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The Association Between Head and Cervical Posture and Temporomandibular Disorders: A Systematic Review

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Aims: *To carry out a systematic review to assess the evidence concerning the association between head and cervical posture and temporomandibular disorders (TMD).* ***Methods:*** *A search of Medline, Pubmed, Embase, Web of Science, Lilacs, and Cochrane Library databases was conducted in all languages with the help of a health sciences librarian. Key words used in the search were* posture, head posture, cervical spine or neck, vertebrae, cervical lordosis, craniomandibular disorders or temporomandibular disorders, temporomandibular disorders, and orofacial pain or facial pain. *Abstracts which appeared to fulfill the initial selection criteria were selected by consensus. The original articles were retrieved and evaluated to ensure they met the inclusion criteria. A methodological checklist was used to evaluate the quality of the selected articles and their references were hand-searched for possible missing articles.* ***Results:*** *Twelve studies met all inclusion criteria and were analyzed in detail for their methodology and information quality. Nine articles that analyzed the association between head posture and TMD included patients with mixed TMD diagnosis; 1 article differentiated among muscular, articular, and mixed symptomatology; and 3 articles analyzed information from patients with only articular problems. Finally, 2 studies evaluated the association between head posture and TMD in patients with muscular TMD. Several methodological defects were noted in the 12 studies.* ***Conclusion:*** *Since most of the studies included in this systematic review were of poor methodological quality, the findings of the studies should be interpreted with caution. The association between intra-articular and muscular TMD and head and cervical posture is still unclear, and better controlled studies with comprehensive TMD diagnoses, greater sample sizes, and objective posture evaluation are necessary.* J OROFAC PAIN 2006;20:9–23

Key words: cervical lordosis, head posture, systematic review, temporomandibular disorders

Temporomandibular disorders (TMD), also referred to as craniomandibular disorders (CMD), consist of a group of pathologies that affect the masticatory muscles, the temporomandibular joints (TMJ), and/or related structures.[1,2] Although universal consensus has not been reached, TMD are considered musculoskeletal disorders of the masticatory system; they are usually manifested by 1 or more of the following signs and symptoms: pain, joint sounds, limitation in jaw movement, muscle tenderness, and joint tenderness.[3] Other symptoms affecting the head and neck region, such as headache, ear-related symptoms, and cervical spine disorders are also sometimes associated with TMD.[4,5]

Epidemiologic studies have reported that 50% to 75% of the general population exhibit at least 1 sign of TMD, whereas about 25% of the population has symptoms of TMD.[4,6] While TMD commonly occur, it is estimated that only one fifth of symptomatic individuals will actually seek evaluation and care.[7]

Head posture has been studied for many years in relation to occlusion,[8–11] to the development and function of the dentofacial structures,[12,13] and to its possible association with TMD.[12,14–29] Changes in head posture have been associated with changes in the stomatognathic system; thus, head posture is presumed to have an influence on the biomechanical behavior of the TMJ and associated structures.[8,9,30–36] Some studies have reported the position of the head affects the resting position of the mandible,[19,30,31,33,34,36–38] increases muscular activity,[39] and alters the internal arrangement of the TMJ.[40] In addition, a close association between head and cervical posture improvement and the relief of symptoms of TMD has been found.[21,23,28]

The association between head and cervical posture and TMD has been debated in the literature. It is supposed that head posture may either cause TMD or predispose individuals to it. Differences of opinion exist in this matter, ie, some studies support the connection between TMD and head and cervical posture,[14,21,25,35,41,42] while others do not.[17,20,27] Therefore, a comprehensive systematic review was necessary to critically analyze the information on the association between TMD and head and cervical posture. It was hoped that the findings of this systematic review would demonstrate whether the evidence available is sufficient to indicate an association between head and cervical posture and intra-articular and muscular TMD and to guide clinicians in planning treatment for patients with TMD. The authors also hoped to identify areas in need of further research.[43,44]

Materials and Methods

Search Strategy

A computerized database search was performed to identify relevant articles. For this review, the search strategy of Dickersin and Lefebvre[45] was used to search the literature for published studies on the association between head and cervical posture and intra-articular and muscular TMD. Studies were searched from 1965 up to and including November 9, 2004, and were obtained through an extensive search of bibliographic databases, including Medline (1966 through week 4 of October 2004), Embase (1988 through week 45 of 2004), Cochrane Library and Best Evidence (1991 through the third quarter of 2004), ISI Web of Science (1965 through November 9, 2004), PubMed (1966 through November 9, 2004), Lilacs (1982 through November 9, 2004), and Medline in Process (1966 through week 1 of November 2004). Key words used in the search were *posture, head posture, cervical spine or neck, vertebrae, cervical lordosis, craniomandibular disorders or temporomandibular disorders, temporomandibular joint disorders,* and *orofacial pain or facial pain*. For details regarding the specific search terms and combinations see Table 1. These terms were selected with the help of a librarian who specializes in health sciences databases.

In addition, the literature search was complemented by manually searching the bibliographies of the identified papers for key authors and journals (*Journal of Orofacial Pain, Cranio, Journal of Oral Rehabilitation, European Journal of Orthodontics,* and *American Journal of Orthodontics and Dentofacial Orthopedics*).

