalgia= 7.2% Arthralgia=2.4%,	Myalgia= 18.9% Arthralgia=5.1%,	Myalgia= 13.05% Arthralgia=3.75%,
Suvinen TI,et al. (2004)(74)	128	Clinical exam and a standardized questionnaire.	Finland	Study population from regular visit to pediatric dental clinic	15,18,23	ns	ns	15 yrs (12%) 18 yrs (9%) 23 yrs (6%)

Reference (author year)	Sample Size (n)	Diagnostic system	Country	Source of Sample	Age	Prevalence in Males	Prevalence in Females	Total Prevalence
Turp JC, et al. (2016) (75)	7-day survey n=2524 3-month survey n=2515	Regional: Pain Scale	Germany	Random selection of population using demographic consulting company	>14	ns	ns	7-day prevalence TMJ pain=4%, 3-month prevalence TMJ pain=0.9%
Schmitter M,et al. (2005)(68)	65-76 yrs. =58, 18-44	RDC/TMD clinical exam	Germany	Randomly selected from old homes	18-44, 65-76	ns	ns	65-76 yrs. (TMJ pain=0%, Myalgia=10.3%), 18-44 yrs. (TMJ pain=16%, Myalgia=22.8%)
Gesch D, et al. (2004) (76)	4289	Guidelines by AAOP	Germany	Randomized population	20-79	Jaw pain=4.1%, Muscle pain=8.9%	Jaw pain=8.1% Muscle pain=15.1%	Jaw pain=5%, Muscle pain=12%
Pow EH,et al. (2001)(77)	1526	Telephone survey technique	China	Population	>18	na	na	Jaw pain 5%
Jivnani HM,et al. (2017) (78)	200	DC/TMD	India	Random sample of UG medical students	18-28	TMJ pain=3%	TMJ pain=4.5%	TMJ pain=3.7. %
Balke Z, et al. (2010)(79)	223	RDC/TMD	Iran	Random selection from patients for routine medical care in urban and rural public health clinics	18-65	ns	ns	Myofascial pain(urban=7.6%, Rural=12.5%); Arthralgia(urban=10.1%, Rural=15.4%)
Schmitter M, et al. (2007) (80)	151	RDC/TMD clinical exam	Iran	Randomly selected females from the health center	>18	na	9.93%	na
Katz J, et al. (2002)(81)	20,689	Self-report pain in the masticatory system in past 6 months	Israel	Healthy population seeking dental care	18-21	Myalgia=4%, TMJ pain=8.2%	Myalgia=4%, TMJ pain=8.9%	Myalgia=4%, TMJ pain=8.4%
Mobilio N, et al. (2011) (82)	2005	Questions from RDC/TMD	Italy	Random digit dialing -sample of people between the ages of 15 and 70.	>15	Jaw pain=3.5	Jaw pain=6.5%	Jaw pain=4.9%

(Ia): Myofascial pain without limited mouth opening (Ib)Myofascial pain with limited; (IIIa) Arthralgias, ns- not stated, na-not applicable

Reference (author year)	Sample size(n)	Diagnostic system	Country	Source of Sample	Age	Prevalence in Males	Prevalence in Females	Total Prevalence
Jagger RG, et al. (1992)(83)	219	Clinical Exam	Saudi Arabia	Population sample	>16	ns	ns	Pain on wide opening=8%, Pain in front of ears=19%
Tay KJ ,et al. (2018) (84)	2043	DC/TMD question-naire	Singapore	Asian military	18-65	ns	ns	TMD pain=16.69%
Montero J, et al. (2018)(67)	35-64=2602; 65-74=2529	WHO based Clinical exam by trained investigator/ oral health surveys question-naire	Spain	Population sample	35-44, 65-74	ns	ns	Self-Report (35-64) =8.6%, (65-74)=10.9% ; Exam (35-64) =11.9 %;(65-74) =9.1%;
Adern B, et al. (2018) (85)	2011 (n=28,681); 2012 (n=28,082), 2013 (n=17,007), Total (n=73,770)	2Q TMD-P Question	Sweden	Adult patients attending public dental health services	>20	ns	ns	2011=1.7% 2012=1.5% 2013=1.5% Total=1.5%
Lovgren A, et al. (2018)(86)	54	DC/TMD questions and clinical exam	Sweden	Dental students	18-45	ns	ns	Myalgia=27.8%, Arthralgia=14.8%

