BIOPSYCHOSOCIAL FACTORS ASSOCIATED WITH

TEMPOROMANDIBULAR JOINT DISORDERS

APPROVED BY SUPERVISORY COMMITTEE

_____

_____

_____

_____

_____

_____

DEDICATION

I would like to thank the members of my graduate committee for their support and guidance over the past two years. Dr. Robert Gatchel, I appreciate your encouragement and knowledge in order to build upon your previous research. Thank you for providing an environment that allowed me to excel. Dr. Anna Stowell, thank you for your involvement in this project and making multiple suggestions throughout the process. Dr. Martin Deschner, thank you for your support and assistance. Mr. Rob Haggard, thank you for your kind words and assistance, answering each question, and giving me the opportunity to grow as a researcher. To my family, thank you for always giving me your love and support throughout my endeavors. I appreciate the time and space you have given me to allow me to grow and giving me encouragement during my studies. Finally, I would like to thank my fiancé, Alan Kramer, for his unfailing love, support, and late night edits.

BIOPSYCHOSOCIAL FACTORS ASSOCIATED WITH TEMPOROMANDIBULAR JOINT DISORDERS

by

CARMEN AMANDA RIEL JIMENEZ

THESIS

Presented to the Faculty of the Graduate School of Biomedical Sciences

The University of Texas Southwestern Medical Center at Dallas

In Partial Fulfillment of the Requirements

For the Degree of

MASTER OF SCIENCE

The University of Texas Southwestern Medical Center at Dallas

Dallas, Texas

August, 2010

BIOPSYCHOSOCIAL FACTORS ASSOCIATED WITH

TEMPOROMANDIBULAR JOINT DISORDERS

CARMEN AMANDA RIEL JIMENEZ, B.A.

The University of Texas Southwestern Medical Center at Dallas, 2010

ROBERT J. GATCHEL, Ph.D., ABPP

The present study represents a continuation of research that has focused on the treatment of acute temporomandibular joint disorders (TMDs) using non-surgical interventions. This study follows previous studies of Wright and colleagues (2004), Gatchel and colleagues (2006), and Stowell and colleagues (2007). Data were collected from 221 patients at community dental practices. Patients were subsequently assigned to one of three treatment groups based on baseline measurements: Low-Risk/ Non-Intervention (LR/NI), High-Risk/ Biobehavioral Treatment (HR/BB), and High-Risk/ Self-Care Treatment (HR/SC).

The current study primarily investigated the biopsychosocial differences between temporomandibular joint disorder (TMD) diagnoses. Findings suggested that participants with a combined diagnosis of myofascial pain disorder (MPD) and other disorders reported more pain, psychosocial dysfunction, depression, and somatization compared to participants with no diagnoses. In terms of functional performance, findings indicated that participants with a combination of MPD and other disorders reported more pain while chewing. However, no differences were found in particle size breakdown, broadness, or difference in weight. This study also examined whether high-risk participants reported higher rates of perceived stress. Findings indicated that there were no significant differences between the amounts of perceived stress.

Finally, the present study examined the benefits of a biobehavioral treatment compared to a self-care treatment regimen from baseline to one-year follow-up. Preliminary findings suggested that, over time, participants had a reduction in self-reported pain and an increase in psychosocial functioning regardless of their treatment group assignment. Preliminary findings revealed that the number of visits to health care providers for jaw-related pain did not differ among treatment groups. Due to the small number of participants that had reached the one-year time point at the time of analysis, six-month analyses were also conducted. Findings suggested that all participants, regardless of treatment group, reported less pain and less psychosocial dysfunction at the six-month follow-up. Additionally, there was a significant difference found between HR participants and LR/NI participants. However, no significant differences were found between HR/BB and HR/SC treatment. In terms of visits to health care providers for jaw

pain, no significant differences were found between HR/BB and HR/SC treatment groups at the six-month time point.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

LIST OF ABBREVIATIONS

BPS - Biopsychosocial

CPI – Characteristic Pain Intensity

DD – Disc Displacement

DJD – Degenerative Joint Diseases

GCPS – Graded Chronic Pain Scale

HR/BB – High-Risk/Biobehavioral

HR/SC – High-Risk/Self-Care

LR/NI – Low-Risk/ Non-Intervention

MPD – Myofascial Pain Disorder

RDC/TMD – Research Diagnostic Criteria for Temporomandibular Joint Disorders

TMD – Temporomandibular Joint Disorder

TMJMD – Temporomandibular Joint and Muscle Disorders

CHAPTER ONE
Introduction

Pain is a significant health problem in the United States. It is one of the most common reasons for individuals to seek medical treatment and costs the American public more than $100 billion each year in health care costs and lost productivity (National Institutes of Health, 2009; NIH). In 1999, the Joint Commission on the Accreditation of Healthcare Organizations declared pain as the fifth vital sign and, as such, duration, intensity, and location are to be documented during each physician visit (The Joint Commission, 2009). The Joint Commission (2009) also asserted that patients have the right to have pain assessed and managed.

Of all the pain disorders, temporomandibular joint disorders (TMDs) are one of the most commonly occurring musculoskeletal conditions resulting in pain and disability, second only to chronic low back pain (National Institute of Dental and Craniofacial Research, 2008; NIDCR). In the United States alone, the prevalence of TMD is estimated to be between 5-15% (NIH, 1996). The NIDCR (2008) estimates TMDs cost an average of four billion dollars annually.

Several researchers (Edwards, Gatchel, Adams, & Stowell, 2006; Gatchel, Garofalo, Ellis, & Holt, 1996; Kight, Gatchel, & Wesley, 1999) have demonstrated a link between TMDs and certain psychopathologies. TMD patients most often suffer from mood disorders, anxiety disorders, somatoform disorders, and substance use disorders (Gatchel, et al., 1996; Kight, et al., 1999). The treatment of TMDs varies greatly. The most common forms of treatment include biopsychosocial interventions, self-care

interventions, physical therapy, pharmacologic therapies, and surgery; albeit, not necessarily in this order (Gardea, Gatchel, & Mishra, 2001; NIH, 1996).

The purpose of the present study was to examine the common biopsychosocial factors among an acute pain population. In addition, this study evaluated the effectiveness of three treatment protocols: biobehavioral, self-care, and non-intervention. While most literature on TMDs focuses on chronic facial pain, fewer studies focus specifically on the area of acute jaw pain. The major goals of the present investigation were to add a current understanding of psychosocial profiles of patients with acute TMDs, and to investigate the differences in treatment of acute TMD pain with biobehavioral and self-care treatment regimens.

CHAPTER TWO
Review of the Literature

Defining Temporomandibular Joint Disorders

Temporomandibular joint disorders, commonly referred to as TMDs, TMJ, or TMJDs, are a collection of disorders characterized by orofacial pain, chewing dysfunction, or a combination of the two (National Institutes of Health, 1996; NIH). TMD ranks as one of the highest commonly occurring musculoskeletal conditions resulting in pain and disability, second only to chronic low back pain, and is the most common cause of facial pain (National Institute of Dental and Craniofacial Research, 2008; NIDCR). Common symptoms of facial pain reported by TMD patients include pain, headache, joint discomfort or dysfunction, earaches, ringing in the ear, dizziness, pain in the upper and lower back, or neck aches (American Dental Association, 2009; Cooper & Kleinberg, 2007; Glaros, 2008; ADA). In addition to these pain symptoms, patients may experience clicking, popping, or grating noises when opening or closing the mouth (ADA, 2009; Glaros, 2008). Pain may also be accompanied by dental changes, such as tooth wear and excessive overbite (Cooper & Kleinberg, 2007). The severity of TMD symptoms can range from noticeable, but otherwise insignificant problems, to seriously debilitating pain and dysfunction, impairing a patient's normal activities (NIH, 1996).

Data indicate that the prevalence of TMD is between 5-15%, with some studies showing a greater prevalence of symptoms in women (NIH, 1996; Phillips, Gatchel, Wesley, & Ellis, 2001). According to the NIDCR (2008), treatment for TMDs costs an average of $4 billion annually. While insurance companies may cover the diagnosis of

TMD, most will not cover the treatments offered by clinicians (ADA, 2009). In a study analyzing the cost-effectiveness of treatments, Stowell, Gatchel, and Wildenstein (2007) concluded that patients receiving early biobehavioral intervention treatments had a significant decrease in health-care expenses after one year compared to patients with no biobehavioral intervention treatment. Furthermore, researchers (Stowell, et al., 2007) found that pain related to TMD decreased over time. Therefore, early intervention not only prevents the progression of TMD symptoms, as they found, but it is also more cost-effective for the patient.

Research Diagnostic Criteria

Researchers and clinicians have used varying terminology and diagnostic classifications over the years. However, a dual-axis system developed by Dworkin and LeResche is generally accepted as the best and most widely used classification scheme for TMD (Okeson, 1997). This system, referred to as the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD), was developed in order to define the subtypes of TMD and to standardize the diagnosis of TMDs. The RDC/TMD is comprised of two parts: the history questionnaire and self-report measures completed by the patient; and a physical examination, which is conducted by a trained clinician (see Tables 1 and 2). The RDC/TMD has two particular strengths: clinical researchers have the capability to accurately diagnose TMD in a standardized format; and the RDC/TMD is a comprehensive conceptualization of the disorders (Dworkin & LeResche, 1992). Another strength of the RDC/TMD is that imaging, albeit useful, is not necessary.

Clinicians use physiological measurements and patient reports to diagnose TMD conditions.

Axis I

Axis I of the RDC/TMD assesses the clinical characteristics of TMD, by means of palpation and physical measures of oral and facial tasks (Dworkin & LeResche, 1992). Clinicians palpate 16 muscle sites extraorally and 4 muscle sites intraorally and the patient scores his or her pain during the muscle palpation on a scale from 0 to 3, with 0 signifying “no pain”. Examiners also take measurements of mandibular opening and joint sounds. Diagnoses are split into three categories: masticatory muscle disorders; disc displacements; or other degenerative joint conditions, such as arthralgia and osteoarthritis. Group I (muscle disorders) includes two subgroups, which are defined based on jaw opening limitations. The first subgroup (myofascial pain) refers to pain in the muscle and is associated with pain or tenderness in response to palpation. The second (myofascial pain with limited opening) is described as restricted movement and inflexibility of the muscle in addition to muscle pain. Disc displacements (DD) constitute Group II of the clinical conditions and includes three subcategories, which are also defined based on the restrictions of the mandible opening. The first subgroup is disc displacement with reduction, which occurs when the disc is shifted from its original position and typically results in a noise or clicking sound. A click is a distinct sound that has a definitive beginning and ending. The second subgroup is disc displacement without reduction, with limited opening. In this disorder, the disc is also shifted from its normal position, but it is also associated with restricted opening of the jaw. In addition, there is

an absence of joint sounds or the sounds do not meet the criteria of disc displacement with reduction. The final subgroup (disc displacement without reduction and without limited opening) is a condition in which the disc is not in its original position between the condyle, but does not include joint sounds or a limitation in mandible opening. Group III includes degenerative joint diseases (DJD), namely arthralgia, arthritis, and arthrosis. Arthralgia is pain or tenderness of the joint and is primarily based upon self-reports. Osteoarthritis is an inflammatory condition of the joint and includes arthralgia, as well as coarse crepitus or degeneration of the joint. Coarse crepitus is a continuous sound over a longer period of mandible movement and is the sound of bone grinding against bone. Alternatively, the examiner may hear fine crepitus, which is a finer continuous grating sound and may make overlapping continuous sounds. Osteoarthrosis occurs when the joint structure is abnormal. Patients presenting with osteoarthrosis do not experience joint pain or tenderness, but have coarse crepitus or degeneration of the joint.

The RDC/TMD diagnoses within the three groups are not mutually exclusive, allowing a patient to be diagnosed with anywhere from zero up to five diagnoses (one muscle diagnosis, one disc displacement, and one diagnosis from Group III for each joint). However, it is very uncommon for a patient to be assigned more than three diagnoses in practice.

Axis II

The Axis II portion of the RDC/TMD provides a reliable, valid assessment of psychosocial factors, including: pain intensity, pain-related disability, depression, and nonspecific physical symptoms (i.e., somatization; Dworkin & LeResche, 1992;

Dworkin, Sherman, et al., 2002). While pain is the hallmark feature of TMDs, functional limitation is also important in the assessment of patients' disability in association with these disorders. The RDC/TMD blends three reliable clinical questionnaires in order to assess for psychosocial factors. The questionnaire combines items from the Multidimensional Pain Inventory (MPI), Medical Outcomes Survey-Pain Index, and methods of grading chronic pain severity (Dworkin & LeResche, 1992). In order to screen for depression and assess the severity of nonspecific physical symptoms, the RDC/TMD includes scales from the Symptom Checklist 90 (SCL-90). Finally, a brief jaw disability checklist is incorporated to assess the amount of interference TMD has on patients as it relates to mandibular function, such as talking or chewing.

