Association Between Macro and Micro Traumatic Events and Temporomandibular Disorders: A Retrospective Study

A Manuscript-based Thesis

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DEDICATION

I would like to dedicate this work to my parents, who have been my pillars of strength and their love, encouragement, and guidance have shaped me into the person I am today. The immense gratitude and admiration I have for my parents is being reflected by this work, and it honors their unwavering faith in me, and I hope it makes them proud.

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LIST OF ABBREVIATIONS

TMJ Temporomandibular Joint

TMD Temporomandibular Disorder

TMDs Temporomandibular Disorders

TMJD Temporomandibular Joint Disorders

IASP International Association for the Study of Pain

NHIS National Health Interview survey

RDC/TMD Research Diagnostic Criteria for Temporomandibular Disorders

DC/TMD Diagnostic Criteria for Temporomandibular Disorders

NIH National Institute of Health

NSAIDs Non-steroidal Anti-inflammatory Drugs

OHIP Oral Health Impact Profile

ADL Activities of Daily Living

OPPERA Prospective Evaluation and Risk Assessment

VAS Visual Analogue Scale

OPG Orthopantomogram

MRI Magnetic Resonance Imaging

CBCT Cone- Bean Computed Tomography

MVA Motor Vehicle Accident

REB Research Ethics Board

MGH Montreal General Hospital

MUHC McGill University Health Center

Abstract

Introduction: Temporomandibular disorders (TMD) are the most common non-dental cause of orofacial pain which often occurs following micro or macro trauma. Musculoskeletal microtrauma is defined as damage to the tissue by constant exposure to low-magnitude forces (parafunctional habits etc.) whereas macro trauma refers to any direct or indirect injury to the jaw following a whiplash or vehicle accident, or prolonged mouth opening affecting tissue integrity.

Aim: Overall, the thesis aims to report and compare the TMD patient's characteristics, self-reported signs, and symptoms, clinical signs and examination findings, preceding events specifically micro and macro trauma as well as their association with TMD diagnosis and symptom severity. The primary objective is to assess the association of micro and macro traumatic events and temporomandibular disorders with the secondary aim to report the patient demographics, TMD-related history as well as symptomatic characteristics.

Methods: A cross-sectional study was conducted using the medical records of 465 patients visiting the Orofacial Pain and TMD clinic at Montreal General Hospital. Patients aged ≥15 years with a confirmed diagnosis of TMD based on DC/TMD criteria and without any pre-existing orofacial syndrome. Patient demographic, self-reported complaints, and clinical examination were evaluated. Patients were divided into 4 groups: Macro trauma, Micro trauma, Both and no trauma history. Patient characteristics, symptom severity, clinical signs, and diagnosis were compared using the chi-square test and One-way ANOVA. P-value ≤0.05 was considered statistically significant.

Results: Our sample population consists of 75.6% females and 24.4% males with the mean age of our sample population being 45.39. More than fifty percent of the patients reported pain in TMJ or jaw as the reason for consultation. Macro trauma was the reported cause of TMD among 210 patients and 59.1% of the total population reported parafunctional habits. A statistically significant ($p \leq 0.05$) association was found between reporting micro and macro traumatic events and TMD symptom severity. Micro trauma history was associated with TMD diagnosis. Although there was no association between macro trauma and type of TMD diagnosis, patients with macro trauma history had more severe TMD clinical signs and self-reported symptoms.

Conclusion: We conclude that different types of traumatic events may play a role in TMD development and patient's with micro/macro traumatic event history present with different patient-reported and clinical manifestations compared to those without any preceding event. Thorough patient history recording and clinical examination of TMJ will help to develop more effective and efficient preventive treatments, especially for those with facial trauma history, and will ultimately reduce patient discomfort, and treatment cost and improve quality of life.

RÉSUMÉ

Introduction : Les troubles de l'articulation temporo-mandibulaire (ATM) sont la cause la plus fréquente de douleur orofaciale non dentaire, souvent survenant après un micro ou macro traumatisme. Le microtraumatisme musculosquelettique est défini comme des dommages aux tissus causés par une exposition constante à des forces de faible amplitude (habitudes para-fonctionnelles, etc.), tandis que le macro traumatisme fait référence à toute blessure directe ou indirecte à la mâchoire suite à un coup de fouet, un accident de véhicule, ou une ouverture prolongée de la bouche affectant l'intégrité des tissus.

Objectif : Dans l'ensemble, la thèse vise à rapporter et comparer les caractéristiques des patients atteints de troubles de l'ATM, les signes et symptômes auto-déclarés, les signes cliniques et les résultats d'examen, les événements précédents spécifiquement les micro et macro traumatismes ainsi que leur association avec le diagnostic de troubles de l'ATM et la gravité des symptômes. L'objectif principal est d'évaluer l'association des événements micro et macro traumatiques et des troubles de l'articulation temporo-mandibulaire, l'objectif secondaire étant de rapporter les données démographiques des patients, l'historique des troubles de l'ATM ainsi que les caractéristiques symptomatiques.

Méthodes : Une étude rétrospective a été menée à partir des dossiers médicaux de 465 patients consultant le service de douleur orofaciale et de troubles de l'ATM de l'Hôpital Général de Montréal. Les patients âgés de ≥ 15 ans avec un diagnostic confirmé de troubles de l'ATM basé sur les critères DC/TMD et sans aucun syndrome orofacial préexistant. Les données démographiques des patients, les plaintes auto-déclarées et l'examen clinique ont été évalués. Les patients ont été répartis en 4 groupes : Macro traumatisme, Micro traumatisme, Les deux et aucune histoire de traumatisme. Les caractéristiques des patients, la gravité des symptômes, les signes cliniques et le diagnostic entre les deux groupes ont été comparés en utilisant le test du chi-carré et l'ANOVA à un facteur. Une valeur de $p \leq 0,05$ a été considérée comme statistiquement significative.

Résultats : Notre population échantillonnée est composée de 75,6 % de femmes et 24,4 % d'hommes avec un âge moyen de 45,39 ans. Plus de cinquante pour cent des patients ont signalé une douleur dans l'ATM ou la mâchoire comme raison de la consultation. Le macro traumatisme était la cause des troubles de l'ATM chez 210 patients et 59,1 % de la population totale ont

signalé des habitudes parafonctionnelles. Une association statistiquement significative ($p \leq 0,05$) a été trouvée entre le fait de signaler des événements micro et macro traumatiques et la gravité des symptômes de l'ATM. L'antécédent de micro traumatisme était associé au diagnostic de troubles de l'ATM. Cependant, il n'y avait pas d'association entre le macro traumatisme et le diagnostic de troubles de l'ATM, mais les patients ayant des antécédents de macro traumatisme présentaient des signes et symptômes de troubles de l'ATM plus sévères.

Conclusion : Nous concluons que différents types d'événements traumatiques jouent un rôle dans le développement des troubles de l'ATM et que les patients ayant des antécédents d'événements micro/macro traumatiques présentent des manifestations cliniques et auto-déclarées différentes par rapport à ceux sans événement précédent. Un enregistrement minutieux de l'historique des patients et un examen clinique approfondi des patients atteints de troubles de l'ATM aideront à développer des traitements préventifs efficaces et efficients, en particulier pour ceux ayant des antécédents de traumatisme facial, et réduiront finalement l'inconfort des patients, les coûts de traitement et amélioreront la qualité de vie.

PREFACE

This thesis follows a manuscript-based thesis style. As per McGill University standards, the manuscripts included in this thesis should be logically coherent and should have a unified theme. The first manuscript in this thesis provides an overview of Temporomandibular Disorders and Orofacial Pain Characteristic alongwith patient reported related signs and symptoms. The second manuscript retrospectively assesses the association of reporting of micro and/or macro traumatic events preceding symptom development and TMD using the patient reported symptoms and clinical examination findings. Following a brief introduction of the topic in the first chapter, the second chapter provides previous and current knowledge in the field of TMD in terms of its prevalence, diagnosis and identified etiological factors. Chapter three emphasizes the study aims and hypothesis. The methodology followed to accomplish the study aims was presented in chapter four. Manuscript one and two are presented in chapter five and six respectively. Chapter seven presents a comprehensive discussion including some methodological considerations for the present study. Chapter eight summarizes the conclusions drawn from both the manuscripts. Finally, chapter nine and ten elucidates the clinical implications of the study findings and the attempts made for knowledge translation respectively.

Multiple authors have contributed to the thesis work. Explicit appreciation of each author's contribution is mentioned in the following section.

CONTRIBUTION OF AUTHORS

Manuscript:1 Temporomandibular Disorders and Orofacial Pain Characteristic and related signs and symptoms: A retrospective study

Manuscript:2 Association Between Macro and Micro Traumatic Events and Temporomandibular Disorders: a retrospective study

Ayushi Naik BDS, M.Sc. Candidate: Contributed to reviewing of medical records of TMD patients, data extraction from medical records, data preparation and statistical analysis, and writing of the manuscript.

Firoozeh Samim, Assistant Professor, Faculty of Dentistry, McGill University. She conceived this investigation, designed, and supervised this study, guided with the statistical analysis, and contributed to manuscript writing. She also performed clinical examinations of patients.

CHAPTER 1 INTRODUCTION

Temporomandibular Disorders (TMDs) are the most common non-dental cause of facial pain (1). They are the second most prevalent musculoskeletal pain condition after low back pain (2), affecting the jaw muscles and temporomandibular joint (TMJ)(3). Signs and symptoms of TMDs include but are not limited to pain or tenderness in and around the ear, masticatory muscle, and face. Clinically, patients with pain-related TMD have pain on palpation of masticatory muscles and/or reduced jaw opening(4). TMDs as a group are categorized into pain-related TMD (i.e. myalgia, arthralgia, headache-attributed to TMD) and temporomandibular joint associated disorders (TMJD) (i.e. disc displacements and degenerative diseases)(2).

The National Institute of dental and craniofacial research statistics shows that the prevalence of TMDs ranges from 5% to 12% worldwide (5)**.** This high range is uncommon for a chronic pain condition. Additionally, TMDs are more frequently observed in younger age groups and affect approximately twice more females than males (5)**.** Despite of such high prevalence, only about 4 to 7% of the affected individuals seek treatment for TMD (6-8)**.**

TMD chronicity or pain recurrence is common in nearly two-thirds of cases and often requires long-term management (9). Conservative management approaches typically include patient education about the condition, self-care instructions, diet modifications, hot or cold compresses, massage, physiotherapy, and pharmacologic treatment with over-the-counter medications such as non-steroidal anti-inflammatory medications (NSAIDs) and muscle relaxants. Other treatments that may be implemented for patients who do not respond to conservative treatment include appliance therapy (such as occlusal splints, myofunctional appliances, etc.), trigger point injections with local anesthetics, acupuncture, laser therapy, and psychological management such as cognitive behavioral therapy if required (10).

Moreover, pain is known to become more resistant to treatment when it persists for a longer duration consequently leading to dysfunction that can affect the quality of life of individuals and result in adverse social and economic outcomes (11, 12).

An interplay of several identified biological (hormones, genetics), psychological (stress, anxiety, depression, etc.), and physical (micro trauma, macro trauma) factors are attributed to predisposing, precipitating, and prolonging TMD (13). However, these common etiological

factors assessed within a clinical setting such as parafunctional habits, can be both the cause and consequence of TMD. Therefore, it is difficult to predict whether they contribute to the onset of TMD or exacerbation of TMD symptoms or if they are manifestation of the condition itself (13, 14).

Previous studies have reported controversial findings regarding the contribution of microtrauma and macrotrauma to the development of TMD (15). Musculoskeletal microtrauma is defined as tissue damage resulting from constant exposure to low-magnitude forces such as parafunctional habits whereas macro trauma refers to any direct or indirect injury to the jaw following a whiplash or motor vehicle accident, or prolonged mouth opening affecting tissue integrity (16). However, these studies did not utilize the DC/TMD examination criteria for TMD diagnosis and did not compare important symptomatic parameters, such as self-reported pain descriptions, time elapsed between TMD onset and trauma, and accompanying symptoms, between patients with and without a history of trauma.

Therefore, the main goal of this thesis to provide an updated understanding to clinicians and researchers about the TMD patient population, including their signs and symptoms and assess the association of these symptoms with patient-reported micro and macro traumatic events.

CHAPTER 2 LITERATURE REVIEW

2.1 Prevalence of Temporomandibular Disorders

Prevalence refers to the common occurrence of a characteristic, risk factor, disease, or health condition within a specific population at a given time period (17). It is typically expressed as a percentage of the population and includes both all new and pre-existing cases in the given population at the specified time. There are two main types of prevalence measurement: point prevalence and period prevalence. Point prevalence measures the proportion of individuals with a particular disease or attribute on a specific day, while period prevalence measures the proportion of individuals with the disease or attribute at any time during a specified time interval (18).

Several studies have reported the prevalence of Temporomandibular disorders (TMDs). However, there are variations in prevalence estimates due to differences in the sample population, differences within the population, methodological and assessment approaches used as well as differences in pain assessment. This section aims to summarize the prevalence of painful TMD based on self-report and/or clinical examination in the adult population.

Table 2.1: Summary Prevalence of Painful TMDs based on self-report and/or clinical examination in the adult population

Authors, year	Study Aim	Study design & Method	Study population	Age (in years)	Final sample (n_f) / initial sample (n_i)/ Participation Rate (%)	Condition	Assessment	Prevalence & its Type
Locker and Slade et.al,1988(19)	Prevalence and distribution of TMD symptoms among the Canadian Population	Cross-sectional Random digit dialing technique Telephone survey	Households within the city of Toronto	≥ 18	677/1002/67.5%	TMD pain	Questions asked in the interview: joint pain, facial pain, stiffness or tenderness of jaw muscles, and frequent headaches and pain in the ears, neck, and around the eyes. Based on the response HELKIMO anamnestic classification was used.	12.9% (Point Prevalence)
Goulet *et al.*, 1995(7)	Prevalence in the general population of the classic triad of TMD symptoms, their interrelationships, and the degree of association between jaw pain and sleep problems.	Cross-sectional Telephone survey Random Digit Dialing	Provinc e of Québec	≥ 18	897/1386/64%	TMD pain	Questions asked:1. Would you say that you feel pain in the muscle of your jaws or in your jaw joints very often, quite often, sometimes, or never? If very often, quite often, or sometimes: (a) In general, would you say the pain intensity is mild, moderate, or severe? (b) In general, would you say the pain is mostly present upon awakening, in the morning, the afternoon, or in the evening? 2. Would you say that you have difficulty opening your mouth as wide as you wish because of jaw pain?	30% Point prevalence

A. Nekora-Azak *et al,* 2006(20)	Prevalence and distribution of symptoms commonly associated with TMD in the Turkish Population	Cross-sectional Telephone Survey Random Digit Dialing	Households, In the city of Istanbul	≥ 18	949/1253/75.7%	TMD Pain	Questioned for Joint and jaw pain, its severity, and functional consequences and treatment taken for same in the previous year. (same Questionnaire as Goulet et. al, 1995)	31% (Point prevalence)
Scmitter *et al.*, 2007(21)	Prevalence of myofascial pain and its association with occlusal factors in a threshold country non-patient population	Cross-sectional Self-reported questionnaire/ Clinical examination RDC/TMD	Six healthcare bases in Mashhad	18-65	151/171/88.3%	Myofascial pain	1)How would you rate your facial pain on a 0-10 scale at present, that is right now, where 0 is "no pain" and 10 is "pain as bad as could be"? RDC/TMD clinical examination	9.93% (point prevalence)
Isong *et al.*, 2008(22)	Temporomandibular Joint and Muscle Disorder-type Pain in US Adults	Cross-sectional Interview	General population, USA	≥ 18	24,568/30,987/79.2 %	TMD pain	Question: **"**During the past 3 months, did you have facial ache or pain in the jaw muscles or the joint in front of the ear?**"**	4.6% (3- month Period prevalence)
Janal *et al.*, 2008(23)	Prevalence of myofascial temporomandibular disorder in US community women	Cross-sectional Telephone survey/ Clinical examination RDC/TMD	Households in Manhattan, Newark. USA	18-75	782/2033/35.8%	Myofascial pain	**'**Other than a toothache or sinus pain, did you have pain in your face, in the front of your ear or jaw, more than one time, in the last 6 months?**'** Clinical examination RDC/TMD	10.5% (6-month Period prevalence)

Mobilio *et al.*, 2011(24)	Prevalence of TMD symptoms in the Italian population	Cross-sectional Telephone survey	Households in the Municipality of Ferrara, Italy	15-70	2,005/2196/91.3%	Painful TMD	Do you feel pain in your jaw joints or in your jaw muscles at rest or during the jaw movements? Is the pain intensity mild, moderate or severe? Selected questions from RDC/TMD	5.1% (3-month period prevalence)
Türp et al.,2015(25)	Prevalence of self-reported jaw pain in Germany: two cross-sectional surveys of the general German population	Two Cross-sectional Studies Self-reported Questionnaire	Randomly selected general German population	≥ 14	2524/4064/62.1% 2515/4448/56.5%	Jaw Pain	"Whether jaw pain had been present during the previous 7 days?" "Whether pain had generally been present during the past 3 months?"	4% (7-day period prevalence) 0.9% (3- months period prevalence)
Gillborg *et al.*, 2017(26)	Prevalence of temporomandibular disorder (TMD) pain and examine its association with gender and other factors.	Cross-sectional Self-reported questionnaire	Randomly selected population of southern Sweden	20-89	6300/10,000/63%	TMD pain	1) Do you have pain in your temples, face, temporomandibular joint, or jaws once a week or more? (2) Do you have pain when you open your mouth wide or chew once a week or more?	11% (point prevalence)

Iodice et al.,2019(27)	Prevalence of TMD-pain and TMJ noises on n adult population sample, and to evaluate the association between TMD symptoms and oral behaviors self-reported facial trauma and orthodontic treatment.	Cross-sectional study Face-to-face Interview Self-reported questionnaire	General Population Italy	≥ 18	4299/6180/69.5%	TMD pain and TMJ noises	3-item validated for TMD pain screener RDC/TMD for TMJ sounds	16.3% (1-month period prevalence)
Nadershah et al.,2019(28)	Prevalence of TMJD in adults in Jeddah	Cross-sectional Study Self-reported questionnaire	Primary care dental centers Jeddah, Saudi Arabia	≥ 18	500	TMD pain	3-item validated for TMD pain screener	35% (1-month period prevalence)
Qvintus et al.,2020(29)	Prevalence of clinical signs and pain symptoms of TMDs and associated factors in adult Finn	Survey Clinical TMD examination	Health Survey Finland	≥ 18	1577/3469/45.6%	TMD pain	Do you have pain in your temples, face, temporomandibular joint, or jaws once a week or more? (With answering options No/Yes) (Question 1) Do you have pain when you open your mouth wide or chew once a week or more? (With answering options No/Yes) Clinical Examination	34.6% (point prevalence)

Alkhubaizi et al., 2022(30)	Prevalence and risk factors of TMD-related pain in a sample population of dental school clinic patients	Observational cross-sectional study Self-reported questionnaire DC/TMD examination	University Dental Center Kuwait	≥ 18	199/199/100%	TMD pain	3-item validated for TMD pain screener	26.8% (1-month period prevalence)

RDC/TMD- Research Diagnostic Criteria for Temporomandibular Disorders.

TMJ- Temporomandibular Joint

TMD- Temporomandibular Disorder

In 1988, Locker and Slade conducted a telephonic survey using a random digit dialing technique to estimate the prevalence and distribution of TMD symptoms among the Canadian population (18). The study included a random sample of 677 individuals who were representative of 600,000 people aged 18 years and older residing in households in Toronto. Participants were asked to complete a self-reported questionnaire consisting of questions related to various TMD symptoms, such as joint pain, facial pain, joint sounds, limitation in mandibular movement, locking, stiffness or tenderness of jaw muscles, and frequent headaches and pain in the ears, neck, and around the eyes. The participants were then classified based on their responses using the HELKIMO anamnestic classification.

The results of the study showed that the self-reported point prevalence of one or more TMD symptoms was found to 48.4%, with higher reporting of symptoms by women and those aged 44 years and under. The point prevalence of TMD pain was found to be 12.9% among the study population, however, only 3.5% to 9.7% individuals reported needing treatment for their TMD symptoms (19).

A study conducted in the Province of Quebec, assessed of prevalence and self-reported pattern of TMD jaw pain in a random stratified sample of 867 individuals aged 18 years and older (7). Standardized questions were used to collection information on the frequency, intensity, daily pattern of jaw pain, presence of difficulty in opening, joint clicking, and sleeping problems related to TMD.

The study results showed that overall, 30% of the samples responded positively to the presence of jaw pain, however when only those reporting frequent jaw pain were considered the prevalence dropped to 7%. The study concluded by reporting frequent episodes of jaw pain among one out of 15 individuals, but only 2% of the population sought treatment in the preceding nine months (7).

