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Treatment need for temporomandibular disorders in the general population - a meta-analysis

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To my parents

Abstract

The purpose of this study was to determine the prevalence of treatment need for TMD in adult populations through conducting a meta-analysis, and describing factors influencing treatment need for TMD.

Population-based and non-patients studies of TMD, published in the English language, prior to June 2005 were included.

Well defined guidelines for conducting a meta-analysis for observational studies (MOOSE) were followed.

Electronic databases (MEDLINE, CINAHL, SCI-E, and EMBASE) were searched (n=645). Reference lists of relevant articles were screened, and the journals "Orofacial pain" and "Oral Rehabilitation" were hand searched (n=31) for the years 1996 to 5/2005.

There was a very good agreement between the two reviewers in identifications of abstracts (Kappa=0.8), full text articles (kappa=0.9), and in extracting data.

The results of this meta-analysis were based on results of 17 studies, and indicate that the prevalence of treatment need for TMD in adults is about (14%).

Studies with higher quality weights' scores have lower treatment need (5%) than studies with lower quality scores (20%).

Criteria and methods of estimating treatment need, age and time trend factors were found to influence treatment need estimate for TMD. However, no influence was found for the gender factor.

Differences between need estimates derived from clinical TMD signs and from patient-reported symptoms were observed (17% versus 6%).

Subjects in the age group 19-45 years needed more treatment for TMD than subjects in the age group 46-78 (19% versus 5%).

Results of this meta-analysis are substantial for planning and allocating health care resources.

A meta-analysis to estimate treatment demand for TMD is needed.

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ABBREVIATIONS

The following abbreviations appear in the text:

AAOP	=	American Academy of Orofacial Pain
A_i	=	Helkimo's anamnestic dysfunction index
B.C	=	before Christ
CINAHL	=	cumulative index of nursing and allied health literature
CSD	=	cervical spine disorder
D_i	=	Helkimo's clinical dysfunction index
et al.	=	(et altera) and others
MOOSE	=	meta-analysis of observational studies in epidemiology
n	=	number
Pubmed	=	public medline
RDC	=	research diagnostic criteria
SCI-E	=	science citation index-expanded
Std. Dev.	=	Standard deviation
Std. Err.	=	Standard error
TMD	=	temporomandibular disorders
TMJ	=	temporomandibular joint
TMJs	=	temporomandibular joints

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INTRODUCTION

The concept of need

One of the greatest challenges facing health care systems internationally is meeting the health needs of their populations with the available resources. Defining and assessing need is a critical element of the planning process, and many definitions of need have been proposed (Daly et al., 2002).

Sometimes need is defined in terms of treatment required as for example, in the definition by Matthew (1971): “a need for medical care exists when an individual has an illness or disability for which there is an effective and acceptable treatment or cure”.

Bradshaw (1972) proposed taxonomy of need which provides a definition of the differing concepts of need. Here he defines “normative need” as an expert’s or professional’s, administrator’s or social scientist’s definition of need in a given situation. “Felt need” is equated with “want”, expressed as a lay person’s own assessment of his or her requirement for health care. “Expressed need” or demand is felt need converted into action, by seeking assistance, either by use of services or request for information. “Comparative need” is assessed by comparing the health care received by different people with similar characteristics. If some and not others have received care, then there is a comparative need in those not receiving it.

Donabedian (1973) describes need as a state of client that creates a requirement for care and therefore represents a potential for service. Cooper (1975) stated that “a state of health assessed as in need of treatment by a medical practitioner”. Additionally, Carr and Wolfe (1979) described another aspect of need which they term as “unmet need”. This is the difference, if any, between the health judged to be needed and the health care actually provided. According to Sheiham et al. (1982), true treatment need may lie somewhere between the objective (assessed by a dentist) and subjective (assessed by the patient) treatment needs. Spencer (1984) states that “Need does not always lead to use of services and use of services does not always result from need, but the existence of disease and normatively defined need does create a potential for the use of services”. A more modern interpretation of need is: potential to benefit from health care (Carlsson and DeBoever, 1994).

Public Health importance of needs assessment

There are several reasons to conduct a needs assessment:

- To define the problem and to identify its extent and severity
- To obtain a profile of the community to ascertain the causes of the problem (this information helps in developing the appropriate goals and objectives in the problem solution)
- To evaluate the effectiveness of the program (Magi and Allander, 1981).

The definition and concept of need is essential for planning and evaluation of oral health care. Health care needs now extend beyond a narrow clinical interpretation to issues like: the impact of ill health on individuals and on society; the degree of disability and dysfunction that ill health brings; the perceptions and attitudes of patients themselves towards ill health; and the social origin of many common illnesses (Sheiham and Spencer, 1997).

Limitations of oral health needs assessments

Although, clinical criteria based on professional judgement, still largely dominate the assessment of oral health status and the estimation of need, it is increasingly recognized that there are areas where normative need is not sufficient. That does not mean that normative need assessment is not useful. But, it should be recognized that estimates of treatment needs obtained by using the condition-to-need or the direct treatment plan approach do not consider either the outcomes of oral diseases or the consequence of limited resources for health care.

It is also possible that most of these needs would not be perceived by people themselves who, therefore, would not seek the treatments proposed (Sheiham and Spencer, 1997). This observation was confirmed by the gap between the professional and patient's definitions of need (Reisine and Bailit, 1980). Indeed, objectivity methods often depend upon a consensus obtained from a number of subjective approaches. Even within those agreements, there is intraexaminer and interexaminer variability among different judgement (Sheiham et al., 1982).

Meta-analysis as a research tool

Meta-analysis is a quantitative approach for systematically assessing the results of previous research in order to arrive at conclusions about the body of research.

There are four steps in a meta-analysis:

1. studies of a topic are systematically identified
2. eligibility criteria for inclusion and exclusion of the studies are defined
3. data from eligible studies are abstracted or collected from the investigators in study
4. the abstracted data are then analyzed.

The analysis includes formal statistical tests of the heterogeneity of the study results, and, if results are homogeneous, estimation of a summary estimate of the size of the effect of interest. If the studies are not homogeneous, the heterogeneity is explored (Petitti, 2000).

The advantages of meta-analysis are that rather than being based on only a selection of published literature, they contain a comprehensive summary of the evidence, reducing bias and ensuring reliability. Systematic reviews are important because they can help formulate policy and to efficiently use available resources, establish generalisability, increase power and precision and limit bias (Macfarlane et al., 2001).

Meta-analytical methods are already common approaches to the assessment of health technology and related areas, and increasing adaptation of such approaches may be foreseen, in part in response to increasingly wide emphasis on evidence-based approaches to medicine and health care (Sutton, 1998).

The use of meta-analysis of observational epidemiological studies has been increased recently; however, it has also several limitations. One limitation is that publication bias is particularly important in epidemiological research since some analysis may be done in a very explorative way and may be only published selectively. As mainly unexpected significant results may be selected for publication, an overestimation of the risk estimate is likely. An additional problem is that studies may differ considerably in their designs, data collection methods and the definition of the exposure and confounder variables (Blettner et al., 1999).

Temporomandibular disorders: an overview

Brief history of temporomandibular disorders

Pain and dislocation in the jaw region were described and treated in humans as early as 3000 B.C. (McNeill, 1997). In 1934 Costen (an American otolaryngologist) observed that patients with pain in or near the ear, tinnitus, dizziness, a sensation of ear pressure or fullness, and difficulty in swallowing (known as Costen's Syndrome) seemed to improve by altering the vertical dimension of the occlusion (Costen, 1934).

Early theories of cause and effect espoused by various clinicians and investigators in the 1930's to 1960's focused primarily on the structural and functional relationships between the upper and lower teeth and jaws, or dental occlusion (Costen, 1934; Ramfjord and Ash, 1966). In 1966, Krough-Poulsen made a list to screen the symptoms of craniomandibular disorders (CMD). The list comprised limited mouth opening, deviation of the mandible, pain of the musculature and the TMJ, occlusal disharmony, occlusal wear, local and non-specific changes in the periodontal tissues, and tooth mobility. Because malocclusion was perceived to be the underlying cause, treatment of TMD shifted from medicine to dentistry.

Competing models of causation were proposed in the 1950's, first by Schwarz (1959), who saw stress or anxiety as a major etiological factor, and then by Laskin (1969), who extended Schwarz's psychological model. These theories were based primarily on observations in the clinical setting, and not on epidemiological studies. After 1970, advances in imaging techniques that included tomography, arthrography, computed tomography (CT), and, later, magnetic resonance imaging (MRI) resulted in improved visualization of intracapsular structures (Okeson, 1996). These imaging techniques plus increasing experience in clinical management, provided information for more specific diagnoses.

Since 1990's, TMD are considered not as a single entity but as a group of several diseases of varying aetiology and pathology. However, the controversy about different etiologic theories of TMD still exists because of limited knowledge regarding the aetiology and natural history of the course of TMD (Dworkin and LeResche, 1992; McNeill, 1993a).

Definition and terminology of TMD

The American Academy of Orofacial Pain (AAOP) defined Temporomandibular disorders (TMD) as “a collective term embracing a number of clinical problems that involve the masticatory musculature, the temporomandibular joint (TMJ) and associated structures, or both” (Okeson, 1996). These disorders have been principally characterized by:

1) pain in temporomandibular region or in the muscles of mastication,
2) limitations or deviations in mandibular range of motion,
3) TMJ sounds during jaw function (American Dental Association, 1983).

Okeson (1996) made up three categories of symptoms and signs according to the affected structures: the muscles, TMJ, and the dentition. TMD are considered to be a subclassification of musculoskeletal disorders (Okeson, 1996), and typically run a recurrent or chronic course, with a substantial fluctuation of signs and symptoms over time (Wänman, 1996; Kuttila et al., 1997; Magnusson et al., 2000).

Since the 1930’s, the terminology of signs and symptoms of functional disturbances of masticatory system has varied a great deal:

- Costen’s Syndrome (Costen, 1934)
- Temporomandibular Joint Pain-Dysfunction Syndrome (Schwarz, 1956)
- Myofascial Pain Dysfunction Syndrome (MPDS) (Laskin, 1969)
- Occlusomandibular Disturbances (Gerber, 1971)
- Functional TMJ Disturbances or Disorders (Ramfjord and Ash, 1971)
- Mandibular Dysfunction (MD) (Helkimo, 1974a, 1974c; Solberg et al., 1979; Wänman and Agerberg, 1986a, 1986b)
- Mandibular Stress Syndrome (Ogus and Toller, 1981)
- Craniomandibular Dysfunction (CMD) (Zarb, 1985)
- Temporomandibular Pain-Dysfunction Syndrome was recommended by the International Association for the Study of Pain (Merskey, 1986)
- Oromandibular Dysfunction (OMD) introduced by the International Headache Society (headache Classification Committee of the International Headache Society, 1988)
- Temporomandibular Disorders (TMD) (Bell, 1983; McNeill et al., 1990).

Indices and Classifications of TMD

Helkimo´s indices were the first to be developed mainly for epidemiologic purposes in the diagnosis of TMD (Helkimo, 1974a) and are still frequently used (Carlsson and LeResche, 1995), although criticism also has arisen (Carlsson et al., 1980; Mejersjö and Carlsson, 1983; van der Weele and Dibbets, 1987), and several efforts have been made to improve these indices (Fricton, 1986; van der Weele and Dibbets, 1987). Helkimo´s anamnestic index (Ai) comprises three degrees which are no anamnestic dysfunction (Ai0), mild symptoms (AiI) e.g. joint clicking, and severe symptoms (AiII) of TMD e.g. pain in TMJ and the masticatory muscles, limitation of mandibular movement. The clinical dysfunction index (Di) is based on the evaluation of five clinical signs:

- impaired range of movement,
- impaired function of the TMJ,
- muscle pain,
- TMJ pain,
- pain on movement of the mandible (Helkimo, 1974b).

The Di index comprises four degrees which are no clinical dysfunction (Di0), mild dysfunction (DiI), moderate dysfunction (DiII), and severe dysfunction (DiIII) (Helkimo, 1974b).

In adult population studies, severe symptoms of TMD according to Helkimo's anamnestic index vary from 5% to 26%, and severe clinical dysfunction of TMD according to Helkimo's clinical dysfunction index, range from 1% to 22% (Carlsson and LeResche, 1995).

Wänman and Agerberg (1986a) introduced the Accumulated Anamnestic Index (AAi) which consists of seven symptoms and recurrent headache. Wänman (1987) used both Helkimo's anamnestic index and the Accumulated Anamnestic Index in his two-year follow-up study. In the study population at baseline, Helkimo's anamnestic index showed no differences in symptoms of TMD between boys and girls, although according to the Accumulated Anamnestic Index, girls reported more often symptoms than did boys. At the two-year follow-up examination a difference between genders in symptoms of TMD was found with both indices. Some other new indices (Levitt, 1990; Pullinger

and Monterio, 1988; Widmer, 1992) have been presented but none of them has become as widely used in population studies as Helkimo's indices.

The Craniomandibular Index (CMI) was formulated, for epidemiological and clinical research, by Fricton and Schiffman (1986). It consists of two phases which are the Dysfunction Index (DI) reflecting temporomandibular joint tenderness and functional problems, and the Palpation Index (PI) reflecting muscle tenderness problems (Fricton and Schiffman, 1986). Schiffman et al. (1990), in their study used the Craniomandibular Index combined with the Symptom Severity index (SSI), which measures the subjective severity of pain and symptoms. In this study the prevalence of joint disorder was 19%, muscle disorder 23%, and combined muscle and joint disorder 27%. Although Helkimo's clinical dysfunction index does not separate joint and muscle problems and the Craniomandibular Index does, in this study the correlation between the two indices is high (0.89) (Schiffman et al., 1992).

