Temporomandibular disorders and related psychosocial factors in non-patients

A survey and a clinical follow-up study based on the RDC/TMD

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To Marjaana and Oskari
Abstract

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Temporalmandibular disorders (TMD) and psychosocial factors reportedly associate. The underlying factors remain partially obscure, however, and further studies are required to clarify the relationships. The aims of this study were thus to assess in a non-patient working population the prevalence of TMD and related symptoms, and to clinically diagnose and follow the natural courses of TMD over a one-year period. In addition, possible comorbidity of temporomandibular and/or neck muscle pain and perceived stress and their impact on work performance were investigated, as well as how various psychosocial aspects relate to TMD.

A questionnaire was mailed to all 30- to 55-year-old employees of the Finnish Broadcasting Company Ltd. whose employment in the Helsinki area had lasted at least five years (n = 1784). Of the 1339 subjects, who returned the questionnaire, 241 were examined according to the RDC/TMD and standard neck muscle palpation methods. Clinical signs of temporomandibular and/or neck muscle pain were found in 118 subjects. One-year follow-up TMD examinations were conducted on 211 subjects.

The prevalence of frequent painless TMJ-related symptoms was 10%, orofacial pain 7%, neck pain 38%, and headache 15%. TMD diagnoses were: myofascial pain (13%), disc displacements (16%), and arthralgia, osteoarthritis, osteoarthrosis (4%). Chronic myofascial pain was present in 7% and chronic disc displacement with reduction in 11% of the subjects. Symptoms were significantly associated with almost all the studied psychosocial symptoms. Reduced work performance was significantly positively associated with continuous pain, severity of pain, and health stress perception, and according to logistic regression, somatization with the probability of having chronic myofascial pain.

It could be concluded based on the results of this study among a non-patient working population that TMD and related symptoms are common and associated with psychosocial factors. Moreover, myofascial pain and disc displacement with reduction are the most common diagnoses of TMD. In addition, self-reported health related stress, and continuous pain in temporomandibular and/or neck muscles are associated with reduced work performance, and somatization is significantly associated with chronic myofascial pain.
Abbreviations

AAOP = American Academy of Orofacial Pain
COMT = Catechol-O-methyltransferase
CT = Computerized tomography
DC/TMD = Diagnostic Criteria for Temporomandibular Disorders
GCPS = Graded Chronic Pain Scale
IHS = International Headache Society
MRI = Magnetic resonance imaging
OR = Odds ratio
OSQ = Occupational Stress Questionnaire
RDC/TMD = Research Diagnostic Criteria for Temporomandibular Disorders
SCL-90 = Symptom Checklist 90
SCL-90-R = Symptom Checklist 90 Revised
TMD = Temporomandibular disorders
TMJ = Temporomandibular joint
VAS = Visual Analogue Scale
Acknowledgements

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Espoo, May 2010

Mikko Rantala
# Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABSTRACT</td>
<td>4</td>
</tr>
<tr>
<td>ABBREVIATIONS</td>
<td>5</td>
</tr>
<tr>
<td>ACKNOWLEDGEMENTS</td>
<td>6</td>
</tr>
<tr>
<td>LIST OF ORIGINAL PUBLICATIONS</td>
<td>10</td>
</tr>
<tr>
<td>INTRODUCTION</td>
<td>11</td>
</tr>
<tr>
<td>REVIEW OF THE LITERATURE</td>
<td>12</td>
</tr>
<tr>
<td>Temporomandibular disorders</td>
<td>12</td>
</tr>
<tr>
<td>Terminology</td>
<td>12</td>
</tr>
<tr>
<td>PubMed</td>
<td>12</td>
</tr>
<tr>
<td>Definition</td>
<td>12</td>
</tr>
<tr>
<td>Classification</td>
<td>13</td>
</tr>
<tr>
<td>Epidemiology</td>
<td>14</td>
</tr>
<tr>
<td>Etiology</td>
<td>16</td>
</tr>
<tr>
<td>Classification history</td>
<td>20</td>
</tr>
<tr>
<td>Psychosocial factors</td>
<td>24</td>
</tr>
<tr>
<td>Biopsychosocial model of disease.</td>
<td>24</td>
</tr>
<tr>
<td>Psychosocial factors and pain</td>
<td>24</td>
</tr>
<tr>
<td>Depression</td>
<td>25</td>
</tr>
<tr>
<td>Non-specific physical symptoms (somatization).</td>
<td>25</td>
</tr>
<tr>
<td>Stress</td>
<td>25</td>
</tr>
<tr>
<td>Pain intensity and disability</td>
<td>26</td>
</tr>
<tr>
<td>AIMS OF THE STUDY</td>
<td>27</td>
</tr>
<tr>
<td>SUBJECTS AND METHODS</td>
<td>28</td>
</tr>
<tr>
<td>Calibration procedure</td>
<td>28</td>
</tr>
<tr>
<td>Study population</td>
<td>28</td>
</tr>
<tr>
<td>Methods</td>
<td>31</td>
</tr>
<tr>
<td>Questionnaire (I)</td>
<td>31</td>
</tr>
<tr>
<td>Clinical examinations (II, III, IV)</td>
<td>32</td>
</tr>
<tr>
<td>Axis II psychosocial assessment (IV)</td>
<td>32</td>
</tr>
<tr>
<td>Statistical methods</td>
<td>34</td>
</tr>
<tr>
<td>Ethical approval</td>
<td>34</td>
</tr>
<tr>
<td>RESULTS</td>
<td>35</td>
</tr>
<tr>
<td>Subjects</td>
<td>35</td>
</tr>
<tr>
<td>Symptoms (I, II)</td>
<td>35</td>
</tr>
<tr>
<td>Clinical diagnoses of TMD and their fluctuation over a one-year period (II, IV)</td>
<td>35</td>
</tr>
</tbody>
</table>
The effect of temporomandibular and/or neck region muscle pain and stress perception on work performance (III) ........................................................................................................................................ 38
The associations between frequent TMJ-related painless symptoms, orofacial pain, neck pain, headache, and psychosocial factors (I) .................................................................................................................................... 38
The associations between the most common TMD diagnoses and psychosocial factors at the one-year follow-up (IV) ........................................................................................................................................ 38

DISCUSSION .................................................................................................................................................. 40
Subjects .......................................................................................................................................................... 40
Methods ....................................................................................................................................................... 41
Symptoms .................................................................................................................................................... 43
Clinical diagnoses of TMD and their fluctuation over a one-year period .................................................. 43
The effect of temporomandibular and/or neck muscle pain and stress perception on work performance ........................................................................................................................................... 45
The associations between frequent painless TMJ-related symptoms, orofacial pain, neck pain and headache, and psychosocial factors ........................................................................................................... 45
The associations between the most common TMD diagnoses and psychosocial factors in the one-year follow-up ....................................................................................................................................... 46
Future .......................................................................................................................................................... 47

CONCLUSIONS ............................................................................................................................................. 49

REFERENCES ............................................................................................................................................... 50
List of original publications

This thesis is based on the following original publications, which are referred to in the text by their Roman numerals. Additional data are also presented.


The Finnish version of the RDC/TMD and ongoing updates on developments can be found at http://www.rdc-tmdinternational.org/.

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Introduction

Temporomandibular disorders (TMD), is a collective term that embraces a number of clinical problems that involve the masticatory muscles, the temporomandibular joint (TMJ), and the associated structures (de Leeuw, 2008).

Symptoms and signs of TMD in the general population are reportedly common (De Kanter et al., 1993), and the estimates of the prevalence of TMD related pain range from approximately 5% to 10% (Von Korff et al., 1988; Locker & Slade, 1988; Goulet et al., 1995; LeResche, 1997; Isong et al., 2008).

TMD has been found to be twice as common among women as men in the general population, with pain the most common reason for even four to five times more women than men seeking help for their TMD problems (LeResche, 1997; Dworkin et al., 1990a). The prevalence of TMD is highest in young and middle-aged adults and seems to decrease with age thereafter (LeResche, 1997). Moreover, it appears that TMD is fluctuating in nature (Könönen et al., 1996; Kuttila et al., 1997; Magnusson et al., 2000; Rammelsberg et al., 2003) and that myofascial pain is involved in at least half of TMD cases (Stohler, 1999).

TMD and psychological factors (e.g., depression, somatization) are reported to be associated (Rollmann & Gillespie, 2000; Sipilä et al., 2001; Huang et al., 2002; Rammelsberg et al., 2003), although the exact etiology and pathophysiology of myofascial pain remain unclear (Sherman & Turk, 2001; Svensson & Graven-Nielsen, 2001). Of the most common diagnostic subgroups of TMD, myofascial pain seems to be more associated with psychosocial issues than TMJ internal derangements (Eversole & Machado, 1985; McCreary et al., 1991; Yap et al., 2002a). It has been suggested that studies on the etiology of TMD should target the roles of psychosocial factors, i.e., stress, depression, and somatic distress (LeResche, 1997).

The Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD) were developed for research purposes (Dworkin & LeResche, 1992) and have been translated into 19 languages. Their reliability and construct validity to diagnose TMD have been documented (List & Dworkin., 1996; Dworkin et al., 1990b; Dworkin et al., 2002; Look et al., 2010; Ohrbach et al., 2010; Schiffman et al., 2010a; Truelove et al., 2010). In the present study, the first version of the Finnish RDC/TMD was used and further developed among non-patient multiprofessional media personnel. The aim was to assess TMD symptoms, signs and clinical diagnoses and how they relate to various psychosocial factors.
Review of the literature

Temporomandibular disorders

Terminology

Terms used in the dental literature to describe problems associated with temporomandibular joints and masticatory muscles include *Costen syndrome, temporomandibular joint disturbances, temporomandibular joint dysfunction syndrome, functional temporomandibular joint disturbances, occlusomandibular disturbance, myoarthropathy of the temporomandibular joint, myofascial pain-dysfunction syndrome, temporomandibular pain-dysfunction syndrome, and craniomandibular disorders* (Okeson, 1998). *Temporomandibular disorders* was introduced in 1982 (Bell, 1982) and has since gained popularity (Okeson, 1998) perhaps because of not highlighting the role of joints. Currently, both the terms *craniomandibular disorders* and *temporomandibular disorders* are used.