Characteristic Pain Intensity (CPI) is a self-report measure that appraises current pain, average pain, and worst pain. The patient's score is derived from Questions 7 through 9 of the RDC/TMD history questionnaire, and ranges from 0 to 100 (Dworkin & LeResche, 1992). Relatedly, the Graded Chronic Pain Scale (GCPS) is a measure of psychosocial functioning which assesses pain intensity, interference with usual activities, family and leisure activities, work-related activities, and disability days due to pain (Dworkin & LeResche, 1992). Disability points are obtained from the GCPS and informs researchers the extent to which TMD pain interferes with daily activities and the number of lost activity days. This score, ranging from 0 to 100, may be derived from Questions 11 through 13 of the RDC/TMD history questionnaire. As seen in Table 2, the GCPS uses simple scoring rules to categorize pain severity into four hierarchical groups. Grade I is TMD pain of low intensity with little pain-related impediment. Grade II is high-intensity pain and is associated with low amounts of pain-related interference. Grade III

is related to pain-related disability with a high pain intensity. Grade IV is the most debilitating, with severely-limiting pain intensity and a high disability score.

The SCL-90 is integrated in the RDC/TMD in order to assess depression and somatization (Dworkin & LeResche, 1992). The somatization scales measure the number and severity of nonspecific physical symptoms without identifying the underlying cause of the symptoms. The RDC/TMD classifies symptoms associated with depression and somatization as normal, moderate, or severe based upon the patient's responses (see Table 3).

Thus, the RDC/TMD is a measure that gives the researcher or clinician several pieces of reliable information, including demographics, patient characteristics, Axis I diagnoses, and an Axis II profile.

Patient Classification

There are several ways of classifying TMD patients. Most commonly, patients are differentiated by either the stage of their disorder (i.e., acute or chronic) or by their risk category (high or low; i.e., risk for progressing from acute to chronic pain). Garofalo, Gatchel, Wesley, and Ellis (1998) evaluated differences between acute and chronic TMD. Acute patients were defined as those who sought treatment within six months of the initial onset of symptoms, and who had low characteristic pain intensity at the six month follow-up. In contrast, chronic TMD patients were identified as having pain symptoms for more than six months. Using a logistic regression analysis, these researchers found that measures on the RDC/TMD can predict patients who are at greater risk of developing

a chronic disorder. Chronic TMD patients significantly differed from non-chronic TMD patients in the following areas: they experienced more pain and disability as measured by the CPI; they had a greater score on the SCL-90-R Nonspecific Symptom Scale (Axis II); they had a higher GCPS rating; and they were female patients diagnosed with a muscle disorder (Group I disorder; Garofalo, et al., 1998).

Epker, Gatchel, and Ellis (1999) were able to predict, at a rate of 91%, whether an acute patient would develop chronic TMD by combining two variables: measurements of self-reported pain and the presence of myofascial pain. This finding, based on a logistic regression analysis, may be used to classify patients as low- or high-risk for developing chronic TMD. A more recent study (Wright, et al., 2004) found several psychosocial differences between low-risk patients and high-risk patients. High-risk patients scored significantly higher on measures of pain intensity and depression screenings. In addition, high-risk patients showed more dysfunctional overall coping skills than low-risk patients.

Risk Factors

Several risk factors are involved when predicting chronicity of TMD symptoms, including parafunctional activities, number of pain sites, coping skills or outlook on life, and gender. Parafunctional activities are activities involving the jaw and masticatory muscles, but are not associated with eating, drinking, or speaking, such as bruxism (Glaros, 2008). Glaros (2008) studied parafunctional activities and their relationship with TMD patients. For example, parafunctional behaviors that are often cited in this

population are clenching and grinding of teeth. While TMD patients may be unaware of their parafunctional activity, clinicians often see this in patients complaining of facial pain. For example, Kino et al. (2005) found that the majority of TMD patients (46.2%-64.7%) engaged in teeth clenching. Clenching oftentimes increases pain and can eventually produce myofascial pain or arthralgia in otherwise healthy, pain-free individuals. Other researchers (Glaros, Williams, & Lausten, 2005) found that muscle tension in the jaw, face, head, or combination of the three was a significant predictor of jaw pain and accounted for 69% of the overall variability in jaw pain ratings. Thus, frequently engaging in parafunctional behaviors can lead to a diagnosis of TMD (Glaros & Burton, 2004).

In addition to engaging in parafunctional activities, the number of pain sites and/or number of RDC/TMD Axis I diagnoses may also increase a person's risk of developing TMD. In a predictive study completed by LeResche and colleagues (LeResche, Mancl, Drangsholt, Huang, & Korff, 2007), adolescents who complained of pain conditions other than TMD, such as back pain, headache, or stomach pain, were as much as four times more at risk to develop orofacial pain than adolescents who did not report pain symptoms. Garofalo, Gatchel, Wesley, and Ellis (1998) studied acute versus chronic TMD patients and found that chronic patients had a significantly higher number of RDC/TMD Axis I disorders in comparison to non-chronic patients. Likewise, Wright et al. (2004) found that high-risk patients tended to have significantly more overall current or lifetime RDC/TMD Axis I diagnoses. Chronic patients at the six-month follow up period were more likely diagnosed with a muscle disorder than a disc displacement or other joint condition. Furthermore, chronic patients reported higher measures of pain

intensity and disability at the initial interview compared to nonchronic patients (Garofalo, et al., 1998).

A person's view of his or her illness also impacts the risk of developing chronic TMD. One study (Wright, et al., 2004) demonstrated that patients with an anxious component to their illness were more likely to fall in the high-risk category, whereas patients with a depressed component were more likely to be in the low-risk category. The same study cited the primary difference between the two groups was an "…increased number of somatic symptoms, such as clenching and grinding, among patients with anxiety disorders, as well as an increased tendency to deny the intensity of their feelings" (Wright, et al., 2004, p. 481). In addition, LeResche, et al. (2007) found that adolescents who reported having a low satisfaction with life have an increased risk of experiencing clinically significant TMD pain. Poor coping skills may also be a predictor of developing chronic TMD symptoms (Wright, et al., 2004).

A final predictor that is commonly cited is gender (Garofalo, et al., 1998; Huang, LeResche, Critchlow, Martin, & Drangsholt, 2002). Garofalo et al. (1998) noted that female patients were more likely to report ongoing pain symptoms after six months. Cook and Chastain (2001) found that men and women with chronic pain have unique symptom patterns and associated distress. Phillips, Gatchel, Wesley, and Ellis (2001) also ascertained that being a female with a diagnosis of a muscle disorder is highly predictive of later chronicity of TMD symptoms. Other gender differences were found in evaluating research diagnostic criteria as well. Primarily, women who developed chronic TMD suffered more from somatization and anxiety disorders, whereas men who developed chronic TMD were diagnosed more with personality disorders than women (Phillips, et

al., 2001). Huang et al. (2002) cited five common risk factors for myofascial (muscular) pain, including facial trauma (i.e. car accident), clenching of the jaw, third molar removal, somatization, and female gender. Noting these gender differences is important so that clinicians can successfully implement treatment programs for patients. For example, an investigation by Bragdon et al. (2002) showed that men respond differently to pain than women. Specifically, men demonstrated more tolerance to modalities of pain than women did. Furthermore, this study provided evidence that women with TMD have a dysregulation in their pain system, making them more sensitive to experimental pain than pain-free women.

Psychosocial Factors Associated with Temporomandibular Disorders

TMD and Psychopathology

TMD can be devastating, and several researchers have demonstrated that TMD has a relationship with certain psychopathologies (Gatchel, et al., 1996; Kight, et al., 1999; Sherman, et al., 2004; Vimpari, Knuuttila, Sakki, & Kivela, 1995). Vimpari et al. (1995) found that depressed men and women were more likely to have clinically severe symptoms of temporomandibular joint pain and dysfunction syndrome compared to men and women who were not depressed. In a study carried out in Japan, Kino and associates (2005) compared the psychosocial factors found in the subtypes of TMD. They found that patients with myofascial pain (RDC/TMD Group I Disorders) were more likely to experience depressive symptoms. Moreover, Kight, Gatchel, and Wesley (1999) provided evidence that TMD has strong correlations with mood disorders, anxiety disorders, and

substance use disorders. Similarly, Gatchel, Garofalo, Ellis and Holt (1996) revealed that patients with chronic TMD had significantly more current diagnoses of anxiety disorders, mood disorders, and somatization disorders. Interestingly, the chronic group also had significantly more diagnoses of borderline personality disorder. In a study comparing jaw pain to low-back pain, researchers (Edwards, et al., 2006) found that patients with jaw pain commonly use benzodiazapines, which is perhaps related to these patients presenting with more somatoform disorders and anxiety disorders.

Gatchel et al. (1996) also found that patients with acute TMD were more frequently diagnosed with anxiety disorders, whereas chronic TMD patients were more likely to suffer from affective disorders (i.e. Major Depression). Alternatively, Wright et al. (2004) compared low-risk patients to high- risk patients and found that the high-risk group had a greater prevalence of anxiety disorders and somatoform disorders. The researchers (Wright, et al., 2004) also found that high-risk patients were almost four times more likely than low-risk patients to have met criteria for a Cluster C personality disorder (i.e., avoidant personality disorder, dependent personality disorder, or obsessive-compulsive personality disorder). The principle traits of Cluster C disorders are anxiety and fearfulness (American Psychiatric Association, 2000). Patients with painful TMD can also display alexithymia (i.e., having difficulty in identifying and/or expressing feelings to others; Glaros & Lumley, 2005). These studies imply that TMD can exacerbate psychosocial factors, such as pain disorders and mood disorders. Likewise, psychopathology can impact the severity of TMD symptoms; for instance, patients with comorbid anxiety disorders tend to “clamp down” on their jaws or clench more frequently.

Some researchers (McCreary, Clark, Merril, Flack, & Oakley, 1991; Reibmann, John, Wassell, & Hinz, 2008) have attempted to classify typical psychosocial stressors based on TMD subcategories. Although patients with myofascial pain disorders (Group I on the RDC/TMD) report higher pain levels, as well as more distress compared to patients with arthritic conditions, results show similar levels of depression and anxiety (McCreary, et al., 1991). Furthermore, researchers have been unable to find any psychosocial differences between the diagnostic categories outlined in the RDC/TMD that are applicable to clinical settings (McCreary, et al., 1991; Reibmann, et al., 2008). In a study of chronic TMD patients (Reibmann, et al., 2008), researchers concluded that tailored treatments based solely on a patient's RDC/TMD diagnosis should not be utilized.

Dysfunctional Pain and Disability

The majority of TMD patients experience either a GCPS Grade I or II disability (approximately 84%); however, almost 16% of TMD patients experience pain severity that is moderately to severely limiting (Grade III or IV; von Korff, Ormel, Keefe, & Dworkin, 1992). TMD pain patients in von Korff et al.'s study (1992) were most likely to report persistent pain for 90 or more days in the previous 6 months compared to patients suffering from back pain or headaches. Kino et al. (2005) compared different factors that impact patients' pain based on the various subtypes of TMD outlined in the RDC/TMD. Common complaints that were reported by over 50% of patients, regardless of their TMD diagnosis, were unilateral chewing, difficulty opening the mouth, and jaw pain upon waking (Kino, et al., 2005). Kino et al. (2005) also found that patients with a diagnosis of

myofascial pain reported higher disability scores in daily activities of living compared to the other subtypes. Another difference was the duration of pain in arthralgia. Patients with arthralgia had a significantly shorter duration of pain than those with MPD or DD.

Treatment of Temporomandibular Disorders

TMD patients today have a broad variety of treatments to choose from. However, these treatments can be expensive, and insurance companies do not normally cover the cost of TMD treatments (American Dental Association, 2009). White, Williams and Leben (2001) found that patients with TMD used more services and had higher costs compared to other dental patients. They also found that a small proportion of the subjects in the study accounted for a large proportion of the costs (White, et al., 2001). Treatment needs for TMDs are considerable in the general adult population. Researchers (Al-Jundi, John, Setz, Szentpetery, & Kuss, 2008) estimated the prevalence of treatment need for TMD is 16% for the general population. However, these same researchers noted that treatment needs vary according to the definition, geographic location, and age. Al-Jundi et al. (2008) found that the majority of TMD patients are between the ages of 15 and 45 years old. While women may be more likely to develop TMD during their lifetime (LeResche, et al., 2007), Nassif, Al-Salleeh, and Al-Admawi (2003) found that young males also have significant treatment needs. In a sample of 523 adolescent males, 75% had TMD signs or symptoms, with almost 17% suffering from severe signs and/or symptoms.