The TMJ Scale (Levitt, 1990; Levitt, 1991; Levitt et al., 1994) has been developed as a self-report measure for use in the home or office and assesses three domains: physical, psychosocial, and a global, or overall, scale. The physical domain includes assessment of pain, while the psychosocial domain assesses psychological factors and stress. The scale yields information which may be useful to guide clinicians treating TMD, although some questions of its validity as a psychological assessment tool have been noted by Rugh (Rugh et al., 1993) and by Deardorff (1995) as well as by others (Glaros and Glass, 1993). The TMJ Scale has not been the subject of longitudinal studies – that is, cohorts of patients have not been repeatedly assessed with the TMJ Scale over time – but substantial data are available as cross-sectional data collected over a number of years. Reports of scale scores in large samples of patients from multiple dental practices have been published (Levitt and McKinney, 1994). However, the TMJ scale is based solely on self-report, rather than examination findings.

Over the years, many classification schemes for TMD have been offered (Dworkin and LeResche, 1992; Block, 1992; Stegenga et al., 1992a,b; De Leeuw et al., 1994a,b; DeBoever and Carlsson, 1994; Lobbezoo-Scholte et al, 1995a,b; Okeson, 1995; Clark and Takeuchi, 1995).

The research diagnostic criteria for TMD (RDC/TMD), developed by Dworkin and LeResche (1992), is widely used. It is a dual axis system for classifying TMD patients and subjects. It provides specifications for conducting a standardized clinical examination and established a dual diagnosis that recognizes not only the physical conditions (axis I), including muscle disorders, disc displacements and other types of joint conditions that may contribute to the pain disorder, but also the psychosocial issues (axis II) that contribute to the suffering, pain behavior, and disability associated with the patient's pain experience. Three main diagnostic subgroups of TMD can be distinguished: muscle disorders (GroupI); disc displacement (Group II); and arthralgia, arthritis, and arthrosis (group III). Of these 3 groups, the muscle disorders, with or without limited mouth opening, are most prevalent in the community-based samples. Group II and III diagnosis, which do not involve the masticatory muscles, are less common (Lobbezoo et al., 2004). It also includes an assessment of limitation in jaw functional activities. The RDC/TMD has been shown to be reliable for diagnosing TMD in U.S. and Swedish populations (Wahlund *et al.,* 1998). The development of RCD/TMD is a pragmatic attempt to address the classification problem, and a number of studies have shown adequate reliability of the clinical test procedures (John and Zwijnenburg, 2001). However, in the study of Emschoff and Rudisch (2001), the RDC/TMD has been shown to provide insufficient reliability for the determination of arthrogenous TMD.

In 1990, the American Academy of Orofacial Pain (AAOP) established the first well-defined diagnostic classification for TMD, which was revised in 1993 (McNeill, 1993a). Further, the AAOP published an updated diagnostic classification in 1996 (Okeson, 1996). Distinctions have been made between subgroups of TMD patients. The subclassification of TMD consists of two primary diagnostic categories: arthrogenous and myogenous. The myogenous classification is often further subdivided into muscular hyperarousal due to stress and muscular abnormality associated with parafunctional oral habits (e.g., bruxism), and the arthrogenous category is subdivided on the basis of specific structural abnormalities (e.g. internal derangement of the temporomandibular joint or degenerative disease). These classifications are not always clear, and there can be a considerable overlap or progression from one so-called syndrome to another (Kuttila *et al.,* 1998a).

Prevalence of TMD and fluctuation of signs and symptoms

Over the last 50 years, several hundred studies have attempted to determine the prevalence of TMD. The earlier studies reported a high prevalence of both signs and symptoms of TMD, and also a large variance in the prevalence figures (Helkimo, 1979; Carlsson, 1984; Rugh and Solberg, 1985). For example, Helkimo (1974b), studying prevalences in a population of Lapps in the north of Finland, found that 57% of the population suffered from anamnestic symptoms, and 88% were diagnosed as having clinical signs.

In 1990 De Kanter reviewed the published studies of TMD and found a range of 11% to 58% for anamnestic symptoms and 28% to 88% for clinical signs. In his studies of the adult Dutch population, approximately 5% had moderate to severe signs and symptoms depending on age, gender, and status of dentition (de Kanter, 1990).

Longitudinal studies conducted on children and adolescents showed fluctuation tendency of signs and symptoms of TMD (Hirata et al., 1992; Könönen and Nyström, 1993). The same fluctuation tendency was also shown among adults (Österberg et al., 1992; Wänman, 1996).

The variation in the prevalence figures is often due to differences between samples, study designs, definitions, diagnostic criteria, or data presentation (Gross et al., 1988; Von Korff et al., 1988b; De Kanter et al., 1993; Goulet et al., 1995). The methodological factors can probably explain more of the variation in prevalence figures than can any real difference between samples (Carlsson and De Boever, 1994).

In the earlier studies the prevalence of severe dysfunction in the adult population was assumed to vary from 20 to 30% (Helkimo, 1979). However, the studies in the 90's have reported the prevalence of severe dysfunction, according to Helkimo's clinical dysfunction index, to be from 1% to 3% (De Kanter, 1990; Salonen et al., 1990).

An epidemiological study of TMD (Dworkin et al., 1990a) compared patients who were both symptomatic and seeking treatment (clinical cases, CLCA) with randomly selected selected persons who were free from TMD pain (community controls, COCO). In this study, the clinic cases had the highest prevalence of reported symptoms. They had more symptoms than signs, while the community controls had a much higher prevalence of clinical signs than symptoms (Dworkin et al., 1990a).

The prevalences of TMD symptoms and signs are apparently high in non-patient populations (Agerberg and Inkapööl, 1990). About 40 to 75% of non-patient adults had at least one sign, while approximately 33% of persons had at least one symptom of TMD (Schiffman and Fricton, 1988; Dworkin et al., 1990a; De Kanter et al., 1993). Recent studies have concluded that the signs and symptoms of TMD are common in non-patient populations (Pow, 2001; Wahlund, 2003; Gesch, 2004).

TMD signs have been estimated to occur approximately twice as commonly as symptoms, the prevalence of symptoms varying from 5% to 33%, and the prevalence of signs from 1% to 75% (Schiffman and Friction, 1988; DeKanter *et al.,* 1993; Carlsson and LeResche, 1995). In population-based studies, the signs of TMD occur more frequently than the symptoms, usually in a ratio of 2:1 (Carlsson, 1984).

The most common symptoms in the general population are jaw tiredness, jaw stiffness, headache, sounds associated with the TMJs and pain in the jaw and face area (Solberg et al., 1979; Nilner, 1992; Okeson, 1996). One of the most common signs found in clinical examination is muscle tenderness (Jensen et al., 1992). The most common clinical sign of TMD is clicking of the TMJ, the prevalence levels varying from 8 to 50% (Wänman and Agerberg, 1990; Duckro *et al.,* 1990; Glass *et al.,* 1993; Goulet *et al.,* 1995; Könönen *et al.,* 1996; Magnusson *et al.,* 2000). In contrast, mouth opening limitations are relatively rare, occurring in 5% or less of the population (Huber and Hall, 1990; DeKanter *et al.,* 1993).

A great fluctuation was seen in studies concerning TMJ clicking (Magnusson et al., 1986; Wänman, 1987; Könönen et al., 1996).

TMD and age

Both signs and symptoms of TMD are uncommon in young children (De Vis et al., 1984; Kirveskary et al., 1986; Nydell et al., 1994). Prevalence of TMD signs and symptoms reported in epidemiologic studies of children are lower than in adults (Carlsson, 1999).

In 15- to 18-year-olds, the frequency of signs and symptoms is similar to that found in the 20- to 40-year age group (Nilner, 1981).

Older subjects have reported TMD symptoms less frequently than younger ones according to most epidemiologic cross-sectional studies (Carlsson, 1999). A study of a

group of 90-year-old subjects revealed no or only mild TMD signs and symptoms and practically no complaints of masticatory difficulties, in spite of varying dental conditions (Tzakis et al., 1994).

Several studies have reported lower frequencies of symptoms with increasing age (Österberg et al., 1992; De Kanter, 1993; Matsuka et al., 1996) and have shown that the highest prevalence of TMD occurs among adults under 45 years of age, with decreasing levels at an earlier age (Locker and Slade, 1988; Von Korff *et al.,* 1988a; Dworkin, 1990a; Agerberg and Inkapööl, 1990; Duckro *et al.,* 1990; Glass *et al.,* 1993; Lipton *et al.,* 1993; Goulet *et al.,* 1995; LeResche, 1997a). Opposing studies have indicated an increased risk for TMD with advancing age (Tervonen and Knuuttila, 1988; Agerberg and Bergenholtz, 1989; Salonen et al., 1990). Salonen and Hellden (1990) have found that reported symptoms of TMD decrease with age, while clinical signs increase. Other studies provide conflicting results and have shown no relation to age (Harriman et al., 1990; Dworkin et al., 1990a).

The majority of the TMD patients are found to be between 15 and 45 years old (Carlsson, 1999). Therefore, the adult population is of special interest as far as TMD is concerned, and studies regarding the prevalence of TMD and related factors should be directed especially at this stage of age.

TMD and gender

Earlier population studies found the prevalence of symptoms and signs of TMD to be distributed fairly evenly between men and women (Helkimo, 1974a, 1976; Hansson and Nilner, 1975; Swanljung and Rantanen, 1979; Heft 1984). The same tendency has been found in younger populations (Egermark-Eriksson et al., 1981; Nilner and Lassing, 1981; Nilner, 1981). However, later studies have reported a higher prevalence among women (DeKanter, 1990; Salonen *et al.,* 1990; DeKanter *et al.,* 1993; Glass *et al.,* 1993; Lipton *et al.,* 1993; Magnusson *et al.,* 1993; De Leeuw *et al.,* 1994a; Goulet *et al.,* 1995; Magnusson *et al.,* 2000; Johansson et al., 2003). Published data on Brazilian high school and university students showed that women had moderate or severe symptoms of TMD four times as often as men (Conti et al., 1996). Several studies having representative general populations indicate that women experience more TMD-related

pain than men, usually at a ratio of two to one (Dworkin *et al.,* 1990a; Lipton *et al.,* 1993; Goulet *et al.,* 1995; LeResche, 1997; Kamisaka *et al.,* 2000; Riley and Gilbert, 2001).
The most prominent sex differences have been found at the age of 20-40 years (Magnusson *et al.,* 1993; Levitt and McKinney, 1994). According to Goulet et al. (1996), women between 35 and 44 years reported more frequency symptoms associated with TMD and had a two to three times higher prevalence of clinical signs than men.
Many authors have tried to explain why TMD bother women more than men (Sändstrom, 1988; Levitt and MCKinney, 1994; LeResche et al., 1994). However, the true reason or set of reasons remains unknown and warrants additional studies.
In conclusion, the prevalence of many symptoms, such as headache, TMJ clicking, TMJ tenderness and muscle tenderness seems to be higher in women than in men (Locker and Slade, 1988; Pullinger et al., 1988; Agerberg and Bergenholz, 1989; Agerberg and Inkapööl, 1990; De Kanter, 1990; Dworkin et al., 1990a; Salonen et al., 1990; Lipton et al., 1993; Magnusson et al., 1993; De Leeuw et al., 1994a; Wänman, 1995a, 1996).

Risk factors for TMD

The literature on the analytic epidemiologic study of risk factors for any type of TMD is still in its infancy, and only few studies about disc displacements (Group II) or about arthralgia, arthritis, and arthrosis (Group III) disorders are available (Lobbezoo et al., 2004). Numerous efforts have been made in order to resolve the etiology of TMD. De Boever (1979) reported five different etiologic theories of TMD:

- mechanical displacement theory
- neuromuscular theory
- psychophysiological theory
- muscular theory
- psychological theory.

Ramfjord and Ash (1971) supported the muscular and neuromuscular theory associating occlusion with dysfunction. Their conclusion was that the adaptive capacity of adult TMJ is limited. In agreement with them was de Bont (1985), who studied the association between the TMJ and the function of the masticatory system.

The multifactorial etiological approach has been widely discussed. De Boever (1979) concluded that aetiology is a combination of dental, psychological, and muscular factors.

Of the few risk factors studies of TMD subgroups, several case-control studies have shown moderate associations between joint laxity and group II disorders (Westling, 1989), and between loss of posterior support and the risk of Group III disorders (Sato et al., 1996). A recent case-control study of TMD subgroups showed that somatization, tooth clenching, third molar removal, and trauma were risk factors for the myalgia-only and myalgia/arthralgia subgroups (Huang et al., 2002).

General factors, such as impaired health, general joint and muscle diseases, psychological and psychosocial factors, and local influences such as occlusal disturbances, parafunctional activities, i.e. bruxism, and traumas, can affect the condition of the stomatognathic system (Okeson, 1996).