PubMed

To gain an overview of studies on TMD a literature search was performed. A PubMed search (including the Medline database) with specific terms resulted in the following numbers of articles: “Temporomandibular disorders” 13090, “craniomandibular disorders” 12652, “Research Diagnostic Criteria for Temporomandibular Disorders” 346 and “RDC/TMD” 145. A search limited to “published in last 5 years”, “humans” and “English language” with the search term “temporomandibular disorders” resulted in 1691 articles, with the term “craniomandibular disorders” in 1599, with the term “Research Diagnostic Criteria for Temporomandibular Disorders” in 163, and with the term “RDC/TMD” in 92 papers.

Definition

Temporomandibular disorders (TMD), is a collective term that embraces a number of clinical problems that involve the masticatory muscles, the TMJ, and the associated structures (de Leeuw, 2008).

TMD are a common cause of orofacial pain conditions (Rauhala et al., 2000) and pain is the most common symptom of TMD (Dworkin et al., 1990a; de Leeuw, 2008). Other frequent symptoms are TMJ sounds, and limited or asymmetric mandibular movements (de Leeuw, 2008). Common
associated symptoms include ear pain and stuffiness, tinnitus, dizziness, neck pain, and headache (Scrivani et al., 2008).

**Classification**

**Masticatory muscle pain and dysfunction disorders**

Pain and jaw moving difficulties are the most common features of masticatory muscle disorders, with myofascial pain (chronic regional muscle pain) being the most common type. Other muscle related disorders include myositis (primary inflammation), myospasm (acute, involuntary and tonic contraction), local myalgia (possibly secondary to ischemia, bruxism, fatigue, metabolic alterations, autonomic effects, protective co-contraction, and delayed-onset muscle soreness), myofibrotic contracture (painless shortening of muscle due to fibrosis), neoplasia (benign or malignant) and centrally mediated chronic muscle pain (chronic generalized muscle pain) (Gonzales & Mohl, 2006; de Leeuw, 2008).

**Temporomandibular joint disorders**

*Internal derangements*

An internal derangement of the TMJ can be defined as an abnormal relationship between the mandibular condyle and the intra-articular disc (Laskin, 2006; Tanaka et al., 2008) which mechanically disturbs the normally smooth action of the joint (Tenenbaum et al., 1999; Stegenga & de Bont, 2006). The most common internal derangements include anterior disc displacement with or without reduction and hypermobility. In anterior disc displacement with reduction the intra-articular disc has slipped forward from its normal position and returns to its normal position usually accompanied with a clicking or popping sound during movement of the lower jaw. Similar sounds are often heard during movement towards maximal tooth contact position when the disc again slips forward from its normal position. In anterior disc displacement without reduction the intra-articular disc is unable to return to its normal position during movement and this causes locking of the TMJ and sudden onset of restricted mouth opening (de Leeuw, 2008). However, TMJ hypermobility, where the condyle snaps over the apex of the articular eminence, is also accompanied by clicking sounds (McNeill, 1993; de Leeuw, 2008) and disc adhesion has been identified to as causing restricted mouth opening (Laskin, 2006).
Arthritis/arthrosis

Arthritis can be divided by cause into inflammatory (rheumatoid arthritis, juvenile rheumatoid arthritis, psoriatic arthritis, ankylosing spondylitis and Reiter syndrome), degenerative (osteoarthritis, osteoarthrosis), infectious (gonococcal, syphilitic, Tuberculous and Lyme-disease associated arthritis), metabolic (gout, and pseudo-gout), and traumatic arthritis (Zarb & Carlsson, 1999; Abubaker, 2006; de Leeuw, 2008). Osteoarthritis, the most common of these conditions, can be divided further into primary (unknown causes) and secondary (local and systemic factors). It is a chronic non-inflammatory disease that affects the articular cartilage and is associated with simultaneous remodelling of the underlying subchondral bone (Zarb & Carlsson, 1999; Abubaker, 2006). Signs and symptoms associated with arthritis are stiffness, pain, tenderness localized over the afflicted joint, swelling, raised temperature and erythema (skin), crepitation, and bony spurs (Abubaker, 2006).

Epidemiology

Prevalence

The prevalence of TMD symptoms and signs in non-patient populations is high (Agerberg & Carlsson, 1972; Swanljung & Rantanen, 1979; Alanen & Kirveskari, 1982; Wänman & Agerberg, 1986; Von Korff et al., 1988). The variability of prevalence figures is also high, mostly due to the different criteria and populations studied (De Kanter et al., 1993; Carlsson, 1999). Approximately 33% of selected non-patient adult populations have at least one symptom of dysfunction and as many as 40–75% at least one sign of dysfunction (de Leeuw, 2008). In the Health 2000 Health Examination Survey among 6335 adult non-patient Finns at least one clinical TMD sign was found in 38% and more than one in 10% of the studied subjects (Rutkiewicz et al., 2006). The study protocol included palpation of two masticatory muscles and TMJ, mouth opening measurement and TMJ sounds.

The prevalence of TMD related pain has been reported to be approximately 5–10% (Von Korff et al., 1988; Locker & Slade, 1988; Goulet et al., 1995; LeResche, 1997; Isong et al., 2008). However, the prevalence of clinically significant TMD is estimated to be only 3–5% (De Kanter et al., 1993; Goulet et al., 1995). TMD seems to be fluctuating in nature according to studies on adolescents and young adults (Könönen & Nyström, 1993; Könönen et al., 1996; Magnusson et al., 2000). Myofascial pain, the most common subgroup of TMD in non-patient populations (Schiffman et al., 1990; de Leeuw, 2008), also appears to vary over time (Rammelsberg et al., 2003) and it reportedly constitutes at least half of the cases with TMD (Stohler, 1999). There have been few studies on TMD incidence in adult non-patients, but the one-year incidence rate has
been estimated at approximately 2% (de Leeuw, 2008) and there may be racial differences in the prevalence of TMD pain (Isong et al., 2008).

Age and gender

TMD seems to be quite common among children and adolescents. However, the highest prevalence occurs in young and middle-aged adults, followed by a decline with age (LeResche, 1997; List et al., 1999), although the prevalence of TMJ arthritis increases with age (Abubaker, 2006; Tanaka et al., 2008). Women seem to have a higher prevalence of pain conditions, including orofacial pain, although the reason for this remains unresolved (Unruh, 1996; Dao & LeResche, 2000; Johansson et al., 2003). TMD has been found to be twice as common in women as in men in the general population and pain the most common reason for as many as four to five times more women than men seeking help for their TMD problems (Dworkin et al., 1990a; LeResche, 1997; Anastassaki & Magnusson, 2004).

It has been proposed that studies should be targeted especially at adult populations (Sipilä, 2002) and focused on biological and psychosocial factors that are more common in women than in men (LeResche, 1997). Further, men seem to recover from TMD in the long run more often than women, at least among young adults. The different courses and diagnoses of TMD between females and males might explain some of the differences found between the sexes (Wänman, 1996; Carlsson, 1999; List et al., 1999). The difference in TMD pain prevalence between women and men seems to increase already in adolescence (LeResche et al., 2005; Nilsson et al., 2009), and the highest prevalence in women seems to be during the reproductive years, with onset typically after puberty and declining post-menopausally (Von Korff et al., 1988; de Leeuw, 2008). The mechanisms underlying sex-related differences in the prevalence of craniofacial pain conditions, including TMD, remain obscure and probably involve both physiological and psychological factors (Cairns, 2007). Studies strongly suggest that estrogens modulate TMD pain in women (LeResche et al., 1997; Dao & LeResche, 2000; MacFarlane et al., 2002; LeResche et al., 2003; Craft, 2007). However, this modulation by sexual hormones is extremely complex (Cairns, 2007; Craft, 2007).

Non-patients and patients

The most common subtypes of TMD in clinic populations appear to be myofascial pain and arthralgia (Truelove et al., 1992), while in non-patient populations TMJ sounds seem to be the most common symptom (Okeson, 1996). Muscle dysfunction seems to be the most common reason for referral to TMD specialists (Machado et al., 2009) and, along with myalgia, disc displacements in some clinics (Anastassaki & Magnusson, 2004). RDC/TMD arthralgia, osteoarthritis, and osteoarthrosis diagnoses are quite rare, at least in non-patient populations assessed without radiological examinations. However, they are more common in patient
populations (Manfredini et al., 2006). Dworkin and co-workers found that myofascial pain on palpation is four to six times more common in clinical cases than in community controls. Community cases were intermediate. Clicking sounds were the most common joint sounds varying from about 25% to 43%. An interesting observation from this study was that clinical cases reported more pain on all measures, even on palpation of placebo sites (Dworkin et al., 1990a).

General health

According to some studies, TMD subjects use more health care services and take more sick leave than non-TMD subjects (Alanen & Kirveskari, 1983; Wedel & Carlsson, 1987; Kuttila et al., 1997a; White et al., 2001), and medication use is more prevalent among them (White et al., 2001). TMD patients also utilize more dental services than non-TMD subjects (Johansson et al., 2004; Hobson et al., 2008). In addition, perceived poor health and self-reported TMD symptoms seem to be associated (Johansson et al., 2004).

