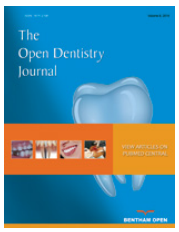

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RESEARCH ARTICLE

The Association between Occlusal Features and Temporomandibular Disorders in Northern Jordan: A Cross-sectional Study

Mohammad S. Alrashdan[1,*], Ashraf Shaweesh[1,2], Abeer A. Khasawneh[1] and Mohamed H. Sannoh[1]

[1]*Department of Oral Medicine and Oral Surgery, Faculty of Dentistry, Jordan University of Science and Technology, Irbid, Jordan*
[2]*School of Dentistry and Health Sciences, Charles Sturt University Wagga Wagga NSW, Australia*

Abstract:

Objective:

To evaluate the possible correlation between basic occlusal features and the outcomes of the Diagnostic Criteria for Temporomandibular Disorders (DC/TMD) Axis I.

Materials and Methods:

A convenient sample of Northern Jordanians was used in the study. Participants were examined in accordance with DC/TMD protocol. Nine occlusal features represented the independent variables; overjet, overbite, midline deviation, pain-free opening, maximum assisted opening, maximum unassisted opening, lateral excursions and protrusion, in addition to the opening pattern (classified as straight, corrected deviation and uncorrected deviation). DC/TMD diagnostic outcomes and their associated features represented the dependent variables, namely, pain-related TMD, Intra-articular Disorders (IAD), Degenerative Joint Disease (DJD), joint sounds (clicking and crepitus), joint locking and headache attributed to TMD. Binary logistic regression, multinomial logistic regression and Chi-square tests were used for statistical analyses.

Results:

A total of 400 participants represented the study population (mean age = 32.3±12.4 years, males=48%, females=52%). 71 subjects (18%) were diagnosed with pain-related TMD, 52 (13%) with IAD, 6 (1.5%) with DJD and 38 (10%) with headache due to TMD. Gender had a significant correlation with pain-related TMD (p= 0.014, OR= 2.16). Maximum pain free opening had a significant inverse relationship with pain related TMD (p= 0.013, OR=0.94), while midline deviation and corrected deviation mouth opening pattern had a significant correlation with IAD (p= 0.04,0.02, OR= 1.30,2.74, respectively). Overbite, midline deviation and pain free opening were significantly associated with unilateral open/close clicking (p= 0.04,0.05,0.03, OR= 0.77, 1.31, 0.94, respectively).

Conclusion:

There is a minimal clinical significance of the correlation between dental occlusion and TMD.

Keywords: Dental occlusion, Diagnostic criteria, Temporomandibular disorders, Temporomandibular joint, Degenerative joint disease, Intra-articular disorders.

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1. INTRODUCTION

Temporomandibular Disorders (TMD) represent a common clinical presentation involving the muscles of mastication, the Temporomandibular Joint (TMJ), or associated orofacial structures [1]. Classic features of TMD include regional pain in the masticatory apparatus, limitations in jaw movements and noises from TMJs during jaw activity [2, 3].

* Address correspondence to this author at the Department of Oral Medicine and Oral Surgery, Faculty of Dentistry, Jordan University of Science and Technology, P. O. Box 3030, Irbid 22110, Jordan; Tel:+ 962 (0) 2 7201000; Fax: + 962 (0) 2 7095123; E-mail: msalrashdan3@just.edu.jo

TMD is also known to be associated with generalized musculoskeletal disorders leading to impaired general health of patients or even somatization, anxiety and depression [1, 3]. There is, generally, an agreement in the literature that TMD is common, with prevalence rates in the population ranging between 10-15% for adults and 4-7% for adolescents [3]. Some reports suggested that TMD prevalence may even reach up to 27% in some populations [4, 5]. Annual incidence of first-onset painful TMD from a large prospective study (OPERA) shows rates of 3-4% [6].

It is currently accepted that TMD has a complex,

multifactorial and biopsychosocial aetiologic background relating to both genotype and phenotype, while one of the classic culprits in this context has always been dental occlusion [2]. Numerous studies investigated such a potential association with a general recent tendency to refute such a relationship between TMD and dental occlusion [3, 7 - 10].