Although occlusion continued to be regarded as one of the major influences on TMD, and treatment of the occlusion as the most important strategy in treatment of TMD (De Boever *et al.,* 2000), the significance of the role of occlusion in the aetiology is still unclear, creating a demand for further longitudinal studies. Several reviews and studies have not found any strong support for an occlusal aetiology of TMD, at least not as a unique or dominant factor (Tervonen and Knuuttila, 1988; Egermark-Eriksson *et al.,* 1990; McNeill, 1993a; Pullinger *et al.,* 1993; McNamara *et al.,* 1995; Okeson, 1996; Clark *et al.,* 1997; Kitai *et al.,* 1997; Watanabe *et al.,* 1998; De Boever *et al.,* 2000; Pullinger and Seligman, 2000). Some studies considered occlusion to be a TMD-related or a co-etiologic factor (Könönen et al., 1987; Szentpetery et al., 1987; Pullinger et al., 1988; Kirveskari et al., 1989; Runge et al., 1989).

The association between trauma and TMD has also been shown epidemiologically (Seligman and Pullinger, 1996; Kamisaka *et al.,* 2000). In contrast, a population-based study by Locker and Slade (1988) found no association between trauma and signs or symptoms of TMD. Additionally, a critical review by Ferrari and Leonard (1998) revealed no substantial theory of mechanical TMJ injury to be connected with TMD.

The generally accepted etiologic concept nowadays is the multifactorial and biopsychosocial approach (De Boever and Carlsson, 1994; Okeson, 2003). The role of

different factors in TMD is still unclear. For instance, condylar displacement (Stohler, 1994), internal derangement, and osteoarthrosis (Zarb and Carlsson, 1994) can be considered either the cause or result of TMD (De Boever and Carlsson, 1994).
The balance between function and dysfunction is said to be dynamic and periodic (De Boever and Carlsson, 1994). Unexplored risk factors, such as adverse early life events, physical activity, obesity, beliefs and coping strategies, and mild traumatic brain injury, among others, all await further study (Lobbezoo et al., 2004). Additional population-based studies are needed to clarify the heterogenous factors related to TMD.

General health and TMD

A number of signs and symptoms of TMD have been found to correlate with poor general health (Mejersjö and Carlsson, 1983). Multidisciplinary knowledge and improved diagnostic techniques have led to the realization that patients with temporomandibular disorders may suffer from a variety of conditions, including systemic-related problems and articular, neuromuscular, neurologic, neurovascular and behavioural disorders (McNeill, 1993a). Several studies with patient samples have found a significant overlap between TMD and pain conditions in other parts of the body (Allebring and Hagerstam, 1993; Hagberg *et al.,* 1994; Turp *et al.,* 1998). Especially patients with masticatory muscle problems have complaints beyond the masticatory system, mostly in the head, neck and back areas (Hagberg *et al.,* 1994). Furthermore, infectious events were associated with the onset of chronic orofacial muscle pain in 67% of patients (McGregor et al., 1996).
A higher prevalence of TMD symptoms than in the general population has been found in patients with rheumatoid arthritis (Tegelberg, 1987), psoriatic arthritis (Könönen, 1987) and ankylosing spondylitis (Wenneberg, 1983). Systemic joint laxity has been suggested to be a significant risk factor of TMD (Blasberg and Chalmers, 1989; Westling, 1992). In addition, high rates of comorbidity between myogenous facial pain and fibromyalgia, a chronic widespread pain of unknown origin, have been noted in several studies (Plesh *et al.,* 1996; Hedenberg-Magnusson *et al.,* 1999). Several studies have shown that approximately 75% of fibromyalgia patients fulfill criteria for TMD, and 12-25% of TMD patients meet diagnostic criteria for fibromyalgia (Plesh et al., 1996;

Cimino et al., 1998). Whether fibromyalgia increases risk for TMD, or TMD increases risk for fibromyalgia or is another manifestation of this syndrome, or whether both conditions are caused by common risk factors is not known (Wolfe, 1995).

Several other disorders appear to occur more often among persons with TMD than among the general population. Both migraine and tension-type headache have been associated with TMD symptoms in cross-sectional and case-control studies (Wänman and Agerberg, 1987). Headache, ear and neck problems have often been related to TMD (Magnusson, 1995; Keersmaekers, 1996).

Aural symptoms like otalgia, tinnitus, impaired hearing, fullness of ears, hyperacusis and vertigo are common in functional disorders of the masticatory system (Cooper and Cooper, 1993; Keersmaekers et al., 1996). In patient studies, otalgia and tinnitus are often correlated with temporomandibular disorders (Feinmesser and Fluman, 1987).

According to Austin (1997), insomnia, defined as the inability to initiate or maintain sleep, may be a perpetuating factor of TMD. In the study by Goulet et al. (1995), 36% of those with jaw pain and restlessness after sleep complained of severe pain, compared with only 15% in the group with jaw pain without sleep problems.

Symptomatic TMD patients reported three or four times more other joint problems than asymptomatic subjects (Morrow et al., 1996). The symptoms of TMD may be reduced by treating the contributing general diseases (Agerberg and Helkimo, 1987).

In addition, the severity of signs and symptoms of TMD has been correlated with the length of sick leave, both in TMD patients and in population samples (Alanen and Kirveskari, 1983). After stomatognathic treatment the amount of prescribed medicine as well as sick leaves decreased (Kirveskari and Alanen, 1984).

Psychological and behavioural factors and TMD

The importance of psychological factors has been emphasized in TMD (Rollman and Gillespie, 2000). They are thought to have a role in the cause or maintenance of TMD (Rugh, 1992), and may predispose the condition to chronicity (Gatchel *et al.,* 1996).

The patients with TMD may often have a combination of psychological and somatic manifestations (Mohl and Ohrbach, 1994). They may also have difficulties in coping with increased life stress and personality characteristics causing problems in difficult life

situations (De Leeuw et al., 1994c). On the other hand, it has been stated that psychological disturbances may be a direct consequence of pain-related life events in TMD patients (Murray *et al.,* 1996). The subjects, who rated themselves as tense, had a risk ratio of temporomandibular disorders from 3.4 to 8.5 times higher than those who did not experience tension (Wänman and Agerberg, 1990). Conflicts at home or at work, financial problems or cultural readjustments may increase stress and thus, increase parafunctional habits, such as bruxism and clenching, which loads the masticatory system more, perhaps too much (Okeson, 1996). Stress may also modify a patient's ability to tolerate TMD pain (Zarb et al., 1994). On the other hand, chronic pain may cause stress, behavioural and emotional changes (Schwarzman and McLellan, 1987), but these may also be a cause of pain (Rugh and Davis, 1992).

Subcategorization of the patients into diagnostic subgroups of TMD suggests that myogenous patients may have more psychological difficulties than patients with arthrogenous TMD (Levitt and McKinney, 1994; Lobbezoo-Scholte *et al.,* 1995a; Spruijt and Wabeke, 1995). TMD patients have many psychological profiles (Lobezoo-Scholte et al., 1995a) and there seems to be widespread agreement that stress, depression, disability and dysfunctional illness behaviour are aspects of TMD patients' profiles (Dworkin and LeResche, 1992). TMD patients with muscle pain have also increased scores in somatization (McGregor et al., 1996).

Somatization is defined as a tendency to experience and communicate somatic distress in response to psychosocial stress and to seek medical help for it (Lipowski, 1988). Somatoform disorder is a condition in which the patient reports somatic complaints, yet no physical evidence of organic disease is present (American Psychiatric Association, 1994). About 20% of patients who frequently use health care resources have been classified as chronically somatizing patients (Karlsson *et al.,* 1997).

It has been suggested that especially patients with masticatory muscle pain may be more prone to report symptoms as compared to normal controls (Wilson *et al.,* 1991) and are likely to be more sensitive to painful stimuli (Reid *et al.,* 1994), although this is argued by the data of Carlson *et al.* (1998).

Depression is a disorder that can be defined as a collection of symptoms such as depressed mood, loss of interest or pleasure, weight loss or weight gain, insomnia or

hypersomnia, feelings of worthlessness, and diminished ability to think or concentrate, etc. (American Psychiatric Association, 1987).

Epidemiological studies have shown that depression is the most common mental disorder in man. Depression affects at least 20 percent of women and 10 percent of men during their lifetimes (Kessler *et al.,* 1994). Numerous studies have also shown a high prevalence of depression in patients with facial pain and TMD (McCreary *et al.,* 1991; Gallagher *et al.,* 1991; Gatchel *et al.,* 1996; Korszun *et al.,* 1996; Carlson *et al.,* 1998; Madland *et al.,* 2000), while the number of population-based studies concerning the connection between depression and TMD (Von Korff *et al.,* 1988a; Dworkin *et al.,* 1990b; Vimpari *et al.,* 1995) is lower than the number of studies with patient samples. In contrast, McGregor (1996) found no differences between depression prevalences in orofacial pain patients and normal controls.

Use of health care services and TMD

Pain is the most frequent reason for seeking medical treatment, irrespective of gender (Nylenna, 1985). Approximately one in three adults will develop TMD pain in his or her lifetime (Dworkin and LeRsche, 1993). Thus, pain from temporomandibular disorders is a common condition. However, only about one fourth of persons with temporomandibular pain sought treatment for their symptoms (von Korff, 1988b; Linet et al., 1989). The severity and persistence of pain, but also its more recent onset influence people's treatment seeking (Von Korff et al., 1991).

A unique aspect of TMD pain is that patients often comment that they are not sure whom they should consult first for their symptoms a physician, dentist, or other health care provider. Indeed, anywhere from 50% to 75% of patients will visit a dentist, while the reminders seek a physician (Turp et al., 1998). However, Patients visit physicians because of a variety of symptoms for example ear problems, headache or dizziness which may be obscuring the TMD (Cooper and Cooper, 1993). According to Glass and Glaros (1995), about 40% of TMD patients may have been misdiagnosed by physicians. Delays in diagnosis and subsequent appropriate referral (Foreman et al., 1994), or incorrect diagnosis (Foreman et al., 1994; Glaros et al., 1995) were common findings in several studies of both dentists and physicians.

There can be overlapping symptomatology between TMD and other medical disorders. In addition to dental diseases, one has to consider diseases and disorders like neuralgias (trigeminal and post-herpetic neuralgia), vascular diseases (migraine, temporal arteritis), ear infections, diseases of salivary glands and lymphatic tissue, sinusitis and neoplasms (McNeill, 1993b).

An association of TMD with cervical spine disorder (CSD) has been often reported (Clark et al., 1987; Cachiotti et al., 1991; De Laat et al., 1993). Patients with temporomandibular or cervical spine disorders may have the same symptoms and differentiating between them depends on clinical examination. According to De Wijer (1995), patients with CSD reported higher intensity, longer duration and greater impact of neck pain, more often tenderness on palpation in the neck, but less often aural symptoms than the patients with TMD.

One has also to include an infected third molar, apical root infection or an impacted tooth in the differential diagnosis of TMD. As a source of orofacial pain, gingival and oral mucosal diseases, pain disorders of the tongue, burning mouth syndrome or atypical odontalgia may mimic the symptoms of TMD.

Twenty nine percent of temporomandibular pain patients had seen at least three different health care providers and 12% had seen five or more different providers (Von Korff, 1995). Consultation of many providers wastes health care resources and can be harmful for the patient (Von Korff, 1995). Glass and Glaros (1993) hypothesized that TMD patients who see a “TMD specialist” are more satisfied with their care and receive care of higher quality than patients who do not visit a TMD specialist.

Demand and need for TMD treatment

Treatment demand

In the general population, treatment-seeking for TMD is usually smaller than the professionally evaluated treatment need for TMD (Magnusson et al., 1994). Despite the large percentages of the population having signs and symptoms of TMD, between 1 and 12% of samples have reported that they sought treatment because of TMD symptoms (Markowitz and Gerry, 1949; Norheim and Dahl, 1978; Swanljung and Rantanen, 1979;

Solberg et al., 1979; Helöe and Helöe, 1979; Pullinger et al., 1988; Von Korff et al., 1988a; Locker and Slade, 1988; Agerberg and Inkapööl, 1990; Schiffman et al., 1990; Magnusson et al., 1991; De Kanter *et al.,* 1992; Magnusson et al., 1993; Goulet *et al.,* 1995; Bibb et al., 1995; Wänman and Wigren, 1995b; Kuttila et al., 1998a; Riley et al., 1998; Egermark et al., 2001; Pow et al., 2001; Magnusson et al., 2002; Macfarlane et al., 2002).

Through a longitudinal approach, a recent study on 114 subjects examined at three different occasions over 20 years followed from the age of 15 to 35 years, 18% had demanded and been provided with some kind of treatment related to TMD during the 20-year follow-up period (Magnusson et al., 2002).

Pain in the face and the TMJs is a common symptom of TMD, and supposed to be the most important reason for seeking treatment for TMD (Von Korff *et al.,* 1988a; Dworkin *et al.,* 1990a). Since most people seek medical care because of subjective complaints as pain, restricted mouth opening or loud clicking, the evaluation of subjective symptoms gives a more realistic basis for the estimation of the actual treatment need (Szentpetery et al., 1986b).

The age of the subjects is of special interest, since many investigations have shown that the majority of patients seeking treatment for TMD are between 20 and 50 years old (Carlsson, 1999).

Individuals seeking professional help for TMD seem to be predominantly women between 20 to 40 years old (Helkimo, 1979; Rieder et al., 1983; de Kanter et al., 1993). The predominance of women is even higher in surveys of people seeking treatment for TMD pain (Dworkin *et al.,* 1990a; Goulet *et al.,* 1995), at a ratio of 4:1 or 5:1 (Locker and Slade, 1988; Bush *et al.,* 1993; Dworkin and LeResche, 1993; Levitt and McKinney, 1994; McNeill 1997).