(Ia): Myofascial pain without limited mouth opening (Ib)Myofascial pain with limited; (IIIa) Arthralgias, ns- not stated, na-not applicable

Reference (author year)	Sample Size(n)	Diagnostic system	Country	Source of Sample	Age	Prevalence in Males	Prevalence in Females	Total Prevalence
Gillborg S, et al. (2017)(87)	6123	2Q TMD-P Question	Sweden	Randomly selected individuals in the county of Skane	20-89	9.1%	12.4%	11.0%
Lovgren A, et al. (2016) (88)	137,718	2Q TMD-P Question	Sweden	Routine dental check-up at the Public Dental Health Service (PDHS)	10-90	q1=1.8%, q2=0.9%	q1=5.2%, q2=2.5%	q1=2.3%, q2=1.7%
Unell L, et al. (2012) (89)	65yr=5676, 75yr=3206	TMDP screener	Sweden	Born in 1942 and 1932, in two Swedish counties.	65-74	65 yrs.=7.8% 75 yrs. =7.2%	65 yrs. =14% 75 yrs.=10.1%	65 yrs.=10.9% 75 yrs.=8.65%
Marklund S, et al. (2008)(90)	308	RDC/TMD	Sweden	Dental students	18-30	na	Myofascial pain prevalence=8%. Myofascial pain incidence = 4%.	na
Salonen L, et al. (1990)(91)	920	Clinical exam as per Helkimo + questions	Sweden	Stratified random sampling of county	>20	Myalgia=12%	Myalgia=21%	Myalgia=17%
Chuang SY, et al. (2002) (92)	254	Question from ADA (Mc Neil)	Taiwan	Dental students	19-25	5.66%	15.79%	9.45%
Mazengo MC, et al. (1994)(93)	100	Exam and questions	Tanzania	Stratified random sample from community	35-44 65-74	ns	ns	35-44=3%, 65-74=11%
Ozan F,et al . (2007) (94)	792	Clinical Exam	Turkey	Regular dental patients in the university clinic	15-72	5.3%	10.3%	7.8%
Nekora-Azak A, et al. (2006)(95)	949	A questionnaire-based on TMD screening methods published by Goulet et al. and Locker and Slade	Turkey	Randomly selected from the population	>18	26.2%	35.6%	31.0%
Joury E, et al. (2018)(96)	2168	Questions based on AAOP	UK	A representative sample of the general noninstitutionalized population.	16-65	6.6%	7%	6.8%

(Ia): Myofascial pain without limited mouth opening (Ib)Myofascial pain with limited; (IIIa) Arthralgias, ns- not stated, na-not applicable

Reference (author year)	Sample size(n)	Diagnostic system	Country	Source of Sample	Age	Prevalence in Males	Prevalence in Females	Total Prevalence
Macfarlane TV, et al. (2002) (97)	2504	postal questionnaire,	UK	Population sample	18-65	na	na	Jaw pain=6%
Chatzopoulos GS, et al. (2017) (98)	4204	Clinical exam and questions	USA	Random selection of patients visiting the dental clinic at the University of Minnesota	18-68	5.6%	13.9%	9.5%
Isong U ,et al. (2008)(21)	30,978	TMJMD-type Pain Instrument	USA	2002 US National Health Interview Survey (NHIS)	>18	2.8%	6.3%	4.6%
Janal MN, et al (2008)(22)	782	RDC/TMD exam	USA	Community women in NY	18-75	na	Myalgia=10.5%	na
Goddard G, et al. (2002)(99)	rural=90, urban=102	RDC/TMD exam	USA	Indian reservation (rural) and San Francisco (urban)	5-84	ns	ns	Jaw pain rural=14.3%, Jaw pain urbanu=20.8%
Lipton JA, et al. (1993) (100)	9495	Survey	USA	US population	>18	3.5%	6.9%	5.3%

Q1: 'Do you have pain in your temple, face, jaw or jaw joint once a week or more?'; Q2: 'Does it hurt once a week or more when you open your mouth or chew?' Gp Ia-Myofascial pain without limited mouth opening, GpIIb Myofascial pain with limited mouth opening, III a Arthralgia, ns-not stated, na-not applicable