Criteria for Considering Studies for this Review

Types of Studies. Clinical trials (CTs), cohort studies, case-control studies, cross-sectional studies, and case series studies relating the head and cervical posture with TMD were included in this review.[46] Case reports and literature reviews were not included. Since the objective of this systematic review was to analyze information on the association between head and cervical posture and muscular and intra-articular TMD, this systematic review was open to all the studies that analyzed this association.

Types of Participants. Inclusion was restricted to studies with participants who *(1)* were humans between 7 and 60 years of age; *(2)* had been diagnosed with TMD; *(3)* had not previously had TMJ surgery; *(4)* had no history of trauma or fracture in the TMJ or craniomandibular system; *(5)* had no other serious comorbid conditions (eg, cancer, rheumatic disease, neurological problems).

Types of Outcome Measures. The primary outcome of interest was measurement of head and cervical posture through body landmarks, pictures, or teleradiographs in patients with TMD.

Data Extraction

Three independent reviewers screened the abstracts of the publications found in the databases. If the abstracts were not available, only

Table 1 Search Results from Different Databases

Database	Key words	Results	Selected	Included studies	Total selected abstracts (%) (n = 12)*
PubMed	1. Temporomandibular joint disorders 2. Orofacial pain 3. Head posture 4. Nos. 1 OR 2 AND 3 5. Cervical spine OR vertebrae 6. Nos. 1 OR 2 AND 5 7. Cervical posture 8. Nos. 1 AND 5 AND 7 9. Nos. 1 OR 2 AND 7	177	9	5	41.6
Medline	1. Temporomandibular joint disorders 2. Cervical vertebrae 3. Head OR exp cephalometry OR exp posture 4. Nos.1 AND 2 AND 3	74	1	1	8.3
Medline in Process	1. Temporomandibular joint disorders 2. Cervical vertebrae 3. Head OR exp cephalometry OR exp posture 4. Nos. 1 AND 2 AND 3	75	0	0	0
Embase	1. Temporomandibular joint disorders 2. Cervical vertebrae 3. Head OR exp cephalometry OR exp posture 4. Nos. 1 AND 2 AND 3	16	0	0	0
Web of Science	(Temporomandibular disorders OR craniomandibular disorders OR temporomandibular joint disorders OR orofacial pain) AND (cervical spine OR cervical vertebrae OR neck) AND (head posture OR head position OR lordosis OR cervical lordosis) DocType=Article; Language=All languages.	7	3	2	16
Lilacs	1. Temporomandibular 2. Posture 3. No. 1 OR 2	7	4	2	16
Cochrane Library	1. Temporomandibular disorders 2. Cervical spine 3. Posture 4. Lordosis 5. Nos. 1 AND 3 6. Nos. 2 AND 3 7. Nos. 5 AND 6	2	0	0	0
Manual search		4	4	4	33.3
Total			21	14	
Repeated articles			2	2	
Final		284	19	12	

*Percentages do not add up to 100% as the same reference could be found in several databases.

the title of the publication was screened for acceptance. If reviewers felt that the abstract or title was potentially useful, copies of the article were obtained and were analyzed by all reviewers in accordance with the inclusion criteria. A copy of the published article was also obtained in cases where there was no consensus between the reviewers and the publication (evaluated through the abstract) potentially met the inclusion criteria. If there was inadequate information to make a decision, a copy of the published article was obtained as well. The reviewers analyzed all papers initially selected by the abstract or title for the inclusion/exclusion criteria. Each criterion was graded on a yes/no basis. The published paper had to provide enough information to meet the criterion. In order for papers to be evaluated at the next level, the critical appraisal, the paper had to meet all the inclusion criteria. When discrepancies occurred between reviewers in regard to whether a paper met a criterion, the rating forms were compared and the criterion discussed until a consensus was reached.

Critical Appraisal

The next step involved rating the final selected studies to determine internal and external validity

1. Type of study
   - i. Random/cohort (P)
   - ii. Pre-experimental/quasirandom/ cross sectional (M)
   - iii. Case control/case series (F)

2. Confounders
   - i. Natural head posture Y N
   - ii. Standing position technique Y N
   - iii. Without shoes Y N
   - iv. Diagnosis method of TMD Y N
   - v. Differences between groups statistically controlled Y N

   P = 4 or all M = 3 F = 0–2

   (clear diagnosis)*
   (Referential Item)*
   - a. Pure muscular Y N
   - b. Pure articular Y N
   - c. Mixed (muscular and articular) Y N
     - Sounds
     - TMJ pain
     - Muscular pain
     - Limited range of motion
     - Deviation of jaw
     - Diagnosis by image

     (At least 3)

3. Agreement to participate
   - i. > 80% (P)
   - ii. 60%–80% (M)
   - iii. < 60% (F)
   - iv. Cannot tell (F)

4. Sample size
   - i. Appropriate: a priori effect size/power (P)
   - ii. Appropriate, no justification provided (M)
   - iii. Small, justification provided (pilot) (M)
   - iv. Small and no justification provided (F)