Etiology

With the exception of traumatic etiologies, the exact causes of most TMD remain unknown or speculative (National Institute of Health Technology Assessment Conference Statement, 1996; Svensson & Graven-Nielsen, 2001; Greene, 2006). Factors thought to associate with TMD are trauma, and anatomical, pathophysiologi cal and psychosocial factors (Laskin et al., 2006; de Leeuw, 2008). However, in some patients, a chronic TMD develops, with persistent pain and physical, behavioral, psychological, and psychosocial symptoms similar to patients with chronic pain syndromes in other areas of the body. The cause of TMD is considered to be multifactorial (Scrivani et al., 2008; Macfarlane et al., 2009a), and indeed the terms biopsychosocial and multifactorial has been introduced to describe the complicated nature of TMD. Presently these concepts are valuable only at the group level, because there are no tools to assess different variables at the individual patient level (Greene, 2006). Etiological factors have been divided into predisposing, initiating and perpetuating factors. Predisposing factors increase the risk, initiating factors cause the onset and perpetuating factors interfere with healing or enhance the progression of TMD (de Leeuw, 2008). While causative etiologic factors are difficult to determine, numerous risk factors for TMD have been suggested. Most risk factors explain only a small portion of TMD in the population, but might explain a significant portion of TMD in persons exposed to particular risk factors (Miller & Mancl, 2008).
Risk factors for TMD

Risk factors for myofascial pain have been assessed in numerous studies (Marbach et al., 1988; Von Korff et al., 1993; LeResche, 1997; Huang et al., 2002; Velly et al., 2003; Slade et al., 2007; Svensson et al., 2008; Lim et al., 2010). From the findings it is possible to conclude that at least younger age, female gender, previous pain and psychological distress may be underlying factors for TMD. Moreover, widespread pain seems to be a risk factor for onset of dysfunctional TMD pain in women but not men (John et al., 2003), and there is some evidence of impairment in central nociceptive processing in women with myofascial TMD (Fernández-de-las-Peñas et al., 2009). Predictors of first onset of facial pain during early adolescence have been found to be similar to other pain conditions in adults (female gender, somatization, number of pain complaints, life dissatisfaction). This suggests that in individuals who develop TMD pain there may also be an underlying vulnerability to experience pain that is not unique to the orofacial region (LeResche et al., 2007). Joint laxity, bruxism, changes in synovial fluid and joint lubrication, and irregularities in the articular surfaces have been proposed as etiologic factors for disc displacements (Könönen et al., 1996; Stegenga & de Bont, 2006). Degenerative osteoarthritis or osteoarthrosis has a non-inflammatory origin and the possible inflammatory changes have been thought to be secondary (Zarb & Carlsson, 1999; de Leeuw, 2008). The degenerative changes in the TMJ are believed to result from dysfunctional remodelling which might be due to decreased host-adaptive capacity by systemic illness, hormonal factors or advancing age, or to excessive physical stress that exceeds the normal adaptive capacity of the TMJ (Tanaka et al., 2008).

Psychosocial factors

Studies have shown associations between TMD and psychological issues in adolescents (Suvinen et al., 2004). However, it appears that psychological factors in childhood are not predictors of orofacial pain in young adults (Macfarlane et al., 2009), and adults (Marbach et al., 1988; Von Korff, 1988; Magni et al., 1993; Velly et al., 2003), while these relations seem not to be completely congruent over time (Ohrbach & Dworkin, 1998). It seems that psychosocial factors are more linked to painful than non-painful TMD conditions (Suvinen et al., 2004, Reissmann et al., 2007; Sipilä et al., 2009), and that the location of pain is not a major factor for the prediction of psychosocial profiles (Reissmann et al., 2008), although there is some evidence of a trend for myofascial pain patients to have higher psychosocial distress than TMJ pain patients (Lindroth et al., 2002; Manfredini et al., 2009).

In a Finnish questionnaire study among 5696 subjects, depression was found to associate with TMD symptoms, especially those related to pain (Sipilä et al., 2001). Somatization has also been noted as a risk factor for myofascial pain in earlier studies among patients and community subjects (Huang et al., 2002; Rammelsberg et al., 2003). Further, it seems that psychosocial factors are associated more with myofascial pain than internal derangements (Yap et al., 2002a).
However, the multidimensional nature of pain experience in TMD has been poorly elucidated, understood, and utilized in the assessment and management of TMD patients (Suvinen & Reade, 1995). Moreover, etiologic studies on TMD should be directed at psychosocial factors including stress, depression, and somatic distress (LeResche, 1997).

Genetic factors

Orofacial pain is the major reason for people to seek help for TMD. However, individuals are not equally susceptible to TMD and the extent to which genetic factors contribute to painful TMD has become a major interest. Recent investigations have focused on genes for individual variation of pain perception (Oakley & Vieira, 2008). Genetic marker studies of genes involved with catecholamine (e.g., dopamine, epinephrine, noradrenaline and serotonin) metabolism and adrenergic receptors suggest that certain polymorphism might be associated with changes in pain responsiveness and pain processing in patients with chronic TMD (Scrivani et al., 2008). A topic of great interest is the Catechol-O-methyltransferase (COMT) enzyme, which has broad biological functions and has been implicated in the pathogenesis of a number of neuropsychiatric disorders, migraine, and Parkinson’s disease. Recent reports have also revealed the involvement of COMT in the regulation of pain perception (Diatchenko et al., 2006). The genetic variant of COMT associated with high pain sensitivity results in decreased synthesis of the enzyme, which suggests that individuals with high sensitivity to pain may have higher levels of catecholamines (Cairns, 2010). However, there might be separate pathways by which psychosocial and COMT haplotypes increase the risk of clinical pain (Slade et al., 2007).

Occlusion

The available research data do not present overwhelming evidence of whether occlusion is a major cause of TMD or not (Okeson, 1998; Scrivani et al., 2008). De Boever et al. (2000) conclude on the basis of their critical analysis of the literature that occlusion does not play a major role in the etiology of TMD. However, the difference in outcome between the groups with and without a TMD history suggests that there are differences in vulnerability to occlusal interferences. It is possible that the etiological role of occlusal interferences in TMD has not been correctly addressed in previous studies (Le Bell et al., 2006; Niemi et al., 2006). Further, based on general population based studies, no conclusions can be drawn about associations between specific types of malocclusion and TMD (John et al., 2002; Gesch et al., 2005; Farella et al., 2007; Mohlin et al., 2007; de Leeuw, 2008) or whether orthodontic treatment causes or prevents TMD (Mohlin et al., 2007; Macfarlane et al., 2009b). In summary, while the controversy over the relationship between occlusion and TMD persists, there is a consensus that generalized prophylactic occlusal adjustment regarding TMD is not justified (De Boever et al., 2000; Koh & Robinson, 2004; Türp et al., 2008).
Bruxism

Studies have addressed bruxism as an underlying factor for TMD (Molina et al., 1999; Glaros et al., 1998; Ahlberg et al., 2005; Glaros et al., 2005; Carlsson et al., 2003; Johansson et al., 2006). Some reports (Lobbezoo & Lavigne, 1997; Pergamalian et al., 2003) have concluded that the link between bruxism and jaw pain seems weak. However, Huang et al. (2002) reported a significant association between self-reported bruxism and both myofascial pain and TMJ arthralgia. Dao et al. (1994) suggested that pain associated with bruxism and with myofascial pain may be two different entities. In the 20-year follow-up study by Carlsson et al. (2003) bruxism was associated with signs and symptoms of TMD. Further, Johansson et al. (2006) found in large Swedish study (n = 12,468) that self-reported bruxism was the strongest risk factor for craniofacial pain. Interestingly, a recent study by Rompré et al. (2007) revealed that mild bruxers may be at greater risk for pain symptoms than moderate or severe bruxers. This was confirmed by Rossetti et al. (2008) who also found that daytime clenching may even be a more important underlying factor in TMD. Overall, the relationship between craniofacial pain and bruxism appears very complex in nature (Svensson et al., 2008).
Classification history

Several approaches for diagnosing and classifying TMD have been published.

<table>
<thead>
<tr>
<th>Author/Source</th>
<th>Year</th>
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<tbody>
<tr>
<td>Costen</td>
<td>1934</td>
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<tr>
<td>Schwartz</td>
<td>1956</td>
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<tr>
<td>Laskin</td>
<td>1969</td>
</tr>
<tr>
<td>Farrar</td>
<td>1972</td>
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<tr>
<td>Helkimo (Helkimo Index)</td>
<td>1974</td>
</tr>
<tr>
<td>Eversole &amp; Machado</td>
<td>1985</td>
</tr>
<tr>
<td>Bell</td>
<td>1986</td>
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<tr>
<td>Wänman &amp; Agerberg</td>
<td>1986</td>
</tr>
<tr>
<td>Fricton &amp; Schiffman (Craniomandibular Index)</td>
<td>1986</td>
</tr>
<tr>
<td>International Headache Society (IHS)</td>
<td>1988, 2004</td>
</tr>
<tr>
<td>Dworkin &amp; LeResche (RDC/TMD)</td>
<td>1992</td>
</tr>
<tr>
<td>Truelove et al.</td>
<td>1992</td>
</tr>
<tr>
<td>Okeson. American Academy of Orofacial Pain (AAOP)</td>
<td>1996</td>
</tr>
</tbody>
</table>

Some of the most common methods are described in some detail below.

The Helkimo Index

The Helkimo index is commonly used classification for TMD. The Helkimo Anamnestic Index classifies TMD according to subjective symptoms and the Helkimo Clinical Dysfunction Index classifies TMD by clinical findings of impaired range of movement, impaired TMJ function, muscle pain, TMJ pain, and pain on movement of mandible (Helkimo, 1974).

The International Headache Society (IHS) Classification and Diagnostic Criteria for Headache Disorders, Cranial Neuralgias, and Facial Pain

The International Headache Society classifies pain conditions in the head and face. Part 11 of the classification is “Headache or facial pain associated with disorder of cranium, neck, eyes, ears, nose, sinuses, teeth, mouth, or other facial or cranial structures”. TMJ and masticatory muscles are in a different category. The IHS Classification (1988) was last updated in 2004.
The American Academy of Orofacial Pain (AAOP)

In 1990, American Academy of Orofacial Pain (AAOP) published “Craniomandibular disorders: Guidelines for evaluation, diagnosis, and management”, and in 1993 an updated version, “Temporomandibular disorders: Guidelines for evaluation, diagnosis, and management” (McNeill, 1990; McNeill, 1993). These two editions focused mainly on TMD, while the next version had a broader view on disorders affecting the orofacial area and was titled “Orofacial pain: Assessment, diagnosis, and management” (Okeson, 1996). In the 2008 version, TMJ disorders include congenital or developmental disorders, disc derangement disorders, TMJ dislocation, inflammatory disorders, non-inflammatory disorders, ankylosis, and fracture. Masticatory muscle disorders include local myalgia, myofascial pain, centrally mediated myalgia, myospasm, myositis, myofibrotic contracture, and masticatory muscle neoplasia (de Leeuw, 2008).

Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD)

The dual Axis instrument

The variation among problems labelled as TMD and the fact that these conditions have no common etiology or biological explanation are the reason for the lack of universally accepted scientifically based guidelines for diagnosis. Dworkin and LeResche (1992) established a standardized examination procedure (RDC/TMD) to overcome this problem and to be used internationally for research purposes. Development of the instrument included studies on symptoms and psychosocial factors (Von Korff et al., 1988), and clinical signs (Dworkin et al., 1990a) in subjects labelled as clinical cases, community cases and community controls. Dworkin and co-workers also showed that TMD examinations are not highly reliable, at least not without a calibration procedure (Dworkin et al., 1990b).

The RDC/TMD includes physical Axis I and psychosocial Axis II (Table 1.). Axis I examinations are conducted according to a specific protocol which includes palpation of 20 muscle sites and four TMJ sites bilaterally. Muscles are palpated to detect pain and joints are palpated to detect joint sounds (clicking, coarse crepitus, fine crepitus), and/or pain. Jaw movements are also measured. The diagnoses include only the most common forms of TMD: myofascial pain (Group I), disc displacements (Group II), and arthralgia, arthritis, and arthrosis (Group III). The RDC/TMD permits multiple diagnoses for each subject. Psychosocial assessment includes Graded Chronic Pain Scale (GCPS) (Von Korff et al., 1990; Von Korff et al., 1992; Dworkin & LeResche, 1992), psychological depression, and non-specific physical symptoms (somatization) based on the subscales of the Symptom Checklist 90 (SCL-90) (Derogatis et al., 1973; Derogatis, 1983; Von Korff et al., 1988; Dworkin & LeResche, 1992; Holi et al., 1998).
The RDC/TMD has been translated into several languages. It has been used widely internationally for research purposes in adults, and also in children and adolescents (Wahlund et al., 1998; List et al., 2001). In addition, computerized diagnosis software for the RDC/TMD has been developed in the National University of Singapore and used in several studies (Yap et al., 2001; Yap et al., 2002a; Yap et al., 2002b; Yap et al., 2004a; Yap et al., 2004b).

There have been critics concerning the RCD/TMD and its clinical usefulness (Huddleston Slater et al., 2004; Limchaichana et al., 2007; Naeije et al., 2009; Steenks & de Wijer, 2009; Visscher et al., 2009) and more clinically oriented systems based on the RDC/TMD have been suggested (Truelove et al., 1992; Hasanain et al., 2009). The recently published multisite RDC/TMD Validation Project (Anderson et al., 2010; Look et al., 2010; Ohrbach et al., 2010; Schiffman et al., 2010a; Schiffman et al., 2010b; Truelove et al., 2010) answered some of these criticisms. This revised RDC/TMD is supposed to be more suitable for clinical settings, and the updated acronym DC/TMD will support this (http://www.rdc-tmdinternational.org/).

**Reliability and validity of the RDC/TMD**

The reliability and construct validity of the instrument to diagnose TMD have been documented (List et al., 1996; Dworkin et al., 1990b; Dworkin et al., 2002; Schiffman et al., 2010; Look et al., 2010; Truelove et al., 2010; Ohrbach et al., 2010). In addition, the overall reliability and validity of the RDC/TMD protocol have been tested and revisions of the current Axis I diagnostic algorithms published (Schiffman et al., 2010; Look et al., 2010; Truelove et al., 2010). However, even experienced clinicians have shown low reliability in assessing clinical signs of TMD without calibration (Dworkin et al., 1990b; Leher et al., 2005). For this reason repeated calibration of the examiners is recommended to increase reliability, and recalibration has been shown to considerably improve inter-examiner reliability for assessing the RDC/TMD clinical variables and diagnoses (List et al., 2006).

The RDC/TMD Axis II components have been shown to be reliable and valid indicators for depression, non-specific physical symptoms, and psychosocial dysfunction (Dworkin et al., 2002; Ohrbach et al., 2010). This view has been strengthened by reliability and validity studies within different study populations internationally (John et al., 2006; Khoo et al., 2008). In a German study (John et al., 2006) the reliability and validity of the GCPS was shown. Both in Germany (John et al., 2006) and The Netherlands (Lobbezoo et al., 2005) the SCL-90 was already translated and validated, so reliability and validity were not tested in these studies. In the Malay translation study all three Axis II components showed their reliability and validity (Khoo et al., 2008). The validity of the Finnish translation of the SCL-90 as a screening tool has also been demonstrated (Holi et al., 1998). Moreover, extraction of the 32 item subscales of the RDC/TDM Axis II from the 90 item scale (SCL-90-R) seems not to compromise the reliability of the instrument (Ohrbach et al., 2008).
**Table 1. The RDC/TMD Classification (Dworkin & LeResche, 1992)**

<table>
<thead>
<tr>
<th>The RDC/TMD classification Axis I:</th>
<th>The RDC/TMD classification Axis II:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Group I: Muscle disorders</strong></td>
<td><strong>Behavioral:</strong></td>
</tr>
<tr>
<td>A. Myofascial pain</td>
<td>Mandibular functional disability</td>
</tr>
<tr>
<td>B. Myofascial pain with limited opening</td>
<td>Psychosocial:</td>
</tr>
<tr>
<td>C. No Group I diagnosis</td>
<td>Graded Chronic Pain Scale (for assessing pain severity and life interference):</td>
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<tr>
<td></td>
<td>Grade 0: No TMD pain in the prior 6 months</td>
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<td></td>
<td>Grade 1: Low intensity – Low intensity pain</td>
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<td></td>
<td>Grade 2: High intensity – High intensity pain</td>
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<tr>
<td></td>
<td>Grade 3: Moderately limiting</td>
</tr>
<tr>
<td></td>
<td>Grade 4: Severely limiting</td>
</tr>
<tr>
<td><strong>Group II: Disc displacements</strong></td>
<td><strong>Psychologic:</strong></td>
</tr>
<tr>
<td>A. Disc displacement with reduction</td>
<td>Depression</td>
</tr>
<tr>
<td>B. Disc displacement without reduction, with limited opening</td>
<td>Normal</td>
</tr>
<tr>
<td>C. Disc displacement without reduction, without limited opening</td>
<td>Moderate</td>
</tr>
<tr>
<td>D. No Group II diagnosis</td>
<td>Severe</td>
</tr>
<tr>
<td><strong>Group III: Arthralgia, arthritis, and arthrosis</strong></td>
<td>Non-specific physical symptoms (somatization), pain items included and/or excluded</td>
</tr>
<tr>
<td>A. Arthralgia</td>
<td>Normal</td>
</tr>
<tr>
<td>B. Osteoarthritis of the TMJ</td>
<td>Moderate</td>
</tr>
<tr>
<td>C. Osteoarthrosis of the TMJ</td>
<td>Severe</td>
</tr>
<tr>
<td>D. No Group III diagnosis</td>
<td></td>
</tr>
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</table>
Psychosocial factors

Biopsychosocial model of disease

George L. Engel stated (1977): “The dominant model of disease today is biomedical, and it leaves no room within this framework for the social, psychological, and behavioral dimensions of illness. A biopsychosocial model is proposed that provides a blueprint for research, a framework for teaching, and a design for action in the real world of health care.” As Jeffrey P. Okeson discussed the issue, the biopsychosocial model is a general model or approach that posits that biological, psychological, and social factors all play a significant role in human functioning in the context of disease. To fully classify a pain disorder, the clinician must consider both the somatosensory and the psychosocial input. Each time nociceptive impulses reach the higher centers, activity between brain areas such as the thalamus, cortex, and limbic structures influence the interpretation of this input. In reality, this interaction is likely to represent the psychologic influence on the pain experience (Okeson, 1996). The biopsychosocial model could also be applied to painful TMD as biomedical and biopsychosocial methods best support the assessment and management of the cardinal features of TMD, i.e., pain and dysfunction or physical (peripheral) and psychosocial (central) factors (Dworkin & Massoth, 1994; Suvinen et al., 2005).

Psychosocial factors and pain

Pain is a complex, highly personal, and multidimensional experience influenced by a variety of biological and psychosocial factors (Fillingim, 2000; Macfarlane, 2001; Murray & Peck, 2007; Svensson et al., 2008). Previous pain experience and previous mental disorders seem to be associated with chronic pain (Elliot, 2002; Croft et al., 2003), as would be expected based on the modern version of the gate control theory of pain (Melzack, 1965), namely neuromatrix (Melzack, 1999). The body-self neuromatrix and produced neurosignature are, among other stimuli, affected by stress (Melzack, 1999), the importance of which has long been recognized (Selye, 1936; Selye, 1956). In this perspective health is viewed as a balance between the physical, psychological and socioenvironmental factors that affect well-being. The critical point might not be the actual nociceptive input but rather how this afferent barrage is integrated and processed in the central nervous system (Svensson et al., 2008). Furthermore, pain contains both sensory and affective dimensions and is often accompanied by desires to terminate, reduce, or escape its presence (Price, 2000). However, a multidimensional biopsychosocial approach based on information processing and integration between physical and psychological processes is recommended to be used not only in the assessment, but also in the management of TMD (Suvinen et al., 2005).
Depression

The terms depression or depressed refer to sadness and other related emotions and behaviors. Depression can be divided into mild, moderate and major depression. Chronic musculoskeletal pain patients with depression also have more psychosocial stressors and more severe anxiety (Poleshuck et al., 2009). The RDC/TMD Depression scale assesses negative mood and vegetative symptoms of poor functioning. Most of the typical symptoms of depressive syndromes according to current diagnostic criteria are included here (symptoms of dysphoric mood and affect, signs of withdrawal of life interest, lack of motivation, loss of vital energy, feelings of hopelessness, thoughts of suicide, and cognitive and somatic correlates of depression) (Derogatis et al., 1973; Derogatis, 1983). However, in a prospective study by Von Korff et al. (1993) depression was not significantly associated with onset of TMD pain symptoms in a three-year period.