TMD patients seek pain relief from a wide variety of health care providers, including dentists, chiropractors, massage therapists, oral surgeons, ophthalmologists,

physical therapists, and psychologists (Stowell, et al., 2007). A growing number of patients are also exploring more non-traditional treatments, such as acupuncture (Shin, Ha, Song, & Lee, 2007). Because insurance companies rarely cover the treatment cost of TMDs, affordability of care typically dictates the type of treatment sought out by a patient (ADA, 2009). Treatment of TMD can be divided into two main groups, non-surgical interventions and surgical intervention. Non-surgical interventions include treatments such as counseling, physiotherapy, pharmacotherapy, and occlusal splint therapy. On the other hand, surgical interventions include arthrocentesis, arthroscopy, and arthrotomy.

Self-Care Treatment Programs

Structured, therapist-led self-care regimens have shown positive results with pain management in TMD (Dworkin, Huggins, et al., 2002). A recent study developed a tailored self-care program for TMD patients and compared it to usual treatment (Dworkin, Huggins, et al., 2002). Usual treatment was defined as the normal treatment attending dentists used when treating their TMD patients. Treatments were used at the discretion of the participating dentists, and included physiotherapy, patient education, medication, and/or occlusal appliances. In contrast, the self-treatment group received a structured treatment in which researchers used a three-session intervention that highlighted the importance of education and self-care. Patients were educated and given readings about TMD, pain, and stress management. During sessions, patients practiced relaxation and stress management skills, such as abdominal breathing and progressive muscle relaxation. They were also taught to monitor their signs and symptoms. Finally,

with the guidance of a trained clinician, patients created a schedule of coping behaviors that targeted physical, emotional, or psychosocial factors specific to the their pain disorder. Findings revealed that patients involved in this self-care regimen had significantly fewer visits to the doctor, their perceived ability to cope improved, and general knowledge of TMD was enhanced compared to usual treatment.

Biopsychosocial Interventions

Cognitive-behavioral interventions directed towards TMD have been studied in depth by several researchers (Gardea, et al., 2001; Stowell, et al., 2007; Suvinen, Reade, Kemppainen, Kononen, & Dworkin, 2005). Such treatments are comprehensive and typically involve a combination of skills training and biofeedback. By and large, programs that involve relaxation techniques, electromyography, biofeedback training, and education can be more effective in treating TMD compared to occlusal splints alone or no treatment at all (Medlicott & Harris, 2006). Stowell and colleagues (2007) found that cognitive-behavioral programs that emphasized early intervention for high-risk patients were not only beneficial to the patient in terms of symptom reduction, they were also cost-effective. Those receiving interventions early in their diagnosis experienced a significant reduction in TMD-related health care expenses over the course of one year compared to those who received no intervention.

Gardea, Gatchel, and Mishra (2001) studied the long-term efficacy of biobehavioral treatments for patients with TMD. Specifically, they compared biofeedback, cognitive-behavioral skills training (CBST), a combination of biofeedback and CBST, and no treatment. After one year, patients that received a combination of

biofeedback and CBST were better able to manage their pain based on CPI scores. The combined group also showed significant improvement on Graded Chronic Pain Scales, implying that the patients were able to minimize any interference with daily activities, especially those involving facial movement.

Thus, in order to more effectively treat and prevent TMD, clinicians and researchers must strive to obtain a better understanding of the demographics, personalities, and specific needs of TMD patients. Early intervention is beneficial and necessary to prevent TMD from reaching the chronic stage.

Physical Therapy

A recent meta-analysis by Medlicott and Harris (2006) concluded that physical therapy may be effective for patients with an impaired total vertical opening, which can arise from disc displacement, arthritis, or myofascial disorders. Treatment protocols often include active exercises, manual mobilizations, and an at home exercise program for participants (Medlicott & Harris, 2006). Michelotti and associates (Michelotti, de Wijer, Steenks, & Farella, 2005) described home exercise regimens to include several components, such as patient education, counseling, thermotherapy, auto-massage, stretching exercises, coordination, and mobilization exercises. It is believed that therapeutic exercise for musculoskeletal complaints improve an individual's overall functioning; however, researchers concluded that the actual efficacy of physical therapy for TMDs is unknown, given the limited number of randomized clinical trials in the literature (Michelotti, et al., 2005).

Habit-reversal training and proper uses of the jaw is commonly integrated into the patient education component of physical therapy. As stated previously, parafunctional behaviors oftentimes go unnoticed by TMD patients (Glaros, 2008). In order to raise awareness of these activities and decrease its effect, Glaros (2008) suggests employing habit reversal training. The training consists of the following three steps: heightening the patients' consciousness of the unwanted behavior; developing an alternative to the behavior; and substituting the alternative behavior for the unwanted behavior. Clinicians utilizing habit reversal training may use biofeedback to aid in the increase of patients' attentiveness to parafunctional behaviors.

Pharmacotherapy

TMD patients are commonly prescribed medications to help with the symptoms associated with TMD. In fact, researchers (Johansson Cahlin, Samuelsson, & Dahlström, 2006) have noted that 51% of TMD patients use some form of pharmaceutical on a regular basis compared to 36% of matched controls. The most commonly utilized medications for women with a muscle disorder are antidepressants (26%), sleep medications or sedatives (7%), and tranquilizers (6%; Johansson Cahlin, et al., 2006). Opioid analegesics are also commonly prescribed for patients with chronic facial pain (Zuniga, 1998). However, in terms of opioid treatment, Zuniga (1998) asserted that long-term opioid use to treat TMDs is not justified based on current data.

Occlusal Splint Therapy

Dahlstrom and Carlsson (1984) found that patients who were younger and had a shorter duration of symptoms were more likely to have favorable results with occlusal splints compared to biofeedback. Researchers (Dahlström & Carlsson, 1984) found that both biofeedback training and splint therapy were effective treatments for patients at the one-month mark as well as the 12-month examination. Furthermore, there were no significant differences between biofeedback and splints in any respect. In a more recent study, Emshoff (2006) found that occlusal splint therapy provided a total remission from TMD pain symptoms for 41% of patients. Emshoff (2006) also determined that splint therapy was less effected for chronic patients (onset greater than two years) compared to acute TMD patients (onset 6 months or less).

Surgical Approaches

Surgical interventions on the temporomandibular joint (TMJ) are considered a more extreme treatment typically considered useful for a small percentage of patients. Surgery is usually indicated only after more conservative treatments have failed, and patients have one or more of the following: persistent moderate to severe pain; the pain is deemed disabling; and/or evidence of a pathologic condition (NIH, 1996). Surgical approaches include "…arthrocentesis, arthroscopy, arthrotomy/ arthroplasty, condylotomy, orthognathic surgery, and even total TMJ replacement" (NIH, 1996, p. 5).

Rationale for the Current Study

Research has been conducted in various areas of TMD. However, a thorough literature review (Ovid MEDLINE(R), PsychINFO, PubMed; October 13, 2009) revealed that most studies have focused on chronic subjects and/or have limited follow-up. The purpose of this study was to evaluate the biopsychosocial factors that affect an acute pain population, specifically, participants who may have any of the subcategories of TMD as outlined in the RDC/TMD. If a relationship exists between psychosocial factors and the differing subcategories of TMD, health care providers and clinical researchers may be able to diagnose and tailor treatments to their patients with greater ease. Furthermore, such knowledge will improve our general understanding of patients suffering from jaw pain and discomfort.

The present study also examined the outcomes of three different treatment groups of acute TMD participants at the one-year post-intake evaluation in an ongoing program. These treatment groups were as follows: high-risk participants who received a biobehavioral treatment (HR/BB); high-risk participants who followed a structured, therapist-led self-care regimen (HR/SC); and low-risk participants who received no intervention beyond usual care (LR/NI). This information will give clinicians a greater understanding of the types of non-invasive treatments that will best manage the psychosocial problems associated with TMD. This study is important because there is little information on the treatment of acute TMDs, particularly when the subcategories of TMD are compared to each other. Moreover, this was a community-based study, in which

researchers and clinicians worked with participants within a dental or clinical setting in the community, based upon direct patient referral from within these clinics.

Scope of the Current Investigation

Diagnostic-Related Hypotheses

Patients with chronic MPD (Group I on the RDC/TMD) report higher pain levels, as well as more distress compared to patients with arthritic conditions (McCreary, et al., 1991). Kino et al. (2005) also found that chronic TMD patients with a diagnosis of MPD reported higher disability scores in activities of daily living compared to other diagnostic categories. However, the current body of literature has not investigated biopsychosocial factors of RDC/TMD Axis I diagnoses in acute TMD patients. As mentioned previously, Epker, Gatchel, and Ellis (1999) were able to predict whether an acute patient would develop chronic TMD at a rate of 91% by combining two variables: measurements of self-reported pain and the presence of myofascial pain. Thus, patients with MPD could have a more dysfunctional biopsychosocial profile compared to patients with either DD or DJD. Therefore, the following hypotheses were proposed:

1. a. It was anticipated that patients with a myofascial pain disorder (MPD) would have higher CPI (Characteristic Pain Intensity) and GCPS (Graded Chronic Pain Scales) scores compared to patients with disc displacement (DD) or a degenerative joint condition (DJD) at baseline.

   b. It was expected that patients with MPD would show greater psychological distress (i.e., higher rates of depression symptoms) as measured by depression

and somatization scales on the RDC/TMD in comparison to patients with either disc displacements or degenerative joint conditions at pre-intervention.

2. It was anticipated that participants with MPD would show greater dysfunction in physical measures of chewing performance compared to participants with DDs or other DJDs using the self-reported pain scale and particle size breakdown measured by the Functional Chewing Performance assessment at baseline.

Risk-Related Hypotheses

According to a study in 2004 by Wright and colleagues, high-risk patients are more likely to have an anxiety or somatoform disorder, which could be related to perceived stress. In addition, several studies have found that early intervention for acute TMD patients have a significant effect on patient's functioning (e.g., Epker, et al., 1999; Gardea, et al., 2001; Garofalo, et al., 1998). Thus, the following risk-related hypotheses were proposed:

3. It was predicted that high-risk participants would have higher rates of perceived stress compared to low-risk participants based on the Perceived Stress Scale at pre-intervention.
4. It was anticipated that both the HR/BB and HR/SC patients would show improvement in physical functioning (GCPS), report lower levels of self-reported pain (CPI), and have lower levels of self-reported depression at long-term follow up (one year) compared to pre-treatment measurements.

Treatment-Related Hypotheses

Previous studies have shown the effectiveness of early biopsychosocial interventions with patients who were at a high risk of developing chronic TMD (Gatchel, et al., 2006). In a study evaluating the methodological quality of systematic reviews of the treatment of TMDs, researchers (Bessa-Nogueira, Vasconcelos, & Niederman, 2008) concluded that many studies have inadequate or inaccurate measurements, sample size, and patient follow-up. These researchers also raised concerns that studies need "more attention to clinical trial design, implementation, and reporting" (Bessa-Nogueira, et al., 2008, p. 34) in order to provide the best patient care. The current study investigated the effectiveness of a biobehavioral treatment group versus a self-care treatment regimen. Therefore, the following hypotheses were predicted:

5. It was predicted that, at long-term one-year follow up, all HR/BB participants would have significantly lower levels of self-reported pain (CPI scale scores) compared to patients in the HR/SC group.
6. At one-year follow up, it was predicted that participants in the HR/BB group would have significantly better levels of psychosocial functioning (GCPS) than participants in the HR/SC group.
7. It was anticipated that, at the one-year follow up, participants in the biobehavioral treatment group would have fewer visits to health care providers due to jaw pain and/or discomfort compared to patients in the self-care treatment group.