5. Data collection methods
   - A. Cephalometry
     - Interrater reliability Y N N/A
     - Intrarater reliability Y N N/A
     - Reliable test inst. Y N N/A
     - Validity test inst. Y N N/A
     - Sensitivity Y N N/A
     - Well described Y N N/A
   - B. Picture (photo)
     - Interrater reliability Y N N/A
     - Intrarater reliability Y N N/A
     - Reliable test inst. Y N N/A
     - Validity test inst. Y N N/A
     - Sensitivity Y N N/A
     - Well described Y N N/A
   - C. Body landmark
     - Interrater reliability Y N N/A
     - Intrarater reliability Y N N/A
     - Reliable test inst. Y N N/A
     - Validity test inst. Y N N/A
     - Sensitivity Y N N/A
     - Well described Y N N/A

Per each outcome: (5–6) = P (3–4) = M (0–2) = F
N/A is not a fail for this category
If some items are classified as N/A, the rating is as follows:
0%–33% of items = F
34%–66% of items = M
67%–100% of items = P

***Scoring for outcome measure (Total):
P = all outcomes received P
M = 1–2 outcomes received score P
F = none of the outcome measures met all criteria
Note: if there is only 1 outcome, this represents the value of this item

6. Blinding
   - Patients Y N N/A
   - Clinicians Y N N/A
   - Assessors Y N N/A

Blinding: P = all, M = 1, F = 0
N/A is not a fail for this category

7. Subjects starting and finishing study
   - i. Immediate
     - > 80% (P)
     - 60%–80% (M)
     - < 60% (F)

8. External validity (generalizability of the study)
   - i. Internal validity of the study Y N
     1. good design (selection bias)
     2. there is clear control of confounders
     3. statistical analysis proper and sample size
     4. consistency in outcomes (reliable, valid, sensitive)

     (all for Y)
   - ii. Results applicable to clinical setting (clinical relevance) Y N
   - iii. Patients similar to clinical setting for demographics, severity, co-morbidity and other prognostic factors? Y N
   - iv. Subjects accounted for at conclusion (> 80%) Y N

   P = all M = 3 F = 0–2

9. Were there statistical tests of the intervention effects?
   - i. Appropriate/suitable statistical tests (80% outcomes) Y N
   - ii. Precision (*P* value) Y N
   - iii. Precision (confidence interval) Y N

   P = all M = 2 F = 0–1

CRITICAL APPRAISAL—Final Decision
REVIEW RATING: (9 Items)

WEAK	MODERATE	STRONG
(Any F)	(No F; < 4 P)	(No F; 4 or more P)

Fig 1 Critical appraisal of included studies. *These items were used only for evaluation of the diagnosis used by the study; they were not used for evaluation of the quality of the study. Adapted from Thomas H, Ciliska D, Dobbins M, Micucci S. A process for systematically reviewing the literature. Providing the research evidence for public health nursing interventions. Worldviews Evidence-Based Nurs 2004;1:3,176–184. Used by permission. (www.hamilton.ca/ephpp)

(Fig 1). This critical appraisal was performed using a tool[47,48] that has been used in previous systematic reviews.[49,50] This tool considered study design, control of confounding variables, subjects' agreement to participate, sample-size calculation, validity, reliability of outcomes measurements, blinding, statistical analysis, and external validity. At this stage, 2 reviewers independently evaluated the studies based on specific predetermined criteria. If there was inadequate information in the published papers to allow evaluation of the criteria, the authors of the studies were contacted, via regular mail and/or e-mail, to clarify study design and specific characteristics of the study, such as sample size, participation agreement, reliability and validity of the outcomes, and statistical analysis. When the information was received, articles were evaluated with the critical appraisal sheet (Fig 1). If the authors did not reply, articles were evaluated with the information available. Each study was then given a grade of pass (P), moderate (M), or fail (F) in each category (9 categories in total). The rating system was based on a similar rating system developed by de Vet et al[43] and used in previous systematic reviews.[49,50] The critical appraisal was independently completed by the 2 reviewers, and their results were compared. Any discrepancies were settled through discussion. Finally, every study was graded as weak, moderate, or strong, depending on how many of the critical appraisal criteria were met (Fig 1). All criteria were weighted equally.

Results

The database search of the literature resulted in a total of 284 articles. Of these 284 articles, 19 were selected as potential studies based on their abstracts. Only 12 studies actually fulfilled the initial criteria. The kappa for agreement among the reviewers in selecting articles after applying inclusion and exclusion criteria was k = 0.91. When discrepancies occurred in the rating of the paper, reasons were identified, and a consensus of the reviewers was reached. Seven studies were rejected after applying the inclusion/exclusion criteria.[18,51–56]

When the database results were compared, PubMed had been used to obtain the greatest percentage of finally selected articles (41.6%), followed by manual search (33.3%), Web of Science (16%), Lilacs (16%), and Medline (8.3%). No articles from Embase, Cochrane Library, or Medline in Process were selected. Some articles were found in more than 1 database.

The primary reasons for exclusion from the study were as follows: *(1)* the measurement of head posture or cervical posture was not clear[18,51,52,56]; *(2)* participant eligibility criteria were not met[55]; *(3)* the diagnosis of TMD was unclear or nonexistent[54]; and *(4)* the study was not experimental research (eg, the "article" was a letter to the editor).[53]

The authors of the 12 articles that met all selection criteria were contacted by the reviewers.[14–16,17,20–22,24–27,29] Only 2 authors[27,29] responded to the mail/e-mail communication and provided further information on the study design and methods. The remaining 10 authors did not provide further information. However, the articles were analyzed based on the available information. At the end of the critical appraisal stage, there was an agreement of k = 0.815 between raters.