A study conducted in households of Istanbul, utilizing the same questionnaire as Locker and Slade and Goulet, reported similar prevalence of jaw pain, with approximately 31% of respondents reporting it (20). About 21.7% of the positive respondents reported sleep disturbance and 12.2% sought treatment for at one TMD symptom in the preceding year. The study found a significant association between TMD pain and difficulty in opening mouth (20).

Another cross-sectional study in the city of Mashhad focusing on females visiting the government financed medical bases, reported a point prevalence of 9.93% (21). Clinical examination confirming TMD diagnosis was carried out in accordance with the RDC/TMD criteria which evaluated TMJ clicking and pain, masticatory muscles using defined pressure and mandibular range of motion. The response rate for the study was 95% and the estimated prevalence of myofascial pain was comparable to other studies which applied RDC/TMD (21).

In 2008, Isong et al and Janal et al individually carried out cross-sectional studies in the US to report the prevalence of TMD and myofascial pain in US adults and community women respectively. Isong et al. collected the data from the National Health Interview Survey 2002 (NHIS) consisting of 30,978 people. They reported a 3-month period prevalence of self-reported Temporomandibular Joint Disorder pain (TMJD) to be 4.6% and illustrated racial and gender differences in TMD prevalence. They reported that non-Hispanic white women have a higher prevalence of TMD. In comparison to this, Janal et al. conducted a random telephonic survey within the telephone exchanges in Manhattan. The reported 6-month period prevalence in community women was 10.5%. Unlike Isong, Janal implements RDC/TMD criteria for diagnosis (22, 23).

In a study conducted in the municipality of Ferrara, Italy, using the random digit dialing technique, 3,400 calls were attempted to measure the prevalence of TMD symptoms. Based on the initial pilot analysis of 120 calls to understand the compliance, acceptability and cooperation of population, an age group of 15- 70 years for chosen for the study. Parental consent for 15-18 years age group was acquired. The interviewer was trained on the use of RDC/TMD questions prior to commencement of the data collection. The participation rate was 91.3% and the final sample was composed of 804 males and 1201 females. Among 5.1% of individuals who complained of jaw pain, more than half of the individuals reported mild pain. Jaw clicking was prevalent among 33.3% of the individuals and parafunctional habits were reported by 37.3% of the sample population. The study reported lower prevalence in the Italian population as compared to the other previously conducted studies (24).

In 2015, two cross-sectional surveys were conducted within the German population to estimate the prevalence of self-reported jaw pain over a 7-day period and 3 months duration. The representative sample consisted of 2425 and 2515 individuals, respectively, who were assessed

using Regional Pain Scale. In the first survey, the 7-day period prevalence of jaw pain was 4% amongst which 60 individuals were experiencing unilateral jaw pain and 40 participants reported bilateral jaw pain. In the second survey, as the duration of the pain increased, the period prevalence reduced to 0.9%. Pain on one side of the jaw was reported by twelve individuals, whereas pain on both sides was reported by ten participants (25).

Gillborg et al. conducted a study in southern Sweden and estimated the prevalence of TMD pain to be 11%. They randomly selected 10,000 subjects aged 20-89 years residing in the Skåne region and collected responses from 6330 subjects who reported experiencing facial pain at least once a week while opening their mouth or chewing. The gender distribution of the participants was comparable to that of the general population and females experienced 1.4 times more TMD pain as compared to males. Participants with TMD pain also reported more frequent headaches, higher oral health impact profile (OHIP-14) score, almost thrice more tooth wear, and poor general health as compared to other participants without TMD pain. (26)

In Italy, a cross-sectional study was conducted in the Campania region, where data were collected from the general population in public spaces such as supermarkets, cinemas, shopping centers, etc. The study included 6,180 individuals older than 18 years with sufficient comprehension of the Italian language and without any self-reported systemic and psychiatric disease. The final sample of 4299 individuals comprised 60.5% females and 1853 subjects within the age group of 18 – 30 years. The study reported a higher prevalence of TMD among young adults and females. TMD clicking (30.7%) was the most reported symptom followed by TMD pain (16.3%) and TMJ crepitus (10.3%). Oral behavior, facial trauma, and orthodontic treatment were reported by 29.1% of subjects, 7.2% of subjects, and 43.6% respectively. The study found a significant association between TMD pain and female gender, oral behavior as well as facial trauma, however, reported that ongoing orthodontic treatment seems to only temporarily increase TMD complaints (27).

Nadershah conducted a cross-sectional study in the primary care dental centers in Jeddah, Kingdom of Saudi Arabia, recruiting 500 participants equally from five areas in the city. The sample had an equal distribution of males and females. The study utilized a 3-item TMD pain screener developed by Gonzalez *et al.*(31), where a score of 3 or more indicated the presence of

TMD. Among recruited participants, 46% reported intermittent pain in the temple or jaw, and 35% of the total sample screened positive for TMD pain (28).

Qvintus et al. conducted a study on the prevalence of TMD signs and symptoms based on the follow-up 2011 Health survey conducted to assess the well-being of Finnish Adults. From the total 8135 invitees of the survey, 3469 individuals were invited to participate in the Oral health examination. Only 45% of the individuals participated in the oral examination and one-third of the participants reported at least one TMD clinical sign. Following the clinical examination, participants were inquired for self-reported TMD pain symptoms using the two questions by Nilsson et al.(32) and found that most of the participants had facial pain weekly compared to pain on jaw function. The most reported clinical sign was TMJ clicking with a prevalence of 15.4% However, the study authors noted that no solid conclusions could be drawn on TMD diagnosis from the acquired data, although the study results were representative of the Finnish population (29).

In a recent cross-sectional study conducted at the Kuwait University Dental Center which offers free dental care to the entire population, the characteristics of patients with TMD pain were assessed and its prevalence was estimated. The study enrolled 199 fully dentate participants aged 18 years or above who did not have any acute odontogenic pain, history of orthodontic treatment or facial trauma or previous treatment with occlusal guard. The one-month period prevalence was evaluated using TMD pain screener and was found to be 26.5%. However, its important to note that the positive TMD cases were not confirmed with a clinical examination in this study (30).

It is evident from the results of the above studies that prevalence of TMD is highly variable across different populations ranging from as low as 0.9% to as high as 31%.

2.2 Diagnostic Approach for TMD

2.2.1 History recording in TMD patient

A thorough patient history is crucial in the evaluation and management of TMD (Temporomandibular Joint Disorders) and differentiation from other orofacial pain conditions

with similar manifestations. TMD has a multifactorial etiology, and a comprehensive patient history can provide valuable information to help develop an appropriate treatment plan(33, 34).

Recording the chief complaints and their duration is important to understand the nature of the pain and its timeline. Gathering information about events preceding the pain initiation, aggravating factors such as chewing, speaking, yawning, etc., and alleviating factors can provide insights into the triggers and exacerbating factors of TMD symptoms(35).

Obtaining a detailed dental history, including any previous dental treatments and oral parafunctional habits such as teeth clenching or grinding, can help identify potential contributing factors to TMD(36).

Recording pain description and rating the pain intensity on a visual analogue scale (VAS) can aid in differentiating TMD from other orofacial pain conditions, such as neuropathic pain, atypical facial pain, or orofacial neuralgias, and can also be useful in monitoring treatment progress over time(35).

In addition to dental history, obtaining a detailed past and current medical history, including medication listing and hospitalization history, is important to identify any existing comorbid conditions that may impact TMD prognosis or increase pain sensitivity (36,37).

Recording recreational habits such as smoking, alcohol or drug use, as well as information on stress levels, sleep quality, level of life satisfaction, and recent or past traumatic events, such as loss of a close family member or job loss, can provide insights into potential risk factors or triggers for TMD symptoms (33).

A comprehensive patient history, along with a thorough clinical examination, can provide valuable information for accurate diagnosis and development of an appropriate treatment plan for TMD patients. It is important for clinicians to take a holistic approach and consider various factors that may contribute to TMD to provide optimal care to patients(37).

2.2.2 TMD Screening

TMD pain disorder screener was developed by Gonzalez *et al.*(31), consist of short (three-item) and long (six-item) versions. This screening instrument has exhibited excellent validity in

identification of participants with painful TMD (sensitivity; 99%) and healthy control participants (specificity; 97%) (31). The TMD screener is represented in Table 2.2.

Table 2.2: Temporomandibular Pain Disorder Screener
1) In the last 30 days, on average, how long did any pain in your jaw or temple area on either side last? a. No pain b. From very brief to more than a week, but it does stop. c. Continuous.
2) In the last 30 days, have you had pain or stiffness in your jaw on awakening? a. No b. Yes
3) In the last 30 days, did the following activities change any pain (that makes it better or makes it worse) in your jaw or temple area on either side? A. Chewing hard or tough food a. No b. Yes B. Opening your mouth or moving your jaw forward to the side a. No b. Yes C. Jaw habits such as holding teeth together, clenching, grinding or chewing gum a. No b. Yes D. Other jaw activities such as talking, kissing or yawning a. No b. Yes

Note: Items 1 through 3A constitute the short version of the screening instrument, and Items 1 through 3D constitute the long version. An “a” response has 0 points, a “b” response 1 point, and a “c” response has 2 points.

2.2.3 TMD Diagnosis

Table 2.3 Clinical And Research Application of DC/TMD Axis I and Axis II tests

	Axis I: Physical Assessment		Axis II Psychological States	
	Pain Diagnosis	Joint Diagnosis	Distress and Pain Disability	
Application	Clinical or Research		Clinical	Clinical or Research
Screening Test	TMD pain Screener	DC/TMD for disc displacement, degenerative joint disease and subluxation	PHQ-4, GCPS	PHQ-9,GAD-7,PHQ-15 and GCPS
Confirmatory test	DC/TMD for myalgia, arthralgia and headache attributed to TMD	MRI (Disc Displacements), CT scan (Degenerative disorders),Panoramic radiographs, MRI or CT scan for subluxation	Combination with the mental health provider	Psychiatric or behavioural medicine interview

Patient Health Questionnaire-4(PHQ-4), Graded chronic pain scale (GCPS), Patient Health Questionnaire-9(PHQ-9), Generalised Anxiety disorder-7(GAD-7), Patient Health Questionnaire-15 (PHQ-15)

Several diagnostic instruments are available to implement in clinical and research setting such as Helkimo’s Index, Symptom Severity Index (SSI), Craniomandibular Index (CMI), and Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD), and Diagnostic Criteria (DC/TMD). The current most used diagnostic instrument is DC/TMD which was derived from revisions of the RDC/TMD(38).

2.2.3.1 Diagnostic criteria for Temporomandibular disorders (DC/TMD)

The DC/TMD diagnostic instrument accounts for both physical assessment (Axis I) and Psychosocial assessment (Axis II). Upon physical assessment, TMD diagnosis is broadly classified into muscle disorders, TMJ disorders and headache attributed to TMD. Muscle disorders are further divided into myalgia; tendonitis; myositis; and spasm. Among these, Myalgia is further sub-classified as local myalgia, myofascial pain and myofascial pain with a referral. TMJ disorders mainly consist of arthralgia, disc displacement with reduction, disc displacement with reduction with intermediate locking, disc displacement without reduction with a limited opening, disc displacement without reduction without limited opening, degenerative joint disorders (osteoarthritis, osteoarthrosis), luxation and subluxation (38). Table 2.3 demonstrates Axis I and Axis II along with various screening instruments, questionnaires and confirmatory diagnostic test to be applied in clinical and/or research setting when following the DC/TMD criteria.

2.2.4 Intra-oral and Extra-oral examination in TMD patients

Based on the location of pain indicated by the patient through pointing to the painful spot in the orofacial region, clinicians must confirm by thoroughly palpating the spot and the surrounding areas to determine if the pain is localized or widespread. Palpation should be performed both at rest and during mandibular function. The presence or location of clicking and crepitus in the TMJ should be confirmed by auscultation with a stethoscope. Other factors such as overjet, overbite, occlusal relationship, range of mouth-opening including pain-free maximum mouth opening, maximum unassisted mouth opening, maximum assisted mouth opening, and any deviation of the mandible should be recorded (38). An intra-oral examination should be conducted to assess the state of dentition, identify any dental problems, and detect mucosal pathologies of the hard and soft tissues of the oral cavity and pharynx (35).

2.2.5 Imaging

Imaging is a valuable adjunct in TMD diagnosis. Although orthopantomogram (OPG) provides limited information, it is the most commonly used, simple, convenient and cost-effective imaging modality for TMD. Differential diagnosis of bony TMJ such as neoplasms, fractures, growth disturbances, ankylosis can be easily ruled out using (OPG) (39). Magnetic resonance

imaging (MRI) is the gold standard for assessing the osseous and non-osseous structures surrounding TMJ, while Cone-Beam Computed Tomography (CBCT) is primarily used to further evaluate the osseous structures abnormalities such in cases of TMJ ankylosis, benign bony neoplasms or overgrowth, or for the planning of osseous surgery, such as for eminectomy for recurrence TMJ dislocation (40). Other less often used imaging modalities include ultrasound and bone scintigraphy but are used minimally due to low sensitivity and specificity (41-43).

2.3 Factors involved in TMD onset and persistence.

The etiology of TMD is believed to be multifactorial, involving a complex interplay of various biological, mechanical, psychological, social, cultural, and emotional risk factors that contribute to the development, persistence, and predisposition of TMD pain and dysfunction. A systematic review has identified several factors associated with TMD, including patient demographics, sex hormones, genetics, trauma, occlusal changes, parafunctional habits, stress, pain coping etc as identified factors associated with TMD (44). The aim of this section is to review in detail the role of above listed risk factors in the TMD etiology.

2.3.1 Socio-demographics

Several cross-sectional, case-control studies and systematic reviews have consistently reported that female gender increases the risk of TMD. A systematic review of cross-sectional studies conducted by Bueno et al, to evaluate gender differences in the prevalence of TMD and found that female gender has two times greater risk of TMD as compared to males (45). The socio-demographic analysis of the "Orofacial Pain Prospective Evaluation and Risk Assessment" (OPPERA) case-control study participants indicated that females had three folds greater odds of developing TMD as compared to males (46). Additionally, a retrospective study of TMD patient visiting dental clinics at University of Minnesota school of dentistry conducted by Chatzopoulos et al, found that there were four times more female TMD patients as compared to males (47).

However there are some contradictory findings as well. For example, a prospective cohort study conducted in the year 1986 among the Health Maintenance Organization enrollees (n = 1016) in Seatle, showed that the risk of developing TMD was only slightly higher among females as compared to males (48). This variation in findings of medical records-based studies vs

population-based studies indicates that gender differences are more relevantly associated with care seeking behavior and severity of TMD rather than incidence.

It should be noted that while female gender has been identified as a consistent risk factor for TMD, the exact mechanisms underlying this association are not fully understood and further research is needed to better elucidate the relationship between gender and TMD risk.

The occurrence of TMD tends to peak during individuals' full fertility age, which typically falls within the age group of 30-45 years. However, studies have shown that the onset of TMD can be observed among young adults in the age group of 18 to 44 years, with higher prevalence of TMJ pain reported in this age group (14).

A 2-year prospective cohort study conducted among UK adults between 2003-2004 also reported similar associations between TMD symptoms and age, with young adults experiencing higher prevalence of TMD symptoms compared to older adults (49). Similarly, population based studies conducted by LeReshe et al. and Glass et al., demonstrated a higher prevalence of TMD signs and symptoms among individuals in the age group of 25 to 54 years of age group (50, 51).

However, there are some studies that have not found significant variations in TMD prevalence with age. For example, a study conducted in rural areas of northeast Germany which involved clinical and anamnestic examination of the population, did not find significant differences in TMD signs and symptoms prevalence with age (52).

The variation in prevalence trends of TMD with age could be influenced by multiple factors, including differences in study populations, methodologies, and cultural or environmental factors. Further research is needed to better understand the relationship between age and TMD prevalence, as well as the potential mechanisms underlying the observed variations.

The role of race and ethnicity in TMD prevalence and incidence is an important area of research, and findings from studies have shown some variability. For example, a study conducted by Plesh et al. in California among African-American and Caucasian women in the age group of 19 to 23 years found a threefold higher reporting of facial and jaw pain among Caucasian women compared to African-American women (53).

On the other hand, the OPPERA study, which investigated risk factors for first onset TMD, reported that African Americans had the highest TMD incidence compared to Whites and Asians (41). This suggests that race and ethnicity may play a role in TMD incidence, with African Americans being at higher risk for developing TMD.

It is important to note that race and ethnicity are complex factors that can be influenced by various social, cultural, and environmental factors. Additionally, disparities in healthcare access and utilization, as well as potential biases in reporting and diagnosis, may also contribute to the observed differences in TMD prevalence and incidence among different racial and ethnic groups.

The relationship between socioeconomic status and TMD is also complex and remains unclear. It is possible that there may be bidirectional associations, where TMD may impact an individual's ability to work efficiently, leading to work loss and resulting in lower socioeconomic status. On the other hand, lower socioeconomic status individuals tend to be more stressed and are at higher risk of developing moderate to severe TMD when compared to those with high socio-economic status (54).

2.3.2 Hormones

There is evidence to suggest that female sex hormone, particularly estrogen may play a role in the prevalence and pathophysiology of TMD (55). Several studies have found higher levels of estrogen in TMD patients compared to healthy controls. For example, Landi et al. compared the serum levels of estrogen (17-beta-estradiol) and progesterone levels among TMD patients and healthy controls and found that TMD patients had higher levels of 17-beta-estradiol compared to healthy controls, although the levels of progesterone were nearly same (56).

Other studies have also explored the impact of use of oral contraceptive pills or exogenous hormone on the risk of developing TMD. These studies concluded that the risk of developing TMD was approximately 30% higher among women receiving oral contraceptive compared others (57). However, another study proposed although exogenous hormones increase risk of TMD among women, endogenous hormone are essential for TMJ remodeling (58).

Animal studies have shown that estrogen centrally affects pain neurotransmission and modulation (59, 60). Overall, a systematic review of studies evaluating relation of estrogen levels

with TMD concluded weak association among them and proposed that further investigation is required to confirm the co-relation (61).

Overall, while further research is needed to better understand the role of female sex hormones in TMD, there is evidence to suggest that estrogen may play a role in the prevalence and pathophysiology of TMD, and hormonal factors should be considered in the assessment and management of TMD in females.

2.3.3 Genetic Factors

Taking into account the multifactorial etiology of TMD, several genetic variants are expected to contribute to its development and progression (62). The OPPERA study performed genotyping of 358 genes which are involved in pain processes by comparing TMD cases with controls. The study found an association between HTR2A and COMT genes and TMD. They also revealed few other genes such as NR3C1, CAMK4, CHRM2, IFRD1, and GRK5 to be potential risk factors for TMD (63). A few biological pathways demonstrating the interaction of genetic variation in developing TMD were proposed by Smith et al. in a prospective cohort study (64).

A systematic review evaluating the role of heritability in TMD pain concluded that there is definitely gene involvement, however, it is the cumulative effect of genes along with other environmental factors which leads to TMD development. Furthermore, it is evident from the literature that genetic contributions from candidate genes that encode proteins involved in the processing of painful stimuli from the serotonergic and catecholaminergic system (65).

Further research is needed to better understand the specific genetic mechanisms and pathways involved in TMD, and how they interact with other environmental factors to contribute to the development and progression of this condition. Genetic studies can provide valuable insights into the underlying biological mechanisms of TMD, which may lead to improved diagnosis, prevention, and management strategies in the future.

2.3.4 Occlusal Factors

The relationship between occlusion and TMD has not been well-understood and has remained a topic of controversy among the dental community. Various population-based studies evaluating the association between different types of malocclusions, functional occlusion and TMD among

adults were reviewed in a systematic review. The findings on the association between occlusion and TMD were highly inconsistent, and no specific morphological or functional occlusal factor was significant.

Some studies have reported positive relationship between number of rotated laterals and patient reported dysfunction as well as between excessive abrasion and clinical dysfunction. However,the strength of these co-relations was unclear (66). Similar results were reported by a large epidemiological cross-sectional survey of adults residing in Pomerania which aimed to study the association between morphologic occlusion as well as factors of functional occlusion and participant perceived TMD symptoms (67). A review highlighting the role of functional occlusal relationships in TMD suggest that most controlled studies do not demonstrate any association between occlusal interferences and TMD signs and symptoms. Except for TMJ condyle repositioning secondary to intracapsular arthrosis, no TMD conditions are associated with occlusal factors. Moreover, TMD symptom provocation or in general TMJ health is not influenced by occlusal guidance patterns (68). Another recent systematic review also confirmed that there is no disease-specific association between occlusion and TMD (69).

Pullinger et al., retrospectively studied the association of previous orthodontic treatment in TMD patients and reported that although no significant association was found, symptoms of TMD were more severe among orthodontically treated patients (70). A case-controls study determining and evaluating the combined effect of factors associated with TMD found no significant association of orthodontic treatment (71). A systematic review aiming to evaluate the studies reporting influence of malocclusion and orthodontic treatment on TMD reported higher prevalence of symptoms among subjects with untreated crossbite, crowding of teeth/high PAR (Peer Assessment Rating) index value (overall severity of malocclusion), or large overjet. However, other studies reported no co-relation between malocclusion and TMD. Furthermore, there was no influence of difference types of orthodontic treatment as well as no difference between TMD patients treated and untreated for malocclusion (72). A twenty-year cohort study reported that orthodontic treatment neither causes nor prevents TMD (73).