CHAPTER THREE
Methodology

Participants

The cohort for analysis was drawn from patients recruited from community-based dental clinics in the Dallas/ Ft. Worth metroplex. The Baylor College of Dentistry of The Texas A&M University System Health Science Center was a participating clinic, as was Texas Women's University Dental Hygiene Clinic, which was supervised by Ms. Trisha Nunn. In addition to these sites, patients were recruited from the community dental practices of Drs. Riggs, Curtis, and Neely. Dr. Richard Riggs is an active dentist in Richardson, Texas, whose practice focuses on the evaluation and management of orofacial pain disorders using a multidisciplinary approach. Dr. David Curtis is located in Colleyville, Texas, and specializes in TMDs. Dr. Curtis has been in practice for over 20 years and also uses a multidisciplinary treatment approach. Dr. Michael Neely practices in the Highland Park area and actively researches migraine headaches of dental origin. Overall, a sample of 221 patients was evaluated for treatment for this study.

Research associates were all educated at the Masters-level and licensed in their respective disciplines (i.e., Social Work, Counseling). These evaluators were initially trained on the RDC/TMD administration by an experienced oral surgeon. Interrater reliability for correct completion of the TMD Exam form were conducted on non-subject volunteers prior to the beginning of the study. Quality control of evaluators was then maintained by re-evaluating randomly selected cases throughout the project, as well as re-calibrating evaluations. The initial guidelines delineated by Dworkin, LeResche and

Derouen (1988) were followed. In addition to training in the RDC/TMD, research clinicians were trained in biobehavioral and self-care treatment protocols by a licensed psychologist. They were also supervised by a licensed psychologist on a weekly basis via review of session recordings to ensure quality of treatment and protocol adherence.

Participants were considered eligible for participation if they were over 18 years old and had acute temporomandibular joint and muscle disorder (TMJMD) pain or discomfort for 6 months or less at the time of their entry into the study. Potential participants with a comorbid pain-exacerbating physical condition (such as other musculoskeletal pain conditions or cancer), or a history of jaw pain before the most recent episode, were excluded from the current study. Collaborating dentists and research associates at each clinical site determined patients' eligibility for this study. High-risk subjects (those at risk for progressing to chronic TMD) were identified at intake using an algorithm developed in previous studies to predict risk score (Epker, et al., 1999; Wright, et al., 2004). Participants were evaluated between September, 2008 and May, 2010.

Procedure

The participants in this study were primarily recruited and referred to the study by the aforementioned collaborating dental practices in the Metroplex. After the collaborating dentist or research associate determined a participant's eligibility, the potential participant was given a packet consisting of a consent form, HIPAA form, patient information form, and payment voucher ($20). Participants were then scheduled for a series of pre-intervention biopsychosocial (BPS) evaluations.

The pre-intervention biopsychosocial (BPS) evaluation was preferably completed within one week. The evaluation included both physical measures and psychosocial measures. A trained clinician administered the RDC/TMD, including the components of the “at-risk” screening algorithm. This algorithm consisted of: Question 3 from the RDC History Questionnaire; the Characteristic Pain Intensity (CPI); and the evaluation of oral facial pain, as assessed by muscle palpation on Items 1, 8 and 10 of the Oral Facial Examination. The trained clinician also administered the Functional Evaluation of Chewing Performance, another physical measure. The psychosocial measures that were included in this study was as follows: GCPS; CPI; Perceived Stress Scale; Beck Depression Inventory-II; Health Care Utilization, which collects information about types of care received, both related and unrelated to jaw pain; Medication Use Information; SF-36 Health Survey; Symptom Checklist; Headache Questionnaire; Orthodonic History Questionnaire; and Treatment Cost Data.

Based on results found during the pre-intervention screening, participants were assigned to one of three groups: high-risk, biobehavioral treatment group; high-risk, self-care treatment group; or low-risk, non-intervention group. There was an ongoing matching of all three groups for age, gender, race and time-since original-onset of TMJMD, based on an urn randomization procedure. The treating dentists were kept blind as to subject-group assignment.

The high-risk, biobehavioral group was administered six intervention sessions, consisting of individual meetings with a trained clinician who followed a standardized treatment protocol. These six sessions were optimally completed within approximately six weeks. During Session One, the clinician provided the participant with an overview

and rationale for the biobehavioral treatment. At the end of Session One, the participant was instructed in proper diaphragmatic breathing technique for the purpose of relaxation and pain management. In Session Two, participants were given relaxation training; specifically, they were taught progressive muscle relaxation. During Session Three, the clinician introduced the idea of the participant using relaxation skills in everyday situations. The clinician also introduced biofeedback training to reinforce skills acquisition. The clinician taught the participant distraction methods and activity scheduling in Session Four. Biofeedback was also integrated into Session Four. In Session Five, the participant was given a rationale for cognitive interventions and was taught how to identify and correct non-constructive automatic thoughts. The participant again received biofeedback training during this session. Finally, in Session Six, the clinician reviewed with the participant the skills he or she had gained over the past five sessions. The clinician also discussed how to maintain gains and helped the participants create a plan for coping with pain flares and reoccurrences in the future. In each of these sessions, participants were given handouts and assigned homework to complete before their next session. Participants were also provided with a comprehensive workbook, which included overviews of what was taught in each session and daily logs, in which participants recorded their pain or discomfort, their stress level, the frequency of stress, pain triggers, how they coped with the pain, and amount of sleep.

Participants who were assigned to the high-risk, self-care treatment group were also assigned six intervention sessions. However, the self-care group did not receive any training or coping techniques. Rather, this group was given several pertinent readings over the course of their treatment. These readings were geared towards teaching the

participant about TMDs, self-care activities, medications, patient-physician communication, treatment options, and nutrition. The trained clinicians reviewed the major points of the readings with the participant in session and gathered feedback and the participant's reactions to the readings. Participants were also asked to fill out a daily log, which tracked the participant's pain or discomfort, stress, and tension.

The low-risk, non-intervention group received whatever standard-of-care that would normally be offered to them and that they accepted as offered by any providers with whom they consulted. All care pertaining to the participants' jaw pain and discomfort was documented.

At the end of treatment and at the one-year mark, all participants, regardless of treatment assignment, were asked to participate in a post-intervention BPS evaluation that was identical to the pre-intervention BPS evaluation.

Of note, the current study was a competitive renewal of an ongoing TMJMD project, and many of the core co-investigators and collaborators had been involved in various aspects of this type of project for over the past ten years. The study used the same protocol used in Wright, et al. (2004) and Stowell, et al. (2007). This study was funded by the National Institute of Dental and Craniofacial Research through the University of Texas at Arlington and the Baylor College of Dentistry of The Texas A&M University System Health Science Center. The Institutional Review Boards (IRBs) at each institution approved of, and oversaw the current study, requiring that all members of the research team complete the necessary training regarding ethical treatment of participants.

Instruments and Outcome Measures

Patient Information Form

The patient information form is a study-specific data sheet that elicits information covering the following information: demographics, education, contact information, employment status, personal injury litigation involvement or worker's compensation, history of jaw pain (onset, date of treatment, type of treatment), and chronic health problems.

Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD)

The RDC/TMD is a system used to define the subtypes of TMD and to standardize the diagnosis of TMDs (Dworkin & LeResche, 1992). As reviewed earlier, the RDC/TMD is comprised of two axes. Axis I is a physical measure that outlines the clinical characteristics of TMDs, separating them into three subcategories: myofascial pain disorder (MPD); disc displacements (DD); and degenerative joint diseases (DJD). Axis II assesses psychosocial factors commonly seen in patients with TMDs.

Characteristic Pain Inventory (CPI)

The CPI is a self-report measure derived from the RDC/TMD History Questionnaire and appraises current pain, average pain, and worst pain in the jaw. The patient's score ranges from 0 to 100, with 100 being in the most pain. The mean score of Questions 7 through 9 are taken and then multiplied by 10.

Graded Chronic Pain Scale (GCPS)

The Graded Chronic Pain Scale (GCPS) is a measure derived from Axis II of the RDC/TMD and assesses pain intensity, interferences with usual activities, family and leisure activities, work-related activities, and disability days due to pain. A disability score gives researchers the extent to which TMD pain interferes with daily activities for a participant and the number of activity days that was lost due to pain. This score ranges from 0 to 100. The GCPS uses simple scoring rules to categorize pain severity into four hierarchical groups. Grade I is TMD pain of low intensity with little pain-related impediment. Grade II is high-intensity pain and is associated with low amounts of pain-related interference. Grade III is related to pain-related disability with a high pain intensity. Grade IV is the most debilitating, with severely-limiting pain intensity and a high disability score.

Perceived Stress Scale, 10-Item Version (PSS-10)

The PSS-10 is a shortened version of a 14-item instrument that is designed to measure the extent to which a person recognizes situations as stressful (Cohen, Kamarck, & Mermelstein, 1983). Participants are asked to rate their level of stress using a four point Likert scale. The PSS-10 may be used as an outcome variable to measure people's appraised levels of stress in life situations. The PSS-10 has been shown to be a reliable and valid measure of perceived stress (Roberti, Harrington, & Storch, 2006).

Chewing Performance Test

The major indices to be used are the evaluations of median particle size and broadness of the distribution as well as the participant's self-rating of pain. Standardized tablets (5 mm thick and 20 mm in diameter) of a new, softer CutterSil® (which is a condensation silicon impression material) are formed using a Plexiglass template. After hardening for at least one hour, the tablets are cut into quarters. Five portions, containing three quarter-tablets each, are packaged for each subject (Buschang, Throckmorton, Travers, & Johnson, 1997). Once the chewed samples are obtained from subjects, they are air dried in filter papers over a stainless steel colander. The samples are then separated using a series of 7 sieves, with mesh sizes 5.6mm, 4.0mm, 2.8mm, 2.0mm, 0.85mm, 0.425mm, and 0.25mm, stacked on a mechanical stacker and vibrated for two minutes. Once the sample is separated, the contents of each sieve are weighted to the nearest 0.01 gm. Cumulative weight percentages (defined by the amount of the sample that can pass through each successive sieve) are calculated for each chewed sample. From these percentages, the median particle size (MPS) and broadness of particle distribution are estimated using the Rosin-Rammler equation (Olthoff, van der Bilt, Bosman, & Kleizen, 1984).

Health Care Utilization Form

The health care utilization form is a clinician-administered form in which participants are asked when they first began experiencing jaw pain or discomfort. The participant is then asked to list the total number of visits to a heath care provider for any condition, including jaw pain; which visits were exclusively related to jaw pain; and what type of

professional rendered the service. The participant is also asked if he or she was hospitalized for any reason and if so, the reason for the hospitalization as well as the length of stay. This form is presented to participants throughout the study in order to determine their health care utilization and to track the cost of treatment.

Design and Statistical Analyses

Analyses were carried out to detect any significant differences in demographic variables between those participants with a MPD and participants with a DD or DJD. Additional analyses were conducted to identify whether significant differences exist in demographic variables between patients with MPD versus those without such a diagnosis. The following were included: gender, race, marital status, and education level. Demographic data were analyzed with Pearson Chi-Square analyses between group assignments. Participants' age was analyzed using a *t*-test. Although no differences were expected, the purpose of this analysis was to ensure that no demographic variables influenced the outcome of the study.

Statistical analyses of group mean differences of patients with myofascial pain disorder, disc displacement, and degenerative joint disorders were performed using one-way ANOVAs in order to evaluate the biopsychosocial profiles of differing TMD diagnoses. A MANCOVA was conducted to determine whether the type of RDC/TMD Axis I diagnosis had a significant impact on a participant's self-reported pain and his or her ability to breakdown materials by chewing. Repeated measures mixed ANOVAs were carried out on outcome measures administered at pre-treatment and one-year follow-up to

assess outcomes for group mean differences in high-risk versus low-risk participants. An independent-samples *t* test was conducted for the PSS data to compare population means scores of high-risk patients to low-risk participants. Repeated measures mixed ANOVAs were carried out in order to provide an initial analysis of the benefits of biobehavioral treatment compared to self-care treatment with regard to self-reported pain and psychosocial functioning. An independent-samples t-test was conducted in order to evaluate differences in the number of visits to health care providers from post-treatment to the one-year follow-up for jaw pain based on treatment group.

CHAPTER FOUR
Results

DEMOGRAPHICS

Demographic Variables: Descriptive Analyses

During the time period of September, 2008 to May, 2010, there were 221 patients that were screened and consented into this study. As can be seen in Table 4, 77.4% of this sample was female and 18.6% was male. The majority of the sample was Caucasian (66.1%). The remaining portions of the sample were comprised of Latino/a (12.2%), African-American (10.4%), Asian-American (2.7%), and Other races/ethnicities (5.0%). An additional 0.5% of the cohort did not endorse a demographic variable for Race/Ethnicity during intake. The average age of the sample was 43.11 years, and ranged 17-years-old to 80-years-old. The majority (44.3%) of the sample was married. A total of 35.3% of the sample was single, 11.8% was separated or divorced, 0.5% reported their spouse as deceased, and 3.2% of participants from this sample did not endorse any of the marital status choices during their intake. In terms of education level, all participants had at least an eighth grade education. The majority of participants (31.7%) had graduated from college and 18.2% of participants more than 17 years of education. The remainder of participants had 8-15 years of education (46.1%). A little over half of participants (53.4%) reported working either full- or part- time, whereas 41.2% were not employed; 3.6% participants from this sample did not report employment status.