Detailed information on the study design, participants, interventions, and outcomes of the finally selected studies, as well as information on the limitations and strengths of the studies, is summarized in Table 2.

Characteristics of the Studies

Of the 12 studies included in the critical review, 11 studies[14-17,20,21,24-27,29] were classified as cross sectional studies, and 1 study[22] was classified as a case series. However, only 2 studies[17,22] used random selection in their experimental process. Nine studies[14,17,21,22,24–27,29] included patients with mixed TMD (muscular and intra-articular), and 1 study[27] differentiated among muscular, intra-articular, and mixed symptomatology. Three articles[16,20,27] analyzed the information from patients with only intra-articular problems (internal derangement of the TMJ and intra-articular TMD evaluated clinically). Finally, 2 studies[15,27] evaluated the association between head posture and TMD only in patients with a muscular diagnosis (masticatory muscle hyperactivity, and muscular TMD respectively).

Methodological Quality of Included Studies

The results of the critical appraisal are presented in Table 3. The primary defects of the studies analyzed by this review were:

- The use of a nonrandomized sample selection process (10 of 12 studies).
- The lack of sufficient information on the methodology used to measure the head and cervical posture (10 of 12 studies).
- The failure to calculate sample size and associ-

Table 2 Characteristics of Studies of Head and Cervical Posture and TMD

Study	Type of study	Methods	Results	Strengths and weaknesses
TMD subclassification into muscular, articular, and mixed diagnoses				
Visscher et al[27] Is there a relationship between head posture and craniomandibular pain?	Descriptive cross-sectional study	• Convenience sample—patients recruited from Clinic Centre for Dentistry Amsterdam (TMD complaints) and from relatives or friends of the staff • Sample size: 85 nonpatients and 106 patients; mean age 34 ± 13.3 y • Analysis of posture (muscular, articular, or mixed) • Head posture evaluated through photographs and radiographs • Patients evaluated using a mirror in natural head posture	• No significant differences in head posture between patients with TMD and healthy subjects • No significant differences in head posture between patients with arthogenousTMD and healthy subjects • No significant differences in head posture between patients with myogenousTMD and healthy subjects	• Good control of confounding variables • Interreliability of measurements good (interclass correlation coefficient 0.83 to 0.96) • Good description of the method of head position • Clinicians blinded with respect to group • Convenience sample used • Sample sizes not balanced for each category of TMD, making comparison difficult • Validity of the head posture evaluation not reported
Mixed TMD diagnosis				
Armijo et al[29] Clinic and teleradiographic alterations in patients with anterior disc displacement with reduction.	Cross-sectional study, descriptive analysis	• Sample size: 25 experimental subjects and 25 control subjects; age range 7 to 48 y for experimental group and 7 to 49 y for control group • Mixed diagnosis of TMD • Even if the predominant sign was disc displacement with reduction, muscular pain or muscular tension could be present† • Self-balance position without any intervention used to take teleradiographs and evaluate head and cervical posture	• Tendency for patients with anterior disc displacement to present a posterior rotation of the head, a diminution in the cranium-atlas space and atlas-axis space, anda decreased cervical lordosis compared with a control group ($P < .05$)†	• Good control of confounding variables • Sample size appropriate (power of 0.94)† • Use of teleradiographs to evaluate head and cervical posture • Evaluators of teleradiographs were blinded • Convenience sample used • Reliability of measurements not reported • Clear control of confounding variables
Darlow et al[17] The relationship of posture to myofascial pain dysfunction syndrome.	Descriptive cross-sectional study	• Sample size: 30 patients with myofascial pain of the masticatory muscles and 30 control patients; mean age 36.9 y for experimental group; 32.3 y for control group • Diagnosis of TMD mixed • Posture evaluated through photographs • Natural balance posture of the head used to take the photographs (most relaxed head posture with the arms relaxed to the side without any external intervention) • Head posture evaluated using landmarks in natural standing posture	• No significant differences in posture found between myofascial pain patients and controls	• Randomization used to select patients from both groups • Clinicians blinded • Sample size was small (power of 0.37)* • Reliability and validity of method of head posture evaluation not reported • Poor description of the outcome measurement methodology (head posture) • Based on methodological assumptions (poor sample size, poor description of head posture, validity and reliability) generalizability of results is not simple

*Statistical power calculated by the authors of this review.
†Information provided by the authors.

Table 2 (continued)