2.3.5 Parafunctional Habits

Oral parafunctional habits include nail biting, gum chewing, lip biting, teeth clenching/ grinding (bruxism) etc (74). Bruxism is the most associated parafunctional habit with TMD and can be defined as voluntarily or involuntarily repeating jaw movements such as teeth grinding, clenching, or bracing or thrusting of the mandible. Bruxism can be during sleep or during awake state and is referred to as night bruxism or awake bruxism respectively (74).

A cross-sectional telephonic survey of the general population of United Kingdom, Germany and Italy was conducted using the clinical questionnaire on bruxism (using the International Classification of Sleep Disorders [ICSD] minimal set of criteria) found 8.2% prevalence of self-reported teeth grinding at least weekly. Moreover, the study also reported more than hald of these subjects to have consequences of sleep bruxism such as pain or discomfort on waking up, increasing teeth sensitivity, increased necessity of dental treatments etc. This signifies that oral parafunctional habits act as micro-trauma's to the TMJ (75).

Studies have shown that oral parafunctional habits are a risk factor for TMD development and persistence. A systematic review of the cross-sectional studies associating parafunctional habits with TMD conducted until 2008 concluded a strong positive association between self-reported bruxism and TMD pain but weaker association with TMD symptoms when clinical diagnostic criteria were applied (76).

Farella et al., experimentally studied the impact of prolonged teeth clenching by recruiting 10 pain-free females who were asked to clench to exhaustion in randomized maximum clenching force. The authors evaluated perceived pain, fatigue and pressure-pain thresholds in the masticatory muscles before, immediately after experiment and following day and found that prolonged low-level tooth clenching causes delayed soreness in the jaw-elevator muscles (77).

A study evaluated oral parafunction as a risk factor among TMD patients by comparing them with healthy controls and found that the odds of having TMD increases by 4.9 with day time clenching/grinding (78). When comparison of frequency, amplitude and duration of daytime clenching or grinding was done among women with masticatory myalgia and pain-free individuals while performing standardized mental ability tasks, higher frequency of parafunction was observed among patients with existing masticatory pain. Therefore, the association between bruxism and TMD is not well understood in terms of cause-effect relationship (79). One cannot

truly say if parafunction habits caused TMD or if TMD lead to increased parafunctional behavior.

2.3.6 Psychosocial factors

Anxiety and Depression are the two most commonly reported and associated psychological factors in chronic pain conditions like TMD (80). Although the co-relation with TMD remains unclear as one cannot strongly predict whether psychological factors preceded TMD or were a result of TMD.

A combined cross-sectional and prospective study explored the relationship between anxiety trait, subjective somatic symptoms and pain associated with TMD. The study was conducted by recruiting 106 TMD patients who were clinically examined and filled out the McGill Pain Questionnaire (MPQ), State Trait Anxiety Inventory (STAI) and Somatic Complaints Questionnaire (SCQ) at time of recruited and two years after evaluation and treatment. The results of the study found a significant correlation between anxiety, somatic complaints and TMD-pain and concluded that these factors are important predictors of TMD pain, response to treatment and progression (81).

A prospective cohort study reporting whether depressive symptoms were associated with onset of 5 common pain symptoms (back pain, severe headache, chest pain, abdominal pain and TMD pain) among 806 participants of the adult health maintenance organization in Seattle. These participants were interviewed at the time of study enrolment and followed -up three years period using the Symptom Checklist 90-Revised (SCL-90-R) Depression scale. The study did not find any significant association between depressive symptoms and TMD incidence and the odd's ratio reported after adjusting for age, sex, education and severity of depressive symptoms were normal (OR = 1.00), moderate (OR = 1.17), and severe (OR = 1.60) (48). This signifies that there is no difference in risk of developing TMD among moderate to severely depressed subjects(48).

Longitudinal epidemiological study among enrollees of the group health cooperative to assess the various physical, psychological and behavioral factors involved in the course of TMD was conducted by Orbach and Dworkin. Pain intensity was rated on visual analogue scale (VAS), clinical examination was conducted to assess the physical factors, and depression, anxiety as well as somatization was assessed using SCL-90-R. The findings of the study showed that

somatic awareness scores decreased in TMD patients who reported substantial improvement in facial pain after 5 years and that baseline somatic awareness scores predicted levels of pain following treatment (82).

The OPPERA study also prospectively explored and reported several psychosocial factors to be associated with the risk of developing TMD. This study utilized several psychosocial measures such as STAI, SCL-90-R, perceived stress scale (PSS), Life experience survey (LES), measures of somatic symptoms and pain coping/catastrophizing. The most strongly associated psychosocial factors were perceived stress, stressful life events and negative affectivity (83). We can say that several psychosocial factors interact and play a role in increasing the risk of development and chronicity of TMD. Moreover, these psychosocial factors can also be an outcome of the existing TMD condition, and therefore, it is difficult to rule out the exact etiology.

A very few prospective studies on risk factors for the first onset of TMD have been conducted. One such study comparing the epidemiology of pain complaints has confirmed that the presence of an existing chronic pain condition is a strong predictor for developing another pain condition (78).

Overall, while there is evidence suggesting a relationship between psychological factors and TMD, the exact nature of this relationship and whether psychological factors are a cause or a consequence of TMD remains uncertain and requires further research. It is likely that a complex interplay of various factors, including oral parafunctional habits, psychological factors, and other biopsychosocial factors, contribute to the development, persistence, and chronicity of TMD.

2.3.7 Pain amplification due to Co-morbid pain conditions

A very few prospective studies on risk factors for the first onset of TMD have been conducted. One such study comparing the epidemiology of pain complaints has confirmed that presence of an existing chronic pain condition is a strong predictor for developing another pain condition (84).

A population based cross-sectional study obtained data from the 2000–2005 US National Health Interview Survey (NHIS) to compare the prevalence of self-reported co-morbid conditions such

as headache and pain in neck, back or joints among TMD respondents. The study reported that 83% of the individuals reporting TMD have at least one existing pain co-morbidity and among those approximately two-thirds of individuals reported more than one pain comorbidity. Furthermore, less than 17% of individuals reported TMD pain without any existing pain co-morbidity. The likelihood having low-back pain is 2.5-5 times greater among TMD pain patients (85).

A recent systematic review evaluated the cross-sectional studies conducted on the presence of co-morbid pain conditions among TMD patients. The review included 8 studies which report chronic pain conditions present among TMD patients. More than 50% of the TMD patients report existing chronic pain conditions such as chronic back pain, myofascial syndrome, and chronic stomach pain. Other reported conditions were chronic migraine headache (40%), irritable bowel syndrome (19%), and fibromyalgia (14%) (86).

A study assessing the relationship between headache and TMD symptoms in the general population of north Italy found that subjects with TMD had higher headache prevalence as compared to subjects without TMD (27.2% vs 15.2%). In a univariate analysis, TMD symptoms such as TMJ pain, joint sounds and functional jaw pain were associated with headache and after adjusting for confounders, a logistic regression confirmed significant relationship between headache and TMD (OR 1.83, 95% CI, 1.07–3.15) (87).

Studies evaluating the prevalence of headache among TMD patients and vice versa were systematically reviewed and meta-analyzed. The findings show that migraine and tension-type headache (TTH) are more common and are significantly associated with TMD. Although it was found that migraine patients are at higher risk of developing TMD, the most prevalent subtype of TMD has not been identified (88).

Prospective studies clinically diagnosing first onset TMD have reported that individuals who are more sensitive to noxious stimuli at baseline are 2.7 times more likely to develop TMD pain as compared to those who are less pain sensitive (89).

Despite some evidence, we cannot confirm if baseline pain sensitivity has an impact on the severity and persistence of pain experienced by TMD patients. Therefore, more research is needed to determine if pain sensitivity is a risk factor for TMD onset and persistence.

2.3.8 Mechanical Factors

The role of extrinsic trauma in precipitating TMD was evaluated in cross-sectional retrospective study among 727 patients with TMD symptoms who sought treatment between January 1, 1983 to May 29 1984. The data was collected using the Zung pain and distress scale and the Minnesota multiphasic personality index along with patient history interview followed by clinical examination. Among the 661 confirmed symptomatic TMD patients, any significant form of trauma to body was reported by 84% patients. Approximately 43% of the patients suspected extrinsic trauma to the head and neck region as cause of onset of TMD symptoms. Motor Vehicle accident (26%), Whiplash injury (21%), fall/fight/sports injury (22%) as well as oral surgery (1%), intubation for general anesthesia (3 patients) were some specific traumas reported by the patients. However, the results of the study did not provide evidence on the details of traumatic events or the timing of the events (90).

In 1987, the records from traffic accident commission (TAC) of individuals seeking treatment for temporomandibular pain dysfunction (TMPD) following a motor vehicle accident were studied retrospectively. Out of 20,673 subjects who sought treatment for TMPD, only 28 subjects were identified who had met motor vehicle accident. The study did not find any association between direct or indirect trauma and TMPD. Subjects with mandibular fractures (0.4%) and whiplash injuries (0.5%) sought treatment. Among those with trauma incidence, two-thirds of subjects sought treatment immediately after the accident whereas, others sought treatment after 2 months (91).

Pullinger and Seligmann studied the differences in the trauma history among the diagnostic groups of TMD patients and non-patient control subjects. They conducted personal interview of 230 TMD patients who were referred to different general practice dental clinic. Trauma was further subdivided as MVA and other injuries such as physical assault, sports injury etc. The two controlled groups consisted of a symptomatic individual (n=161) and asymptomatic individuals (n=61). The study found higher prevalence of trauma ranging from 49% to 79% among all the diagnostic groups of TMD unlike symptomatic and asymptomatic control groups which reported 18% and 13% respectively. Moreover, the results show high prevalence frequency, multiple trauma exposures and significant association between trauma history and diagnosis of disc displacement without reduction and osteoarthritis group (92).

Another study illustrated the characteristics and response to treatment of TMD patients who developed the condition following motor vehicle accident and compared the same with those who develop it independently. The authors retrospectively analyzed equal number of records (n=52) of the patients in the above mentioned categories undergoing treatment at the Mount Sinai Hospital Craniofacial pain clinical research unit. Patients who developed TMD without any history for precipitating event responded better to the treatment and approximately 75% of this patient showed improvement of symptoms and were satisfied unlike the patients with MVA history. Moreover, patients with myofascial pain dysfunction (MPD) and TMD improved faster as compared to patient's with only diagnosis of MPD. Despite of more extensive and aggressive treatment among posttraumatic TMD patients, they recover at a significantly lower rate indicating varying underlying pathophysiological mechanism (93).

Heise et al., studied the incidence of temporomandibular joint pain and dysfunction following a cervical musculoskeletal injury by interviewing and examining patients with these injuries. The patients with radiographic evidence (group 1= 63) of cervical skeletal injury and those without any radiographic evidence (group 2= 92) were interviewed, examined and followed up via telephone at 1 month as well one year interval. Interestingly, the findings indicated that incidence of TMJ pain and clicking was extremely low and patients with initial pain/dysfunction following injury resolved within a year and did not subsequently developed any new symptoms (94).

A study compared TMD patients with history of trauma and those without any history of trauma to the head and neck region by evaluating the patients visiting the facial pain clinic at the University of Ghent, Belgium. A total of 400 patients with confirmed diagnosis of TMD pain and dysfunction based on the Helkimo Index (HI) were included. From the total recruited patients, 98 patients (group 1) reported developing TMD following a trauma to the head and neck region whereas 302 patients (group 2) reported no preceding trauma history. Both the groups were managed conservatively and followed up after 1 year to compare the response to treatment. More severe limitation in jaw opening occurred in trauma group (14.3%) as compared to the no-trauma group (4.1%). The severity of pain and dysfunction indicated by the Helkimo index was more pronounced in trauma group. Response to conservative treatment was almost equal in both the groups. The results of the study show that trauma is a common initiating factor

in TMD development. Moreover, although the patients with trauma have more severe pain and dysfunction, they respond well to the conservative treatment and have a good prognosis (95).

A narrative review elucidating the relationship between whiplash injury and TMD was conducted, including studies conducted in 1966 to 2009 by searching into six different databases. The review found 32 eligible articles on the topic from which 8 prospective and retrospective studies on TMD incidence in trauma patient were found. The authors reported conflicting evidence and low quality studies regarding the influence of whiplash on development of TMD as the incidence varied from low to moderate among these studies. Although the evidence gave some confirmation on less response to TMD treatment among whiplash injury patients, the mechanism remains poorly understood (96).

A cross-sectional study was conducted among the first-year university students in Japan to evaluated the association between TMD and experiences of jaw injury, third molar extraction and orthodontic treatment. TMD symptoms were reported by 715 students from a pool of 2374 students and were further grouped based on TMD diagnosis. On applying the logistic regression by adjusting for age, sex, emotional stress and oral parafunction, TMD symptoms were significantly associated with jaw injury and third molar extraction. The odds of jaw injury among participants with only pain in TMJ, only difficulty in mouth opening, both pain and difficulty in mouth opening and with all TMD symptoms were 2.25, 2.47, 3.38, and 2.01 respectively. The study concluded that jaw injury and third molar extraction might cumulatively play a role in TMD onset (97).

The OPPERA prospective study was conducted to determine the risk factors for first onset TMD. The study followed 2,737 TMD free people enrolled between 2006 and 2008 for a period of approximately 5.2 years. At enrollment the participants were confirmed to not have any TMD symptoms based on the RDC/TMD criteria. Around 260 people developed TMD during the period. When evaluating the etiologic factors among the incident TMD participants, the study did not find meaningful associations between history of external jaw trauma and TMD incidence. The authors claimed that trauma might contribute to TMD only in the immediate aftermath of injury or via delayed response through subsequent physiological changes. Furthermore, there was no data collected on details of traumatic episodes reported by the participants (98).

Although the OPPERA prospective study lacked evidence on trauma and TMD, the case-control study reported odds ratios ranging from 4.2 to 8.3 for the question pertaining to trauma and TMD incidence (13).

A retrospective study of TMD patients investigated whether they have experienced any type of direct, indirect/whiplash trauma in some point of time in their life. The study reviewed records of 271 patients belonging to 18-70 years age group and visiting the orofacial pain clinic of Yeditepe University of Dentistry. History of direct trauma and whiplash was reported by 18.6% patients and 14.8% patients respectively. The patients were diagnosed and grouped based on the RDC/TMD. The authors did not find any significant association ($P < 0.05$) between trauma and any diagnostic category of TMD (99).

M.Grusha et al.,(100) retrospectively analyzed radiographic using MRI scans and clinical features of TMD patients and compared patients with a history of motor vehicle accidents preceding their symptoms with those without any direct jaw injury. The study was conducted at the dental center and all the participants were clinically evaluated by a single clinician. The authors compared 54 post-MVA patients with 82 non-trauma patients. The study results show that there were significant (p value < 0.05) clinical and radiographic features differences between the MVA group and non-trauma group. Although, there might be no evidence of jaw injury on imaging, MVA patients have showed more severe symptoms and chronic pain complaints compared to the non-trauma group. Moreover, MVA patient with ligation history have higher prevalence of disc displacements on scans (100).

The systematic review conducted on studies reporting prevalence of whiplash injury among TMD patients found that only 6 studies out of 32 eligible studies met the inclusion criteria defined by the authors and were included for review. Among the included studies, only one study used RDC/TMD criteria for TMD diagnosis. The prevalence of whiplash injury among the TMD patients in the included studies ranged from 8.4% to 70%. The review suggested TMD following a whiplash trauma has a different pathogenesis and may develop over time, rather than being part of an acute syndrome. Moreover, TMD patients with a history of whiplash trauma report more TMD pain, more severe jaw dysfunction, more headaches, stress, dizziness, and sleeping problems as well as poor response to treatment compared with TMD patients without a history of

neck injury or trauma. The review indicated the need for more well-designed population based studies on the development of TMD after whiplash trauma using the DC/TMD criteria (101).

It is worth noting that the findings on the role of macro and micro trauma in the etiology of TMD vary significantly between studies. Many studies lack justification of the strength of association, do not utilize the newly developed DC/TMD criteria for TMD diagnosis, and fail to compare important symptomatic characteristics reported by patients, such as pain intensity, frequency, type, detailed description of traumatic events, time elapsed between trauma and TMD symptom onset, and other accompanying symptoms among trauma patients and non-trauma TMD patients. Previous studies on association of trauma and TMD were mainly cross-sectional studies but had insufficient sample size. There are a few prospective cohort studies and retrospective studies reporting association between trauma and TMD.

Furthermore, no study reporting the TMD and orofacial pain characteristic as well as association between micro and/or macro trauma and TMD has been conducted within the Canadian population in the recent years.

Therefore, the present study aims to fill the existing knowledge gap by providing a detailed description of patient symptoms who report macro or micro traumatic events as the cause for TMD, as well as updating the demographics and characteristics of signs and symptoms of TMD patients in the Quebec population.

CHAPTER 3 STUDY AIMS AND OBJECTIVES

3.1 Overall Objective

As evident from the aforementioned context, to the best of our knowledge, no recent study HAS been conducted within Canada demonstrating patient demographics, self-reported related primary and accompanying signs and symptoms as well as discomfort/dysfunction of TMJ and events preceding symptom development of Temporomandibular Disorders. After the development of the DC/TMD diagnostic criteria for TMD, no study has compared the TMD patient symptoms and diagnosis among individuals with history of micro or macro traumatic events with those without any preceding events.

Therefore, the two main aims of this study are;

1) To describe TMD and orofacial pain patient characteristics, signs and symptoms of those seeking care at orofacial pain and TMD clinic at Montreal General Hospital.
2) To assess the association of reporting micro and macro traumatic events and developing TMD symptoms.

3.2 Specific Objective

Manuscript 1

Aim 1.1: To describe the self-reported symptoms of TMDs and orofacial pain characteristics of patients seeking care at the Orofacial pain and TMD clinic at Montreal General Hospital between January 2018 and May 2022.

Manuscript 2

Aim 2.1: To assess the association between micro or macro traumatic events and TMD symptoms development.

Null Hypothesis: There is no association between micro or macro traumatic events and TMD development. History of micro or macro traumatic events does not play any role in TMD symptoms.

Aim 2.2: To compare the differences between TMD patients with a history of micro or macro traumatic events prior to symptom development with those developing TMD independently.

Null Hypothesis: There is no difference between TMD patients with a history of micro or macro traumatic event prior to symptom development and those individuals who develop TMD independently.

CHAPTER 4 METHODOLOGY

This section aims to provide an overview of the methods used to accomplish the objectives of the study.

4.1 Study Designs and Settings

We conducted a cross-sectional retrospective study by collecting information from the dental records of the patients referred to or consulting at Orofacial pain and TMD clinic at Montreal General Hospital.

4.2 Ethical approval, Consents and Patient confidentiality

Several steps were taken to provide highest ethical standards and ensure patient confidentiality. First, we submitted the study protocol to seek ethical approval from the Research Ethics Board (REB) of McGill University Health Center (MUHC). The project number approved for the study is PTS_TMD / 2023-8850 and approval confirmation is attached in the Appendix 1.

All the patients seeking consultation and treatment at Orofacial pain and TMD clinic of Montreal General Hospital are requested to fill out general consent forms during their first visit. The general consents forms indicate if the patients are willing to share their clinical records for any research purposes.

The information from clinical records were entered into the excel sheet by assigning randomly generated codes to patient names to ensure anonymity. Patient codes were kept by the principle investigator in a password protected digital file behind the MUHC firewall in case we need to re-access patient records for any missing or follow-up information. Only the authors had access to the collected data. In case of sharing collected data among the authors, the files were always transferred through secured links and password protected files. The data collected will be stored in a password protected computer for 7 years following the completion of the study as per the hospital protocol, then the digital files will be destroyed.

4.3 Sample Population and Eligibility criteria

Our sample population consists of all the patients referred to or seeking care at Orofacial pain and TMD clinic at Montreal General Hospital (MGH) between January 2018 to May 2022. We

selected our sample population from MGH as this is the only Orofacial pain clinic in Quebec accepting Régie de l'assurance Maladie du Québec (RAMQ) for diagnosis and treatment expenses of Orofacial pain. All patients reported referred or visiting were seeking treatment for orofacial pain, discomfort and/or dysfunction.

Inclusion criteria

Manuscript 1

We only included clinical records of patients age ≥ 15 years. The hospital policy only allows examination and treatment of patients above this age and remaining are referred to the pediatric dental clinic. The clinical records of patients who reported complain of pain/discomfort/dysfunction of the TMJ and orofacial region were included to accomplish aim 1.1.