A recent systematic review concluded that a disease-specific association between dental occlusion and TMD is lacking and that even a relationship in the opposite direction (in which TMD may lead to changes in occlusal features) is plausible [7]. The robust evidence from the literature on the high efficacy of a conservative approach in TMD management as well as the importance of psychosocial, rather than dental, factors in TMD patients also favors a neutral role of dental occlusion in TMD [2, 3, 11, 12]. Furthermore, several criticisms to the studies that linked TMD to occlusal factors were highlighted, and these include; insufficient and biased sample selection, poor consideration of confounders and the use of non-validated or reproducible indices [9].

The available literature shows that the correlation between dental occlusion and TMD has not been exclusively studied in Middle Eastern populations. Therefore, this study was designed to evaluate the possible correlation between basic occlusal features and the TMD diagnostic outcomes according to the diagnostic criteria of TMD (DC/TMD) Axis I protocol in a Jordanian population.

2. MATERIALS AND METHODS

This study was approved by the institutional review board (IRB) at Jordan University of Science and Technology (approval ID: 337/2016). Participants were examined at the oral medicine and the otorhinolaryngology departments at a major hospital in Northern Jordan; King Abdulla University Hospital at Jordan University of Science and Technology.

Inclusion and exclusion criteria were based on previously conducted studies in the same setting [4]. In brief, participants had to be at least 18 years old, living in Northern Jordan, fully dentate and not wearing removable partial or complete dentures and not having odontogenic pain complaint at the time of examination (as this could mask TMD or other orofacial pain) or a recent history of trauma or surgery to the maxillofacial structures. Participants also had to be free from cognitive or intellectual disabilities, or significant facial deformities or dental anomalies.

A convenient sample of 400 participants was enrolled into the study. The sample size was deemed satisfactory using the G*Power 3.1.9.2 software (Heinrich-Heine-University, Düsseldorf, Germany). Intra-examiner reliability of the Axis I DC/TMD diagnostic outcomes was determined by evaluation of 50 duplicate examinations by the first author, and Kappa was found adequate ($\kappa = 0.83$).

All participants received written and verbal information about the nature of the study and written consent was obtained from all subjects, prior to examination. The study adhered to the guidelines of the Declaration of Helsinki and the STROBE statement (STrengthening the Reporting of OBservational studies in Epidemiology) [13]. The DC/TMD protocol was used for the examination and diagnosis of all subjects as previously described [14]. Importantly, symptoms suggestive of TMD had to be present for at least 6 months to ensure chronicity of TMD when present. Nine occlusal features were measured in mm and represented the independent variables; overjet, overbite, midline deviation, pain-free opening, maximum assisted opening, maximum unassisted opening, lateral excursions and protrusion, in addition to the opening pattern (classified as straight, corrected deviation and uncorrected deviation). DC/TMD diagnostic outcomes and their associated features represented the dependent variables, namely, pain-related TMD, Intra-articular Disorders (IAD), Degenerative Joint Disease (DJD), joint sounds (clicking and crepitus), joint locking and headache attributed to TMD. To facilitate comparisons, the age variable was subdivided into four categories; group 1: growing phase, group 2: third decade, group 3: fourth and fifth decades and group 4: sixth decade onwards.

Data analysis was performed via SPSS computer software (Statistical Package for the Social Sciences, v24.0; IBM, Armonk, NY, USA). Chi-square tests of association, binary logistic regression and multinomial logistic regression tests were run to identify the possible relationship between the independent and dependent variables in this research. The statistical significance was set at probability values of $P \leq 0.05$ and a 95% confidence interval.

3. RESULTS

A total of 400 participants were examined in accordance with the DC/TMD protocol (males= 191(48%), females=209(52%)). Their demographics, joint examination results, occlusal and mandibular movements as well as their TMD features are shown in Tables **1** and **2**.

Table 1. Demographics and distribution of joint sounds and locking among different temporomandibular disorders (TMD) subgroups.

Variable \ Diagnosis		Pain-related TMD	Intra-articular Disorders (IAD)	Headache Attributed to TMD	Degenerative Joint Disease (DJD)	None	Subtotal (% of Total Population)
Age group	1	14	8	7	0	29	51(13%)
	2	31	24	16	0	127	182(46%)
	3	17	15	10	2	85	119(30%)
	4	9	5	5	4	30	48(12%)
Gender	M	20	25	9	4	142	191(48%)
	F	51	27	29	2	129	209(52%)

(Table 1) contd.....