Study	Type of study	Methods	Results	Strengths and weaknesses
Lee et al[24] The relationship between forward head posture and temporomandibular disorders.	Descriptive cross-sectional study	• Sample size: 33 patients with TMD and 33 healthy subjects; age range 13 to 65 y • Diagnosis of TMD mixed • Posture evaluated through photographs • Natural balance posture of the head used to take the photographs (most relaxed head posture with the arms relaxed to the side without any external intervention)	• Head was positioned more forward in patients with TMD than in healthy volunteers • Angle ear-seventh cervical vertebra-horizontal plane smaller in patients with TMD than in control patients, demonstrating that patients with TMD had more forward head position than controls • No organization of patients into subcategories (masticatory muscle pain or articular pain disorders); thus, the conclusions can only be applicable to a group of patients with masticatory muscle pain, TMJ pain, and cervical pain	• Partial control of confounding variables • Appropriate sample size (power of .85)* • Patients blinded to head evaluation • Convenience sample • Randomization not used to select patients • Validity and reliability of method used to measure head posture not reported with respect to group • Clinicians not blinded when analyzing photographs • Paired *t* test used to analyze differences in the variables between the 2 groups; should have used an independent *t* test
Nicolakis et al[25] Relationship between craniomandibular disorders and poor posture.	Descriptive cross-sectional study	• Sample size: 25 patients with TMD (mean age 28.2 y) and 25 control subjects (mean age 28.3 y) • Diagnosis of TMD mixed • Analysis of posture through landmarks in standing position without any external intervention	• Patients with TMD had more postural abnormalities than healthy controls	• Good control of confounding variables • Good reliability of measurements • Clinicians blinded to group allocation • General description of head posture: Deviation of the plumb line anterior to the shoulder considered forward head position • Validity and methodology of head posture evaluation not described • Validity of method of posture evaluation not reported
Huggare and Raustia[21] Head posture and cervico-vertebral and craniofacial morphology in patients with craniomandibular dysfunction.	Cross-sectional study	• Sample size: 16 subjects with TMD and 16 asymptomatic subjects; age range 14 to 44 y for symptomatic subjects and 21 to 40 y for asymptomatic subjects • Patients classified according to Helkimo Index angulations • 56% of patients in the experimental group has severe TMD dysfunction • Analysis of posture through teleradiographs in natural head posture	• Head was more extended in the dysfunction group than in the control group • Extension expressed as significantly more increased craniovertebral and craniocervical angulations.	• Good control of confounding variables • Sample size appropriate (power of 0.95)* • Reliability and validity of method of evaluation of head posture not reported • Clinicians not blinded • Poor description of outcomes (head posture)

*Statistical power calculated by the authors of this review.
†Information provided by the authors.

Table 2 (continued)

Study	Type of study	Methods	Results	Strengths and weaknesses
Sonneson et al[26] Temporomandibular disorders in relation to craniofacial dimensions, head posture and bite force in children selected for orthodontic treatment.	Descriptive case series	• Sample size: 96 children; age range 7 to 13 y • Diagnosis of TMD mixed • Patients classified according to Helkimo Index • Subjects with TMD were compared with subjects with TMD but without having the specific trait of TMD (pseudocontrol group) • Posture evaluated through photographs • Natural head posture with mirror used to take teleradiographs	• Children with clicking and reduced mobility of the joints had marked forward inclination of the upper cervical spine and increased craniocervical angulation (forward head position) compared with children not having these characteristics • Associations between TMD signs and head posture obtained ranged from 0.21 to 0.37, which were low to moderate	• Interreliability of measurements good to perfect (Kappa coefficient) • Partial control of confounding variables • Sample size small by categories (subjects who had each trait of TMD) • Poor description of method of head posture evaluation • Clinicians not blinded to head posture evaluations
Braun[14] Postural differences between asymptomatic men and women and craniofacial pain patients.	Descriptive cross-sectional study	• Sample size: 40 asymptomatic subjects and 9 symptomatic subjects • Mixed diagnosis of TMD (not clearly stated) • Posture evaluated through photographs • Head posture analyzed in natural head position with patient seated in a chair	• Female patients with TMD presented greater forward head position than female healthy controls	• Unbalanced design (different sample sizes) • Low power • Poor control of confounding variables • Symptomatic subjects not representative of the population (9 subjects) • Poor description of methodology • Reliability and validity of method of evaluation of head posture not reported • Clinicians not blinded to group • Statistical analysis questionable
Kritsineli and Shim[22] Malocclusion, body posture, and temporomandibular disorder in children with primary and mixed dentition.	Descriptive case series	• Sample size: 40 children with mixed dentition; age range 7 to 12 y • Subjects randomly selected from large population of children with mixed dentition from the pediatric clinic at Tufts University School of Dental Medicine • Subjects with clicking, and signs of condylar or mandibular displacement selected for further analysis • Posture evaluated using body landmarks; evaluation performed in standing position	• Forward head position significantly associated with clicking, deviation of mouth while opening, and posterior condylar displacement	• Randomization used in subject selection • General description of method of evaluation of head posture (shoulders not in line with ears) • Reliability and validity of head posture not reported • Clinicians not blinded • Statistical analysis unclear • Poor internal and external validity

*Statistical power calculated by the authors of this review.
†Information provided by the authors.

Table 2 (continued)

