Impact of painful comorbidities associated persistent and recurrent temporomandibular disorder-related pain

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DEDICATION

This work is dedicated to my parents Mr. Shahid Ejaz and Mrs. Zeba Shahid for their endless love and support throughout the course of my postgraduate program.

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LIST OF ABBREVIATIONS

TMD	Temporomandibular Disorder
TMJ	Temporomandibular Joint
TMJD	Temporomandibular Joint Disorder
NIDCR	National Institute of Dental and Craniofacial Research
TIRR	Temporomandibular Implant Registry and Repository
VAS	Visual Analogue Scale
OR	Odds Ratio
RR	Relative Risk
CI	Confidence Interval
RDC/TMD	Research Diagnostic Criteria for Temporomandibular Disorders
CMI	Craniomandibular Index
SSI	Symptom Severity Index
SS	Symptom Severity
WPI	Widespread Pain Index
SCL-90	Symptom Check List 90
IDR	Incidence Density Ratio
BSI	Brief Symptom Inventory
PSS	Perceived Stress Scale
STAI	State-Trait Anxiety Inventory
k	Kappa
ICC	Interclass correlation coefficient

ABSTRACT

Objectives: The primary aims of this study were to determine if: i) TMD-related pain was associated with migraine and musculoskeletal comorbidities; and ii) persistent or recurrent TMD-related pain were related to these comorbidities.

Methods: Data from 750 TMD-related pain cases – of which 477 were classified as persistent and 261 as recurrent TMD-related pain, and 146 controls – were obtained from the National Institute of Dental and Craniofacial Research's Temporomandibular Joint Implant Registry and Repository (NIDCR's TIRR). The diagnosis of TMD-related pain was determined by clinical examination using a modified Craniomandibular Index wherein the exam items were redesigned to conform to those specified for the Research Diagnostic Criteria. Controls were participants without TMD. Patterns of pain (i.e., persistent or recurrent) and comorbidities were assessed using questionnaires from the TIRR. Painful comorbidities include migraine and musculoskeletal conditions. Univariate and multivariable logistic regression analyses were used to investigate the associations between TMD-related pain and painful comorbidities.

Results: There was a significant difference in the mean age of TMD-related pain cases (mean = 41.9, SD = 14.7) and of controls (mean = 34.2, SD = 13.8, $P < .0001$). Females were significantly more prevalent among cases (89%) than among controls (66%, $P < .0001$). The mean pain intensity (0 - 10 NRS) in the last 6 months was significantly higher for persistent (mean = 7.8, SD = 2.6) as compared to recurrent (mean = 6.3, SD = 2.7, $P < 0.001$) TMD-related pain. In multivariable logistic analyses adjusted by age, gender, and psychological comorbidities, migraine (OR = 2.19, $P = 0.004$), neck pain (OR = 7.44, $P < .0001$), back pain (OR = 4.45, $P < .0001$) and fibromyalgia (OR = 4.80, $P = 0.03$) were associated with TMD-related pain. Furthermore, neck and back pains remained related to TMD-related pain, persistent or recurrent, when the model included the painful comorbidities, with the exception of migraine. Finally, persistent TMD-related pain cases were more likely to have fibromyalgia (OR = 1.92, $P = 0.01$) than the recurrent cases.

Conclusion: These results demonstrated that participants with musculoskeletal painful conditions were more likely to have TMD-related pain, regardless of TMD characteristics such as recurrent and persistent TMD-related pain. A significant difference was nonetheless noted on the odds of fibromyalgia between persistent and recurrent TMD-related pain. Finally, the association with migraine seems to be modified by the manifestation of other comorbid conditions and type of TMD-related pain as compared to other painful comorbidities. To our knowledge, this study is the first to assess the association between painful comorbid conditions and TMD-related pain (persistent or recurrent) regardless of occurrence of other painful comorbid conditions. Understanding the relationship between TMD-related pain with painful comorbid conditions will lead to better patient management using a multidisciplinary approach.

RÉSUMÉ

Objectif: Les principaux objectifs de cette étude étaient de déterminer si: i) la douleur liée au troubles de l'articulation temporomandibulaire (TMD) était associée à la migraine et les comorbidités musculo-squelettiques, et ii) la douleur persistante ou récurrente liée aux TAT était associée à ces comorbidités

Méthode: Les données de 750 cas de douleur liée aux TMD – dont 477 furent classés comme ayant de la douleur persistante et 261 comme ayant de la douleur récurrente liée aux TMD, ainsi que 146 contrôles – ont été obtenus à partir du *Temporomandibular Joint Implant Registry and Repository* de la *National Institute of Dental and Craniofacial Research* (la TIRR de la NIDCR). Le diagnostic de douleur liée au TMD a été déterminé par un examen clinique en utilisant un indice craniomandibulaire modifiée, où les questions de l`examen furent modifiées afin d`être conformes à celles spécifiées par le *Research Diagnostic Criteria*. Les contrôles étaient des participants sans TMD. Les modèles de la douleur (i.e. persistante ou récurrente) et les comorbidités ont été évalués au moyen de questionnaires de la TIRR. Les comorbidités douloureuses comprennent la migraine et les troubles musculo-squelettiques. Des analyses de régression logistique univariée et multivariée ont été utilisés pour étudier les associations entre la douleur liée aux TMD et les comorbidités douloureuses.

Résultats: Il y avait une différence significative dans l'âge moyen des cas de douleur liée aux TMD (moyenne = 41,9 , SD = 14,7) et des contrôles (moyenne = 34,2 , SD = 13,8 , P < 0,0001) . Les femmes étaient significativement plus fréquentes parmis les cas (89 %) que parmis les contrôles (66 % , p < 0,0001) . L`intensité de douleur (0 - 10 NRS) dans les 6 derniers mois était significativement plus élevée pour la douleur persistante (moyenne = 7,8 , SD = 2,6) que pour la douleur récurrente (moyenne = 6.3 , SD = 2,7 , p <0,001) liée aux TMD. Dans des analyses logistique multivariée ajusté selon l'âge , le sexe et les comorbidités psychologiques, la migraine (OR = 2,19 , *P* = 0,004) , les douleurs au cou (OR = 7.44 , *P* < 0,0001) , les maux de dos (OR = 4,45 , *P* < 0,0001) et la fibromyalgie (OR = 4,80 , *P* = 0,03) étaient associés à la douleur liée aux TMD . En outre, les maux de cou et de dos restèrent associés à la douleur liée aux TMD, persistante ou récurrente, lorsque le modèle inclut les comorbidités douloureuses, sauf la migraine. Enfin, les cas de douleur persistantes liée aux TMD étaient plus susceptibles d'avoir une fibromyalgie (OR = 1,92 , *P* = 0,01) que les cas récurrents.

Conclusion: Ces résultats démontrent que les participants souffrant de pathologies musculo-squelettiques étaient plus susceptibles d'avoir des douleurs liées aux TMD, indépendamment des caractéristiques de leurs TMD, tels que la douleur récurrente et persistante liée aux TMD. Cependant, l'association de la migraine semble être modifié par la manifestation d'autres comorbidités et le type de douleur liée aux TMD liées comparés à d'autres comorbidités douloureuses. Comprendre la relation entre la douleur liée aux TMD et les conditions douloureuses comorbides conduira à une meilleure gestion des patients en utilisant une approche multidisciplinaire.

PREFACE

This thesis has followed a manuscript based thesis style. As per McGill University standards, the manuscripts included in thesis should be logically-coherent and should have a unified theme. The manuscript in this thesis discusses a novel project on the impact of painful comorbidities associated with the persistence and recurrence of temporomandibular disorder-related pain. Following a concise introduction of the topic in the first chapter, the second chapter provides previous and current knowledge in the field of temporomandibular disorder pain. Chapter three proposes the objectives of study based on knowledge provided by the literature. Following a comprehensive discussion of the methodology in chapter four, a manuscript is presented. Finally the last chapter discusses the methodological considerations and conclusion of the study.

Multiple authors have contributed in the this thesis work; explicit appreciation of each author‘s contribution is mentioned in the following section.

CONTRIBUTION OF AUTHORS

Manuscript:

Impact of Painful Comorbidities with Persistent and Recurrent Temporomandibular Disorder-Related Pain

Ahad S. Ahmed, Master‘s Candidate: Conceived objective of the investigation, carried out statistical analysis and wrote the manuscript.

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Ana Miriam Velly, Associate professor, Faculty of Dentistry McGill University, Montreal, Quebec, Canada: Designed and supervised NIDCR’s TIRR study, contributed to design of analysis, carried out statistical analysis, reviewed and contributed to manuscript writing.

1. INTRODUCTION

Temporomandibular muscle and joint disorders (TMJD) are the second most commonly occurring musculoskeletal disorders (after chronic back pain) resulting in pain and disability (1). Studies have estimated that 5 to 10% of the population is affected by TMD-related pain (2, 3). A TMD-related pain sufferer frequently visits multiple healthcare providers in search of a cure or effective management of their persistent or recurrent pain. Some individuals seeking treatment for TMD will progress to chronic pain with significant disability and impact on their life (4).

Multiple studies have found that TMD-related pain participants often report painful conditions at sites other than the masticatory system (e.g., migraine, neck pain, back pain and fibromyalgia) (5-11). Furthermore, prospective cohort studies show that patients with painful comorbidities were more likely to present persistent TMD-related pain than those without (9, 12, 13). Rammelsberg *et al.* demonstrated that the number of palpation sites (extra oral and body sites) was a significant predictor of persistent TMD *versus* remitted (OR = 1.81; 95% CI: 1.00 – 3.29, $P = 0.05$), and recurrent (OR = 1.18; 95% CI: 1.03 – 1.35, $P = 0.02$) *versus* persistent TMD (14). The specific mechanisms implicated in the co-occurrence of TMD and comorbidity is not clear but has been suggested that patients with comorbid conditions present dysregulation in multiple systems (15).

The aim of this thesis was to assess the association between painful comorbidities and TMD-related pain. More specifically, our primary aim was to determine if: i) TMD-related pain was associated with migraine and musculoskeletal comorbidities; and ii) Persistent or recurrent TMD-related pain was related to these comorbidities. Our general hypothesis is that participants

with painful comorbidities were more likely to have: persistent than recurrent TMD-related pain; and more severe pain.

2. LITERATURE REVIEW

2.1.1 Temporomandibular Disorders

Temporomandibular Disorder (TMD) is a collective term used to describe musculoskeletal conditions characterized by pain in the muscle of mastication, the temporomandibular joint, or both (16). TMD-related pain is characterized by pain in the jaw, temple, ear and face and is often altered by jaw function. The most common signs include tenderness in the muscles and/or TMJs upon palpation, pain with jaw range of motion, joint clicking, and/or limitation of the jaw opening (17). TMDs are the second most commonly occurring musculoskeletal disorders (after chronic back pain) resulting in pain and disability (1). The prevalence of TMD-related pain ranges between 5 to 10% (2, 3), declining after 45-50 years and being more common among females (2-18%) than males (0-10%) (18, 19). The female-to-male gender prevalence ratio ranges from 1.2 to 2.6 (18). One half to two-thirds of people with TMD will seek treatment and approximately 15% of them will develop chronic TMD (1).

2.2 Epidemiology of Temporomandibular Disorders

2.2.1 Prevalence of Temporomandibular disorders-related pain

Point and period prevalence of TMD-related pain are summarized in Table 2-1. Point prevalence is measured at a single point in time for each patient. Period prevalence is a measure of the proportion of people in a population that were present at any time during a specified period of time. It is used when it is difficult to determine if a disease is present or not in a population (20).

A study among a random sample of 677 Canadian adults between 18-65 years of age (67.7% response rate) reported an overall prevalence of 5.5% and 7.5%, respectively, when assessing pain in TMJ while opening mouth and chewing (21).

In a survey (Von Korff *et al.*) among a random sample of 1,016 (80% participation rate) patients from health maintenance organization (HMO) in Seattle, USA, 12% of participants reported experiencing pain in the muscles of the face, joint in front of the ear, and jaw in the past 6 months. The estimated prevalence of such pain was higher among females (15%) as compared to males (8%) (22).

It was also estimated that one in five individuals (point prevalence = 21%) reported pain during jaw movement in a survey carried out in 1993 (De Kanter *et al.*), among a random sample of 3,468 (1,653 males and 1,815 females) Dutch individuals (52% participation rate). This prevalence was also higher among females as compared to males (23).

A random-digit dialing survey conducted in Quebec, Canada (Goulet *et al.*), including 897 individuals (64% participation rate), found that 30% of the participants reported having at least one episode of pain in the masticatory muscles and jaw joints. Furthermore, this survey estimated that the point prevalence was found lower with increasing age (55+) and highest among ages 25-54 years (24).

Another random-digit dialing survey performed in New York metropolitan area (Janal *et al*.) among 19,586 (60% participation rate) women (18-75 years) demonstrated that approximately 10% of the individuals reported pain in face or in front of the jaw, in the past six months. In the same survey, 782 (39% participation rate) women received clinical examination according to RDC/TMD. Of those approximately 11% reported pain in the jaw and face. Although the prevalence rates were similar between telephone survey and clinical examination in

this study, a low concordance was found between the two rates in this study (sensitivity = 42.7%) (3).

Approximately 5% of individuals reported facial ache or pain in the jaw muscles or the joint in front of the ear, during the past 3 months, in a 2008 population-based survey (Isong *et al*.) including 30,978 subjects (17,498 females and 13,480 males) from National Health Institute Survey (NHIS), with 79% participation rate. The prevalence was higher among women (6.3%) as compared to males (2.8%). Furthermore, non-Hispanic white women (6.7%) had a higher prevalence as compared to non-Hispanic black women (5.1%) (2).

A recent OPPERA cohort study conducted in 2011 (Slade *et al.*) among 3,263 individuals found that women in the 35-44 years age group reported the highest prevalence (7.1%) of TMD-related pain as compared to the 18-24 years age group (3.5%). However, the overall prevalence for all population was not estimated (25).

A number of early studies also investigated the prevalence of TMD-related pain. A study conducted among Lapps of Northern Finland (Helkimo *et al.*) found that the estimated prevalence of TMD-related pain (facial or jaw pain) was 10% in males and 14% in females. The highest prevalence was within the age group of 35-44 years old (26). Similarly, in a sample of young women in Sweden (Mohlin *et al.*) the prevalence of pain in the facial muscles or temporomandibular joint was 6% (27).

Table 2-1. Prevalence of Temporomandibular Disorder Pain						
Author/Year	Study design	Sample size	Disease Definition	Age range	Assessment	Prevalence (%)
Von Korff *et al.*, (1988)	Cohort	1,016	Orofacial Pain and Jaw pain	18-75	Symptom Checklist	12
De Kanter *et al*., (1993)	Survey	4,496	Jaw Pain	15-74	Clinical Examination	21
Goulet *et al.*, (1995)	Survey	897	TMD pain	18+	Telephone Survey/ Questionnaire	30
Janal *et al*., (2008)	Survey	782	Myofacial TMD	18-75	Telephone Survey/Clinical Examination	10.5
Isong *et al.*, (2008)	Survey	30,987	Myofacial TMD	-	Self-reported	4.6
Slade *et al.,* (2011)	Cohort	3,263	TMD pain	35-44	RDC/TMD	7.1

2.2.2 Incidence of Temporomandibular Disorders

Incidence by definition is the fraction or proportion of a group initially free of the condition that develops it over a given period of time (20). In epidemiology, there are two types of incidence; cumulative incidence and incidence rate. Cumulative proportion is a measure of disease frequency in a specified period of time divided by the size of general population at risk, whereas, the incidence rate is the number of new cases of disease during a period of time divided by the person-time-at-risk throughout the observation period. The denominator for incidence rate changes as individuals originally at risk develop the disease during the observation period, and are removed from the denominator (28).

A few studies have estimated the incidence of TMD-related pain (Table 2-2). A cohort study (Von Korff *et al.*) including 1,016 HMO enrolees (15% drop-out rate) aged 18-65 and evaluating 5 pain conditions (back pain, severe headache, chest pain, abdominal pain and TMD-related pain), found that the estimated cumulative incidence of TMD-related pain was approximately 2% (29).

Another longitudinal cohort study conducted in 2007 (Nilsson *et al.*) among 2,255 participating (10% drop-out rate) Swedish adolescents (aged 13-19) over three years found an annual incidence of 2.9%. The incidence of TMD-related pain was higher among girls (4.5%) in comparison to boys (1.3%) (30).

In 2013, Slade *et al.* carried out a cohort study among 2,737 individuals from a community in the USA, demonstrating that the cumulative incidence in this study was approximately 4%, whereas, dropout rates of the participants were not provided. However, this annual incidence increased from 2.5% per annum (age group 18-24 years) to 4.5% per annum

(age group 35-44 years) with increasing age. Furthermore, females (hazard ratio = 1.30) also had a slightly higher incidence of TMD-related pain than males (31).

Table 2-2. Incidence of Temporomandibular Disorder Pain

Author	Study design	Sample size	Disease Definition	Annual incidence %
Von Korff *et al.*, 1993	Cohort	1,016	TMD pain	2.2
Nilsson *et al.,* 2007	Cohort	2,255	TMD pain	2.9
Slade *et al.,* 2013	Cohort	2,737	TMD pain	3.9

2.3 Classification of Temporomandibular Disorders

To classify any disease or disorder, a classification system is formed for accurate diagnoses. Many classifications have been proposed for TMDs including Helkimo's Index, Symptom Severity Index (SSI), Craniomandibular Index (CMI) and Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD). In this study we will discuss the most recent classification systems i.e. CMI and RDC/TMD.

2.3.1 Research Diagnostic Criteria for Temporomandibular Disorders

This classification was first developed by Dworkin *et al*. to achieve greater reliability and minimal variability in research and clinical settings (32). A characteristic feature of RDC/TMD is its dual-axis approach, which withholds clinical examination (Axis I) as well as psychological assessment and pain-related disability (Axis II) of the TMD subject. The Axis I of the RDC divides TMD into three subgroups i.e. Group I (muscle disorders), Group II (disc displacements) and Group III (joint diseases).

Group I TMDs have been further classified into myofascial pain (I.a) and myofascial pain with limited opening (I.b). Myofascial pain is characterized by pain in the muscles of mastication or pain on palpation in at least 3 sites, with one of them at least on the same side as the reported pain. Myofascial pain with limited opening is characterized by pain in the mandibular region and/or muscles of mastication with limitations in mandibular range of motion such as pain-free unassisted opening of < 40 mm and passive stretch of ≥ 5 mm.

Group II TMDs (disc displacement) are further classified into three subtypes as follow: a) disc displacement with reduction (II.a), where the joint is pain-free, produce a clicking sound on excursion with either opening or closing and/or clicking eliminated on protrusive

movement, b) disc displacement without reduction with limited opening (II.b), characterized by absence of TMJ clicking, and/or painful unassisted opening of ≤ 35mm and passive stretch of ≤ 4mm, and c) disc displacement without reduction without limited opening (II.c), characterized by painful unassisted opening (> 35mm and passive stretch > 4mm) with contralateral excursion of more than 7 mm.

Group III TMDs are characterized by other common joint diseases. The diseases include joint a) arthralgia (III.a), defined as pain in the joint without crepitus, b) osteoarthritis (III.b), characterized by pain in the joint with crepitus, and c) osteoarthrosis (III.c), defined as pain-free joint with crepitus.

2.3.1.1 Validity and Reliability of RDC/TMD

The main aim of every study is to report results that are deemed to be valid. If a research study fails to achieve validity, it is unable to provide results that are accurate and reliable. Validity is defined as the degree to which a study accurately exhibits what the research question aims to measure, and elucidates the accuracy of the measurement, corresponding to the true state of the phenomenon (28). Types of validity are as follows:

Content validity is defined as the extent to which a specific method of measurement comprises the entire dimension one intends to measure, excluding the rest. Construct validity in contrast refers to the extent to which a measurement is related in a coherent way and corresponds to theoretical concepts concerning the phenomenon under study. Lastly, criterion validity reflects the extent that the measurements predict a directly observable phenomenon. However, reliability instead refers to reproducibility and precision of the instrument by a different group of people at a different time and place (28, 33).

RDC/TMD has been widely studied for its reliability, and has subsequently shown appropriate results. A study by John *et al.* determined the reliability of clinical TMD diagnoses using standardized methods and operational definitions contained in the RDC; 230 subjects were recruited for this study which involved 30 clinical examiners at ten different international clinical centres. The assessment of reliability was conducted through the calculation of Interclass Correlation Coefficient (ICC). Results reported in the study demonstrated fair to good reliability for myofascial pain with or without limited opening with a median ICC of 0.51 and 0.60. Moreover, the median ICC for arthralgia was reported to be 0.47 and 0.61 for disc displacement with reduction. Improvement in the median ICC was observed (0.72), when the diagnoses were grouped into pain and non-pain. Due to low prevalence of disc displacement without reduction, osteoarthritis and osteoarthrosis the ICC could not be calculated and reported in this study (34).

Similarly, another study (Look *et al*.) reported reliability of the RDC/TMD to be good to excellent for the diagnosis of myofascial pain and myofascial pain with limited opening (kappa (k) > 0.75). When groups were evaluated discretely, the score was reported to be good for myofascial pain (k = 0.62), myofascial pain with limited opening (k = 0.58), disc displacement with reduction (k = 0.63), disc displacement without reduction with limited opening (k = 0.62), arthralgia (k = 0.55) and combined (arthralgia and osteoarthritis) (k = 0.59). Moreover, the results showed poor to slightly fair (k = 0.31 – 0.43) score for disc displacement without reduction without limited opening and osteoarthrosis (35).

A study (Schiffman *et al*.) carried out to establish validated Axis I RDC/TMD included 614 cases diagnosed as TMD and 91 controls. Target validity was set at ≥ 0.70 for sensitivity and ≥ 0.95 for specificity. The results from this revised study concluded that sufficient sensitivity and specificity scores (i.e. exceeding target levels) were achieved for myofascial pain (0.65, 0.92),

and myofascial pain with limited opening (0.79, 0.92), respectively. After combining group I diagnoses, target sensitivity and specificity were observed at 0.87 and 0.98, respectively. However, for group II and group III diagnoses the sensitivity and specificity remained low. Similarly, acceptable sensitivity (ranging from 0.03 – 0.53) and specificity (ranging from 0.86 – 0.99) were observed for joint pain (0.92, 0.96), as well as for disc displacement without reduction with limited opening (0.80, 0.97). For group III (osteoarthritis and osteoarthrosis), sensitivity and specificity were reported to be lower (0.35 – 0.53) than the target levels (36). However, more studies need to be carried out to continuously improve the quality of diagnostic criteria (37).

As such, a recent study (Schiffman *et al.*) in 2014 proposed a modified version of RDC/TMD currently known as DC/TMD. This recommended evidence-based new DC/TMD has been well-thought-out and is suitable for both clinical and research settings. In this study acceptable sensitivity and specificity were observed for myalgia (0.90, 0.99), myofascial pain with referral (0.86, 0.98), arthralgia (0.89, 0.98) and headaches attributed to TMD (0.89, 0.87). However, low to moderate sensitivity and specificity were observed for disc displacement with reduction (0.34, 0.92), disc displacement with reduction with intermittent locking (0.38, 0.98), disc displacement without reduction with limited opening (0.80, 0.97), disc displacement without reduction without limited opening (0.54, 0.79) and degenerative disease (0.55, 0.61) (38).

2.3.2 Craniomandibular Index

Craniomandibular Index (CMI) was first introduced in 1986 by Fricton *et al*. This diagnostic criterion for the TMD was introduced for epidemiological studies to provide a standardized measure of severity of limitations of mandibular movement, TMJ sounds, and

muscle and joint tenderness. Moreover, this criterion was also based on clinical examination, objective criteria and its related scoring (39).

The CMI was divided into subcategories such as Dysfunction Index and Palpation Index. Calculation of Dysfunction Index was based on examination of functional TMJ-related problems, whereas, Palpation Index is calculated by adding the score of tenderness on palpation of the muscles of mastication and the TMJ capsule (39, 40).

A number of studies have been conducted for validating the use of CMI. A study conducted in 1987 (Fricton *et al.*) demonstrated that the validity of CMI was fairly accurate to be used in the clinical studies; however, precautions should be taken by the examiners in order to ensure accuracy and reproducibility of results (40). A few items in the CMI demand a single examiner – unaware of the patient's status – to rate the score. In cases where multiple examiners are involved, a thorough discussion regarding all items and scoring prior to the beginning of the study, as well as the use of a pressure algometer for muscle palpation, are recommended.. These strict recommendations ensuring accuracy have resulted in a lack of popularity towards the CMI in clinical patient care (Clarke *et al*. 1993).

Another study (Pehling *et al.*) evaluated the criterion validity on the basis of CMI. The agreement between the two indices for measurement of TMD severity was highly significant, with an ICC = 0.97 ($P < .001$) and a mean CMI score of 0.26 (SD = 0.19) among 12 patients, whereas, the mean score was 0.26 (SD = 0.18) (41).

2.3.3 TMD-related pain characteristics

It has been demonstrated in studies with 5-year outcome that TMD-related pain tends to persist in about 30% of the patients (13, 42). The International Association for the Study of Pain

(IASP) defines chronic pain as “pain without apparent biological value that has persisted beyond the normal tissue healing time (usually taken to be 3 months)” (43). This chronic pain is also classified as persistent or recurrent pain. Persistent pain is synonymous with constant pain, whereas recurrent pain is explained as intermittent in nature, recurring at intervals. The definition of persistent and recurrent is a subject to controversy, as there is no valid definition of persistent or recurrent TMD-related pain. Prevalence of persistent pain ranges from 29 to 31% and recurrent TMD-related pain ranges from 36 to 71% among a population of TMD-related pain patients (13).

The specific mechanisms implicated in the recurrence or persistence of TMD-related pain are still unclear. Theories on the mechanism of chronic TMD-related pain are controversial, ranging from peripheral causes (such as trauma), to central mechanisms (such as depression, catastrophizing, and genetic predisposition to central sensitization), or a combination of peripheral and central theories (44).

2.4 Aetiology of Temporomandibular Disorder Pain

Multiple studies have demonstrated that the aetiology of TMD-related pain is multifactorial (45, 46) involving complex mechanisms such as, emotional-affective system, cognition, pain behaviour and environmental factors (47).

The term biopsychosocial was first introduced by Engel *et al*., and it integrates biological, psychological, and social factors. This idea included not only the disorder but also illness that surrounds the disorder (48). The biopsychosocial model is closely related to the multidimensional model which is categorized by biologically-induced disorder with illness.