Of the 221 patients that consented to the study, 189 participants completed the pre-intervention biopsychosocial evaluation and were eligible for treatment (see Table 5).

Over two-thirds (78.8%) of the sample was female and 21.2% was male. The majority of the sample was Caucasian (67.2%). The remaining portions of the sample were comprised of Latino/a (12.7%), African-American (11.1%), Asian-American (3.2%), and Other races/ethnicities (5.3%). An additional 0.5% of the cohort did not endorse a demographic variable for Race/Ethnicity during intake. The average age of the sample was 43.85 years, and ranged from 18-years-old to 80-years-old at the time of the baseline evaluation. The majority (46.6%) of the sample was married. A total of 37.0% of the sample was single, 12.2% was separated or divorced, and 1.1% reported their spouse as deceased during their intake. The most participants (52.9%) had graduated from college, with 19.6% participants reporting 17 or more years of education. The remainder of participants had 8 to 15 years of education (44.4%) or did not endorse highest grade completed (2.6%). A total of 35.4% of the sample was categorized as LR/NI, whereas 27.5% and 24.9% were randomized into the HR/BB and HR/SC treatment groups, respectively.

Group Composition by TMD Diagnosis

From the core sample of 189 patients who completed baseline measurements, 20 did not meet the criteria for an RDC/TMD Axis I diagnosis, 53 had a diagnosis of MPD, 28 had a diagnosis of either DD or DJD, and 88 had diagnosis of MPD in combination with either diagnoses of DD or DJD (see Table 6). Gender was a significant factor between TMD diagnoses, χ^2 (1, n= 189) = 9.80, p = .020. These results indicate that women were more likely than men to have a TMD diagnosis and seek treatment. Race/ethnicity was not a significant factor for participants with differing RDC/TMD Axis I Diagnoses, χ^2 (15, n=

189) = 14.90, p > .05. Likewise, marital status was not found to be a significant factor in for participants in the study, χ^2 (12, n= 189) = 14.59, *p* = .05. A one-way ANOVA for demographic differences demonstrated no significant differences in age for participants with varying RDC/TMD diagnoses, *F* (3, 185) = .48, *p* > .05. Finally, level of education was not a significant factor for participants with differing TMD diagnoses, χ^2 (6, n= 184) = 1.60, *p* > .05.

CHAPTER FIVE
Results

RDC/TMD AXIS I DIAGNOSTIC PROFILES

Psychosocial Measures

Overall, it was found that participants with a combination of MPD and other disorders (DD or DJD) differed significantly from participants with no diagnoses, MPD only, or DD or DJD only on many psychosocial variables (see Figures 1 and 2). As seen in Table 7, one-way ANOVAs were conducted to evaluate whether RDC/TMD Axis I diagnoses had an effect on participants' CPI or GCPS scores. There was a significant difference among the groups, F (3, 185) = 5.81, p = .001, η^2=.086. Follow-up tests were conducted to evaluate pairwise differences among the means using a Bonferroni adjusted alpha level of .0125 per test (.05/4). Results indicated that, on average, participants with a combination of MPD and other diagnoses (M = 57.65, SD = 18.15) reported more pain compared to those without an RDC/TMD Axis I disorder. In addition to higher CPI scores, participants with MPD combined with another TMD disorder (M = 32.82, SD = 26.04) had significantly higher GCPS scores compared to participants without an RDC/TMD Axis I Diagnosis (M = 20.09, SD = 23.10), F (3, 185) = 3.76, p = .012, η^2=.058. Post-hoc tests indicated that participants with MPD and either DD or DJD (M = 35.30, SD = 25.77) reported more interference with psychosocial activities compared to those without a diagnosis of TMD (M = 19.00, SD = 26.58).

Using the RDC/TMD History Questionnaire, participants with a mutual diagnosis of MPD and either DD or DJD (M = .97, SD = .78) had significantly higher levels of

depression (*M* = .49, *SD* = .51), *F* (3, 185) = 3.22, *p* = .024, η^2=.050 (see Table 7). A one-way ANOVA revealed that a mutual diagnosis of MPD and DD or DJD had a statistically significant effect on somatization, pain inclusive, *F* (3, 185) = 6.79, *p* < .001, η^2=.099. Follow-up tests were conducted to evaluate pairwise differences among the means using a Bonferroni adjusted alpha level of .0125 per test (.05/4). With regard to nonspecific physical symptoms with pain included, subjects with a combination of MPD and other diagnosis (*M* = .96, *SD* = .73) were more likely to have complaints of symptoms compared to those without any diagnosis (*M* = .41, *SD* = .26). Those with a mutual diagnosis including MPD also had more somatic complaints than those with a diagnosis of either DD or DJD (*M* = .49, *SD* = .41). There were also significant differences among participants with differing diagnoses of TMD in terms of nonspecific physical symptoms, pain excluded, *F* (3, 185) = 5.35, *p* = .001, η^2=.080. Post-hoc tests again revealed that those with MPD combined with either DD or DJD (*M* = .76, *SD* = .79) had more somatic complaints, excluding pain, compared to those with either no RDC/TMD Axis I diagnosis (*M* = .25, *SD* = .31) or those with a diagnosis of only DD or DJD (*M* = .33, *SD* = .47).

Physical Measures

As seen in Table 8, a MANCOVA was conducted to determine whether the type of RDC/TMD Axis I diagnosis had a significant impact on a participant's self-reported pain and his or her ability to breakdown materials by chewing. Diagnoses were separated based on a diagnosis of MPD and are as follows: no diagnoses, MPD diagnosis only, DD or DJD only, combination of MPD and DD or DJD. The Hotelling's Trace multivariate

test of overall differences among groups was statistically significant, Hotelling's = .194, F (12, 680) = 3.66, $p < .001$, partial $\eta^2 = .061$. Follow-up tests were conducted to evaluate pairwise differences among Axis I diagnoses. The Holm's sequential Bonferroni procedure was used to control for Type I error across four pairwise comparisons. There were significant differences in the amount of reported pain between participants with multiple diagnoses, including MPD, compared to those with no diagnoses, those with only MPD, and those with DD or DJD only. However, with regard to measures of median particle size breakdown, broadness of particle distribution, and cumulative weight after chewing, no differences were found among the RCD/TMD Axis I Diagnoses.

CHAPTER SIX
Results

HIGH-RISK VS. LOW-RISK PARTICIPANTS

Perceived Stress

Patients were asked to appraise their levels of stress in life situations. Analyses were then conducted based upon participants' risk category, regardless of group assignment (i.e., all HR vs. LR). In the high-risk category, approximately 61 participants had multiple diagnoses, including MPD, as seen in Table 9. On the other hand, approximately 20 participants had multiple diagnoses, including MPD, in the low-risk category. As seen in Table 9, an independent-samples *t* test revealed that risk category did not have a statistically significant effect on participants' perceived amount of stress at pre-intervention, $t\ (152) = -.99$, $p > .05$.

Treatment Outcomes at One-Year Follow-Up

Among the pre-treatment sample of high-risk participants who completed six sessions of treatment, data were collected at the one-year follow-up (n= 14) for participants who had progressed to those collection points. Repeated measures ANOVAs were performed for outcome measures and scales, including CPI, GCPS, and self-reported depression using the multivariate criterion of Hotelling's Trace (see Table 10).

CPI

The results of a repeated measures ANOVA showed that there was a significant difference in the CPI score from pre- to one-year follow-up, Hotelling's = 1.80, F (1,13) = 23.43, $p < .001$. However, multivariate tests indicate a non-significant treatment group-by-time interaction effect, Hotelling's = .04, F (2, 13) = .29, $p = .75$.

GCPS

With regard to functional disabilities, the results of a repeated measures ANOVA showed that there was a significant time main effect from pre- to one-year follow-up, Hotelling's = .60, F (1,13) = 7.80, $p = .015$. The treatment group-by-time interaction effect, however, was non-significant, Hotelling's = .25, F (2, 13) = 1.63, $p = .233$.

Depression

Overall, high-risk patients did not report lower levels of depression over time, Hotelling's = .03, F (1, 13) = .40, $p = .540$. The treatment group-by-time interaction effect was also non-significant, Hotelling's = .24, F (2, 13) = 1.53, $p = .253$.

CHAPTER SEVEN
Results

BIOBEHAVIORAL TREATMENT VS. SELF-CARE REGIMEN

Treatment Outcomes at One-Year Follow-Up

Among the pre-treatment sample of high-risk participants who completed all six sessions of biobehavioral or self-care treatment, data were collected at the one-year follow-up (n= 14) for participants who had progressed to those collection points. Of the treatment completers, ten participants were from the HR/BB group and four participants were from the HR/SC group. Repeated measures ANOVAs were performed for outcome measures and scales, including CPI and GCPS, using the multivariate criterion of Hotelling's Trace (see Table 11). Participants' overall health care utilization was measured using an independent-samples *t*-test (see Table 12).

CPI

The results of a repeated measures ANOVA showed that there was a significant difference in the CPI score over time, Hotelling's = 1.80, F (1,13) = 23.43, $p < .001$. However, the type of treatment participant's received (i.e., biobehavioral or self-care) was not found to be a significant factor in the reduction of CPI scores, Hotelling's = .05, F (2, 13) = .29, $p = .75$. It is likely that the small number of participants (n=14) that reached this time point impacted the results.

GCPS

With regard to functional disabilities, the results of a repeated measures ANOVA showed that there was a significant time main effect from pre- to one-year follow-up, Hotelling's = .60, F (1,13) = 7.80, p = .015. The treatment group-by-time interaction effect, however, was non-significant, Hotelling's = .25, F (2, 13) = 1.63, p = .233.

Health Care Utilization

When comparing the HR/BB group to the HR/SC group, the results of an independent-samples t-test showed that there was not a significant difference in the number of health care visits from pre-intervention to one-year follow up, t (12) = .768, p = .458 (HR/BB group M = 7.20, SD = 7.13; HR/SC group M = 4.25, SD = 4.03).

Treatment Outcomes at Six-Month Follow-Up

Subsequent analyses at the six-month follow-up were conducted in order to determine whether a trend towards significance between treatment groups existed. Among the pre-treatment sample of high-risk participants who completed six sessions of biobehavioral or self-care treatment, data were collected at the six-month follow-up (n= 27) for participants who had progressed to those collection points. Sixteen participants were assigned to the biobehavioral treatment group and 11 participants were assigned to the self-care treatment group. There were 27 participants in the Low-Risk/Non-Intervention category who reached the six-month follow-up at the time analyses were conducted. As

with the one-year follow-up analyses, repeated measures ANOVAs were performed for outcome measures and scales, including CPI and GCPS, using the multivariate criterion of Hotelling's Trace, seen in Table 13. Participants' overall health care utilization was measured using an independent-samples *t*-test (Table 14).

CPI

The results of a repeated measures ANOVA showed that there was a significant difference in participants' CPI score from pre-intervention to six-month follow-up, Hotelling's = 3.23, F (1,51) = 164.79, $p < .001$. Post-hoc analysis and Tukey HSD revealed that participants from the Low-Risk/ Non-Intervention group (n=27, μ=-14.05) reported significantly lower CPI scores compared to the High-Risk/ Biobehavioral group (p=.003). Additionally, participants in the Low-Risk/Non-Intervention (n=27, μ=-12.45) had significantly lower CPI scores than participants who were in the High-Risk/ Self-Care group (p=.03). However, there was no statistically significant interaction between CPI scores and the type of treatment high-risk participants received (i.e., biobehavioral or self-care; p >.05).