Treatment need

The estimation of treatment need for TMD has been made in several ways. The early epidemiologic studies of TMD estimated that 20% to 25% of the general population had severe signs of dysfunction and were in need of treatment (Helkimo, 1979). In a Hungarian population based study by Szentpetery (1986a), it is postulated that the

prevalence of subjective symptoms (20%) might represent the extent of treatment need of a population. In a cross-sectional study by Tervonen (1988), stomatognathic treatment need in Finnish adults was recorded as the number of subjects with one or more clinical signs of stomatognathic dysfunction, excluding those needing a complete set of full dentures. Altogether 44% of the study population had at least one clinical sign and 27% had moderate or severe signs (Tervonen, 1988). Magnusson et al. (1991) based their estimation for TMD treatment need on the examiner's clinical experience, taking into account both the clinical signs and the subjective symptoms, and assumed functional TMD treatment need to be between 21% and 27%.

After knowledge of TMD increased, estimations of treatment need have decreased, although opinions vary greatly (Carlsson, 1984; Rugh and Sohlberg, 1985; De Kanter et al., 1990; Magnusson et al., 1991). The levels of the treatment need are suggested to be varying from 5% to 16% (Schiffman et al., 1990; Agerberg and Inkapööl, 1990; Dworkin *et al.,* 1990a; Salonen *et al.,* 1990; Magnusson *et al.,* 1993; Kuttila *et al.,* 1998a). Schiffman et al. (1990) estimated treatment need for TMD with the Symptom Severity Index to be 6%. In their study, the subjects who had disorders severe enough to be comparable to patients' disorders were considered to need treatment for TMD. In the study of Agerberg and Inkapööl (1990), the estimation of treatment need was based on the subjects' estimation and was 12%. According to Bakke and Möller (1992), prevalences of severe craniomandibular disorders accompanied by headache and facial pain urgently in need of treatment are 5-15% in adults.

Little is known about the significance of TMD diagnostic subgroups, i.e., myogenous or arthrogenous symptoms, in the treatment need for TMD. It has been suggested that patients with myogenous TMD have a more acute need for treatment than arthrogenous patients (De Leeuw *et al.,* 1994a; Kuttila *et al.,* 1998a), as well as a less favourable prognosis (Scholte *et al.,* 1993). In recent studies, the group needing active treatment was about 10% (Kuttila et al., 1997; Magnusson et al., 2002).

It is obvious that it is impossible to relate prevalence figures directly to treatment need, while aetiology, diagnosis, and definitions have led to variation in estimations (Magnusson et al., 1991; Zarb and Carlsson, 1994). In the older population however, the need for treatment seems to decrease with age (Greene, 1994). Further, it has been

shown that women need treatment for their TMD problems two to three times as often as men (Agerberg and Inkapööl, 1990; Kuttila *et al.,* 1998a). Need is relative to time, place and assessor (Magi and Allander, 1981).

De Kanter et al. (1992) suggested that signs and symptoms should be separated from treatment need for TMD, and the treatment need indices should also include “signs present with no need for treatment” versus “signs present with need for treatment”.

A review identified estimates for TMD treatment need ranging from 1.5% to 30% (Carlsson et al., 1999). This report was based on a narrative review of the literature up to the year 1994.

Aim of the study

Prevalence of TMD and treatment need estimation varies considerably among studies. In addition, prevalence figures cannot be transferred directly into treatment need. As there is a variety of figures for TMD treatment need, a meta-analysis is necessary to answer this important question. In addition, meta-analysis is superior to narrative reviews because of its advantages, as it contains a comprehensive summary of the evidence rather than being based on only a selection of the published literature, and its ability to reduce bias and ensure reliability.

The hypothesis for the present study is that it should be possible to find common methods and criteria in estimating treatment need for TMD among studies, and to derive a generalized treatment need estimate in more practical and reliable way than is possible from present-day review studies.

The aims of the study were to:

I. identify and describe adult population-based and non-patients studies which have a treatment need estimate for temporomandibular disorders,
II. determine the prevalence of treatment need for TMD in adult populations through conducting a meta-analysis and
III. describe factors influencing treatment need for TMD.

METHODS

The present review attempts to adopt Meta-analysis Of Observational Studies in Epidemiology (MOOSE) guidelines for conducting a meta-analysis of observational studies (Stroup et al., 2000) (see appendix, table 4). Steps followed in conducting this meta-analysis are summarized (Figure 1.).

Studies selection criteria

Studies were included in the review if the following conditions were met:

Types of publication:

The review was restricted to full reports, published in English up to 31/05/2005.

Letters, editorials, PhD theses and abstracts were excluded.

Types of studies:

Observational studies (cross-sectional surveys, cohorts and case-control studies) were included.

Clinical trials of treatment, case reports, case series, occupational studies and experimental laboratory studies were excluded. Previously published literature reviews were excluded but, they were screened for additional relevant publications.

Population:

Population-based as well as non-patients studies of adults and studies which covered both adults and adolescents (aged 10 years and over) were considered. Studies which covered only adolescents were excluded. A population-based study is defined as a study pertaining to a general population defined by geopolitical boundaries (Last, 1995). Therefore, epidemiological studies where participants were considered to be representative of the general population were included.

Treatment need definition:

Need definitions based on self-reported symptoms and/or clinical signs were included.

Studies presenting data on other pain syndromes were excluded.

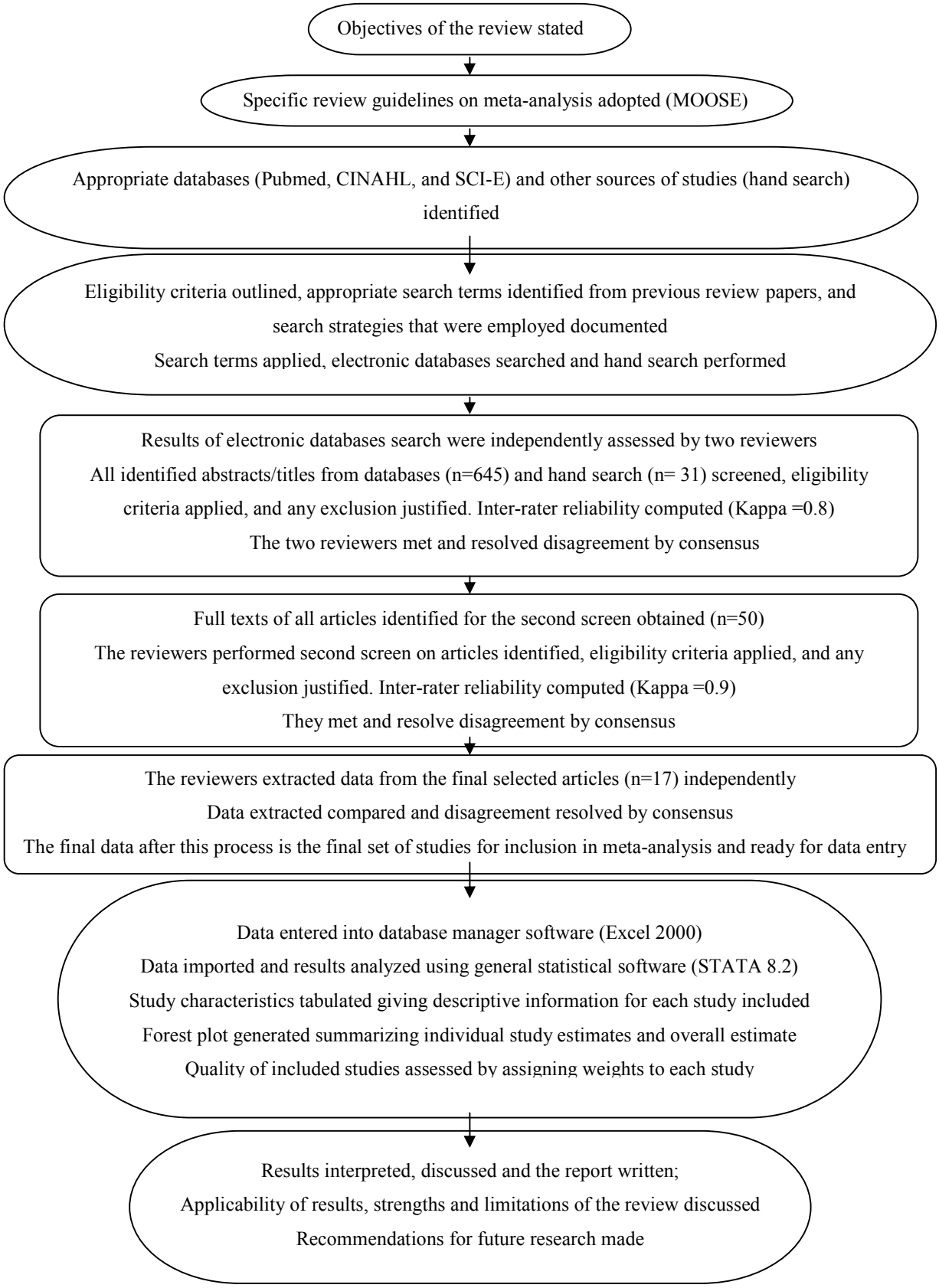

Figure 1. Steps followed in conducting the present meta-analysis

Search strategies to identify studies

Description of electronic databases

Publications were retrieved by a computerized search of the following databases: Medline (PubMed = Public Medline) searched through National Library of Medicine from 1966 to May 2005; CINAHL (Cumulative index of nursing and allied health literature) searched from 1982 to May 2005; EMBASE (Exerpta medica) searched from 1947 to May 2005; SCI-E (Science Citation Index Expanded) searched through WEB OF SCIENCE from 1945 to May 2005.

Approach to database search

The terminology used in review papers on TMD was utilized to identify MeSH and free text terms. A comprehensive search was performed by combining the terms "temporomandibular disorders", "temporomandibular-joint-disorders", "craniomandibular-disorders", "temporomandibular-joint-dysfunction-syndrome", "TMD", "CMD", "craniomandibular dysfunction", "temporomandibular dysfunction", "oromandibular-dysfunction", "facial pain", "myofacial pain-syndromes", "facial arthromyalgia" and "need".

The references of all relevant studies and existing reviews were screened for additional relevant publications.

The journals "Oral Rehabilitation" and "Orofacial pain" were manually searched for about 10 years (1996 to 5/2005) in order to assess the sensitivity of the search. The journals were selected because they were in their content diverse (one being a dental journal with a particular focus on mandibular function and dysfunction and the other one being on pain in the orofacial region).

Some experts in the field were contacted for additional information (i.e. A. Szentpetery, Halle/Saale; Y. Matzuka, Okayama; and P. U. Dijkstra, Groningen).

Selection of relevant publications

Two reviewers (M. A. Al-Jundi, M. T. John) independently determined whether studies met inclusion criteria. Each reviewer assessed and categorized abstracts of articles as “included” or “rejected”.
Complete articles were obtained for those in the included category. The selection process was repeated until all articles were ultimately categorized as included and excluded. Reasons for rejections and exclusions of studies were recorded. The feasibility, appropriateness of data, and ease of use was established for study selection. The same two reviewers independently extracted data from each article using the data-extraction form (see Appendix).

Database electronic search

Each publication was initially assessed for relevance using data presented in the abstract. Criteria for abstracts selection were that the study to be selected should have at least a hint about treatment need for TMD and should be a population-based or a non-patients study. All abstracts were evaluated by two assessors independently, then results were compared, and repeated abstracts ruled out. When there was disagreement then both assessors together discussed and decided whether to include the abstract or not. When the abstract was not available or failed to provide sufficient information, a reprint of the full paper was obtained. For the selected abstracts, reprints of the full papers were obtained.

Hand search

The tables of contents of hand searched journals (Journal of Oral Rehabilitation and Journal of Orofacial pain) were screened. When the title contained at least a hint about need of treatment for TMD then reprints of the full papers were obtained and screened. References obtained from searched electronic databases, references of relevant books and doctoral Theses available at Martin-Luther-University Halle-Wittenberg dental library were searched. In addition, references of all selected articles and previous reviews were also screened for additional relevant publications.

Data extraction

For each paper the following information was extracted:
title, author, year of publication, aim of the study, no. of participated subjects, participation rate population age range, percentage of participated women, sample information about population, country of study, method of investigation (postal questionnaire, telephone interview, clinical examination), criteria and definition of treatment need for TMD, type of sampling, treatment need estimate (in percentage), and the reference (see Appendix).
If the prevalence estimate of treatment need for TMD was not specifically reported as a percent value, it was computed by dividing the number of subjects identified as in need of TMD treatment by the total number of subjects participated in the study at the time of assessment.

Assessment of reviewers' agreement

Agreement between the two assessors in identification and selection of relevant abstracts was compared (inter-rater reliability computed with kappa statistic). It was also used to compare agreement of the same two reviewers in selection of relevant articles for inclusion in the meta-analysis. Data extracted from articles by the two reviewers was also compared and differences explained.
Disagreements were identified, discussed and discrepancies were resolved by consensus.

Data management and analysis

Firstly, extracted data were entered in an EXCEL worksheet (Microsoft Office EXCEL 2000). Estimates of treatment need for TMD were entered as a percent value. Later, they were converted to proportions for easy data transfer and computation.
The data were transferred and managed by a general statistical software package of the STATA corporation special edition version 8.2.

