ORIGINAL ARTICLE
DOI: 10.33897/fujd.v6i1.479

Association of Temporomandibular disorders with Malocclusion Complexity using Index of Complexity, Outcome and Need (ICON): A Case-Control study

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Received: 12 Mar 2025 / Revised: 27 Jan 2026 / Accepted: 28 Jan 2026 / Published online: 31 Jan 2026

ABSTRACT

Objective: Our study's objective was to investigate the association between temporomandibular disorders (TMDs) and complexity of the patient's malocclusion utilizing Index of Complexity, Outcome, and Need (ICON).

Materials and Methods: This case-control observational study was carried out at the Department of Orthodontics, Dental College HITEC-IMS, Taxila from September 2024 till February 2025. A total of 300 participants aged 18-35 years were included in this study. Out of 300, 150 individuals were included into the case group (diagnosed with TMD using the Fonseca questionnaire) while 150 individuals were included in the control group (without TMD). Malocclusion complexity was assessed using ICON. Comparison of TMD and ICON grades were done using chi-square test while logistic regression was used to assess the association of TMD with the complexity of patient's malocclusion.

Results: The mean age of the patient was 25.14 ± 4.72 years. Out of 300 participants, females constituted 61.3% while males constituted 38.7% of the sample. A significant association was observed between higher ICON grades and TMD (p=0.001). The results of logistic regression indicated that individuals with "difficult" or "very difficult" ICON grades had higher odds of developing TMD (OR=1.206). No significant association was found between TMD and gender (p=0.947).

Conclusion: Malocclusion complexity is significantly associated with TMD, with higher ICON grades correlating with an increased risk of TMD. These findings highlight the importance of evaluating malocclusion in TMD diagnosis and management.

Keywords: Association, Case-Control Studies, Malocclusion, Temporomandibular Joint Disorders

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DOI:10.33897/fujd.v6i1.479

How to cite this Article:

Tariq S, Hasnain M, Shafique J, Qamar U, Aized S, Tarar AAY. Association of Temporomandibular disorders with Malocclusion Complexity using Index of Complexity, Outcome and Need (ICON): A Case-Control study. Found Univ J Dent. 2026;6(1):35-41

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INTRODUCTION

Malocclusion develops because of the discrepancy between the size of the teeth and the jaws which can range from minor discrepancies in dental alignment to severe deviations that can impact the functional occlusion and aesthetics of an individual.[1] It is thought to be one of the contributing factor to temporomandibular disorders (TMDs)[2] that are a group of disorders characterized by discomfort and dysfunction in the muscles and the jaw joint that govern jaw movements. It includes a variety of neuromuscular and musculoskeletal disorders affecting masticatory muscles, the temporomandibular joint (TMJ) and the structures that are associated with it.[3] Common sign and symptoms are TMJ pain, limited jaw mobilization, clicking sound or locking of the jaw.[4] Interestingly, TMD symptoms are more common in females that males, with a reported 5:1 female-to-male ratio.[5]

The aetiology of TMDs is very complex. Evidence suggests that psychological, physiological, structural, postural, and genetic factors all play a role in the development of TMD by disrupting the functional equilibrium of the stomatognathic system, which consists of the jaw muscles, TMJ and the tooth occlusion.[6] Malocclusion may be a factor in the onset or exacerbation of TMDs as it could lead to uneven stresses on the TMJ, resulting in strain and inflammation that may manifest as TMD symptoms.[7] Evidence suggests that some of the traits of malocclusion have been linked to TMD such as increased overjet, deep-bite, anterior open bite, posterior crossbite, crowding, angle malocclusion and dolichofacial growth pattern of an individual.[8]

As the link between malocclusion severity and TMD is still controversial and no study has done so far in Pakistan that associate malocclusion complexity with TMD. Therefore, the purpose of our research was to find out the association between TMDs and complexity of malocclusion utilizing Index of Complexity, Outcome, and Need (ICON), that is a tool which quantifies malocclusion complexity, providing a standardized method to assess orthodontic treatment need of an individual.[9] Understanding this relationship is very crucial for developing the targeted diagnostic and therapeutic strategies that will address both malocclusion and TMDs.