Study	Type of study	Methods	Results	Strengths and weaknesses
Articular TMD diagnosis				
D'Attilio et al[16] Cervical lordosis angle measured on lateral cephalograms; findings in skeletal class II female subjects with and without TMD: A cross-sectional study.	Cross-sectional study	• Sample size: 50 patients with TMD and 50 healthy patients subjects; age range 25 to 35 y (mean, 29.3 y) • Convenience sample • Articular TMD: Participants with TMD required to have uni- or bilateral TMJ disc displacement • Diagnosis verified by magnetic resonance imaging (MRI) • All control subjects had normal disc position bilaterally evaluated by MRI • Head posture evaluated through teleradiographs taken using a mirror • Patients evaluated in natural head posture	• Subjects having TMD showed significantly lower lordosis angle (CVT/EVT). Lordosis rectified in patients with TMD	• Convenience sample used • Good control of confounding variables • Sample size and power good (80%)* • Reliability of head posture evaluation good • Radiologist who analyzed MRI scans blinded to group classification • MRI classification completely reliable (confirmed after 6 mo)
Hackney et al[20] Relationship between forward head posture and diagnosed internal derangement of the temporomandibular joint.	Descriptive cross-sectional study	• Sample size: 22 patients with internal derangement (19 women and 3 men) and 22 healthy volunteers; range 14 to 68 y for patients (mean, 38.6 y) and 13 to 69 years for the healthy volunteers (mean, 35.4 y) • Convenience sample • Diagnosis of TMD of articular origin: Diagnosis of internal derangement of the TMJ was made by 1 dentist and was based on clinical examination, which was confirmed by MRI in all cases • Head posture evaluated through photographs • Sitting and standing natural head positions were used to take photographs	• No significant differences between patients and control subjects in head posture	• Good control of confounding variables • Small sample size with low power (0.34)* • Validity of method of evaluation of head posture not reported • Clinician who evaluated photographs not blinded • Questionable statistical analysis; paired *t* test used to analyze 2 different groups
Muscular TMD diagnosis				
Chiao et al[15] Relationship between physical global posture and temporomandibular joint dysfunction: Masticatory muscle overactivity.	Cross-sectional study	• Sample size: 53 women; age range 20 to 30 y • Convenience sample • Diagnosis of TMD of muscular origin. • Having pain in at least 1 masticatory muscle on palpation along with parafunctional habits and absence of signs and symptoms of intra-articular pathology was considered "muscular hyperactivity" • Patients with signs and symptoms of intra-articular disorders excluded • Posture evaluated using photographs and landmarks in standing position without any external intervention	• No significant difference in incidence of cervical lordosis between subjects with hyperactivity of the masticatory muscles and normal subjects	• Good control of confounding variables • Convenience sample used • Sample size not appropriate (power of 0.20)* • Use of landmarks to evaluate cervical posture • General description of cervical posture • Reliability and validity of method of evaluation of head posture not reported • Clinicians not blinded

*Statistical power calculated by the authors of this review.
†Information provided by the authors.

Table 3 Methodological Scoring of Included Studies

Study	Score 1	2	3	4	5	6	7	8	9	Total score	Rating
TMD subclassification into muscular, articular, and mixed diagnoses											
Visscher et al[27]	M	P*	P*	F	P	P	P*	M	F	2F, 2M, 5P	Weak
Mixed TMD diagnosis											
Armijo et al[29]	M	P*	P*	P	F	P*	P*	M	P*	1F, 2M, 6P	Weak
Darlow et al[17]	M	P	F	F	F	P	P	M	M	3F, 3M, 3P	Weak
Lee et al[24]	M	P	F	M	F	M	P	F	F	4F, 3M, 2P	Weak
Nicolaskis et al[25]	M	P	F	M	F	P	P	M	P*	2F, 3M, 4P	Weak
Huggare and Raustia[21]	M	P	F	M	F	F	P	F	F	5F, 2M, 2P	Weak
Sonnesen et al[26]	F	M	F	F	P	F	P	F	M	5F, 2M, 2P	Weak
Braun[14]	M	F	F	F	M	F	P	F	F	6F, 2M, 1P	Weak
Kritsineli and Shim[22]	M	F	F	F	F	F	P	F	F	7F, 1M, 1P	Weak
Articular TMD diagnosis											
D'Attilio et al[16]	M	P	F	M	P	P	P	M	M	1F, 4M, 4P	Weak
Hackney et al[20]	M	P	F	F	M	M	P	F	F	4F, 3M, 2P	Weak
Muscular TMD diagnosis											
Chiao et al[15]	M	P	M	F	F	F	P	F	M	4F, 3M, 2P	Weak

*Information provided by authors.
1 = Type of study; 2 = confounders; 3 = agreement to participate; 4 = sample size; 5 = data collection methods; 6 = blinding; 7 = subjects starting and finishing the study; 8 = external validity; 9 = statistical analysis; P = pass; M = moderate; F = fail.

ated power of the studies (12 of 12 studies). Where possible, the authors of this systematic review calculated the power of the study based on the study findings.

- Poor descriptions of outcome measures in terms of validity, reliability, and responsiveness (10 of 12 studies). Furthermore, the authors of the publications did not report intra- and/or inter-rater reliability of the assessors who performed the outcome measurements (where applicable).
- Failure to use independent assessors blinded to group allocation when applicable as well as during measurement analysis (7 of 10 studies).

Head Posture and Mixed TMD

Nine studies[14,17,21,22,24–29] addressed the association between TMD of mixed origin and head and cervical posture. The system of evaluation for TMD was clinical (ie, based on signs and symptoms). The criteria used for the majority of the studies[17,22,24,27,29] were disc derangements evaluated clinically (ie, clicking), associated muscular disorders determined by pain on palpation, reduced range of jaw opening and deviation of the mandible, pain in the TMJ area with mandibular movement, or spontaneous TMJ or muscular pain. Seven of these studies[14,21,22,24–26,29] concluded that an abnormal head and cervical posture was present in patients with TMD, and 2 studies[17,27] found no differences in head posture between patients and healthy controls. For more details, see Table 2.

