Relationship Between Overbite/Overjet and Clicking or Crepitus of the Temporomandibular Joint

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Aims: *Since occlusal variables such as overbite and overjet have been thought to be associated with temporomandibular disorders (TMD), and joint sounds are some of the most prevalent signs of TMD, the aim of this study was to determine whether overbite and overjet are risk factors for temporomandibular joint (TMJ) sounds.* ***Methods:*** *A population-based cross-sectional study of 3,033 subjects (age range, 10 to 75 years; 53% female) was conducted in Germany. Overbite/overjet, reproducible reciprocal clicking (RRC) during open-close jaw movements that did not occur in the protrusive jaw position, and joint crepitus were assessed according to the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD).* ***Results:*** *When age and gender were controlled for, high or low values of overbite and overjet were not associated with a greater risk of RRC and crepitus as compared to a reference category of a normal overbite and overjet of 2 to 3 mm (multiple logistic regression; odds ratios 0.7 to 1.3;* P *> .05 for all).* ***Conclusion:*** *This study showed that higher or lower overbite or overjet jaw relationships, even extreme values, are not risk factors for TMJ sounds as assessed by clinical examination.* J OROFAC PAIN 2005;19:218–225

Key words: crepitus, disc displacement, overbite, overjet, temporomandibular disorders

Pain in the face, jaw, or temple is the most important symptom of temporomandibular disorders (TMD). However, according to a systematic review of large surveys (≥ 600, both genders included, age range ≥ 40 years),[1] temporomandibular joint (TMJ) sounds are the most frequently reported symptoms of TMD, with a median prevalence of 11.6%; the most frequent clinical TMD signs were clicking (median prevalence of 26.6%) and crepitus (median prevalence 21% if assessed by stethoscope, 4% if assessed without a stethoscope). In the general population, people report that their joint noises influence their oral health-related quality of life.[2]

In clinical TMD patient populations, TMD diagnoses involving joint noises (ie, disc displacement with and without reduction, osteoarthrosis/-itis) are prevalent.[3,4] Joint noises have been found to occur significantly more often in TMD pain patients than in controls,[5–8] and sounds are associated with pain as well as with limited mouth opening.[9] These associations between joint sounds and other TMD symptoms are of substantial clinical relevance, because patients are often treated because of clicking noises in the TMJ,[10] and joint noises are thought to be risk factors for more severe TMD.[11]

Although the importance of joint noises is considerable, as characterized by their prevalence and their influence on oral health–related quality of life, on use of health care resources, and possibly, on the occurrence of more severe TMD, etiologic factors for the various diagnostic TMD subtypes are largely unknown.[12,13] Knowledge about potential risk factors for TMD that are both prevalent and modifiable would be of importance for public health. Recently, the authors have shown that there is no relationship between overbite/overjet and TMD as perceived by the subject (self-report of TMD pain, limited mouth opening, and joint noises).[14] However, that previous study only used self-report measures of joint noises, and hence, may not have adequately assessed the risk of overjet and overbite for TMD. It has previously been shown that there is only a weak correlation between reported and clinically assessed TMD signs and symptoms.[15] Therefore, it would be useful to explore the influence of risk factors of importance to public health, such as overbite and overjet, not only on self-reported TMD, but also on an “objective” TMD sign—the presence or absence of joint sounds as determined by standardized clinical examination utilizing manual palpation.

Based on the hypothesis that malocclusion may cause derangements of the TMJ, the aim of this population-based cross-sectional study was to determine the relationship between overbite/overjet and TMJ sounds assessed in the clinical examination.

Materials and Methods

Subjects

Subjects (n = 3,033) came from 2 population-based cross-sectional studies in Germany. Children and adolescents (n = 1,011) came from a regional survey in Halle/Saale of 1,190 individuals aged 10 to 18 years (85% response rate). They were sampled with a 2-stage cluster technique from a register containing all children and adolescents in Halle/Saale required to attend school between the ages of 10 to 18 years. The sample was representative for 24,129 children and adolescents attending general schools in Halle/Saale in 1999 (specialty schools were excluded from the sampling). Adult subjects (n = 655) and senior subjects (n = 1,367) were identified as all subjects who were examined clinically in a nationwide oral health survey (Dritte Deutsche Mundgesundheitsstudie [DMS] III) of 1,179 individuals aged 35 to 44 years (55.6% response) and 2,424 individuals aged 65 to 74 years (56.4% response).[16] A multistage stratified sampling technique was used to select DMS III study subjects from population registries of the local government offices who were then examined at 90 different sites across Germany. Further details of the sampling strategy have previously been published.[16,17] This sample was representative for subjects with German citizenship who were born between January 1, 1953 and December 31, 1962 (adult subjects) and between January 1, 1923 and December 31, 1932 (senior subjects).