Non-specific physical symptoms (somatization)

Somatization could be defined as "a tendency to experience and communicate somatic distress in response to psychosocial stress and to seek medical help for it" (Lipowski, 1988). While there are other ways to define somatization, all these definitions have one element in common, namely the presence of somatic symptoms that cannot be (adequately) explained by organic findings (De Gucht & Fischler, 2002). Somatization is common among chronic pain patients and the effect of pain is highly context dependent and modified by affect and memory (Birket-Smith, 2001).

The somatization dimension of the SCL-90-R included in the RDC/TMD reflects distress arising from bodily perceptions. The somatization scale can be assessed with or without pain items. Complaints focused on cardiovascular, gastrointestinal, respiratory, and other systems with autonomic mediation are included. Many of these symptoms are included in diagnostic criteria for anxiety disorders and have a high prevalence in disorders with suggested functional etiology. All of them may also reflect a physical illness. This is why the term “non-specific physical symptoms” was used instead of “somatization” in the RDC/TMD (Dworkin & LeResche, 1992).

Stress

Physiological systems activated by stress do not only protect and restore but can also damage the body (Selye, 1936). Acute and chronic stress (the cumulative load of minor, day-to-day stresses) can have long term consequences and damage the body (McEven, 1998). The most widely accepted theory for the etiology of stress-related disorders is a diathesis-stress framework which suggests that an individual has underlying predisposition to a disease and in order to develop the disorder, the individual must be exposed to a stressor that interacts in some way with the predisposing factors (Korszun, 2002). The stress-depression link could be conceived of as a
function of inadequate resources for managing one’s individually perceived level of life distress. It follows that any somatic depressive symptoms should arise when the biological coping systems are overtaxed (Bedi, 1999). Biological processes by which emotional stressors contribute to the onset and maintenance of painful TMD include at least the hypothalamic-pituitary-adrenal axis, and the serotoninergic and opioid systems (Korszun, 2002; Gameiro et al., 2006).

Stress experiences reportedly arise from multifactorial work and life issues (von Onciul, 1996). Whilst the causal links are difficult to determine, there are many studies on possible consequences of increased and prolonged stress on health, ranging from various somatic, chronic pain, and psychosomatic disorders to serious mental distress disorders (Bedi, 1999; Gabriel & Liimatainen, 2000).

However, in a prior large-scale survey investigating the severity of occupational stress in the UK, approximately 20% of the random working sample reported very high or extremely high levels of stress at work (Smith, 2000). Perceived stress was related to potentially stressful working conditions. Females in full-time work reported higher levels of stress than males, and when age was examined it was found that those at either end of the working age range reported less stress than those in the 35–55 year-old age group (Smith, 2000).

**Pain intensity and disability**

It is well known that both the subjective report of pain intensity and activity limitation describes the severity of a pain condition (Dworkin & LeResche, 1992). The GCPS, a self-report instrument, was developed to measure these two dimensions of chronic facial pain condition using seven questions with a 0–IV score scale. The first three questions are for assessing pain intensity in terms of current pain, worst intensity of pain, and average pain intensity. The last four measure pain-related disability days and interference with daily activities (Von Korff et al., 1990; Von Korff et al., 1992). Ease of use was one of the most important criteria for including this instrument in RDC/TMD Axis II (Dworkin & LeResche, 1992). It has been found to be a valid and reliable instrument for use as a self-completion questionnaire (Smith, 1997) and used in earlier pain studies (Elliot et al., 1999; Elliot et al. 2002).
Aims of the study

TMD seem to be rather common among non-patient populations. However, studies that have used standardized methods to assess TMD, including both physical and psychosocial aspects, are rare. The general aims of the present study in a Finnish non-patient population were to:

1. assess the prevalence of TMD and related pain symptoms, and their associations with psychosocial factors,
2. clinically diagnose and follow the natural courses of TMD during a 1-year period,
3. assess possible comorbidity of TMD and/or neck muscle pain with perceived stress and their impact on work performance, and
4. investigate how various psychosocial factors relate to chronic TMD.

The hypotheses of this study among non-patients were that:

1. TMD and related pain symptoms are common, and they are associated with psychosocial factors,
2. TMD may fluctuate,
3. work performance is associated with TMD and/or neck muscle pain, and
4. there may be different associations between psychosocial factors and specific subgroups of chronic TMD.
Subjects and methods

Calibration procedure

The preliminary Finnish version of the RDC/TMD was translated from the original by two experienced TMD researchers according to the International RDC/TMD Consortium guidelines (see www.rdc-tmdinternational.org). The RDC/TMD Axis I was used in the calibration examinations conducted by three examiners on 15 subjects prior to the actual study and to confirm that the Finnish version was understandable and acceptable. The calibration procedure was conducted at the Department of Stomatognathic Physiology and Prosthetic Dentistry, Institute of Dentistry, University of Helsinki (by Docent Tuija Suvinen) according to the examination specifications of the original RDC/TMD developers (Dworkin and LeResche, 1992). Before and after these examinations the translated version was checked for clarity by the experienced researchers. All three researchers agreed on 86% of the studied subjects regarding the diagnosis “No myofascial pain” (Group Ic). The examiners gave the same diagnosis for 90% of the Group II (disc displacements), and 87% of the Group III (arthralgia, arthritis, arthrosis) joints examined.

Study population

At the baseline 1999, a standardized, self-administered questionnaire was mailed to all 30- to 55-year-old employees of the Finnish Broadcasting Company Ltd. whose employment with the company in the Helsinki area had lasted at least five years (n = 1784). The subjects were prompted to participate in the study by the company’s internal media (newsletter, TV channel, IntraNet) and a personal invitation letter. The response rate was 75%. The mean age of respondents was 46 years (SD 7) in both genders (males 51%).

Of these 1339 subjects, 241 were randomly selected to participate in the clinical TMD study (II). The mean age of the examined subjects was also 46 years (SD 7) and 48% were males. The type of work of the clinically studied individuals included management (13%), journalism (24%), program production (22%), planning and development (13%), maintenance (17%), administration (9%), and others (3%). Of the studied subjects, 73% were married or cohabiting, 15% single, and 12% divorced, separated or widowed. Mean duration of education was 15 years (SD 4) and mean weekly working time was 40 hours (SD 6).

Among the 118 (49%) subjects with clinically confirmed signs of myofascial TMD and/or neck pain, the gender distribution was 2:1 (males 31%) and mean age 47 years. In addition, perceived symptoms were reported by 93 subjects (39% of the total 241 subjects studied), and duration and severity of perceived pain were assessed in a blind interview by Visual Analogue Scale (VAS). Subjects were also asked if these pain symptoms were continuous.
Clinical follow-up examinations at one year were conducted on 213 (88%) subjects. Two subjects did not complete the Axis II questionnaire and were excluded from the follow-up study. A total of 211 subjects (males 47%, mean age 46 years, SD 6) were examined according to the RDC/TMD. The study profile is shown in Figure 1.
Figure 1. Numbers of participating and drop-out subjects.
Methods

Questionnaire (I)

The questionnaire included items on sociodemographic background, perceived pain and TMJ-related painless symptoms, psychosocial status, and health behavior. Answers were given anonymously.

Sociodemographic data

Age, gender, marital status (married or cohabiting, single, divorced, or widowed) and weekly working hours were included. Type of work was classed as leadership or management = superior; journalism = journalist; program production or technical support = production; program planning, research and development = planning; service, logistics or maintenance = service; administration = administration. Shift work was also categorised.

Physical symptoms

TMJ-related painless symptoms (jaw-opening difficulties, jaw-moving difficulties, a feeling of tiredness in the jaws, TMJ clicking or crepitus, or jaws becoming caught or locked), orofacial pain (facial pain, jaw pain, or mouth or tongue pain), neck pain or headache were determined on a five-point scale (1 = never, 2 = seldom, 3 = sometimes, 4 = often, and 5 = continually). Symptoms perceived were dichotomised as frequent (present often or continually) or non-frequent (else). At least one of the symptoms had to be frequent in the sum variables (TMJ-related painless symptoms or orofacial pain).

Psychosocial factors

The SCL-90-R (Derogatis et al., 1973; Derogatis, 1983) depression and somatization classification subscales were used according the RDC/TMD. Subjects were classified as normal, or as having moderate or severe depression or somatization. Classification was done by dividing subjects by percentiles: normal below the 70th percentile, moderate above the 70th percentile, and severe above the 90th percentile of the study population as proposed in the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD) (Dworkin & LeResche, 1992).

Level of perceived stress according to the Occupational Stress Questionnaire (OSQ) (Elo et al., 1992) was measured as follows: “Stress means the situation when a person feels tense, restless, nervous, or anxious, or is unable to sleep at night because his mind is troubled all the time. Do you feel that kind of stress these days?” “Rather much” or “very much” were considered as high
stress, and “not at all”, “only a little”, or “to some extent” as low stress. Satisfaction with life and work were measured as follows: “How satisfied are you with your present life (/work)?” “Rather satisfied” or “very satisfied” were considered as satisfied, and “neither satisfied nor dissatisfied”, “rather dissatisfied”, or “very dissatisfied” as dissatisfied. Influence potential, hurry at work, and distribution of work were also assessed according to the OSQ.

Health behavior

Current self-rated general state of health was assessed by an overall rating on a five-point scale (1 = excellent, 2 = good, 3 = average, 4 = poor, or 5 = very poor). This measure was dichotomised by categorising response scores 1–3 as good health, and scores 4–5 as poor health. Numbers of physician and dentist visits, medications, and days absent from work during the past 12 months were also asked about, as well as the reason for the latest appointment. Pain was one of the five options available.

Clinical examinations (II, III, IV)

All subjects were interviewed about pain symptoms included in the RDC/TMD Axis I. They were all then clinically examined in a conventional dental chair at the company’s dental clinic by the same calibrated dentist (Mikko Rantala, D.D.S). Examinations were performed according to the RDC/TMD (II, III, and IV). During the clinical study (II) the other calibrated examiner (Professor Mauno Könönen) examined every tenth subject (n = 24) according to the RDC/TMD. The Kappa statistic (Cohen’s Kappa, K) was used to test inter-examiner agreement for the diagnosis of myofascial pain (n = 7, K = 0.80). In study III, neck muscle pain was assessed by a physician using standardized muscle palpation methods. In addition, temporomandibular and/or neck muscle pain severity was assessed by VAS.