Furthermore, Dworkin and LeResche presented a comprehensive biopsychosocial model of chronic pain development and experience to deeply understand TMD-related pain. The model presented integrated multilevel factors, which play a role at different stages of pain development. Furthermore, this model explained the variability in the individual expression of subjective pain experience and pain behaviour. It also explains the dynamic nature of intrinsic and extrinsic intrapersonal factors. Intrinsic factors include nociception, pain perception, and pain appraisal, whereas, the extrinsic factors include behaviour pain responses, social aspects of pain, and the health care system. This was one of the first models to show how these aforementioned factors can enhance or, diminish and how the change in the pain perception and behaviour leads to chronic TMD-related pain. Dworkin and LeResche developed a Research Diagnostic Criteria of TMD for the systematic assessment of TMD-related pain after the development of this model (32).

Following evidence from the biopsychosocial model explained by Dworkin *et al*., a new model was proposed (49). This model suggests that TMD risk (onset and persistence) is influenced by phenotype risk factors such as psychological distress and pain amplification (e.g. pro-inflammatory states, impaired pain regulation, cardiovascular function, and neuroendocrine function) as noted in various health conditions. These conditions have abnormal amplification due to dysfunction in the central nervous system (50) (Figure 2-1). This abnormal amplification in the peripheral stimuli plays a key role without any known injury, leading to functional pain. This type of pain is characterized by painful comorbidities such as fibromyalgia, chronic neck and shoulder pain, headaches, widespread pain or generalized hypersensitivity (51).

Over the years a variety of contributing factors have been suggested for TMD-related pain. These putative risk factors and comorbidities will be explained in the following section.

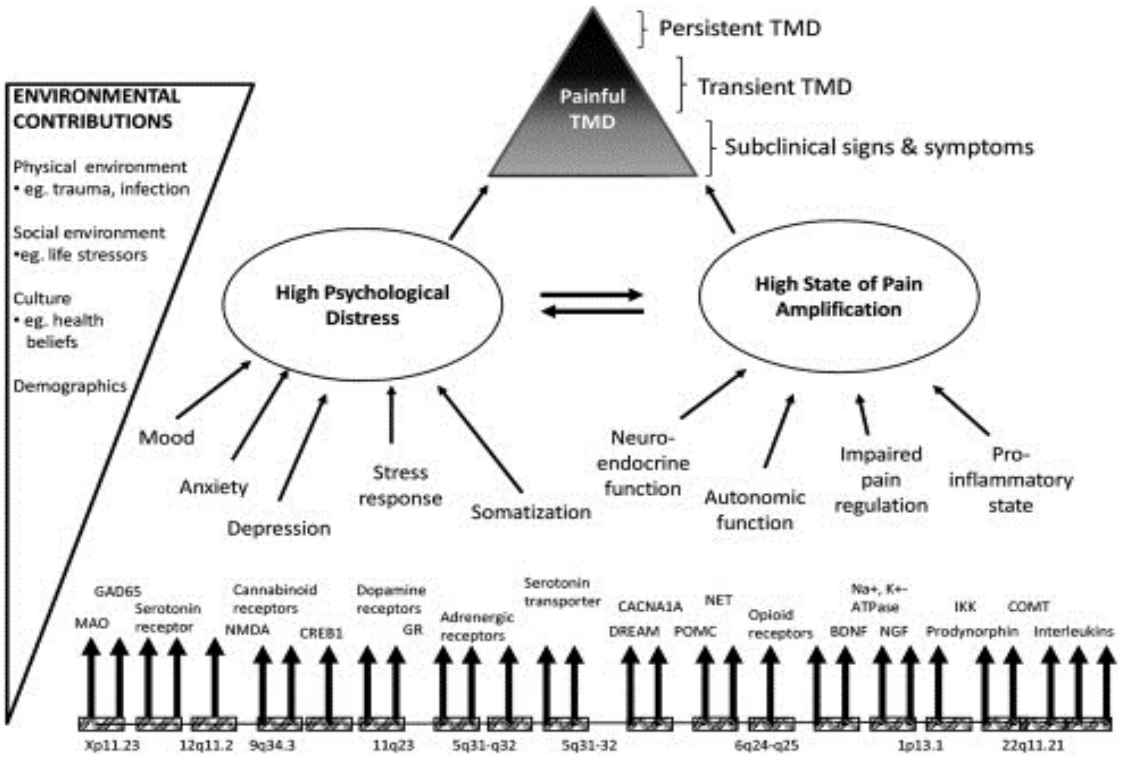

Figure 2-1. Model showing phenotypes: psychological distress and pain amplification that contributes to the onset and persistence of TMD-related pain (Maixner, Diatchenko *et al.* 2011). Reproduced with permissions.

2.5 Putative Risk Factors for Temporomandibular Disorders

Risk factors are defined as the characteristics associated with an increased risk of becoming diseased (20). A risk factor always precedes the onset of disease outcome. Well-known risk factors for TMD-related pain include gender, bruxism (i.e. clenching), trauma and , psychological factors. In this section, several studies with an overview of risk factors of TMD-related pain are discussed.

2.5.1 Gender

Data from several studies suggest that symptoms related to TMD-related pain are more common among females in comparison to males. There is no scientific evidence as to why TMD-related pain is more common among females. According to the present literature, it could be due to the treatment-based seeking behavior of females (52). A study conducted in 1996 (Wanman *et al.*) demonstrated that men tend to recover faster compared to women. Furthermore, longer duration of TMD-related pain symptoms is perhaps the central reason for females to seek treatment more than males (53).

A survey conducted in 2011 (Sander *et al.*) including 3,954 individuals reported a difference of prevalence in males and females. In this survey, the symptoms of TMD-related pain were significantly higher in females (12.6%) as compared to males (7.5%) (54).

Similarly, a retrospective cross-sectional study (Schmid-Schwap *et al.*) among 502 patients found a higher visual analog score (VAS) pain scores and pain on palpation (masticatory muscles) among females in comparison to males. This study also reported a significantly lower degree of mouth opening in females ($P < 0.001$). There was, moreover, an inverse association found between perceived distress and symptoms of TMD-related pain in females ($P < 0.001$) (55).

Myofascial pain disorder symptoms were higher among females (54%, n = 62) than males (56) in a cohort study (Dougall *et al.*) including 207 subjects. It was found that females seek treatment for TMD-related pain more than males (57) in previous studies among females who developed TMD-related pain at the age of 17 (n = 25) and who were still untreated (92%, n = 23) at the age of 28, compared to males who developed TMD-related pain and remained untreated (28%, n = 5) at the age of 28.

2.5.2 Bruxism

Bruxism is a diurnal or nocturnal tooth contact parafunctional activity, characterized by clenching and grinding (58). Nocturnal bruxism while sleeping is regarded as sleep bruxism (SB). The prevalence estimate of bruxism ranges from 4% to 8% (59-62). Bruxism and its association with TMD-related pain are considered a debatable topic to date. The results of some of these studies are discussed in the following section.

A case-control study (Marbach *et al.*) observed that frequency clenching or grinding was comparable among 151 participants with TMD-related pain and 139 volunteers. These results were in concordance with Cacchiotti *et al.*, where the frequency of clenching or grinding was not significantly different between 41 patients with TMD-related pain and 40 dental students. In these studies bruxism was assessed with questionnaires (63, 64).

Another case-control study (Huang *et al.*) including 97 subjects with only myofascial pain, 20 with only arthralgia, 157 with both myofascial pain and arthralgia, and 195 controls without TMD, found that clenching was associated with myofascial pain alone (OR = 4.8), and myofascial pain along with arthralgia (OR = 3.3). Oral habits and clenching were assessed using questionnaires (65).

These results are in agreement with another case-control study (Velly *et al.*) among 83 patients with myofascial pain and 100 controls, which also demonstrated that clenching was related to myofascial pain. More specifically, this study showed that clenching-grinding (OR = 8.40; 95% CI: 2.74 – 25.73), and clenching only (OR = 2.54; 95% CI: 1.10 – 5.58) were strongly related to chronic myofascial pain. In this study bruxism was assessed by questionnaires (66). The results from these case-control studies are in agreement with cohort studies.

A prospective-cohort study (Ohrbach *et al.*) including 2,737 subjects, demonstrated that oral parafunctions, assessed by the oral behaviors checklist, increases the risk of TMD-related pain (RR = 1.14, 95% CI: 1.00 – 1.31) (67).

SB was associated with myofascial pain (OR = 5.93, 95% CI: 3.19 – 11.02) in a case-control study (Fernandes *et al.*) including 272 patients in a university-based clinic, wherein diagnosis of SB was in accordance with validated clinical diagnostic criteria proposed by American Academy of Sleep Medicine (68). The results of this study agree with those of a previous study conducted in 1992 (Goulet *et al.*), which demonstrated a positive effect between bruxism and TMD-related pain.

However, another case-control study (Raphael *et al.*) among 124 women with myofascial TMD-related pain who experienced SB, and 46 controls found no significant difference among cases (9.7%) and controls (10.9%). In this study, SB was recorded by polysomnographic methods (69).

2.5.3 Trauma

Any force exceeding the normal functional loading and affecting the joint is described as trauma. It can be categorized as direct or indirect, depending on the nature of the force. Direct traumas are defined as isolated force to the structure, such as over-stretching, compression or dental extraction, whereas indirect trauma is defined as sudden blow without having a direct contact to the structures, such as whiplash injuries (58).

Trauma to the temporomandibular joint is also considered one of the risk factors for TMD-related pain. There are a few studies which provide associations to direct and indirect trauma such as whiplash injuries. The latter are usually caused by motor vehicle accidents, in

which the cervical portion of the vertebral column is flexed beyond its extent and ruptures or tears certain ligaments in the neck. The pain usually arises months after the incident.

Nineteen patients with whiplash injury after a motor vehicle accident, and 20 age-gender matched controls with ankle injury assessed in a prospective cohort study (Kasch *et al.*) demonstrated that there are no significant differences between whiplash injuries and ankle injuries in relation to the development of TMD-related pain. The subjects were examined within four weeks of the incident and after 6 months, using McGill Pain Questionnaire (MPQ) and VAS (0-100) for pain assessment (Kasch, Hjorth *et al*. 2002).

A retrospective-cohort study (Huang *et al.*) among 34,491 HMO enrolees showed that subjects with facial trauma and third molar removal were 2 to 3 times more likely to have TMD-related pain (70). Similarly, a case-control study (Velly *et al.*), evaluating the contributing factors to chronic myofascial pain found that the patients with a history of head and neck trauma were more likely to have myofascial pain (OR = 2.08; CI: 1.03 – 4.40) (66).

Another retrospective cross-sectional study (Plesh *et al.*) including 778 individuals demonstrated a statistically significant relationship between the frequency and intensity of pain in the patients who underwent surgery (71).

2.5.4 Psychological Factors

Evidence suggests that some of the TMD-related pain patients experience more psychological comorbidities compared to healthy individuals (72-75). Patients with TMDs have been found to have psychological and behavioural characteristics similar to patients with other comorbid pain conditions (58). Stress, anxiety and depression are common among individuals

with TMD-related pain, and as such, higher levels of stress (76, 77), anxiety (77), and depression (76, 78) are noted among them.

A survey conducted in 2010 (Wirz *et al.*) including 1,767 individuals with orofacial pain (e.g. TMD) found that 30% of these patients reported psychological comorbidities (i.e. emotional distress, anxiety and depression) (79). Similarly, another survey (n = 2,299 individuals) demonstrated that orofacial pain (e.g. TMD) subjects were more likely to report higher levels of anxiety (OR = 3.5, 95% CI: 2.4 – 5.1) and depression (OR = 4.6, 95% CI: 2.9 – 7.2) than controls (80).

A case-control study (Huang *et al.*) among 261 subjects with myofascial pain demonstrated that individuals with higher levels of somatization were more likely to have myofascial pain and arthralgia (OR = 5.1, 95% CI: 2.9 – 8.9) than myofascial pain alone (OR = 3.7, 95% CI: 2.0 – 6.9); the instrument used to assess psychological comorbidities was Symptom Checklist 90-Revised (SCL-90R) (65).

Similarly, Velly *et al*.'s case-control study conducted with 83 cases and 100 controls demonstrated that myofascial pain patients were more likely to have anxiety (OR = 5.1; 95% CI: 1.4 – 19.4) and depression (OR= 3.5, 95% CI: 1.1-11.5) compared to controls. This study also used SCL-90 for the assessment of psychological comorbidities (66).

A recent case-control study (Fillingim *et al.*) including 1,633 controls and 185 TMD pain cases showed that participants with TMD-related pain were more likely to have higher levels of anxiety, stress and depression as compared to controls (81). The psychological comorbidities were measured with SCL-90R, Perceived Stress Scale (PSS) and State-Trait Anxiety Inventory (STAI). Furthermore, a 5 year cohort study (Fillingim *et al.*) among 2,737 participants demonstrated that subjects exposed to psychological comorbidities (e.g. depression, anxiety and

stress) were almost 1.3 times more likely to develop TMD-related pain – SLC-90R, PSS and STAI were used to assess these psychological comorbidities (82).

Individuals with higher levels of anxiety were almost 3 times more likely to have chronic orofacial pain than subjects who had lower levels (RR = 2.8, 95% CI: 1.3 – 6.2) in a model adjusted by age, gender and the presence of widespread pain, according to a cohort study including 1,329 individuals; Hospital Anxiety and Depression scale and Health Anxiety Questionnaire were used to assess psychological comorbidities (83).

Furthermore, another cohort study including 171 individuals showed that those with depression (incidence density ratio [IDR] = 3.2, 95% CI: 1.5 – 6.7) and perceived stress (IDR = 2.6, 95% CI: 1.2 – 5.5) had a higher risk to develop TMD-related pain. In this study the instruments used to assess psychological comorbidities were Brief Symptom Inventory (BSI), PSS and STAI (84).

2.6 Painful Comorbidities and Temporomandibular Disorder Pain

Comorbidities are defined as a "concurrent existence and occurrence of two or more medically diagnosed diseases in the same individual" (85). Scientific evidence suggests that TMD-related pain coexists with painful comorbid conditions. Multiple studies have found that TMD-related pain participants often report painful conditions at sites other than the masticatory system (e.g., migraine, fibromyalgia, back pain and neck pain) (5-11). Several studies noted that the prevalence of comorbid pain conditions were higher among women than men (86-88). Moreover, Hispanics (OR = 1.6, 95% CI: 1.2 – 1.6) and Blacks (OR = 1.4, 95% CI: 1.3 – 1.8) were also more likely than non-Hispanic whites to report comorbid pain conditions (87). This section will explain each of these comorbid pain conditions.

2.6.1 Migraine

Headaches are defined as pain or ache in the head, more specifically the pain arising above the orbito-meatus line of the head, which begins from the canthus of the eye to the external auditory meatus. Migraine affects 10-14% of the general population, with females experiencing migraines more often than males (89-91). Migraine is common among TMD-related pain patients (92-96). The International Headache Society (IHS) diagnostic criteria for migraine (97) and the Research Diagnostic Criteria (RDC)/TMD (98) denote significant overlap including headache, peri-cranial tenderness, and chronicity. Both TMD-related pain and migraine are mediated by trigeminal nerve/ganglion and characterized by pain in the head and/or face, peri-cranial tenderness and are more common in women (89-91, 99-101).

Multiple cross-sectional and case-control studies have shown that individuals with TMD-related pain were almost 2 to 9 times more likely to have headache than controls (87, 102-106).

A case-control study conducted in 2011 (Anderson *et al.*) including 86 subjects with painful TMD, 309 painful TMD subjects with headaches, and 149 subjects without painful TMD or headaches, demonstrated that TMD-related pain patients with headaches were more likely to have severe TMD-related pain. In this study ICDH-II tension-type headache criteria was used for the assessment of headaches (107).

Macfarlane *et al.*'s case-control study conducted among 1,981 participants found that young adults with headache once or twice a month (OR = 2.1, 95% CI: 1.2 – 3.7) or at least once a week (OR = 3.7, 95% CI: 1.6 – 8.4) had an increased risk of orofacial pain (76). In addition, a cohort study (LeResche *et al.*) including 1,996 participants demonstrated that for adolescents with headache, the risk of developing TMD-related pain was 2.7 times (95% CI: 1.6 – 4.4) that

of those without headaches. Children were asked if they ever had headaches in the past year (108) in this study.

A nested case-control study using questionnaires to assess headaches among 280 participants found an increased odds of incidence of headaches among those who had TMD-related pain and spinal pain (OR = 5.2, 95% CI: 2.0 – 13.7) (109).

2.6.2 Musculoskeletal Comorbidities

2.6.2.1 Fibromyalgia

Fibromyalgia is a musculoskeletal pain condition, characterized by widespread pain in the body with fatigue, cognitive dysfunction and somatic symptoms (110, 111). In the new guidelines proposed by the ACR (American College of Rheumatology), the former tender point tests are being replaced with Widespread Pain Index (WPI) and Symptom Severity (SS). Current diagnostic criteria for fibromyalgia require the following conditions to be met 1) WPI is ≥ 5 and SS is ≥ 7, or if the WPI is 3-6 with SS ≥ 9; 2) if the pain symptoms persists more than three months, and 3) no other disorder that could explain the pain (111, 112).

Fibromyalgia usually affects young or middle aged females in comparison to males (113-115). In the general population, the prevalence of fibromyalgia ranges from 2-4% (113, 116, 117). Furthermore, many of the patients with fibromyalgia and widespread pain exhibit TMD-related pain (12, 118-120).

A cohort study (LeResche *et al.*) including 1,996 adolescents (boys and girls) demonstrated that subjects with pain conditions elsewhere in the body had 2 times the risk of developing TMD-related pain within the next 3 years (OR = 3.2, 95% CI: 1.7 – 6.1) compared to

those without these pain conditions. In this study pain conditions elsewhere in the body were classified using questionnaires (108).

Aggarwal *et al.* demonstrated that widespread pain and fibromyalgia increased the risk of orofacial pain in a cohort study including 1,735 subjects, where widespread pain predicted the onset of orofacial pain (RR = 4.0, 95% CI: 2.2 – 7.4). Chronic widespread pain was classified using American College of Rheumatology guidelines (83).

A cohort study (John *et al.*) including 397 participants showed that among women without dysfunctional TMD-related pain at baseline, widespread pain was a risk factor for development of TMD-related pain (OR = 1.9, 95% CI 1.2 – 2.8, $P = 0.003$). In this study, graded chronic pain was used for the assessment of pain (12).

Velly *et al.* conducted a cohort study in 2010 among 485 participants, demonstrating that baseline widespread pain (OR: 2.53, $P = 0.04$) was related to the onset of clinically significant TMD-related pain; chronic widespread pain was classified using American College of Rheumatology guidelines (9).

2.6.2.2 Back and Neck pain

Multiple studies have reported that neck and back pain symptoms are commonly reported by individuals with TMD-related pain (16% to 93%) (5, 87, 103, 121-123). Several cross-sectional and case-control studies demonstrated that subjects with TMD-related pain are 3 to 5 times more likely to have back pain compared to individuals without TMD-related pain (87, 103, 106). Moreover, participants with TMD-related pain are also more likely to report neck pain (OR = 4.0 – 7.9) (87, 106).

A nested case-control study including 1,981 participants found that adults with intermittent

(OR= 3.6; 95% CI: 2.2-5.9) and frequent (OR= 5.3; 95%CI: 2.5-11.3) neck pain were more likely to have orofacial pain. Similarly, participants with back pain were also 3 times more likely to have orofacial pain. In this study neck and back pain were assessed using questionnaires (76).

Another nested case-control study that assessed back pain among 280 dental students using a questionnaire, demonstrated that students with spinal pain were at a greater risk of developing TMD-related pain compared to those without spinal pain (OR= 2.9; 95% CI: 1.3-6.2). It also showed that females with spinal pain were almost 5 times more likely to develop TMD-related pain (109).

Adolescents who were exposed to back pain had an increased likelihood of TMD-related pain compared to the unexposed group (OR = 3.9, 95% CI: 2.2–6.8) in a prospective-cohort study conducted among 1,981 individuals (108).

Furthermore, a matched case-control study, including 96 cases with long-term back pain and 192 controls found that back pain cases were 7 times more likely (95% CI: 3.9–13.7) to have TMD compared to controls (124).

3. STUDY OBJECTIVES

The general aim of this project was to assess the association between painful comorbidities and TMD-related pain. More specifically, our primary aim was to determine if:

i) TMD-related pain was associated with migraine and musculoskeletal comorbidities.

ii) Persistent or recurrent TMD-related pain was related to painful comorbidities.

iii) Participants with painful comorbidities were more likely to have: persistent than recurrent TMD-related pain; and more severe pain.

4. METHODOLOGY

In this chapter, ethics, study design, study population, data collection and statistical analyses used to assess the study objectives of the manuscript, will be explained in detail.

4.1 Ethics

The protocol of the study was approved by the research ethics committee of the University of Minnesota, Minneapolis, USA prior to the start of the study. All subjects were given thorough explanations regarding their participation, and signed a consent form. A second protocol of the study was approved by the research ethics committee of the Jewish General Hospital, Montreal, Canada, where the database was kept on a secured computer and used for analysis in this study.

4.2 Study design

A case-control analysis was used in this study. Case-control study is a type of observational analytic epidemiologic investigation that compares the frequency of exposure (painful comorbidities) between subjects who developed the disease (TMD-related pain), and those without the disease (without TMD). Controls were chosen to reflect the frequency of exposure in the underlying population at risk, from which the cases arose. This design has many advantages 1) it is quick and cost-effective in comparison to other study designs, 2) it allows identification of associated factors with disease having low incidence, and 3) multiple risk factors can be examined for a single disease (125).

However, case-control studies are subject to certain types of bias such as selection and information bias. It is more difficult to establish causality because as exposure (painful comorbidities) and the outcome are collected at the same time, as it is more difficult to establish if the risk factor preceded the onset of disease. Biases related with case-control design will be explained in detail in the discussion chapter.

4.3 National Institute of Dental and Craniofacial Research's Temporomandibular Joint Implant Registry and Repository

TMD-related pain cases and controls in this study were selected from the National Institute of Dental and Craniofacial Research's Temporomandibular Joint Implant Registry and Repository (NIDCR's TIRR). This database is located in Minneapolis, Minnesota, United States of America. NIDCR's TIRR maintains extensive clinical information, which includes TMD sings and symptoms, medical findings, laboratory data, radiographs, demographics, specific surgical and implant data, and dental records (126).

4.4 Study population

TMD-related pain patients and controls were selected from the National Institute of Dental and Craniofacial Research's Temporomandibular Joint Implant Registry and Repository (NIDCR's TIRR). These participants were recruited between 2003 and 2011 from many regions of the United States. All subjects who agreed to participate signed a consent form and were given thorough explanations about their participation prior to initiation of the study, by the researchers.

4.4.1 Inclusion and Exclusion criteria

Inclusion criteria of this study are as follow: 1) participants able to understand English language, as all the questionnaires used in this study were in English, and 2) all participants must be 18 years of age or above. Subjects with rare diseases such as Tuberculosis, Liver Diseases, Hepatitis, Parkinson's disease, Multiple Sclerosis, Sickle Cell Anemia, Sexually Transmitted Disease, and Human Immunodeficiency Virus were excluded from the study.

4.4.2 TMD-related pain cases

In this study the CMI/RDC examinations were performed by calibrated examiners at the University of Minnesota Oral Health Research Center as described elsewhere (9) (Clinical examination form in Appendix). Calibrated examiners from the NIDCR's TIRR defined cases on the basis of their clinical evaluation, and the presence of TMD-related pain such as 1) pain or ache in the jaw, preauricular area, or inside the ear, or pain during opening or 2) pain reported by the subject in response to palpation of the following muscles: posterior temporalis, middle temporalis, anterior temporalis, origin of masseter, body of masseter, insertion of masseter, posterior mandibular region, submandibular region, lateral pterygoid area, and tendon of the temporalis.

4.4.3 Controls Selection

Controls were selected from the NIDCR's TIRR dental clinics as appropriate comparison groups. They received the same clinical examination as reported (section 4.4.2). Controls were subjects; who visited clinics for any problem except TMD-related pain. Controls were selected

from the NIDCR's TIRR clinics not to represent the TMD-related pain-free population, but who are at risk to develop TMD-related pain.

In every case control-study the selection of controls is considered one of the most critical steps in the study. Those selected in our study were categorized as clinical controls. Selection of controls from the clinics has certain advantages; these subjects are more cooperative and the information gathered from them is less likely to be affected by recall bias compared to population controls. Recruiting clinical controls is more convenient and costs less in comparison to those picked from the population. Finally, the controls in this study were recruited from the same database as the cases – this strategy meant that the controls in our study could possibly have a similar exposure status (painful comorbidities) as our TMD-related pain cases.

4.5 Assessment and Data Collection

The instrument used in this study to assess exposure or characteristic of interest (painful comorbidities) was NIDCR's TIRRs medical questionnaire (Appendix).

4.5.1 Putative Exposure

To measure putative exposure (painful comorbidities), all patients completed a detailed questionnaire which assessed a number of painful comorbidities (Questionnaire in the Appendix). From this list, the painful comorbidities selected were: migraine and musculoskeletal comorbidities (i.e. fibromyalgia, back pain and neck pain).

4.5.2 Outcome variables

The outcome variable for this study was the diagnosis of TMD-related pain (see section 4.4.2). Patients were further classified into TMD pain subgroups of persistent or recurrent TMD-related pain by answering the question "What is the pattern of your worst problem?" With the response being 1) persistent pain 2) recurrent pain and 3) pain one time. Patients reporting pain only one time were not included in the study (Medical questionnaire in Appendix).

In addition, pain intensity was assessed using three questions from the Graded Chronic Pain Scale (GCPS) on a scale of 0-10 numeric rating scale (NRS): 1) "How would you rate the worst pain at present time?" 2) "In the past six months how intense was your worst pain?" 3) "In the past six months, on average, how intense was your worst pain?" (127).

4.5.3 Confounding variables

Confounding is a central issue for epidemiological studies. It occurs when the measured association between an exposure (painful comorbidities) and disease occurrence (TMD-related pain). A confounding variable has bidirectional associations, that is, 1) It must be associated with the disease regardless of the risk factors, and 2) it must be associated with the risk factors, regardless of the disease. The consequences of confounding include an overestimation or an underestimation of the effect (e.g. odds ratio) (128). There are several methods by which confounding can be controlled to prevent bias in the results. In this study age, gender and psychological comorbidities (i.e. depression, anxiety, mental health treatment, physical abuse, and stress) were the possible confounders.