The study protocol for the study of children and adolescents was reviewed and approved by the ethics committee of the Martin Luther University Halle-Wittenberg, the local education authority, and the parents’ council. The study protocol of the DMS III was reviewed and approved by an institutional review board consisting of members of Bundeszahnärztekammer (German Dental Association) and the Kassenzahnärztliche Bundesvereinigung (National Association of Statutory Health Insurance Dentists). All study subjects gave their informed consent.

Outcome and Exposure Variables

The outcomes were joint noises defined according to the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD)[18] and assessed by digital palpation in 3 categories:

1. Reproducible reciprocal clicking (RRC): Clicking on both vertical opening and closing that occurs at a point at least 5 mm greater in interincisal distance on opening than on closing and does not occur in protrusive jaw opening
2. Crepitus: A grinding sound that is continuous over a longer period of jaw movement
3. No joint noise: No joint noises, and joint noises not fulfilling one of the first 2 definitions

Five dental practitioners took part in both studies. These clinicians were trained by 1 of the authors (MTJ). The interobserver agreement for detecting joint sounds in young subjects and adults showed overall agreement across examiners of 78%. Kappa values for every possible pair of examiners ranged between 0.52 and 0.86 (median, 0.75).[19] Agreement for assessment of sounds in seniors was similar (median kappa 0.65).[20]

The exposure variables “overbite” and “overjet” were defined and measured according to the

RDC/TMD[18] and the manual of the DMS III.[20] Reliability was assessed for overjet and overbite by the intraclass correlation coefficient (ICC). Excellent interobserver reliability was demonstrated (ICC of 0.95 for overjet and 0.92 for overbite in children and adolescents; 0.94 for overjet and 0.89 for overbite in adults and seniors).[14,16]

Statistical Analysis

Sample characteristics (frequencies and means) were computed for joint sounds, overbite, overjet, age, and gender for the 3 age groups (children/adolescents, adults, and seniors) and 5 joint sound categories: no joint noises, unilateral RRC, bilateral RRC, unilateral crepitus, and bilateral crepitus (Table 1). For all outcome categories, an overall χ^2 test of differences between age groups was performed followed by pairwise χ^2 tests when statistically significant results were observed in the omnibus test. Holm's multiple comparison procedure was used to adjust the level of statistical significance for multiple testing.[21] Overbite and overjet differences between the various outcome categories or age groups were compared using 1-way analysis of variance (ANOVA). Significant results were followed by pairwise *t* tests; the level regarded to be statistically significant was determined by Holm's multiple comparison procedure.

The 9 different possible combinations of joint sounds within each subject were tabulated. Given that there were no subjects with RRC in 1 joint and crepitus in the other, the joint-sound combinations were collapsed into 3 subject-level categories (no sounds in either joint, unilateral or bilateral RRC, and unilateral or bilateral crepitus) to assess the association with overbite and overjet. Overbite and overjet were grouped into 5 categories (≤ –1 mm, 0 to 1 mm, 2 to 3 mm, 4 to 5 mm, and ≥ 6 mm) to permit detection of a nonlinear association (eg, a higher frequency of joint sounds for low or high values of overbite and overjet). Frequencies of overbite and overjet were computed separately for subjects with and without joint sounds, and the χ^2 test was used to test for associations.

Multinomial logistic regression analysis was used to test for an association between joint sounds and overjet or overbite after controlling for the influence of age and gender. The dependent variable in these analyses was joint sound category (no sounds in either joint, unilateral or bilateral RRC, or unilateral or bilateral crepitus). Odds ratios and 95% confidence intervals (CIs) were computed for RRC and crepitus relative to no sounds for the 5 categories of overbite and overjet. A likelihood ratio test was used to test whether overbite or overjet contributed any statistically significant information beyond the influence of gender and age group. A goodness-of-fit test was used to assess model fit.[22] Additionally, a sensitivity analysis was performed to check whether results would change if the outcome of the analysis was an RDC/TMD group IIa diagnosis (disc displacement with reduction) instead of RRC.