In the follow-up study (IV) diagnoses of myofascial pain and myofascial pain with limited opening were combined into the category of myofascial pain, and disc displacement with reduction in either or both TMJ was considered as disc displacement with reduction. These diagnoses were recorded as chronic if made at both examinations.

Axis II psychosocial assessment (IV)

Psychosocial (depression, somatization, graded chronic pain) status was assessed according to the RDC/TMD Axis II. The subjects completed the Finnish translation of the RDC/TMD history questionnaire. Depression and somatization (non-specific physical symptoms with pain items) were categorised into three groups: normal, moderate, and severe. To avoid possible cross-national variations in reporting psychological issues (Holi, 1998; Simon, 2002) the study
population was divided into three groups by percentiles to define depression and somatization instead of using the USA-based reference values suggested earlier (Dworkin & LeResche, 1992). Classification was done by calculating raw mean scores for these scales and by dividing the subjects by percentiles: normal below the 70th percentile, moderate above the 70th percentile, and severe above the 90th percentile of the study population. Pain was graded according to the GCPS as instructed in the RDC/TMD (Dworkin & LeResche, 1992). Mandibular functional disability scores were not studied.
Statistical methods

Paper I: The Chi-square test was used to study the associations between categorical variables with the level of significance set at \( p < 0.05 \).

Paper II: The Chi-square test was used to study associations between the most common diagnoses and categorical demographic characteristics (gender, age group, marital status, type of work). The level of significance was set at \( p < 0.05 \).

Paper III: The Chi-square test was used to analyse categorical variables and the t-test to compare group means. A logistic regression model was fitted to analyse the effects of stress and pain variables on the probability of perceived impact on work performance (categorised as yes = 1, or no = 0). Variables from the questionnaire data were used in the multivariate analysis as follows: pain duration in years, pain severity (VAS scores), pain type (continuous = 1, other = 0) and perceived stress severity scores regarding home, work, financial, social life and health issues (1–5 scale). The forced entry method was used, i.e. the independent variables were entered in the model in a single step.

Paper IV: The Chi-square test was used to study the significance of the associations for the variables by age and gender. Logistic regression models were fitted to analyze the effects of age, gender, depression, and somatization on the probability of having chronic myofascial pain and disc displacement with reduction. Age groups (30–39, 40–49, 50–55), gender (women = 0, men = 1), and depression and somatization grades (normal, moderate, severe) were included as independent variables. The forced entry method was used, i.e. the independent variables were entered in the multivariate models in a single step.

All analyses were performed with SPSS statistical software, version 9.0, 10.0 or 11.0 (SPSS Inc., Chicago, IL, USA).

Ethical approval

Ethical approval was obtained from the University of Helsinki, Institute of Dentistry Ethical Committee.
Results

Subjects

In the baseline questionnaire study (I) 5% of the subjects rated their general state of health as poor, although none reported very poor health. Pain was claimed as the reason for the latest health care visit by 13% of the subjects, significantly more often among those with symptoms of frequent neck pain (p = 0.002) and headache (p = 0.005), and pain led to the latest dental visit for 3%. Perceived poor general state of health was significantly associated with all the symptoms, but only neck pain and headache with days absent from work. Subjects with TMJ-related painless symptoms, orofacial pain, neck pain, or headache more often used sedatives and sleeping pills than others. Type of work or work position was not associated with any of the studied variables (I, III).

TMJ-related painless symptoms and all pain symptoms were significantly associated with female gender (≤ 0.001) (I) and TMD diagnoses were also found statistically significantly more often in women than in men (p < 0.05) (II). Male gender was significantly negatively associated with the probability of having chronic disc displacement (p = 0.049) (IV). Work performance was not significantly associated with gender (III).

Symptoms (I, II)

The prevalence of frequent TMJ-related painless symptoms was 10%, orofacial pain 7%, neck pain 38%, and headache 15% (I). Overall, 43% of the subjects reported at least one of these symptoms as frequent. TMJ-related painless symptoms, orofacial pain or both were experienced frequently by 13%. TMJ-related painless symptoms and all pain symptoms were not associated with weekly working hours or marital status, and only headache was significantly associated with younger age. In the clinical study (II) current pain symptoms in the face or jaw regions were reported at the interview by 15% of the subjects: painful sites were muscles 12%, TMJ 2%, or both 3%. Pain in one or more jaw movements was found in 9% of the subjects (opening 6%, lateral movements 4%, protrusion 3%).

Clinical diagnoses of TMD and their fluctuation over a one-year period (II, IV)

The most common diagnoses in the clinical study (II) were myofascial pain 13%, disc displacement with reduction in the right temporomandibular joint 9%, and in the left joint 11% (Table 2.). Sixteen percent had disc displacement with reduction in one or both joints. Myofascial
pain was not associated with either right or left disc displacement. Based on the RDC/TMD, diagnoses were made as follows: Group I = 13%, Group II = 16% and Group III = 4%. Altogether, 73% of the subjects did not receive any RDC/TMD diagnosis.

In the follow-up study (IV), myofascial pain was diagnosed in 11% and disc displacement in 12% of the clinically studied subjects. Chronic myofascial pain was present in 7% and chronic disc displacement in 11% of the subjects. Of these, two had both diagnoses. The fluctuation in these diagnostic subgroups of TMD is shown in Figure 2.

### Table 2. TMD diagnoses in non-patients according to the RDC/TMD (II)

<table>
<thead>
<tr>
<th>n = 241, percentages</th>
<th>total</th>
<th>right</th>
<th>left</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Group I. Muscle disorders</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. Myofascial pain</td>
<td>12.9</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>b. Myofascial pain with limited opening</td>
<td>0.4</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>c. No Group I</td>
<td>86.7</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Group II. Disc Displacements</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. Disc displacement with reduction</td>
<td>15.8</td>
<td>9.1</td>
<td>10.8</td>
</tr>
<tr>
<td>b. Disc displacement without reduction, with limited opening</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>c. Disc displacement without reduction, without limited opening</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>d. No Group II</td>
<td>84.2</td>
<td>90.9</td>
<td>89.2</td>
</tr>
<tr>
<td><strong>Group III. Arthralgia, Arthritis, Arthrosis</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. Arthralgia</td>
<td>1.2</td>
<td>0.4</td>
<td>0.8</td>
</tr>
<tr>
<td>b. Osteoarthritis of the TMJ</td>
<td>0.4</td>
<td>0</td>
<td>0.4</td>
</tr>
<tr>
<td>c. Osteoarthrosis of the TMJ</td>
<td>2.5</td>
<td>1.2</td>
<td>1.2</td>
</tr>
<tr>
<td>d. No Group III</td>
<td>96.3</td>
<td>98.3</td>
<td>97.5</td>
</tr>
</tbody>
</table>
Clinical study

No myofascial pain

Follow-up

No myofascial pain

Myofascial pain

No disc displacement with reduction

Myofascial pain

No disc displacement with reduction

Disc displacement with reduction

Disc displacement with reduction

Figure 2. Fluctuation of myofascial pain and disc displacement over a one-year period (IV), n = 211.
The effect of temporomandibular and/or neck region muscle pain and stress perception on work performance (III)

Of the 118 studied subjects with clinically confirmed signs of temporomandibular and/or neck muscle pain, 47% reported that this problem interfered with their ability to perform work. Work performance was not significantly associated with age or work position. Those with a perceived impact on work performance reported that pain was more severe (mean VAS 6, SD 2) compared with those reporting no impact on work (mean VAS 4, SD 2) (p < 0.001). Mean duration of pain was 13 years (SD 9) in the work impact group, which was not significantly different from the no work impact group (p = 0.05). There were more subjects (16%) in the work impact group with continuous pain when compared with the no work impact group (4%) (p < 0.001). Those reporting that their pain had an impact on work performance had significantly more stress related to work (p < 0.01) and health (p < 0.001) issues. According to logistic regression, the reduced work performance was significantly positively associated with continuous pain (p < 0.05), pain severity (p < 0.05), and health stress perception (p < 0.05). Work stress was not positively associated with reduced work performance. An increment of one category of perceived health stress had a twofold effect on the probability of reduced work performance while the effects of the other studied independent variables were simultaneously controlled.

The associations between frequent TMJ-related painless symptoms, orofacial pain, neck pain, headache, and psychosocial factors (I)

In the questionnaire study (I) frequent TMJ-related painless symptoms, orofacial pain, neck pain and headache were significantly associated with somatization, depression and perceived stress (p < 0.001). TMJ-related painless symptoms were not associated with satisfaction with work and orofacial pain was not associated with evenly distributed work (ns). All other work related psychosocial factors and satisfaction with life were associated with all the studied symptoms (p < 0.05).

The associations between the most common TMD diagnoses and psychosocial factors at the one-year follow-up (IV)

Chronic myofascial pain, chronic disc displacement with reduction, depression, and somatization were not associated in the bivariate analyses with gender or age group in the follow-up study (IV). According to logistic regression, somatization was significantly positively associated with the probability of chronic myofascial pain (p = 0.006). An increase in the level of somatization by one category increased the probability of having chronic myofascial pain over three-fold (OR = 3.2; 95% CI = 1.4–7.2). Somatization was not associated with chronic disc displacement and depression was not associated with either diagnosis. Percentage distributions of the GCPS values
were as follows: Grade 0 = 82%, grade I = 13% and grade II = 4%. Grades III and IV were not found.
Discussion

Subjects

The inclusion criteria of five years in the same employment meant that all subjects were exposed to a similar work environment and had access to free-of-charge occupational health and dental care services. However, this may have led to a “healthy worker effect”, where the absence of ex- or new employees can bias the results (Li & Sung, 1999; Baillargeon, 2001). It has been proposed that studies concerning TMD and related factors should be focused on adult populations, because the prevalence of TMD is reportedly highest in working-age populations (Von Korff et al., 1988; Carlsson, 1999).