Manuscript 2

In addition to the inclusion criteria of Manuscript 1, we only included clinical records of patients with a confirmed diagnosis of TMD based on the DC/TMD criteria. The diagnosis was also confirmed by clinical examination by the Orofacial pain and Oral medicine residents as well as an orofacial pain and TMD clinician. Patients with diagnosis of acute as well as chronic TMD were considered eligible for the study. Furthermore,

Exclusion criteria

Manuscript 1 and 2

Patients with incomplete records or missing information were excluded from the study. Patient clinical records with pre-existing medical history of complex systemic disorders or head and neck syndromes were excluded. Records of medically compromised and patients with disabilities were excluded.

4.4 Sample size

Manuscript 1

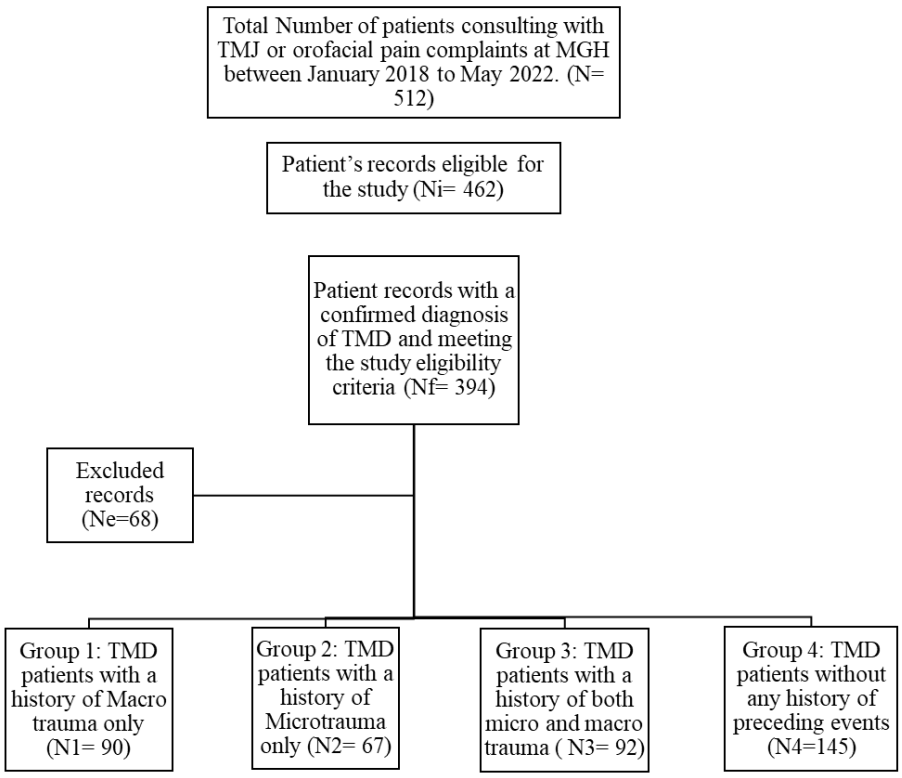
Initially, we retrieved clinical records of 517 who visited the Orofacial pain and TMD clinic at MGH with a chief complain of pain or discomfort in the TMJ and orofacial region. We excluded

55 records as they did not comply with the eligibility criteria for the study. The main reasons for exclusion were missing information, odontogenic pain complain, treated or with existing head and neck syndromes, medically compromised or patients with disability. We finally included 462 clinical records for the study analysis.

Manuscript 2

Among the 517 records reviewed, 394 records met the eligibility criteria and were used for further analysis. The distribution of included records based on the event preceding TMD symptoms initiation is represented in Figure 4.1

Figure 4.1 Flowchart illustrating sample size and categorization of TMD patient records based on event preceding TMD symptom onset into trauma or no trauma group.



4.5 Data Collection

Manuscript 1

We collected patient self-reported information using Orofacial pain health questionnaire (OPHQ) (see Appendix). Quebec being a bilingual province, the questionnaire consists of English version as well as French translation of the questions. The questionnaire is provided to all the patients at their first to the orofacial pain and TMD clinic. If the information were missing in the OPHQ, the residents tried to get information from the patients at the time of clinical examination. The first part of questionnaire consists of patient's personal and demographic information such as age, gender, marital status, and occupation. Question (Q) one and two inquire about patient's main reason to seek consultation and time of initiation of problem. Question 3 are pain location diagrams as per the recommendation from the DC/TMD self-report assessment. Pain-site drawings were reported to be a useful tool for screening and assessing pain in studies on chronic musculoskeletal pain. Questions 4 to 10 are related to pain intensity, frequency, duration, factors aggravating and alleviating pain as well as accompanying signs and symptoms. The pain intensity was recorded on a Visual Analogue Scale (VAS) where patient's were asked to rate their pain from 0 to 10, where rating of 0 indicated the no pain, 1-3 indicated mild pain, 4-6 represented moderate pain and 7-10 marked severe pain intensity. The rating of 10 on the scale indicated worst pain. Other potential contributing factors such as history of trauma and its description, inference of condition with life aspects and sleep quality are inquired by question 11 to 13. In addition to this, information regarding the previous consultation and treatment for current complain, medical and dental history, allergies and history of hospitalization is acquired in subsequent questions. Furthermore, last part of the questionnaire has Yes/No response questions pertaining to smoking, alcohol consumption, and Beverages such as tea, coffee, cola etc consumption. The last question allows patients to self-report any additional information pertaining to the condition which was missed.

For the accomplishing Aim 1.1, we collected only the self-reported information which included age of the patient when they first visited the clinic, gender, chief complaint, self-reported past medical and dental history, medications, parafunctional habits, self-reported type and severity of clinical symptoms, location of pain, self-reported events preceding, previous TMD treatments including medications, self-reported triggering/ aggravating factors and alleviating factors and signs and symptoms of TMD. The information was extracted from medical records and compiled in an excel spreadsheet.

Manuscript 2

As per the recommendations of the DC/TMD criteria, our scrutiny included both detailed patient history and thorough clinical examination to reach a confirmed diagnosis. For the purpose of manuscript 2, in addition to the patient demographic, we collected information on patient reported main reason for consultation, pain description (site, intensity, frequency and type), detailed history and description of microtrauma and macrotrauma, time of initiation of symptoms, any accompanying reported symptoms and TMD related discomfort and/or dysfunction. Further, we also collected information from DC/TMD examination form which was completed by the residents and clinicians during patient's clinical examination. The major advantage of using the DC/TMD criteria is its applicability in both clinical and research settings ensure peasy knowledge transfer between clinicians and researchers. Therefore, ensuring that the researchers can easily convert clinical experience into relevant research questions and research findings are more relevant and reliable for implementation in clinical practice.

Clinical examination

All the patients were clinically examined by orofacial pain and oral medicine resident, general dentistry practice resident followed by confirmation of these examination findings by a certified orofacial pain and TMD specialist. The examiners were trained, and their examination techniques were calibrated for all the clinical variables. The intra-oral examination included registration of dental status, and examination of soft tissues for any abnormalities. The extra-oral examination comprised of evaluation of pain site marked on drawings by patient, incisal relationships recording (over jet, overbite and midline deviation), registration of jaw opening, lateral and protrusive movements, TMJ sounds as well as joint and muscle palpation.

Jaw function examination: Mandibular opening was measured by measuring the distance between incisal edges of the upper incisors and lower incisors using a scale. We recorded maximum pain free jaw opening, maximum unassisted opening with pain followed by maximum examiner assisted opening.

TMJ sounds were registered by bilateral palpation during open, close, lateral and protrusive movements. Stethoscope was used for TMJ sounds when necessary.

Lateral Palpation and posterior palpation by placing index finger in the ear was done to register TMJ pain. Pain on jaw function was recorded as well.

Masticatory and supplemental muscle palpation was done with firm finger pressure applied for two seconds and was registered if it elicited a palpebral reflex in the eyes or a protection reflex.

Bi-digital palpation of the center part of the sternocleidomastoid muscle and trapezious muscle was done to check for referred pain.

The TMD patient's diagnosis were broadly classified into pain-related TMD (myalgia, myofascial pain, myofascial pain with referral, arthralgia, headache attributed to TMD), Intra-articular TMD (disc displacements with/or without reduction, disc displacements with/or without limited mouth opening, degenerative joint disease, and subluxation), Bruxism and Combined (combination of pain-related and intra-articular TMD diagnosis). Although bruxism does not fall under TMD diagnosis categories, we included these patients as bruxism is type of microtrauma and these patients initially consulted with TMD related complain and the study aim is to associate microtrauma with TMD. It was also of our interest to know if microtrauma is cause or consequence of TMD. Further, the patient's reporting any type of trauma were sub-categorize into Macrotrauma, Microtrauma and both. "Macrotrauma" was indicated for patients with a history of Motor vehicle accidents, fall injury, direct jaw injury, prolonged mouth opening due to dental/ oral and maxillofacial procedures. "Microtrauma" was indicated for patients reporting oral parafunctional habits such as clenching, grinding, lip bitting etc. "Both" was indicated for patients who reported history of microtrauma and macrotrauma.

4.6 Data Analysis

Manuscript 1

The primary aim of this manuscript is to describe the socio-demographics, pain characteristics, and other self-reported TMD related factors of sample population. Therefore, we only used descriptive statistics to accomplish the aim. The collected data was imported from excel spreadsheet to SPSS software for analysis. Frequency distribution tables for the study variables were generated. Mean and standard deviation of numerical variables was calculated.

Manuscript 2

The data collected mostly consisted of categorical variables, therefore we generated contingency tables to compare the distribution of various study variables across the different types of trauma groups as well as the no trauma group.

The chi-square test was used to assess the statistical differences and associations between the microtrauma as well as macro trauma and no trauma groups. Pearson's corelation coefficient was used to study the associations between the groups and TMD. A p-value of less than or equal to 0.05 was set to be statistically significant. Comparison of mean for numerical variables such as age, pain intensity was done using one-way ANOVA test.

If there was a statistically significant association between the study variables and trauma groups, a secondary analysis using Phi and Cramer's V was used to assess the strength of the association. A Phi coefficient takes values between -1 and 1 where:

- -1 indicates a perfect negative relationship between the two variables.
- 0 indicates no association between the two variables.
- 1 indicates a perfect positive relationship between the two variables.

In other words, the further away the Phi's coefficient is from zero, the stronger the relationship between the two variables.

Cramer's V is an effect size measurement for the chi-square test. It is denoted by ES where the value of $ES \leq 0.2$ indicates a weak association between variables, $0.2 < ES \leq 0.6$ indicates moderate association and $ES > 0.6$ indicates strong association.

CHAPTER 5: MANUSCRIPT 1

Temporomandibular Disorders and Patient Self-Reported Orofacial Pain Characteristic and related signs and symptoms: A retrospective study

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Abstract

Introduction: Temporomandibular disorders (TMD) are the most common non-dental cause of chronic orofacial pain. They often manifest as pain and/or tenderness in masticatory muscles, temporomandibular joint, and in/around the ears affecting 5-12% of the population worldwide.

Aim: The main aim of this study is to assess and review the self-reported TMD-related parameters and characteristics of patients visiting the Orofacial pain and TMD clinic at Montreal General Hospital.

Methodology: A retrospective analysis of 462 clinical records of patient's visiting orofacial pain and TMD clinic at Montreal General Hospital between January 2018 to May 2022 was conducted. General Informed consent was obtained from patients during their first visit. Records of patients aged ≥ 15 years, seeking consultation for orofacial pain and without any existing systemic disorders, disability or head and neck syndrome were included. Parameters such patient demographics, chief complain, self-reported factors such as TMD signs and symptoms, TMJ discomfort or dysfunction, pain descriptions, events preceding symptoms onset, aggravating and alleviating factors, accompanying symptoms and effects on quality of life were studied. Frequency distribution tables and mean were calculated using IBM SPSS statistical software.

Results: Our sample population consists of 75% females and 24% males with the mean age of our sample population being 45.39 ± 17.04. More than fifty percent of the patients reported pain in TMJ or jaw as the reason for consultation. Macro trauma and dental or maxillofacial surgery were the reported initiating events for TMD among 210 patients and 59.1% of the total population reported parafunctional habits. Approximately 70% of the TMD patient reported at least one accompanying symptoms with headache being the most reported one. TMD pain was reported to affect patient quality of life by interfering in daily activities such as emotional disturbance, sleep disturbances, change in bite in more than 70% of the patient population.

Conclusion: The findings of this study show rising prevalence rates of orofacial pain reporting compared to the previous studies especially in women and full fertility age group. The study also reports several factors such as trauma, parafunctional habits etc which play role in TMD and significantly impacts patient's quality of life. Therefore, healthcare providers should implement

multidisciplinary approach to address the various symptoms and accompanying conditions that often occur or lead to TMD.

Introduction

Temporomandibular disorders (TMDs) are the most common non-dental cause of chronic orofacial pain (1). TMDs refer to a group of musculoskeletal disorders that affect and cause pain as well as dysfunction in the temporomandibular joint (TMJ), masticatory muscles, and/or the surrounding tissue (2, 3). They can be divided into pain-related TMD which include myalgia, arthralgia, headache-attributed to TMD, and Temporomandibular Joint Disorder (TMJD) or Intra-articular TMDs consisting of disc displacement disorders and degenerative joint disorders (4). Pain, tenderness in the jaw muscles, functional TMJ joint disability, trismus, and limited/reduced mouth opening are some of the common complaints of TMD patients.

TMDs are known to be the second most prevalent musculoskeletal chronic pain condition after low back pain. Nearly 33% of the population worldwide suffer from at least one TMD symptom in their lifetime. Furthermore, only 3.6 to 7% of the affected population is known to seek treatment for TMD (5-7). The incidence of TMD per year is known to be nearly 4% worldwide and has been increasing in the past few years (5). In the Province of Quebec, an assessment of prevalence and self-reported pattern of TMD jaw pain was done in 1995 reporting an overall prevalence of 30% which indicated frequent episodes of jaw pain among one out of 15 individuals (6).The cost of treating TMD reported by the National Institute of Dental and Craniofacial Research was $4 billion annually in the United States (7). Apart from imposing a financial burden on patients, TMD has an impact on an individual's daily activities, and quality of life as well as causes emotional disturbance (4, 8). Furthermore, due to multifactorial etiology and symptom variations among different patients as well as among the same patient at different intervals, the diagnostic process of TMD is difficult and complex (9-11). Early Intervention with a biopsychosocial management approach in TMD patients has been found to considerably reduce pain, improve coping abilities and reduce emotional distress (12).

Studies reporting population demographics and their relation to TMD have shown discrepancies in their results. A systematic review of prevalence studies showed a higher prevalence of TMD in women compared to men,but reported a negative association between age and TMD prevalence (13). On the contrary, a cross-sectional survey of a nationally representative sample of U.S. adults represents an inverted-U relationship of TMD prevalence among women peaking around 40 -50 years of age but did not differ markedly from the prevalence in men (5, 14, 15).

With most TMD signs and symptoms being subjective, clinicians need to understand the demographics of the TMD patient population as well as their perspective on signs and symptoms experienced and other factors contributing to this disorder. This will help and guide clinicians in providing care to TMD patients and in improving their quality of life.

Therefore, the primary aim of this study is to assess and review the self-reported TMD-related parameters and characteristics of patients visiting the Orofacial pain and TMD clinic at Montreal General Hospital.

Methodology

Study design

A cross-sectional retrospective study was conducted using clinical records of TMD patients who were referred to or visiting the Orofacial pain and TMD clinic at Montreal General Hospital, which is affiliated with McGill University Health Center, between January 2018 to May 2022.

Consents

At the patients' first visit to the clinic, a general informed consent form was obtained, confirming their willingness to allow their clinical records to be used for research purposes.

Ethical Approval

The ethical approval for the human records retrospective study was obtained from the research ethics board of McGill University Health Centre. The project number for approval was **(PTS_TMD / 2023-8850)**

Patient confidentiality

During the study, data collected from patients' clinical records were entered into a password protected Excel sheet. To ensure patient anonymity, all data were recorded anonymously by assigning randomly generated numbers to each patient and entering the information into separate Excel sheets. This approach ensured that patient identities were not disclosed.

Inclusion criteria

This study included clinical records of patients aged 15 years and older. Only records of patients who reported with a complain of pain in the TMJ, jaw or facial region were included. All patient

records with either acute or chronic pain complain were included in this study. Acute pain was defined as pain lasting < 3 months whereas chronic pain was pain lasting ≥ 3 months on at least half of the days since the pain complaint begin (16).

Exclusion Criteria

Patients with disabilities or history of orofacial syndrome or head and neck cancer were excluded from the study.

Sample Selection

We studied the records of patients visiting the Orofacial pain and TMD clinic at Montreal General Hospital as this is the only Orofacial pain clinic in Quebec accepting **Régie de l'assurance Maladie du Québec** (RAMQ) for diagnosis and treatment expenses of Orofacial pain.

Data collection

All the self-reported information was collected through orofacial pain questionnaire. This included age of the patient at their first visit, gender, chief complaint, self-reported past medical and dental history, medications, parafunctional habits, self-reported type and severity of symptoms, location of pain, self-reported preceding events, previous TMD treatments including medications, triggering/ aggravating factors and alleviating factors and signs and symptoms of TMD as well as accompanying symptoms.

The collected data from patient records was entered into the excel sheet and coded with randomly generated numbers to ensure patient confidentiality.

Data Analysis

The IBM SPSS software (version 29.0.0) was used for statistical analysis of the data. Descriptive statistics including frequency distribution, mean and standard deviation were used for the study variables.

Results

We initially had 517 clinical records of patients who consulted at the Orofacial Pain and TMD Clinic at Montreal General Hospital. Among them, 55 records did not comply with the eligibility

criteria or lacked confirmation of TMD diagnosis based on DC/TMD, or missed information Therefore, the total number of eligible records for the study was 462.

The mean age of the TMD patients in our sample was 45.30 ± 17.04 years, with 75.8% (n=350) of the patients being female and 24.2% (n=112) being male. The age distribution was almost equal in all age groups, with slightly more patients in the 31-45 years age group, as shown in Table 1.

Table 5.1: **Age and gender distributions of patient's with orofacial pain complain**

Age and gender distributions of patient's with orofacial pain complain			
Variables		**Frequency (n)**	**Percent**
Age (in years)	15-30	112	24.2%
	31-45	126	27.3%
	46-60	122	26.4%
	≥61	102	22.1%
Gender	Males	112	24.2%
	Females	350	75.8%

The most reported TMD-related chief complain was pain in TMJ or jaw (n=245) followed by pain in the facial region other temporal region and the jaw or masticatory muscle (n=98), Limited mouth opening (n=37), TMJ clicking with or without pain (n=32), Jaw dislocation, deviation or locking (n=12), Bruxism or headache (n=12), Other complains (n=26) such as Upper lip pain, Maxillary pain, Dysesthesia, vertigo, earache, tinnitus, facial swelling etc. The frequency distribution of each reported TMD symptom is represented in Table 2.

Table 5.2: **Frequency distribution of each TMD-related symptom reported by patients.**

TMD- related Chief Complaints		
Self-reported TMD Symptoms	**Frequency (n)**	**Percent (%)**
TMJ/Jaw pain	245	53
Facial pain/ Masticatory muscle	98	21.20
Limited mouth opening	37	8
TMJ clicking with/without pain	32	6.90
Others	26	5.60
Jaw dislocation/deviation/locking	12	2.60
Bruxism/headache	10	2.20
N/A	2	0.40

TMD: temporomandibular disorder, TMJ: temporomandibular joint, N/A: Not Available

Table 5.3: **Frequency distribution of orofacial pain characteristics and duration of chief complain.**

Characteristics of chief complain and classification			
Factors		**Frequency (n)**	**Percent**
Duration of TMD complain	Acute (<3 months)	30	6.5%
	Chronic (≥ 3 months)	432	93.5
Side Affected	Unilateral	249	53.9%
	Bilateral	213	46.1%
Pain Intensity	Mild (0-3)	52	11.3%
	Moderate (4-6)	317	68.6%
	Severe (7-10)	93	20.1%
Pain Frequency	Constant	301	65.2%
	Intermittent	117	25,3%
	Episodic	44	9.5%
Pain Type	Dull	133	28.8%
	Pressing/Pressure type	117	25.3%
	Throbbing	117	25.3%
	Sharp/Electric-type/Piercing	95	20.6%

Most TMD patients in our study reported having a TMD complaint for more than 3 months, with a mean duration of 13.62 ± 19.33 months. The majority of patients reported moderate intensity pain, with a mean pain score of 5.57 ± 2.21 on a scale of 0 to 10. The most reported pain type was a constant dull pain (n=225), followed by intermittent dull pain (n=86), intermittent sharp pain (n=68), constant sharp pain (n=37), and burning pain (n=8). The most frequently reported pain location was the jaw and TMJ (n=268), followed by the temporal region (n=51), facial region (n=44), and masticatory muscles (n=42). The majority of patients reported pain on one side (n=253), while 98 patients reported pain on both sides. The detailed distribution of pain intensity, type and frequency, duration of pain complaint, and side affected is presented in Table 3.