STATA software is not designed exclusively for meta-analysis but at least 14 meta-analysis commands are available, and they can perform: meta-analyses, cumulative meta-analyses, forest and funnel plots, publication bias, meta-regression, and sensitivity analyses.

Due to the presence of different criteria for estimating treatment need, some studies [n=6 (35%)] provided more than one treatment need estimate. To capture the lower and the upper bound the minimum and the maximum treatment need estimates were computed, so that a broad range of treatment need estimates was obtained.

To show the central tendency of treatment need estimates for TMD the median and the mean were also computed. The median of a sample depends on whether the number of terms in the sample is even or odd. If the number of terms is odd, then the median is the value of the term in the middle. This is the value such that the number of terms having values greater than or equal to it is the same as the number of terms having values less than or equal to it. If the number of terms is even, then the median is the average of the two terms in the middle, such that the number of terms having values greater than or equal to it is the same as the number of terms having values less than or equal to it.

The mean of a sample is the mathematical average of all the terms. To calculate the mean, we added up all the terms, and then divided by the number of terms in the sample. This type of mean is also called the arithmetic mean (more commonly "average").

Studies reported treatment need estimate in different age intervals, and direct comparison is difficult. For the purpose of comparison, the middle of the age interval was taken, for example the age 42 years was taken for the age group 19-65 years. Further, the resulted age was classified into two groups (19-45 years and 46-78 years). Finally, the summary estimate was compared between these two groups of age.

Weighting of included studies

Because we assumed that treatment need estimates are correspondingly affected by the same factors as those used in calculating the quality of the study, weighting of the included studies according to the quality score was performed.

Factors used in calculating quality of the study are:

- number of participants should be ≥ 600 subjects
- whether an age span covered (in contrast to studies reporting a single age)
- study included both genders
- randomized sampling type used
- response rate should be ≥ 85%

All variables were assumed to be of equal importance to the validity of the original research and were weighted equally. Each was assigned a score of 1 if deemed adequate and 0 if deemed inadequate. An index of study quality was obtained by summing the scores of the variables. The maximum possible score attainable was 5. For the purpose of comparison, they are further divided by three groups of score: “1 or 2”, “3”, and “4 or 5”. Summary need estimates were computed for each group.

Results

Results of the search of electronic data bases and hand searching

A breakdown of the search results by databases and hand searching can be seen in Table 1. After checking for duplicates and excluding studies that did not fulfil the selection criteria, the results of the search from four databases and hand search were combined. This resulted in 17* papers on non-patients adolescents and adults studies. Out of them 6 papers were found from the references and published reviews (Table 1).

Electronic databases / Hand search	No. of abstracts identified	No. of abstracts selected	Unique articles identified	
			All years	1982 to 5/2005 publications only
MEDLINE (pub med)	349	19	11 (65%)	11 (85%)
Science Citation Index Expanded	157	14	3 (18%)	3 (23%)
CINAHL	40	3	1 (6%)	1 (8%)
EMBASE	99	3	0	0
Hand search of reference lists and reviews	31	11	6 (35%)	2 (15%)
Overall results of electronic and Hand search	676	50	21	17
Total no. of unique articles after excluding duplicates			17	13

Table 1 Sensitivity of electronic databases and hand search for reports of non-patients studies of treatment need for TMD. (Percentages do not add up to 100% as the same reference could be found in several databases).

* The study on Saudi military students (Nassif et al., 2003) was not included in the present meta-analysis as it did not give a clear estimate of treatment need but, recommended a comprehensive TMD evaluation of subjects in category II (51.4%) and category III (16.7%) in order to further identify the recommended need for TMD Therapy.

No additional relevant articles were identified through the hand searching of either "Journal of Orofacial pain" or "Journal of Oral rehabilitation".
Medline had the highest sensitivity (65% papers retrieved) followed by SCI Expanded (18%), where the sensitivity was defined as the proportion of the total number of known studies identified by the search (Dickersin et al., 1994).
In order to compare the four databases, the common time interval of 1982 to 5/2005 was also considered. Medline had also the highest sensitivity (85%) followed by Science Citation Index Expanded (23%).

Assessment of reviewers' agreement

There was a very good agreement (Kappa=0.8) (Std. Err. =0.04) between the two observers in identification of relevant abstracts, articles selection (kappa=0.9) (Std. Err. =0.16), and data extraction.

Agreement of reviewers in extracting information

All information extracted independently by the two reviewers were the same except:

- In one study (Wänman, 1995), there was disagreement in extracting method of examination used to determine the treatment need estimate. One reviewer extracted it as only from "clinical examination" whereas the other one extracted it as from "clinical examination and questionnaire".
- In another study (Wänman, 1986b), there was disagreement in extracting Type of sampling. One reviewer extracted it as random whereas the other one extracted it as non-random sampling.

Weighting of included studies

Summary estimate of treatment need is 20% (Std. Dev. =8.4%) for studies with quality score 2 (n=7), changed to 16% (Std. Dev. =9.2%) for studies with quality score 3 or 4 (n=9), and remarkably reduced to 5% for studies with quality score 5 (n=1).

Description of study characteristics

There was a wide variation across studies regarding study settings, the method and criteria used for need assessment and the definition of treatment need for temporomandibular disorders (Table 2).

The earliest year of publication was 1971 and the latest 2002. Four (23%) studies were published before more than twenty years. However, six (35%) studies were published during the last ten years.

Most of the studies were conducted in Europe: n=11 (65%), especially in Sweden: n=8 (47%). This was followed by North and South America: n=5 (29%) and East Asia: n=1 (6%).

The sample size ranged from n=84 (Magnusson, 1994) to n=2033 participants (Shiau, 1992). The median study size was n=468. The total number of subjects participated in studies included in this meta-analysis n=9454.

Participants' age varied from 10 to 90 years. In three (18%) studies participants' minimum age was ≤ 17 years whereas in eight (47%) studies participants' maximum age was ≥ 65 years.

For the purpose of comparison, the middle of the age interval was taken, for example the age 42 years was taken for the age group 19-65. So, participants' age varied from 19 to 78 years. It is further divided into two groups of age. The first group contained studies n=14 (82%) with subjects aged between 19 to 45 years old. The second group contained studies n=3 (18%) with subjects aged between 46 to 78 years old.

Most of studies n=14 (82%) involved both men and women. However, two studies confined to women (Schiffman, 1990; Posselt, 1971) and in one gender was not reported (Wänman, 1995b).

The proportion of women participating ranged from 8% (Hansson, 1975) to 100% (Schiffman, 1990; and Posselt, 1971), and median was 51% which is roughly the percentage of women in the general population of most industrialized countries.

The calculated gender ratios showed the comparability of the studies with respect to gender. It ranged from 0:1.0 to 1:0.7.

Table 2. Studies with treatment need estimates for TMD of non-patient adolescents and adults and their sampling characteristics, participation rate, method of examination, criteria, etc

authors	country	no. of subjects	♀ prop.	♂:♀ ratio	age (y)	gender	area	sample	response	♀ needed treatment	method	criteria	TMD treatment need [%]			
													minimum	median	mean	maximum
Magnusson 2002	Sweden	114	0.430	1:1.3	35	both	urban	random	0.81	0.273	clinical	authors' estimate	11	11	11	11
Kuttila 1998	Finland	506	0.514	1:0.9	25 to 65	both	urban	random	0.87	0.761	clinical	active treatment need	9.1	33.3	33.3	57.5
										0.595		active and passive treatment need				
Conti 1996	Brazil	310	0.516	1:0.9	18 to 21	both	urban	random	1	0.800	questionnaire	moderate and severe TMD symptoms	6.5	6.5	6.5	6.5
Waenman 1995	Sweden	358	n.r.	n.c.	35, 50, 65	n.r.	both*	random	0.95	n.r.	clinical	authors' estimate for different age	6	14	15.3	26
Bibb 1995	USA	429	0.580	1:0.7	65 to 90	both	urban	selective	0.69	0.750	clinical	symptoms of notable intensity or disability	1	1	1	1
Magnusson 1994	Sweden	84	0.450	1:1.2	25	both	urban	random	0.62	0.381	clinical	authors' estimate	25	25	25	25
Shiau 1992	Taiwan	2033	0.429	1:1.3	17 to 32	both	urban	random	1	0.481	clinical	more than one sign	5.3	5.3	5.3	5.3
Magnusson 1991	Sweden	119	0.462	1:1.2	20	both	urban	selective	0.88	0.656	both	authors' estimate	27	27	27	27
Agerberg 1990	Sweden	637	0.507	1:1.0	18 to 65	both	urban	random	0.82	0.652	questionnaire	authors' estimate (subjective symptoms)	14	16.5	16.5	19
										0.694	clinical	authors' estimate (objective signs)				
Schiffman 1990	USA	250	1	0:1.0	22,23, 25	women	urban	selective	0.86	1.000	questionnaire	subjects with SSI[a] values equal to or greater than patients' SSI means	6	6	6	6
Locker 1988	Canada	677	0.557	1:0.8	≥18	both	urban	random	0.68	n.r.	questionnaire	reported all three symptoms two or more symptoms problems with eating, talking, or swallowing moderate to severe pain or other symptoms caused a great deal of bother	3.5	4.8	5.7	9.7
Tervonen 1988	Finland	1275	0.542	1:0.8	25, 35, 50, 65	both	both*	random	0.80	0.642	clinical	moderate and severe signs of TMD	27	27	27	27
Waenman 1986	Sweden	264	0.477	1:1.1	19	both	urban	selective	0.93	n.r.	clinical	symptoms in all three examinations	9	9	9	9
Solberg 1979	USA	739	0.500	1:1.0	19 to 65	both	urban	selective	0.82	n.r.	both	authors' estimate	5	5	5	5
Hansson 1975	Sweden	1069	0.077	1:12	10 to 79	both	urban	selective	0.96	n.r.	clinical	authors' minimum estimate authors' maximum estimate	25	27.5	27.5	30
Helkimo 1974	Finland	321	0.514	1:0.9	15 to 65	both	both*	random	0.81	n.r.	clinical	Helkimo's dysfunction index DIII[※]	22	24	24	26
											questionnaire	Helkimo's anamnestic index AIII[∞]				
Posselt 1971	Sweden	269	1	0:1.0	19 to 22	women	urban	selective	1	1.000	clinical	authors' estimate	20.8	20.8	20.8	20.8
median													9.1	14	15.3	19

Abbreviations: n.c. = not calculable, n.r. = not reported, * both = urban and rural areas, [a] SSI = Symptom Severity Index, ※ DIII = severe signs, ∞ AIII = severe reported symptoms

The studies were mostly performed in urban residential areas (83%), but only three studies (18%) covered urban and rural residential areas (Helkimo 1974, Tervonen 1988, and Wänman 1995b).
Sampling type was random in ten studies (59%).
The proportion of subjects participating ranged from 62 to 100% (median 86%).
Ten (59%) studies used only clinical examination as the basis for a treatment need assessment method, three (18%) studies used questionnaire only, and four (24%) studies used both clinical examination and questionnaire.
Criteria for estimating treatment need varied as follows:

- Authors' estimate: n=8 (47%)
- Moderate and severe TMD symptoms: n=3 (18%)
- Clinical signs of dysfunction: n=2 (12%)
- Symptoms in all three examinations: n=1 (6%)
- Symptom Severity Index: n=1 (6%)
- Kutilla's definition: n=1 (6%)
- Helkimo's index: n=1 (6%).

Summary estimate of the meta-analysis

Out of the 17 studies identified (Table 2) six studies (35%) provided more than one treatment need estimate. A considerable variation of need figures was observed ranged from 1% to 58%.
The median of the need estimates was 14% when the median of the estimates was used for the calculation of the summary need measure. It changed to 15% when the mean, to 9% when the minimum, and to 19% when the maximum need estimate per studies was used to compute the meta-analysis summary measure.
A forest plot was constructed plotting each study point and 95% confidence interval estimate (Figure 2). A forest plot is a graphical display of results from individual studies, allowing visual comparison of trial results and examination of degree of heterogeneity among studies.