3.1.3 Prevalence of TMD Pain by Race, Time Period and Geography

Lipton, in the large National Health Interview Survey, showed a slightly lower prevalence of jaw joint and facial pain among African Americans when compared to whites, although this estimate was not adjusted for socioeconomic status(SES), or gender.(100) However, in a later NHIS-based study, after adjusting for socioeconomic status, Non-Hispanic black women had much lower prevalence at younger ages (approximately 4% at 25 to 34 years), which increased thereafter up to 55 to 64 years of age. A similar racial pattern was present in Hispanic black men, with the lowest prevalence at ages 25 to 34 years, while non-Hispanic white men had a higher prevalence.(21) Another small cross-sectional study of 4 to 6-year-old children showed higher proportions of African American children reporting TMD pain, although this study also did not adjust by SES, among other methodological concerns. Dworkin and LeResche reported the effect of the time interval on the prevalence of TMD pain in a Caucasian population to range from 3.6% for point prevalence (current pain) to 12% for 6-month period prevalence to 34% for lifetime prevalence. (101) In two representative samples consisting of 2524 and 2515 subjects, respectively, the 7-day and 3-month pain prevalence were measured by using the Regional Pain Scale (RPS). The 7-day jaw pain prevalence was 4.0% while the 3-month prevalence of jaw pain was 0.9 %, suggesting that jaw

pain may be fleeting and that insignificant jaw pain may be forgotten over a longer time period .(75)

3.1.4 Prevalence of TMD Pain by Diagnostic systems

Several diagnostic systems and their combinations were used in the prevalence studies. As discussed earlier, RDC/TMD, DC/TMD, AAOP questions for the survey, 2Q TMD-P questions or modification of any of the above were included in the review (Table5). One of the most validated and commonly used was RDC/TMD for the diagnosis of TMD. There were twenty-four studies on prevalence of TMD pain that used the RDC/TMD for their diagnosis. Table 7 provides a summary of all the studies. Prevalence reports were highly variable across studies. Prevalence for myofascial pain varied from 0.4% in Germany to 28.1% in Uganda while using the same metrics.(44) Although the population in Uganda consisted of children from orphanage, it was included in this review as it was the only study from that country. Myofascial pain with or without mouth opening limitation was the most prevalent diagnosis in TMD pain population studies. The prevalence of Myofascial pain ranged from 0.4% to 27.8%. The prevalence of arthralgia ranged from 0-21% as depicted in Figure 3. The distribution of diagnosis as per RDC/TMD seems to suggest that myofascial/muscle pain is more common in the general population than the

inflammatory-degenerative (group III) disorders. RDC/TMD has not been validated in children, but it is the most common diagnostic system used.

There were five studies that used DC/TMD as its diagnostic criteria (See Table 8). The prevalence of Myalgia in these studies ranged from 2.2% to 27.8%. The prevalence of arthralgia ranged from 2% to14%. There was a high prevalence of myalgia and arthralgia in dental students compared to the general population.

Fig 3: Box plot of TMD Pain Prevalence in studies using the RDC/TMD diagnostic system.