GCPS

With regard to functional disabilities, the results of a repeated measures ANOVA showed a significant difference in participants' GCPS scores from pre-intervention to six-month follow up, Hotelling's = .82, F (1,48) = 39.23, $p < .001$. The treatment group-by-time interaction effect was also significant, Hotelling's = .22, F (2, 48) = 5.27, $p = .009$. Post-hoc analysis and Tukey LSD revealed that participants in the Low-Risk/Non-Intervention

group (n=27, μ=-8.57) reported significantly lower GCPS scores compared to the High-Risk/ Biobehavioral group (p=.05). However, participants in the Low-Risk/Non-Intervention group (n=27, μ=-1.60) did not have a significantly different GCPS score compared to the High-Risk/Self-Care group. Additionally, no statistically significant interactions between CPI scores and the type of treatment high-risk participants received was observed (i.e., biobehavioral or self-care; p >.05). While all participants reported a significantly lower GCPS score from pre-intervention to six-month follow up, participants who received either the biobehavioral or self-care treatment had reported less disability due to jaw pain than the non-intervention group at the six-month follow up (see Table 15).

Health Care Utilization

When comparing the participants who received the biobehavioral treatment as opposed to participants who followed a self-care treatment regimen, the results of an independent-samples *t*-test revealed there were no significant differences between groups from pre-intervention to six-month follow up, t (26) = -.10, p = .924 (Biobehavioral treatment n= 13, M = 7.23, SD = 6.15; Self-Care Treatment n=13, M = 7.54, SD = 9.64).

CHAPTER EIGHT
Conclusions and Recommendations

The purpose of the present study was to examine the biopsychosocial profiles of patients with differing diagnoses of TMD using the RDC/TMD and other measures of physical functioning. Also, perceived stress and outcomes were examined among high-risk participants. Secondarily, this study presented a preliminary investigation of the long-term outcomes of biobehavioral treatment versus a self-care regimen. The major goals of the present investigation were to add to the current understanding of the diagnostic categories of TMD and perform preliminary analyses of treatment outcomes at the one-year follow-up.

Diagnostic-Related Hypotheses

It was hypothesized that participants with MPD would differ significantly on physical and psychosocial measures of functioning. Specific hypotheses were that participants with MPD would endorse higher CPI scores, higher GCPS scores, more depressive symptoms, more somatization, and less functional chewing performance. Findings revealed that, among acute TMD participants, those with multiple diagnoses, including MPD, were more likely to report higher pain as well as more interference with daily activities due to pain compared to participants who did not have a TMD diagnosis. Participants diagnosed with mutual diagnosis of MPD and DD or DJD also had significantly higher symptoms of depression compared to participants with no diagnosis.

Finally, participants with MPD and DD or DJD reported higher somatization compared to participants with a no diagnosis and participants with a diagnosis of only DD or DJD. Participants with more than one diagnosis, including MPD, may experience more pain, thereby affecting their depressive symptoms, somatization, and ability to engage in daily activities. Other studies have found similar results with regard to chronic TMD patients (Kino, et al., 2005; McCreary, et al., 1991). While having only one diagnosis does not significantly differ from a healthy control, participants with multiple diagnoses including MPD were found to experience many more biopsychosocial interferences. This could be related to the fact that the presence of MPD is a major predictor of acute TMD developing into chronic TMD without proper intervention (Epker, et al., 1999).

With regard to chewing performance, participants with a combination of MPD and DD or DJD significantly differed in the amount of reported pain compared to participants with no diagnoses, only MPD, or DD or DJD diagnoses at the pre-intervention stage. Measures of median particle size, difference in particle weight before and after chewing, and broadness of particles were all found to be non-significant. While participants with a combination of MPD and other disorders reported a greater amount of pain and dysfunction compared to those without a diagnosis, only a diagnosis of MPD, or a diagnosis of DD or DHD, there was not a physical difference in chewing performance and functioning. This suggests that while participants with multiple disorders may experience more pain while chewing, their functioning is not impaired.

Risk-Related Hypotheses

It was hypothesized that acute, high-risk participants would present with higher rates of perceived stress in comparison to acute, low-risk participants. However, this hypothesis was found to be incorrect, as there was no significant difference found in perceived stress between the two groups. It could be speculated that risk score is more related to a person's coping style and reaction to stress, rather than his or her perceived amount of stress. Future studies may use a coping inventory coupled with the Perceived Stress Scale, such as the Ways of Coping Inventory (Folkman, Lazarus, Dunkel-Schetter, DeLongis, & Gruen, 1986).

It was predicted that high-risk participants would show more improvement on CPI scores, GCPS scores, and depressive symptoms one year post treatment, regardless of the treatment they received. While results were preliminary, time was found to be a significant indicator of improved functioning. However, treatment group assignment was not indicative of improved symptomatology. It is likely that the type of group assignment was not significant due to the very limited amount of participants (n=14) who reached the one-year mark at the time this study was conducted.

Treatment-Related Hypotheses

Gatchel et al. (2006) found that, on average, acute TMD patients had reduced pain levels at the one-year follow-up after participating in an early intervention biobehavioral skills training with biofeedback. The present study hypothesized that participants who received

biobehavioral treatment would likewise report significantly lower levels of self-reported pain, more so than participants who received a self-care treatment regimen. While findings suggest that both biobehavioral and self-care treatment groups benefited from early intervention over time in terms of pain, there was not a significant difference between the two treatment groups. It is extremely likely that the small number of participants (n=14) who reached the one-year mark at the time of data analysis impacted the significance and power of the results.

Six-month analyses were then conducted to determine whether a trend towards significance existed. Findings suggested that all participants reported significantly improved levels of pain at the six-month follow-up. Findings revealed that the Low-Risk/Non-intervention group had significantly lower levels of self-reported pain compared to participants in either High-Risk/Biobehavioral or High-Risk/Self-Care groups. However, no differences were found between the types of intervention received. This could be an indication that the most important component of psychosocial treatment for TMD patients is education and attention. In a recent study by Turner, Mancl, and Aaron (2006), chronic TMD patients were assigned to either CBT or an attention/education control group. They found greater improvement in pain, activity interference, jaw functioning, and depression in patients were assigned to CBT versus the education/attention group. It is expected that these results will be replicated in this present study.

The current study also hypothesized that participants would report an increase in psychosocial functioning and experience less interference with daily activities. The results suggest that, over time, participants engaging in biobehavioral or self-care

treatment will have better levels of functioning as measured by the GCPS. These findings support the advantage of early intervention treatment for TMD patients, regardless of the type of non-invasive treatment that is received. There was not a significant difference between the two treatment groups. Again, additional evaluation with more one-year follow-up data will provide much more information than this very preliminary study. Six-month analyses were conducted to determine whether there was a trend towards significance between treatment groups in terms of GCPS scores. As was found in the one-year analyses, all participants reported lower disability levels due to jaw pain at the six-month follow-up. While the Low-Risk/Non-Intervention group reported significantly lower GCPS scores than the High-Risk/Biobehavioral group, there was not a significant difference in GCPS scores between Non-Intervention and Self-Care participants. Additionally, findings suggested that there was not a significant difference between participants in the biobehavioral treatment group and participants in the self-care treatment group. However, it was found that high-risk participants who received either treatment from this program had lower GCPS scores compared to low-risk participants who received the standard of care. This could suggest that biobehavioral or self-care treatment can decrease the amount of psychosocial dysfunction in TMD patients within a short amount of time, with significant results. Moreover, TMD patients, regardless of risk scores, may experience benefits from a biopsychosocial treatment program more quickly compared to receiving the normal standard-of-care offered to them.

In a previous study, Stowell and colleagues (2007) found that patients receiving an early intervention biobehavioral treatment had reduced jaw-related health costs after one-year. The current study hypothesized that participants in the biobehavioral treatment

group would have fewer jaw-related visits to health care providers in comparison to the self-care treatment group. However, findings suggested that there was not a significant difference in health care utilization between the two treatment groups. Again, the number of participants (n=14) who reached the one-year time point at the time of data analysis likely impacted the findings. It is expected that, given time for more participants to reach the one-year mark, the efficacy of the program will be borne out. Additionally, this is the first attempt to translate a study that was successful in the university, medical setting to one in the community that may be more easily applied and readily accessible to areas where no community dental care currently exists.

Six-month analyses were conducted to determine if a trend towards significance existed between treatment groups. Findings suggested that there was not a significant difference in the number of visits to a health care providers for jaw pain between the treatment groups.

Limitations and Directions for Future Research

While the current study revealed several significant biopsychosocial factors associated with a combined diagnosis of MPD and DD or DJD in an acute population, there are several limitations. This study was limited by a sample of predominately female Caucasian patients. In addition, participants were highly educated. Although this is the sample typically seen by practitioners in the community, sociocultural issues may have

contributed to the different results than might be found in more diverse samples. Future research may compare participants receiving treatment from private dental clinics versus those who receive care from community health centers. Future research should attempt to further the knowledge base of the characteristics of the subgroups of TMD in order to better treat patients in the community.

Preliminary data at the one-year mark was insufficient to conduct analyses investigating the benefits of biobehavioral treatment versus a self-care treatment regimen. Comparison of scores on the RDC/TMD from pre-treatment to the one-year follow-up and beyond may demonstrate a treatment effect on several biopsychosocial subscales as well as cost-effectiveness in terms of health care utilization. Future research on health care utilization should not only include the number of visits to health care providers, but also the cost associated with each provider. While additional analyses were conducted in order to investigate the benefits of a biobehavioral treatment versus a self-care treatment, the number of participants who reached this time point was likely insufficient to infer whether one treatment was superior to another.

APPENDIX A
Figures

FIGURE 1.

Psychosocial Factors by RDC/TMD Axis I Diagnosis at Intake: CPI and GCPS

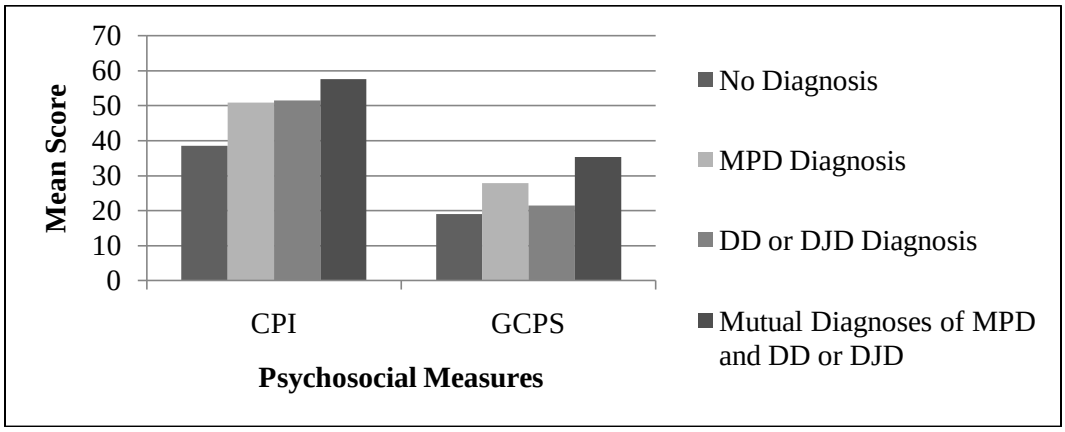
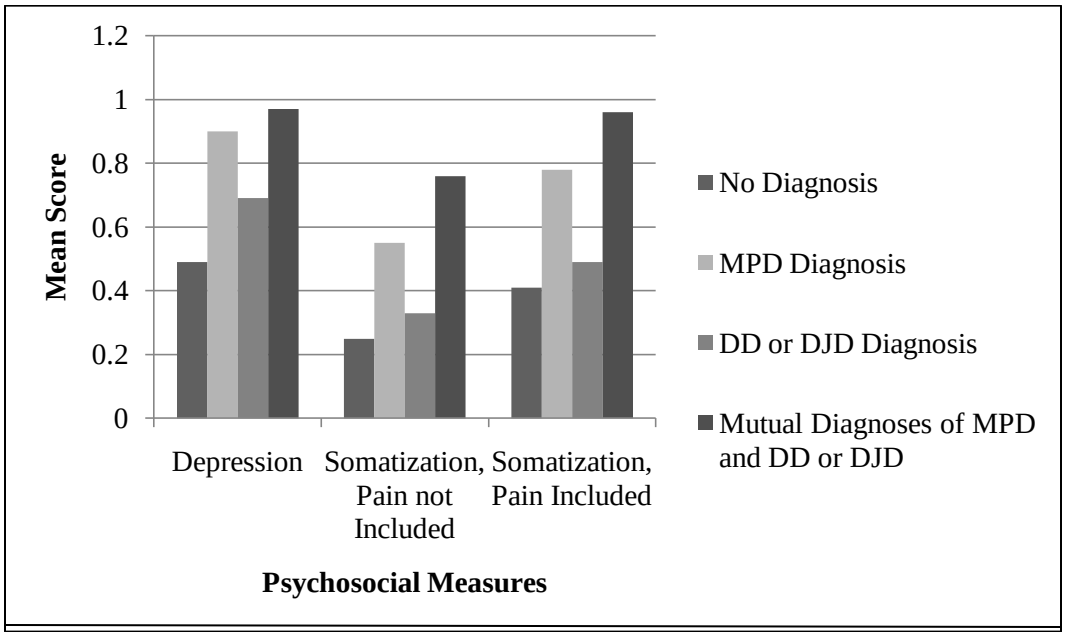


FIGURE 2.