4.6 Statistical analyses

Descriptive analyses were done on the variables in the data set to determine the mean and frequencies. Chi-square, Student's t-test and ANOVA were used to compare categorical and continuous variables between groups in this study. A chi-square statistic is a measure of how much the observed cell counts in a two-way table diverge from the expected cell counts. The difference between the observed and expected count is taken and its value squared and divided by the expected value. Finally, a summation of the cells is taken. The value of the chi-square will either provide evidence against or towards the null hypothesis.

Null hypothesis is a statement of no effect or no difference (Moore, 2005). A student's t-test was performed in addition to the chi-square statistic to further assess difference between the means. Furthermore, ANOVA was performed to assess the difference between more than two means. For example in this study the difference in the means between persistent, recurrent TMD-related pain and controls.

Unpaired logistic regression analysis was used for the association between TMD-related pain and comorbidities. Logistic regression equation can be written as:

$$\ln\left(\frac{p}{1-p}\right) = \beta_0 + \sum_{i=1}^{k} \beta_i * X_i$$

Where,

P is the probability of Y =1, or the probability of the outcome

Xi is the i^{th} predictor variable, i = 1, 2, 3…k;

β_o is the log odds of probability of outcome when predictor variables have a value of zero

β_i is the regression parameter associated with the i^{th} predictor variable such that odds ratio associated with increase in one unit of the i^{th} variable, when other variables are constant, is

$$\mathbf{OR_i} = \boldsymbol{e}^{\boldsymbol{\beta}_i}$$

Pearson correlation matrix was calculated to investigate the relationship between pain intensity and painful comorbidities.

4.6.1 Comorbidities associated with temporomandibular disorders

These aforementioned tests were used to compare categorical and continuous variables between groups: TMD-related pain *versus* controls, persistent or recurrent TMD-related pain *versus* controls, and persistent *versus* recurrent TMD-related pain.

We performed unconditional univariate and multivariable logistic regression analyses to assess the association between painful comorbidities (independent variables) and TMD-related pain (dependent variables). Stratification by gender and TMJ surgery was performed in these analyses because a large number of patients from the NIDCR's TIRR received TMJ surgeries. All analyses were adjusted for age, gender and psychological comorbidities.

Moreover, we performed unconditional univariate and multivariable logistic regression analyses to evaluate the association between painful comorbidities and persistent or recurrent TMD-related pain. These analyses were also adjusted for age, gender and psychological comorbidities.

The likelihood ratio test (129) was used to assess the significance of the odds ratio and of the interaction in the model. These terms were based on biological plausibility and remained in the model only if the significance level of their regression coefficient was equal to or lower than

0.05. All analyses were performed with SAS 9.3 software (Statistical Analysis System; SAS Institute Inc, Cary, NC, USA).

4.6.2 Statistical power

This section will give a brief overview of the post-hoc power analysis for the manuscript used in the thesis (Tables 4-1, 4-2 and 4-3). Power analyses were performed using Power Sample size (PS) software version 3.0.

This current study was planned to ensure an adequate power to assess TMD-related pain and painful comorbidities. We estimated the power for 261 recurrent TMD-related pain, 477 persistent TMD-related pain and 750 TMD-related pain participants. Based on our sample size, detected odds ratios and prevalence of comorbid conditions among controls, in almost all of the analyses we have a sufficient power ranging from 0.80 – 1.00 to perform statistical analyses in this study (Figures 4-1, 4-2, 4-3 and 4-4).

Table 4-1. Power analysis for the association between TMD-related pain and painful comorbidities

Comorbidities	TMD-related pain (n = 750)		
	Controls (%)	OR	Power
Migraine	15	2.19	.999
Neck	8	7.44	.999
Back	10	4.45	.999
Fibromyalgia	1	4.71	.999

Table 4-2. Power analysis for the association between persistent TMD-related pain and painful comorbidities

Comorbidities	TMD-related pain (n = 477)		
	Controls (%)	OR	Power
Migraine	15	2.25	1.0
Neck	8	9.93	1.0
Back	10	5.01	1.0
Fibromyalgia	1	5.38	0.990

Table 4-3. Power analysis for the association between recurrent TMD-related pain and painful comorbidities

Comorbidities	TMD-related pain (n = 261)		
	Controls (%)	OR	Power
Migraine	15	2.19	0.986
Neck	8	5.02	1.0
Back	10	3.48	1.0
Fibromyalgia	1	3.57	0.657

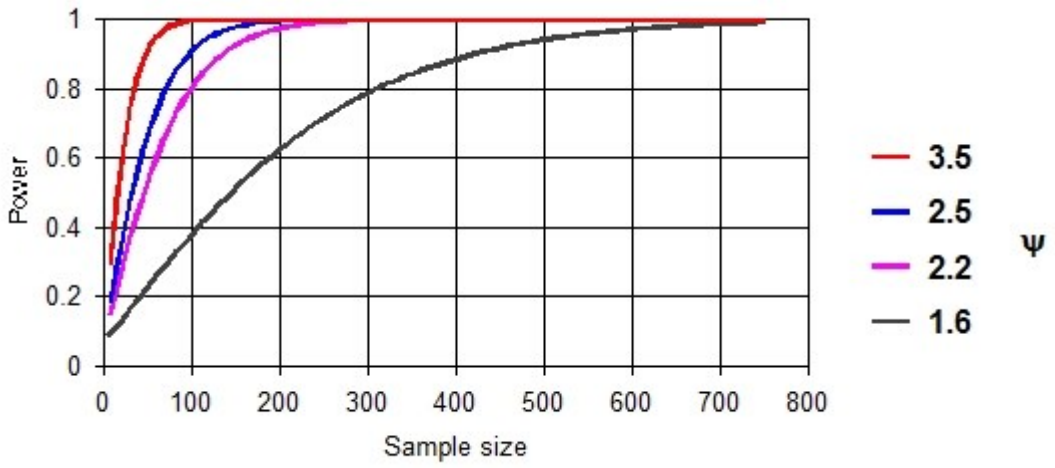

Figure 4-1. Post hoc power analysis for the association between migraine and TMD-related pain (sample size = 750, α=0.05 and Power = 0.999, Ψ = observed odds ratio)

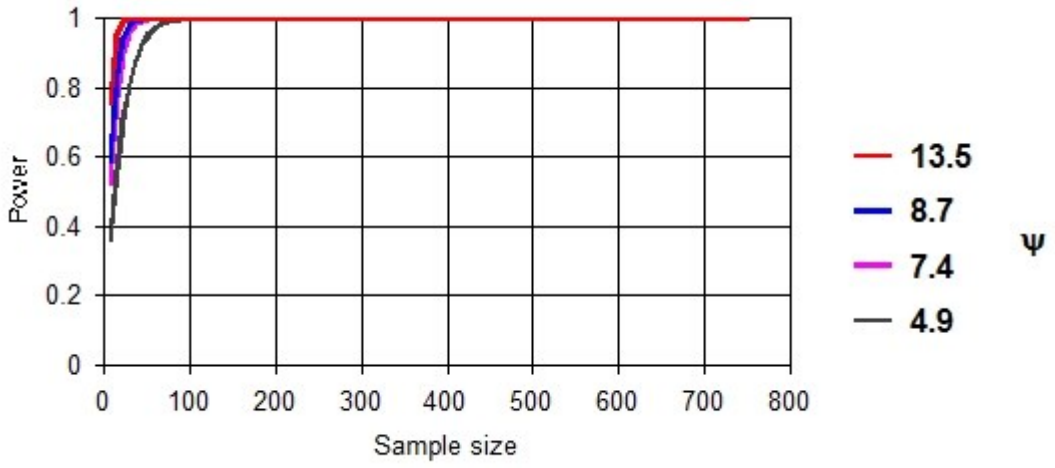

Figure 4-2. Post hoc power analysis for the association between neck pain and TMD-related pain (sample size= 750, α=0.05 and Power = 0.999, Ψ = observed odds ratios)

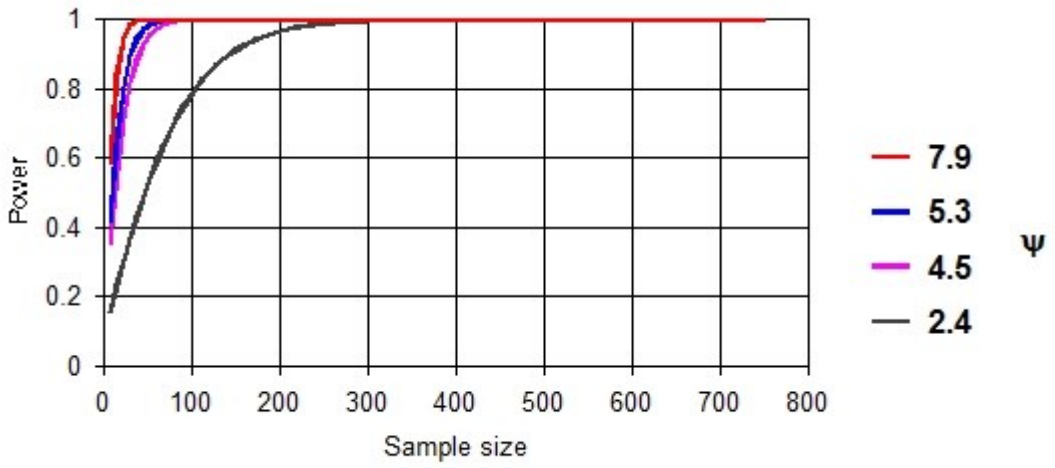

Figure 1-3. Post hoc power analysis for the association between back pain and TMD-related pain (sample size= 750, α=0.05 and Power = 0.999, Ψ = observed odds ratios).

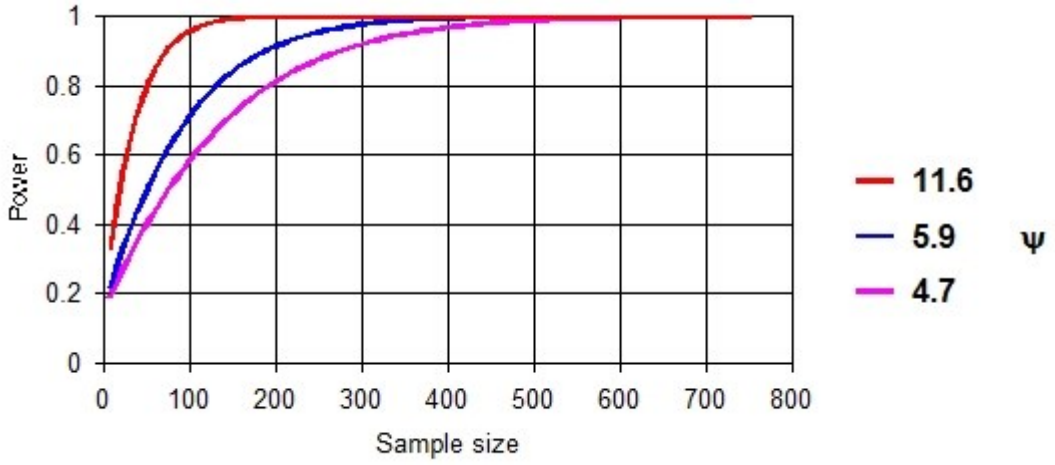

Figure 4-4. Post hoc power analysis for the association between fibromyalgia and TMD-related pain (sample size= 750, α=0.05 Power = 0.999, Ψ = observed odds ratios).

5. MANUSCRIPT

Impact of Painful Comorbidities with Persistent and Recurrent Temporomandibular Disorder-Related Pain

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Abstract

Objective: The primary aims of this study were to determine if: i) Temporomandibular Disorder (TMD)-related pain is associated with migraine and musculoskeletal comorbidities; and ii) persistent or recurrent TMD-related pain is related to these comorbidities.

Method: Data from 750 TMD-related pain cases, from which 477 were classified as persistent, 261 as recurrent TMD-related pain, and 146 controls were obtained from the National Institute of Dental and Craniofacial Research's Temporomandibular Joint Implant Registry and Repository (NIDCR's TIRR). The diagnosis of TMD-related pain was determined by clinical examination using a modified Craniomandibular Index wherein the exam items were redesigned to conform to those specified for the Research Diagnostic Criteria. Controls were participants without TMD. Patterns of pain (i.e., persistent/recurrent) and comorbidities were assessed using questionnaires from the TIRR. Painful comorbidities included migraine and musculoskeletal conditions. Univariate and multivariable logistic regression analyses were used to investigate the associations between TMD-related pain and painful comorbidities.

Results: There was a significant difference in the mean age of TMD-related pain cases (mean = 41.9, SD = 14.7) and of controls (mean = 34.2, SD = 13.8, $P < .0001$). Females were significantly more prevalent among cases (89%) than controls (66%, $P < .0001$). The mean of pain intensity on 0-10 numeric rating scale (NRS) in the last 6 months was significantly higher for persistent (mean = 7.8, SD = 2.6) as compared to recurrent (mean = 6.3, SD = 2.7, $P < 0.001$). In multivariable logistic analyses adjusted by age, gender, and psychological comorbidities, migraine (Odds Ratio [OR] = 2.19, $P = 0.004$), neck pain (OR = 7.44, $P < .0001$), back pain (OR = 4.45, $P < .0001$) and fibromyalgia (OR = 4.80, $P = 0.03$) were associated with TMD-related pain. Furthermore, neck and back pain remained related to TMD-related pain, persistent or recurrent, when the model included the painful comorbidities, with exception of migraine. Finally, persistent TMD-related pain cases were more likely to have diagnosis of fibromyalgia (OR = 1.92, $P = 0.01$) than the recurrent cases.

Conclusion: These results demonstrated that participants with neck and back pain were more likely to have TMD-related pain, regardless of TMD characteristics such as recurrent and persistent TMD-related pain. A significant difference was nonetheless noted on the odds of fibromyalgia between persistent and recurrent TMD-related pain. Finally, the association with migraine seems to be modified by the manifestation of other comorbid conditions and type of TMD-related pain as compared to other painful comorbidities. To our knowledge, this study is the first to assess the association between painful comorbid conditions and TMD-related pain (persistent or recurrent) regardless of occurrence of other painful comorbid conditions. Understanding the relationship between TMD-related pain with painful comorbid conditions will lead to better patient management using a multidisciplinary approach.

Keywords

Temporomandibular disorder pain; Comorbidities; Epidemiology

Introduction

Temporomandibular muscle and joint disorders (TMJD) are the second most commonly occurring musculoskeletal disorders (after chronic back pain) resulting in pain and disability(1). It has been estimated that 5 to 10% of the population is affected by TMD-related pain (2, 3). A TMD-related pain sufferer frequently visits multiple healthcare providers in search of a cure or effective management of their persistent or recurrent pain. Some individuals seeking treatment for TMD will progress to chronic pain with significant disability and negative impact on quality of life (4).

Multiple studies have found that TMD-related pain patients often report painful conditions at sites other than the masticatory system (e.g., migraine, fibromyalgia, back pain and neck pain) (5-11). Furthermore, prospective cohort studies show that patients with painful comorbidities were more likely to present persistent TMD-related pain than those without (9, 12, 13). Rammelsberg *et al.* demonstrated that the number of palpation sites (extra oral and body sites) was a significant predictor of persistent *versus* remitted TMD (Odds ratio [OR] = 1.81; 95% CI: 1.00 – 3.29, $P = 0.05$), and recurrent (OR = 1.18; 95% CI: 1.03 – 1.35, $P = 0.02$) *versus* persistent TMD (14). The specific mechanisms implicated in the co-occurrence of TMD and comorbidity is not clear but has been suggested that patients with comorbid conditions present dysregulation in multiple systems (15).

The overall purpose of this case-control study was to assess the association between painful comorbidities and TMD-related pain. More specifically, our primary aim was to determine if: i) TMD-related pain was associated with migraine and musculoskeletal comorbidities; and ii) Persistent or recurrent TMD-related pain was related to these comorbidities. Our general hypothesis is that participants with painful comorbidities were more

likely to have i) persistent than recurrent TMD-related pain and ii) increased pain severity. To our knowledge, this study is the first to assess the association between painful comorbid conditions and TMD-related pain, persistent or recurrent, regardless of occurrence of other painful comorbid conditions.

Methods

Study population

In this case-control study, 750 TMD-related pain participants and controls were selected from the National Institute of Dental and Craniofacial Research's Temporomandibular Joint Implant Registry and Repository (NIDCR's TIRR) from 2002 to 2011. All participants who were unable to converse in English, under 18 years of age or with rare diseases such as tuberculosis, liver diseases, hepatitis, Parkinson's disease, multiple sclerosis, sickle cell anemia, sexually transmitted disease, and human immunodeficiency virus were excluded. All participants who agreed to participate signed a consent form. Research ethics committees of University of Minnesota, Minneapolis, USA and the Jewish General Hospital, Montreal, Canada approved this study.

TMD specialists performed a comprehensive diagnostic examination of all participants. The diagnosis of TMD-related pain was determined by clinical assessment using a modified Craniomandibular Index (CMI) wherein the CMI examination items were redesigned to conform precisely to those specified for the Research Diagnostic Criteria (RDC) (130). The CMI examination has shown to have an excellent intra- and inter-examiner reliability and validity (41).

Participants were classified into TMD-related pain subgroups as persistent or recurrent TMD-related pain based on their answer to the question "What is the pattern of your worst problem?" The responses were: 1) persistent pain, 2) recurrent pain or 3) pain one time. Twelve participants were excluded from these analyses because they reported pain only once, instead of persistently or recurrently. Pain intensity was assessed using Graded Chronic Pain Scale (GCPS) on a 0-10 numeric rating scale (NRS): 1) "How would you rate the worst pain at present time?" 2) "In the past six months how intense was your worst pain?" 3) "In the past six months, on the average, how intense was your worst pain?" (127).

Putative Exposure

The painful comorbidities identified (yes/no) through the medical health TIRR questionnaire were migraine, neck pain, back pain and fibromyalgia. The total number of painful comorbidities was also included in the analysis.

Putative Confounders

In the current study, age, gender and psychological comorbidities (i.e., depression, anxiety, mental health treatment, physical abuse, and stress) were considered putative confounders. These psychological comorbidities were also assessed using the medical health TIRR questionnaire. Furthermore, the total number of psychological comorbidities was included in the analysis as another putative confounder.

Statistical analysis

Chi-square, Student's t-test and ANOVA were used to compare categorical and continuous variables between groups: TMD-related pain *versus* controls and persistent-recurrent TMD-related pain *versus* controls, and persistent *versus* recurrent TMD-related pain. Furthermore, we performed unconditional univariate and multivariable logistic regression analyses to assess the association between painful comorbidities (independent variables) and TMD-related pain (dependent variables). These analyses were stratified by gender and temporomandibular joint (TMJ) surgery because a large number of patients from the NIDCR's TIRR received TMJ surgeries. All analyses were adjusted for age, gender and psychological comorbidities. Moreover, we also performed unconditional univariate and multivariable logistic regression analyses to evaluate the association between painful comorbidities and persistent or recurrent TMD-related pain. These analyses were adjusted for age, gender and psychological comorbidities. Odds ratios (OR) were estimated with 95% confidence intervals (CI). Pearson correlation was performed to appraise the association between TMD-related pain and the average pain intensity in the past 6 months. All analyses were performed with SAS 9.3 software (Statistical Analysis System; SAS Institute Inc, Cary, NC, USA).

Results

Table 5-1 shows demographics of 750 TMD-related pain participants and 146 controls. TMD-related pain cases more frequently reported persistent (n = 477/738, 65%) than recurrent pain (n = 261/738, 35%; $P < .0001$). Relative to controls, TMD-related pain patients were more likely to be females ($P < .0001$) and older ($P < .0001$). These differences remained when controls were compared to persistent or recurrent TMD-related pain cases.

Table 5-2 illustrates the pain characteristics among TMD-related pain cases and its subtypes (persistent and recurrent pain). The average pain intensity in the past 6 months (0 - 10 NRS) was moderate (mean = 5.6; SD = 2.6). Pain intensity was more severe among persistent than recurrent TMD-related pain ($P < .0001$).

Painful Comorbidities with TMD-related pain and subgroups

Table 5-3 shows the frequency of comorbidities among cases and controls. The most common comorbidities among TMD-related pain cases were neck pain (n = 316; 55%) and back pain (n = 265; 46%), while migraine (n = 21; 15%) and back pain (n = 13; 10%) were most common among controls. Figure 5-1 shows the frequency of the count of these painful comorbidities among cases and controls. TMD-related pain cases (29%) often reported more than one painful comorbid condition, contrary to controls (4%). TMD-related pain was strongly related to a greater number of painful comorbidities in crude (OR = 3.54; 95% CI: 2.53 – 4.95, $P < .0001$) and multivariable models adjusted by age and gender (OR = 2.86; 95% CI: 2.00 – 4.07, $P < .0001$) and psychological comorbidities (OR = 2.65; 95% CI: 1.84 – 3.81, $P < .0001$). The magnitude of the effect relative to controls did not change significantly for persistent (OR = 2.95, 95% CI: 2.01 – 4.31, $P < .0001$) and recurrent TMD-related pain (OR = 2.25, 95% CI: 1.51 – 3.34, $P < .0001$). However, persistent TMD-related pain cases were more likely to have a greater number of comorbidities than the recurrent cases (OR = 1.23, 95% CI: 1.03 – 1.47, $P = 0.02$). The number of comorbidities was positively associated with pain intensity (r = 0.38, $P < .0001$).

Migraine

Table 5-3 shows the relationship between migraine and TMD-related pain. In the crude analysis, TMD-related pain cases were 3.5 times as likely than controls to have migraine (OR = 3.47; $P < .0001$). This significant association remained when the model was adjusted by age and gender (OR = 2.58; $P = 0.003$) and psychological comorbidities (OR = 2.19; $P = 0.004$). In the stratified analyses, we observed that TMD-related pain female cases were more likely to have migraine than female controls (OR = 2.03; 95% CI: 1.14 – 3.62, $P = 0.02$), and that TMD-related pain male cases were more likely to have migraine, however, the latter association was not significant, perhaps because only 43 patients were included in the analyses (OR = 3.04; 95% CI: 0.78 – 11.75, $P = 0.11$). We investigated if the previous relation between migraine and TMD-related pain would remain, regardless of the occurrence of other painful comorbidities. A borderline association was noted when the model was adjusted including painful comorbidities (OR = 1.63, 95% CI: 0.91– 2.91, $P = 0.12$, Table 5-3).

Furthermore, we noted that compared to controls, TMD-related pain cases who underwent TMJ surgery (n = 356; OR = 2.91, $P = 0.0003$) or who did not (n = 553; OR = 1.81, $P = 0.037$) showed a greater likelihood to have migraine, regardless of their age, gender and psychological factors. A positive association was noted when the model was adjusted by painful comorbidities among controls and TMD-related pain patients who received surgery (n = 165; OR = 2.53, $P = 0.009$), but no significant association was noted with TMD-related pain and no surgery (n = 344, OR = 1.29, $P = 0.43$ (Tables 5-5 and 5-6).

Crude and adjusted odds ratios for persistent and recurrent TMD-related pain are presented in Table 5-4. Migraine remains associated with persistent (OR = 2.73; $P = 0.004$) and recurrent TMD-related pain (OR = 2.44; $P = 0.01$) in the multivariable analysis adjusted by age

and gender. This result remained significant for persistent (OR = 2.25; *P* = 0.004) and recurrent TMD-related pain (OR = 2.19; *P* = 0.001) when we adjusted the analysis by age, gender and psychological comorbidities. This result remained significant for persistent TMD-related pain (OR = 1.87, 95% CI: 1.00 – 3.48, *P* = 0.05) when the model was adjusted by other painful comorbidities, and no significant association was observed with recurrent TMD-related pain (OR = 1.38, 95% CI: 0.70 – 2.73, *P* = 0.35). No significant difference was observed between persistent and recurrent TMD-related pain groups (OR = 1.08; 95% CI: 0.72 – 1.61; *P* = 0.71). A moderate positive correlation was noted between migraine and pain intensity (r = 0.29, *P* < .0001).

Neck pain

Neck pain was also strongly related to TMD-related pain in the univariate (OR = 13.47, *P* < .0001) and in the multivariable model adjusted by age and gender (OR = 8.72, *P* < .0001), and psychological comorbidities (OR = 7.44, *P* < .0001). Furthermore, the magnitude of effect previously reported was similar among males (OR = 7.38; 95% CI: 1.54 – 35.45) and females (OR = 7.24; 95% CI: 3.42 – 15.33). TMD-related pain remained moderately related to neck pain in a model adjusted by other painful comorbid conditions (OR = 4.95; *P* < .0001) (Table 5-4).

TMD-related pain cases who underwent surgery (n = 293, OR = 10.12, *P* < 0.001) or not (n = 472, OR = 6.31, 95% CI: 3.15 – 12.62, *P* < .0001) were both more likely to have neck pain than controls, regardless of their age, gender and psychological factors. When the model was adjusted by the comorbidities, this relationship remained regardless of the presence (n = 165, OR = 7.31, *P* < 0.0001) or not of a surgery (n = 344; OR = 4.24, *P* = 0.0001) (Tables 5-5 and 5-6).

In addition, in a multivariable model adjusted by age and gender, TMD-related pain cases with persistent (OR = 11.82; $P < .0001$) and recurrent pain (OR = 5.58; $P < .0001$) were more likely to have neck pain compared to controls (Table 5-4). This association remained when the model was adjusted by age, gender and psychological comorbidities: persistent (OR = 9.93; $P < .0001$) and recurrent TMD-related pain (OR = 5.02, $P < .0001$). A positive association was noted when the model was adjusted by other painful comorbidities: TMD-persistent (OR = 6.66, 95% CI: 3.16 – 14.01, $P < 0.0001$) and recurrent (OR = 3.44, 95% CI: 1.51 – 7.88, $P = 0.003$). Persistent TMD-related pain cases were more likely to have neck pain than the recurrent cases (OR = 2.34; 95% CI: 1.48 – 3.68, $P = 0.0002$). Neck pain was more strongly related to pain intensity (r = 0.41, $P < .0001$) than migraine.