Variable \ Diagnosis			Pain-related TMD	Intra-articular Disorders (IAD)	Headache Attributed to TMD	Degenerative Joint Disease (DJD)	None	Subtotal (% of Total Population)
Joint clicking	Open/ close	Unilateral	10	23	4	0	15	48(12%)
		Bilateral	15	25	8	0	4	44(11%)
	Lateral/ protrusive	Unilateral	8	26	2	0	12	46(11%)
		Bilateral	9	15	4	0	2	26(7%)
Joint crepitus	Open/ close		1	0	1	2	4	7(3%)
	Lateral/ protrusive		3	3	3	4	5	15(5%)
Joint locking			5	9	5	1	4	19(5%)

Table 2. Occlusal features and mandibular movements (mm).

Occlusal Feature		Range	Mean ± SD
OJ		(-2)-7	2.2±1.4
OB		(-3)-8	2.5±1.5
MLD		0-5	1±0.9
PFO		18-62	41.3±8
MAO		27-67	47.9±6.7
MUO		22-65	45±6.9
Lateral excursion	R	1-17	8.9±2.9
	L	0-19	9.3±3.2
Protrusion		1-22	8.6±3.8
Opening pattern (N)	1	270	
	2	120	
	3	10	

OJ=overjet, OB=overbite, MLD=midline deviation, PFO= pain-free opening, MAO= maximum assisted opening, MUO=maximum unassisted opening, opening pattern 1= straight, 2= corrected deviation, 3= uncorrected deviation, SD= standard deviation

The age ranged between 18 and 78 years (mean = 32.3±12.4). A majority of the population fell into the middle age groups (second and third) (76%). A total of 92 participants (23%) had joint clicking on open/close movements, while 72 (18%) had to click on lateral/protrusive movements. A total of 22 subjects (6%) had crepitation of their TMJ. Joint locking was identified in 19 individuals (5%). With regards to TMD diagnostic outcomes, 71 subjects (18%) were diagnosed with pain-related TMD, 52 (13%) with IAD, 6 (1.5%) with DJD and 38 (10%) with a headache due to TMD. The mean lateral excursions to the right and the left were comparable; 8.9±2.9 and 9.3±3.2, respectively.

270 participants (68%) had a straight opening pattern, while 120(30%) had corrected deviation and 10 (2%) had uncorrected deviation mouth opening pattern.

The binary logistic regression test results between independent variables (demographics, occlusal and mandibular features) on one side and TMD diagnostic outcomes on the other side are shown in Table **3** (with the exception of uncorrected deviation due to small number resulting in non-meaningful results).

Table 3. Correlations between (demographics, occlusal features and mandibular movements) and (DC/TMD) showing levels of significance (P) and odds ratio (OR).

Variable \ Diagnosis		Pain-related TMD		IAD		Headache Attributed to TMD	
		P	OR	P	OR	P	OR
Age group	1						
	2	0.46	0.73	0.61	1.32	0.74	0.72
	3	0.72	0.69	0.25	3.54	0.88	1.38
	4	0.93	1.20	0.23	10.64	0.87	1.67
Gender		0.014*	2.16	0.49	1.33	0.21	3.50
OJ		0.93	0.96	0.76	1.04	0.77	0.86
OB		0.41	0.94	0.52	0.87	0.21	1.43
MLD		0.45	0.89	0.04*	1.30	0.16	1.51
Opening pattern	Corrected deviation	0.82	1.07	0.02*	2.74	0.76	0.91

(Table 3) contd.....

Variable \ Diagnosis		Pain-related TMD		IAD		Headache Attributed to TMD	
		P	OR	P	OR	P	OR
PFO		0.013*	0.94	0.11	0.91	0.77	1.22
MAO		0.93	1.07	0.13	1.14	0.53	0.89
MUO		0.49	1.42	0.57	0.90	0.85	0.97
Lateral excursion	R	0.82	0.98	0.84	1.03	0.29	1.12
	L	0.73	1.01	0.98	1.04	0.27	0.93
Protrusion		0.67	0.95	0.15	0.91	0.08	1.52

OJ=overjet, OB=overbite, MLD=midline deviation, PFO= pain-free opening, MAO= maximum assisted opening, MUO=maximum unassisted opening *p≤0.05

Table 4. Correlations between occlusal features AND joint sounds and locking showing levels of significance (P) and odds ratio (OR).