Statistical analyses were carried out using the statistical package STATA (Release 7.0 StataCorp, 1999, Stata Statistical Software), and a probability level of .05 was considered statistically significant.

Results

Response

The study outcome, joint sounds, could be assessed in 3,024 subjects (99.7%); sounds could not be obtained from 3 (0.5%) adults and 6 (0.4%) seniors. The exposure variables, overbite and overjet, were obtained on 2,975 subjects (98.1%), but not on 6 adult subjects (0.9%) and 52 senior subjects (3.8%).

Outcome and Exposure Variables in the Study Population

Joint sounds, according to the RDC/TMD definitions, were found in 263 subjects (8.7%). Unilateral RRC was found in 92 subjects (3%). Ninety-two subjects (3%) had bilateral RRC, 48 (1.6%) had unilateral crepitus, and 31 (1%) had bilateral crepitus.

The frequency of joint sounds varied by age group (χ^2(df 2) = 32.3, $P < .001$). Adult subjects (12.1%) and seniors (9.9%) presented joint sounds more often than children and adolescents (4.8%; Holm's, $P < .05$). The prevalence of unilateral RRC was almost the same within the 3 age groups (about 3%), whereas the prevalence of bilateral RRC changed with age (χ^2 (df 2) = 30.3, $P < .001$). The senior and adult groups had the highest prevalences of bilateral RRC (5.7% and 3.3%, respectively); the lowest prevalence was observed in children and adolescents (1.0%; Holm's, $P < .05$). Crepitus in children and adolescents was rare (0.5%) and only a unilateral phenomenon. The prevalence of unilateral crepitus was similar in adults and seniors (2.1%), but bilateral crepitus was more prevalent in seniors compared to adults (1.9% versus 0.8%; x^2 (df 1) = 3.5, $P = .06$). All together, female subjects presented joint sounds

Table 1 Sample Characteristics by TMJ Sound Status in the 3 Age Groups

Demographic and exposure variables	No sounds	Unilateral RRC	Bilateral RRC	Unilateral crepitus	Bilateral crepitus
Children/adolescents*					
No. with feature (%)	963 (95.2)	33 (3.3)	10 (1.0)	5 (0.5)	0
Mean age in years (SD)	13.1 (2.0)	14.4 (1.6)	13.9 (2.1)	13.8 (2.8)	0
No. female gender (%)	497 (52)	16 (48)	5 (50)	5 (100)	0
Mean overbite in mm (SD)	3.2 (1.9)	2.9 (1.8)	3.4 (1.7)	3.4 (2.2)	0
Mean overjet in mm (SD)	3.0 (1.9)	2.8 (1.8)	3.2 (1.9)	3.4 (0.5)	0
Adults†					
No. with feature (%)	573 (87.9)	23 (3.5)	37 (5.7)	14 (2.1)	5 (0.8)
Mean age in years (SD)	39.6 (2.9)	40.2 (2.6)	39.3 (2.7)	38.8 (3.1)	39.2 (3.8)
No. female gender (%)	287 (50.1)	16 (69.6)	25 (67.6)	11 (78.6)	3 (60.0)
Mean overbite in mm (SD)	3.8 (2.3)	4.9 (2.8)	3.5 (2.3)	4.5 (2.3)	3.6 (3.4)
Mean overjet in mm (SD)	3.0 (2.1)	3.3 (2.7)	3.0 (2.1)	3.1 (1.5)	4.4 (4.6)
Seniors‡					
No. with feature (%)	1225 (90.1)	36 (2.6)	45 (3.3)	29 (2.1)	26 (1.9)
Mean age in years (SD)	69.2 (2.8)	68.8 (2.8)	70.0 (2.8)	70.3 (2.5)	68.8 (2.7)
No. female gender (%)	667 (54.4)	22 (61.1)	28 (62.2)	19 (65.5)	17 (65.4)
Mean overbite in mm (SD)	2.7 (2.2)	2.9 (2.0)	2.5 (1.6)	3.0 (2.4)	2.7 (1.8)
Mean overjet in mm (SD)	2.4 (2.2)	2.4 (1.8)	2.4 (1.6)	2.3 (2.0)	2.9 (2.3)