Psychosocial Factors by RDC/TMD Axis I Diagnosis at Intake: Depression and Somatization



APPENDIX B
Tables

TABLE 15. GCPS Scores from Pre-Intervention to Six-Month Follow-Up by Treatment Group.

Table 1.

Research Diagnostic Criteria for Temporomandibular Joint Disorders (RDC/TMD)

Axis I		
	Group	Subgroup
	I: Muscle Disorders/ Myofacial Pain Disorders (MPD)	a. Myofacial pain b. Myofacial pain with limited opening
	II: Disc Displacements (DD)	a. Disc displacements with reduction b. Disc displacements without reduction, with limited opening c. Disc displacements without reduction, without limited opening
	III: Degenerative Joint Diseases (DJD)	a. Arthralgia b. Osteoarthritis c. Osteoarthrosis
Axis II		
	Psychosocial factors	Pain intensity Pain related disability Depression Somatization

Table 2.

RDC/TMD Classification of Graded Chronic Pain Scale

Classification	Scoring Criteria
Grade 0	No TMD pain in prior 6 months
Low Disability	
Grade I: Low Intensity	CPI < 50, and less than 3 Disability Points
Grade II: High Intensity	CPI ≥ 50, and less than 3 Disability Points
High Disability	
Grade III: Moderately Limiting	3-4 Disability Points, regardless of CPI
Grade IV: Severely Limiting	5-6 Disability Points, regardless of CPI

Table 3.

RDC/TMD Classification of Symptomatology

Classification	Raw Mean Scale Score[a]		
	Normal	Moderate	Severe
Depression	<0.535	0.535 to <1.105	≥ 1.105
Nonspecific Physical Symptoms, pain included	<0.500	0.500 to <1.000	≥ 1.000
Nonspecific Physical Symptoms, pain excluded	<0.428	0.428 to <0.857	≥ 0.857

[a]Raw mean scores are computed by adding up the item score for all items answered and dividing by the number of items answered

Table 4.

Demographic Variables for Consented Participants

Variables	(n=221)
Age-Mean	43.11
Range in Years	17-80
Gender (%)	
Male	41 (18.6)
Female	171 (77.4)
Missing data	9 (4.1)
Race (%)	
Caucasian	146 (66.1)
Latino (a)	27 (12.2)
African American	23 (10.4)
Asian	6 (2.7)
Other	11 (5.0)
Missing data	1 (.5)
Marital Status (%)	
Single	78 (35.3)
Married	93 (44.3)
Divorced or separated	26 (11.8)
Widowed	1 (.5)
Missing data	7 (3.2)
Years of Education (%)	
8-15 Years	94 (46.1)
16 Years	70 (31.7)
17+ Years	40 (18.2)
Missing data	17 (7.7)
Employment Status (%)	
Full- or Part Time Employment	118 (53.4)
No Employment	91 (41.2)
Missing data	8 (3.6)

Table 5.

Demographic Variables for Pre-Intervention Participants

Variables	(n=189)
Age-Mean	43.85
Range in Years	18-80
Gender (%)	
Male	40 (21.2)
Female	149 (78.8)
Race (%)	
Caucasian	127 (67.2)
Latino (a)	24 (12.7)
African American	21 (11.1)
Asian	6 (3.2)
Other	10 (5.3)
Missing data	1 (0.5)
Marital Status (%)	
Single	70 (37.0)
Married	88 (46.6)
Divorced or separated	23 (12.2)
Widowed	2 (1.1)
Missing data	6 (3.2)
Years of Education (%)	
8-15 Years	84 (44.4)
16 Years	63 (33.3)
17+ Years	37 (19.6)
Missing data	5 (2.6)
Risk Status/ Treatment Group (%)	
Low-Risk/ Non-Intervention	67 (35.4)
High-Risk/ Biobehavioral	52 (27.5)
High-Risk/ Self-Care	47 (24.9)

Table 6.

Demographic Variables of Participants by RDC/TMD Axis I Diagnosis

	Axis I Diagnostic Category						
Variables	None (n=20)	MPD (n=53)	DD or DJD (n=28)	Combination of MPD and DD or DJD (n=88)	χ^2	*df*	*p***
Age-Mean	46.25	44.43	41.07	43.83			
Range in Years	24-70	19-80	18-70	18-80			
Gender (%)					9.80	3	.020**
Male	9 (45.0)	8 (15.1)	8 (28.6)	15 (17.0)			
Female	11 (55.0)	45(84.9)	20 (71.4)	73(82.9)			
Race (%)					14.90	15	.459
Caucasian	15 (75.0)	32 (60.4)	16 (57.1)	64 (72.7)			
Latino (a)	3 (15.0)	6 (11.3)	7 (25.0)	8 (9.1)			
African American	1 (5.0)	9 (17.0)	1 (3.6)	10 (11.4)			
Asian	1 (5.0)	2 (3.8)	1 (3.6)	2 (2.3)			
Other	0 (0.0)	4 (1.9)	3 (10.7)	3 (3.4)			
Missing data	0 (0.0)	0 (0.0)	0 (0.0)	1 (1.1)			
Marital Status (%)					14.59	12	.265
Single	4 (20.0)	26 (49.1)	10 (35.7)	30 (34.1)			
Married	13 (65.0)	19 (35.8)	14 (50.0)	42 (47.7)			
Divorced or separated	1 (5.0)	6 (11.3)	3 (10.7)	13 (14.7)			
Widowed	0 (0.0)	0 (0.0)	0 (0.0)	2 (2.2)			
Missing data	2 (10.0)	2 (3.7)	1 (3.5)	1 (1.1)			
Years of Education (%)					1.60	6	.953
8-15 Years	9 (45.0)	24 (45.2)	12 (42.8)	39 (44.3)			
16 Years	6 (30.0)	18 (33.9)	12 (42.8)	27 (30.6)			
17+ Years	5 (25.0)	11(20.7)	4 (14.2)	17 (19.3)			

** Significant at $p < 0.05$

Table 7.

Psychosocial Measures by RDC/TMD Axis I Diagnoses

	RDC/TMD Axis I Diagnoses[a]					
Measure	No Diagnosis (n=20)	MPD Diagnosis (n=53)	DD or DJD Diagnosis (n=28)	Mutual Diagnoses of MPD and DD or DJD (n=88)	*F* (df), *p*-value**	η^2
CPI	38.50 (21.18)	50.88 (19.92)	51.55 (19.36)	57.65 (18.15)	*F* (3,185)= 5.81, *p*=.001**	0.086
GCPS	19.00 (26.58)	27.92 (25.92)	21.43 (19.80)	35.30 (25.77)	*F* (3,185)= 3.76, *p*=.024**	0.058
Depression	0.49 (0.51)	0.90 (0.70)	0.69 (0.41)	0.97 (0.78)	*F* (3,185)= 3.22, *p*=.001**	0.050
Somatization, Pain Excluded	0.25 (0.31)	0.55 (0.56)	0.33 (0.47)	0.76 (0.79)	*F* (3,185)= 5.35, *p*=.001**	0.080
Somatization, Pain Included	0.41 (0.56)	0.78 (0.59)	0.49 (0.73)	0.96 (0.73)	*F* (3,185)= 6.79, *p*<.001**	0.099

Note. Standard deviations appear in parentheses below means

[a] Group Diagnosis is based upon the RDC/TMD criteria

** Significant at $p < 0.05$

Table 8.

MANCOVA Results of Chewing Performance by RDC/TMD Axis I Diagnosis

Outcome Measures		*F*	*df*	*p*	η^2
Hotelling's Trace	0.194	3.67	12, 680	.000**	.061
Pain Rating		10.27	3	.000**	.289
Median Particle Size		3.43	3	.065	.065
Broadness		.857	3	.464	.011
Difference in Weight		.329	3	.804	.004

** Significant at $p < 0.05$

Table 9.

T-Test of Perceived Stress at Pre-Intervention: RDC/TMD Axis I Diagnosis and Risk Category

	RDC/TMD Axis I Diagnosis							
Risk Category	None	MPD	DD or DJD	MPD and DD or DJD	n	Mean	SD	*t*-score (df), *p*-value**
Low-Risk	12	22	12	20	66	21.06	3.86	*t* (152)= -0.99, *p*=.322
High-Risk	4	26	13	61	88	21.74	1.27	

** Significant at $p < 0.05$

Table 10.

Repeated Measures ANOVA Results: Treatment Outcomes of High-Risk Participants at One-Year Follow-Up.

Outcome Measures	Effect	Hotelling's Trace	*F*	*df*	*p***
CPI	Time	1.80	23.43	13	.000**
	Time by Treatment Group	0.04	0.29	13	.750
GCPS	Time	0.60	7.80	13	.015**
	Time by Treatment Group	0.25	1.63	13	.233
Depression	Time	0.03	0.40	13	.540
	Time by Treatment Group	0.24	1.53	13	.253

** Significant at $p < 0.05$

Table 11.

Repeated Measures ANOVA Results: Treatment Outcomes of HR/BB vs. HR/SC Participants at One-Year Follow-Up.

Outcome Measures	Effect	Hotelling's Trace	*F*	*df*	*p***
CPI	Time	1.80	23.43	13	.000**
	Time by Treatment Group	0.05	0.29	13	.750
GCPS	Time	0.60	7.80	13	.015**
	Time by Treatment Group	0.25	1.63	13	.233

** Significant at $p < 0.05$

Table 12.

Independent-Samples t-Test Results: Number of Health Care Visits of HR/BB vs. HR/SC Participants at One-Year Follow-Up.

Measure	Treatment Group	n	Mean	SD	*t*-score (df), *p*-value**
Number of Visits	HR/BB	10	7.20	7.13	t(12)= -0.77, p=.281
	HR/SC	4	4.25	4.03	

** Significant at $p < 0.05$

Table 13.

Repeated Measures ANOVA Results: Treatment Outcomes of HR/BB vs. HR/SC Participants at Six-Month Follow-Up.

Outcome Measures	Effect	Hotelling's Trace	*F*	*df*	*p***
CPI	Time	3.23	164.79	51	.000**
	Time by Treatment Group	0.62	15.89	52	.000**
GCPS	Time	0.82	39.23	48	.000**
	Time by Treatment Group	0.22	5.27	48	.009**

** Significant at $p < 0.05$

Table 14.

Independent-Samples t-Test Results: Number of Health Care Visits of HR/BB vs. HR/SC Participants at Six-Month Follow-Up.

Measure	Treatment Group	n	Mean	SD	*t*-score (df), *p*-value**
Number of Visits	HR/BB	13	7.23	6.15	t(26)= -0.10, p=.924
	HR/SC	13	7.54	9.64	

** Significant at $p < 0.05$

Table 15.

GCPS Scores from Pre-Intervention to Six-Month Follow-Up by Treatment Group.

Patient Group Assignment	Time Point		Hotelling's Trace	*F*	*df*	*p*
	Pre-Intervention	Six-Month Follow Up				
High-Risk/ Biobehavioral (n=15)	39.78	3.78	.219	5.27	2	.009**
High-Risk/ Self-Care (n=9)	25.93	3.70				
Low-Risk/ Non-Intervention (n=27)	18.77	7.65				

** Significant at $p < 0.05$

REFERENCES

Al-Jundi, M. A., John, M. T., Setz, J. M., Szentpetery, A., & Kuss, O. (2008). Meta-analysis of treatment need for temporomandibular disorders in adult nonpatients. *Journal Of Orofacial Pain, 22*(2), 97-107.

American Dental Association. (2009). TMD/TMJ (Temporomandibular Disorders). Retrieved February 20, 2009, from http://www.ada.org/public/topics/tmd_tmj.asp

American Psychiatric Association. (2000). *Diagnostic and statistical manual of mental disorders: DSM-IV-TR*. Washington, D.C.

Bessa-Nogueira, R. V., Vasconcelos, B. C. E., & Niederman, R. (2008). The methodological quality of systematic reviews comparing temporomandibular joint disorder surgical and non-surgical treatment. *BMC Oral Health, 8*, 27-36.