Exposure to any type of macro trauma such as motor vehicle accident (MVA), fall injury, violence, physical abuse, whiplash etc prior to TMD development was reported by 27.7% TMD patients. However, 17.5% patients attributed dental or maxillofacial surgical procedures as an event leading to their TMD complain. Other reported preceding events were stress, radiation therapy, appliance, systemic condition, autoimmune condition, physical activity like swimming, noise, Opening Wide, Infection and Ear Infection. More than half of the patients reported having at least one parafunctional habit. Any type of jaw movement such as eating, chewing, talking, leaning on the chin, opening wide, yawning, mastication, dental treatment triggered pain in most

of the patients as illustrated in table 4. Anti-inflammatory medicines such as Tylenol, Advil etc relieved TMD pain in approximately one-third of patients. Conservative management such as massage, hot or cold compress, topical anti-inflammatory creams, exercise, rest, and physiotherapy was reported beneficial by patients. Other reported alleviating factors included hair oil, osteopathy, removing glasses, heat, yoga, alcohol, smoking, brushing, acupuncture, pressure, stretching, psychological therapy, soft diet, stress, work, sleep, chiropractor, and appliance. Approximately 70% of the TMD patient reported presence of at least one accompanying symptom such as headache, dizziness, autonomic signs including swelling, redness, and earache. Headache was the commonly reported accompanying symptom. The frequency distribution of various patient reported factors in TMD development and progression are represented in table 4.

Table 5.4: Frequency distribution of patient reported parameters contributing to orofacial pain complain and accompanying symptoms.

TMD related patient-reported factors			
Factors		**Frequency (n)**	**Percent**
Preceding event	Trauma	128	27.7%
	Dental/ Maxillofacial Surgery	81	17.5%
	Others	40	8.7%
	No events	213	46.1%
Parafunctional Habits	Yes	273	59.1%
	No	189	40.9%
Aggravating factors	Jaw movements	256	55.4%
	Stress	20	4.3%
	>1 aggravating factor	45	9.7%
	Others	33	7.1%
	None	98	21.2%
Alleviating factors	Medication	106	22.9%
	Medication with conservative management	54	11.7%
	Conservative management	80	17.3%
	Jaw positioning/movement	21	4.5%
	Others	23	5.0%
	Injections	7	1.5%
	None	171	37.0%
Presence or Absence of accompanying symptoms	Yes	316	68.4%
	No	146	31.6%
Accompanying Symptoms	Headache	201	43.5%
	Autonomic signs	57	12.3%
	Dizziness	19	4.1%

	Others	19	4.1%
	Earache	19	4.1%
	None	146	31.6%

The frequency distribution of patient-reported TMD-related discomfort or dysfunction are illustrated in Table 5. More than 50 percent of TMD patient reported history of headache. TMD pain was reported to affect patient quality of life by interfering in daily activities such as emotional disturbance, sleep disturbances, change in bite in more than 70% of the patient population.

Table 5.5: Frequency distribution of patient-reported discomfort and dysfunction pertaining to orofacial pain complain

Patient-reported TMD-related discomfort/ dysfunction			
		Frequency (n)	**Percent**
Clicking with or without crepitus	Bilateral	210	45.5%
	Unilateral	77	16.7%
	No	175	37.9%
Jaw locking	Closed lock	40	8.7%
	Open lock	17	3.7%
	Unspecified	59	12.8%
	No	346	74.9%
Restricted mouth opening	Yes	174	37.7%
	No	288	62.3%
Difficulty in chewing, speaking, or swallowing	Yes	188	40.7%
	No	274	59.3%
History of headache	Present	268	58.0%
	Absent	194	42.0%
Type of Headache	Associated with jaw	50	10.8%
	Migraine	47	10.2%
	Tension-type	35	7.6%
	Temporal	15	3.2%
	Other type	13	2.8%
	Unclear	108	23.4%
	None	194	42.0%
Affects QoL	Yes	335	72.5%
	No	127	27.5%

QoL: Quality of Life.

Discussion

The present study aimed to describe the patient-reported TMD-related signs, symptoms, duration of complain, event preceding to TMD development, other symptomatic parameters such as

aggravating and alleviating factors, TMD related discomfort and dysfunction and accompanying symptoms. To the best of our knowledge there is no recent evidence reporting on the patient reported TMD factors in the Canadian population.

Overall, the findings of our study provide important insights into the patient-reported factors potentially associated with TMD development and progression in the Canadian population. The results can be used to inform the development of targeted interventions and treatments that take into account the unique needs and experiences of TMD patients. In addition, the present study highlights the variety of factors that may contribute to the development and progression of TMD, including trauma, parafunctional habits, and systemic conditions. Understanding these factors can help inform the development of effective prevention and treatment strategies for TMD.

In the present study, the ratio of females to male patients seeking consultation for TMD-related complain was 3.3:1. This is similar to results of previous population-based studies that have found higher prevalence of TMD complaints among females as compared to males which could be attributed to hormonal factors, behavioral, psychological factors or sociocultural factors associated with feminine gender (17-21). Some have proposed females to have high sensitivity to biologic stimuli which also explains higher prevalence of musculoskeletal disorders among them (22). Furthermore, females are behaviorally brought up to be more expressive about their discomfort or dysfunction as compared to males (23, 24). This may also contribute to the higher ratio of females seeking consultation for TMD-related complaints. However, it is important to note that further research is needed to better understand the underlying factors contributing to the higher prevalence of TMD among females.

Although our sample has nearly equal distribution of TMD patients among different age ranges, the occurrence of TMD symptoms seems to be slightly higher in among 31 to 45 years age group. These findings are comparable to previous studies that found the TMD symptom occurrence to spike in the age ranges from 30 to 50 years (25-27). The peak occurrence age range for TMD coincides with the individuals full fertility age and can be a result of hormonal factors (20).

The most commonly reported TMD-related chief complaint in our study was pain in the TMJ or jaw, reported by 53% of the patients, followed by pain in the facial region, temporal region, and masticatory muscle reported by 21% of the patients. This is consistent with previous research

which has identified pain as the most common TMD symptom reported by patients (25-27). Most of the patients in our study reported having TMD-related complaints for more than three months, which is also in line with previous studies (28-30).

In terms of the factors that may contribute to the development or exacerbation of TMD, our study found that more than half of the patients reported having at least parafunctional habit such as clenching, grinding or bruxism. This is consistent with previous research that has identified parafunctional habits as risk factors for TMD development patients (31). In addition, exposure to macro trauma such as motor vehicle accidents or falls prior to TMD development was reported by 28% of the patients in our study, while 18% attributed dental or maxillofacial surgical procedures as an event leading to their TMD complaint. These findings are also consistent with previous research that has identified trauma and dental procedures as potential risk factors for orofacial pain (32, 33).

In terms of treatment and management, our study found that anti-inflammatory medicines such as Tylenol and Advil were reported to as effective in relieving TMD pain by approximately one-third of the patients. Conservative management such as massage, hot or cold compress, topical anti-inflammatory creams, exercise, rest, and physiotherapy was reported beneficial by patients. Other reported alleviating factors included hair oil, osteopathy, removing glasses, heat, yoga, alcohol, smoking, brushing, acupuncture, pressure, stretching, psychological therapy, soft diet, stress, work, sleep, chiropractor, and appliance. These findings are consistent with previous research that has identified a range of conservative management strategies as effective in alleviating TMD symptoms (8).

The higher prevalence of TMJ or jaw pain in TMD patients in our study could be attributed to the fact that our study population consists of patients seeking consultation for TMD-related complaints, whereas the study by Goulet et al.(6) surveyed the general population without specific TMD symptoms. It is possible that individuals with more severe TMD symptoms, including TMJ or jaw pain, are more likely to seek medical attention and be included in our study sample. Furthermore, differences in study design and TMD assessment methods could also contribute to the variation in reported prevalence of jaw pain. The other reported patient chief complains were facial pain, masticatory muscle pain, TMJ clicking with or without crepitus, Jaw locking, bruxism which is aligns with the results in other previous studies (28-30). Nonetheless,

our findings highlight the impact of TMJ pain on TMD or Orofacial pain patients and the need for effective management and treatment options.

In our study, the number of chronic TMD patients are higher as compared to acute TMD. This could be due to longer waiting period for consultation at the orofacial pain clinics in Quebec. Moreover, it can also be due to complexity in diagnosis of TMD. TMD patients often consult Ear Nose and Throat specialist, neurologist etc with complain of ear pain or headache and receive some treatments. Further, when there is no improvement, they are referred to orofacial pain specialist.

The presence TMJ clicking with or without crepitus was reported by approximately two-third of the patient population which is higher than the prevalence found in previous studies ranging from 18% to 35% (34).The higher prevalence of TMJ clicking with or without crepitus in our study may be due to the fact that our study specifically focused on patients seeking consultation for TMD-related complaints, while previous studies may have included a broader population. Additionally, the sensitivity and specificity of diagnostic criteria used in previous studies may differ from those used in our study. TMJ clicking and crepitus are commonly reported in TMD patients and can be a result of disc displacement, joint degeneration or changes in muscle activity. It is important to note that not all patients with TMJ clicking or crepitus have TMD-related symptoms and vice versa.

Headaches are a common symptom associated with TMD, and the present study also found a significant number of TMD patients reporting headache. Studies have suggested that patients with headaches are more likely to have TMD and vice versa a clinical (35-37). Additionally, there is evidence to suggest that TMD-related headaches may respond well to treatments targeting the underlying TMD condition. However, it is important to note that headaches can have multiple underlying causes, and proper diagnosis and treatment is crucial for effective management of this symptom.

Our investigation found that approximately 28% TMD patient reported trauma due to motor vehicle accident (MVA), fall injury, violence, physical abuse, whiplash etc as well as 17.5% reported dental and maxillofacial surgical procedures as the events preceding TMD development. External trauma to the head and neck has been known as an initiating factor in causing TMD (38).

Moreover, there is some evidence from the recent OPPERA study confirming higher TMD prevalence among individuals who have experienced events causing jaw injury and prolonged mouth opening (32). A recent systematic review also confirmed higher prevalence whiplash injuries among TMD patients (31). Hawkins and Durham provided some plausible explanation that there is increased nociceptive sensitivity of the masseter muscle and increased cytokine expression due to prolonged mouth opening which may be the reason for TMD occurrence following dental procedures (33).

These findings highlight the importance of considering the patient's history of trauma or previous dental and maxillofacial procedures when evaluating TMD. It also suggests the need for preventive measures and careful management of patients who undergo dental and maxillofacial surgical procedures, as they may be at a higher risk for developing TMD. Additionally, healthcare providers should be aware of the potential impact of trauma to the head and neck in TMD development and consider this as a potential contributing factor during diagnosis and treatment.

In the present study, 72.5% patients reported effect on quality of life in terms of poor sleep quality, effect on daily activities, change in bite affecting appetite, emotional disturbance, lack of concentration, etc. Our study results are consistent with other previous studies which reported almost threefold poor quality of life among TMD patients compared to the general population (39-41). The study by Sitar et al., found a similar prevalence of poor sleep among TMD patients (42).

The use of medical records ensured a large sample size and a diverse patient population. Additionally, the retrospective nature of the study allowed for the collection of data over a longer period. However, one potential limitation of the study is that it relied on patient self-reporting, which may not always accurately reflect the extent of their symptoms or their impact on daily life. Additionally, as the study only included patients who sought consultation at the Orofacial pain and TMD clinic, it may not be representative of the entire Canadian population with TMD.

Patient-reported symptoms may not always accurately reflect the underlying clinical condition. Future studies may consider incorporating both patient-reported symptoms and clinical assessments to provide a more comprehensive understanding of TMD. Additionally, the retrospective nature of the study may have limitations such as incomplete medical records and

potential recall bias. Prospective studies may provide more reliable data for assessing TMD symptoms and their impact on quality of life.

Conclusion

Based on the results of the study, it is recommended that healthcare professionals screen patients for TMD symptoms, particularly among women in the full fertility age range. Additionally, healthcare providers should be aware of the high prevalence of TMJ and jaw pain in TMD patients in Canada and should consider this when developing treatment plans. Finally, given the significant impact of TMD on a patient's quality of life, it is recommended that a multidisciplinary approach to care be implemented to address the various symptoms and accompanying conditions that often occur in TMD patients.

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CHAPTER 6 MANUSCRIPT 2

Association Between Macro and Micro Traumatic Events and Temporomandibular Disorders: a retrospective study

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Abstract

Introduction: Temporomandibular disorders (TMD) are the most common non-dental cause of chronic orofacial pain often manifesting as pain and/or tenderness in masticatory muscles, temporomandibular joint, and in/around the ears affecting 5-12% of the population worldwide. The known factors in developing TMD include micro and macro trauma, occlusal disturbances, parafunctional oral habits, hormones, stress, anxiety, depression, etc.

Aim: The primary aim of this study is to assess the association between micro and macro traumatic events and temporomandibular disorders. The secondary aim is to compare the variation and association of patient-reported symptoms and clinical findings across TMD patients with history of micro and macro traumatic events with those without any trauma history.

Methodology: A cross-sectional retrospective study of 396 TMD patients referred to or visiting the Orofacial pain and TMD clinic between January 2018 to May 2022 was conducted. Patients ≥15 years of age, with a confirmed TMD diagnosis based on the DC/TMD criteria and clinical examination were included. Patients were divided into 4 groups based on history and type of trauma preceding TMD symptom onset: 1) Macro trauma, 2) Micro trauma, 3) Both and 4) No trauma history. Contingency tables were generated to compare the variables distribution across groups, Pearson's correlation coefficient was used to check the correlation, Chi-square was used to compare the groups. Phi and Cramer's V were used to analyze the strength of association. P value ≤ 0.05 was considered statistically significant.

Results: Approximately, one-third of TMD patients had a history of macro trauma such as MVA, fall injury, prolonged mouth opening etc. and around 17% patient-reported micro-trauma to precede there TMD symptoms. The study found no association between macro trauma group and type of TMD diagnosis (p value > 0.05) but micro trauma group showed positive correlation with TMD diagnosis. Moreover, there was variation in TMD signs, symptoms, self-reported parameters, and clinical measures across various types of trauma groups and no trauma group (p value < 0.05) . Macro trauma group reported more severe symptoms presentation and clinical manifestation as compared to other groups.

Conclusion: Although there was no statistically significant association between macro trauma and type of TMD diagnosis, there were significant statistical and clinical differences in patient-

reported symptoms and clinical manifestations among TMD patients with history of micro and/or macro traumatic event preceding symptom initiation when compared to patient's without any preceding event. Therefore, thorough patient history recording, and clinical examination are essential for early detection of TMD symptoms especially among those with history of any preceding traumatic event for early treatment intervention to provide more effective treatment, reduce cost and improve quality of life.

Introduction

Temporomandibular Disorders (TMDs) are a group of musculoskeletal disorders affect and cause pain as well as dysfunction in the temporomandibular joint (TMJ), masticatory muscles, and/or the surrounding tissue (1, 2). According to statistics from the National Institute of Dental and Craniofacial Research, the prevalence of TMDs worldwide is estimated to be between 5% to 12% (3). Classical signs for TMD diagnosis include pain, restricted mouth opening, mandibular deviations, clicking sounds, and/or crepitus in the TMJ (4).

The etiopathogenesis of TMDs is thought to be multifactorial and not well understood (5). Physical factors such as macro trauma, parafunctional oral habits like bruxism, psychological factors namely stress, anxiety, depression, hormonal factors, systemic disease, and genetics have been attributed as possible factors in TMD development and persistence (6-10).

Musculoskeletal microtrauma is defined as damage to the tissue caused by constant exposure to low-magnitude forces which can result in tissue disruption of involved tissue over a longer duration (11). Microtrauma in the orofacial region occurs mainly due to parafunctional habits such as bruxism, teeth clenching, and overuse behaviors. On the contrary, Macro trauma refers to any direct or indirect injury to the jaw following whiplash or vehicle accident or prolonged mouth opening which can affect tissue integrity (5). Both macro and micro trauma are known to play a significant role in development and management of TMDs (12).

Orbach et. al and colleagues investigated several risk factors for TMD by conducting OPPERA study and found that macro and micro traumatic events, such as history of jaw injury, orthodontic procedures, and parafunctional behaviors were more common among TMD cases compared to other participants (13). A recent systematic review reported the prevalence of whiplash injuries among TMD patients to range from 8.4% to 70% (14). Results of a retrospective study in New York at center for oral, facial, and head pain showed 32% of the TMD patients reported history of macro trauma. At least one in four TMD patients report preceding trauma and surgery as the cause for developing TMD (5, 15).

Few studies have been conducted evaluating the association of micro and macro traumatic events with temporomandibular symptoms and diagnosis (6, 16-19). However, these studies did not compare the patient reported symptoms and clinical signs difference between the micro and

macro traumatic TMD groups as well as the no trauma history TMD patients using the newly practiced diagnostic criteria for TMD (DC/TMD) for diagnosis.

Therefore, the primary aim of this study is to assess the association between reporting of micro or macro traumatic events and symptoms of temporomandibular disorders (TMD). The secondary aim of this study is to compare the differences between TMD patients with a history of micro or macro traumatic events prior to symptom development with those who develop TMD independently.

Methodology:

A cross-sectional retrospective study was conducted using clinical records of patients diagnosed with TMD visiting the department of orofacial pain and TMD clinic at Montreal General Hospital between January 2018 to May 2022. These selected clinical records were of individuals who were either referred by dentists or physicians or self-reported with complaints of Orofacial pain who signed the general consent form permitting to use their data anonymously for research purposes.

Ethical Conduct, consents, and patient confidentiality

The study protocol has been approved by the research ethics board of McGill University Health centre research ethics board and the study approval number is PTS_TMD / 2023-8850.

Eligibility criteria

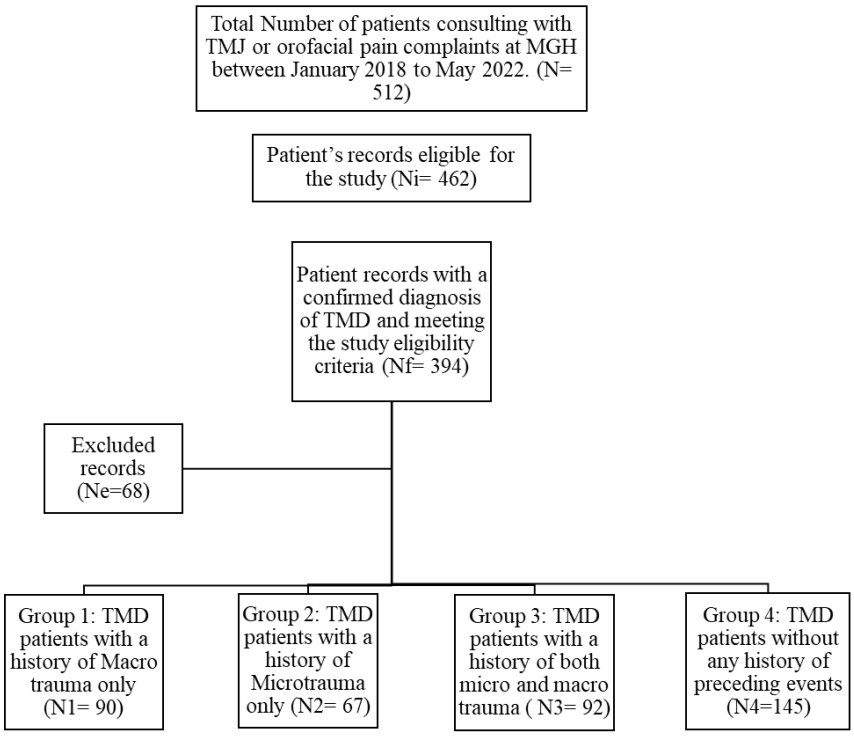
All clinical records of the patients with a confirmed diagnosis from patient reported symptoms and clinical examination of TMD based on the Diagnostic Criteria for TMD (DC/TMD) (20) were eligible. The records of patients belonging to age ≥ 15 years were included in the study.

All patient records with either acute or chronic TMD pain were included, with acute TMD pain defined as pain lasting less than three months and chronic TMD pain defined as pain lasting for three months or longer on at least half of the days since the pain complaint began (21).

Patients with disabilities, existing orofacial syndrome or medically compromised or incomplete information were excluded from our study.

Sample size

Figure 6.1 Flowchart illustrating sample size and categorization of TMD patient records based on event preceding TMD symptom onset into trauma or no trauma group.



All the charts of 517 patients visiting the orofacial pain and TMD clinic at Montreal General Hospital between 1st January 2018 to 26th May 2022 were selected and reviewed.

Among the 517 records reviewed, 394 records met the eligibility criteria.

Data collection and patient classification

The self-reported information pertaining to demographics, chief complain, symptoms etc were collected from the Orofacial Pain Health Questionnaire completed by all the patient's at their first visit to the clinic. **Table 6.1** represents all the data collected from patient records alongwith patient categories based on preceding event reporting.