* n = 1,011; age range 10 to 18 years.
† n = 652; age range 35 to 44 years.
‡ n = 1,361; age range 65 to 74 years.

significantly more often (n = 167, 10.3%) than males (n = 96, 6.8%; x^2 (df 1) = 11.6, $P < .001$). The female predominance could be found in nearly all sound categories.

One-way ANOVA did not show any significant differences of overbite and overjet among sound categories (overbite, $P = .41$; overjet, $P = .85$). In contrast, significant differences were found among the age groups (overbite, $P < .001$; overjet, $P < .001$). Significant differences for overbite were found between all age groups (Holm's, $P < .05$). Adults had the largest average overbite (3.8 mm), followed by children/adolescents (3.2 mm) and seniors (2.7 mm). Adults and children/adolescents had larger overjets than seniors (3.0 mm and 2.4 mm for adults and children/adolescents versus 2.4 mm for seniors; Holm's $P < .05$). Means for overbite and overjet were only slightly different for male subjects as compared to female subjects (data not presented).

Relationship Between Sounds in Right and Left TMJs

The prevalence of sounds was nearly equal in both TMJs (right TMJ: n = 194, 6.4%; left TMJ: n = 192, 6.3%). The comparison of joint sounds in the right and left TMJs showed that for subjects with unilateral RRC, crepitus was not present on the contralateral joint (Table 2). The 9 joint sound combinations in Table 2 were therefore reduced to 3 categories at the subject level: subjects with no sounds (n = 2,761), those with unilateral or bilateral RRC (n = 184), and with unilateral or bilateral crepitus (n = 79).

Joint Sounds in the Overbite/Overjet Categories

Tables 3 and 4 show joint sound categorization at the subject level. The prevalences of subjects with RRC and crepitus within the overbite and overjet categories are shown in Tables 3 and 4. The results are presented for all age groups combined because there were no significant associations between joint noises and overbite or overjet within each age group (all P values > .05; χ^2 test). The frequencies of subjects in the overbite and overjet categories were similar in each joint sound category, which indicates that there was no association between joint sounds and overbite ($P = .34$) (Table 3) or overjet ($P = .68$) (Table 4). Also, there were no associations of overbite and overjet with RRC and crepitus in females or males (all P values > .05; χ^2 test).

Table 2 Relationship Between the Joint Sounds in the 2 TMJs

		Left TMJs		
		No sounds (n = 2,832)	RRC (n = 143)	Crepitus (n = 49)
Right TMJs		n (%)	n (%)	n (%)
No sounds	(n = 2,830)	2,761 (91.3)	51 (1.7)	18 (0.6)
RRC	(n = 133)	41 (1.4)	92 (3.1)	0
Crepitus	(n = 61)	30 (1.0)	0	31 (1.0)

Table 3 Prevalence of RRC and Crepitus (Unilateral or Bilateral) by Various Overbite Categories

		Joint sounds		
		No sounds (n = 2,715)	RRC (n = 181)	Crepitus (n = 79)
Overbite	n	n (%)	n (%)	n (%)
–8 to –1 mm	38	37 (2)	1 (1)	0
0 to 1 mm	536	496 (18)	26 (14)	14 (18)
2 to 3 mm	1324	1194 (44)	92 (51)	38 (48)
4 to 5 mm	679	631 (23)	33 (18)	15 (19)
6 to 15 mm	398	357 (13)	29 (16)	12 (15)

n = 2,975, χ^2 (df 8) = 9.0, P = .34.

Table 4 Prevalence of RRC and Crepitus (Unilateral or Bilateral) by Various Overjet Categories

		Joint sounds		
		No sounds (n = 2,715)	RRC (n = 181)	Crepitus (n = 79)
Overjet	n	n (%)	n (%)	n (%)
–7 to –1 mm	84	80 (3)	3 (2)	1 (1)
0 to 1 mm	564	515 (19)	32 (18)	17 (22)
2 to 3 mm	1471	1331 (49)	101 (56)	39 (49)
4 to 5 mm	607	563 (21)	30 (16)	14 (18)
6 to 14 mm	249	226 (8)	15 (8)	8 (10)

n = 2,975, χ^2 (df 8) = 5.7, P = .68.