MATERIALS AND METHODS

This case control observational study was carried out at the Department of Orthodontics, Dental College, HITEC-IMS, Taxila from September 2024 till February 2025. Approval from the Institutional Review Board was obtained for this study [Ref No. Dental/HITEC/IRB/88]. Adult patients between 18-35 years were included in the study while patients having any history of trauma to the jaw or TMJ, previous orthodontic treatment within the last 2 years, history of parafunctional habits, systemic conditions affecting TMJ and cognitive or communication disorders that prevents participation were excluded from the study. Total 300 patients were selected for this study through non-probability consecutive sampling; 150 individuals with the diagnosis of any kind of TMD were designated as cases, while 150 individuals without TMD were designated as controls. G* Power 3.1.9.7 was used to calculate the sample size considering the values of P1 0.37,10 P2 0.56,11 0.90 power of the test, 0.05 α error prob and allocation ratio N2/N1 as 1. Patients who met our selection criteria were chosen and their informed written consent was obtained. Identification of TMD was accomplished using a questionnaire proposed by Fonseca (Figure 1).[12] These patients were then classified into no, mild, moderate and severe TMD through clinical index classification (Figure 1).[12] Complexity of malocclusion was estimated in both groups through ICON (Figure 2).[13]

IBM SPSS version 27 was used for statistical analysis. Qualitative variables (Gender and ICON grades) were analysed as Frequency & Percentage while quantitative variable (Age of the patient) was analyzed as Mean ± SD. Normality of the data was checked through Kolmogorov Smirnov test. Comparison of categorical variables (ICON & TMD grading) were done using Chi-square test while association between ICON scores and TMD was assessed using logistic regression.

RESULTS

Our study included total 300 patients, of whom 184 (61.3%) were females and 116 (38.7%) were males. The mean age of the patient was 25.14 ± 4.72 years. With respect to complexity of malocclusion, 23 (7.7%) individuals fell into grade 1 (easy), 68 (22.7%) into grade 2(mild), 96(32%) into grade 3(moderate), 73(24.3%) into grade 4 (difficult) and 40 (13.3%) into grade 5 (very difficult) of ICON. With respect to TMD, 150 patients

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(50%) were presented with no TMD, 82 (27.3%) with mild TMD, 56 (18.7%) with moderate TMD and 12(4%) with severe grade of TMD. Figure 3 showed a bar chart that represents that as compared to control group, most individuals in the case group were in the upper two ICON levels (difficult and very difficult), whereas the majority of those in the control group were in the lowest three levels; with the result of chi-square test showing statistically significant correlation between ICON grades and TMD (p = 0.001).

Results of binary logistic regression revealed no statistically significant association between TMD and gender (p = 0.947) (Table 1). However, TMD has been associated with malocclusion complexity with difficult and very difficult cases showing more risk of TMDs (OR 1.206 and 1.491). Result of Omnibus test of model coefficients showed that the logistic regression model was statistically significant, $\chi 2(5) = 12.785$, p = 0.025. The model correctly classified 59.7 % of cases. The Hosmer–Lemeshow goodness-of-fit test showed that the data fits the model well (p = 0.094). Moreover, the Nagelkerke (R^2) value was 0.056.

Table 1: Results of Binary Logistic Regression

Variable	Variable Subcategory	p -value[a]	OR	95% CI	
				Lower	Upper
Gender	Male	0.947	1.016	0.629	1.642
	Female	-	-	-	-
ICON Grade	Grade 1	0.115	0.429	0.150	1.228
	Grade 2	0.043	0.438	0.197	0.975
	Grade 3	0.108	0.541	0.255	1.144
	Grade 4	0.643	1.206	0.545	2.669
	Grade 5	0.234	1.491	-	-

[a]p-value < 0.05 was considered as statistically significant

CI: Confidence interval; OR: Odds Ratio

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Figure 1: Fonseca's Questionnaire And Clinical Index Classification

Questions	No	Sometimes	Yes
1- Is it hard for you to open your mouth?			
2- Is it hard for you to move your mandible from side to side?			
3- Do you get tired /muscular pain while chewing?			
4- Do you have frequent headaches?			
5- Do you have pain on the nape or stiff neck?			
6- Have you havearches or pain in craniomandibular joints?			
7- Do you clench or grind your teeth ?			
8- Do you consider yourself a tense (nervous) person?			
10- Do you consider yourself a tense (nervous) person			

Total between 0 and 15 points	No TMD
Total between 20 and 40 points	Mild TMD
Total between 45 and 65 points	Moderate TMD
Total between 70 and 100 points	Severe TMD

Figure 2: Index of Complexity, Outcome and Need

	Score	0	1	2	3	4	5
Aesthetic	1–10 As judged using IOTN AC						
Upper arch crowding	Score only the highest trait either spacing or crowding	Less than 2 mm	2·1 to 5 mm	5·1 to 9 mm	9·1 to 13 mm	13·1 to 17 mm	> 17 mm or impacted teeth
Upper spacing		Up to 2 mm	2·1–5 mm	5·1–9 mm	>9 mm		
Crossbite	Transverse relationship of cusp to cusp or worse	No crossbite	Crossbite present				
Incisor open bite	Score only the highest trait either open bite or overbite	Complete bite	Less than 1 mm	1·1–2 mm	2·1–4 mm	>4 mm	
Incisor overbite	Lower incisor coverage	Up to ⅓ tooth	⅓–⅔ coverage	⅔ up to full covered	Fully covered		
Buccal segment anteroposterior	Left and right added together	Cusp to embrasure relationship only, Class I, II or III	Any cusp relation up to but not including cusp to cusp	Cusp to cusp relationship			