Clinical examination

Prior to starting the clinical examination, the residents reviewed the OPHQ completed by the

Table 6.1: Data collected from medical records and patient categorization	
Patient demographics	Age Gender Date for first appointment
Self-reported parameters from OHPQ	Chief complain Time of initiation of chief complain Parafunctional habits (if any) History of trauma Trauma description Time elapsed between trauma and TMD symptoms onset Pain Description: Intensity, Frequency, Location and Type Difficulty in chewing, Swallowing or speech Accompanying symptoms
Clinical Examination Findings	Location of pain on Palpation Clicking with/without crepitus Limitation of mouth opening TMD Diagnosis
Patient categorization based on patient reported event preceding TMD symptoms onset	
Group 1: Macrotrauma	Patients who developed TMD following trauma (Motor Vehicle accident, whiplash, fall injury etc) or any dental/maxillofacial surgical procedure
Group 2: Microtrauma	Patient's with a history of any parafunctional habits preceding TMD symptoms
Group 3: Both	Patient's reporting both history of micro and macro trauma
Group 4: No Trauma history	Patients who developed TMD without any history of preceding event

patients and completed any missing information, if necessary, by interviewing the patient. The examiners were trained, and their examination techniques were calibrated.

Statistical analysis

IBM SPSS software for statistical analysis. Contingency tables were generated to study and compare the distribution and mean of various study variables across the trauma groups and no trauma group. The chi-square test was used to compare the differences between the study groups while Pearson's chi-square was used for other variables. One way ANOVA was used to compare the means for nominal variables. All the statistical tests were two-tailed and p-value of ≤ 0.05 was considered statistically significant. If association was found, Phi and Cramer's V or Effect Size (ES) was calculated to assess the strength of association.

Results

Among the total 394 records, 297 record were of female patients and 97 records were of male patients. The mean age of females was 46.36± 16.80 and for males was 41.74± 15.94. The mean age among the different trauma and no trauma group were, Macro trauma group (mean age = 44.46 ± 17.48), Micro trauma group (Mean age =44.87 ± 16.05), Both group (42.49 ± 15.08) and No trauma group (47.60 ± 17.36).

Macro traumatic events such as fall injury, direct face injury, orthodontic treatment, prolonged mouth opening, motor vehicle accident was reported by 22.80% while micro trauma caused by parafunctional habits was reported by 17.00% of the patient population as event preceding TMD. The remaining patients reported either combination of micro and macro traumatic events (23.40%) or no events preceding TMD symptom initiation (36.80%). Based on the diagnosis in the clinical record, patient diagnosis was categorized into pain-related TMD (N=147), Intra-articular TMD (N= 69) and combination of one or more pain-related and intra-articular TMD (N=178).

Different types of patient-reported events preceding TMD symptom development, and their distribution are represented in Table 6.2.

Table 6.2: Frequency and distribution of different types of patients reported events preceding TMD symptom onset

	N	%
Direct face injury	45	11.42%
Fall Injury	24	6.09%
MVA	40	10.15%
Orthodontic treatment	10	2.54%
Prolonged mouth opening	62	15.74%
Parafunctional habits	67	17.00%
No	150	38.07%

MVA (Motor Vehicle Accident)

The main reason reported for consultation was pain in and/or around the ear or in the jaw. Table 6.3 illustrates the distribution of TMD patient reported main reason for consultation obtained at their first appointment. Pain in and around ear/in jaw was more common among patients with history of micro trauma compared to other groups. Overall, all the groups differed from each

other in regard to the main reason for consultation (p value < 0.05). However, when individual groups were compared with no history of trauma group, there was statistically significant association (p value < 0.05) with macro trauma group. Micro and macro trauma groups showed significant differences in the reporting of main complain and were moderately associated (p value ≤ 0.05, ES = 0.3).

Table :6.3 Distribution of main reason for consultation reported by TMD patients for consultation across various types of trauma and no trauma group

	Types of trauma			
Reason for consultation	**Macro trauma (N_1=90)**	**Micro trauma (N_2=67)**	**Both (N_3=92)**	**No trauma (N_4=145)**
Pain in and around ear/ in jaw	45.60%	65.70%	59.86%	49.00%
Facial pain (in cheeks, temple etc)	24.40%	14.90%	23.90%	20.75%
Clicking sound on opening and/or closing mouth with/without pain	5.60%	6.01%	5.60%	9.70%
Jaw locking or deviating	3.30%	1.50%	2.20%	3.40%
Reduced/limited mouth opening	7.80%	4.50%	8.44%	10.30%
Headache	0.00%	4.50%	0.00%	3.40%
Others complains	13.3%	3.50%	0.00%	3.45%

Other complains: Upper lip pain, Maxillary pain, Dysesthesia, vertigo, open bite, palatal pain, earache, tinnitus, facial swelling etc.

There was no statistically significant association (p value > 0.05) on comparison of various trauma groups with no history of trauma patients in terms of the type of TMD diagnosis. However, based on the distribution (Table 6.4), TMD patients with history of micro trauma were more likely to be diagnosed with combination of pain-related TMD and intra-articular TMD (45.65%) compared to other groups.

Table6.4: Distribution of TMD diagnosis across various types of trauma and no trauma group

	Type of trauma			
Diagnosis	**Macro trauma (N_1=90)**	**Micro trauma (N_2=67)**	**Both (N_3=92)**	**No trauma (N_4=145)**
Pain-related TMD	36.67%	28.36%	38.04%	41.38%

Intra-articular TMD	15.56%	16.42%	16.30%	20.00%
Combined	47.78%	55.22%	45.65%	38.62%

TMD: Temporomandibular Disorder

Approximately 90% of the TMD patients in each trauma group and no trauma group were chronic cases. Only around 7% of the TMD cases were acute and majority of those were patient with macro trauma history.

The time elapsed between various types of trauma incidence and TMD onset varied significantly among the macro trauma and both groups. Most patient with macro trauma developed TMD symptoms acutely (72.2%) specifically within ≤ 3 weeks. However, those with both micro and macro trauma often developed symptoms chronically after 4 to 6 months.

The location of pain on palpation varied across the groups and showed significantly weak association (ES = 0.2) with history of trauma (p value < 0.004).

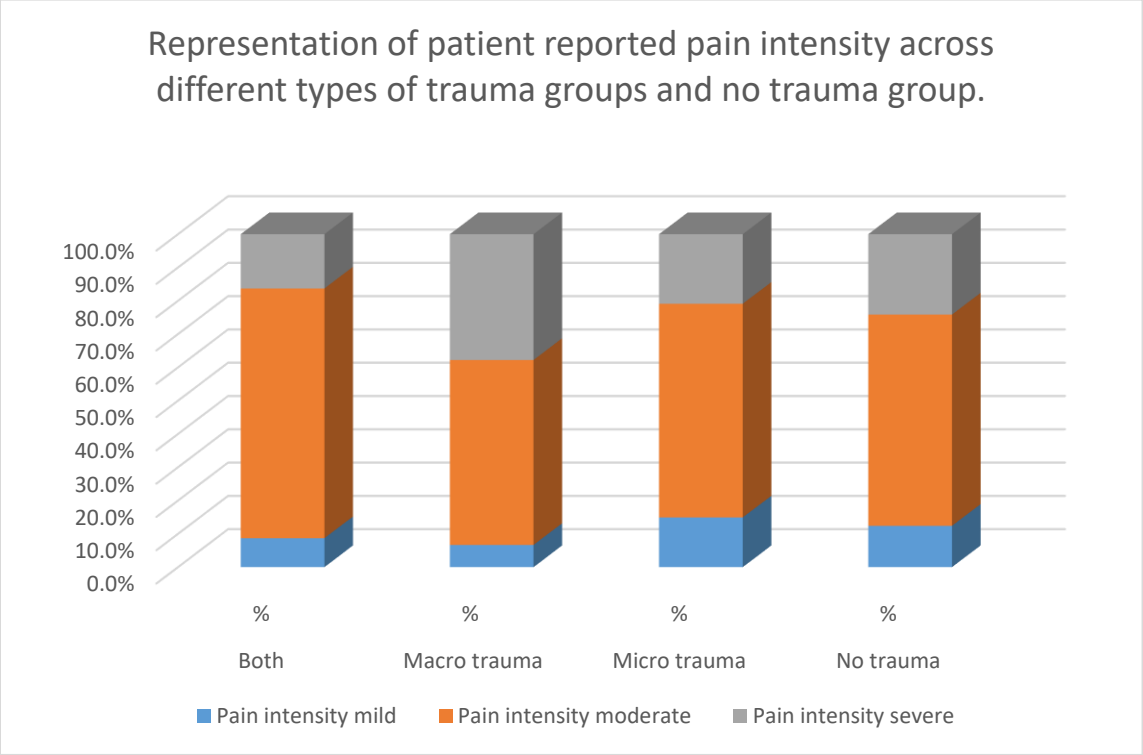
The location of pain on palpation across the trauma groups varied significantly in our study, pain was mainly situated in the masticatory muscles (40.45%) among the micro trauma group whereas macro trauma (25%) and both groups (34.48%) presented pain in TMJ and masseter muscle. Moreover, no trauma group (45.56%) mainly presented pain in the temporalis and/or masseter muscles.

All the groups reported almost similar mean pain intensity. The mean pain intensity calculated across groups was as follow macro trauma group 5.93± 1.94, micro trauma group 5.34± 1.64, both 5.42 ± 1.40 and no trauma group 5.33± 1.59.

The pain description such as pain intensity, pain type and pain frequency reported by patients with history of any trauma when compared to the no trauma history group did not show any significant difference ($p > 0.05$) except when macro trauma group was compared with no trauma group ($p < 0.05$, ES= 0.2) and micro trauma group ($p < 0.05$, ES = 0.3). Patient's with macro trauma history had almost twice more severe pain as compared to the other groups. Although

more than fifty percent of all the groups reported constant pain, macrotrauma and both groups has significantly higher reporting compared to other groups. Higher reporting of intermittent pain was found among the no trauma group. Pain frequency and pain type were weakly associated when patient with both micro and macro trauma were compared with no trauma group (p value < 0.05, ES= 0.2). Dull pain was more common among the no trauma group, whereas macrotrauma and both groups often reported pressing or pressure-type pain and throbbing pain. Interestingly, approximately, one-fourth of macro trauma group reported sharp or electric shock type pain. The distribution of patient reported pain intensity, pain frequency and pain type are represented in figure 6.2, 6.3 and 6.4 respectively.

Figure .6.2 Self-reported pain intensity distribution across study groups.



Mild intensity: pain rated as 0 to 3 on a visual analogue scale (VAS) where 0 indicates no pain and 10 indicated worst possible pain, Moderate intensity : rating of 4 to 6 and severe intensity : pain rated as 7 to 10.

Figure 6.3: Self-reported pain frequency distribution across groups

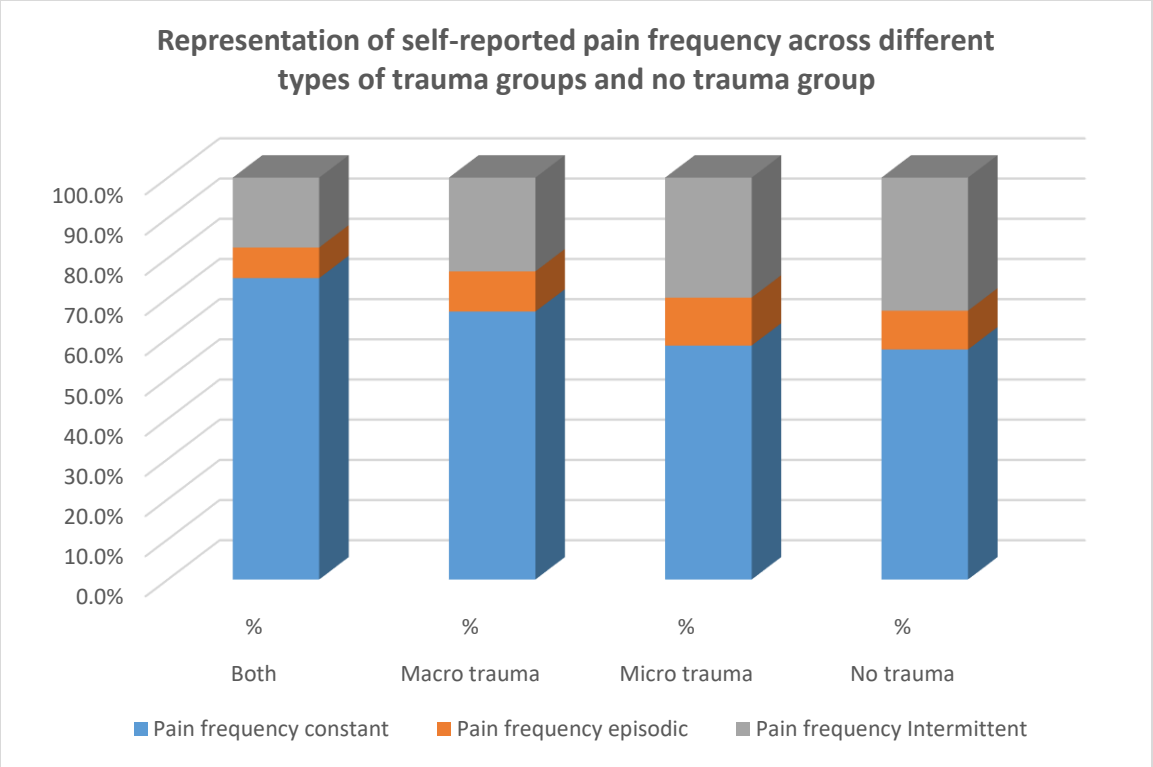


Figure 6.4: Self-reported pain type distribution across study groups

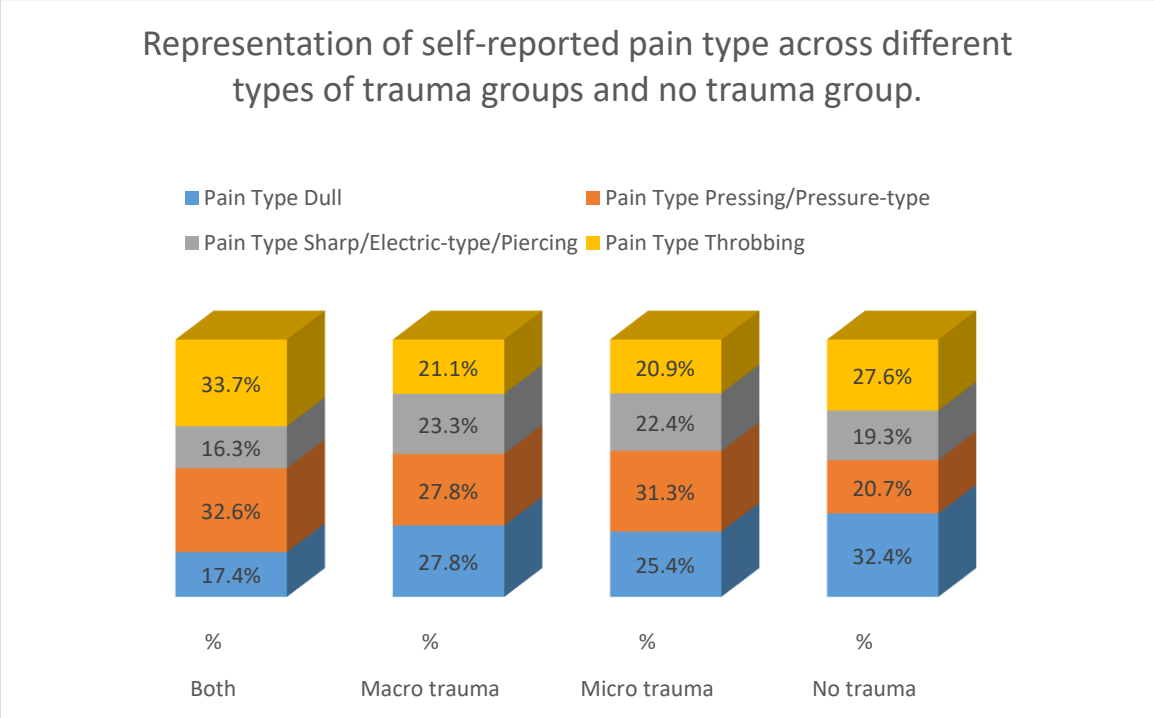


Table 6.5: Distribution and Association of patient-reported parameters across various types of traumas and no trauma group							
Factors	**Types of trauma reported**						**Comparison group**
	Macro trauma (N_1=90)	***P* value ***	**Micro trauma (N_2=67)**	***P* value ***	**Both (N_3=92)**	***P* value ***	**No trauma (N_4=145)**
Accompanying symptoms							
Autonomic signs	18.89%	0.01	8.96%	0.02	13.04%	0.08	8.97%
Dizziness	2.22%		7.46%		4.35%		4.14%
Earache	3.33%		8.96%		1.09%		2.76%
Headache	31.11%		56.72%		44.57%		45.52%
Others	5.56%		2.99%		4.35%		3.45%
No	38.89%		14.93%		32.61%		35.17%
Difficulty in chewing, speaking, and swallowing							
Yes	46.67%	0.04	55.22%	0.005	36.96%	0.04	33.79%
No	53.33%		44.78%		63.04%		66.21%
Others: Photophobia, phonophobia, nausea, vomiting etc, *p value** ≤ 0.05 was considered statistically significant.							

The distribution of patient-reported accompanying symptoms and effect on jaw function are represented in Table 6.5. These parameters statistically significant differences across various trauma groups and in comparison, with the no trauma group. Surprisingly, when patient reporting both macro trauma and micro trauma were compared with no trauma group there was statistically no significant difference (p value > 0.05). Accompanying symptoms (p value < 0.05, ES = 0.3) and difficulties in chewing, speaking, and swallowing (p value < 0.05, ES ≥0.2) were moderately associated with trauma incidence. Although headache was the most prevalent accompanying symptoms reported by all the groups, it slightly more among the microtrauma group.

The clinically evaluated TMD related factors such as presence of clicking and/or crepitus (p value < 0.05), jaw locking (p value = 0.04) and limited mouth opening (p value < 0.05) were significantly associated with trauma incidence. Interestingly, any type of jaw locking was not associated with macro or micro trauma history when compared with no trauma group. Although the clinical measures exhibited positive statistical significance (Phi = 0.2), these measures were only weakly associated (ES < 0.2).

Table 6.6 : Distribution and association of clinical signs across various trauma and no trauma group

		Types of Traumas reported						Comparison group
Clinically confirmed symptoms		**Macro trauma (N_1=90)**	**P Value***	**Micro trauma (N_2=67)**	**P value***	**Both (N_3=92)**	**P value***	**No trauma (N_4=145)**
Presence of Clicking and/or Crepitus	Unilateral	17.78%	<0.001	11.94%	0.006	13.04%	<0.01	18.62%
	Bilateral	34.44%		62.69%		58.70%		39.31%
	No	47.78%		25.37%		28.26%		42.07%
Jaw locking	Closed lock	5.56%	0.153	16.42%	0.045	11.96%	<0.001	6.90%
	Open lock	7.78%		1.49%		2.17%		2.76%
	Unspecified	8.89%		5.97%		17.39%		15.86%
	No	77.78%		76.12%		68.48%		74.48%
Limited mouth opening	Present	32.22%	<0.001	53.73%	<0.001	48.91%	<0.001	28.28%
	Absent	67.78%		46.27%		51.09%		71.72%

Discussion

We aimed to study the association between reporting of micro and macro traumatic events and TMDs. We also investigated the variation in self-reported symptoms and clinical signs among TMD patient with a history of micro and/or macro trauma preceding symptom onset and compared them with those without any history of preceding event.

Although, the study results showed no association statistically between a history of macro trauma and type of TMD diagnosis, there was statistically significant association between reporting of micro trauma and TMD diagnosis. However, clinically macro-trauma often precedes TMD symptom development. Moreover, all the trauma groups differed from the no trauma group in terms of the main reason for consultation, self-reported parameters such as difficulty in chewing, speaking, or swallowing and accompanying symptoms, pain location on palpation, clinical signs such as clicking and/or crepitus in joint, jaw locking and limited mouth opening. The mean pain intensity was almost similar across trauma and no trauma group. Pain frequency and pain type were only weakly associated when TMD patient reporting both micro and macro trauma were compared with no trauma group.

The female to male TMD patient ratio among all the study groups was approximately 3.5:1 which is similar to other previous studies on trauma and TMD (16, 22, 23). The mean age for all the groups was around 45.22 ± 16.72 similar to other previous studies analysing trauma and TMD (24). The distribution of reporting of traumatic events such as Motor Vehicle accident (10.15%), direct face injury (11.42%), fall injury (6.09%), prolonged mouth opening due to dental/ maxillofacial surgical procedures (15.74%) among TMD patients is similar to other previous studies (16, 18, 25). The time elapsed from macro trauma incident to initiation of TMD complain was about 3 weeks among two-thirds of the macro trauma patients, but was significantly longer among the TMD patient reporting either only micro trauma or/and macro trauma. This could be explained by the difference in etiological pathways in macro trauma and micro trauma.