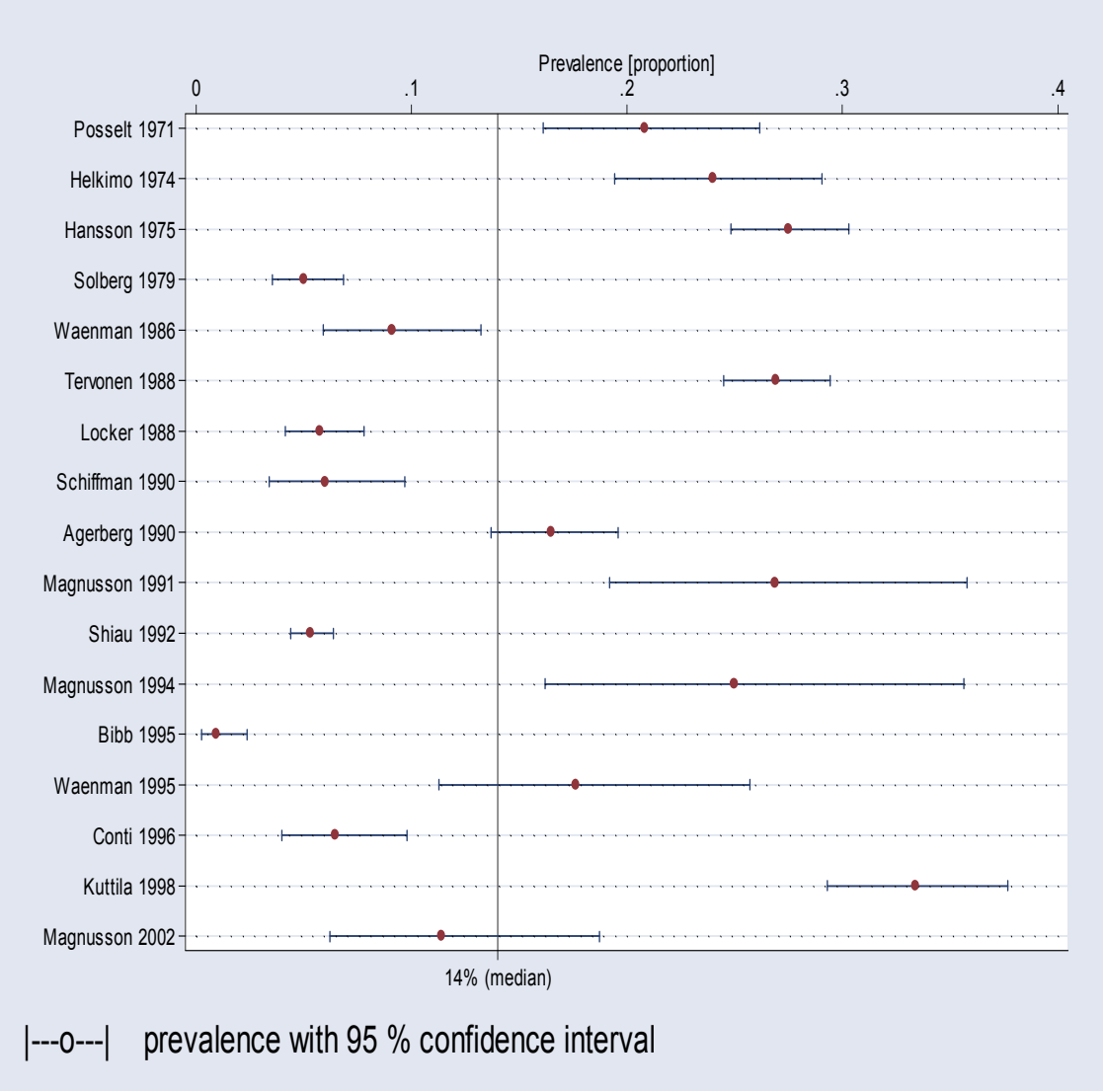

Figure 2. Forest plot of the meta-analysis summarizing individual study estimates and overall estimate of treatment need for TMD

Variation of need summary estimate by study characteristics

The treatment need estimates for TMD were stratified by study characteristics (Table 3). The summary estimate of treatment need varied for the different variables.

studies characteristics	subdivision	number of studies	TMD treatment need [%]			
			minimum	median	mean	maximum
sampling type	random studies	10	10.1	15.3	15.9	22
	non-random studies	7	9	9	9	9
participants' age interval	19-45 years	14	12.5	18.7	18.7	19.9
	46-78 years	3	3.5	4.8	5.7	9.7
publication year interval	during the last 10 years (2003-1994)	6	7.8	12.5	13.2	18
	published between (1993-1984)	7	9	9	9	9.7
	before more than 20 years (1983-1971)	4	21.4	22.4	22.4	23.4
sampling size	< 600 subjects (small)	11	9.1	14	15.3	20.8
	≥ 600 subjects (large)	6	9.7	10.9	11.1	14.4
residential area	urban	14	9.1	10	10	10.4
	rural and urban	3	22	24	24	26
response rate	< 90%	11	11	16.5	16.5	19
	≥ 90%	6	7.7	7.7	12.2	14.9
gender of samples	both gender	14	10.1	13.8	13.8	15
	only women	2	13.4	13.4	13.4	13.4
	not mentioned	1	6	14	15.3	26
method of examination	clinical examination	10	10.1	17.4	18.1	22.9
	questionnaire	3	6	6	6	6.5
	clinical examination and questionnaire	4	18	20.3	20.3	22.5
proportion of women	< 50%	6	18	18	18	18
	≥ 50%	10	7.8	11.5	11.5	14.4
	not mentioned	1	6	14	15.3	26
place of studies	Europe	11	20.8	24	24	26
	north and south America	5	5	5	5.7	6
	east Asia	1	5.3	5.3	5.3	5.3
criteria of estimating need	authors' estimate	8	17.4	18.7	18.7	22.9
	Kutilla's definition	1	9.1	33.3	33.3	57.5
	moderate and severe TMD symptoms	3	3.5	4.8	5.7	9.7
	Helkimo's index	1	22	24	24	26
	clinical signs of dysfunction	2	16.2	16.2	16.2	16.2
	symptoms in all three examinations	1	9	9	9	9
	symptom severity index	1	6	6	6	6

Table 3. Summary estimates of treatment need stratified by study characteristics

Considering median for the central tendency, the variations are as the following:

- Sampling type: 15% for random studies but, 9% for non-random studies.
  This could be due to sampling variability or by chance.
  Populations included were described in detail (see Appendix, table 5);
- Participants' age: 19% for the age interval 19-45 years but, 5% for the age interval 46-78 years;
- Publication year: 13% for studies published during the last 10 years but, 22% for studies published before more than 20 years;
- Sampling size: 11% for large samples (≥ 600 subjects) but, 14% for small samples (< 600 subjects);
- Residential area: 10% for urban population and 24% for rural and urban population;
- Response rate: 17% for < 90% response and 8% for ≥ 90% response;
- Gender of samples: 14% for both gender and 13% for studies with only women;
- Method of examination: 17% for only clinical examination, 6% for only questionnaire, and 20% for both clinical examination and questionnaire;
- Proportion of women: 12% for studies with ≥ 50% of women and 18% for studies with < 50% of women;
- Place of studies: 24% for studies done in Europe, 5% for studies done in North and South America and in East Asia;
- Criteria of estimating need:
  - authors' estimate: 19%
  - Kutilla's definition: 33%
  - moderate and severe TMD symptoms: 5%
  - Helkimo's index: 24%
  - clinical signs of dysfunction: 16%
  - symptoms in all three examinations: 9%
  - symptom severity index: 6%.

Discussion

With the many controversies related to TMD, it is not surprising that the estimation of treatment need has varied considerably. Concern has been expressed regarding the lack of generally accepted standards for definitions, methods of investigation, and presentation of results. These factors probably explain more of the variation than do any real differences between samples. The presented meta-analytical approach examined the methodological and the sample similarities and differences, which might explain the high prevalence ranges of treatment need for TMD (1-58%).

Main findings

This meta-analysis evaluated the results of 17 studies regarding the prevalence of treatment need for TMD in adults and explained associated factors. Well defined guidelines for conducting a meta-analysis of observational studies in epidemiology (MOOSE) were used. An electronic literature search has been conducted using four databases. The Medline database showed the highest sensitivity (65%) compared to others, and this was similar to previously reported data (Dickersin et al., 1994; Macfarlane et al., 2001). However, it should be noted that the Medline search was the least specific, retrieving the highest proportion of irrelevant articles.

The median of the summary need estimates varied from 9 to 19%. Considering the central tendency of treatment need estimate median is 14%. By applying quality weighting to the included studies and computing the summary need estimate, it is clear that studies with higher quality scores (3, 4 or 5) have lower treatment need than studies with lower quality scores (1 or 2). Such result was expected.

When need estimates were stratified by study characteristics, the largest differences in the median of need estimates were observed for “criteria of estimating need” followed by place of study, and then by participants’ age. Summary measures changed little (≤ 6% difference), for the variables (type of sampling, size of samples, gender of samples and proportion of women). Treatment need estimates changed a lot (≥ 9%), for the

variables (criteria of estimating need, place of study, participants' age, residential area, response rate, publication year interval, method of examination).

Factors possibly influencing treatment need for TMD

Factors influencing TMD treatment need estimates are similar to factors affecting TMD prevalence. If TMD prevalence is changing we hypothesize that there is change in TMD treatment need estimates. Treatment need estimates for TMD depend on understanding of TMD aetiology, treatment modalities and prognoses.

A recent meta-analysis of 51 prevalence studies presented a wide range of results. The prevalence of signs and symptoms ranged from 0 to 93% for clinically assessed TMD and from 6 to 93% for anamnestic TMD prevalence (De Kanter et al., 1993). The average value for perceived dysfunction was 30% among 15.000 subjects; the average value for clinically assessed dysfunction was 44% among 16.000 subjects. These high prevalences are due to inclusion of mild signs and symptoms. Severe pain and dysfunction occur rarely (Kuttila, 1998b). There are approximately only 5 to 10% for whom the condition represents a serious problem.

The prevalence figures not even those indicating severe signs and symptoms cannot be transferred directly into treatment need. The subjects' own demand must also be considered. Though 1/3 of subjects reporting dysfunction and less than ± 50% of them with moderate to severe clinically assessed dysfunction, the summary estimate of treatment need for TMD was found to be about 14%.

Pain in the temporomandibular region is a symptom that has been reported to occur in about 10% of adults, with less variation between various studies (5% to 13%) than some of other symptoms. Dworkin stated that 97% of the TMD patients had anamnestically TMD pain (Dworkin et al., 1990a). While in the study by Kuttila (1998a), 91% of the subjects with active TMD treatment need reported TMD pain at baseline.

Epidemiologic and clinical studies of TMD confirm its fundamental status as a pain problem, more specifically, a chronic pain problem (Bell, 1986; Dworkin et al., 1992; Fricton et al., 1987). Comparison of TMD with other common chronic pain conditions

such as headache and back pain, for chronicity, intensity, psychosocial profile, use of health care resources and disability parameters, confirms that in all these major respects TMD is essentially a chronic pain condition. Empirical support of this view comes from two large scale longitudinal population-based studies (Von Korff et al., 1988c; Dworkin et al., 1990a), and from the extensive work of Turk and Rudy (Turk and Rudy, 1987 and 1988), Rudy and colleagues (Rudy et al., 1990) in a pain clinic setting. It also comes from psychosocial assessment of TMD patients by Marbach and colleagues (Marbach et al., 1983; Lipton and Marbach, 1984), Keefe (Keefe and Dolan 1986) and others (Speculand et al., 1983; Schnurr et al., 1990; McCreary et al., 1991).

Unexpectedly, there was a higher summary estimate of treatment need for random studies compared with non-random studies, which could be due to sampling variability or by chance.

The main factors assumed to affect treatment need estimates are:

- criteria for estimating treatment need
- age and gender
- time trends
- method of estimating treatment need.

Criteria for estimating treatment need for TMD

The lack of well-defined criteria can be problematic in estimating treatment need for TMD (Magnusson et al., 1991, 1994). On the other hand, treatment need for TMD cannot only be based on indices of signs and symptoms of TMD.

According to Rugh and Solberg (1985), it is necessary to separate subclinical and clinical cases in order to find cases with reasonably severe clinical conditions for treatment.

To separate the treatment need figures from the prevalence figures, to explain the great variation among the prevalence studies, and to systematize some concepts used in

discussions about TMD, an interesting approach to evaluation of treatment need for TMD was presented by Kuttila (1998a). The author suggested a classification of patients into 3 groups: active, passive, and no treatment need. “Active treatment need for TMD” denotes patients with moderate or severe signs and symptoms of TMD that prompt the individual to seek help, or a patient who is estimated by clinician as needing care independently of other possible oral health problems. “Passive treatment need for TMD” includes those with mild signs of TMD, or only minor or fluctuating symptoms. The subjects in this subgroup are assessed as needing no treatment if no other dental care was considered. “No treatment need for TMD” refers to those patients whose TMD problems did not call for treatment in any circumstances.

In the Finnish study by Tervonen (1988), subjects needing a new full set of complete dentures were excluded from the treatment need analyses. Contrary to Kuttila study (1998b), stomatognathic treatment need was evaluated in relation to other dental treatment needs such as periodontal, orthodontic or prosthetic care. According to Kuttila (1998b), the TMD treatment need estimation of the adult population may be incomplete, if it is separated from other dental treatment needs.

The reliability and validity of the classification of the subjects into the different treatment need subgroups are difficult to assess. In borderline cases it is almost impossible to give any reliable basis for clinical decisions as to when to treat, due to lack of prolonged follow-up studies. The treatment decision depends on the signs and symptoms of TMD and naturally on the experience of the examiner.

The Helkimo clinical dysfunction index was originally constructed for epidemiological purposes and can not as such be applied to treatment need analysis. If only DiIII figures are considered as treatment need figures for TMD, several subjects with moderate signs and symptoms of TMD and probably needing treatment would be excluded from the treatment need figures. Combining the figures for moderate and severe dysfunction (DiII+ DiIII) would, on the other hand, have led to too excessive treatment need estimations. Helkimo stated (1979) that “It might be questioned which figure best reflects the treatment need in a population, the one estimated by the doctor after

evaluation of the severity of a patient's signs and symptoms or the one given by the actual number of patients seeking treatment for their symptoms".