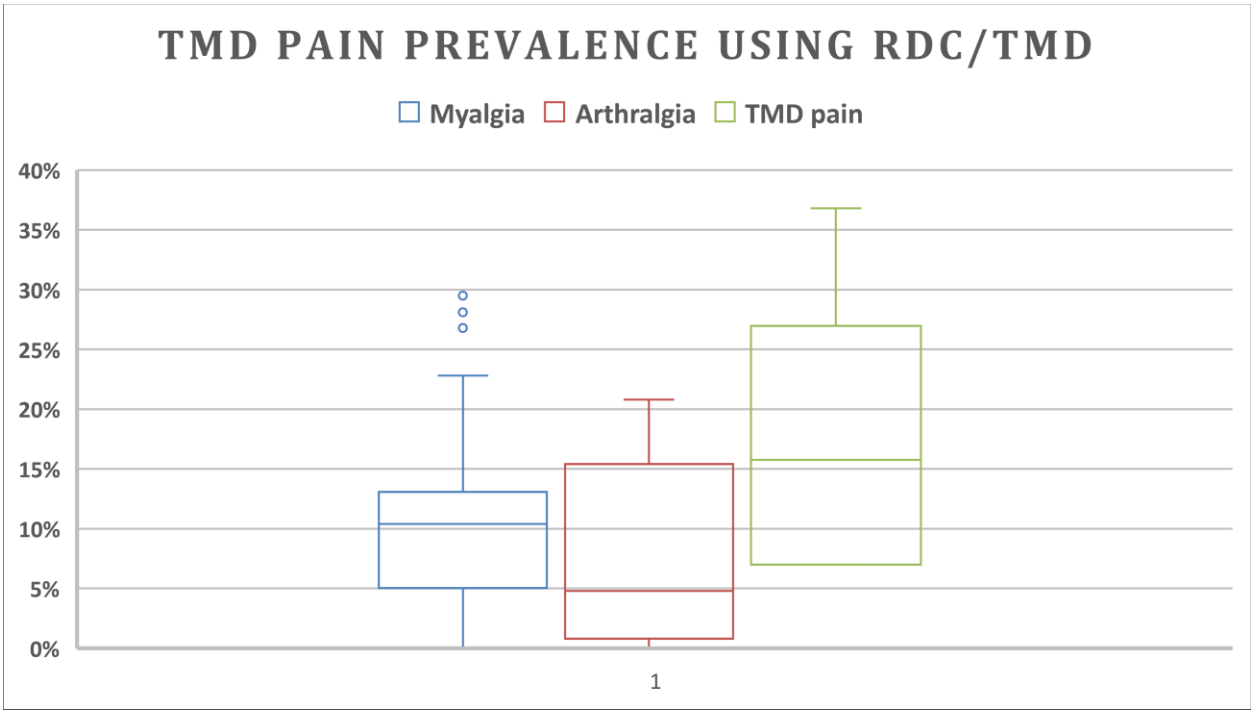


Table 7: TMD Pain Prevalence studies using RDC/TMD

Reference (author year)	Sample Size(n)	Diagnostic system	Country	Source of Sample	Age	Prevalence in Males	Prevalence in Females	Total Prevalence
Progiante PS ,et al . (2015) (66)	1643	RDC/TMD Axis 1	Brazil	Public health database	20-65	ns	ns	gp 1a=19.0%, gp1b=10.5%, gp3a=16%
Wu N et al, (2010)(50)	Germany=561, China=497	RDC/TMD Axis 1	China, Germany	Random populations from schools in Germany and China	13-18	ns	ns	Germany (gp1=0.4 %,gp 3=1.4%) China(gp 1=0.8, gp3=5.2%)
Tuuliainen L et al , (2015)(73)	6155	Modified RDC/TMD	Finland	Cluster sampling from national health survey database(2000-2001)	30-75	Myalgia= 7.2% Arthralgia=2.4%,	Myalgia= 18.9% Arthralgia=5.1%,	Myalgia= 13.05% Arthralgia=3.75%,
Vierola A, et al. (2012)(52)	483	Modified RDC/TMD questions (past 3 months)	Finland	Primary school children	6-8	ns	ns	Pain in masticatory system=7.3%, Pain in TMJ=3.7%, Pain in mandible movement=5%
Schmitter M, et al , (2005)(68)	65-76 yrs =58, 18-44	RDC/TMD clinical exam	Germany	Randomly selected from old homes	18-44, 65-76	ns	ns	65-76 yrs. (TMJ pain=0%, Myalgia=10.3%), 18-44 yrs. (TMJ pain=16%, Myalgia=22.8%)
Marpaung C, et al. (2018)(102)	7-12yrs=545; 13-18yrs=812	Dutch variant of RDC/TMD questions and oral parafunctions questionnaire	Indonesia	Elementary and high school	7-12, 13-18	7-12=24.5%, 13-18=34.1%	7-12=22.9% 13-18=39.5%	7-12=23.7% 13-18=36.8%

(Ia): Myofascial pain without limited mouth opening (Ib)Myofascial pain with limited; (IIIa) Arthralgias, ns- not stated, na-not applicable