Head Posture and Intra-articular TMD

Three articles[16,20,27] addressed the association between articular TMD and head and cervical posture. One study[20] used photographs, another[16] used teleradiographs, and the third study[27] used both photographs and teleradiographs to analyze head and cervical posture. According to Hackney et al,[20] who diagnosed the disc displacements through MRI, and Visscher et al,[27] who made a clinical diagnosis of articular TMD, there were no differences in head posture between patients with internal derangement and articular disorders (respectively) and a control group. However, D'Attilio et al[16] found that patients having TMD with disc displacement verified by MRI showed a significantly lower lordosis angle (decreased cervical lordosis) than a control group.

Head Posture and Muscular TMD

Two studies[15,27] investigated the association between head posture and muscular TMD (the latter[27] focused on the association between head posture and cervical lordosis/presence of muscular TMD; the former[15] on hyperactivity of the masticatory muscles). One of the studies[27] used photographs and teleradiographs to evaluate head posture; the other[15] used photographs and landmarks to assess cervical lordosis.

Visscher et al[27] confirmed patient complaints of pain in the area of masseter and/or temporalis muscles by pain in the same area on dynamic/static

test or active movements. They concluded that patients with muscular TMD did not differ significantly from patients without TMD. Muscular hyperactivity in the Chiao et al's study[15] was defined as having pain in at least 1 masticatory muscle on palpation, along with parafunctional habits and absence of signs and symptoms of intra-articular pathology. The conclusions of these authors were contradictory and did not reflect the results. However, when the authors of this current systematic review analyzed results of the Chiao et al's study[15] (comparing graphs and values of each group and making the statistical analysis), cervical lordosis was increased in patients with hyperactivity of masticatory muscles as well as in control subjects.

Discussion

In the present systematic review, few publications were found that addressed muscular and intra-articular TMD and its association with head or cervical posture. Furthermore, few publications met the inclusion criteria for a specific evaluation of the head or cervical posture as well as a clear diagnosis of muscular and intra-articular TMD.

Readers without a sound understanding of the process (including strengths and weaknesses of systematic reviews) are referred to articles about systematic reviews in health sciences[57–60] to fully understand the background assumptions for the present paper.

Head Posture and Mixed TMD

Most studies included in this systematic review considered patients with a mixed TMD diagnosis, ie, patients with a combination of signs and symptoms, and sometimes lacked clear or defined criteria for TMD classification. Braun,[14] for example, stated that TMD diagnosis consisted only of a complaint of jaw pain, jaw dysfunction, daily headaches, or neck pain. Sonnesen et al[26] divided the signs and symptoms of TMD into 65 categories and also classified subjects according to the Helkimo Index.[61] However, the criteria used to define TMD were not clear.

To make clear conclusions regarding head and cervical posture and TMD, more accurate diagnosis and definition of terms are needed. A mixed diagnosis offers only a general statement about this association. Assuming this limitation, the association of mixed TMD with head and cervical posture is still uncertain. When analyzing the information that exists in the literature, one realizes that the quality of the studies available is poor. Most of the studies did not include random sample selection in their process, which could lead to bias. Another factor to consider is study sample size. Four of the studies reviewed[14,17,22,24] had low power and inadequate sample sizes, meaning that internal and external validity are questionable and results cannot be extrapolated to larger populations. Other methodological flaws encountered included incorrect statistical analysis,[14,21,22,24] failure to use a blinded process in the evaluation of outcomes,[14,21,22,24] and lack of information on the validity[14,17,21,22,24–27,29] or reliability[14,17,21,22,24,26,29] of measurements.

Three studies[21,26,29] that used teleradiographs to evaluate head posture found an association between abnormal head and cervical posture and TMD. One study[27] did not find any difference between a group of patients with TMD and a control group.

Sonnesen et al[26] evaluated head posture and compared patients having a specific TMD trait to patients without this trait. Children with clicking TMJ and limited jaw mobility had marked forward inclination of the head. However, the control group was not truly a control group, since control subjects also had TMD (but with a different trait). The sample size was also small (between 6 and 15 patients per comparison), which makes extrapolations difficult because of low statistical power.

Huggare and Raustia[21] found significantly greater craniovertebral and craniocervical angles in a group of patients with TMD compared with control subjects. They reported good power (0.95). However, their statistical analysis was flawed. They did have good control of the confounders and divided patients from healthy subjects, analyzing head and cervical posture through teleradiographs. Armijo et al[29] also used teleradiographs and found differences in cervical lordosis, craniocervical spaces, and craniocervical angulation between patients and healthy controls in a study having good power (0.90) with equal sample sizes and clear control of confounders. Nevertheless, this study's sample selection was not randomized, with no description of validity or reliability of the measurements. On the other hand, Visscher et al[27] used teleradiographs and found no differences between control patients and patients with TMD. Even if the authors had tried to differentiate and classify patients with different diagnoses, sample size comparisons were unequal (40 controls and 13 patients with TMD), which makes comparisons unbalanced. Since patients were also not randomly selected from a population of patients having

TMD, the probability that these subjects represent all patients with TMD is questionable.

Of the studies that used photographs,[14,24,27] 2 found an association between head posture and TMD,[14,24] and 1 study[27] did not support this conclusion. The study by Visscher et al[27] was discussed previously, and the same flaws are applicable. Lee et al[24] found that the head was positioned more forward in patients with TMD compared to controls. Although they based their results on a study with good power (0.85), methodological problems included incorrect statistical analysis, lack of blinding, and failure to report the validity and reliability of the outcomes measures. The results obtained by Braun[14] are also controversial. This author reported that abnormal forward head posture was related with TMD, but methodological flaws in the study make the results questionable.