It has also been reported that TMD subjects use health care services more often than others (Alanen & Kirveskari, 1983; Wedel & Carlsson, 1987; Kuttila et al., 1997a; White et al., 2001). The results of the present study are in line with this finding. However, employees who reported more TMJ-related painless problems and orofacial pain symptoms did not differ from others regarding absence from work. This finding did not accord with earlier findings (Kuttila et al., 1997a) and may be linked to the overall low sickness absence rates in the studied company, which are below the average in Finland. The use of sedatives and sleeping pills was significantly associated with all symptoms (I). The association with pain symptoms is understandable, but with painless symptoms is not. One possible reason is that the symptoms were not exclusive, but this remains unexplained.

Pain and TMJ-related painless symptoms were significantly associated with female gender (I), as several other studies have shown (Von Korff et al., 1988; Agerberg & Bergenholtz, 1989; Andersson et al., 1993; Bush et al., 1993; Dao & LeResche, 2000; Magnusson et al., 2000; Egermark et al., 2001; Isong et al., 2008) and it has been estimated that TMD are approximately twice as common in women as in men in the general population (LeResche, 1997). Disc displacement with reduction was more prevalent among women than men, although statistically significant difference was not seen in the right TMJ (II). Agerberg & Bergenholtz (1989), Agerberg & Inkapööl (1990), Magnusson et al. (2000) and Rutkiewicz et al. (2006) reported in their studies among non-patients that TMJ sounds were also more prevalent among women. In this study (II), female gender was significantly associated with myofascial pain, as in earlier studies on TMD (Von Korff et al., 1988; LeResche et al., 1991; Dao & LeResche, 2000). The difference in TMD pain prevalence between women and men seems to increase already at adolescence (LeResche et al., 2005; Nilsson et al., 2009) and men seem eventually to recover from TMD more often than women, at least in young adulthoods. These divergent courses and diagnoses of TMD between female and male might explain some of the differences found (Wänman, 1996; List et al., 1999). Further, the highest prevalence in women seems to be during
the reproductive years (Von Korff et al., 1988; de Leeuw, 2008) and previous studies strongly suggest that estrogens modulate TMD pain in women (LeResche et al., 1997; Dao & LeResche, 2000; MacFarlane et al., 2002; LeResche et al., 2003; Cairns, 2007; Craft, 2007). However, the mechanisms underlying sex-related differences in the prevalence of TMD remain largely unclear and probably involve both physiological and psychological factors (Cairns, 2007). In the present study the gender difference was not statistically significant in the bivariate analyses regarding the chronic TMD problems (IV). This may be due to the relatively small sample size and number of chronic TMD subjects. Furthermore, in the multivariate analysis males were significantly less likely than females to have chronic disc displacement with reduction. Women more often reported psychosocial disturbances and pain symptoms, which accords with earlier findings (Von Korff et al., 1988; Bush et al., 1993; Magnusson et al., 2000; Egermark et al., 2001).

Methods

In the calibration procedure the Group I diagnoses “Myofascial pain” and “Myofascial pain with limited opening” might have been influenced from the prior examination because the protocol of the RDC/TMD includes assisted opening of the mouth, which stretches the muscles. Therefore, the diagnosis “Myofascial pain with limited opening” might change to “Myofascial pain” after one or two examinations. Further, it might be more relevant to check agreement between researchers on the group Ic diagnosis of “No myofascial pain”. A thorough RDC/TMD Axis I reliability study by Look et al. (2010) found that excellent reliability was achieved only for combined Group Ia and Ib diagnoses. Moreover, Truelove et al. (2010) reported in the RDC/TMD Axis I validity study, that target sensitivity and specificity were only observed when these diagnoses were combined. In the present study, TMJ diagnoses were more stable in multiple examinations conducted on the same day. Overall, the agreement between researchers in the calibration procedure can be considered acceptable. While the number of studied subjects in the calibration project was quite low for statistics, it was in line with the RDC/TMD study protocol (Dworkin & LeResche, 1992).

The lack of uniform diagnostic methods has led to wide variations in prevalence figures for TMD (De Kanter et al., 1993; LeResche, 1997; Carlsson, 1999; de Leeuw, 2008). Another problem is that TMD examinations do not yield many objective measurements. On the contrary, most clinical findings from examination are the result of subjective reporting by the patient or the clinician (Dworkin et al., 2002). The RDC/TMD is a dual Axis instrument supported by a history and examination protocol, and it reflects the biopsychosocial health model. However, the reliability of the RDC/TMD has been reported for classification of subjects into specific TMD subgroups (Axis I) and assessment of the psychosocial aspects (Axis II) (Dworkin et al., 1990b; List & Dworkin, 1996; Dworkin et al., 2002; John & Zwijnenburg, 2001; John et al., 2005; Lobbezoo et al., 2005; John et al., 2006; Khoo et al., 2008). The RDC/TMD was chosen to enable diagnosis as reliable as
possible for the subgroups of TMD, and to provide a psychosocial dimension within the study instrument.

There are numerous muscle disorder diagnoses (Dworkin & LeResche, 1992; de Leeuw, 2008). Myofascial pain seems to be the most common of these and is therefore included in the RDC/TMD. In the original paper by Dworkin & LeResche (1992) there is an Appendix to Axis I for ruling out uncommon muscle conditions (i.e., muscle spasm, myositis, contracture) prior to using the RDC/TMD. However, there are no precise criteria for these and only general guidelines are given. This might have an influence on the diagnoses made. However, given that these conditions are uncommon, that guidelines are provided, and that there have to be both symptoms and signs for a diagnosis of myofascial pain (chronic painful condition), the effect on validity could be regarded as minor.

To increase the reliability and validity of clinical diagnoses for disc displacements and osteoarthritis, the RDC/TMD contains brief image analysis criteria based on magnetic resonance imaging (MRI) and computerized tomography (CT), respectively (Dworkin & LeResche, 1992). The absence of comprehensive reliability and validity studies on these was taken into account in the RDC/TMD Validation Project (Ahmad et al., 2009; Schiffman et al., 2010). Based on the study by Ahmad et al. (2009), using the new criteria, the reliability of the radiologists for assessing osseous diagnoses with CT was good, and disc diagnoses with MRI was excellent. In the present non-patient population study, MRI and CT studies were impossible, which probably had an effect on the sensitivity and specificity of the method used. On the other hand, the sensitivity of the method to detect TMJ problems in particular with clear clinical signs could be higher than the overall sensitivity. Moreover, MRI studies suggest that from 9% to 30% of asymptomatic TMJ subjects could have disc displacements, while according to a postmortem study gross morphologic changes can be present in the absence of TMD (de Leeuw, 2008). Based on the Validation Project, which the DC/TMD originates from, MRI and CT should be used whenever possible to classify Group II and Group III disorders.

The RDC/TMD Axis II components have been reported to be reliable and valid indicators of depression, non-specific physical symptoms and graded chronic pain. They were not designed, however, to provide psychiatric diagnoses (Dworkin et al., 2002). Instead, they were meant to serve as screening tools for these psychosocial factors and for the assessment of TMD to be consistent with biopsychosocial models for understanding disease and illness (Dworkin et al., 2002). As a part of the multisite RDC/TMD Validation Project, evaluation of psychometric properties of the Axis II measures indicated that these had overall good to excellent psychometric properties (Ohrbach et al., 2010).

To avoid possible cross-national variations in reporting psychological issues (Simon et al., 2002) and to take account of the fact that in the Finnish validation study for SCL-90 subjects scored
higher on all subscales than in USA (Holi et al., 1998), the study population was divided into three groups by percentiles according to RDC/TMD to assess depression and somatization (Axis II) instead of using the USA based reference values suggested earlier (Dworkin & LeResche, 1992). The OSQ (Elo et. al., 1992), which has been used in Finland prior to this study (I), was chosen to assess more work-related psychosocial aspect and stress symptoms.

Part of the purpose of this study was to develop the Finnish RDC/TMD. Further developments (including back translation and cultural equivalency) can be found at the International RDC/TMD website along with other ongoing updates.

**Symptoms**

Depending on the criteria used, the prevalence of perceived TMD symptoms varies considerably (De Kanter et al., 1993; Carlsson, 1999). TMJ-related painless symptoms, orofacial pain or both were perceived frequently by 13% and in the clinical study (II) current pain symptoms in the face or jaw region were reported at the interview by 15%, suggesting an estimate figure for TMD symptoms in the studied population. In a questionnaire study or by interview, however, defining a disorder like TMD is difficult without clinical examination. Subjects reported frequent orofacial pain equally or less than in earlier studies (Von Korff et al., 1988; Goulet et al., 1995), whereas the frequency of neck pain (Dvorak, 1988; Bovim et al., 1994; Hogg-Johnson et al., 2008) and headache (Agerberg & Bergenholtz, 1989) was almost the same as reported earlier (I). However, these figures indicate that neck pain is the most common of these symptoms.

**Clinical diagnoses of TMD and their fluctuation over a one-year period**

According to the present study using the Finnish version of the RDC/TMD, the occurrence of TMD symptoms, signs, and diagnoses in a Finnish non-patient working population seems to be quite similar to those suggested by earlier studies among adult non-patient populations (Von Korff et al., 1988; De Kanter et al., 1993), although exact comparisons are difficult due to the different methods used (De Kanter et al., 1993; Dworkin et al., 2002). Muscle disorders and disc displacement with reduction have been considered the most common clinical TMD findings while disc displacement without reduction, arthralgia, arthritis, and arthrosis have all been rare, at least in non-patient populations (Gonzales & Mohl, 2006; de Leeuw, 2008). This was also seen in the present study.

The prevalence of muscle pain on palpation was relatively high and in accordance with earlier studies (Agerberg & Inkapöööl, 1990; Dworkin et al., 1990a; Rutkiewicz et al., 2006). Yet, the prevalence figures for the diagnoses were unlikely to be overestimated because of the criterion that the subjects had to report concomitant pain symptoms in order to have a myofascial pain
diagnosis (Dworkin & LeResche, 1992). Further, perceived pain seems to be a critical factor in diagnosing TMD and at least the proportion of myofascial pain with limited opening and arthralgia diagnoses seem to be larger among patients than non-patients (List & Dworkin, 1996). However, even among patients they are not as prevalent as myofascial pain and disc displacement with reduction (Yap et al., 2002a).