Reference (author year)	Sample Size(n)	Diagnostic system	Country	Source of Sample	Age	Prevalence in Males	Prevalence in Females	Total Prevalence
Balke Z,at al. (2010)(79)	223	RDC/TMD Axis I	Iran	Random selection from patients for routine medical care	18-65	ns	ns	Myofascial pain (urban=7.6%, Rural=12.5%); Arthralgia (urban=10.1%, Rural=15.4%)
Schmitter M et al. (2007) (80)	151	RDC/TMD clinical exam	Iran	Randomly selected females from health center	>18	na	9.93%	na
Emodi-Perlman A,et al. (2012)(103)	244	Modified RDC/TMD clinical exam and pain questions	Israel	School children	5-12	Myalgia=8.2%	Myalgia=2.7%	Myalgia=4.3%
Paduano S, et al. (2018) (104)	361	RDC/TMD clinical exam and oral behavior checklist	Italy	Public school	14-18	Gp Ia=1.67%: Gp IIb=0.27%: Gp IIIa=0.27%	Gp1a=9.1%; Gp1b=0.83 Gp3a=1.66%	Gp1a=10.8%; Gp1b=1.1%; Gp3a=1.9%
Tecco S, et al (2017)(47)	567	RDC/TMD Axis I	Italy	Volunteers from routine dental visit	11-19	Myalgia=6.5%	Myalgia=10.35%	Myalgia=9.87%
Mobilio N, et al (2011) (82)	2005	Questions from RDC/TMD Axis I	Italy	Random digit dialing -sample of people between the ages of 15 and 70.	>18	Jaw pain=3.5	Jaw pain=6.5%	Jaw pain=4.9%
Moyaho-Bernal A, et al. (2010)(63)	235	RDC/TMD Axis I	Mexico	School children	8-12	Jaw pain=0%, Myalgia=5%	Jaw pain=0.8%, Myalgia=3.9%	Jaw pain-0.4%, Myalgia-4.3%
Casanova-Rosado JF, et al. (2006) (105)	506	RDC/TMD clinical exam	Mexico	Randomly selected students from school and university	14-25	ns	ns	Myofascial pain =10.9%, Arthralgia=0%

(Ia): Myofascial pain without limited mouth opening (Ib)Myofascial pain with limited; (IIIa) Arthralgias, ns- not stated, na-not applicable

Reference (author year)	Sample Size(n)	Diagnostic system	Country	Source of Sample	Age	Prevalence in Males	Prevalence in Females	Total Prevalence
Marpaung C, et al. (2018)(60)	4235	Modified (RDC/TMD) questions	Netherland	Dutch secondary schools	12-18	TMD pain=17.6%	TMD pain=26.1%	TMD pain=21.6%
Ostensjo V, et al. (2017)(53)	562	RDC/TMD Clinical Exam and 2Q TMD-P Question	Norway	Four clinics two clinics in urban areas and two in rural areas to achieve a geographical spread.	13-19	Myalgia (1.4%), Arthralgia (0.17%), Myalgia and Arthralgia (0.17%)	Myalgia (2.3%), Arthralgia (1.4%), Myalgia and Arthralgia (1.4%)	Myalgia (1.8%), Arthralgia (0.5%), Myalgia and Arthralgia (0.5%)
Loster JE, et al. (2017)(55)	260	RDC/TMD Axis I	Poland	Volunteers were students from three randomly selected high schools	18	ns	ns	Gp1a=20%, Gp3a=4.2%%
Al-Khotani A, et al. (2016)(56)	456	RDC/TMD Axis I	Saudi Arabia	School children	10-18	ns	ns	Gp1a=15.56%, Gp1b=3.41%, Gp3a=4.8%
Marklund S, et al. (2008) (90)	308	RDC/TMD Axis I	Sweden	Dental students	18-30	na	Myofascial pain prevalence=8%. Myofascial pain incidence = 4%.	Na
List T, et al. (1999)(59)	862	RDC/TMD questions	Sweden	Public dental clinic	12-18	ns	na	TMD pain=7%
Wahlund, et al. (2003)(61)	864	RDC/TMD	Sweden	Public dental clinic	13-19	ns	ns	TMD pain=7%
Friedman Rubin P, et al. (2018) (44)	153	RDC/TMD clinical exam and questions	Uganda	Orphanage	6-17	Myalgia (34.9%), Arthralgia (39.7)	Myalgia (23.3), Arthralgia (27.8)	Myalgia (28.1), Arthralgia (26.8)
Janal MN, et al. (2008)(22)	782	RDC/TMD exam	USA	Community women in NY	18-75	na	Myalgia=10.5%	na
Goddard G, et al.(2002)(99)	Rural=90, Urban=102	RDC/TMD exam	USA	Indian reservation and San Francisco	5-84	ns	ns	Jaw pain rural=14.3%, Urban=20.8%