In the current study, there was no statistical significance of macro trauma with TMD diagnosis, which contrasts with the results of few previous studies on TMD and trauma (16, 17, 25-27).

These difference in the study results could be due to differences in study design, selection and size of study groups, and diagnostic criteria. In our study, we implemented the DC/TMD, whereas previous studies utilized other criteria and due to broader categorisation of TMD diagnosis in our study. Furthermore, most of the previous studies were conducted on general population with healthy individuals as the comparison group was healthy (28). Moreover, a recent retrospective study analysing TMD diagnosis and macro trauma also found similar results (18).

The association of micro trauma with TMD has been long debated, as it can be the cause or the consequence of the condition (29). The results of the present study show association between TMD diagnosis and micro trauma reporting which is consistent with the previous study findings (30-32). However, it is difficult to determine if the damage to the tissues occurred solely due to micro trauma or if it was influenced by several other factors. As indicated in our study, approximately one-fourth of the macro trauma patients also reported micro trauma caused by parafunctional habits. Therefore, damage due to oral parafunction could merely be perceived as a behavioural or psychological problem rather than purely traumatic. Therefore, further research is required to know the role of micro-trauma in development and progression of TMD.

In the present study, patients with a history of macro trauma reported higher pain intensities, more severe TMD symptoms and evident clinical outcomes including difficulty in speech, chewing and swallowing as well as accompanying symptoms such as headache, autonomic signs etc as compared to the patient's who developed TMD independently (25, 26, 33). There was significant difference between the microtrauma and macro trauma patients in terms of patient reported TMD-related symptoms and parameters, accompanying symptoms and clinical measures (29, 34, 35). Similar differences were also observed in other previously conducted studies. The moderate to weak correlation of all the patient reported parameters and clinical measures with macro trauma, micro trauma and both groups indicate some influence of various types of trauma in TMD. Previous studies found similar results but did not comment on the strength of the association reported (18, 25, 36). Based on the results, it is likely for patients with a history of any type of traumatic event preceding TMD development, often present with a combination of pain related and intraarticular TMD and may have more symptoms compared to TMD patients without a history of trauma.

The present study has several strengths including an overall large sample size and sufficient sample size of each study group, which ensures the validity of the reported results. Standardized and calibrated clinical examination were conducted for all the patients and TMD diagnosis was made based on both patient self-report and clinical examination by an orofacial pain expert, adding to reliability of the study results. The study also reported the strength of association between the trauma groups and TMD symptoms as well as corelation, duration between trauma incidence and TMD symptom initiation, trauma description and implemented the new DC/TMD criteria for diagnosis. The retrospective study design minimized missing information.

However, there are limitations to consider in interpreting the results due to its retrospective study design. The cause-effect relationship between different types of traumatic events and types of TMD diagnosis cannot be established in the present study. Recall bias is also a concern in cross-sectional retrospective study as patients may have difficulty in accurately recalling the past injuries, potentially leading to underreporting of traumatic events that could have contributed to TMD. Although, this might have not been the case as our sample population were patient's trying to identify and cure there current TMD complain. Detection bias is another important in retrospective studies, as the clinician's knowledge of the role of trauma in TMD from the

existing literature might have influenced the diagnostic process. Moreover, reliance on patient reports of trauma incident description and pain descriptions, which are subjective and sometimes inaccurate, is another potential study limitation. Additionally, we did not adjust for potential confounding factors such as age, sex etc in our analysis.

Despite these limitations, the study provides important insights into the role of micro and macro traumatic events in TMD development and progression, and the strengths of the study design, including a large sample size and standardized clinical examinations, contribute to the validity of the findings. Further research using prospective designs and objective measures may help to further elucidate the relationship between traumatic events and TMD.

Conclusion

Based on the findings of our study and considering the strengths and limitations of our study design, we conclude that different types of traumatic events may play a role in the development of TMD. Patients with a history of micro and/or macro traumatic events preceding the initiation of TMD symptoms may present with differences in patient-reported symptoms and clinical manifestations compared to those without any preceding events. Therefore, we recommend regular screening of all trauma patients, including those with a history of dental/maxillofacial surgical procedures, for early detection of TMD symptoms. It is important to collect patient self-report on preceding event description along with clinical examination, as it may influence TMD development and prognosis. Early intervention for TMD patients with a history of any type of trauma can help reduce patient discomfort, treatment cost, and ultimately improve their quality of life. Further research using prospective designs and objective measures is needed to better understand the relationship between traumatic events and TMD, and to guide appropriate interventions for patients with a history of trauma.

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CHAPTER 7 DISCUSSION

This section aims to summarize the results of both the studies, followed by highlighting the methodological considerations when interpreting the study results such as different types of study bias, strengths, and limitations.

7.1 Summary of Results

7.1.1 Manuscript 1

Based on our review of the literature, there is lack of recent evidence highlighting the patient reported factors and orofacial pain characteristics of TMD population within Canada. The findings of this retrospective study conducted using the medical records of TMD patients provided insights into patient demographics and self-reported factors that are potentially associated with TMD development and progression. These results will be of paramount importance to inform the development of effective preventive measures and treatments for TMD by considering the unique needs and experiences of TMD patients.

The results illustrated the main reason for consultation within an orofacial pain and TMD clinic was TMJ pain usually lasting for more than 3 months. Female patients and full fertility age group portray more treatment seeking behaviors. Macro trauma such as fall injury, MVA, direct blow to the face or prolonged mouth opening during a dental/ maxillofacial surgical procedure are potential risk factors for orofacial pain development. Constant orofacial pain of moderate intensity and dull type is reported by patients which aggravates upon jaw movement or function and can be relieved with anti-inflammatories in most of the cases. Clicking and crepitus complaints are often reported but do not always represent TMD. Headache is the most reported accompanied symptom by the patients. Orofacial pain complains impacts sleep quality, daily activities and causes emotional distress in most of the patients.

Our study found self-reported jaw or TMJ pain among 52% of the patients seeking consultation. These results are in line with other recent retrospective studies conducted following similar methodology as our study (102, 103). Although when self-reported jaw pain complain was assessed within the Quebec population before two decades, the prevalence was 30% (7) which is much lower than our study. This difference is expected as our study was conducted specifically

including individuals seeking care for orofacial pain or TMD complaint whereas the previous study was conducted among the general population.

The potential factors reported by patients owing to onset, exacerbation or progression of their pain in the jaw or TMJ or orofacial region in our study such as macro trauma, parafunctional habits, prolonged mouth opening etc were also reported in the OPPERA study case control as well as prospective study (13, 14). Hawkins and Durham provided some plausible explanation that there is increased nociceptive sensitivity of the masseter muscle and increased cytokine expression due to prolonged mouth opening which may be the reason for TMD occurrence following dental procedures (104).

Several patients in our study have reported history of headache. Patients have also reported headaches being the most common symptom accompanying TMD. The studies conducted by Ciancaglini and Radaeli, Goncalves et al., and Ballegaard et al., have suggested that patients with headache are likely to have a clinical confirmation of TMD (105-107).

7.1.2 Manuscript 2

The association of micro and macro traumatic events and temporomandibular disorders has been a topic of debate in the field of orofacial pain. Following the implementation of DC/TMD diagnostic criteria for TMD, the studies investigating this association retrospectively are limited. Moreover, very few studies have considered patient's self-report and experience of TMD symptoms in addition to clinical examination and compared them across patients with experience of micro and/or macro traumatic events and no traumatic events.

Our investigation found that patients with micro traumatic event experience are more likely to be diagnosed with combination of pain related and intraarticular TMD. However, the self-reported TMD symptoms such as pain intensity, TMJ discomfort or dysfunction as well as clinical outcomes were more pronounced among patients with history of macro trauma. Moreover, patient reports and clinical examination findings vary significantly based on the type of event which potentially initiated TMD symptoms. They are also different when compared with those TMD patients who did not have any event leading to their complaint.

TMD patients often report macro trauma following a MVA, fall injury, direct blow to the face, dental/maxillofacial procedures as an event initiating their symptoms (70, 92). Similar results

were found in our study where approximately 46.2% of the total included patient reported experienced some form of macro trauma. Moreover, this patient has showed more severe symptoms compared to those without any history of trauma in our study as well as in previous studies (93, 100). In addition, our study did not find any association between macro trauma and type of TMD diagnosis which is similar to a recent retrospective study (99).

Oral parafunction can be reflective of existing behavioral or psychological problems rather than a micro trauma to the TMJ or masticatory muscle. Moreover, as reported in the OPPERA study, it is difficult to interpret if oral parafunction initiated TMD or contributed to its progression or is a consequence of the condition (53). Study by Leketas et al. showed that TMD cases report higher oral parafunctional behaviors when compared to healthy controls (108). Nevertheless, our study found association between reporting of micro trauma and type of TMD diagnosis which aligns with the existing literature (78).

7.2 Methodological considerations

7.2.1 Bias

Any type of epidemiological study conducted is prone to bias. In simple terms, bias can be described as inaccuracies or fallacies in study results or conclusions due to the tendency that prevents researcher from answering a research question unprejudiced (109). They can be introduced at any phase of research including study designs, data collection, data analysis and often during publication. Therefore, it is important to evaluate and report possible bias in any study conducted. Moreover, it is essential to design studies and predict every instance of introducing bias to minimize its possibility. The types of bias expected in this study and measures taken to prevent them are discussed below.

7.2.1.1 Selection Bias

The manner in which individual's medical records were selected for the study can result in selection bias. Factors such as diagnosis can lead to selection bias. In order to minimize this, we utilized the DC/TMD criteria for the diagnosis and only those patient records were included which have confirmed diagnosis of TMD based on the criteria on patient self-report and clinical examination.

7.2.1.2 Information Bias

In the case of comparison of multiple groups, this type of bias arise from differences in the way data was obtained. To minimize the chances of misclassification of patients into various trauma groups based on the patient report, we created a separate category “both” for patients with macrotrauma and microtrauma history for analysis. Moreover, the chances of misdiagnosis were minimized as all the patients were confirmed to have TMD based on DC/TMD clinical examination protocol. Moreover, the questionnaire utilized for patient-reported information was formulated based using validated instruments for assessing pain intensity and questions were prepared based on recommended standards for orofacial pain examination.

Recall bias occurs when the examiner or interviewer is aware about the exposure as well as outcome status of the patient included. Although, there was minimal intervention by the residents or clinicians while patients filled out the self-report questionnaire but in certain cases it was unavoidable to intervene where patients were unable to complete important relevant questions. Moreover, the patients might have missed reporting certain events which contributed to some level of their chief complaint.

Detection bias occurs due to prior knowledge of the examiner regarding the effect of exposure on outcome. In our case, clinicians’ knowledge from existing literature on trauma association with TMD might have impacted the diagnosis.

7.2.2 Strengths of the studies

The current cross-sectional study with retrospective analysis has several strengths; i) the sample size was large , diverse and sufficient ensuring results validity; ii) retrospective study design ensured high participation rate and no missing information; iii) all the included patients were clinically evaluated and diagnosed by calibrated residents and the diagnosis was confirmed by standardized examination using DC/TMD criteria by orofacial pain and TMD specialist to reduce the chances of misdiagnosis and patient misclassification; iv) all the data from clinical records was collected and extracted by a single person which ensured homogeneity of information; v) patient self-report was paired with clinical examination to present reliable information in study results.

7.2.3 Limitations of the studies

Owing to the retrospective study designs, the study had some limitations such as the cause-effect relationship cannot be established. The clinician's knowledge of trauma exposure and TMD from the existing literature might have impacted in diagnosis process. We had to rely on patient report for certain qualitative factors such as pain descriptions, trauma incident descriptions etc. Since details about the trauma incident were collected from the patients, the accuracy of described details might be altered if the incident occurred earlier. The chances of misclassification of diagnosis were overcome by using the standardized, DC/TMD criteria for diagnosis. The inclusion of patients seeking consultation at the Orofacial pain and TMD clinic might not be representative of the entire Canadian population with TMD complain. When measuring association of trauma and TMD we did not adjust for potential confounding factors which might have affected the accuracy of study results.

CHAPTER 8 CONCLUSION

The following conclusions can be drawn from the results of the two retrospective studies presented in this thesis:

- Chronic pain in the jaw or TMJ joint is the most common reason to seek consultation at an Orofacial pain and TMD clinic.
- Among the patients, Women in full fertility age group were most common group to seek attention and treatment due to pain.
- Macro trauma due to MVA, fall injury, dental/maxillofacial surgical procedures often preceded initiation of orofacial pain symptoms.
- Orofacial pain is mostly characterized as a constant, dull type sensation with moderate intensity and it can often be alleviated to some extent with anti-inflammatory medications.
- Headache is the most common accompanied symptom associated with TMJ or jaw pain and impacts quality of life in terms of sleep disturbances, emotional distress, and lack of concentration.
- Future studies based on general population are required to determine the actual prevalence of jaw or TMJ pain and its impact within the Canadian population.
- Although TMD patients often report macro trauma preceding the initiation of their TMD symptom, it might not be associated with the clinical diagnosis based on the DC/TMD criteria.
- Micro traumatic events play a role in exacerbation or onset of TMD symptoms and often manifest as combined pain-related and intraarticular TMD.
- TMD symptom manifestation is more severe among patients with a history of macro trauma compared to patients who develop TMD independently of any traumatic event or those with a history of micro traumatic events.
- Self-reported temporomandibular disorder (TMD) symptoms, accompanying symptoms, and clinical examination findings vary based on the etiology or preceding event.
- Cause-effect relation between micro and/or macro traumatic events and TMD cannot be established due to retrospective nature of the current study indicating need for more prospective study to identify the risk factors for TMD.

CHAPTER 9 CLINICAL IMPLICATIONS

Temporomandibular disorders (TMDs) are the second most reported chronic musculoskeletal disorder after low back pain and are the most common non-dental cause of orofacial pain. The onset of TMD is attributed to an interplay of several biological, psychological, physical, and environmental factors. Therefore, a multidisciplinary approach by health care providers is required for treatment or prevention of its progression. Additionally, as reported in the current study results, multiple factors initiate and worsen TMD symptoms, as well as often accompanying symptoms are associated with the condition.

We suggest that the identification of all the factors contributing to TMD onset and progression should be done through a detailed recording of patient history followed by a thorough clinical examination based on the DC/TMD criteria. Furthermore, we recommend screening for TMD symptoms among all the patient's seeking dental care, particularly women and full fertility age groups. Moreover, patients at higher risk of developing TMD such as those with history of trauma, maxillofacial surgical procedures, parafunctional habits etc should be screened regularly and educated to establish any early preventive measures if necessary. Early intervention with preventive measures will lead to decreased patient discomfort, treatment cost and eventually a higher quality of life.

CHAPTER 10 KNOWLEDGE TRANSLATION

The results of the current study were presented in form of poster presentation at the McGill University Research Day (2022, 2023) and a video presentation of the study was submitted to the Network of Oral and Bone Health Research (RSBO) (submitted for 2022). Manuscript 1 and Manuscript 2 will be sent out for publication in June 2023.

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APPENDIX

Research Ethics Board Approval Letter

Centre universitaire de santé McGill | McGill University Health Centre

2022-06-21

Dr. Firoozeh Samim
MUHC-Montreal General Hospital
Dept. of Oral and Maxillofacial Surgery Mouth Diseases and TMD & Orofacial Pain Clinic
Room B3-131 1650 Cedar Ave,
Montreal, Quebec H3G 1A4

email: firoozeh.samim@mcgill.ca

RE: REB Conditional Approval of a New Research Project
Influence of Previous Trauma and surgical procedures in Development and Management of Temporomandibular Disorders: A retrospective study
(PTS_TMD / 2023-8850)

MUHC REB Co-Chair for the PED panel: Carlo Cicero Oneto

Dear Dr. Samim,

Thank you for the initial submission of the research project indicated above.

On 2022-06-21, a delegated review of the research project was provided by member(s) of the McGill University Health Centre (MUHC) Research Ethics Board (REB), more precisely its Pediatric (PED) panel.

The *Initial Submission Form* (F11HRR-96405) as well as the following documents were reviewed:

- **Research protocol**
- (TMD_Trauma_protocol_for_ethical_approval_draft.doc) [Date: 2022-05-26, Version: 001]

After reviewing the documents, **this research project was approved unanimously by the MUHC REB conditional upon the receipt of responses to the conditions listed in the *REB Conditions & PI Responses Form* (F20-97806) and documents attached to it.** This will be reported to the MUHC REB and will be entered accordingly into the minutes of the next PED meeting.

Corrected documents attached to the F20-97806 will have to be submitted in "track changes".

We trust this will prove satisfactory to you. Thank you for your consideration in this matter.

Best Regards,

Ms. Elizabeth Craven, Coordinator, MUHC REB

Centre universitaire de santé McGill | McGill University Health Centre

2022-07-12

Dr. Firoozeh Samim

email: firoozeh.samim@mcgill.ca

Re: MUHC Authorization (PTS_TMD / 2023-8850)

"Influence of Previous Trauma and surgical procedures in Development and Management of Temporomandibular Disorders: A retrospective study"

Dear Dr. Samim,

We are writing to confirm that the study mentioned above has received research ethics board approval and all required institutional approvals, namely:

- Access to health records

You are hereby authorized to conduct your research at the McGill University Health Centre (MUHC) as well as to initiate recruitment.

Please refer to the MUHC Study number in all future correspondence relating to this study.

In accordance with applicable policies it is the investigator's responsibility to ensure that staff involved in the study is competent and qualified and, when required, has received certification to conduct clinical research.

Should you have any questions, please do not hesitate to contact the support for the Personne mandatée at personne.mandatee@muhc.mcgill.ca.

We wish you every success with the conduct of the research.

Sincerely,

Sheldon Levy

S. Levy for K. Woolrich, Personne Mandatée
Sheldon Levy
for:
Keith Woolrich
Personne Mandatée
Centre Universitaire de Santé McGill

Signed on 2022-07-12 at 10:50

Orofacial Pain Health Questionnaire

TMD/OFP patient form

Patient's details / Information sur la patient

Name/ *Nom* _____ Age / *Âge* _____

Sex/*Sexe* (M/F)☐ Marital status / *État civil:* _____

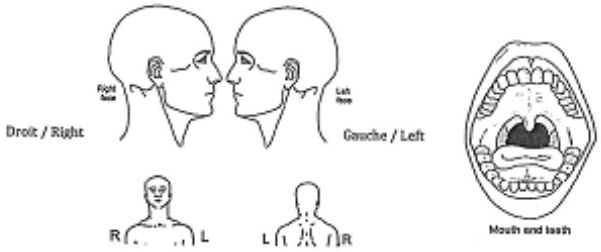
Occupation _____

1. What bothers you the most? / *Qu'est-ce qui vous dérange le plus?*

2. When did this problem first start to bother you? At what age? /
   Depuis quand avez-vous ce problème ? De puis quel âge ?

3. Pain location (also marked on the below drawing where you feel pain or sensation)
   Localisation de la douleur (svp, indiquer l'endroit sur les dessins où vous sentez la douleur ou de la sensibilité)

_____



4. How long does this pain stay? (duration) / *Durée de la douleur quand vous la ressentez ?*

_____

5. Pain attack frequency (mark continuous if no pain-free periods) /
   Fréquence des attaques de douleur (indiquer "continu" s'il y a aucun arrêt de la douleur)

_____

1

6. Pain severity (mark on scale below or rate from 1-10) /
Gravité de la douleur (indiquer la gravité sur l'échelle si dessous ou évaluer de 1 à 10 la gravité de la douleur)

No pain Pas de douleur	0	1	2	3	4	5	6	7	8	9	(10)	Worst pain Douleur sévère

7. Factors that precipitate/aggravate pain:
Indiquez les facteurs qui précipitent/aggravent ou créent la douleur :

_____

8. Pain is eased by / *La douleur est soulagée par:*

_____

9. How do you describe this pain? (pressing/piercing/throbbing/burning/electric/sharp/other)
Comment décrirez-vous cette douleur? (perçant / électrique/tranchant/autre)

_____

10. Accompanying signs and symptoms (Please mark)

- Systemic: nausea/vomiting/photophobia/phonophobia/dizziness
- *Systémique: nausée/ vomissement/photophobie / étourdissement*

- Local: tearing/rhinorrhea/swelling/redness / Local: /inflammation/rougeur
- *Local: Headache / maux de tête*

11. History of trauma (Yes/No)☐If yes: date (YYYY-MM-DD) _____

Description: _____

Historique de trauma (Yes / No). Si oui : date (YYYY-MM-DD)_____

Description : _____

12. Has your condition interfered with any aspects of your life? (yes/ No)
If yes please check and circle all that apply (YES / NO)

- Work/ physical activities
- Family/ social activity
- Chewing/ swallowing

Weight Gain/loss
Emotions/sexual activity
Sleep

Other .....