Table 5 Odds Ratio for Unilateral and Bilateral RRC or Crepitus by Overbite and Overjet (Adjusted for Age and Gender)

Exposure category	Odds ratio (95%CI)	
	RRC	Crepitus
Overbite		
–8 to 1 mm*	0.7 (0.4–1.1)	0.8 (0.4–1.4)
2 to 3 mm†	1	1
4 to 5 mm	0.7 (0.4–1.0)	0.8 (0.4–1.5)
6 to 15 mm	1.0 (0.6–1.6)	1.2 (0.6–2.3)
Overjet		
–7 to 1 mm*	0.8 (0.5–1.2)	0.9 (0.5–1.7)
2 to 3 mm†	1	1
4 to 5 mm	0.7 (0.5–1.1)	0.9 (0.5–1.7)
6 to14 mm	0.9 (0.5–1.5)	1.3 (0.6–2.8)

*Overbite and overjet categories "≤ – 1mm" and "0 to 1 mm") combined because of small number of subjects with negative values.
†Reference category.

Overbite and Overjet—Joint Sounds Relationship in the Multivariable Statistical Model

Multinomial logistic regression analysis was used to assess for associations between the overbite categories and joint noises. After age and gender were controlled for, none of the overbite categories significantly differed compared to the "normal" reference category of 2 to 3 mm, as indicated by findings that all confidence intervals included the null value of "1" (Table 5). All calculated odds ratios were between 0.7 and 1.3. Odds ratios of this small magnitude would not be considered clinically relevant. The likelihood ratio test indicated that overbite did not contribute any statistically significant information beyond the age and gender influence on joint noises (P = .26). The goodness-of-fit test showed no evidence of lack of fit.

The results for overjet were similar to those for overbite, and showed no associations between overjet and joint noises (Table 5).

Sensitivity Analysis

Sixteen percent (n = 479) of the sample presented with an RDC/TMD group IIa diagnosis (disc displacement with reduction) in 1 or both TMJs. The use of this diagnostic category instead of RRC did not substantially change the magnitude of the odds ratios nor their statistical significance in the multivariable analyses.

Discussion

This population-based study did not find a relationship between overbite and overjet and objective TMD symptoms—clicking and crepitation sounds in the TMJ. Even extreme values of overbite or overjet were not shown to be significant risk factors for these conditions. The relatively narrow confidence intervals for the associations in the present study preclude the existence of associations of moderate to large magnitudes.

This study has several strengths. First, the study involved a large number of subjects from a population-based sample with a wide age range (10 to 75 years), which decreased the potential for selection bias of subjects and enabled wider generalization of the results. Second, examiners were trained and calibrated to assess both the overbite and overjet measurements and joint sounds, and sufficiently high values of reliability were shown for both. Third, the influence of potentially confounding variables age and gender were both controlled in the analyses and explored by stratified analyses. Other variables, such as orthodontic treatment, were not included in the model as confounders, because they were not associated with the outcome in previous analyses, which is an essential requirement for confounding. Only a few previous studies about the relationship between overbite and overjet and joint sounds controlled all of the aforementioned influential factors in a multivariate fashion.[23,24] Clear definition of cases and consideration of age and gender influence should be minimum requirements in TMD studies.[25] Fourth, the present study separated clicking from crepitus as the outcome and excluded less reliable joint sounds that are not reciprocal or reproducible.