Back pain

Participants with TMD-related pain were almost 8 times as likely to have back pain in comparison to controls in a crude analysis (OR = 7.87; $P < .0001$). The magnitude of this effect was lower but remained significant when the model was adjusted by age and gender (OR = 5.30; $P < .0001$), and psychological comorbidities (OR = 4.45; $P < .0001$) (Table 5-3). More specifically, this association was moderate among males (OR = 6.95; 95% CI: 1.40 – 34.55, $P = 0.02$) and weaker among females (OR = 3.92; 95% CI: 1.97 – 7.79, $P < .0001$). Furthermore, back pain remained related to TMD-related pain, regardless of other painful comorbidities, age, gender and psychological comorbidities (OR = 2.39, $P = 0.02$, Table 5-3).

Relative to controls, the relationship between back pain and TMD-related pain remained among cases who did not receive surgery (n = 472, OR = 4.31, $P < .0001$) and those who did (n = 293, OR = 4.28, $P < .0001$). A positive association was noted when the model was adjusted

by painful comorbidities among patients without surgery (n = 344; OR = 2.50, *P* = 0.010), but not with TMD-related pain and surgery (n = 165; OR = 1.62, *P* = 0.26) (Tables 5-5 and 5-6).

Moreover, in an adjusted model by age and gender, back pain remained associated with persistent (OR = 5.95; *P* < .0001) and recurrent TMD-related pain (OR = 3.93; *P* = 0.0006) (Table 5-4). These relations between back pain and persistent or recurrent TMD-related pain were not modified when the models also included age, gender and psychological comorbidities: persistent TMD (OR = 5.00, *P* < .0001) and recurrent TMD (OR = 3.48, *P* = 0.0004) (Table 5-4). This result exhibited a borderline association when the model was adjusted by other painful comorbidities: persistent TMD (OR = 2.25, 95% CI: 1.09 – 4.64, *P* = 0.05) and recurrent TMD (OR = 2.05, 95% CI: 0.94 – 4.45, *P* = 0.07), without significant difference between persistent and recurrent cases (OR = 1.07, 95% CI: 0.69 – 1.64, *P* = 0.78). A moderate correlation was noted between back pain and pain intensity (r = 0.24, *P* < .0001).

Fibromyalgia

In a crude analysis, a strong association was observed between TMD-related pain and fibromyalgia (OR = 11.63; *P* = 0.0007). This relationship was significantly confounded by age, gender (OR = 5.93; *P* < 0.015), and psychological comorbidities (OR = 4.80; *P* = 0.03) (Table 5-3). Moreover, TMD-related pain female cases were more likely to have fibromyalgia (OR = 4.12; 95% CI: 1.00 – 17.57, *P* = 0.05) than female controls. It was not possible to perform these analyses among males because none of the male controls reported fibromyalgia. Furthermore, in a model adjusted by age, gender and psychological comorbidities, relative to controls, TMD-related pain cases who did not undergo surgery were more likely to have fibromyalgia (n = 551, OR = 4.10, *P* = 0.06). A moderate, but not significant association was

noted between fibromyalgia and TMD-related pain cases who underwent surgery (n = 355, OR = 5.40, $P = 0.025$) (Tables 5-5 and 5-6).

In an adjusted model by age and gender, fibromyalgia was more strongly associated with persistent TMD-related pain (OR = 6.74; $P = 0.001$) than with TMD-related recurrent pain (OR = 4.32; $P = 0.06$). Fibromyalgia remained strongly associated with persistent TMD-related pain (OR = 5.38; $P = 0.02$), while the association with TMD-related recurrent pain (OR = 3.57; $P = 0.11$) was moderate but not significant. The analyses were adjusted by age, gender and psychological comorbidities (Table 5-4). A significant difference was noted between persistent and recurrent TMD-related pain (OR = 1.92; 95% CI: 1.14 – 3.22, $P = 0.01$). Fibromyalgia was weakly correlated with pain intensity (r = 0.19, $P < .0001$).

Discussion

This study demonstrated for the first time that painful comorbidities such as neck pain, back pain and fibromyalgia are associated to TMD-related pain, regardless of TMD-related pain quality: either persistent or recurrent pain. The relationship with migraine appears to be modified by the type of TMD-related pain: as persistent or recurrent, and by the presence of other painful comorbid conditions.

The significant association between TMD-related pain and migraine is expected, as cohort studies demonstrated that participants with headache were 3 to 9 times as likely to develop TMD-related pain (108, 131). In addition, our results are supported by multiple case-controls studies that demonstrated TMD-related pain participants were 2 to 7 times more likely to report migraine (8, 73, 87, 132). Moreover, migraine was related to persistent or recurrent TMD-related pain, regardless of patients age, gender or psychological comorbidities (Table 5-4).

This phenomenon of recurrent TMD-related pain could be coinciding with the recurrent nature of migraine headache (133). In a qualitative study, Nilsson *et al.* interviewed adolescents for TMD-related pain experience, concluding that adolescents with TMD live with recurrent pain – which coincides with headaches (134). However, a clear biological mechanism underlying the association between persistent TMD-related pain and migraine has yet to be elucidated. A moderate positive correlation was noted between migraine and pain intensity ($r = 0.29$, $P < .0001$), which is in agreement with Anderson *et al.* who reported a significant association of headaches and TMD pain intensity ($P < 0.001$) (107).

The current study also demonstrated a strong and significant association between TMD-related pain and back, and neck pain in an adjusted analysis by age, gender and psychological comorbidities (Table 5-3). These results are in agreement with a cohort study, in which participants with back pain were almost 4 times as likely to develop TMD-related pain (108), and with case-control studies that showed a significant association between TMD-related pain and back and neck pain, with OR estimates ranging from 5.0 to 8.0 (87, 135). Furthermore, we found that participants with back or neck pain were more likely to have persistent and recurrent TMD-related pain (Table 5-4), which is partially in agreement with Rammelsberg *et al*. who found that patients with many body pain sites (headache, chest pain, back pain and abdominal pain) were more likely to have persistent TMD-related pain. We also found a moderate to strong correlation between neck and back pain, and pain intensity. However, Rammelsberg *et al.* did not find any significant association with pain intensity and number of body pain sites (13).

In our study, fibromyalgia was strongly related to TMD-related pain in a model adjusted by age and gender and psychological comorbidities (Table 5-3). These results are in agreement with cohort and case-control studies which found a positive relationship between widespread

body pain and TMD-related pain (9, 12, 73, 83). Furthermore, fibromyalgia was related to persistent TMD-related pain in an adjusted analysis by age, gender and psychological comorbidities. A number of cohort studies conducted also found that participants with widespread pain or fibromyalgia were 2 to 3 times as likely to have persistent TMD-related pain than those without these comorbidities (9, 12, 29). This persistence of pain could be explained by the chronicity and persistent nature of fibromyalgia (115). Our result showing that persistent TMD-related pain cases are more likely to have fibromyalgia than recurrent cases is also in agreement with a cohort study conducted by Rammelsberg *et al*., who demonstrated that participants with myofacial pain, as well as pain in several body sites (headache, chest pain, back pain and abdominal pain) at baseline were more likely to have persistent TMD-related pain in comparison to recurrent or remitted TMD-related pain, over a period of 5-years (13).

The findings of this study should be interpreted in the context of its limitations. First, comorbidities were self-reported by the participants through a questionnaire. This could lead to a possible information bias, as a clinical diagnosis is required for confirmation of the disease. We noted, nonetheless, that the frequency of painful comorbid conditions among TMD-related pain cases [migraine (39%), neck pain (55%), back pain (46%) and fibromyalgia (15%)] were similar to the frequency estimates reported in previous studies [migraine (27-58%) (5, 96, 136, 137), neck and back pain (42-68%) (5, 87, 138) and fibromyalgia (13-18%) (114, 139)]. Second, there is no valid definition of persistent or recurrent pain and the chance of misclassification needs to be considered. In the study by Rammelsberg *et al.* year, while the frequency of recurrent TMD-related pain (36%) is similar to our study (35%), the frequency of persistent TMD-related pain (31%) was lower than in our study (65%). The higher frequency of persistent TMD-related pain in our study may be due to TMD participants from the NIDCR's TIRR who underwent TMJ

surgeries. Third, the relationship between comorbidities and TMD-related pain may be biased by unmeasured confounding variables.

Our study has several strengths. First, the database from NIDCR's TIRR comprises a representative sample of participants with TMD-related pain. Second, our sample size in this study is large, which provides sufficient power to perform analyses exploring a relationship between painful comorbidities and persistent or recurrent TMD-related pain. Based on the large sample size, odds ratios and the prevalence of comorbidities (Tables 5-3 and 5-4), this study had sufficient power, ranging from 80% to 100%. The only low power analysis (65%) was that of fibromyalgia and TMD-recurrent pain (OR = 3.57, 95% CI: 0.78 – 16.40). Third, all participants received a clinical examination by trained examiners, for the diagnosis of TMD-related pain.

In conclusion, the current study demonstrated that participants with neck and back pain were more likely to have TMD-related pain, regardless of TMD characteristics such as recurrent and persistent TMD-related pain. A significant difference was nonetheless noted on the odds of fibromyalgia between persistent and recurrent TMD-related pain. The association of migraine, however, appears to be modified by the presence of other comorbid conditions and type of TMD-related pain as compared to other painful comorbidities. Understanding the relationship between TMD-related pain with painful comorbid conditions will lead to better patient management using a multidisciplinary approach.

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Table 5-1. Demographics of TMD cases (persistent and recurrent) and controls				
Demographics	**Controls (n = 146)**	**Cases (n = 750)**	**Persistent TMD (n = 477)**	**Recurrent TMD (n = 261)**
Age *mean (SD)*	34.2 (13.8)*	41.9 (14.7)*	40.7 (14.2)*	44.1 (15.3)*
Males *n (%)*	50 (34)	84 (11)	53 (11)	29 (11)
Females *n (%)*	96 (66)*	666 (89)*	424 (89)*	232 (89)*
* $P < 0.05$				

Table 5-2. Pain characteristics of TMD cases, subgroups of TMD-related pain			
	Cases (n = 750)	**Persistent TMD (n = 477)**	**Recurrent TMD (n = 261)**
Worst pain at present time *mean (SD)*	4.9 (3.1)	5.8 (2.9)*	3.5 (2.7)*
Worst pain intensity in the past six months *mean (SD)*	7.2 (2.8)	7.8 (2.6)*	6.3 (2.7)*
Average worst pain in the past six months *mean (SD)*	5.6 (2.6)	6.1 (2.6)*	4.7 (2.4)*
* $P < 0.05$			

Table 5-3. Crude and adjusted OR and 95% CI for the association between TMD-related pain and painful comorbidities.

Comorbidity	*Category*	*Case/ Controls (n)*	*Crude*	*Model 1*	*Model 2*	*Model 3*
Migraine	No	446/116	1.0 (Referent)			
	Yes	280/21	3.47 (2.13-5.65)	2.58 (1.54-4.34)	2.19 (1.29 – 3.72)	1.63 (0.91-2.91)
Neck Pain	No	260/122	1.0 (Referent)			
	Yes	316/11	13.47 (7.12-25.51)	8.72 (4.51-16.87)	7.44 (3.77-14.53)	4.95 (2.42-10.13)
Back Pain	No	311/120	1.0 (Referent)			
	Yes	265/13	7.87 (4.34-14.26)	5.30 (2.86-9.84)	4.45 (2.37-8.37)	2.39 (1.21-4.71)
Fibromyalgia	No	615/135	1.0 (Referent)			
	Yes	106/2	11.63 (2.84-47.71)	5.93 (1.41-24.88)	4.80 (1.12-19.93)	*Not included*

Model 1: Adjusted by age (OR = 1.03 to 1.04, $P < .0001$) and gender (OR = 3.38 to 4.08, $P < .0001$).
Model 2: Adjusted by age (OR = 1.03 to 1.04, $P < .0001$), gender (OR = 3.04 to 3.44, $P < .0001$) and psychological comorbidities (OR = 1.21 to 1.34, $P < .05$).
Model 3: Adjusted by full model including all comorbidities, except fibromyalgia: age (OR = 1.03, $P < .0001$), gender (OR = 2.80, $P < .0001$), and psychological comorbidities (OR = 1.14, $P = 0.13$).

Table 5-4. Crude and adjusted OR and 95% CI for the association between painful comorbidities and persistent or recurrent TMD-related pain.

Comorbidity	*TMD-related pain*	*Category*	*Case/ Control (n)*	*Crude*	*Model 1*	*Model 2*
Migraine	Persistent	No	275/116	1.0 (Referent)		
		Yes	186/21	3.74 (2.26-6.16)	2.73 (1.60-4.66)	2.25 (1.30-3.89)
	Recurrent	No	163/116	1.0 (Referent)		
		Yes	91/21	3.08 (1.81-5.24)	2.44 (1.36-4.38)	2.19 (1.20-3.99)
Neck Pain	Persistent	No	133/122	1.0 (Referent)		
		Yes	214/11	17.84 (9.28-34.30)	11.82 (5.98-23.38)	9.93 (4.96-19.88)
	Recurrent	No	120/122	1.0 (Referent)		
		Yes	99/11	9.15(4.67-17.92)	5.58 (2.71-11.45)	5.02 (2.37-10.60)
Back Pain	Persistent	No	179/120	1.0 (Referent)		
		Yes	168/13	8.66 (4.71-15.94)	5.95 (3.14-11.28)	5.01 (2.62-9.61)
	Recurrent	No	127/120	1.0 (Referent)		
		Yes	92/13	6.69 (3.55-12.58)	3.93 (2.00-7.74)	3.48 (1.73-7.04)
Fibromyalgia	Persistent	No	383/135	1.0 (Referent)		
		Yes	74/2	13.04 (3.16-53.85)	6.74 (1.59-28.58)	5.38 (1.26-23.00)
	Recurrent	No	223/135	1.0 (Referent)		
		Yes	30/2	9.08 (2.14-38.60)	4.32 (0.93-20.14)	3.57 (0.78-16.40)

Model 1: Adjusted by age (OR = 1.03 to 1.05, $P < .0004$) and gender (OR = 3.77 to 4.19, $P < .0001$).
Model 2: Adjusted by age (OR = 1.03 to 1.05, $P < .0001$), gender (OR = 2.80 to 3.96, $P < .0007$). Psychological comorbidities: Persistent TMD (OR = 1.27 to 1.40, $P < .05$), Recurrent TMD (OR = 1.11 to 1.19, $P > .05$).

Table 5-5. Crude and adjusted OR and 95% CI for the association between TMD-related pain *without surgery* and painful comorbidities.					
Comorbidity	***Category***	***Crude***	***Model 1***	***Model 2***	***Model 3***
Migraine	No	1.0 (Referent)			
	Yes	3.31 (2.00 – 5.46)	2.23 (1.30 – 3.83)	1.81 (1.4 – 3.16)	1.23 (0.70 – 2.40)
Neck Pain	No	1.0 (Referent)			
	Yes	11.94 (6.24 – 22.84)	7.68 (3.91 – 15.06)	6.31 (3.15 – 12.62)	4.24 (2.01 – 8.92)
Back Pain	No	1.0 (Referent)			
	Yes	8.05 (4.39 – 14.76)	5.19 (2.75 – 9.78)	4.31 (2.25 – 8.26)	2.50 (1.24 – 5.04)
Fibromyalgia	No	1.0 (Referent)			
	Yes	10.74 (2.59 – 44.48)	5.20 (1.22 – 22.18)	4.10 (0.95 – 17.66)	*Not included*
Model 1: Adjusted by age and gender. Model 2: Adjusted by age, gender and psychological comorbidities.					

Table 5-6. Crude and adjusted OR and 95% CI for the association between TMD-related pain *with surgery* and painful comorbidities.					
Comorbidity	***Category***	***Crude***	***Model 1***	***Model 2***	***Model 3***
Migraine	No	1.0 (Referent)			
	Yes	3.74 (2.21 – 6.35)	3.20 (1.81 – 5.66)	2.91 (1.63 – 5.21)	2.53 (1.27 – 5.04)
Neck Pain	No	1.0 (Referent)			
	Yes	17.34 (8.74 – 34.40)	10.75 (5.20 – 22.22)	10.12 (4.79 – 21.38)	7.31 (3.20 – 16.72)
Back Pain	No	1.0 (Referent)			
	Yes	7.57 (3.98 – 14.39)	4.82 (2.42 – 9.59)	4.28 (2.12 – 8.67)	1.62 (0.70 – 3.78)
Fibromyalgia	No	1.0 (Referent)			
	Yes	12.97 (3.09 – 54.51)	6.04 (1.39 – 26.29)	5.40 (1.23 – 23.68)	*Not included*
Model 1: Adjusted by age and gender. Model 2: Adjusted by age, gender and psychological comorbidities.					

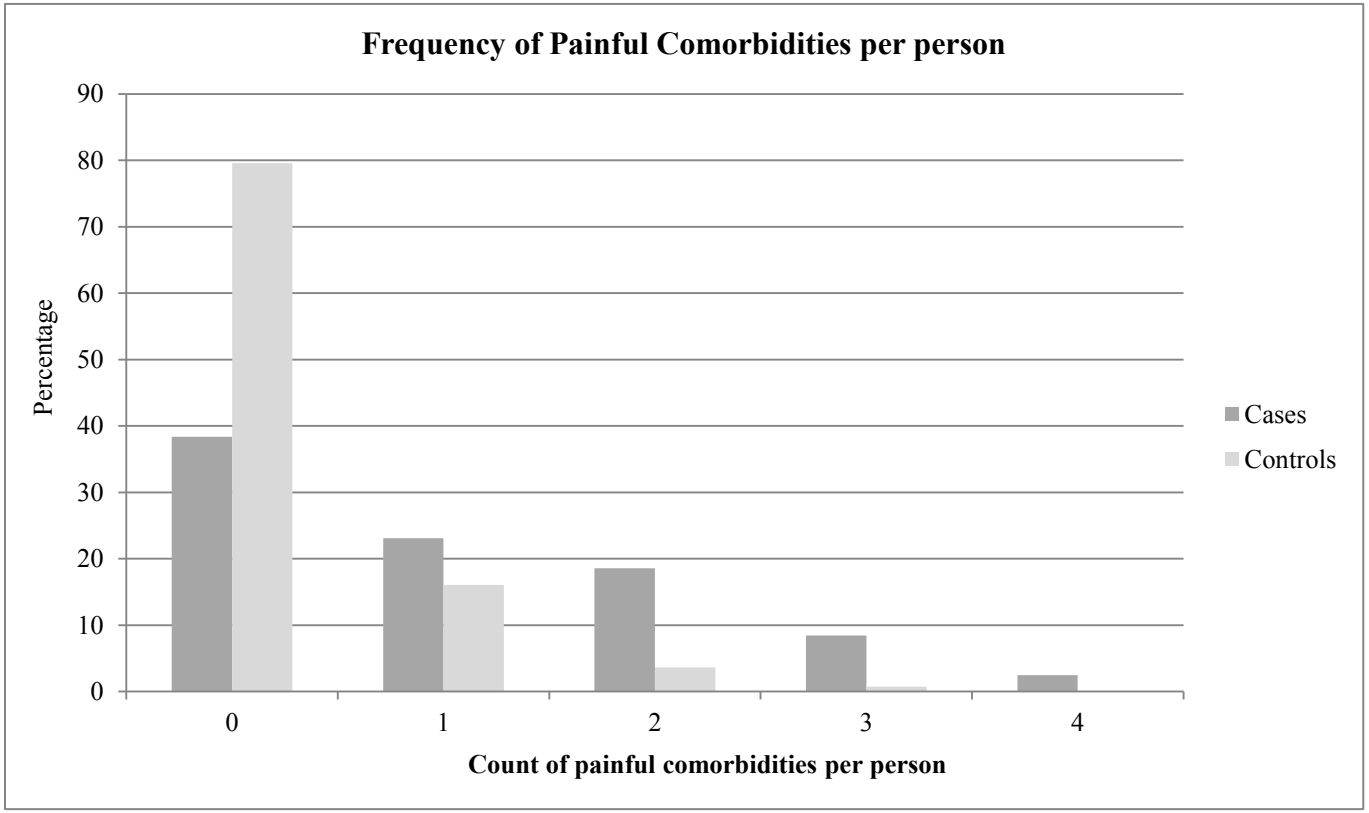


Figure 5-1. Number of painful comorbid conditions per person

6. DISCUSSION

This section will provide a summary of the results, methodological considerations, strengths and limitations of this thesis.

First, the aim of this study was to evaluate the relationship between TMD-related pain (persistent or recurrent) and painful comorbidities. Subsequently, it was investigated if these results were affected by patients' gender, age and psychological comorbidities. Finally, we investigated how much of these painful comorbidities were independently associated with TMD-related pain. It was also evaluated how much of these results remained among persistent and recurrent TMD-related pain. To our knowledge, this study is the first to assess the association between painful comorbid conditions and TMD-related pain (persistent or recurrent) regardless of occurrence of other painful comorbid conditions.

6.1 Summary of results

6.1.1 TMD-related pain and painful comorbidities

In this study, painful comorbidities were strongly associated with TMD-related pain. Moreover, TMD-related pain was strongly related to a greater number of painful comorbidities in crude and multivariable models adjusted by age and gender and psychological comorbidities.

Furthermore, this study also observed that TMD-related pain cases were 3.5 times more likely to have migraine than controls in a crude analysis. The result shows that this significant association was not modified by patients' age, gender and psychological comorbidities. However, the association did not remain when the analysis was adjusted by a full model including all comorbidities (Table 5-3).

Neck pain was also strongly related to TMD-related pain in the univariate and in the multivariable model adjusted by age and gender and psychological comorbidities (Table 5-3). Moreover, participants with TMD-related pain were almost 8 times as likely to have back pain in comparison to controls in a crude analysis. This association remained significant when the model was adjusted by age and gender and psychological comorbidities. Neck and back pain remained significantly associated with TMD-related pain when adjusted by other comorbidities (Table 5-3).

In addition, TMD-related pain was strongly related to fibromyalgia in a crude analysis. However, this relationship remains significant when adjusted by patients' age, gender and psychological comorbidities (Table 5-3).

6.1.2 Persistent or recurrent TMD-related pain and painful comorbidities

In this study the magnitude of the effect relative to controls did not change significantly for persistent and recurrent TMD-related pain. However, persistent TMD-related pain cases were more likely to have a greater number of comorbidities than the recurrent cases.

Migraine remains associated with persistent and recurrent TMD-related pain in the multivariable analysis adjusted by age and gender. This result remained significant for persistent and recurrent TMD-related pain when we adjusted the analysis by age, gender and psychological comorbidities. However, when the analysis was adjusted by other painful comorbidities the results remained significant for persistent TMD-related pain, but no significant association was observed with recurrent TMD-related pain.

In addition, in a multivariable model adjusted by age and gender, TMD-related pain cases with persistent and recurrent pain were more likely to have neck pain compared to controls

(Table 5-4). This association for persistent and recurrent TMD-related pain remained when the model was adjusted by age, gender and psychological comorbidities. A positive association was noted for both (persistent and recurrent TMD-related pain) when the model was adjusted by other painful comorbidities.

Moreover, in an adjusted model by age and gender, back pain remained associated with persistent and recurrent TMD-related pain (Table 5-4). These relations between back pain and persistent or recurrent TMD-related pain were not modified when the models also included age, gender and psychological comorbidities.

In an adjusted model by age and gender, fibromyalgia was more strongly associated with persistent TMD-related pain than with TMD-related recurrent pain. Fibromyalgia remained strongly associated with persistent TMD-related pain, while the magnitude of the effect was high but not significant for recurrent TMD-related pain. The analyses were adjusted by age, gender and psychological comorbidities (Table 5-4).

6.2 Methodological Considerations

Due to the systematic nature of errors in a cases-control study, incurring bias is always a possibility, as explained earlier. This section provides in-depth discussion of validity of the results.

6.2.1 Consistency with other studies

Many studies have demonstrated the significant overlap between TMD-related pain and other pain conditions, such as migraine, neck pain, back pain and fibromyalgia (5, 73, 124, 139-145).

6.2.2 Bias

A bias is defined as any systematic error in any epidemiological study, which can result in incorrect estimation of association between the exposure and the disease (147). Any study can be subject to bias due to the selection of participants, measurement of variables, or uncontrolled confounding factors. Types of biases expected to occur in a case-control study are detailed below:

6.2.2.1 Selection bias

Selection bias refers to any error that arises in the process of identifying the study populations (146). For example, it could occur if the diagnoses of TMD-related pain cases or controls are dependent of risk factors such as comorbid conditions. To control for selection bias, certain measures were considered in this study. The objective and hypothesis of the study were not disclosed to the research team who collected the data and conducted data entry. The study base is defined as a reference population from which the data for the study has been collected (147). For this reason our controls were also selected from the same study base (i.e. NIDCR's TIRR) as the cases; this can help decrease the chance of selection bias (148), as controls in our study may have a similar chance to be exposed to comorbidities as cases.

6.2.2.2 Information bias

Information bias is a type of systematic error in which the cases and controls report exposure information differently for several reasons. It can arise from misrepresentation in the estimate effect due to measurement error or misclassification (146).

Certain measures were applied control information bias in our study. The NIDCR's TIRR is a valid and recognized database comprising of subjects diagnosed by multiple TMD

specialists. Cases were provided with questionnaires to complete instantly after the diagnosis of TMD, which is considered a standard approach to reduce information bias (149).

NIDCR's TIRR questionnaires were distributed to the patients in a comfortable environment where they completed the information in privacy. The exposure of cases and controls (i.e. painful comorbidities) were taken into account through a dichotomous questionnaire, which could possibly induce information bias as a clinical diagnosis is required for confirmation of the disease. However, we hence compared the prevalence and frequencies of comorbid conditions among our controls and cases in the analysis. We noted that frequency of painful comorbid conditions in our study was similar to that reported in other studies.

Furthermore, there is no valid definition of persistent or recurrent pain and the chance of misclassification needs to be considered. The frequency of persistent TMD-related pain in our study (65%) was moreover found to be higher than reported by Rammelsberg *et al*. (31%) (13). This could be due to the majority of the participants at NIDCR's TIRR underwent surgery for the TMD-related pain. To account for the latter possibilities, we stratified our analysis by surgery. However, we did not see any difference in the results, which certainly controls for information bias.

6.2.2.3 Bias due to Confounding

Confounding can lead to overestimation or underestimation of the true association between exposure and disease, and can consequently change the direction of the observed effect.