Treatment need for TMD in relation to age and gender

The summary estimate of treatment need between the two age intervals varied widely. It is reduced from 19% for the age interval 19-45 years to 5% for the age group 46-78 years. These results agree with the longitudinal findings as well as cross-sectional epidemiologic results that the majority of the TMD patients are found to be between 15 and 45 years old and warrant the conclusion that there is no increased risk of developing symptoms of TMD with increasing age.

In this study, not much difference was found (1%) when summary need estimate compared between studies with only females subjects and studies with both genders.

The difference in TMD prevalence between males and females is still not well understood, some theories have been proposed to explain why females are more affected than males. Smith (1976) suggested that females seek treatment more frequently than males, because they maintain a closer contact with health care professionals during their lives, resulting in more complaints and referrals for TMD treatment.

On the other hand, Weinberg and Sändstrom (1988) believe that this difference is because of the fact that males can more easily handle their stress, which is reflected in lower levels of functional disorders. Levitt and McKinney (1994) found that females with TMD compared with males with TMD reported a high level of severity of all physical and psychologic symptoms, which could help to explain the high female male ratio in patients seeking treatment. Differences between females and males in the presence of estrogen receptors in the temporomandibular joint (Abubaker et al., 1993) and the possible role of exogenous hormones have been suggested to be important for gender differences (LeResche et al., 1994). Despite these theories, the true reason or set of reasons why females present more frequently for treatment remains unknown and warrants additional studies.

This is further supported by results of a 10 year follow-up study, which indicated different courses for TMD signs and symptoms in men and women (Wänman, 1996). During the observation period, men seemed to recover from TMD signs and symptoms to a greater extent than women, which indicates a gender difference in duration of TMD. The usually longer duration of TMD symptoms in women may help to explain why they are more likely than men to seek care.

Method of estimating treatment need for TMD

Some investigators conclude that self-administered questionnaires are the best way to ask about the symptoms related to TMD (Agerberg and Helkimo, 1987, Wänman, 1987), while others prefer interviews (Nilner and Lassing, 1981; Agerberg and Inkapööl, 1990; Könönen and Nyström, 1993; Kovero, 1997).

Our finding about differences between need estimates derived from clinical TMD signs and from patient-reported symptoms (17% versus 6%) agrees with the finding of a previous meta-analysis by De Kanter and colleagues (De Kanter et al., 1993) which showed the differences between professional diagnosis (clinically assessed TMD) and patients' openions (anamnestically assessed TMD).

Many variables in clinical examination are semi-objective (Magnusson, 1995). When looking at individual parameters, the mouth opening ability has been regarded as one of the most important criteria for TMD diagnosis. Recording of maximal mouth opening capacity is the most reliable parameter (Kopp and Wenneberg, 1983).

On the other hand, the validity and reliability of muscle palpation have been questioned (Goulet and Clark, 1990; Dworkin and LeResche, 1992; Jensen and Olesen, 1995). The quantification of tenderness on muscle palpation depends on the pain tolerance of the subject, the given instructions, the exerted pressure, and above of all on the examiners experience (Jensen and Olesen, 1995). According to Widmer (1992), the diagnostic utility of muscle palpation when discriminating patients from non-patients or when making a differential diagnosis, is unknown.

According to Goulet and Clark (1990), the reliability of detecting joint sounds is poorer when compared to measuring the range of mandibular movements. Joint sounds in general have low stability (Dworkin et al., 1990; Goulet and Clark, 1990), and their diagnostic validity is only moderate (Ohrbach, 1994). Discrimination of sounds that indicate joint pathology is not always easy but can be improved by repeated trials (Ohrbach, 1994).

It seems that temporomandibular joint clicking and slightly limited jaw opening ability are not always regarded as abnormal unless pain or marked dysfunction accompanies it.

Time trends and fluctuation of TMD treatment need

As the professional opinion about the treatment need in general and more specifically because TMD depends on time, treatment need may have changed up to the present time.

In our meta-analysis a time influence on treatment need estimates was present. The summary estimate of treatment need was found to be higher in studies published before the last two decades, but remarkably reduced during the last decade.

A major influence of changed need over time would be a shift in prevalence over time. However, determining trends in the prevalence of TMD is not easy; critical factors are the definition of the condition, the survey methods, and the characteristics of the population. Trends could be studied by using the same definitions and methods in a similar population years later, or by studying the number of people seeking care within a defined population, such as a health maintenance organization (HMO), over time (Drangsholt and LeResche, 1999).

To our knowledge, only few published studies have specifically looked at trends in TMD incidence or prevalence over time. Sato et al. (1996) compared the prevalence of “pain when opening the mouth wide” among two different cohorts of 70-year-olds 20 years apart, both in the same community. They used the same methods and many of the same investigators for both groups. Their data showed substantial decreases in the report of functional jaw pain for the most recent cohort. This difference could be due to

better dental health of the second group, to other selection factors associated with this cohort or to chance.

Locker conducted telephone surveys for TMD pain in 1987 (Locker and Slade, 1988) and 1992 among the same population (Locker and Miller, 1994). His studies found small differences in the prevalence of adults aged 18-65 years who reported TMD pain ("pain in the face in front of the ear") in the last 4 weeks (7.5%, 1987; 5.8% in 1992).

Kuttila (1998b) reported that the fluctuation of treatment need for TMD was small, during a 2-year follow-up of an epidemiologic sample of 515 subjects. The "active treatment need" for TMD varied between 7% and 9%, "passive treatment need" varied from 40% to 46%, and "no treatment need" varied from 46% to 51%.

Recently, Magnusson et al. (2005) reported in a final summary a prospective investigation over two decades on signs and symptoms of TMD and associated variables. Originally, 402 randomly selected 7-, 11-, and 15-year-olds were examined clinically and by means of a questionnaire. The same examination procedure was repeated three times: after 4-5 years and after 10 years and 20 years, respectively. They concluded a substantial fluctuation of TMD signs and symptoms in this sample of Swedish subjects followed for 20 years from childhood to adult. The demand for TMD treatment was low at all examinations, while the estimated treatment need was larger.

In conclusion, no convincing evidence about a change in TMD prevalence over time was found. Such a change in TMD prevalence could have explained the time influence on treatment need. Therefore, the need estimate change was attributed to a change in the understanding of TMD.

Comparison of this review with previous reviews

A previous review reported treatment need estimates for TMD ranging from 1.5% to 30% (Carlsson et al., 1999). Summary estimate of treatment need was not computed. The report was based on a narrative review of the literature which included 14 studies published up to the year 1994 (Kuttila, 1998b). However, the review did not follow well defined guidelines. Reviewing process was not described. It presented many study

details (authors, publication year, country, sample characteristics such as size, age and gender, study design, treatment need estimate in percentage, method and criteria of collecting information). However, there was no description of populations of included studies; the ratio between males and females, or proportions of females participated in the studies, and response rates were not reported. For studies reporting more than one treatment need estimate (n=4), only the range of treatment need estimate were reported without reporting the central tendency by computing median or mean.

Treatment need estimates were not stratified by study characteristics to find possible influencing factors on TMD treatment need and there was no graphic summarizing individual study estimates and overall estimate.

In contrast to the study of Kuttila (1998b), the present study applied rigorous methodology. Treatment need for TMD assessed to range from 1% to 58%. Summary estimate of treatment need was computed (14%).

Well defined guidelines were followed (MOOSE guidelines) and steps in conducting this meta-analysis were described. Adequate study details with description of populations of included studies, the ratio between males and females and proportions of females participated in the studies, and response rate were reported. For studies reporting more than one treatment need estimate (n=6), median and mean of treatment need estimates were computed to show the central tendency, in addition to minimum and maximum treatment need estimates.

Treatment need estimates were stratified by study characteristics (sampling type, participants' age, publication year interval, sampling size, residential area, response rate, gender of samples, method of examinations, proportion of women, place of studies and criteria of estimating need) to find possible influencing factors on TMD treatment need. Forest plot graph drown to summarize individual study estimates and overall estimate.

There are other strengths of the present study. One of the requirements of Cochrane systematic review and meta-analysis is independent data extraction by two reviewers. In this meta-analysis, abstracts identification from searched electronic databases and articles selection for inclusion in meta-analysis were done by two reviewers separately.

Data extraction was also done by two reviewers separately. So, agreements between reviewers could be assessed and the quality of the study increased. Very good data agreement for abstracts identification (kappa=0.8), articles selection (kappa=0.9) and data extraction was achieved.

For the hand search, references obtained from computerised search, references of available articles and previous reviews; references of relevant books and doctoral Theses available at Martin-Luther-University Halle-Wittenberg dental library were searched in addition to hand searched journals. Some of the experts in the field were contacted for more information about the subject.

Usually, publication bias is a problem for meta-analysis. Studies which have statistically significant results are more likely to be published than studies which do not have significant findings (Chalmers et al., 1987; Begg and Berlin, 1988; Easterbrook et al., 1991). However, publication bias is probably not a problem for our study because we have only descriptive data without a p-value. We consider it strength of our meta-analysis that publication bias is unlikely to be a limitation in our study.

The present study faced some methodological challenges. Some studies (n=6) provided more than one treatment need estimate due to the presence of different criteria. Minimum and maximum treatment need estimates were computed to capture the lower and the upper bound so that a broad range was presented. In addition, mean as well as median were computed to have the central tendency of need estimate.

Limitations of this study

The most important feature of a meta-analysis is the effort made to locate all original reports on the topic of interest. In our study, only articles in the English language were included. This can introduce language bias; however lack of resources precluded translation from other languages into the English language. We would have included German or Arabic studies but such studies were not available.

The quality of included studies in our meta-analysis was not assessed by specific criteria but by judgement of reviewers. The hand search was done only by one reviewer;

hence it was not possible to assess agreement of reviewers for additional articles identified by hand search.

This review included not only population-based investigations but also non-patient samples' studies, trying to include more relevant studies to allow wider generalisation of the results.

Confidence interval for the overall summary estimate of treatment need was not computed due to methodological complexity.

Public health importance of the study

There is clearly a greater awareness of TMD, as evidenced by the dramatic increase in number of published studies (Antczak-Bouckoms, 1995), funded research, number of clinicians reportedly treating these patients, and interest expressed in the lay press.

Treatment need data related to the TMD prevalence are essential in qualifying TMD in terms of planning oral health care programs. In addition, due to the diversity of treatment needs for temporomandibular conditions, the manpower needs will be spread fairly evenly among general dentists and the various specialities.

According to Drangsholt and LeResche (1999), TMD pain affects about 10% of women and 6% of men in any given year. Application of these percentages today's adult U.S. population would yield roughly 6,675,000 men and 13,350,000 women, or a total of 20 million adults in 1998. Further extension of the population prevalence for the world, assuming similar proportions across cultures, would give a rough estimate of 450 million adults afflicted worldwide (Drangsholt and LeResche, 1999).

Recently, Hirsch and John (2005) studied cost scenarios for diagnosis and treatment of TMD in Germany. They stated that "The direct costs for TMD in dentistry which may be regarded as the lower limit of total TMD health care expenditures range from 170 to 880 million Euros per year, i. e. from 1.3% to 6.5% of the total expenditures of oral diseases". Calculations of costs were based on available prevalence and treatment demand data for TMD as well as assumptions about the frequency of diagnostic and

treatment modalities applied in routine dental practice. They concluded that TMD have a substantial economic impact on health care in Germany (Hirsch and John, 2005).

More efforts should be directed towards dental educational programs training students to manage these patients and there is a need for increased emphasis on physical diagnosis and the ability to see complex diseases in a psychosocial context.

Future research

The majority of the epidemiological studies of TMD have been conducted in Europe especially in Sweden. Studies carried out in one country may not be generalisable to other populations, for example because of cultural factors or the different prevalence of aetiological factors. Therefore, further studies are needed based on populations other than in European countries.

This meta-analysis has shown the need for more epidemiological studies assessing the treatment need for TMD in the general population.

There is often a substantial discrepancy between need and demand for TMD treatment. The solution may be facilitated by continuing research, for example, the combination of improved epidemiologic, basic, and clinical methods following evidence-based principles.

To our knowledge, no meta-analysis has been published addressing treatment demand for TMD. The issue of demand for TMD treatment is one which needs to be considered in any practical discussion of using treatment needs data.

SUMMARY

The purpose of this study was to determine the prevalence of treatment need for TMD in adult populations through conducting a meta-analysis, and describing factors influencing treatment need for TMD.

Well defined guidelines for conducting a meta-analysis for observational studies (MOOSE) were used. All identified abstracts/titles from four electronic databases (Medline, CINAHL, SCI-E, and EMBASE) (n=645) and hand search (n=31) were screened. The final selected articles (n=17) resulted from the full text screened articles (n=50). Results were independently assessed by two reviewers.

There was a very good agreement between the two reviewers in identifications of abstracts (Kappa=0.8), full text articles (kappa=0.9), and in extracting data.

The study faced some methodological challenges. Some studies (n=6) provided more than one treatment need estimate due to the presence of different criteria. Minimum and maximum treatment need estimates were computed to capture the lower and the upper bound so that a broad range was presented. In addition, mean as well as median were computed to have the central tendency of need estimates. Considering median for deriving the summary estimate, the prevalence of treatment need for TMD is 14%.

Studies with higher quality weights' scores have lower treatment need (5%) than studies with lower quality scores (20%).

When need estimates were stratified by study characteristics, the largest differences in the median of need estimates were observed for "criteria of estimating need". Summary measures changed little (≤ 6% difference), for the variables (type of sampling, size of samples and gender distribution). Treatment need estimates changed a lot (≥ 9% difference), for the variables (criteria of estimating need, place of study, participants' age, residential area, response rate, publication year interval, method of examination).