There are several potential limitations of the present study. First, the use of TMD symptoms instead of diagnostic categorization for all outcomes or the failure to consider interactions in the statistical analysis might have reduced the ability to detect exposure-outcome associations. However, the sensitivity analysis did not show different results when the RDC/TMD group IIa diagnosis (disc displacement with reduction) was used instead of RRC. Because of the rarity of diagnoses such as osteoarthrosis or disc displacement without reduction in the general population,[26] it is nearly impossible to investigate these outcomes in population-based research. Proxies for disease-based joint outcomes have to be used to achieve sufficient statistical power in risk factor research. Second, the study sample is not ideal because it consists of 2 separate samples. The sample of children and adolescents was recruited from a narrow geographical area in Germany, whereas the adults and seniors came from a nationwide study. The 2 samples showed different response rates. The whole sample included 3 age groups that covered the age range from 10 to 75 years but only had 3 narrow age brackets. These limitations may restrict the generalization of the results to the entire German population. Third, because the study was cross-sectional, and subjects were assessed at only 1 point in time, it is not possible to know if the exposure (overbite/overjet) preceded the outcome (TMJ sounds). Fourth, palpation was used to assess joint sounds, rather than imaging or auscultation. It could be argued that palpation is an inadequate outcome measure. Other, more sensitive methods are available for measuring the outcome (TMJ internal derangements). Technical devices, such as stethoscopes, can help to detect more clicking (and crepitation) sounds in the TMJ through auscultation than palpation (73% vs 12%, respectively).[27] However, such high levels of "derangement" from auscultation are difficult to interpret. Even with an audiovisual system for the assessment of TMJ sounds, malocclusion was not a significant factor in contribution to TMJ sounds.[28] Imaging techniques for the TMJ, such as magnetic resonance imaging (MRI), could also be used for evaluating soft- and hard-tissue components of the TMJ,[29] but these methods are expensive and time-consuming and therefore are not feasible for studies involving large samples.[13]

The authors acknowledge the limitations of using only clinical criteria to define the outcome. Clinical examination of the TMJ is not free of misclassification error.[30] However, the authors do not believe that misclassification of TMJ sounds was dependent on overbite and overjet status (differential misclassification). If such misclassification had occurred, it would have jeopardized the finding of no association. Furthermore, auscultation, electronic devices, and MRI are not currently required as reference standards in making a group II joint diagnosis using the widely accepted RDC/TMD. Instead, the findings of the present study can be generalized to subjects with disc displacement with reduction, because clicking, as defined in this study (RRC), is the main criterion for the diagnosis "disc displacement with reduction" in the RDC/TMD. The validity of this diagnosis is supported by evidence that clicking is a relatively stable phenomenon over a short interval[31] and 1 of the strongest clinical predictors for disc displacement, as verified with MRI.[32] In a review of the literature, Tenenbaum and coworkers concluded that the use of palpation and sense of hearing without the aid of a highly sensitive amplification device for the assessment of disc displacement is regarded as sufficient.[13] Thus, the finding of no association between overbite/overjet and RRC is comparable with previous clinic-based studies using the diagnostic category disc displacement with reduction.[23,33,34]

The findings of the present study can be generalized to subjects with osteoarthrosis as well, since crepitus as assessed in this study is a major accepted criterion of osteoarthrosis, as defined by the RDC/TMD. It has been previously noted that crepitus is a reliable sign for structural changes of the TMJ,[35] which supports the validity of this diagnosis. However, due to different case definitions, the authors' research on the association between overbite/overjet and crepitus cannot be compared with clinic-based studies using imaging procedures to define osteoarthrosis.[23,33,34] Other diagnoses such as disc displacement without reduction were extremely rare in our population sample as well as in patient populations[3,4] and therefore were not considered in the analyses. The major advantage of clinic-based research is that rare joint diagnoses can be studied.

Previous findings on this subject indicate that the relationship between overbite/overjet and joint sounds has not been consistent across different types of TMD measures and should therefore not be overstated.[36] Given the available scientific literature, no specific association between joint sounds and overbite and overjet values could be found. It is of particular importance that various studies using different research designs come to similar conclusions. Clinic-based and population-based research are complementary tools with varying advantages and disadvantages in regard to investigating the relationship between overbite and overjet and TMJ pathology. Clinic-based studies have the advantage of including cases, but population-based studies have the advantage of including appropriate control subjects.[37]

Conclusions

The results of this study support the view that wide ranges of overbite or overjet are compatible with a normal function of the TMJ. There was no higher risk for RRC or crepitus even in subjects with extreme overbite or overjet values. Hence, attempting to treat or prevent derangements of the TMJ that appear as sounds by creating "more normal" values of overbite or overjet with orthodontic treatment during growth or with dental or surgical treatment in adults is not supported by this study.

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