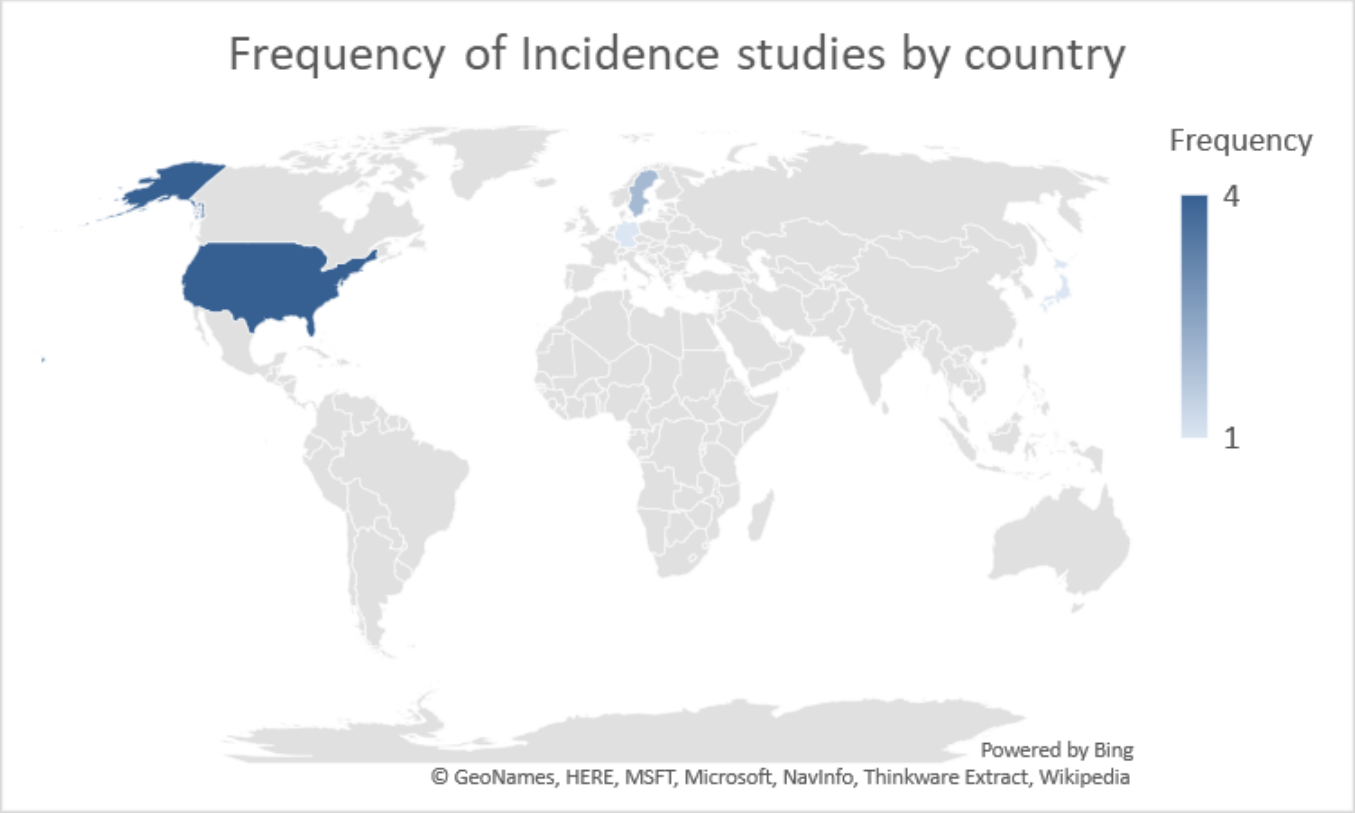
(Ia): Myofascial pain without limited mouth opening (Ib)Myofascial pain with limited; (IIIa) Arthralgias, ns- not stated, na-not applicable