There are certain methods to control for confounding, such as by selecting individuals of similar age group, gender or others. It can also be controlled at the analytical stage of the study. Possible confounders for the analyses were identified from a priori knowledge. In this current

study, age and gender were the potential confounders identified and were adjusted in the analysis. One of the methods to control for confounding is matching cases and control. Matching is conducted for strong confounders (150). However, we did not use matching in our analysis, as in our study gender was associated with the disease and some comorbidities, but not all. Therefore, gender was not a confounder in our analysis. To account for the gender confounder effect, all models were adjusted by gender. Finally, in this study we stratified our analysis by gender as we would like evaluate the association between TMD-related pain and comorbidity among females and among males. The stratification serves as a novelty in this study.

6.3 Strengths

6.3.1 Representative Sample

The sample from this study was collected from the NIDCR's TIRR, which is classified as one of the most valid database for TMD-related pain patients. This database has multiple specialists and professionals who use proper diagnostic criteria on all the patients.

Controls were also selected from the same database; they presented with any dental related condition besides TMD-related pain. This in turn increases the generalizability of the representative sample. Patients from all over the United States who seek treatment for TMD-related pain are recruited at NIDCR's TIRR, which makes our sample representative of the population within the United States.

6.3.2 Clinical Examination

All participants in this study underwent a clinical examination by a TMD specialist using CMI on the basis of RDC/TMD. Studies report that the sensitivity and specificity of RDC/TMD

and DC/TMD remains acceptable after modifications, which shows that our study has a low chance of misclassification. In a recent study (Schiffman *et al.*), excellent sensitivity and specificity were observed among painful TMD-related pain subgroups such as myofascial (0.90, 0.99) and arthralgia (0.89, 0.98) (38).

6.4 Limitations

This study also has some limitations briefly explained in this section. The information was collected from the participants through a TIRR questionnaire which presented all medical-related conditions, and they were asked to answer each question by selecting 'yes' or 'no'. In our study, comorbid conditions such as migraine could have a possibility of bias, as migraine has specific characteristics which are different from headaches. Participants who experienced headaches may have unknowingly responded to migraine. The chance of misclassification reduces as conditions like fibromyalgia, however, have a definite diagnosis and patients would be well aware of their condition. The chance of misclassification appears to be low because the frequency of painful comorbid conditions among TMD-related pain cases [migraine (39%), neck pain (55%), back pain (46%) and fibromyalgia (15%)] were similar to the frequency estimates reported in previous studies [migraine (27-58%) (5, 96, 136, 137), neck and back pain (42-68%) (5, 87, 138) and fibromyalgia (13-18%) (114, 139)]. We also incurred information bias when TMD-related pain patients were divided into its subtypes (i.e. persistent and recurrent TMD-related pain) as there is no valid definition for persistent or recurrent TMD-related pain. There is a chance of misclassification that needs to be considered in our study.

7. CONCLUSION

The following conclusion can be drawn from the results of our manuscript in the thesis.

1) Participants with neck and back pain were more likely to have TMD-related pain, regardless of TMD characteristics such as recurrent and persistent TMD-related pain.

2) The association of migraine, however, appears to be modified by the presence of other comorbid conditions and type of TMD-related pain compared to other painful comorbidities.

3) A significant difference was nonetheless noted on the odds of fibromyalgia between persistent and recurrent TMD-related pain.

4) To our knowledge, this study is the first to assess the association between painful comorbid conditions and TMD-related pain (persistent or recurrent) regardless of occurrence of other painful comorbid conditions.

8. LIST OF REFERENCES

1. National Institute of Dental and Craniofacial Research. Facial Pain. 2009; Available from: http://www.nidcr.nih.gov/DataStatistics/FindDataByTopic/FacialPain.

2. Isong U, Gansky SA, Plesh O. Temporomandibular joint and muscle disorder-type pain in U.S. adults: the National Health Interview Survey. J Orofac Pain. 2008;22(4):317-22. Epub 2008/12/19.

3. Janal MN, Raphael KG, Nayak S, Klausner J. Prevalence of myofascial temporomandibular disorder in US community women. J Oral Rehabil. 2008;35(11):801-9. Epub 2008/11/04.

4. Rudy TE, Turk DC, Kubinski JA, Zaki HS. Differential treatment responses of TMD patients as a function of psychological characteristics. Pain. 1995;61(1):103-12. Epub 1995/04/01.

5. Hagberg C, Hagberg M, Kopp S. Musculoskeletal symptoms and psychosocial factors among patients with craniomandibular disorders. Acta Odontol Scand. 1994;52(3):170-7. Epub 1994/06/01.

6. Cimino R, Michelotti A, Stradi R, Farinaro C. Comparison of clinical and psychologic features of fibromyalgia and masticatory myofascial pain. J Orofac Pain. 1998;12(1):35-41.

7. Raphael KG, Marbach JJ. Comorbid fibromyalgia accounts for reduced fecundity in women with myofascial face pain. Clin J Pain. 2000;16(1):29-36.

8. Stuginski-Barbosa J, Macedo HR, Bigal ME, Speciali JG. Signs of temporomandibular disorders in migraine patients: a prospective, controlled study. Clin J Pain. 2010;26(5):418-21.

9. Velly AM, Look JO, Schiffman E, Lenton PA, Kang W, Messner RP, et al. The effect of fibromyalgia and widespread pain on the clinically significant temporomandibular muscle and joint pain disorders--a prospective 18-month cohort study. J Pain. 2010;11(11):1155-64.

10. Blumenfeld A, Bender SD, Glassman B, Malizia D. Bruxism, temporomandibular dysfunction, tension type headache, and migraine: a comment. Headache. 2011;51(10):1549-50. Epub 2011/11/16.

11. Plesh O, Noonan C, Buchwald DS, Goldberg J, Afari N. Temporomandibular disorder-type pain and migraine headache in women: a preliminary twin study. J Orofac Pain. 2012;26(2):91-8. Epub 2012/05/05.

12. John MT, Miglioretti DL, LeResche L, Von Korff M, Critchlow CW. Widespread pain as a risk factor for dysfunctional temporomandibular disorder pain. Pain. 2003;102(3):257-63.

13. Rammelsberg P, LeResche L, Dworkin S, Mancl L. Longitudinal outcome of temporomandibular disorders: a 5-year epidemiologic study of muscle disorders defined by research diagnostic criteria for temporomandibular disorders. J Orofac Pain. 2003;17(1):9-20. Epub 2003/05/22.

14. Rammelsberg P, LeResche L, Dworkin S, Mancl L. Longitudinal outcome of temporomandibular disorders: a 5-year epidemiologic study of muscle disorders defined by research diagnostic criteria for temporomandibular disorders. J Orofac Pain. 2003;17(1):9-20.

15. Chen H, Nackley A, Miller V, Diatchenko L, Maixner W. Multisystem dysregulation in painful temporomandibular disorders. The journal of pain : official journal of the American Pain Society. 2013;14(9):983-96. Epub 2013/06/01.

16. Laskin D, Greenfield E, Gale E, Ruth J, Neff P, Alling C et al. . The President's conference on the examination, diagnosis and management of temporomandibular disorders. Chicago: American Dental Association; 1983.

17. Truelove EL, Sommers EE, LeResche L, Dworkin SF, Von Korff M. Clinical diagnostic criteria for TMD. New classification permits multiple diagnoses. J Am Dent Assoc. 1992;123(4):47-54.

18. Drangsholt M, LeResche L. Temporomandibular Disorders Pain. In: Crombie IK CP, Linton SJ, LeResche L, Von Korff M, eds. , editor. Epidemiology of Pain. Seattle: IASP; 1999. p. 203-33.

19. LeResche L. Epidemiology of temporomandibular disorders: Implications for the investigation of etiologic factors. Crit Rev Oral Biol Med. 1997;8:291-305.

20. Fletcher RH, Fletcher SW. Clinical epidemiology : the essentials. 4th ed. Philadelphia: Lippincott Williams & Wilkins; 2005. xv, 252 p. p.

21. Locker D, Slade G. Prevalence of symptoms associated with temporomandibular disorders in a Canadian population. Community Dent Oral Epidemiol. 1988;16(5):310-3. Epub 1988/10/01.

22. Von Korff M, Dworkin SF, Le Resche L, Kruger A. An epidemiologic comparison of pain complaints. Pain. 1988;32(2):173-83. Epub 1988/02/01.

23. De Kanter RJ, Truin GJ, Burgersdijk RC, Van 't Hof MA, Battistuzzi PG, Kalsbeek H, et al. Prevalence in the Dutch adult population and a meta-analysis of signs and symptoms of temporomandibular disorder. J Dent Res. 1993;72(11):1509-18. Epub 1993/11/01.

24. Goulet JP, Lavigne GJ, Lund JP. Jaw pain prevalence among French-speaking Canadians in Quebec and related symptoms of temporomandibular disorders. J Dent Res. 1995;74(11):1738-44. Epub 1995/11/01.

25. Slade GD, Bair E, By K, Mulkey F, Baraian C, Rothwell R, et al. Study methods, recruitment, sociodemographic findings, and demographic representativeness in the OPPERA study. J Pain. 2011;12(11 Suppl):T12-26.

26. Helkimo M. Studies on function and dysfunction of the masticatory system. IV. Age and sex distribution of symptoms of dysfunction of the masticatory system in Lapps in the north of Finland. Acta Odontol Scand. 1974;32(4):255-67. Epub 1974/01/01.

27. Mohlin B. Prevalence of mandibular dysfunction and relation between malocclusion and mandibular dysfunction in a group of women in Sweden. Eur J Orthod. 1983;5(2):115-23. Epub 1983/05/01.

28. Fletcher RH, Fletcher SW, Fletcher GS. Clinical epidemiology : the essentials. 5th ed. Philadelphia: Wolters Kluwer/Lippincott Williams & Wilkins Health; 2014. 253 p. p.

29. Von Korff M, Le Resche L, Dworkin SF. First onset of common pain symptoms: a prospective study of depression as a risk factor. Pain. 1993;55(2):251-8. Epub 1993/11/01.

30. Nilsson IM, List T, Drangsholt M. Incidence and temporal patterns of temporomandibular disorder pain among Swedish adolescents. J Orofac Pain. 2007;21(2):127-32. Epub 2007/06/06.

31. Slade GD, Bair E, Greenspan JD, Dubner R, Fillingim RB, Diatchenko L, et al. Signs and symptoms of first-onset TMD and sociodemographic predictors of its development: the OPPERA prospective cohort study. J Pain. 2013;14(12 Suppl):T20-32 e1-3. Epub 2013/12/07.

32. Dworkin SF, LeResche L. Research diagnostic criteria for temporomandibular disorders: review, criteria, examinations and specifications, critique. Journal of craniomandibular disorders : facial & oral pain. 1992;6(4):301-55. Epub 1992/01/01.

33. Koepsell TD, Weiss NS. Epidemiologic methods : studying the occurrence of illness. Oxford ; New York: Oxford University Press; 2003. ix, 513 p. p.

34. John MT, Dworkin SF, Mancl LA. Reliability of clinical temporomandibular disorder diagnoses. Pain. 2005;118(1-2):61-9. Epub 2005/09/13.

35. Look JO, John MT, Tai F, Huggins KH, Lenton PA, Truelove EL, et al. The Research Diagnostic Criteria For Temporomandibular Disorders. II: reliability of Axis I diagnoses and selected clinical measures. Journal of orofacial pain. 2010;24(1):25-34. Epub 2010/03/10.

36. Schiffman EL, Truelove EL, Ohrbach R, Anderson GC, John MT, List T, et al. The Research Diagnostic Criteria for Temporomandibular Disorders. I: overview and methodology for assessment of validity. J Orofac Pain. 2010;24(1):7-24. Epub 2010/03/10.

37. Truelove E, Pan W, Look JO, Mancl LA, Ohrbach RK, Velly AM, et al. The Research Diagnostic Criteria for Temporomandibular Disorders. III: validity of Axis I diagnoses. J Orofac Pain. 2010;24(1):35-47. Epub 2010/03/10.

38. Schiffman E, Ohrbach R, Truelove E, Look J, Anderson G, Goulet JP, 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 Groupdagger. Journal of oral & facial pain and headache. 2014;28(1):6-27. Epub 2014/02/01.

39. Fricton JR, Schiffman EL. Reliability of a craniomandibular index. J Dent Res. 1986;65(11):1359-64. Epub 1986/11/01.

40. Fricton JR, Schiffman EL. The craniomandibular index: validity. J Prosthet Dent. 1987;58(2):222-8. Epub 1987/08/01.

41. Pehling J, Schiffman E, Look J, Shaefer J, Lenton P, Fricton J. Interexaminer reliability and clinical validity of the temporomandibular index: a new outcome measure for temporomandibular disorders. J Orofac Pain. 2002;16(4):296-304. Epub 2002/11/29.

42. Ohrbach R, Dworkin SF. Five-year outcomes in TMD: relationship of changes in pain to changes in physical and psychological variables. Pain. 1998;74(2-3):315-26. Epub 1998/03/31.

43. Merskey H, Bogduk N, International Association for the Study of Pain. Task Force on Taxonomy. Classification of chronic pain : descriptions of chronic pain syndromes and definitions of pain terms. 2nd ed. Seattle: IASP Press; 1994. xvi, 222 p. p.

44. Maixner W, Fillingim R, Sigurdsson A, Kincaid S, Silva S. Sensitivity of patients with painful temporomandibular disorders to experimentally evoked pain: evidence for altered temporal summation of pain. Pain. 1998;76(1-2):71-81. Epub 1998/08/08.

45. Okeson JP. Orofacial pain : guidelines for assessment, diagnosis, and management. Chicago: Quintessence Pub. Co., Inc.; 1996. x, 285 p. p.

46. Woda A, Pionchon P. A unified concept of idiopathic orofacial pain: clinical features. J Orofac Pain. 1999;13(3):172-84; discussion 85-95. Epub 2000/05/24.

47. Dworkin SF, Suvinen TI, editors. Orofacial pain/temporomandibular disorders. Review of the scientific literature on biobehavioural aspects of temporomandibular disorders. Behavioral, cognitive and emotional factors related to etiology, assessment, diagnosis and management. Proceedings of the World Workshop on Oral Medicine III; 1998; Chicago: IL

48. Engel GL. The need for a new medical model: a challenge for biomedicine. Science. 1977;196(4286):129-36. Epub 1977/04/08.

49. Maixner W, Diatchenko L, Dubner R, Fillingim RB, Greenspan JD, Knott C, et al. Orofacial pain prospective evaluation and risk assessment study--the OPPERA study. J Pain. 2011;12(11 Suppl):T4-11 e1-2. Epub 2011/12/07.

50. Maixner W, Diatchenko L, Dubner R, Fillingim RB, Greenspan JD, Knott C, et al. Orofacial pain prospective evaluation and risk assessment study--the OPPERA study. J Pain. 2011;12(11 Suppl):T4-11.e1-2.

51. Svensson P, Baad-Hansen L. The mechanisms of joint and muscle pain. J Am Dent Assoc. 2010;141(6):672-4. Epub 2010/06/03.

52. Carlsson GE. Epidemiology and treatment need for temporomandibular disorders. Journal of orofacial pain. 1999;13(4):232-7. Epub 2000/05/24.

53. Wanman A. Longitudinal course of symptoms of craniomandibular disorders in men and women. A 10-year follow-up study of an epidemiologic sample. Acta odontologica Scandinavica. 1996;54(6):337-42. Epub 1996/12/01.

54. Sanders AE, Slade GD. Gender modifies effect of perceived stress on orofacial pain symptoms: National Survey of Adult Oral Health. J Orofac Pain. 2011;25(4):317-26. Epub 2012/01/17.

55. Schmid-Schwap M, Bristela M, Kundi M, Piehslinger E. Sex-specific differences in patients with temporomandibular disorders. J Orofac Pain. 2013;27(1):42-50.

56. Dougall AL, Jimenez CA, Haggard RA, Stowell AW, Riggs RR, Gatchel RJ. Biopsychosocial factors associated with the subcategories of acute temporomandibular joint disorders. Journal of orofacial pain. 2012;26(1):7-16. Epub 2012/02/01.

57. LeResche L. Epidemiology of temporomandibular disorders: implications for the investigation of etiologic factors. Critical reviews in oral biology and medicine : an official publication of the American Association of Oral Biologists. 1997;8(3):291-305. Epub 1997/01/01.

58. De Leeuw R, American Academy of Orofacial Pain. Orofacial pain : guidelines for assessment, diagnosis, and management. 4th ed. Chicago: Quintessence; 2008. ix, 316 p. p.

59. Glaros AG. Incidence of diurnal and nocturnal bruxism. J Prosthet Dent. 1981;45(5):545-9. Epub 1981/05/01.

60. Reding GR, Rubright WC, Zimmerman SO. Incidence of bruxism. J Dent Res. 1966;45(4):1198-204. Epub 1966/07/01.

61. Hublin C, Kaprio J, Partinen M, Koskenvuo M. Sleep bruxism based on self-report in a nationwide twin cohort. J Sleep Res. 1998;7(1):61-7. Epub 1998/06/05.

62. Ohayon MM, Li KK, Guilleminault C. Risk factors for sleep bruxism in the general population. Chest. 2001;119(1):53-61. Epub 2001/02/07.

63. Marbach JJ, Lennon MC, Dohrenwend BP. Candidate risk factors for temporomandibular pain and dysfunction syndrome: psychosocial, health behavior, physical illness and injury. Pain. 1988;34(2):139-51. Epub 1988/08/01.

64. Cacchiotti DA, Plesh O, Bianchi P, McNeill C. Signs and symptoms in samples with and without temporomandibular disorders. Journal of craniomandibular disorders : facial & oral pain. 1991;5(3):167-72. Epub 1991/01/01.

65. Huang GJ, LeResche L, Critchlow CW, Martin MD, Drangsholt MT. Risk factors for diagnostic subgroups of painful temporomandibular disorders (TMD). J Dent Res. 2002;81(4):284-8. Epub 2002/07/05.

66. Velly AM, Gornitsky M, Philippe P. Contributing factors to chronic myofascial pain: a case-control study. Pain. 2003;104(3):491-9.

67. Ohrbach R, Bair E, Fillingim RB, Gonzalez Y, Gordon SM, Lim PF, et al. Clinical orofacial characteristics associated with risk of first-onset TMD: the OPPERA prospective cohort study. J Pain. 2013;14(12 Suppl):T33-50. Epub 2013/12/07.

68. Fernandes G, Franco AL, Siqueira JT, Goncalves DA, Camparis CM. Sleep bruxism increases the risk for painful temporomandibular disorder, depression and non-specific physical symptoms. J Oral Rehabil. 2012;39(7):538-44.

69. Raphael KG, Sirois DA, Janal MN, Wigren PE, Dubrovsky B, Nemelivsky LV, et al. Sleep bruxism and myofascial temporomandibular disorders: a laboratory-based polysomnographic investigation. J Am Dent Assoc. 2012;143(11):1223-31. Epub 2012/11/02.

70. Huang GJ, Rue TC. Third-molar extraction as a risk factor for temporomandibular disorder. J Am Dent Assoc. 2006;137(11):1547-54. Epub 2006/11/04.

71. Plesh O, Gansky SA, Curtis DA, Pogrel MA. The relationship between chronic facial pain and a history of trauma and surgery. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 1999;88(1):16-21. Epub 1999/08/12.

72. Fillingim RB, Ohrbach R, Greenspan JD, Knott C, Dubner R, Bair E, et al. Potential psychosocial risk factors for chronic TMD: descriptive data and empirically identified domains from the OPPERA case-control study. J Pain. 2011;12(11 Suppl):T46-60. Epub 2011/12/07.

73. Macfarlane TV, Gray RJM, Kincey J, Worthington HV. Factors associated with the temporomandibular disorder, pain dysfunction syndrome (PDS): Manchester case-control study. Oral Dis. 2001;7(6):321-30.

74. Manfredini D, Winocur E, Ahlberg J, Guarda-Nardini L, Lobbezoo F. Psychosocial impairment in temporomandibular disorders patients. RDC/TMD axis II findings from a multicentre study. J Dent. 2010;38(10):765-72.

75. Quartana PJ, Buenaver LF, Edwards RR, Klick B, Haythornthwaite JA, Smith MT. Pain catastrophizing and salivary cortisol responses to laboratory pain testing in temporomandibular disorder and healthy participants. J Pain. 2010;11(2):186-94. Epub 2009/10/27.

76. Macfarlane TV, Kenealy P, Kingdon HA, Mohlin B, Pilley JR, Mwangi CW, et al. Orofacial pain in young adults and associated childhood and adulthood factors: results of the population study, Wales, United Kingdom. Community Dent Oral Epidemiol. 2009;37(5):438-50. Epub 2009/07/25.

77. Carlson CR, Okeson JP, Falace DA, Nitz AJ, Curran SL, Anderson D. Comparison of psychologic and physiologic functioning between patients with masticatory muscle pain and matched controls. J Orofac Pain. 1993;7(1):15-22. Epub 1993/01/01.

78. Manfredini D, Landi N, Bandettini Di Poggio A, Dell'Osso L, Bosco M. A critical review on the importance of psychological factors in temporomandibular disorders. Minerva Stomatol. 2003;52(6):321-6, 7-30.

79. Wirz S, Ellerkmann RK, Buecheler M, Putensen C, Nadstawek J, Wartenberg HC. Management of chronic orofacial pain: a survey of general dentists in german university hospitals. Pain Med. 2010;11(3):416-24.

80. Aggarwal VR, McBeth J, Zakrzewska JM, Lunt M, Macfarlane GJ. The epidemiology of chronic syndromes that are frequently unexplained: do they have common associated factors? Int J Epidemiol. 2006;35(2):468-76.

81. Fillingim RB, Ohrbach R, Greenspan JD, Knott C, Dubner R, Bair E, et al. Potential psychosocial risk factors for chronic TMD: descriptive data and empirically identified domains from the OPPERA case-control study. J Pain. 2011;12(11 Suppl):T46-60. Epub 2011/12/07.

82. Fillingim RB, Ohrbach R, Greenspan JD, Knott C, Diatchenko L, Dubner R, et al. Psychological factors associated with development of TMD: the OPPERA prospective cohort study. J Pain. 2013;14(12 Suppl):T75-90. Epub 2013/12/07.

83. Aggarwal VR, Macfarlane GJ, Farragher TM, McBeth J. Risk factors for onset of chronic oro-facial pain--results of the North Cheshire oro-facial pain prospective population study. Pain. 2010;149(2):354-9. Epub 2010/03/23.

84. Slade GD, Diatchenko L, Bhalang K, Sigurdsson A, Fillingim RB, Belfer I, et al. Influence of psychological factors on risk of temporomandibular disorders. J Dent Res. 2007;86(11):1120-5.

85. Nardi R, Scanelli G, Corrao S, Iori I, Mathieu G, Cataldi Amatrian R. Co-morbidity does not reflect complexity in internal medicine patients. Eur J Intern Med. 2007;18(5):359-68. Epub 2007/08/19.

86. Dominick CH, Blyth FM, Nicholas MK. Unpacking the burden: understanding the relationships between chronic pain and comorbidity in the general population. Pain. 2012;153(2):293-304. Epub 2011/11/11.

87. Plesh O, Adams SH, Gansky SA. Temporomandibular joint and muscle disorder-type pain and comorbid pains in a national US sample. J Orofac Pain. 2011;25(3):190-8. Epub 2011/08/13.

88. Plesh O, Adams SH, Gansky SA. Racial/Ethnic and gender prevalences in reported common pains in a national sample. J Orofac Pain. 2011;25(1):25-31.

89. Lipton RB, Bigal ME, Diamond M, Freitag F, Reed ML, Stewart WF. Migraine prevalence, disease burden, and the need for preventive therapy. Neurology. 2007;68(5):343-9.

90. Lipton RB, Stewart WF, Diamond S, Diamond ML, Reed M. Prevalence and burden of migraine in the United States: data from the American Migraine Study II. Headache. 2001;41(7):646-57. Epub 2001/09/14.

91. Stewart WF, Lipton RB, Celentano DD, Reed ML. Prevalence of migraine headache in the United States. Relation to age, income, race, and other sociodemographic factors. Jama. 1992;267(1):64-9.

92. Shimshak DG, Kent RL, DeFuria M. Medical claims profiles of subjects with temporomandibular joint disorders. Cranio. 1997;15(2):150-8.

93. Goncalves DA, Bigal ME, Jales LC, Camparis CM, Speciali JG. Headache and Symptoms of Temporomandibular Disorder: An Epidemiological Study. Headache. 2009.

94. Goncalves DA, Speciali JG, Jales LC, Camparis CM, Bigal ME. Temporomandibular symptoms, migraine, and chronic daily headaches in the population. Neurology. 2009;73(8):645-6.

95. Di Paolo C, Di Nunno A, Vanacore N, Bruti G. ID migraine questionnaire in temporomandibular disorders with craniofacial pain: a study by using a multidisciplinary approach. Neurol Sci. 2009;30(4):295-9.

96. Ballegaard V, Thede-Schmidt-Hansen P, Svensson P, Jensen R. Are headache and temporomandibular disorders related? A blinded study. Cephalalgia. 2008;28(8):832-41.

97. Oleson J. Classification and Diagnostic Criteria for Headache Disorders, Cranial Neuralgias, and Facial Pain. Cephalalgia. 1988;8(Supplement 7):1-64.

98. Dworkin SF, LeResche L. Research diagnostic criteria for temporomandibular disorders: review, criteria, examinations and specifications, critique. [Review]. Journal of Craniomandibular Disorders. 1992;6(4):302-55.

99. Olesen J. Some clinical features of the acute migraine attack. An analysis of 750 patients. Headache. 1978;18(5):268-71.

100. Schiffman E, Haley D, Baker C, Lindgren B. Diagnostic criteria for screening headache patients for temporomandibular disorders. Headache. 1995;35(3):121-4. Epub 1995/03/01.

101. Schiffman EL, Fricton JR, Haley DP, Shapiro BL. The prevalence and treatment needs of subjects with temporomandibular disorders. J Am Dent Assoc. 1990;120(3):295-303. Epub 1990/03/01.

102. Macfarlane TV, Gray RJM, Kincey J, Worthington HV. Factors associated with the temporomandibular disorder, pain dysfunction syndrome (PDS): Manchester case-control study. Oral Dis. 2001;7(6):321-30.