The main factors which affect treatment need estimates are criteria for estimating treatment need, age, time trends, and method of estimating treatment need. The summary estimate of treatment need reduced from 19% for the age interval 19-45 years to 5% for the age group 46-78 years.

Differences between need estimates derived from clinical TMD signs and from patient-reported symptoms were observed (17% versus 6%).

A time influence on prevalence of treatment need was present. The summary estimate of treatment need was found to be higher in studies published before the last two decades (22%), but remarkably reduced during the last decade (13%). However, no convincing evidence about a change in TMD prevalence over time was found. Therefore, the need estimate change was attributed to a change in the understanding of TMD.

Not much difference was found (1%) when summary need estimates were compared between studies with only females subjects and studies with both genders.

The results of this meta-analysis are of public health importance. They can be used to plan and allocate health care resources.

Zusammenfassung

Der Zweck dieser Studie war, die Behandlungsnotwendigkeit bei Craniomandibulärer Dysfunktion (CMD) bei Erwachsenen durch eine Meta-Analyse zu bestimmen und die Faktoren, die die Behandlungsnotwendigkeit beeinflussen, zu beschreiben.

Es wurden gut definierte Richtlinien für die Durchführung einer Meta-Analyse für beobachtende Studien (MOOSE) benutzt. Alle ausgewählte Zusammenfassungen/Titel von vier elektronischen Datenbanken (MEDLINE, CINAHL, SCI-E, und EMBASE) (N=645) und die Handrecherchen (N=31) wurden durchgesucht**.** Die letztendlich ausgesuchten Artikel (N=17) gingen aus den textlich vollständig durchgesehenen Artikeln (N=50) hervor. Die Brauchbarkeit der Artikel wurde von zwei Rezensenten beurteilt.

Es wurde eine sehr gute Übereinstimmung zwischen den zwei Rezensenten bei der Auswahl von Zusammenfassungen (kappa=0.8), Volltext-Artikeln (kappa=0.9) und der Auswahl von Daten erzielt.

Die Studie hatte einige methodische Herausforderungen zu meistern. Einige Studien (N=6) lieferten mehr als einen ermittelten Behandlungsnotwendigkeits-Prozentwert, da verschiedene Kriterien existierten. Minimal- und Maximal-Behandlungsnotwendigkeits-Prozentwerte wurden errechnet, um den unteren und oberen Grenzbereich zu erfassen. Außerdem wurden Durchschnittswert wie auch Median berechnet, um die mittlere Tendenz des ermittelten Notwendigkeits-Prozentwerts zu erhalten. Berücksichtigt man den Median, um den summarischen Prozentwert abzuleiten, liegt die Behandlungsnotwendigkeit von CMD bei 14%.

Studien mit höheren Qualitäts-Wertungen haben eine geringere Behandlungsnotwendigkeit (5%) als Studien mit niedrigeren Qualitäts-Wertungen (20%) erbracht.

Als die Prozentwerte der Behandlungsnotwendigkeit nach Studiencharakteristiken geordnet wurden, wurden die größten Differenzen des Medians der ermittelten Notwendigkeits-Prozentwerte bei „Kriterien für die Ermittlung der Notwendigkeits-Prozentwerte“ beobachtet. Gesamtwerte des Medians änderten wenig (≤ 6% Differenz) bei den Variablen „Typ der Stichprobenerhebung“, „Größe der Stichproben“ und

„Geschlechter-Aufteilung“. Die Behandlungsnotwendigkeits-Prozentwerte änderten sich sehr (≥ 9% Differenz) bei den Variablen „Kriterien der Notwendigkeits-Prozentwerte“, „Ort der Studie“, „Alter der Probanden“, „Wohngebiet“, „Response-Rate“, „Intervall der Publikationsjahre“, „Untersuchungsmethode“.

Die gefundenen Hauptfaktoren, die die ermittelten Behandlungsnotwendigkeits-Prozentwerte beeinflussen, sind „Kriterien für Behandlungsnotwendigkeits-Prozentwerte“, „Alter“, „Zeittrends“ und „Ermittlungsmethode der Behandlungsnotwendigkeits-Prozentwerte“. Der ermittelte Gesamt-Prozentwert der Behandlungsnotwendigkeit verringerte sich von 19% für das Altersintervall von 19 – 24 Jahren auf 5% für die Altersgruppe von 46 – 78 Jahren.

Differenzen zwischen ermittelten Notwendigkeits-Prozentwerten, die sich von klinischen CMD-Zeichen und von Symptomen, die vom Patienten berichtet wurden, ableiten, wurden beobachtet (17% gegenüber 6%).

Es gab einen Einfluss der Zeit auf die Behandlungsnotwendigkeit. Es wurde herausgefunden, dass der ermittelte Gesamt-Prozentwert der Behandlungsnotwendigkeit in Studien, die in den letzten zwei Jahrzehnten veröffentlicht wurden, höher war (22%), im letzten Jahrzehnt sich aber verringerte (13%). Dennoch wurde kein überzeugender Beweis für eine Veränderung der CMD-Prevalenz während der Zeit gefunden. Deshalb wurde die Änderung der Behandlungsnotwendigkeits-Prozentwerte einem veränderten Verständnis von CMD zugeschrieben.

Es wurde keine große Differenz festgestellt (1%) wenn die Behandlungsnotwendigkeit aus Studien mit nur weiblichen Teilnehmern und Studien mit beiden Geschlechtern verglichen wurden.

Die Ergebnisse dieser Meta-Analyse sind von Bedeutung für das Gesundheitswesen. Sie können für die Planung und die Anwendung der Möglichkeiten der Gesundheitsversorgung genutzt werden.

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Appendix

Reporting of background should include
Problem definition
Hypothesis statement
Description of study outcome(s)
Type of exposure or intervention used
Type of study designs used
Study population
Reporting of search strategy should include
Qualifications of searchers (eg, librarians and investigators)
Search strategy, including time period included in the synthesis and keywords
Effort to include all available studies, including contact with authors
Databases and registries searched
Search software used, name and version, including special features used (eg, explosion)
Use of hand searching (eg, reference lists of obtained articles)
List of citations located and those excluded, including justification
Method of addressing articles published in languages other than English
Method of handling abstracts and unpublished studies
Description of any contact with authors
Reporting of methods should include
Description of relevance or appropriateness of studies assembled for assessing the hypothesisto be tested
Rationale for the selection and coding of data (eg, sound clinical principles or convenience)
Documentation of how data were classified and coded (eg, multiple raters, blinding, and interrater reliability)
Assessment of confounding (eg, comparability of cases and controls in studies where appropriate)
Assessment of study quality, including blinding of quality assessors; stratification or regression on possible predictors of study results
Assessment of heterogeneity
Description of statistical methods (eg, complete description of fixed or random effects models, justification of whether the chosen models account for predictors of study results, dose-response models, or cumulative meta-analysis) in sufficient detail to be replicated
Provision of appropriate tables and graphics
Reporting of results should include
Graphic summarizing individual study estimates and overall estimate
Table giving descriptive information for each study included
Results of sensitivity testing (eg, subgroup analysis)
Indication of statistical uncertainty of findings
Reporting of discussion should include
Quantitative assessment of bias (eg, publication bias)
Justification for exclusion (eg, exclusion of non–English-language citations)
Assessment of quality of included studies
Reporting of conclusions should include
Consideration of alternative explanations for observed results
Generalization of the conclusions (ie, appropriate for the data presented and within the domain of the literature review)
Guidelines for future research
Disclosure of funding source

Table 4: A proposed reporting checklist for authors, editors, and reviewers of meta-analyses of observational studies (Stroup et al., 2000).

authors	Samples' information about population
Magnusson 2002	School children at the age of 15 years, examination repeated after 5, 10, and 20 years after the first examination (followed up to the age of 35 years).
Kuttila 1998	Drawn from records representing the population of the municipality of Jyvaeskylae, Finland.
Conti 1996	High school and university students living in Bauru, Brazil.
Waenman 1995	Those living in Vaesterbotten in the northen part of Sweden on the coast and in the inland region.
Bibb 1995	Caucasian residing in Los Angeles (USA) enrolled in Medicare Screening and Health promotion Trial.
Magnusson 1994	School children followed longitudinally from the age of 15 to 25 years,
Shiau 1992	First and fourth year students at the national Taiwan university, selected of all schools of the university.
Magnusson 1991	School children were followed longitudinally from the age of 15 to 20 years.
Agerberg 1990	Obtained from the population register at the data Center of the Country Council of Stockholm, Sweden.
Schiffman 1990	Sophomore, junior and senior female nursing students at the University of Minnesota School of Nursing.
Locker 1988	Households within the city of Toronto containing one or more persons aged 18 years and over.
Tervonen 1988	Selected from the local population registers by randomly dividing the population into ten subgroups and picking the first male and female aged 25, 35, 50 and 65 years from each group.
Waenman 1986	They constituted a sample of all individuals in this age group (born in 1964) receiving dental care at one of two public dental clinics, and living in the town of Skelleftea, in northern Sweden.
Solberg 1979	The sample obtained from a population of students by the University of California at Los Angeles who underwent this compulsory medical screening.
Hansson 1975	White collar workers and tradesmen working in a ship-building Yard in the south of Sweden.
Helkimo 1974	Subjects who took part in the general health survey in the district of Inari in the north of Finland in 1969 and 1970. 100% genuine Sklots or Inari-Lapps persons were included.
Posselt 1971	Nursing students at the Royal Dental School, Mamoe, Sweden.

Table 5: Description of populations of included studies in the meta-analysis

Data-extraction form

Title:

Author:

Year of publication:

Aim of study:

No. of participated subjects:

Participation rate:

Population age range:

Percentage of participated women:

Sample information about population:

Type of sampling:

Country of study:

Method of investigation:

Criteria and definition of treatment need for TMD:

Treatment need estimate (in percentage):

Reference:

CONCLUSIONS AND OUTLOOK

1. The definition and concept of need is essential for planning and evaluation of oral health care (Sheiham and Spencer, 1997). Normative need is defined as an expert's or professional's, administrator's or social scientist's definition of need in a given situation (Bradshaw, 1972).

2. Need does not always lead to use of services and use of services does not always result from need, but the existence of disease and normatively defined need does create a potential for the use of services" (Spencer, 1984).

3. Epidemiologic and clinical studies of TMD confirm its fundamental status as a chronic pain problem. Pain in the temporomandibular region is a symptom that has been reported to occur in about 10% of adults, and approximately one in three adults will develop TMD pain in his or her lifetime (Dworkin and LeRsche, 1993).

4. Today, accepted etiologic concept of TMD is the multifactorial (aetiology is a combination of dental, psychological, and muscular factors) and biopsychosocial approach which views expression of pain and dysfunction as the current resolution of personal and environmental forces operating across time (Okeson, 2003).

5. Meta-analysis is a quantitative approach for systematically assessing the results of previous research in order to arrive at conclusions about the body of research. It is superior to narrative reviews because of its advantages, as it contains a comprehensive summary of the evidence rather than being based on only a selection of the published literature. Meta-analysis has the ability to reduce bias, establish generalisability, increase power and precision, and ensure reliability.

6. The results of this meta-analysis indicate that the prevalence of treatment need for TMD in adults is about (14%). Better need estimates depend on results of studies identifying modifiable risk factors.

7. Subjects in the age group 19-45 years needed more treatment for TMD than subjects in the age group 46-78 (19% versus 5%).

8. There are clear differences between need estimates based on clinically assessed (17%) and anamnestically assessed (6%) TMD treatment need.

9. A time influence on prevalence of treatment need was observed. The summary estimate of treatment need found higher with studies published before the last two decades (22%), but remarkably reduced during the last decade (13%). However, no convincing evidence about a change in TMD prevalence over time was found. Therefore, the need estimate change was attributed to a change in the understanding of TMD.

10. Although, there are many classification schemes for TMD, the research diagnostic criteria for TMD (RDC/TMD), developed by Dworkin and LeResche (1992), demonstrates sufficiently high reliability for the most common TMD diagnosis, supporting its use in clinical research and decision making.

11. It is well established that a majority of patients suffering from TMD can be managed with simple treatment that can be provided by general dental practitioners; and specialist clinics should be available for patients who do not receive sufficient relief of their symptoms with simple, conservative therapy.

12. Aspects of the burden related to TMD are based on need estimates in combination with the treatments planned for patients in need. Need estimates characterize aspects of the importance of a disease and therefore influence the curricula of dental students.

13. The results of this meta-analysis are of public health importance. They can be used to plan and allocate health care resources.

Lebenslauf

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Selbstständigkeitserklärung

Ich erkläre eidesstattlich, dass mir über die Betreuung der Dissertation mit dem Titel

Treatment need for temporomandibular disorders in the general population - a meta-analysis

hinaus keine weitere Hilfe zuteil geworden ist und ich bei der Abfassung der Arbeit keine anderen, als die in der Dissertation angeführten, Hilfsmittel benutzt habe.
Ich versichere die Dissertation nicht vorher oder zeitgleich bei einer anderen Fakultät eingereicht zu haben.
Ich habe bisher an keiner anderen medizinischen Fakultät ein Gesuch um Zulassung zur Promotion eingereicht.

Halle/Saale, den 27.10.2005

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