Finally, of the 3 studies that used landmarks,[17,22,25] 2 studies[22,25] did find an association between head posture and TMD, but the other[17] did not find this association. These 3 studies had similar weaknesses. The description of the method of evaluation of head posture was general, lacking a clear objective measurement. Reliability, according to Nicolakis et al[25] and Darlow et al,[17] was good; however, reliability of the measurements in the Kritsineli and Shim study[22] was not reported. Validity of the head posture measurement was not reported in any of the studies. Therefore, based on the information provided by these 3 studies, results are inconclusive.

Head Posture and Intra-articular TMD

Three studies[16,20,27] analyzed the association between TMD of articular origin and head and cervical posture. One study used teleradiographs,[16] another used photographs,[20] and the third study used both teleradiographs and photographs.[27]

Visscher et al[27] found no differences between patients with arthrogenous TMD and controls for both photographic and teleradiographic methods. However, this article based its conclusions on a comparison between 11 patients and 62 normal controls. As previously discussed, unequal sample size between control and experimental groups, with lack of randomization in the sample selection, adds uncertainty to the conclusions of this study. In addition, the articular diagnosis was based clinically on the presence of more pain on dynamic testing than on static testing, pain on lateral or posterior palpation of the TMJ area, and pain during joint play testing, but disc status was not confirmed by MRI. It is well established that clinical evaluation does not provide a definitive diagnosis of disc status, since approximately one third of asymptomatic volunteers have internal derangement.[62]

Hackney et al[20] found no difference in head posture between patients with TMJ internal derangement and control patients. Although the authors confirmed the clinical diagnosis of internal derangement with MRI, the sample size, power (0.34), statistical analysis, and lack of reporting validity of outcomes measurements raise concerns about this study's conclusions.

Finally, D'Attilio et al[16] found a significantly lower lordosis angle in patients with TMJ internal derangement determined with MRI compared with controls who had normal disc position, determined by MRI as well. This means that patients with TMD had a tendency to have an abnormal cervical curvature. Sample size was sufficient for the study to have a power of 0.80. Moreover, the diagnosis was performed by a radiologist who was blinded to the patient's allocation, and the cephalometric analysis was shown to be reliable, establishing consistent results. However, this study was cross-sectional in nature, and future longitudinal studies are necessary to support the authors' findings.

Head Posture and Muscular TMD

Two studies[15,27] analyzed the association between myogenous TMD and either head posture[27] or cervical lordosis.[15] Neither study found any significant differences in head posture and cervical lordosis between patients and healthy controls. In their comparison of patients with muscular TMD and healthy subjects, Visscher et al[27] had a more balanced subject pool comparison (63 myogenous subjects and 62 healthy subjects for teleradiograph analysis and 75 myogenous subjects and 74 healthy subjects for photograph analysis), which improved the consistency of their results. They found that there were no significant differences in head posture between patients with TMD and healthy controls.

Chiao et al[15] evaluated the cervical lordosis through photographs and landmarks, but the method used to measure the cervical lordosis was imprecise. Moreover, neither the validity nor the reliability of the evaluation for cervical lordosis and for muscular hyperactivity was described. This study had low power (0.20), with a small sample size. The authors did not accurately analyze the results, and conclusions were contradictory to results. For example, it was concluded that patients with hyperactivity had increased cervical lordosis when compared with the control group;

however, the information provided in the graphs and tables did not confirm this finding.

Strengths and Limitations of Study

This systematic review is the first one investigating the association between head and cervical posture and muscular and intra-articular TMD. A comprehensive search was made for all the published research in this area over a wide range of years (1965–2004) and all available languages.

The findings of this review are specific to the association between muscular, intra-articular and mixed TMD and head and cervical posture. The information obtained from this systematic review was limited by the quality of the studies found. Although attempts to complete possible missing information were made, the response rate to requests for information was low. Most of the studies provided a mixed diagnosis with poorly established criteria. Because the objective of this systematic review was to analyze information regarding the association between head and cervical posture with muscular and intra-articular TMD, all studies analyzing this association were included (not only randomized controlled trials). However, the random selection of the sample in these studies was evaluated. Attempts were made to obtain articles not found by database searches; the 12 selected articles included 4 articles obtained by a manual search. The studies identified in this systematic review may not represent all existing research in the area, since unpublished research and literature prior to 1965 were not obtained.

Conclusions

Most of the studies included in this review were of a poor methodological quality; therefore, their findings and conclusions must be interpreted with caution. Based on the findings, it is not clear that head and cervical posture are associated with intra-articular and muscular TMD. In the absence of the highest level of evidence, clinicians have to make decisions based on lower levels of evidence.

More methodologically sound research is necessary. It is recommended that investigations of the association between TMD and head and cervical posture provide a clear diagnosis of the TMD condition in question, including intra-articular and muscular TMD. Trials should be large enough to be clinically meaningful, adequately powered, and include valid and reliable outcome measures. Furthermore, attempts should be made to blind assessors performing outcome measures and where possible, to blind the participants as well. Researchers should also follow the guidelines of the CONSORT[63] statement when designing their study and when writing the methods and results sections of their publications.

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