103. Ohrbach R, Fillingim RB, Mulkey F, Gonzalez Y, Gordon S, Gremillion H, et al. Clinical findings and pain symptoms as potential risk factors for chronic TMD: descriptive data and empirically identified domains from the OPPERA case-control study. J Pain. 2011;12(11 Suppl):T27-45. Epub 2011/12/07.

104. Goncalves DA, Bigal ME, Jales LC, Camparis CM, Speciali JG. Headache and Symptoms of Temporomandibular Disorder: An Epidemiological Study. Headache. 2009;50:231-41.

105. Goncalves DA, Camparis CM, Speciali JG, Franco AL, Castanharo SM, Bigal ME. Temporomandibular disorders are differentially associated with headache diagnoses: a controlled study. Clin J Pain. 2011;27(7):611-5. Epub 2011/03/04.

106. Nilsson IM, List T, Drangsholt M. Headache and Co-morbid Pains Associated with TMD Pain in Adolescents. J Dent Res. 2013. Epub 2013/07/03.

107. Anderson GC, John MT, Ohrbach R, Nixdorf DR, Schiffman EL, Truelove ES, et al. Influence of headache frequency on clinical signs and symptoms of TMD in subjects with temple headache and TMD pain. Pain. 2011;152(4):765-71.

108. LeResche L, Mancl LA, Drangsholt MT, Huang G, Von Korff M. Predictors of onset of facial pain and temporomandibular disorders in early adolescence. Pain. 2007;129(3):269-78.

109. Marklund S, Wiesinger B, Wanman A. Reciprocal influence on the incidence of symptoms in trigeminally and spinally innervated areas. Eur J Pain. 2010;14(4):366-71.

110. Wolfe F, Smythe HA, Yunus MB, Bennett RM, Bombardier C, Goldenberg DL, et al. The American College of Rheumatology 1990 Criteria for the Classification of Fibromyalgia. Report of the Multicenter Criteria Committee. Arthritis and rheumatism. 1990;33(2):160-72. Epub 1990/02/01.

111. Wolfe F, Clauw DJ, Fitzcharles MA, Goldenberg DL, Katz RS, Mease P, et al. The American College of Rheumatology preliminary diagnostic criteria for fibromyalgia and measurement of symptom severity. Arthritis care & research. 2010;62(5):600-10. Epub 2010/05/13.

112. Jahan F, Nanji K, Qidwai W, Qasim R. Fibromyalgia syndrome: an overview of pathophysiology, diagnosis and management. Oman medical journal. 2012;27(3):192-5. Epub 2012/07/20.

113. Wolfe F, Ross K, Anderson J, Russell IJ, Hebert L. The prevalence and characteristics of fibromyalgia in the general population. Arthritis and rheumatism. 1995;38(1):19-28. Epub 1995/01/01.

114. Aaron LA, Burke MM, Buchwald D. Overlapping conditions among patients with chronic fatigue syndrome, fibromyalgia, and temporomandibular disorder. Arch Intern Med. 2000;160(2):221-7.

115. Clauw DJ, Crofford LJ. Chronic widespread pain and fibromyalgia: what we know, and what we need to know. Best practice & research Clinical rheumatology. 2003;17(4):685-701. Epub 2003/07/10.

116. Lawrence RC, Felson DT, Helmick CG, Arnold LM, Choi H, Deyo RA, et al. Estimates of the prevalence of arthritis and other rheumatic conditions in the United States. Part II. Arthritis and rheumatism. 2008;58(1):26-35. Epub 2008/01/01.

117. Assumpcao A, Cavalcante AB, Capela CE, Sauer JF, Chalot SD, Pereira CA, et al. Prevalence of fibromyalgia in a low socioeconomic status population. BMC musculoskeletal disorders. 2009;10:64. Epub 2009/06/10.

118. Velly AM, Look JO, Schiffman E, Lenton PA, Kang W, Messner RP, et al. The effect of fibromyalgia and widespread pain on the clinically significant temporomandibular muscle and joint pain disorders--a prospective 18-month cohort study. J Pain. 2010;11(11):1155-64. Epub 2010/05/15.

119. Macfarlane TV, Blinkhorn AS, Davies RM, Kincey J, Worthington HV. Predictors of outcome for orofacial pain in the general population: a four-year follow-up study. J Dent Res. 2004;83(9):712-7.

120. Balasubramaniam R, de Leeuw R, Zhu H, Nickerson RB, Okeson JP, Carlson CR. Prevalence of temporomandibular disorders in fibromyalgia and failed back syndrome patients: a blinded prospective comparison study. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2007;104(2):204-16.

121. De Laat A MH, Stevens A, Verbeke G. Correlation between cervical spine and temporomandibular disorders. Clin Oral Investig. 1998;2:54-7.

122. Aaron LA, Burke MM, Buchwald D. Overlapping conditions among patients with chronic fatigue syndrome, fibromyalgia, and temporomandibular disorder. Arch Intern Med. 2000;160(2):221-7.

123. Visscher CM, Lobbezoo F, de Boer W, van der Zaag J, Naeije M. Prevalence of cervical spinal pain in craniomandibular pain patients. Eur J Oral Sci. 2001;109(2):76-80. Epub 2001/05/12.

124. Wiesinger B, Malker H, Englund E, Wanman A. Back pain in relation to musculoskeletal disorders in the jaw-face: a matched case-control study. Pain. 2007;131(3):311-9.

125. Koepsell TD, Weiss NS. Epedemiologic methods : studying the occurrence of illness. Second edition. ed. p. p.

126. Myers S, Kaimal S, Springsteen J, Ferreira J, Ko CC, Fricton J. Development of a National TMJ Implant Registry and Repository-- NIDCR's TIRR. Northwest Dent. 2007;86(6):13-8. Epub 2008/02/05.

127. Von Korff M, Ormel J, Keefe FJ, Dworkin SF. Grading the severity of chronic pain. Pain. 1992;50(2):133-49. Epub 1992/08/01.

128. Rothman KJ. Epidemiology : an introduction. New York, N.Y.: Oxford University Press; 2002. viii, 223 p. p.

129. Hosmer DW, Lemeshow S. Applied logistic regression. New York: Wiley; 1989. xiii, 307 p. p.

130. Dworkin SF, LeResche L. Research diagnostic criteria for temporomandibular disorders: review, criteria, examinations and specifications, critique. J Craniomandib Disord. 1992;6(4):301-55. Epub 1992/01/01.

131. Ohrbach R, Fillingim RB, Mulkey F, Gonzalez Y, Gordon S, Gremillion H, et al. Clinical findings and pain symptoms as potential risk factors for chronic TMD: descriptive data and empirically identified domains from the OPPERA case-control study. J Pain. 2011;12(11 Suppl):T27-45.

132. Franco AL, Goncalves DA, Castanharo SM, Speciali JG, Bigal ME, Camparis CM. Migraine is the most prevalent primary headache in individuals with temporomandibular disorders. J Orofac Pain. 2010;24(3):287-92. Epub 2010/07/29.

133. Olesen J. The international classification of headache disorders. 2nd edition (ICHD-II). Rev Neurol (Paris). 2005;161(6-7):689-91. Epub 2005/09/06.

134. Nilsson IM, List T, Willman A. Adolescents with temporomandibular disorder pain-the living with TMD pain phenomenon. J Orofac Pain. 2011;25(2):107-16.

135. Macfarlane TV, Kenealy P, Kingdon HA, Mohlin B, Pilley JR, Mwangi CW, et al. Orofacial pain in young adults and associated childhood and adulthood factors: results of the population study, Wales, United Kingdom. Community Dent Oral Epidemiol. 2009;37(5):438-50.

136. Ciancaglini R, Radaelli G. The relationship between headache and symptoms of temporomandibular disorder in the general population. J Dent. 2001;29(2):93-8.

137. Goncalves DA, Camparis CM, Speciali JG, Franco AL, Castanharo SM, Bigal ME. Temporomandibular disorders are differentially associated with headache diagnoses: a controlled study. Clin J Pain. 2011;27(7):611-5.

138. Dao TT, Reynolds WJ, Tenenbaum HC. Comorbidity between myofascial pain of the masticatory muscles and fibromyalgia. J Orofac Pain. 1997;11(3):232-41.

139. Plesh O, Wolfe F, Lane N. The relationship between fibromyalgia and temporomandibular disorders: prevalence and symptom severity. J Rheumatol. 1996;23(11):1948-52.

140. Leblebici B, Pektas ZO, Ortancil O, Hurcan EC, Bagis S, Akman MN. Coexistence of fibromyalgia, temporomandibular disorder, and masticatory myofascial pain syndromes. Rheumatol Int. 2007;27(6):541-4.

141. Korszun A, Papadopoulos E, Demitrack M, Engleberg C, Crofford L. The relationship between temporomandibular disorders and stress-associated syndromes. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 1998;86(4):416-20.

142. Turp JC, Kowalski CJ, O'Leary N, Stohler CS. Pain maps from facial pain patients indicate a broad pain geography. J Dent Res. 1998;77(6):1465-72.

143. Aaron LA, Buchwald D. A review of the evidence for overlap among unexplained clinical conditions. Ann Intern Med. 2001;134(9 Pt 2):868-81.

144. Rhodus NL, Fricton J, Carlson P, Messner R. Oral symptoms associated with fibromyalgia syndrome. J Rheumatol. 2003;30(8):1841-5.

145. Lim PF, Smith S, Bhalang K, Slade GD, Maixner W. Development of temporomandibular disorders is associated with greater bodily pain experience. Clin J Pain. 2010;26(2):116-20.

146. Hennekens CH, Buring JE. Epidemiology in Medicine. 1st ed. Mayrent SL, editor: Lippincott Williams & Wlikins 1987.

147. Miettinen OS. The "case-control" study: valid selection of subjects. Journal of chronic diseases. 1985;38(7):543-48. Epub 1985/01/01.

148. Wacholder S, Silverman DT, McLaughlin JK, Mandel JS. Selection of controls in case-control studies. II. Types of controls. American journal of epidemiology. 1992;135(9):1029-41. Epub 1992/05/01.

149. Armitage P, Colton T. Bias in Case-Control Studies. Encycl. Biostat. Chichester, UK: John Wiley & Sons, Ltd; 2005.

150. Rothman KJ. Modern epidemiology. 1st ed. Boston: Little, Brown; 1986. xvi, 358 p. p.

9. APPENDIX

(Consent form, Examination form and Medical Questionnaire)

National Institute of Dental and Craniofacial Research
TMJ Implant Registry & Repository (NIDCR's TIRR)

CONSENT TO PARTICIPATE

You are invited to participate in a data and tissue registry and repository related to temporomandibular joint dysfunction (TMD). You were selected as a possible participant because you 1) have a past or current history of TMD, 2) have had or will have temporomandibular joint (TMJ) surgery, or 3) have had or currently have a TMJ implant. We ask that you read this form and ask any questions you may have before agreeing to be a participant in NIDCR's TIRR.

This project is being conducted by James R. Fricton, DDS, MS; Sandra L. Myers, DMD; John O. Look, DDS, MPH, PhD; and Ana Velly DDS, PhD in the Department of Diagnostic & Biological Sciences at the University of Minnesota School of Dentistry. It is funded by the National Institute of Dental & Craniofacial Research (NIDCR) at the National Institutes of Health (NIH).

Project Purpose:
Many different treatments have been recommended for people with TMD including medications, splints, physical therapy, dental treatment and surgery. Implants have sometimes been used to support or replace the moving parts of the joint. For some people, these implants have caused problems that have necessitated their removal. The disease process of TMD and causes of failure of TMJ implants are not well understood.

The purpose of NIDCR's TIRR is to create a national database to centralize medical information, biological tissues, and retrieved TMJ implants. Information and biological specimens will then be made available to researchers. Studies using these materials will lead to a better understanding of TMD and improved treatment outcomes.

Project Procedures:
If you agree to participate in this project, you will be asked to do the following:

1. Complete an initial registration, medical history, and questionnaire. These initial forms will take approximately 40 – 60 minutes to complete.

2. Allow NIDCR's TIRR to contact you to complete follow-up questionnaires.

3. Give permission to NIDCR's TIRR to obtain and transfer information from your health records and/or data from previous studies.

4. Undergo a clinical examination to evaluate your temporomandibular joint.

Benefits of Participation:
The direct benefit of participation in this project is that you will have access to a private, electronic record of your TMJ health information.

Additionally, your participation benefits TMJ research because the use of your medical information will enable researchers to learn more about factors involved in the success of TMJ treatments including

implants and surgical or non-surgical therapy. This information may be valuable in preventing and treating adverse reactions to implants and ultimately in the design of new implant materials.

Risks of Participation:
There is a risk associated with the release of private information from your health records. NIDCR's TIRR follows all confidentiality guidelines to ensure the protection of your privacy. See the "Confidentiality" portion of this consent form for details on how your private information is protected.

Compensation:
You will receive no compensation for your participation in this project.

Participation Related Injury:
In the event that your participation in this project results in an injury, treatment will be available including first-aid, emergency treatment and follow-up care as needed. Care for such injuries will be billed in the ordinary manner to you or your insurance company. If you think that you have suffered an injury related to participation in this project, let the project staff know right away.

Confidentiality:
All records and private information obtained by NIDCR's TIRR will be kept private. Data is maintained on a secure website at the University of Minnesota. All identifying information will be removed from your data before it is released to researchers. A research code will be assigned to this information so that the researcher cannot link it to you. You will be asked to sign a separate Patient Information Release form in order for NIDCR's TIRR to obtain information from your past health records. In any publications or presentations, no information will be used that would make it possible to identify you as a participant. Your record for this project may be reviewed by the NIDCR, the Food and Drug Administration, and departments at the University of Minnesota with appropriate regulatory oversight. Due to the necessity of gathering information from your doctor or past records, this data may be faxed or transmitted to NIDCR's TIRR via the Internet. Every attempt will be made to protect you and your information transmission via the secure Academic Health Center website. To these extents, confidentiality is not absolute.

Protected Health Information (PHI):
Your PHI created or received for the purposes of this project is protected under the federal regulation known as HIPAA. Refer to the attached HIPAA authorization for details concerning the use of this information.

Voluntary Nature of the Project:
Participation in this project is voluntary. Your decision whether or not to participate will not affect your current or future relations with the University of Minnesota or your doctor/surgeon. If you decide to participate, you are free to withdraw at any time without affecting those relationships. If you choose to withdraw from this project, you will not be contacted by NIDCR's TIRR any more, and all information identifying you will be destroyed. Your specimens will remain the property of NIDCR's TIRR and will not be returned to you, though we will destroy the identifying link to your specimen. You should contact the project staff person listed in this consent form to withdraw from NIDCR's TIRR.

Contacts and Questions:
The person describing this project to you is available to answer any questions you have now or in the future. Also, **you are encouraged to** contact the Program Director, Dr. James R. Fricton, at 612-626-

4744 for any additional questions. You may contact NIDCR's TIRR in writing or in person at the University of Minnesota School of Dentistry, 7-546 Moos Tower, 515 Delaware St. SE, Minneapolis, MN 55455.

If you have any questions or concerns regarding the project and would like to talk to someone other than the researcher(s), **you are encouraged to** contact the Fairview Research Helpline at telephone number 612-672-7692 or toll free at 866-508-6961. You may also contact this office in writing or in person at the University of Minnesota Medical Center, Fairview-Riverside Campus, #815 Professional Building, 2450 Riverside Avenue, Minneapolis, MN 55454.

If you are interested in results from this project or publications by researchers involved in NIDCR's TIRR, this information will be listed on the project's website: http://tmjregistry.org.

Personnel from this project may contact you to invite you to participate in other studies. If you do not wish to be contacted, please inform the project staff at 612-626-4744.

You will be given a copy of this form to keep for your records.

Statement of Consent:
I have read the above information. I have asked questions and have received answers. I agree to participate in NIDCR's TIRR.

_____ _____
Signature of Subject Date

_____ _____
Signature of Person Obtaining Consent Date

HIPAA[1] AUTHORIZATION TO USE AND DISCLOSE INDIVIDUAL HEALTH INFORMATION FOR RESEARCH PURPOSES

1. Purpose. As a research participant, I authorize **Dr. James Fricton** and the researcher's staff to use and disclose my individual health information for the purpose of conducting the research project entitled National Institutes of Dental and Craniofacial Research's TMJ Implant Registry and Repository (NIDCR'sTIRR). **Human Subjects' Code: 0210M33782**

2. Individual Health Information to be Used or Disclosed. My individual health information that may be used or disclosed to conduct this research includes: Demographic information, results of physical exams, x-rays diagnostic and medical procedures as well as medical history.

3. Parties Who May Disclose My Individual Health Information. The researcher and the researcher's staff may obtain my individual health information from:
Hospitals: _____
Clinics: _____
Other Providers: _____

4. Parties Who May Receive or Use My Individual Health Information. The individual health information disclosed by parties listed in item 3 and information disclosed by me during the course of the research may be received and used by Dr. James Fricton and the researcher staff, the National Institute of Health/NIDCR and the FDA.

5. Right to Refuse to Sign this Authorization. I do not have to sign this Authorization. If I decide not to sign the Authorization, I may not be allowed to participate in this study or receive any research related treatment that is provided through the study. However, my decision not to sign this authorization will not affect any other treatment, payment, or enrollment in health plans or eligibility for benefits.

6. Right to Revoke. I can change my mind and withdraw this authorization at any time by sending a written notice to Dr. James Fricton at the University of Minnesota School of Dentistry/Division of TMJ and Orofacial Pain, 6-320 Moos Tower, 515 Delaware St. S.E., Minneapolis, MN 55455 to inform the researcher of my decision. If I withdraw this authorization, the researcher may only use and disclose the protected health information already collected for this research study. No further health information about me will be collected by or disclosed to the researcher for this study.

7. Potential for Re-disclosure. Once my health information is disclosed under this authorization, there is a potential that it will be re-disclosed outside this study and no longer covered by this authorization. However, the research team and the University's Institutional Review Board (the committee that reviews studies to be sure that the rights and safety of study participants are protected) are very careful to protect your privacy and limit the disclosure of identifying information about you.

8. Also, there are other laws that may require my individual health information to be disclosed for public purposes. Examples include potential disclosures if required for mandated reporting of abuse or neglect, judicial proceedings, health oversight activities and public health measures.

This authorization does not have an expiration date.
I am the research participant or personal representative authorized to act on behalf of the participant.
I have read this information, and I will receive a copy of this authorization form after it is signed.

_____	_____
signature of research participant or research participant's personal representative	date
_____	_____
printed name of research participant or research participant's personal representative	description of personal representative's authority to act on behalf of the research participant

[1] HIPAA is the Health Insurance Portability and Accountability Act of 1996, a federal law related to privacy of health information.

NIDCR'S TIRR PATIENT REGISTRATION FORM

1. Patient Name: (Last, First, MI)	2. Birth Date (MM/DD/YY)	3. Sex □ M □ F

4. Address (Street)	Apt No.	City	State	Country	Zip

5. Home Phone	6. E-mail	7. Spouse Name (Last, First, MI)

8. Employer's Name	City	State	Work Phone

9. Person to Notify in an Emergency	City	State	Phone

10. Name of Relative Not Living With You	City	State	Phone

11. Ethnicity: (please choose only one)	12. Racial Group: (you may choose more than one)	
□ Hispanic or Latino	□ American Indian or Alaska Native	□ Asian
□ Not Hispanic or Latino	□ Native Hawaiian or Other Pacific Islander	□ White
□ Unknown	□ Black or African American	□ Unknown or unlisted

13. Marital Status: □ Single/Never Married □ Single/Divorced □ Married □ Widowed □ Separated □ No Answer

14. Primary Occupation	15. Number of Children: Ages of Female Children: Ages of Male Children:

16. PRIMARY JOB STATUS In the Past Month (check only one)		17. EDUCATIONAL LEVEL (last year completed)
□ Employed fulltime	□ Employed part time	□ No formal education
□ Fulltime student and not employed	□ Fulltime homemaker	□ High school
□ Have a job but am on unpaid leave	□ Retired and not employed	□ Vocational technical school
□ Have a job but am on paid leave	□ Unemployed	□ College
□ Disabled due to health problems	□ Other _____	□ Graduate school
		□ Post graduate

18. Are you receiving or applying for any DISABILITY INCOME? □ Yes □ No

If so, what type (list all that apply)?

□ None	□ Social security disability	□ Worker compensation.
□ Long term assistance	□ General assistance	□ Private insurance
□ Veterans	□ Other_____	

19. Referring Doctor Name	Specialty	Address	Phone	E-Mail

20. Primary Physician Name	Specialty	Address	Phone	E-Mail

21. Primary Dentist Name	Address	Phone	E-Mail

22. Primary Pharmacy Name	Address	Phone	E-Mail

TIRR Examination

Patient Name:	Date:	Examiner:

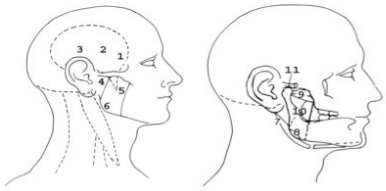
Mandibular Range of Motion

1. Incisal overlap and midline deviation of lower incisor	☐ Right (#8) or ☐ Left (#9) __ mm vertical __ mm horizontal __ mm deviation ☐To right ☐To left		
2. Incisal pattern on opening (deviation ≥ 5mm)	☐ Straight ☐ Uncorrected to right ☐ Uncorrected to left ☐ Corrected(S) ☐ Other:		
3. Unassisted opening without pain	__ mm		
4. Maximum unassisted opening (by patient)	__ mm		
Pain?	☐ no	☐ joint ☐ Rt ☐ Lt	☐ muscle ☐ Rt ☐ Lt
5. Maximum assisted opening (with stretch)	__ mm		
Pain?	☐ no	☐ joint ☐ Rt ☐ Lt	☐ muscle ☐ Rt ☐ Lt
6. Right lateral excursion	__ mm		
Pain?	☐ no	☐ joint ☐ Rt ☐ Lt	☐ muscle ☐ Rt ☐ Lt
7. Left lateral excursion	__ mm		
Pain?	☐ no	☐ joint ☐ Rt ☐ Lt	☐ muscle ☐ Rt ☐ Lt
8. Protrusion	__ mm		
Pain?	☐ no	☐ joint ☐ Rt ☐ Lt	☐ muscle ☐ Rt ☐ Lt

TMJ Examination

1. TMJ movement on opening	Right:	☐ normal	☐ limited	☐ closed lock ☐ locks open
	Left:	☐ normal	☐ limited	☐ closed lock ☐ locks open
2. TMJ lateral pole tenderness		☐ none	☐ on right	☐ on left ☐ both
3. TMJ sounds on right	opening click or pop:	☐ none	☐ reproducible	☐ non-reproducible
	closing click or pop:	☐ none	☐ reproducible	☐ non-reproducible
	crepitus:	☐ none	☐ fine	☐ coarse
	Is click eliminated on protrusive opening?	☐ no	☐ yes	
4. TMJ sounds on left	opening click:	☐ none	☐ reproducible	☐ non-reproducible
	closing click:	☐ none	☐ reproducible	☐ non-reproducible
	crepitus:	☐ none	☐ fine	☐ coarse
	Is click eliminated on protrusive opening?	☐ no	☐ yes	

Tenderness of Muscles



Right Side Yes	No	Dupl		Left Side Yes	No	Dupl
☐	☐	☐	1. Anterior Temporalis	☐	☐	☐
☐	☐	☐	2. Middle Temporalis	☐	☐	☐
☐	☐	☐	3. Posterior Temporalis	☐	☐	☐
☐	☐	☐	4. Origin of the Masseter	☐	☐	☐
☐	☐	☐	5. Body of the Masseter	☐	☐	☐
☐	☐	☐	6. Insertion of Masseter	☐	☐	☐
☐	☐	☐	7. Posterior Mandibular	☐	☐	☐
☐	☐	☐	8. Submandibular Area	☐	☐	☐

Occlusal Examination

1. Missing teeth and not permanently replaced	Right:	01 02 03 04 05 06 07 08		09 10 11 12 13 14 15 16	
	Left:	32 31 30 29 28 27 26 25		24 23 22 21 20 19 18 17	
2. Dentures	Maxillary:	☐ none	☐ complete	☐ partial	
	Mandibular:	☐ none	☐ complete	☐ partial	
	Edentulous:	☐ no dentures			
3. Angle classification	Right:	☐ I	☐ II.1	☐ II.2	☐ III
	Left:	☐ I	☐ II.1	☐ II.2	☐ III
4. Cross bite	Right:	☐ none	☐ both	☐ anterior only	☐ posterior only
	Left:	☐ none	☐ both	☐ anterior only	☐ posterior only
5. Open bite	Right:	☐ none	☐ both	☐ anterior only	☐ posterior only
	Left:	☐ none	☐ both	☐ anterior only	☐ posterior only
6. Additional items:					

Updated 2/22/06

Diagnosis (check all that apply)

R L Joint Disorders	Muscle Disorders	Neuropathic
☐ ☐ TMJ Ankylosis and Adhesions 524.61	☐ Muscle Spasm 728.85	☐ Trigeminal Neuralgia 350.1
☐ ☐ TMJ Arthralgia and Inflammation 524.62	☐ Myofascial Pain: Masticatory 729.1	☐ Atypical Face Pain 350.2
☐ ☐ TMJ Disc Disorder (reducing) 524.63	☐ Myofascial Pain: Cervical 729.1	☐ Glossodynia/ Burning Mouth 529.6
☐ ☐ TMJ Disc Disorder (non-reducing) 524.63	☐ Fibromyalgia/Chronic fatigue 729.1	Other
☐ ☐ TMJ Dislocated Jaw, closed lock 830.00	Headache	☐ Orofacial Dyskinesia 333.82
☐ ☐ TMJ Dislocated Jaw, open lock 830.10	☐ Migraine with Aura 346.0	☐ Bruxism/Teeth Grinding 306.8
☐ ☐ TMJ Osteoarthritis, local & 1° 715.18	☐ Migraine without Aura 346.1	☐ Psychological Factors 316.0
☐ ☐ TMJ Rheumatoid Arthritis 715.00	☐ Cluster Headache 346.2	☐ Anomalies of Jaw Size 524.00
☐ ☐ TMJ Traumatic Arthropathy 716.18	☐ Tension-Type Headache 307.81	☐ List:
☐ ☐ TMJ Strain/Sprain from Overuse 848.1	☐ Rebound/Transformed 784.0	_____
☐ ☐ TMJ Implant Failure 524.61		
☐ ☐ TMJ Tumor Benign 213.1		
☐ ☐ TMJ Tumor Other: _____		

Recommendations

Imaging	☐ Bone Scan ☐ MR Scan of Brain ☐ Other:	☐ CT Scan ☐ MR Scan of TMJ	☐ Panorex ☐ Tomograms
Self Care	☐ Exercise ☐ Palliative	☐ Oral Habits ☐ Other:	☐ Pain Diary
Splint/Orthotic	☐ Mandibular Flat ☐ Other:	☐ Maxillary Flat	☐ Repositioning
Medication	☐ Anti-Inflammatory ☐ Neuropathic ☐ Other:	☐ Muscle Relaxant ☐ Sedative	☐ Opioid ☐ Tricyclic
Physical Therapy	☐ Post Surgical ☐ Modality:_____ per wk for ____ wks ☐ Exercise: ☐ Postural ☐ 6 by 6 ☐ Stretching ☐ Relaxation ☐ Conditioning	☐ Evaluate and Treat	
Behavioral Health	☐ Chemical Dependency ☐ Occupational ☐ Stress Management ☐ Other:	☐ Depression/Anxiety ☐ Relaxation/Biofeedback ☐ Team Synthesis	☐ Oral Habit Reversal ☐ Sleep Management
Injections	☐ Botox ☐ Trigger Point Injection:	☐ Nerve Block	☐ TMJ Injections:
TMJ Surgery	☐ Arthrocentesis/Lysis/Lavage ☐ Arthroscopy Lysis & Lavage ☐ Discectomy ☐ Total Joint Implant ☐ Adv. TMJ Arthroscopy w/ ☐ Sup. Lat. Pterygoid Myotomy ☐ Exc. of Fibullated Cartilage ☐ Laser Synovectomy ☐ Arthroscopic Disc Suturing DATE OF FUTURE SURGERY: _____	☐ Athroplasty ☐ Disc Repair ☐ Implant Surgery	☐ Arthroscopy ☐ Disc Repositioning ☐ Laser Repair
Implant Surgery If Applicable	☐ Implant Removed ☐ Implant Placed ☐ Right ☐ Left Type of Implant: ☐ Endotec ☐ Kent/Vitek® ☐ Christensen/TMJ: Stock ☐ Christensen/TMJ: Custom ☐ Lorenz/Biomet		☐ Proplast® ☐ Silicone/Silastic® ☐ Techmedica/TMJ Concepts ☐ Other:
Other			

Dr:	Date:

OFFICE VISIT FOR ESTABLISHED PATIENT

Patient Name	Referring Dr.
Personal info.	insurer:
Date: visit number:	

SUBJECTIVE

Symptoms? ☐ much improved ☐ improved ☐ same ☐ worse

Splint use? ☐ Good ☐ Problem:

Exercises? ☐ Good ☐ Problem:

	First Visit			Last Visit			Today		
Chief Complaints	Sev	Freq	Dur	Sev	Freq	Dur	Sev	Freq	Dur
1.									
2.									
3.									
4.									
5.									