Variable \ Diagnosis		Joint Clicking								Crepitus Lateral/ protrusive		Locking	
		Open/close				Lateral/ protrusive							
		unilateral		bilateral		unilateral		bilateral					
		P	OR	P	OR	P	OR	P	OR	P	OR	P	OR
OJ		0.29	1.22	0.97	0.99	0.35	1.13	0.54	1.11	0.39	1.20	0.91	0.97
OB		0.04*	0.77	0.43	0.94	0.28	0.87	0.35	0.86	0.66	0.92	0.48	0.86
MLD		0.05*	1.31	0.92	1.04	0.64	0.93	0.11	1.33	0.58	0.88	0.83	0.95
PFO		0.03*	0.94	0.27	0.96	0.11	0.95	0.35	0.96	0.04	0.87	0.18	0.98
MAO		0.32	1.00	0.32	0.94	0.92	1.03	0.56	0.97	0.13	1.21	0.87	1.02
MUO		0.54	0.99	0.77	1.15	0.14	1.29	0.91	1.08	0.69	0.96	0.47	0.95
Lateral excursion	R	0.74	1.10	0.12	0.89	0.16	1.15	0.67	1.08	0.62	1.49	0.93	0.98
	L	0.31	0.93	0.22	1.29	0.26	1.40	0.95	1.36	0.68	0.95	0.59	1.00
Protrusion		0.31	0.95	0.09	0.91	0.12	0.94	0.73	0.98	0.48	0.93	0.79	1.07

OJ=overjet, OB=overbite, MLD=midline deviation, PFO= pain-free opening, MAO= maximum assisted opening, MUO=maximum unassisted opening *p≤0.05

Gender was found to significantly correlate with the occurrence of pain-related TMD at a p-value of 0.014 and at the odds ratio of 2.16, which means that females are just over twice as likely to have pain-related TMD as males. Maximum pain-free opening had a significant inverse association with pain-related TMD (P-value of 0.013). However, the odds ratio of nearly 0.94 means the association is weak, probably due to the relatively small number of patients. Neither of the other parameters nor age groups showed a significant correlation with pain-related TMD. Midline deviation was found to significantly correlate with the occurrence of IAD at nearly a marginal p-value of 0.04 and an odds ratio of 1.3. This means that having a midline deviation increases the risk of IAD by 1.3 folds. Corrected deviation mouth opening was found to have a significant association with the occurrence of IAD wherein having a corrected deviation mouth opening (against straight mouth opening) significantly increases the risk of IAD at nearly 2.7 folds at a p-value 0.02. Neither of the other parameters nor gender/age groups showed significant correlations with IAD. However, there appears to be a trend of increasing risk of IAD with increasing age, as seen by the odds ratios of age groups when compared with the youngest age group, yet without statistical significance.

Interestingly, gender was found to non-significantly correlate with the occurrence of headache in patients with TMD at a p-value of 0.21. However, females with TMD were found to be at a higher risk (3.5 times) to suffer from headaches compared to males.

Logistic regression test results of correlations between occlusal features and joint sounds and locking are shown in Table **4**.

For every 1 mm added up to overbite, the odds of unilateral clicking compared to no clicking significantly decreased by about 23% (p = 0.04). Moreover, midline deviation was a marginally significant predictor of unilateral clicking compared to no clicking increasing the chance of unilateral clicking by 31% at a marginally significant p-value of 0.05. Pain-free opening decreased the odds of unilateral clicking compared to no clicking by 6.3% at p = 0.03.

Finally, for those variables with small numbers in which logistic regression tests were not possible, chi-square tests showed a statistically significant association between age and crepitus both at opening/closing and lateral protrusive movements (p = 0.001), as well as between age and open/close joint clicking (p= 0.024).

4. DISCUSSION

To the best of our knowledge, this is the first report to explore the correlation between basic occlusal features and TMD in Middle Eastern populations. The use of the updated DC/TMD protocol as a standard and reproducible assessment tool adds to the value of the current findings in this domain.

The relationship between dental occlusion and TMD has been one of the most controversial topics in the dental community, with noticeable heterogeneity in terms of research methodology and study designs, hence, a definitive conclusion is unavailable [15].

The historical link between TMD and dental occlusion dates back to the first half of the last century when Costen attributed TMJ dysfunction and associated ear symptoms to dental malocclusion [16]. Subsequently, this notion was adopted due to several reasons that seemingly linked TMD to occlusion, including the fact that the dental profession has been classically responsible for TMD management and the clinical effectiveness of apparently occlusally oriented treatment modalities (e.g., occlusal splints) [7]. However, recent years have witnessed a paradigm shift in our understanding of TMD as a condition with a multifactorial biopsychosocial background in which the role of dental occlusion is inconsistent [2, 3].