Bragdon, E. E., Light, K. C., Costello, N. L., Sigurdsson, A., Bunting, S., Bhalang, K., et al. (2002). Group differences in pain modulation: pain-free women compared to pain-free men and to women with TMD. *Pain (03043959), 96*, 227. Retrieved from http://ezproxy.baylor.edu/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=a9h&AN=7793920&site=ehost-live&scope=site

Buschang, P. H., Throckmorton, G. S., Travers, K. H., & Johnson, G. (1997). The effects of bolus size and chewing rate on masticatory performance with artificial test foods. *Journal of Oral Rehabilitation, 24*(7), 522-526.

Cohen, S., Kamarck, T., & Mermelstein, R. (1983). A Global Measure of Perceived Stress. *Journal of Health and Social Behavior, 24*(4), 385-396. Retrieved from http://www.jstor.org/stable/2136404

Cook, A. J., & Chastain, D. C. (2001). The classification of patients with chronic pain: age and sex differences. *Pain Research & Management: The Journal of The Canadian Pain Society 6*(3), 142-151. Retrieved from http://ezproxy.baylor.edu/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=cmedm&AN=11854777&site=ehost-live&scope=site

Cooper, B. C., & Kleinberg, I. (2007). Examination of a large patient population for the presence of symptoms and signs of temporomandibular disorders. *Cranio: The Journal Of Craniomandibular Practice, 25*(2), 114-126.

Dahlström, L., & Carlsson, S. G. (1984). Treatment of mandibular dysfunction: the clinical usefulness of biofeedback in relation to splint therapy. *Journal of Oral Rehabilitation, 11*(3), 277-284.

Dworkin, S. F., Huggins, K. H., Wilson, L., Mancl, L., Turner, J., Massoth, D., et al. (2002). A randomized clinical trial using research diagnostic criteria for temporomandibular disorders-axis II to target clinic cases for a tailored

self-care TMD treatment program. *Journal Of Orofacial Pain, 16*(1), 48-63.

Dworkin, S. F., & LeResche, L. (1992). Research diagnostic criteria for temporomandibular disorders: review, criteria, examinations and specifications, critique. *Journal Of Craniomandibular Disorders: Facial & Oral Pain, 6*(4), 301-355.

Dworkin, S. F., Sherman, J., Mancl, L., Ohrbach, R., LeResche, L., & Truelove, E. (2002). Reliability, validity, and clinical utility of the research diagnostic criteria for Temporomandibular Disorders Axis II Scales: depression, non-specific physical symptoms, and graded chronic pain. *Journal Of Orofacial Pain, 16*(3), 207-220.

Edwards, D., Gatchel, R., Adams, L., & Stowell, A. W. (2006). Emotional Distress and Medication Use in Two Acute Pain Populations: Jaw and Low Back. *Pain Practice, 6*(4), 242-253.

Emshoff, R. (2006). Clinical factors affecting the outcome of occlusal splint therapy of temporomandibular joint disorders. *Journal of Oral Rehabilitation, 33*(6), 393-401.

Epker, J., Gatchell, R. J., & Ellis, E. (1999). A model for predicting chronic TMD: Practical application in clinical settings. *Journal of the American Dental Association, 130*(10), 1470.

Folkman, S., Lazarus, R. S., Dunkel-Schetter, C., DeLongis, A., & Gruen, R. J. (1986). Dynamics of a stressful encounter: Cognitive appraisal, coping, and encounter outcomes. *Journal of Personality and Social Psychology, 50*(5), 992-1003.

Gardea, M. A., Gatchel, R. J., & Mishra, K. D. (2001). Long-Term Efficacy of Biobehavioral Treatment of Temporomandibular Disorders. *Journal of Behavioral Medicine, 24*, 341-359. Retrieved from http://ezproxy.baylor.edu/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=a9h&AN=11306935&site=ehost-live&scope=site

Garofalo, J. P., Gatchel, R. J., Wesley, A. L., & Ellis, E. (1998). Predicting chronicity in acute temporomandibular joint. *Journal of the American Dental Association, 129*(4), 438.

Gatchel, R. J., Garofalo, J. P., Ellis, E., & Holt, C. (1996). Major psychological disorders in acute and chronic TMD: An initial examination. *Journal of the American Dental Association, 127*(9), 1365.

Gatchel, R. J., Stowell, A. W., Wildenstein, L., Riggs, R., & Ellis, E., 3rd. (2006). Efficacy of an early intervention for patients with acute temporomandibular disorder-related pain: a one-year outcome study. *Journal Of The American Dental Association (1939), 137*(3), 339-347.

Glaros, A. G. (2008). Temporomandibular Disorders and Facial Pain: A Psychophysiological Perspective. [Article]. *Applied Psychophysiology & Biofeedback, 33*, 161-171.

Glaros, A. G., & Burton, E. (2004). Parafunctional clenching, pain, and effort in temporomandibular disorders. *Journal Of Behavioral Medicine, 27*(1), 91-100.

Glaros, A. G., & Lumley, M. A. (2005). Alexithymia and pain in temporomandibular disorder. [Article]. *Journal of Psychosomatic Research, 59*, 85-88.

Glaros, A. G., Williams, K., & Lausten, L. (2005). The role of parafunctions, emotions and stress in predicting facial pain. *J Am Dent Assoc, 136*(4), 451-458.

Huang, G. J., LeResche, L., Critchlow, C. W., Martin, M. D., & Drangsholt, M. T. (2002). Risk factors for diagnostic subgroups of painful temporomandibular disorders (TMD). *Journal Of Dental Research, 81*(4), 284-288.

Johansson Cahlin, B., Samuelsson, N., & Dahlström, L. (2006). Utilization of pharmaceuticals among patients with temporomandibular disorders: a controlled study. *Acta Odontologica Scandinavica, 64*(3), 187-192.

Kight, M., Gatchel, R. J., & Wesley, L. (1999). Temporomandibular disorders: evidence for significant overlap with psychopathology. *Health*

Psychology: Official Journal Of The Division Of Health Psychology, American Psychological Association, *18*(2), 177-182.

Kino, K., Sugisaki, M., Haketa, T., Amemori, Y., Ishikawa, T., Shibuya, T., et al. (2005). The comparison between pains, difficulties in function, and associating factors of patients in subtypes of temporomandibular disorders. *Journal of Oral Rehabilitation*, *32*, 315-325. Retrieved from http://ezproxy.baylor.edu/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=a9h&AN=16719621&site=ehost-live&scope=site. doi:10.1111/j.1365-2842.2004.01439.x

LeResche, L., Mancl, L. A., Drangsholt, M. T., Huang, G., & Korff, M. V. (2007). Predictors of onset of facial pain and temporomandibular disorders in early adolescence. [Article]. *Pain (03043959)*, *129*, 269-278.

McCreary, C. P., Clark, G. T., Merril, R. L., Flack, V., & Oakley, M. E. (1991). Psychological distress and diagnostic subgroups of temporomandibular disorder patients. *Pain*, *44*(1), 29-34.

Medlicott, M. S., & Harris, S. R. (2006). A Systematic Review of the Effectiveness of Exercise, Manual Therapy, Electrotherapy, Relaxation Training, and Biofeedback in the Management of Temporomandibular Disorder. *Physical Therapy*, *86*, 955-973. Retrieved from http://ezproxy.baylor.edu/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=a9h&AN=21597637&site=ehost-live&scope=site

Michelotti, A., de Wijer, A., Steenks, M., & Farella, M. (2005). Home-exercise regimes for the management of non-specific temporomandibular disorders. *Journal of Oral Rehabilitation, 32*(11), 779-785.

Nassif, N. J., Al-Salleeh, F., & M. Al-Admawi, F. (2003). The prevalence and treatment needs of symptoms and signs of temporomandibular disorders among young adult males. *Journal of Oral Rehabilitation, 30*, 944. Retrieved from http://ezproxy.baylor.edu/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=a9h&AN=10691745&site=ehost-live&scope=site. doi:10.1046/j.1365-2842.2003.01143.x

National Institute of Dental and Craniofacial Research. (2008, December 20, 2008). Facial Pain. Retrieved September 13, 2009, from http://www.nidcr.nih.gov/DataStatistics/FindDataByTopic/FacialPain/

National Institutes of Health. (1996). Management of temporomandibular disorders. National Institutes of Health Technology Assessment Conference Statement. *Journal Of The American Dental Association (1939), 127*(11), 1595-1606. Retrieved from http://ezproxy.baylor.edu/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=cmedm&AN=8952234&site=ehost-live&scope=site

National Institutes of Health. (2009). Mechanisms, Models, Measurement, & Management in Pain Research (R01)

Okeson, J. P. (1997). Current terminology and diagnostic classification schemes. *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, And Endodontics, 83*(1), 61-64.

Olthoff, L. W., van der Bilt, A., Bosman, F., & Kleizen, H. H. (1984). Distribution of particle sizes in food comminuted by human mastication. *Archives Of Oral Biology, 29*(11), 899-903.

Phillips, J. M., Gatchel, R. J., Wesley, A. L., & Ellis, E. (2001). Clinical implications of sex in acute temporomandibular disorders. *Journal of the American Dental Association, 132*(1), 49.

Reibmann, D. R., John, M. T., Wassell, R. W., & Hinz, A. (2008). Psychosocial profiles of diagnostic subgroups of temporomandibular disorder patients. *European Journal of Oral Sciences, 116*, 237-244. Retrieved from 10.1111/j.1600-0722.2008.00528.x http://ezproxy.baylor.edu/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=a9h&AN=32000730&site=ehost-live&scope=site. doi:10.1111/j.1600-0722.2008.00528.x

Roberti, J. W., Harrington, L. N., & Storch, E. A. (2006). Further Psychometric Support for the 10-Item Version of the Perceived Stress Scale. *Journal of College Counseling, 9*(2), 135-147.

Sherman, J. J., LeResche, L., Huggins, K. H., Mancl, L. A., Sage, J. C., & Dworkin, S. F. (2004). The relationship of somatization and depression to

experimental pain response in women with temporomandibular disorders. *Psychosomatic Medicine*, *66*(6), 852-860.

Shin, B., Ha, C., Song, Y., & Lee, M. S. (2007). Effectiveness of combining manual therapy and acupuncture on temporomandibular joint dysfunction: a retrospective study. *American Journal of Chinese Medicine*, *35*(2), 203-208. Retrieved from www.cinahl.com/cgi-bin/refsvc?jid=2111&accno=2009568538

Stowell, A. W., Gatchel, R. J., & Wildenstein, L. (2007). Cost-effectiveness of treatments for temporomandibular disorders. *Journal of the American Dental Association*, *138*(2), 202-208.

Suvinen, T. I., Reade, P. C., Kemppainen, P., Kononen, M., & Dworkin, S. F. (2005). Review of aetiological concepts of temporomandibular pain disorders: towards a biopsychosocial model for integration of physical disorder factors with psychological and psychosocial illness impact factors. *European Journal Of Pain (London, England)*, *9*(6), 613-633.

The Joint Commission. (2009). Health Care Issues. 2009, from http://www.jointcommission.org/NewsRoom/health_care_issues.htm

Turner, J. A., Mancl, L., & Aaron, L. A. (2006). Short- and long-term efficacy of brief cognitive-behavioral therapy for patients with chronic temporomandibular disorder pain: a randomized, controlled trial. *Pain*, *121*(3), 181-194.

Vimpari, S. S., Knuuttila, M. L., Sakki, T. K., & Kivela, S. L. (1995). Depressive symptoms associated with symptoms of the temporomandibular joint pain and dysfunction syndrome. *Psychosomatic Medicine, 57*(5), 439-444.

von Korff, M., Ormel, J., Keefe, F. J., & Dworkin, S. F. (1992). Grading the severity of chronic pain. *Pain, 50*(2), 133-149.

White, B. A., Williams, L. A., & Leben, J. R. (2001). Health care utilization and cost among health maintenance organization members with temporomandibular disorders. *Journal Of Orofacial Pain, 15*(2), 158-169.

Wright, A. R., Gatchel, R. J., Wildenstein, L., Riggs, R., Buschang, P., & Ellis, E., 3rd. (2004). Biopsychosocial differences between high-risk and low-risk patients with acute TMD-related pain. *Journal Of The American Dental Association (1939), 135*(4), 474-483.

Zuniga, J. R. (1998). The use of nonopioid drugs in management of chronic orofacial pain. *Journal Of Oral And Maxillofacial Surgery: Official Journal Of The American Association Of Oral And Maxillofacial Surgeons, 56*(9), 1075-1080.