CONTRIBUTING FACTORS

	First visit	Last Visit	Today
Stress:	☐better ☐worse ☐same	☐better ☐worse ☐same	☐better ☐worse ☐same
Comments			
Bruxism:	☐better ☐worse ☐same	☐better ☐worse ☐same	☐better ☐worse ☐same
Comments			
Clenching of teeth:	☐better ☐worse ☐same	☐better ☐worse ☐same	☐better ☐worse ☐same
Comments			
Sleep problems:	☐better ☐worse ☐same	☐better ☐worse ☐same	☐better ☐worse ☐same
Comments			
Diet	☐better ☐worse ☐same	☐better ☐worse ☐same	☐better ☐worse ☐same
Comments			
Caffeine:	☐better ☐worse ☐same	☐better ☐worse ☐same	☐better ☐worse ☐same
Comments			
Posture:	☐better ☐worse ☐same	☐better ☐worse ☐same	☐better ☐worse ☐same
Comments			
Depression:	☐better ☐worse ☐same	☐better ☐worse ☐same	☐better ☐worse ☐same
Comments			
Anxiety:	☐better ☐worse ☐same	☐better ☐worse ☐same	☐better ☐worse ☐same
Comments			
Pacing/ hurrying:	☐better ☐worse ☐same	☐better ☐worse ☐same	☐better ☐worse ☐same
Comments			

MEDICAL HISTORY AND REVIEW OF SYSTEMS

Blood Pressure/ Pulse:			
Review of Systems	☐ no chg ☐ chg	☐ no chg ☐ chg	☐ no chg ☐ chg
Medical History	☐ no chg ☐ chg:	☐ no chg ☐ chg:	☐ no chg ☐ chg:
Personal /Family History	☐ no chg ☐ chg:	☐ no chg ☐ chg:	☐ no chg ☐ chg:
Medications List:	☐ no chg ☐ chg:	☐ no chg ☐ chg:	☐ no chg ☐ chg:

OBJECTIVE EXAMINATION

	First Visit	Last Visit	Today
1. Incisal ROM: Unassisted			
2. Incisal ROM: Assisted stretch			
3. Jaw deviation on opening	☐ Straight ☐ To right ☐ to Left ☐ Corrected	☐ Straight ☐ To right ☐ to Left ☐ Corrected	☐ Straight ☐ To right ☐ to Left ☐ Corrected
4. Pain in full range of motion?	☐ None ☐ Muscle ☐ Joint	☐ None ☐ Muscle ☐ Joint	☐ None ☐ Muscle ☐ Joint
5. Muscle Tenderness	Right Left	Right Left	Right Left
Temporalis (any site)……	☐yes ☐No ☐yes ☐No	☐yes ☐No ☐yes ☐No	☐yes ☐No ☐yes ☐No
Masseter (Any site)……	☐yes ☐No ☐yes ☐No	☐yes ☐No ☐yes ☐No	☐yes ☐No ☐yes ☐No
Posterior Mandibular……	☐yes ☐No ☐yes ☐No	☐yes ☐No ☐yes ☐No	☐yes ☐No ☐yes ☐No
Posterior Cervical……	☐yes ☐No ☐yes ☐No	☐yes ☐No ☐yes ☐No	☐yes ☐No ☐yes ☐No
6. TMJ tenderness	☐yes ☐No ☐yes ☐No	☐yes ☐No ☐yes ☐No	☐yes ☐No ☐yes ☐No
7. TMJ Limited Translation	☐yes ☐No ☐yes ☐No	☐yes ☐No ☐yes ☐No	☐yes ☐No ☐yes ☐No
8. TMJ Noise	☐yes ☐No ☐yes ☐No	☐yes ☐No ☐yes ☐No	☐yes ☐No ☐yes ☐No
9. Splint wear facets?		☐ Yes ☐ No	☐ Yes ☐ No
10. Change in bite?		☐ Yes ☐ No	☐ Yes ☐ No

DIAGNOSIS

Primary Diagnosis:	Secondary Diagnoses:
1)	1)
2)	2)
3)	3)
4)	4)

Joint Disorders	Muscle Disorders	Neuropathic
TMJ Ankylosis and adhesions 524.61	Muscle Spasm 728.85	Trigeminal Neuralgia 350.1
TMJ Arthralgia and Inflammation 524.62	Myofascial Pain/ Myositis Mast.729.1	Atypical Face Pain 350.2
TMJ Disc Disorder(reducing) 524.63	Myofascial Pain/ Myositis Cervical 729.1	Glossodynia/ Burning Mouth 529.6
TMJ Disc Disorder(non-reducing) 524.63	Fibromyalgia/ Chronic fatigue 729.1	
TMJ Dislocated Jaw, closed lock 830.00		Other
TMJ Dislocated Jaw, open lock 830.10	Headache	Orofacial Dyskinesia 333.82
TMJ Osteoarthritis, local & 1° 715.18	Migraine with aura 346.0	Bruxism/Teeth Grinding 306.8
TMJ Rheumatoid arthritis 715.00	Migraine without aura 346.1	Psychological Factors assoc. w/ disease 316.0
TMJ Traumatic arthropathy 716.18	Cluster Headache 346.2	Anomalies of Jaw Size 524.00
TMJ Strain/ sprain from overuse 848.1	Tension-Type Headache 307.81	
	Rebound/ transformed 784.0	

TODAYS TREATMENT/ COUNSELING/ COORDINATION OF CARE

- ☐ Reviewed Diagnosis/ Treatment/ Risk/ Prognosis
- ☐ Reviewed Imaging/ Labs
- ☐ Reviewed Contributing Factors
- ☐ Reviewed Exercises: ☐ Jaw ☐ neck ☐ conditioning ☐ posture # ____ per day
- ☐ Reviewed Relaxation/ Habit Reversal: #____ per day
- ☐ Splint: ☐ impressions ☐ insert ☐ adjustment
- ☐ Injections:
- ☐ Rx for Medications:

Todays total appointment time: min. Total counsel time: min

FUTURE RECOMMENDATIONS

- ☐ Continue with current treatment
- ☐ Imaging:
- ☐ Physical Therapy:
- ☐ Health Psychology:
- ☐ Consults:
- ☐ Dental Care:
- ☐ Other;
- ☐ F/U in weeks: with:

I personally took a history from this patient and reviewed the studies and discussed with the patient my assessment and plan.

Signed Staff Dr: Signed Resident: Date:

NIDCR'S TIRR PATIENT REGISTRATION FORM

1. Patient Name: (Last, First, MI)	2. Social Security No.	3. Birth Date (MM/DD/YY)	4. Sex □ M □ F

5. Address (Street)	Apt No.	City	State	Country	Zip

6. Home Phone	7. E-mail	8. Spouse Name (Last, First, MI)

9. Employer's Name	City	State	Work Phone

10. Person to Notify in an Emergency	City	State	Phone

11. Name of Relative Not Living With You	City	State	Phone

12. Ethnicity: (please choose only one)

□ Hispanic or Latino
□ Not Hispanic or Latino
□ Unknown

13. Racial Group: (you may choose more than one)

□ American Indian or Alaska Native
□ Native Hawaiian or Other Pacific Islander
□ Black or African American
□ Asian
□ White
□ Unknown or unlisted

14. Marital Status: □ Single/Never Married □ Single/Divorced □ Married □ Widowed □ Separated □ No Answer

15. Primary Occupation

16. Number of Children:
Ages of Female Children:
Ages of Male Children:

17. PRIMARY JOB STATUS In the Past Month (check only one)

□ Employed fulltime
□ Fulltime student and not employed
□ Have a job but am on unpaid leave
□ Have a job but am on paid leave
□ Disabled due to health problems
□ Employed part time
□ Fulltime homemaker
□ Retired and not employed
□ Unemployed
□ Other _____

18. EDUCATIONAL LEVEL (last year completed)

□ No formal education
□ High school
□ Vocational technical school
□ College
□ Graduate school
□ Post graduate

19. Are you receiving or applying for any DISABILITY INCOME? □ Yes □ No

If so, what type (list all that apply)?

□ None
□ Long term assistance
□ Veterans
□ Social security disability
□ General assistance
□ Other_____
□ Worker compensation.
□ Private insurance

20. Referring Doctor Name	Specialty	Address	Phone	E-Mail

21. Primary Physician Name	Specialty	Address	Phone	E-Mail

22. Primary Dentist Name	Address	Phone	E-Mail

23. Primary Pharmacy Name	Address	Phone	E-Mail

PATIENT INFORMATION

24. Primary Insurance Company Name	**Address**			**Phone**
	Member/Claim #	**Group #**	**Subscriber**	**Relation to Patient**
25. Secondary Insurance Company Name	**Address**			**Phone**
	Member/Claim #	**Group #**	**Subscriber**	**Relation to Patient**
26. Name of Work/Car insurance (if accident was involved)	**Address**			**Phone**
	Member/Claim #	**Group #**	**Subscriber**	**Relation to Patient**
27. Person Responsible for the Bill	**Name**	**Address**		**Phone**
28. Attorney Name (if you have one)	**Address**			**Phone**
	Claim Representative		**Date of Injury**	

While you are a patient here, you will be asked to give certain information about your dental problems, medical history, your response to care you have received, and related information that is needed to assist in identifying and treating your problem(s). The dentists or staff who work with you will also make notes on their observations of you, and all this information will be recorded in your chart. Other information regarding fees incurred, and payments of such fees shall also be maintained as part of your record. This information is intended for use in your examination, diagnosis, and treatment, but may also be reviewed by others for a variety of purposes. Your records may be reviewed as part of the educational or research purposes to identify new or better ways to treat problems of the head, neck, and related structures. They may also be reviewed as part of general survey of patient care to assure standards of high quality service and financial integrity. In all cases, other than those where you have specifically authorized the release of your records, your identity and personal health record will be maintained in the strictest confidence by those authorized to review records.

PATIENT AGREEMENT **Please seek assistance if you do not understand any terms of this agreement**

1. I hereby authorize the doctors and staff working under their supervision, to perform ordinary diagnostic procedures, including x-rays and photographs, to determine the general nature of my dental problems.
2. I understand that the benefits, alternatives, discomforts and risks relating to my treatment will be explained to me in terms that I understand and properly annotated in my chart using appropriate consent forms BEFORE treatment is initiated.
3. I permit the doctors or staff to review my dental record for possible participation in dental research. I understand that someone may contact me to request my participation and that appropriate consent will be obtained before I become involved in the study.
4. I permit the your clinic to photograph or record all or part of my treatment or clinical records for publication in scientific journals or for teaching purposes by the staff or students concerned, provided this material is not identified with me by name, recognition, or otherwise.
5. I authorize the your clinic to utilize all tissues, including teeth, removed during the course of treatment for educational and research purposes in accordance with current tissue policies and regulations concerning the use of human subjects in research.
6. I understand that I must authorize in writing, the copying and distribution of any portion of my health record to any person or agency outside the Clinic with the exception of third party payers. I understand there may be an additional fee for this service.

I have read and understand all of the above. I have crossed out and initialed any statement (1 through 7) to which I do not agree. I further understand that I may withdraw my consent to specific treatment of activities without prejudice to alternative treatment or continuing care.

Patient/Guarantor Signature _____ Date_____

AUTHORIZATION FOR RELEASE OF INFORMATION (All patients/guarantors must sign)

I certify that the above information is correct. I authorize the Clinic to use and release dental, medical or financial information to other parties who have an implicit "right to know" due to my use of their services. This includes insurance companies and state agencies. I understand that no other information related to my treatment or health status will be released without my written consent. I understand and agree to the terms and conditions of the payment policy described above. I agree to pay this account, when due, in accordance with Clinic and State/Federal Agency policies covering the payment of outstanding balances.

Patient/Guarantor Signature _____ Date_____

ASSIGNMENT OF INSURANCE BENEFITS

I authorize the payment of the group insurance benefits otherwise payable to my billing clinic.

Police Holder/Guarantor Signature_____ Date _____

MEDICARE – BENEFICIARY AGREEMENT

I have been notified by my physician/dentist that he or she believes that Medicare is likely to deny payment for the services identified, for the reasons stated. If Medicare denies payment, I agree to be personally and fully responsible for payment.

Police Holder/Guarantor Signature_____ Date _____

MEDICAL HISTORY FORM			
1. Patient Name: (Last, First, MI)	**2. Social Security No.**	**3. Birth Date (MM/DD/YY)**	**4. Sex** □ M □ F

We appreciate the time you spend completing this questionnaire. The information you provide is confidential and will allow us to provide you the best care possible. Thank you. Sincerely, Clinic Staff

5. Please list all major HOSPITALIZATIONS OR SURGERIES for any surgical operation or illness in the past.

Date	Reason or Procedure	Name and Address of Hospital

6. Please list any MAJOR ILLNESSES OR SPECIAL MEDICAL OR PSYCHOLOGICAL PROBLEMS that you have now or have had in the past.

Date	Reason	Name and Address of Doctor Who Treated You

Version 1.1 Revised on 11/22/04

7. What MEDICATIONS are you CURRENTLY taking for any health problems?

Medication Name	Dossage Per Day (mg, cc, etc.)	Times Per Day	Reason	Length of Time Taken

8. What MEDICATIONS have you taken for the problem IN THE PAST but not now?

Medication Name	Dossage Per Day (mg,cc,etc)	Times Per Day	Reason	When and why Did You Stop?

HEALTH PROBLEMS: Please check all health problems that you currently have or had in the past.

9. Cardiovascular	Yes	No
Rheumatic fever/heart disease	☐	☐
Heart murmur	☐	☐
Mitral valve prolapse	☐	☐
Artificial heart valve	☐	☐
Infective endocarditis	☐	☐
High blood pressure	☐	☐
High cholesterol	☐	☐
Angina	☐	☐
Heart attack	☐	☐
Congenital heart defect or lesion	☐	☐
Heart surgery/angioplasty	☐	☐
Pacemaker/defibrillator	☐	☐
Stroke	☐	☐
Vascular disease or surgery	☐	☐
Aneurysm	☐	☐
Other heart problems	☐	☐

10. Respiratory	Yes	No
Asthma	☐	☐
Bronchitis/Pneumonia	☐	☐
Emphysema	☐	☐

11. Allergic/Immunologic	Yes	No
Hay fever	☐	☐
Anaphylactic shock reaction	☐	☐
Reaction to foods:	☐	☐
Type of food: _____		
Reaction to local anesthetic (novacaine)	☐	☐
Reaction to penicillin, other antibiotics	☐	☐
Reaction to sulfa drugs	☐	☐
Reaction to sedatives, or sleeping pills	☐	☐
Reaction to barbiturates	☐	☐
Reaction to aspirin or other pain medication	☐	☐
Reaction to iodine	☐	☐
Reaction to other medications	☐	☐
List:		

12. Gastrointestinal	Yes	No
Stomach/intestinal ulcers	☐	☐
Gastritis	☐	☐
Colitis	☐	☐
Liver disease/jaundice	☐	☐
Gall Bladder Stones	☐	☐

13. Oropharyngeal Disorders	Yes	No
Stomach reflux-heartburn	☐	☐
Bad breath (malodor)	☐	☐
Enlarged tonsils	☐	☐

14. Eyes	Yes	No
Glaucoma	☐	☐
Full or Partial Blindness	☐	☐
Wear glasses/contacts	☐	☐

15. Ear and Nose, and Throat	Yes	No
Sinusitis or sinus headache	☐	☐
Nasal rhinitis	☐	☐
Inner ear infections	☐	☐

16. Neurologic	Yes	No
Multiple sclerosis (MS)	☐	☐
Epilepsy, seizures or convulsions	☐	☐
Migraine	☐	☐
Muscular dystrophy	☐	☐
Cerebral Palsy	☐	☐
Parkinon's Disease	☐	☐

17. Infectious disease	Yes	No
Sexually transmitted disease(syphilis, gonorrhea, or genital herpes)	☐	☐
HIV positive	☐	☐
Hepatitis Type: _____.	☐	☐
Tuberculosis (TB)	☐	☐
Other current infectious disease	☐	☐

18. Skin/Integumentary	Yes	No
Allergy to latex (rubber)	☐	☐
Hives or allergic skin rash	☐	☐
Psoriasis (chronic skin rash)	☐	☐
Dark moles (recent change in appearance)	☐	☐
Birth marks	☐	☐

19. Endocrine	Yes	No
Diabetes	☐	☐
Thyroid disease	☐	☐
Pancreatic disease	☐	☐

20. Genito-Urinary	Yes	No
Bladder problem/ infections	☐	☐
Kidney disease	☐	☐
Women	**Yes**	**No**
Are you taking contraceptives	☐	☐
Are you pregnant	☐	☐
Are you nursing presently	☐	☐
Had a miscarriage or stillbirth	☐	☐
Had a hysterectomy or ovariectomy	☐	☐
Are you on hormone replacement therapy	☐	☐
Dysmenorrhea (painful menstrual periods)	☐	☐
Premenstrual syndrome (PMS)	☐	☐
Menopause	☐	☐
Breast cancer	☐	☐
Men	**Yes**	**No**
Testicular tumors or disorders	☐	☐
Prostatitis	☐	☐
Prostate cancer	☐	☐
Breast cancer	☐	☐

21. Hematologic/Lymphatics	Yes	No
Blood transfusion	☐	☐
Anemia	☐	☐
Hemophilia/other bleeding disorders	☐	☐
Leukemia	☐	☐
Sickle Cell Anemia Disease	☐	☐
Tumor or cancer	☐	☐
Chemotherapy	☐	☐
Radiation therapy	☐	☐

22. Musculoskeletal/Rheumatic	Yes	No
Fibromyalgia	☐	☐
Chronic fatigue syndrome	☐	☐
Osteoarthritis	☐	☐
Osteopoerosis	☐	☐
Rheumatoid arthritis	☐	☐
Artificial joint (knee/hip/other)	☐	☐
Sjogren's syndrome	☐	☐
Muscle pain/rheumatism	☐	☐

23. Mental Health	Yes	No
Depression	☐	☐
Anxiety disorder	☐	☐
Mental health treatment	☐	☐
Physical or sexual abuse	☐	☐
Eating disorder	☐	☐

COMMENTS:

Version 1.1 Revised on 11/22/04

REVIEW OF SYSTEMS: Please check all symptoms that you have had recently (in the past month).

24. Constitutional Symptoms	Yes	No
Frequent fever	☐	☐
Weight loss or gain recently	☐	☐
Unsteady when walking/standing	☐	☐
General weakness	☐	☐
Fatigue	☐	☐
Chills	☐	☐
Hot and cold spells	☐	☐
Change in appetite	☐	☐

25. Cardiovascular	Yes	No
Racing heart (palpitations)	☐	☐
Chest pain	☐	☐
Cold hands	☐	☐
Swollen feet/ankles	☐	☐

26. Respiratory	Yes	No
Chronic cough	☐	☐
Cough up blood	☐	☐
Shortness of breath	☐	☐
Breathing difficulties	☐	☐

27. Gastrointestinal	Yes	No
Stomach pain	☐	☐
Nausea	☐	☐
Vomiting	☐	☐
Persistent diarrhea	☐	☐
Persistent constipation	☐	☐
Heartburn /indigestion	☐	☐
Bloody or black stools	☐	☐
Pain with bowel movement	☐	☐
Bloating (gassy feeling)	☐	☐
Intolerance to a variety of foods	☐	☐

28. Eyes	Yes	No
Eye pain	☐	☐
Eye strain/ sensitivity to light	☐	☐
Double vision	☐	☐
Blind spots	☐	☐
Blurred vision	☐	☐
Seeing halo around lights	☐	☐

29. Ears, Nose, and Throat	Yes	No
Earaches	☐	☐
Frequent nasal congestion	☐	☐
Sneezing frequently	☐	☐
Change in sense of smell	☐	☐
Vertigo (head spinning)	☐	☐
Ringing or noises in the ears	☐	☐
Hearing difficulty/ loss	☐	☐
Plugged Ears	☐	☐
Frequent sore throat	☐	☐
Need to clear throat	☐	☐
Post-nasal drainage	☐	☐
Tight throat	☐	☐
Changes in voice or voice difficulties	☐	☐
Difficulty swallowing	☐	☐
Lump in the throat	☐	☐

30. Oropharyngeal Disorders	Yes	No
Stomach reflux-heartburn	☐	☐
Bad breath (malodor)	☐	☐
Bad taste in mouth	☐	☐
Coating on tongue	☐	☐
Enlarged tonsils	☐	☐
Sore throat with mouth sores	☐	☐

31. Skin/Integumentary	Yes	No
Night sweats	☐	☐
Itching/burning skin	☐	☐
Skin color change	☐	☐
Sweating change	☐	☐
Temperature change of skin	☐	☐

32. Genito-Urinary	Yes	No
Urinary retention or difficulty urinating	☐	☐
Urinate frequently	☐	☐
Pain during urination	☐	☐
Blood in urine	☐	☐

33. Hematologic/Lymphatics	Yes	No
Bleed for a long time	☐	☐
Bruise easily	☐	☐
Swollen glands	☐	☐

34. Musculoskeletal/Rheumatic	Yes	No
Stiff joints	☐	☐
Swollen joints	☐	☐
Aching painful joints	☐	☐
Arm pain/tingling	☐	☐
Hand/wrist pain/carpel tunnel	☐	☐
Low back pain	☐	☐
Neck pain	☐	☐
Shoulder and upper back pain	☐	☐
Leg pain/tingling	☐	☐
Painful feet/ankles	☐	☐
Knee pain	☐	☐

35. Neurologic	Yes	No
Severe headaches	☐	☐
Wake up from headache	☐	☐
Fainting, dizzy spells or black-outs	☐	☐
Speech difficulty/slurring	☐	☐
Facial weakness/drooping	☐	☐
Facial twitching	☐	☐
Tingling or numbness in face	☐	☐
Tingling or numbness in arms/fingers	☐	☐
Hands shake or tremble	☐	☐
Memory loss	☐	☐
Balance problem	☐	☐
Weakness in parts of body	☐	☐

36. Chemical Use	Yes	No
Coffee daily	☐	☐
beer or wine daily	☐	☐
tea daily	☐	☐
cocktails or other alcoholic beverages daily	☐	☐
soft drinks(pop) daily	☐	☐
marijuana or other recreational drugs	☐	☐
cigarettes/pipe/cigar daily	☐	☐
chewing tobacco	☐	☐
cocaine or other stimulants	☐	☐
Drug/alcohol dependency (current/recovering)	☐	☐
Take alcohol or recreational drugs to help with pain	☐	☐
Immediate family members chemically dependent	☐	☐

37. Psychiatric	Yes	No
Stressed out /overwhelmed	☐	☐
Low energy level	☐	☐
Crying spells	☐	☐
Sleep problems/insomnia	☐	☐
Poor concentration	☐	☐
Trouble relaxing	☐	☐
Felt like taking your own life in past 6 months	☐	☐

COMMENTS:

Version 1.1 Revised on 11/22/04

DENTAL AND OROFACIAL HISTORY

38. Have you had any of the following dental treatments?	Yes	No
Orthodontic braces	☐	☐
Orthognathic or bite surgery	☐	☐
Wisdom teeth extracted	☐	☐
Other teeth extracted	☐	☐
Periodontal or gum treatment	☐	☐
Bite adjusted	☐	☐
Splint or bite guard	☐	☐
Crowns or bridge	☐	☐
Dental fillings	☐	☐
Upper full denture	☐	☐
Lower full denture	☐	☐
Upper partial denture	☐	☐
Lower partial denture	☐	☐
Mouth biopsy	☐	☐