Table 8: TMD Pain Prevalence studies using DC/TMD

Reference (author year)	Sample size(n)	Diagnostic system	Country	Source of Sample	Age	Prevalence in Males	Prevalence in Females	Total Prevelence
Jussila P, et al. (2017) (70)	1,962	Modified DC/TMD and 2Q TMD-P Question in last 30 days	Finland	Northern Finland Birth Cohort 1966 (NFBC 1966)	46	Myalgia=2.2%, Arthralgia=2%	Myalgia=7.4%, Arthralgia=8.2%	Myalgia=5.0%, Arthralgia=5.3%
Jivnani HM, et al. (2017)(78)	200	DC/TMD	India	Random sample of UG medical students	18-28	TMJ pain=3%	TMJ pain=4.5%	TMJ pain=7.5%
Graue AM et al. (2016)(54)	167	DC/TMD and 2Q TMD-P Question	Norway	Children and adolescents up to 19years through a public dental health service (PDHS).	12-19	ns	ns	Self-Report(7%), Exam (Myalgia=3%, Myalgia and Arthralgia=1.2%,Arthragia and Headache=0.6%)
Tay KJ, et al. (2018)(84)	2043	DC/TMD questionnaire	Singapore	Asian military	18-65	ns	ns	TMD pain=16.69%
Lovgren A,et al. (2018)(86)	54	DC/TMD questions and clinical exam	Sweden	Dental students	18-45	ns	ns	Myalgia=27.8%, Arthralgia=14.8%

3.2 Studies on Incidence of TMD Pain

Fig 4: Frequency of TMD Pain Incidence studies



There were eight studies that reported the incidence of TMD pain with four from the United States, as depicted in Figure 4. The summaries of these incidence studies are listed in Table 9. All the studies were from high-income regions. The annual incidence of TMD pain ranged from 2.0% to 4.5%. In one of the earliest studies based on TMD symptoms reported in follow-up interviews, the yearly incidence of TMD was 2%, with females tending to show a higher incidence rate than males. (106). LeResche et al. found the annual incidence in adolescents to be

2.3% based on clinical exam following the RDC/TMD protocol.(107) In another prospective cohort study that used clinical examinations to diagnose first onset TMD, the annual incidence rate was 3.5% in a cohort of 171 females aged 18–34 years who were followed for up to three years.(108) Another prospective cohort study by OPPERA of first-onset, painful temporomandibular disorders (TMD) found an annual incidence of 4%.(109)

Table 9: TMD Pain Incidence studies

Reference (Year)	Study type	Definition disorder	Country	Source of sample	Age	Years of follow up	Size baseline	The overall incidence(Annual	Incidence in male	Incidence in females
Sanders AE, et al. (2013)(109)	Prospective cohort	1) ≥5 days/month of pain in TMD locations specified by the examiner; and (2) examiner findings of Arthralgia, Myalgia or both	USA	General population through advertisement	18-44	2.8	2737	4.00%	ns	ns
Marklund S, et al. (2008)(90)	Prospective cohort	Clinical Exam -As per RDC/TMD	Sweden	Dental students in Sweden	18-30	1	308	4.00%	ns	ns
Nilsson IM, et al. (2007)(110)	Prospective cohort	Question- 1 month of TMD pain in last 12 month	Sweden	Regular patients at Public Dental services	12-19	1	2255	2.90%	1.30%	4.50%
G.D Slade,et al (2007)(108)	Longitudinal	Clinical exam	USA	Healthy Female volunteers	18-34	3	171	na	na	2.93%
LeResche, et al. (2007)(107)	Prospective cohort	RDC/TMD Axis 1	USA	11 years old HMO enrollees	11-14	3-36 month	1310	2.30%	ns	ns
Kitai, et al (1997)(111)	Longitudinal	Do you have any pain by active opening or lateral and forward movement of the lower jaw?	Japan	Female students	12-16	4	361	na	na	4.15%
Von Korff et al, (1993)(106)	Longitudinal	pain in the TM region in the last 6 months	USA	HMO enrollees	18-65	3	1061	2.17 per 100 pyr	1.6 per 100 pyr	2.6 per 100 pyr
Heikenheimo et al, (1990)(112)	Longitudinal	pain on maximal opening	Finland	adolescents	12-15	3	167	2.6 per 100 pyr	na	na

na=not applicable, ns=not stated,per year, pa-per annum

Chapter 4: Discussion

Descriptive epidemiological studies are usually undertaken to determine the prevalence and incidence of a problem or condition. Prevalence is calculated as the number of people with the condition at a point in time divided by the total number of people in that population. This measure can help to determine the magnitude of a health problem, and the burden it places on society. Pain often is the main cause when seeking help for TMD problems. (113)

Historically, a landmark cross-sectional study was performed by Helkimo using a classification system of pain and dysfunction and reported age- and gender-specific estimates of dysfunction among a population of Lapps in northern Finland in the early 1970s.(31) He found that the signs and symptoms of TMD were relatively common in this population, but that a smaller percent (21 to 31 percent) had severe dysfunction as per his index. LeResche, in a review article on the epidemiology of TMD, observed that reported jaw pain in children and adolescents varied from 0.7% to 4%, depending on age. (114) Variations in TMD prevalence can be attributed to the differences in the ages of the studied groups, the sample size, and its composition, the number of examiners, as well as definition of the diagnostic criteria. Another reason could be that interviews done directly with the children

possibly compromises the reliability of answers since seven years has been judged to be the minimum age at which a reliable interview can be conducted.