Est-ce que votre condition perturbe des aspects de votre vie? (YES / NO)
Si oui, encerclez les aspects qui s'appliquent:

- Travail / activités physiques
- Famille / activités sociales
- Mâcher / avaler
- Gain de poids / Perte de poids
- Emotions / activités sexuelles
- Sommeil
- Autres: _____

13. Does the pain wake you? (Yes/No)☐
Est-ce que la douleur vous réveille ? (YES/NO)

14. What other doctors or healthcare professionals have you seen for your current problem? What treatment was recommended?
Quels autres docteurs ou professionnels de la santé avez-vous vus concernant votre condition courante ? Quel traitement a-t-il/elle recommandé ?

Practitioner / *Practicien*	*Procedure / Procédure*

15. Do you have any allergies or adverse drug reactions? Yes/ No
Avez-vous des allergies ou des réactions aux médicaments ? OUI / NON

Medications / *Médicaments*	What happens when you take it? *Qu'arrive-t-il quand vous le prenez?*

16. Medical information; Have you ever had or currently have any of the following medical conditions (please circle for each one that applies):
Information Médicale; Aviez-vous déjà eu ou avez présentement une ou plusieurs des conditions suivantes (svp encercler celui qui s'applique):

Anxiety/Depression – *Anxiété/Dépression*	Glaucoma - *Glaucome*
Sleeping problems – *Problèmes de sommeil*	*Stroke – Accident vasculaire cérébral*
Nervous disorders/ fainting spells – *Troubles nerveux - évanouissements*	High blood pressure/ Cholesterol – *Hypertension / Cholestérol*
Seizures / *Convulsions*	Heart problem (Arrhythmia/ MI) – *Problème cardique (Arrhythmie / IM)*
Parkinson's, Huntington's, MS – *Parkinsons, Hutington, Sclérose en plaque*	Shortness of breath / *Essouflement*
Headaches (Tension/ migraine) / *Maux de tête (tension /migraine)*	Asthma/ Lung problem – *Asthme / Problème pulmonaire*
Diabetes -- *Diabète*	Kidney/Liver problems – *Problèmes rénals ou/et de foie*
Thyroid problems - *Problèmes thyroïdiens*	Stomach problem/GERD/ Heartburn- *Problème d'estomac/GERD / Brûlure d'estomac*
Blood clotting problem / *Problème de coagulation*	Irritable Bowel syndrome – *Syndrome de l'intestin irritable*
Arthritis (rheumatoid/osteoid) – *Arthrite (rheumatoid / osteoid)*	Constipation/ Difficulty Urinating – *Constipation / Difficulté à uriner*
Muscle tension/ spasm – *Tension musculaire / spasme)*	Cancer - Cancer
Fibromyalgia - *Fibromyalgie*	Other - *Autre*

17. Please list all surgeries and hospitalizations:
SVP, indiquez toutes les chirurgies et hospitalisation que vous avez eues :

Past surgery / *Chirurgies passées*	Hospitalization- *Hospitalisation*

18. General information:
Information générale:

- Do you smoke? Yes/ No Cigarettes per day …….. Years Smoked …….
- Do you drink Alcohol Yes/No Drinks/ day …….. Drinks/ week
- *Fumez-vous? OUI / NON Cigarettes par jour …….. Nombre d'années que vous fumez : ……*
- *Buvez-vous de l'alcool ? OUI / NON Nombre de boissons par jour …….. Nombre de boissons par semaine ……*

19. Do you have caffeine in your diet? *Prenez-vous de la caféine dans votre diète?*

- Coffee No Yes Cups/ day……
- Tea/Cola No Yes Servings/Day…..
- Chocolate No Yes Servings/ day ……
- Café Non Oui No de tasses/ jour …..
- Thé / Cola Non Oui No de tasses/ jour …..
- Chocolat Non Oui No de tasses/ jour …..

Please add anything that may have been missed:

SVP ajoutez toute information qui peut manquer:

……

19. Do you have caffeine in your diet? *Prenez-vous de la caféine dans votre diète?*

- Coffee No Yes Cups/ day……
- Tea/Cola No Yes Servings/Day…..
- Chocolate No Yes Servings/ day ……
- Café Non Oui No de tasses/ jour …..
- Thé / Cola Non Oui No de tasses/ jour …..
- Chocolat Non Oui No de tasses/ jour …..

Please add anything that may have been missed:

SVP ajoutez toute information qui peut manquer:

……

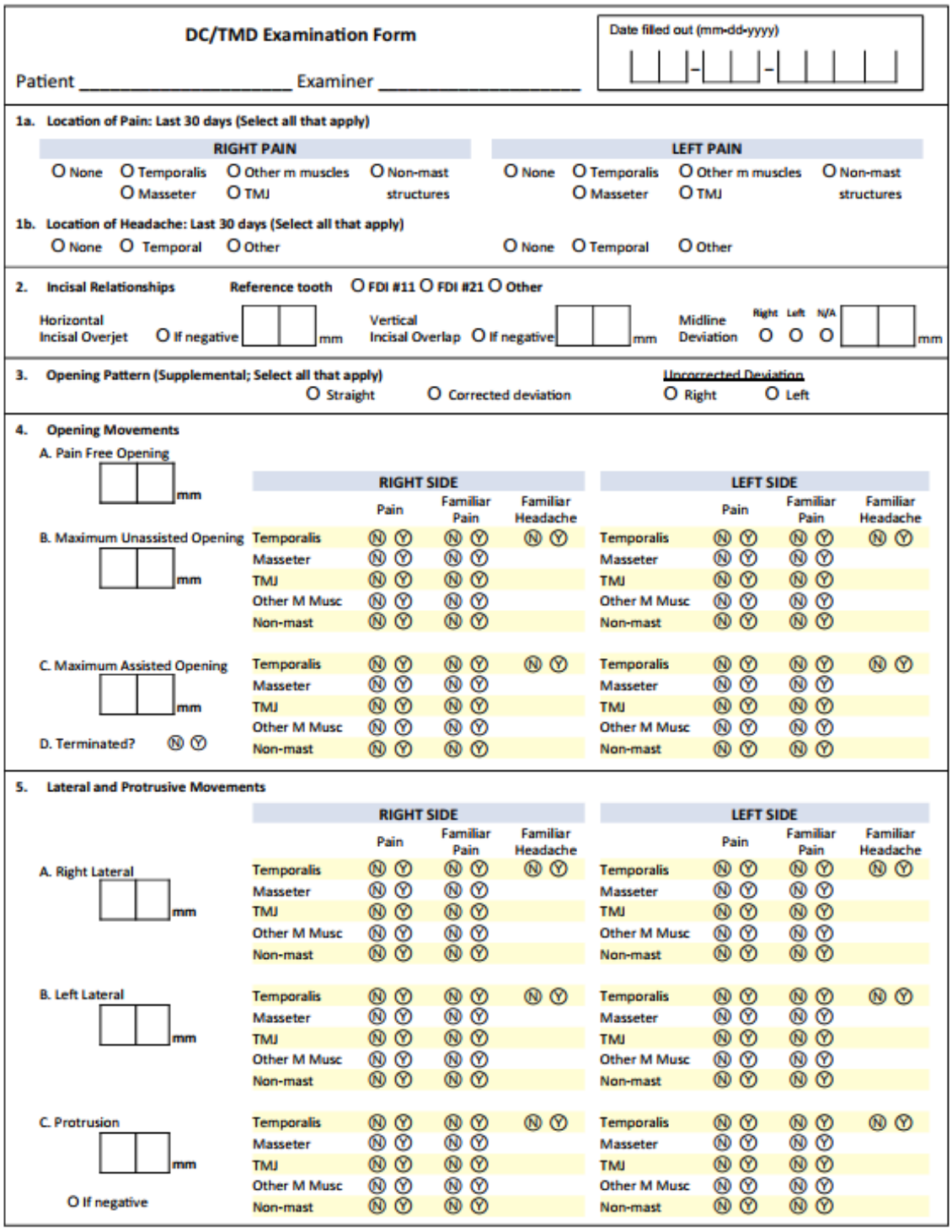
Politique d'annulation
Si un patient a besoin de modifier ou d'annuler un rendez-vous, il doit en informer le bureau d'enregistrement au moins 48 heures avant le rendez-vous au (514) 934-8063. Sinon, des frais de 60$ seront portés à son dossier et un prochain rendez-vous ne sera pas fixé avant que cette somme ne soit acquittée. Initiales **requises** → _____.

Cancellation
If a patient needs to change or cancel an appointment, they must advise the Registration Office at least 48 hours before the appointment at (514) 934-8063. A charge of $60 will be added to the patient's account if adequate notice is not given. Any future appointments will not be booked if this charge is not acquitted. **Initials required** → _____.

Patient's signature: _____

Signature du patient: _____

DC/TMD Examination Form



DC/TMD Examination Form

Date filled out (mm-dd-yyyy) ___-___-____

Patient _____ Examiner _____

1a. Location of Pain: Last 30 days (Select all that apply)

RIGHT PAIN				LEFT PAIN			
O None	O Temporalis	O Other m muscles	O Non-mast structures	O None	O Temporalis	O Other m muscles	O Non-mast structures
	O Masseter	O TMJ			O Masseter	O TMJ	

1b. Location of Headache: Last 30 days (Select all that apply)

O None O Temporal O Other — O None O Temporal O Other

2. Incisal Relationships Reference tooth O FDI #11 O FDI #21 O Other

Horizontal Incisal Overjet O If negative ___ mm — Vertical Incisal Overlap O If negative ___ mm — Midline Deviation Right O Left O N/A O ___ mm

3. Opening Pattern (Supplemental; Select all that apply)

O Straight O Corrected deviation — Uncorrected Deviation: O Right O Left

4. Opening Movements

A. Pain Free Opening ___ mm

B. Maximum Unassisted Opening ___ mm

C. Maximum Assisted Opening ___ mm

D. Terminated? (N) (Y)

	RIGHT SIDE				LEFT SIDE			
		Pain	Familiar Pain	Familiar Headache		Pain	Familiar Pain	Familiar Headache
B. Maximum Unassisted Opening	Temporalis	(N) (Y)	(N) (Y)	(N) (Y)	Temporalis	(N) (Y)	(N) (Y)	(N) (Y)
	Masseter	(N) (Y)	(N) (Y)		Masseter	(N) (Y)	(N) (Y)	
	TMJ	(N) (Y)	(N) (Y)		TMJ	(N) (Y)	(N) (Y)	
	Other M Musc	(N) (Y)	(N) (Y)		Other M Musc	(N) (Y)	(N) (Y)	
	Non-mast	(N) (Y)	(N) (Y)		Non-mast	(N) (Y)	(N) (Y)	
C. Maximum Assisted Opening	Temporalis	(N) (Y)	(N) (Y)	(N) (Y)	Temporalis	(N) (Y)	(N) (Y)	(N) (Y)
	Masseter	(N) (Y)	(N) (Y)		Masseter	(N) (Y)	(N) (Y)	
	TMJ	(N) (Y)	(N) (Y)		TMJ	(N) (Y)	(N) (Y)	
	Other M Musc	(N) (Y)	(N) (Y)		Other M Musc	(N) (Y)	(N) (Y)	
	Non-mast	(N) (Y)	(N) (Y)		Non-mast	(N) (Y)	(N) (Y)	

5. Lateral and Protrusive Movements

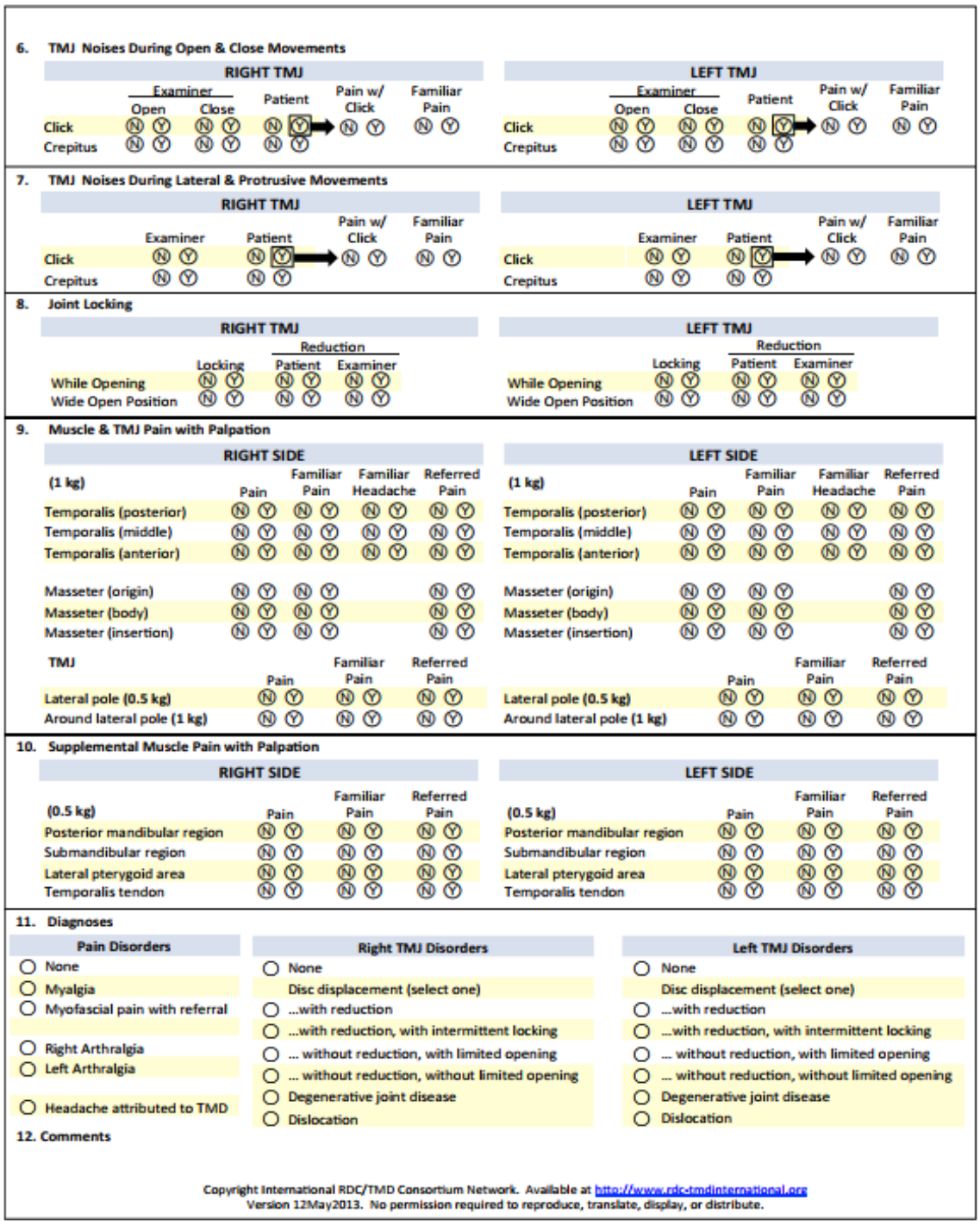
A. Right Lateral ___ mm

B. Left Lateral ___ mm

C. Protrusion ___ mm

O If negative

	RIGHT SIDE				LEFT SIDE			
		Pain	Familiar Pain	Familiar Headache		Pain	Familiar Pain	Familiar Headache
A. Right Lateral	Temporalis	(N) (Y)	(N) (Y)	(N) (Y)	Temporalis	(N) (Y)	(N) (Y)	(N) (Y)
	Masseter	(N) (Y)	(N) (Y)		Masseter	(N) (Y)	(N) (Y)	
	TMJ	(N) (Y)	(N) (Y)		TMJ	(N) (Y)	(N) (Y)	
	Other M Musc	(N) (Y)	(N) (Y)		Other M Musc	(N) (Y)	(N) (Y)	
	Non-mast	(N) (Y)	(N) (Y)		Non-mast	(N) (Y)	(N) (Y)	
B. Left Lateral	Temporalis	(N) (Y)	(N) (Y)	(N) (Y)	Temporalis	(N) (Y)	(N) (Y)	(N) (Y)
	Masseter	(N) (Y)	(N) (Y)		Masseter	(N) (Y)	(N) (Y)	
	TMJ	(N) (Y)	(N) (Y)		TMJ	(N) (Y)	(N) (Y)	
	Other M Musc	(N) (Y)	(N) (Y)		Other M Musc	(N) (Y)	(N) (Y)	
	Non-mast	(N) (Y)	(N) (Y)		Non-mast	(N) (Y)	(N) (Y)	
C. Protrusion	Temporalis	(N) (Y)	(N) (Y)	(N) (Y)	Temporalis	(N) (Y)	(N) (Y)	(N) (Y)
	Masseter	(N) (Y)	(N) (Y)		Masseter	(N) (Y)	(N) (Y)	
	TMJ	(N) (Y)	(N) (Y)		TMJ	(N) (Y)	(N) (Y)	
	Other M Musc	(N) (Y)	(N) (Y)		Other M Musc	(N) (Y)	(N) (Y)	
	Non-mast	(N) (Y)	(N) (Y)		Non-mast	(N) (Y)	(N) (Y)	



6. TMJ Noises During Open & Close Movements

RIGHT TMJ

	Examiner: Open	Examiner: Close	Patient	Pain w/ Click	Familiar Pain
Click	N Y	N Y	N [Y]	N Y	N Y
Crepitus	N Y	N Y	N Y		

LEFT TMJ

	Examiner: Open	Examiner: Close	Patient	Pain w/ Click	Familiar Pain
Click	N Y	N Y	N [Y]	N Y	N Y
Crepitus	N Y	N Y	N Y		

7. TMJ Noises During Lateral & Protrusive Movements

RIGHT TMJ

	Examiner	Patient	Pain w/ Click	Familiar Pain
Click	N Y	N [Y]	N Y	N Y
Crepitus	N Y	N Y		

LEFT TMJ

	Examiner	Patient	Pain w/ Click	Familiar Pain
Click	N Y	N [Y]	N Y	N Y
Crepitus	N Y	N Y		

8. Joint Locking

RIGHT TMJ

	Locking	Reduction: Patient	Reduction: Examiner
While Opening	N Y	N Y	N Y
Wide Open Position	N Y	N Y	N Y

LEFT TMJ

	Locking	Reduction: Patient	Reduction: Examiner
While Opening	N Y	N Y	N Y
Wide Open Position	N Y	N Y	N Y

9. Muscle & TMJ Pain with Palpation

RIGHT SIDE

(1 kg)	Pain	Familiar Pain	Familiar Headache	Referred Pain
Temporalis (posterior)	N Y	N Y	N Y	N Y
Temporalis (middle)	N Y	N Y	N Y	N Y
Temporalis (anterior)	N Y	N Y	N Y	N Y
Masseter (origin)	N Y	N Y		N Y
Masseter (body)	N Y	N Y		N Y
Masseter (insertion)	N Y	N Y		N Y

TMJ	Pain	Familiar Pain	Referred Pain
Lateral pole (0.5 kg)	N Y	N Y	N Y
Around lateral pole (1 kg)	N Y	N Y	N Y

LEFT SIDE

(1 kg)	Pain	Familiar Pain	Familiar Headache	Referred Pain
Temporalis (posterior)	N Y	N Y	N Y	N Y
Temporalis (middle)	N Y	N Y	N Y	N Y
Temporalis (anterior)	N Y	N Y	N Y	N Y
Masseter (origin)	N Y	N Y		N Y
Masseter (body)	N Y	N Y		N Y
Masseter (insertion)	N Y	N Y		N Y

	Pain	Familiar Pain	Referred Pain
Lateral pole (0.5 kg)	N Y	N Y	N Y
Around lateral pole (1 kg)	N Y	N Y	N Y

10. Supplemental Muscle Pain with Palpation

RIGHT SIDE

(0.5 kg)	Pain	Familiar Pain	Referred Pain
Posterior mandibular region	N Y	N Y	N Y
Submandibular region	N Y	N Y	N Y
Lateral pterygoid area	N Y	N Y	N Y
Temporalis tendon	N Y	N Y	N Y

LEFT SIDE

(0.5 kg)	Pain	Familiar Pain	Referred Pain
Posterior mandibular region	N Y	N Y	N Y
Submandibular region	N Y	N Y	N Y
Lateral pterygoid area	N Y	N Y	N Y
Temporalis tendon	N Y	N Y	N Y

11. Diagnoses

Pain Disorders	Right TMJ Disorders	Left TMJ Disorders
○ None	○ None	○ None
○ Myalgia	Disc displacement (select one)	Disc displacement (select one)
○ Myofascial pain with referral	○ ...with reduction	○ ...with reduction
	○ ...with reduction, with intermittent locking	○ ...with reduction, with intermittent locking
○ Right Arthralgia	○ ... without reduction, with limited opening	○ ... without reduction, with limited opening
○ Left Arthralgia	○ ... without reduction, without limited opening	○ ... without reduction, without limited opening
	○ Degenerative joint disease	○ Degenerative joint disease
○ Headache attributed to TMD	○ Dislocation	○ Dislocation

12. Comments

[1]Schiffman, Eric et al. "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 vol. 28,1 (2014): 6-27. doi:10.11607/jop.1151