39. Dental Problems	Yes	No
Missing teeth need replacement	☐	☐
Need new crown(s) or filling(s)	☐	☐
Problem with dentures	☐	☐
Tooth fracture(s)	☐	☐
Broken filling(s)	☐	☐
Tooth decay	☐	☐
Tooth wear	☐	☐
Persistent tooth pain	☐	☐
Tooth or teeth sensitive to hot/cold	☐	☐
Painful tooth when biting on it	☐	☐

40. TMJ and Orofacial Pain	Yes	No
Jaw pain	☐	☐
Facial pain	☐	☐
Cheek pain	☐	☐
TMJ (jaw joint) pain	☐	☐
Jaw joint clicking or popping noise	☐	☐
Jaw joint grating or crepitus noise	☐	☐
Jaw locking or getting stuck open	☐	☐
Jaw locking closed/cannot open all the way	☐	☐
Temple headache	☐	☐
Ear pain	☐	☐
Mouth pain	☐	☐
Jaw stiffness when moving it	☐	☐
Jaw pain on movement	☐	☐
Jaw pain on opening wide	☐	☐
Jaw stiffness upon wakening	☐	☐

41. Mouth Lesions or Disease	Yes	No
Burning or painful tongue	☐	☐
Dry mouth	☐	☐
Mouth sores	☐	☐
Tongue sores	☐	☐
Lips cracking or sore	☐	☐
Fever Blisters/Cold sores on lips	☐	☐
Lumps or bumps in mouth	☐	☐
Swelling in mouth	☐	☐
Mouth ulcers or canker sores	☐	☐
Colored or discolored areas in mouth	☐	☐

42. Dental Occlusion	Yes	No
Difficulty chewing due to bite	☐	☐
Malocclusion (bad bite)	☐	☐
Bite that is changing	☐	☐
Cross bite	☐	☐
Open bite	☐	☐

43. Oral Habits

Have you or others noticed yourself doing any of the following oral habits regularly (more than once a week)?	Yes	No
Chewing on one side	☐	☐
Leaning on the jaw	☐	☐
Grinding the teeth at night	☐	☐
Grinding your teeth when awake	☐	☐
Waking up with sore jaws	☐	☐
Clenching your teeth when awake	☐	☐
Clenching your teeth at night	☐	☐
Holding your jaw forward	☐	☐
Chewing gum	☐	☐
Playing a musical instrument with the mouth	☐	☐
Sleeping on stomach	☐	☐
Touching or holding your teeth together	☐	☐
Holding or pressing the tongue against your teeth	☐	☐
Holding your jaw in a rigid or tense position	☐	☐
Biting objects (pens, tooth picks, etc.)	☐	☐
Biting your cheeks	☐	☐
Biting your nails or cuticles	☐	☐
Biting your lips	☐	☐
Biting tongue	☐	☐
Bracing the phone with shoulder or jaw	☐	☐

44. Periodontal (Gums)	Yes	No
Periodontal disease	☐	☐
Gingivitis or bleeding gums	☐	☐
Loose teeth	☐	☐
Deep pockets in gums	☐	☐
Sore gums	☐	☐
Difficulty in cleaning teeth	☐	☐
Calculus (tartar build-up)	☐	☐
Impacted or unerupted teeth	☐	☐

45. Oral Obstructive Sleep/Breathing Problems	Yes	No
Snore loudly	☐	☐
Stop breathing while sleeping	☐	☐
Choke or struggle for breath while sleeping	☐	☐
Wake up at night frequently	☐	☐
Move around a lot while sleeping	☐	☐
Doze off or fall asleep during day	☐	☐
Have difficulty breathing through nose	☐	☐
Wake up feeling tired	☐	☐

46. Mouth or Facial Injury	Yes	No
Have you had trauma or injury to your jaw, head, or neck?	☐	☐

Describe:_____

_____

Have you or will you consult an attorney about this condition? ☐ ☐

COMMENTS:

Version 1.1 Revised on 11/22/04

GENERAL HEALTH STATUS FORM

1. Patient Name: (Last, First, MI)	2. Social Security No.	3. Birth Date (MM/DD/YY)	4. Sex □ M □ F

This questionnaire is a description of you from YOUR point of view and, thus, there are no right or wrong answers. Please respond with your first thought to each question as accurately as possible. If a question does not seem to apply to you, please answer to the best of your ability. There are three types of questions;

1) Multiple choice questions 2) Yes/No questions 3) Placement on line questions. Although the multiple choice questions and yes/no questions are probably familiar to you, the placement on line questions may not be. Here is an example of this type of question. You need to fill in the dot for both where you feel you are NOW (in the past month) as well as where you feel you SHOULD BE.

Sample: How often have you received emotional support from your family and friends?

Now ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ● ○ ○ ○ ○ ○ ○ ○ ○

Should ○ ● ○ ○ ○ ○ ○

Never Sometimes Half of the the time Usually Always

5. What is your MAIN problem or complaint? (Choose only one)

○ None	○ Jaw Pain	○ Facial Pain	○ Earaches
○ Headache	○ Pain in Jaw Joint	○ Locking of Jaw	○ Inability to Open Jaw
○ Tooth Pain	○ Noises in Jaw Joint	○ Fatigue in Jaws	○ Neck Pain
○ Bite is off	○ Other_____		

6. Choose one answer for each question to describe this MAIN problem:

What side is it on? ○ Right only ○ Left only ○ Both sides

What is the pattern? ○ Persistent ○ Recurrent ○ One-time

Quality of the pain? ○ Throbbing ○ Dull ○ Sharp ○ Burning ○ N/A

How many days (0-30) in the past month has it occurred? _____

7. In the past 6 months, how OFTEN has the MAIN problem occurred?

○ ○

Never Once a Month Once a week Once a day Once an hour Constantly

8. When the MAIN problem occurs, how LONG does it last?

○ ○

Does not occur 1 minute 1 hour 1 day 1 week Continuous

9. How would you rate the WORST pain on a 0 to 10 scale at the PRESENT time, that is right now, where 0 is "no pain" and 10 is "pain as bad as could be"?

⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

No pain Pain as bad as it could be

10. In the past six months, how intense was your worst pain, rated on a 0 to 10 scale where 0 is "no pain" and 10 is "pain as bad as could be"?

⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

No pain — Pain as bad as it could be

11. In the past six months, ON THE AVERAGE, how intense was your pain rated on a 0 to 10 scale where 0 is "no pain" and 10 is "pain as bad as could be"? [That is, your usual pain at times you were experiencing pain].

⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

No pain — Pain as bad as it could be

12. How UNPLEASANT OR DISTURBING is your usual level of this MAIN problem?

⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

Least Imaginable — Worst Imaginable

13. What is your SECOND WORST problem or complaint? (Choose only one)

○ None	○ Jaw Pain	○ Facial Pain	○ Earaches
○ Headache	○ Pain in Jaw Joint	○ Locking of Jaw	○ Inability to Open Jaw
○ Tooth Pain	○ Noises in Jaw Joint	○ Fatigue in Jaws	○ Neck Pain
○ Bite is off	○ Other_____		

14. If present, choose one answer for each question to describe your 2nd worst problem:

What side is it on?	○Right only	○ Left only	○Both sides		
What is the pattern?	○Persistent	○ Recurrent	○One-time		
Quality of the pain?	○Throbbing	○ Dull	○ Sharp	○ Burning	○ N/A
How long does it last?	○It's gone	○ Minutes	○ Hours	○ Days	○ Constant

How many days (0-30) in the past month has it occurred? _____

How intense is it usually on a 0 to 10 scale (10 is the worst)? _____

15. What is your THIRD WORST problem or complaint? (Choose only one)

○ None	○ Jaw Pain	○ Facial Pain	○ Earaches
○ Headache	○ Pain in Jaw Joint	○ Locking of Jaw	○ Inability to Open Jaw
○ Tooth Pain	○ Noises in Jaw Joint	○ Fatigue in Jaws	○ Neck Pain
○ Bite is off	○ Other_____		

16. If present, choose one answer for each question to describe your 3rd worst problem:

What side is it on?	○Right only	○ Left only	○Both sides		
What is the pattern?	○Persistent	○ Recurrent	○One-time		
Quality of the pain?	○Throbbing	○ Dull	○ Sharp	○ Burning	○ N/A
How long does it last?	○It's gone	○ Minutes	○ Hours	○ Days	○ Constant

How many days (0-30) in the past month has it occurred? _____

How intense is it usually on a 0 to 10 scale (10 is the worst)? _____

17. If you have HEADACHES, please answer the following questions about them:

Where does it occur? ○ Temple ○ Forehead ○ Top of head ○ Side of head ○ Base of head

What side is it on? ○ Right only ○ Left only ○ Both sides

What is the pattern? ○ Persistent ○ Recurrent ○ One-time

Quality of the headache? ○Throbbing ○ Dull ○ Sharp ○ Burning ○ N/A How long does it last? ○It's gone ○ Minutes ○ Hours ○ Days ○ Constant

How many days (0-30) in the past month has it occurred? _____

How intense is it usually on a 0 to 10 scale (10 is the worst)? _____

When it occurs, do you have any: ○ Nausea ○ Vomiting ○ Sensitivity to light ○ Sensitivity to noise

Right before it occurs, do you have any: ○ Speech changes ○ Vision changes ○ Weakness ○ Other sensations:_____

Please answer the following questions about all of the above problems.

18. How difficult is it to ENDURE OR TOLERATE the problem(s) over time?

⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

Least imaginable — Worst imaginable

19. In the past six months, how much has the problem interfered with your daily activities rated on a 0 to 10 scale where 0 is "no interference" and 10 is "unable to carry on any activities"?

⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

No interference — Unable to carry on any activities

20. In the past six months, how much has the problem(s) changed your ability to take part in RECREATIONAL, SOCIAL AND FAMILY ACTIVITIES where 0 is "no change" and 10 is "extreme change"?

⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

No change — Extreme change

21. In the past six months, how much has the problem(s) changed your ABILITY TO WORK (including housework) where 0 is "no change" and 10 is "extreme change"?

⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

No change — Extreme change

22. About how many days in the LAST SIX MONTHS (180 days) have you been kept from your usual activities (work, school or housework) because of the problem(s)?

_____ (0-180) Days

23. What activities does the problem(s) prevent or limit you from doing?

	Yes	No		Yes	No
swallowing	☐	☐	chewing	☐	☐
eating hard food	☐	☐	drinking	☐	☐
eating soft foods	☐	☐	exercising	☐	☐
maintaining normal weight	☐	☐	cleaning teeth or face	☐	☐
yawning	☐	☐	having your usual facial appearance	☐	☐
talking	☐	☐	sexual activity	☐	☐
smiling/laughing	☐	☐			

24. What other activities do all health problems prevent or limit you from doing?

	Yes	No		Yes	No
Working	☐	☐	Riding in the car or bus	☐	☐
Driving	☐	☐	Fixing meals	☐	☐
Household chores	☐	☐	Yard work	☐	☐
Walking long distances	☐	☐	Active sports	☐	☐
Hard exercise	☐	☐	Mild exercise	☐	☐
Active hobbies	☐	☐	Reading	☐	☐
Sitting for hours	☐	☐	Standing for hours	☐	☐
Socializing with friends or family	☐	☐	Discussing personal problems	☐	☐
Sleeping	☐	☐			

25. When was the problem first noticed? ____/____/_____ (mm/dd/yy)

26. The problem began with (check all that apply):

○ Jaw surgery	○ Blow to jaw/head/neck	○ Motor vehicle accident
○ Dental work	○ Chewing	○ Tooth extraction
○ Orthodontics (braces)	○ Stressful situation	○ Nothing, pain just came on
○ Work accident	○ Athletic injury	○ Other_____

27. Please describe the onset of your problem:

28. Which TESTS have you had for the problem? (check all that apply)

○ None	○ TMJ x-ray	○ Panoramic xrays
○ Other xrays	○ EMG (electromyography)	○ Urine studies
○ Venogram/arteriogram	○ MR scan (magnetic resonance)	○ Blood studies
○ Arthrogram in the joint	○ Nerve block (injection)	○ CT scan (CAT)
○ Myelogram	○ Diet analysis	○ Thermogram
○ Jaw tracking	○ Bone scan	○ Tooth pulp test
○ Other_____		

29. Which of these HEALTH/HELPING PROFESSIONALS have you seen for the problem? (check all that apply)

○ None	○ Acupuncturist	○ 'insurance' Physician/Dentist
○ Orthodontist	○ Anesthesiologist	○ Internist
○ Ear/Nose/Throat	○ Ophthalmologist	○ TMJ specialist
○ Neurologist	○ Dentist	○ Psychologist
○ Orthopedic Surgeon	○ Rheumatologist	○ Neurosurgeon
○ Oral Surgeon	○ Psychiatrist	○ Physical Therapist
○ Physical Medicine Specialist	○ Occupational Therapist	○ Chiropractor
○ General Practitioner (M.D.)	○ Other_____	

30. Which TREATMENTS have you had for the problem? (check all that apply)

○ No treatment	○ Traction	○ Splints or bite planes
○ Electrical stimulation (TENS)	○ Injections/nerve blocks	○ Counseling
○ Ultrasound or iontophoresis	○ Acupuncture	○ Medications
○ Root canal/dental treatment	○ Massage/acupressure	○ Heat/cold applications
○ Exercise	○ Biofeedback	○ Stress management
○ Neurosurgery	○ TMJ surgery without implants	○ TMJ implant surgery
○ Orthodontic/braces	○ Pain program	○ Hypnosis
○ Chiropractic treatment	○ Botox injections	○ Other_____

31. How many EMERGENCY ROOM VISITS (for any reason) have you had in the past year?

○ 0 ○ 1 ○ 2 or 3 ○ 4 or 5 ○ 6 or more

32. What is the total number of DIFFERENT KINDS OF PILLS or MEDICINES (any type, except vitamins) that you take daily?

○ 0 ○1 to 2 ○ 3 to 4 ○ 5 to 6 ○ 7 or more

33. How many days did you spend IN THE HOSPITAL during the past year?

○ 0 ○ 1 to 3 ○ 4 to 6 ○ 7 to 14 ○ 15 or more

34. How often have you been seen by HEALTH PROFESSIONALS (for any reason) in the last year?

○ ○

Daily	Once a Week	Once a month	Once every 3 months	Not at all

35. How many SURGERIES have you had for a jaw joint (TMJ) problem? Right: ____Left: ____

36. If you have had TMJ surgery, please check the type of surgeries you have had.

O No surgery

	right	left		right	left
Arthroscopic surgery……....	○	○	TMJ disk removal……....	○	○
Orthognathic surgery……....	○	○	TMJ disk implant removal……....	○	○
TMJ disk implant placed……....	○	○	Arthroplasty……....	○	○
Total synthetic joint placement…...	○	○	Arthrocentesis/lysis and lavage……..	○	○
TMJ disk repair……..……....	○	○	Arthrotomy……....	○	○
Other_____	○	○			

37. If you have had a TMJ implant, please check the type of implant(s) that you have had.

O No Implants

	right	left		right	left
Silicone/Silastic® disk (permanent)	○	○	Lorenz/Biomet…….....	○	○
Silicone/Silastic® disk (temporary)	○	○	Proplast/teflon® disk……	○	○
Christensen (TMJ, Inc) joint….....	○	○	Techmedica/TMJ Concepts joint…...	○	○
Hoffman-Pappas/Endotec joint…..	○	○	Kent/Vitek joint……....	○	○
Other:_____	○	○			

38. Please check any side effects you have had from TMJ treatment or TMJ surgery;

O No Side Effects

	right	left		right	left
Facial or jaw swelling……	○	○	Asymmetry of the face……	○	○
Facial muscle weakness……...	○	○	Objectionable scarring……....	○	○
Allergic reaction to drugs…….	○	○	Bruising or discoloration……...	○	○
Numbness to skin……....	○	○	Change in bite……	○	○
Worsening of pain…….....	○	○	Difficulty opening jaw…….....	○	○
Ear ringing……....	○	○	Difficulty chewing…….....	○	○
Ear plugged……....	○	○	Infection…….....	○	○
Ear pain…….....	○	○	TMJ noise or crepitus…….....	○	○
Dental problems…….....	○	○	Eye brow weakness……....	○	○

39. How many years has this problem or other health problems affected your life?

○ less than 1 ○ 1 to 2 ○ 3 to 4 ○ 5 to 10 ○ 11 to 19 ○ 20 or more

40. How many members of your household (not including you) have a pain problem, a physical handicap, or a chronic disease?

○ 0 ○ 1 ○ 2 ○ 3 ○ 4 ○ 5 or more

41. a. Have any of your LIVING blood related family members had the following illnesses or conditions?

	Father	Mother	Any Brother	Any Sister	Any Grandfather	Any Grandmother	Any Child
TMJ disorders………	○	○	○	○	○	○	○
Arthritis………………	○	○	○	○	○	○	○
Heart disease……….	○	○	○	○	○	○	○
Cancer……………….	○	○	○	○	○	○	○
Headaches…………..	○	○	○	○	○	○	○
Hip joint implant…….	○	○	○	○	○	○	○
Knee joint implant….	○	○	○	○	○	○	○
Joint implant failure…	○	○	○	○	○	○	○
None of the above….	○	○	○	○	○	○	○

b. Have any of your DECEASED blood related family members had the following illnesses or conditions?

	Father	Mother	Any Brother	Any Sister	Any Grandfather	Any Grandmother	Any Child
TMJ disorders………	○	○	○	○	○	○	○
Arthritis………………	○	○	○	○	○	○	○
Heart disease……….	○	○	○	○	○	○	○
Cancer……………….	○	○	○	○	○	○	○
Headaches…………..	○	○	○	○	○	○	○
Hip joint implant…….	○	○	○	○	○	○	○
Knee joint implant….	○	○	○	○	○	○	○
Joint implant failure…	○	○	○	○	○	○	○
None of the above….	○	○	○	○	○	○	○

Please fill in the bubble on the: 1) first line where you feel you are NOW (in the past month)
2) second line for where you feel you SHOULD be.

42. What has been your usual activity level in the past month?

Now ○○○○○○○○○○○○○○○○○○○○○○○○○○○○
Should ○○○○○○○○○○○○○○○○○○○○○○○○○○○○

Lay in bed all day	Lay down half the day	Sit and rest half the day	Sit and rest a few times a day	Up and busy all day without any rest

43. What has been your usual exercise level in the past month?

Now ○○○○○○○○○○○○○○○○○○○○○○○○○○○○
Should ○○○○○○○○○○○○○○○○○○○○○○○○○○○○

No exercise	Pleasure drives, go outside	Short walks fishing, etc.	Long walks golf, bowling, etc.	Regular running tennis, etc.

44. What has your usual sleep been like in the past month?

Now ○
Should ○

No sleep	Sleep poorly 3-5 hrs.	Difficulty falling asleep, wake early	Wake on occasion during night	Sleep soundly all night

45. What have your usual eating habits been like in the past month?

Now ○
Should ○

Do not eat	No appetite, eat lightly	Snack most of the day, occasional regular meal	Eat one regular meal and snack for the rest	Eat three good regular meals

46. How often are you tense in a typical day?

Now ○
Should ○

Always	Usually	Half the time	Twice a day	Never

47. How often do you hurry in a typical day?

Now ○
Should ○

I hurry all day and night	I usually hurry	I hurry half the time	I occasionally hurry when necessary	I never hurry

48. How much do you take responsibility for your health?

Now ○
Should ○

Not at all	Somewhat	Moderately	A lot	Completely

49. How often is the problem used as a reason to others that keeps you from doing something?

Now ○
Should ○

Always	Usually	Half the	Sometimes	Never

50. How regular has your lifestyle (eat, sleep, work, etc.) been in the past month?

Now ○
Should ○

Irregular, always miss eating, sleeping, and work	One-two regular days per week	Regular for half the week	Five-six regular days per week	Eat, sleep, and work regularly every day

51. How often do you feel you have had financial problems?

Now ○
Should ○

Always	Usually	Half the time	Sometimes	Never

52. How often do you enjoy your work (or if not working your usual daily activities)?

Now ○
Should ○

Never	Sometimes	Half the time	Usually	Always

53. How often have you received emotional support from your family and friends?

Now ○
Should ○

Never	Sometimes	Half the time	Usually	Always

54. How often are you dependent on family or friends to fulfill your daily needs?

Now ○

Should ○

Always | Usually | Half the Time | Sometimes | Never

55. When you are in pain, how have others reacted in the past month?

Now ○

Should ○

They attend to all of my needs | They do some things for me | They ask me how I am | They complain about me | Nobody knows when I am in pain

56. How are your relationships with your co-workers, or if not working, your companions at your usual daily activities?

Now ○

Should ○

Worst Possible | Poor | Moderate | Good | Best Possible

57. How is your relationship with the most important person in your life (spouse, significant other, best friend)?

Now ○

Should ○

Worst Possible | Poor | Moderate | Good | Best Possible

58. How well do you understand the problem?

Now ○

Should ○

Not at all | Poor | Moderate | Good | Completely

59. How motivated are you to reduce the problem?

Now ○

Should ○

No motivation | Low | Moderate | High | Complete motivation

60. How much do you expect the problem to be reduced in the future?

Now ○

Should ○

No change | Lessened slightly | Half of it gone | Most of it gone | Completely gone

61. How long do you feel it will take to reduce the problem when treated?

Now ○

Should ○

Never be reduced | Months to years | Weeks to months | Days to weeks | Immediate reduction

62. How often do you feel depressed?

Now ○

Should ○

Always | Usually | Half the time | Sometimes | Never

63. How often do you feel anxious or worried?

Now ○

Should ○

Always | Usually | Half the time | Sometimes | Never

64. How often do you feel angry?

Now ○○○○○○○○○○○○○○○○○○○○○○○○○○○○

Should ○○○○○○○○○○○○○○○○○○○○○○○○○○○○

Always | Usually | Half the Time | Sometimes | Never

65. How often do you feel confused about life?

Now ○○○○○○○○○○○○○○○○○○○○○○○○○○○○

Should ○○○○○○○○○○○○○○○○○○○○○○○○○○○○

Always | Usually | Half the time | Sometimes | Never

66. How often do you feel bad about yourself?

Now ○○○○○○○○○○○○○○○○○○○○○○○○○○○○

Should ○○○○○○○○○○○○○○○○○○○○○○○○○○○○

Always | Usually | Half the time | Sometimes | Never

67. How is your energy level?

Now ○○○○○○○○○○○○○○○○○○○○○○○○○○○○

Should ○○○○○○○○○○○○○○○○○○○○○○○○○○○○

Always low | Usually low | Low Half the time | Sometimes low | Never low

68. In general, would you say your health is:

○ Excellent ○ Very good ○ Good ○ Fair ○ Poor

The following questions are about activities you might do during a typical day. Does your health *now* limit you in these activities? If so, how much?

	Yes, limited a lot	**Yes, limited a little**	**No, not limited at all**
69. Moderate activities, such as moving a table, pushing a vacuum cleaner, bowling, or playing golf	☐	☐	☐
70. Climbing **several** flights of stairs	☐	☐	☐

During the *past 4 weeks*, have you had any of the following problems with your work or other regular daily activities as a result of your physical health?

	Yes	**No**
71 Accomplished less than you would like	☐	☐
72. Were limited in the **kind** of work or other activities	☐	☐

During the *past 4 weeks*, have you had any of the following problems with your work or other regular daily activities *as a result of any emotional problems* (such as feeling depressed or anxious)?

	Yes	**No**
73. Accomplished less than you would like	☐	☐
74. Didn't do work or other activities as **carefully** as usual	☐	☐

75. During the *past 4 weeks*, how much did pain **interfere with your normal work** (including both work outside the home and housework)?

○Not at all ○ A little bit ○ Moderately ○ Quite a bit ○ Extremely

These questions are about how you feel and how things have been with you during the past 4 weeks. For each question, please give the one answer that comes closest to the way you have been feeling.

How much of the time during the *past 4 weeks*

	All of the time	**Most of the time**	**A good bit of the time**	**Some of the time**	**A little of the time**	**None of the time**
76. Have you felt calm and peaceful?	☐	☐	☐	☐	☐	☐
77. Did you have a lot of energy?	☐	☐	☐	☐	☐	☐
78. Have you felt downhearted and blue?	☐	☐	☐	☐	☐	☐

79. During the past 4 weeks, how much of the time has your physical health or emotional problems interfered with your social activities (like visiting friends, relatives, etc.)?

○ All of the time ○ Most of the time ○ Some of the time ○ A little of the time ○ None of the time

…….ADDITIONAL QUESTIONS CONTINUED ON THE NEXT PAGE…….

80. In the last month, how much have you been distressed by

	Not at all	A little bit	Moderately	Quite a bit	Extremely
Headaches	⓪	①	②	③	④
Loss of sexual interest or pleasure	⓪	①	②	③	④
Faintness or dizziness	⓪	①	②	③	④
Pains in the heart or chest	⓪	①	②	③	④
Feeling low in energy or slowed down	⓪	①	②	③	④
Thoughts of death or dying	⓪	①	②	③	④
Poor appetite	⓪	①	②	③	④
Crying easily	⓪	①	②	③	④
Blaming yourself for things	⓪	①	②	③	④
Pains in the lower back	⓪	①	②	③	④
Feeling lonely	⓪	①	②	③	④
Feeling blue	⓪	①	②	③	④
Worrying too much about things	⓪	①	②	③	④
Feeling no interest in things	⓪	①	②	③	④
Nausea or upset stomach	⓪	①	②	③	④
Soreness of your muscles	⓪	①	②	③	④
Trouble falling asleep	⓪	①	②	③	④
Trouble getting your breath	⓪	①	②	③	④
Hot or cold spells	⓪	①	②	③	④
Numbness or tingling in parts of your body	⓪	①	②	③	④
A lump in your throat	⓪	①	②	③	④
Feeling hopeless about the future	⓪	①	②	③	④
Feeling weak in parts of your body	⓪	①	②	③	④
Heavy feelings in your arms or legs	⓪	①	②	③	④
Thoughts of ending your life	⓪	①	②	③	④
Overeating	⓪	①	②	③	④
Awakening in the early morning	⓪	①	②	③	④
Sleep that is restless or disturbed	⓪	①	②	③	④
Feeling everything is an effort	⓪	①	②	③	④
Feelings of worthlessness	⓪	①	②	③	④
Feeling of being caught or trapped	⓪	①	②	③	④
Feelings of guilt	⓪	①	②	③	④

Thank you for your time and effort.