In the cross-sectional studies of TMD estimating prevalence, more than 14 different questions were used to ascertain the percentage of persons with self-reported TMD symptoms. As described by Drangsholt et al., these questions varied in the content of information according to at least six factors: 1) type of sensation queried (e.g. tightness, discomfort, or pain); 2) area of the sensation (pain) in the face, 3) whether the feeling (pain) occurs at rest (ambient), with jaw movement (functional) or is unspecified; 4) applicable time period - indefinite, an explicit time interval (e.g. during the last 6 months), or lifetime (ever); 5) pain frequency (e.g. sometimes, often, or very often); and 6) pain severity (e.g. mild, moderate, or severe). (20) Thus the variation in prevalence depends upon how the question is constructed, difference in characteristics of the samples (such as differences in sampling strategies, age, sample sizes, sex), as well as diagnostic system, variables, and data collection methods. Studies included in this review were population-based that is, people chosen from the population of an entire group, such as all adults with a telephone in a city, or all schoolchildren in a district, which generally yields unbiased prevalence estimates.

Ideally, questions should be constructed that are reliable and accurately assess the same concept across different languages and give prevalence estimates for a meaningful condition (such as pain) for a specific time interval, at a defined level of severity. The Research Diagnostic Criteria for TMD (RDC/TMD) was introduced in 1992, which provided both a standardized physical diagnosis and an assessment of the psychosocial factors that might affect treatment and prognosis. In RDC/TMD, the biopsychosocial model of pain was integrated by adopting a two-Axis model.(11) Axis I provided a physical assessment by diagnostic criteria, and Axis II, an evaluation of psychosocial status and pain-related disability. Since the introduction of RDC/TMD, it has been widely used in both research and clinical settings and has been translated into more than 19 languages. The efforts made by the International RDC/TMD consortium over the years have led to increased knowledge about TMD epidemiology and a much more standardized approach to TMD diagnosis.

In 2014, an extensive evaluation found high reliability of Axis I diagnosis, but the validity was below the suggested target.(39) Based on these findings, a revised version of the Diagnostic Criteria for Temporomandibular Disorders (DC/TMD) was launched in 2014, which had improved validity compared to RDC/TMD. Therefore, clinicians and researchers are nowadays recommended to use DC/TMD when categorizing TMD sub-diagnoses. Thus, a further increase in the diffusion of

the use of the DC/TMD in peer-reviewed journals may be reasonably considered to be a goal for the future.

Chapter 5: Conclusions and Limitations

A significant challenge in synthesizing these data was the extent of between-study methodological heterogeneity, particularly relating to the prevalence period and case definition, namely the minimum episode duration, the anatomical location, and whether cases had to experience activity limitation.

Very few of these studies reported the boundaries of time for the prevalence; for example, point prevalence, or pain experienced presently, was commonly mixed with period prevalence and lifetime prevalence, and this ambiguity probably explains some of the variations of the percentages. Also, the severity or the frequency of the pain was not usually reported. This may be problematic, for example, with smaller studies, where authors and readers may pay undue attention to differences in the proportions that maybe the play of chance.

The greatest strength of the study is the extensive systematic review that was undertaken to obtain data for the estimates. Some studies reported considerably higher rates, which may be because the data presented are raw data only and have not been adjusted for the definition of TMD, the study used, nor methodological differences, as occurs in GBD. These data in future GBD studies would be helpful to determine the global burden of TMD pain. Despite these strengths, there were some limitations. TMD has considerable impact on functional quality of life,

participation, and general well-being in addition to economic impact. These studies have not been included in this review and to gain a complete picture of the full impact of TMD in a population, it is important that the prevalence and incidence data be supplemented with burden of disease estimates. The distribution of severity may be different in low-income and middle-income countries where access to healthcare is limited. Disability weight related to TMD pain is less studied, and more information is needed for calculating the global burden of disorder but is an essential avenue for further research.

Chapter 6. References

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