In a recent systematic review, only a single report out of 25 found a significant association between overjet and pain-related TMD as well as between overbite and IAD (disc displacement with reduction, in particular) among other features [10], otherwise, overjet, overbite and midline deviation were unrelated to TMD whether in case-control studies or non-TMD cohort studies [7]. Accordingly, it was concluded that no consistent clinically relevant association could be established between TMD and features of dental occlusion, and therefore dental clinicians were encouraged to abandon such a classic gnathological model linking TMD to occlusion and to move forward towards accepting TMD as a condition related to genetics and psychosocial factors.

Within the orthodontics literature, several studies that related TMD to malocclusion used inappropriate indices, such as the Helkimo index, as indicated by key authors in this domain [17, 18]. Furthermore, the correlations that were reported between TMD and malocclusion in the orthodontics literature are unlikely to be of any clinical significance even though they were statistically significant [7, 9].

The findings of the current study are largely consistent with the previous literature. In the very few statistically significant associations found, the odds ratio values were very close to one, which underlines the low clinical relevance of such findings. One exception was the correlation between a corrected deviation mouth opening pattern (compared to a straight opening pattern) and IAD with an odds ratio of 2.7 at p=0.02. This could be attributed to the small sample size.

Studying the possible correlation between occlusal features and TMD patterns in some specific populations (e.g., bruxists) has also confirmed the absence of such a correlation with a majority of occlusal features, including deep bite, crossbite, open bite, canine asymmetry, large overjet, and mediotrusive interferences [19].

In one study that tested the link between occlusal features and TMJ clicking in a population of 442 TMD subjects, occlusion had a minimal predictive ability for clicking without any clinical relevance [20]. Our results are in-line with such findings where overjet, overbite and pain-free opening were significantly associated with unilateral clicking of TMJ upon opening/closing movements, however, the odds ratio values are highly suggestive of a minor clinical significance.

The finding of higher pain-related TMD frequency, among females as compared to males as well as headache attributed to TMD, fits in an overall accepted proposition that TMD and its associated features are generally more common among females [3, 15, 21].

One possible explanation for the increased occurrence of TMD in women has been suggested to be female sex hormones (oestrogen in particular). This is based on the incidence of TMD in females, which appears to peak during the 3rd to 4th decade and then declines to levels comparable with males, and partly on the association of the onset of TMD in many women with menstrual cycle-related variations in sex hormone levels at puberty [22].

Finally, the increased frequency of joint sounds with increasing age in our population is a possible consequence of age-related joint changes, including reduced adaptive capacity and the subsequent dysfunctional remodeling of the TMJ [23].

It is noteworthy that the assessment of the possible aetiologic factors for TMD was out of the scope of the current study and is unlikely to have affected the reported findings, especially because the oral conditions were controlled in the study population (i.e.all patients were fully dentate and had no odontogenic sources of pain at the time of examination) and the fact that the biopsychosocial model of TMD implies that multiple interrelated factors, that may not be easily identified on many occasions, are involved in the aetiology of TMD. The limitations of the current study include the relatively small sample size, which has led to difficulties in the analysis of some outcomes, such as the uncorrected deviation mouth opening pattern (n=10). Another limitation was the inability to confirm IAD by proper imaging. Nevertheless, the findings are still of value due to the scarce reports from the Middle East on this particular topic.

CONCLUSION

Occlusal features were shown to have a minimal predictive value for TMD and associated features in a Middle Eastern population. Accordingly, a causal role for dental occlusion in Middle Eastern TMD populations is not supported by the current findings and therefore appears unlikely. Further studies with larger samples and more functional occlusal features are required to confirm these findings.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

This study was approved by the institutional review board (IRB) at Jordan University of Science and Technology, Jordan(approval ID: 337/2016).

HUMAN AND ANIMAL RIGHTS

No animals were used in this research. All human research procedures followed were in accordance with the ethical standards of the committee responsible for human experimentation (institutional and national), and with the Helsinki Declaration of 1975, as revised in 2013.

CONSENT FOR PUBLICATION

All participants received written and verbal information about the nature of the study and written consent was obtained

from all subjects, prior to examination.

STANDARDS OF REPORTING

STROBE guidelines and methodology were followed.

AVAILABILITY OF DATA AND MATERIALS

All data supporting the findings of this study will be available from the corresponding author [M.S.A] upon request.

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CONFLICT OF INTEREST

The authors declare no conflict of interest, financial or otherwise.

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