Pain symptoms most often involved muscles in both sides of the face. An opening pattern with uncorrected lateral deviation occurred more often on the left side. Total figures, however, accord with earlier findings (Dworkin et al., 1990a). Uncorrected deviation is one sign of disc dislocation without reduction, but the present prevalences do not explain this discrepancy between right and left side. Further, right side midline deviation was seen clearly more often, which remains unexplained. The results of this study also demonstrate that these problems fluctuate, as has been reported previously in younger subjects, and in community and clinical cases (Könönen et al., 1996; Kuttila et al., 1997; Magnusson et al., 2000; Rammelsberg et al., 2003), although there have been some different findings (Alanen et al., 1997).

During this study, all subjects had equal access to free-of-charge conservative treatment between the examinations. They had courses of treatment on the basis of their subjective needs as well as normative needs assessed by health care professionals, which may have influenced both prevalence and incidence figures. On the other hand, some of the subjects had persistent problems regardless of the treatment received, which is congruent with earlier findings in patients with TMD (Okeson, 1996). However, there is evidence that individuals without major psychological symptoms do not require more than simple therapy, whereas patients with major psychological involvement need multimodal, interdisciplinary therapeutic strategies (Türp et al., 2007). The present study was conducted as a community based follow-up investigation and the outcomes from such a pragmatic setting contribute data comparable to real-life conditions among multiprofessional working personnel.

While the number of subjects studied by another examiner was quite small (every tenth, n = 24) the interexaminer reliability for diagnosis of “Myofascial pain” (Group Ia) in the study (II) could be considered as acceptable (Dworkin et al., 1990b). In this non-patient population the number of Group Ib diagnoses were limited and therefore the reliability between examiners for Group Ia was higher than in the calibration procedure or than in previous reports (Look et al., 2010; Truelove et al., 2010).
The effect of temporomandibular and/or neck muscle pain and stress perception on work performance

Studies have shown that from 6% to 10% of patients with chronic pain are work disabled (Sanders 1996; Teasell & Merskey, 1997). In the present study (III), 47% of the studied subjects with clinically confirmed signs of muscle pain (temporomandibular and/or neck) felt that this pain interfered with and affected their ability to perform work. The high percentage might be due to the construct of the question on perceived impact on work performance, in which subjects were asked simply whether their pain affected their ability to perform work duties or not.

It has been estimated that chronic pain problems in the head/neck region affect at least 12% of the general population (Von Korff et al., 1988; Von Korff et al., 1991; de Leeuw, 2008). Some studies, like the present one, indicate that the prevalence of neck pain may be even higher (Linton, 1990; Hogg-Johnson et al., 2008). Research has indicated that some individuals become more and more disabled and less able to cope with not only the pain problem but also with the demands of their work and daily lives (Paine, 1982; Burke & Richardson, 1996). In this study, we found that those employees who felt stressed about their health issues and had continuous pain or severe pain were more likely to report decreased work performance.

Previous studies indicate that both organizational and personal factors have relevance in terms of decreased work performance (Paine, 1982; Burke & Richardson, 1996). It is generally thought that stress problems are multifactorial and usually, depending on individual coping resources, a process where the individual gradually progresses from imbalance to exhaustion (Selye, 1956; Cherniss, 1980; von Onciul, 1996; Korszun, 2002). There is also general consensus that both stress and pain problems are multidimensional, i.e., that many factors are involved such as coping, psychosocial support, organizational support, as well as the availability of effective and biopsychosocial oriented health care (Paine, 1982; Maslach, 1993; Suvinen & Reade, 1995; von Onciul, 1996; Dworkin & Suvinen, 1998; Suvinen at al., 2005). These factors have been found important in terms of preventing pain and/or stress problems becoming chronic and disabling.

The associations between frequent painless TMJ-related symptoms, orofacial pain, neck pain and headache, and psychosocial factors

Psychosocial factors have been significantly associated with neck pain (Linton, 2000; Ariens at al., 2001a; Ariens et al., 2001b; Carroll et al., 2008) and musculoskeletal disease (Bongers et al., 1993), which accords with our results regarding perceived neck pain. In the questionnaire study (I), psychosocial factors included not only depression and somatization, but also perceived stress, satisfaction with work, influence potential, hurry at work, and distribution of work, all of which reflect the perceived work environment.
Satisfaction with work was not significantly associated with TMJ-related painless symptoms, nor was distribution of work associated with orofacial pain. All other work-related psychosocial factors were significantly associated with the symptoms. However, that the type of work was not associated with TMJ-related painless symptoms or pain problems may suggest that the tasks themselves may not have a major influence on these symptoms. The strong association with stress, depression and somatization, and different pain symptoms were in line with earlier findings (Locker & Slade, 1988; Von Korff et al., 1988; Leino & Hänninen, 1995; Mongini et al., 2000). Although the present study included non-patients, strong associations with painful conditions and psychosocial factors emerged. The prevalence figures of study (I) are in line with findings in the general population. The present findings also confirmed the complex relationship between TMD, the pain variables, gender, and psychosocial factors. However, TMJ-related painless symptoms and the studied pain symptoms seemed to be more associated with work-related psychosocial factors than with type of work itself.

The sum variable “TMJ-related painless symptoms” was associated with the psychosocial variables (I). Nevertheless, it probably should be understood more as “TMD-related painless symptoms” because the sum variable included, along with purely TMJ-related symptoms, also the variables “jaw-opening difficulties”, “jaw-moving difficulties” and “feeling of tiredness in the jaws”, all of which could be related to muscle problems and not only to joints. Moreover, the interest in this study was more with painless vs. painful symptoms than with the source of problems (I). One reason why painless symptoms were also associated with psychosocial variables may be the above; the other possible reason is that the symptoms were not exclusive. However, the reason for this association remains elusive.

The associations between the most common TMD diagnoses and psychosocial factors in the one-year follow-up

The first goal of this part of the study was to find those with chronic myofascial pain or disc displacement with reduction; the second was to cross-sectionally analyse whether these states were associated with the studied independent variables. Logistic regression was used to investigate the associations of chronic myofascial pain and disc displacement with reduction with somatization, depression, age, and gender, all thought to have a major effect on TMD. The multivariate approach enabled study of the independent effect of each background variable on the probability of the studied item, while simultaneously controlling the effects of other background variables. Arthralgia, which is quite a common finding among patients, was not found in this non-patient population, which underscores the difference between patients and non-patients. Thus, arthralgia was unlikely to be a confounding factor in this study (IV).
A significant relationship was found between somatization and myofascial pain. Further, the probability of having chronic myofascial pain increased over three-fold when somatization was increased from normal to moderate or from moderate to severe. This underscores the complex relationship between psychological issues and pain, also in non-patient populations. Nevertheless, somatization has been found to be a risk factor for facial pain (Von Korff et al., 1988) and for myofascial pain in earlier studies in patients and a community setting (Huang et al., 2002; Rammelsberg et al., 2003). However, somatization is also reported to be a possible confounding factor for Axis I diagnoses as subjects with severe somatization might over-report muscle pain on palpation (Wilson et al., 1994; Dworkin et al., 2002). It is noteworthy that depression, unlike an earlier report in a patient population, was not associated with myofascial pain (Yap et al., 2002b). This may well be due to the relatively low psychosocial dysfunction found in the present non-patient population as there were no GCPS grades III and IV, which are groups of high disability caused by the facial pain condition. However, over 4% of the subjects had high intensity pain but low disability. This is a lower figure than in a study by Von Korff et al. (1990) who reported that in a community sample severe and persistent pain was found in 8% of the subjects and that high disability due to facial pain condition was found in 3%. In addition, it seems that depression is not a risk factor for onset of TMD pain symptoms (von Korff et al., 1993), that depression score is not a significant predictor for the outcome of myofascial pain (Rammelsberg et al., 2003), and that multiple pain conditions predict more severe depression than do pain severity or persistence (Dworkin et al., 1990c). Overall, the relationship between TMD pain and psychological variables appears to be very complex (Ohrbach & Dworkin, 1998).

Future

When the etiology of a disease like TMD, is largely unknown, it is vitally important to have reliable and valid instruments to gather the information for the epidemiological studies that are needed to understand the underlying etiologic mechanisms. A reliable method means that the study can be repeated, while validity means that the method measures what it is supposed to measure, both with acceptable accuracy. The RDC/TMD published in 1992 (Dworkin & LeResche) opened the way for better methods to classify TMD as it highlighted the role of strict protocol, calibration of examiners, and the multidimensional nature of TMD. In the absence of a comprehensive reliability and validity study, a large, multisite study was designed to have the reliability and validity of the RDC/TMD tested thoroughly and to recommend revisions to the protocol. The complete series of these studies was published recently (Anderson et al., 2010; Look et al., 2010; Ohrbach et al., 2010; Schiffman et al., 2010a; Schiffman et al., 2010b; Truelove et al., 2010). These revisions were further developed into the Diagnostic Criteria for TMD (DC/TMD), a new version of the RDC/TMD, which can be found at http://www.rdc-tmdinternational.org/. It is hoped and expected that the DC/TMD studies internationally will yield
the more accurate information needed to develop better definitions of etiology and pathogenesis of TMD, and to yield more knowledge on related issues such as psychosocial factors.
Conclusions

Taken together, the results of this study imply that whenever TMD and related pain problems are assessed by health care professionals, the possible psychosocial factor inputs should be considered. From the results of the present survey and clinical one-year follow-up study based on the RDC/TMD in a non-patient working population, it may be concluded that:

1. TMD and related subjective symptoms are common in non-patients and associated with psychosocial factors,

2. myofascial pain and disc displacement with reduction are the most common clinical diagnoses of TMD, and they are fluctuating in nature,

3. self-reported health related stress, and continuous pain in temporomandibular and/or neck muscles are associated with reduced work performance, and

4. somatization seems to be significantly associated with chronic myofascial pain.
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