Occlusal trait	ICON weighting
IOTN Aesthetic Component	7
Left + right buccal antero-posterior	3
Upper arch Crowding	5
Overbite	4
Crossbite	5
Treatment need cut-off	43
Treatment outcome cut-off	31

Complexity grade	Score range
Easy	< 29
Mild	29–50
Moderate	51–63
Difficult	64–77
Very difficult	> 77

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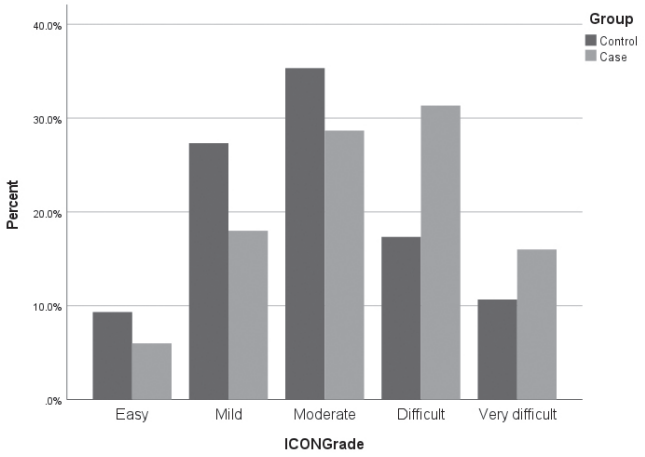
Figure 3: Bar Chart Displaying the Distribution Of Cases And Controls Based On The Index Of Complexity, Outcome And Need Levels (Using Percentages)



DISCUSSION

This study utilized ICON to examine the association between temporomandibular disorders (TMDs) and the complexity of malocclusion. The results of our study showed a statistically significant association between higher ICON grades and TMD, suggesting that the severity of malocclusion may have an impact on TMDs.

Our findings are consistent with previous research indicating a link between TMD symptoms and malocclusion such as Class I, II and III malocclusions (p value <0.0001 and OR= 4.04), deep bite/open bite (p value = 0.003 and OR= 1.89) and midline deviation (p value <0.0001 and OR=7.48).[14] This can be explained by the fact that the malocclusion has the ability to worsen stress and inflammation by disrupting the biomechanical equilibrium of the temporomandibular joint (TMJ).[4] This supports the idea that the malocclusion is a possible risk factor for functional disorders like TMDs in addition to being a cosmetic concern. Similar results were obtained in a study that showed that with more complex malocclusion, the likelihood of presenting with myofascial pain increases.[15] In contrast to our study's results, features of dental malocclusion have little clinical significance and contribute very little to the prediction of TMJ clicking sounds in a cohort of TMD patients.[16]

We have found no statistically significant correlation between gender and TMD in this sample similar to a study,[17] despite the fact that TMDs are more common in females due to variation in sex hormones, their reaction to the stress, how they perceive pain and psychological aspects.[18] Our study's age range and somewhat balanced sample composition may have reduced the noticeable gender differences. Additionally, the logistic regression analysis in our study showed that the patients who fell into the ICON categories of "difficult" and "very difficult" were more likely to experience TMD. These results are consistent with studies that highlights how severe malocclusion increases the strain on TMJ structures, making people more susceptible to TMD.[19] The multifactorial nature of these disorders is highlighted by the moderate Nagelkerke R2 value (0.056), which shows that malocclusion complexity is merely one of numerous factors driving TMD development.

There are certain limitations of this study. Using self-reported questionnaires for initial TMD screening may involve subjectivity,[20] and the cross-sectional nature of this study precludes causal inferences.[21] Future longitudinal studies should investigate the effects of orthodontic treatments that are intended to lessen the complexity of the malocclusion on the development of TMD. Further understanding of the occlusal-TMJ relationship may also be possible by integrating biomechanical analysis and advanced imaging modalities.

CONCLUSION

Malocclusion complexity is significantly associated with TMD, with higher ICON grades correlating with an increased risk of TMD. These findings highlight the importance of evaluating malocclusion in TMD diagnosis and management. Further longitudinal studies are recommended to explore causality and the impact of orthodontic treatment on TMDs.

DISCLAIMER

None.

CONFLICT OF INTEREST

None to declare.

ETHICAL STATEMENT

The ethical approval was provided by the Institutional Review Board of Dental College, HITEC-IMS, Taxila [Ref No. Dental/HITEC/IRB/88].

DOI: 10.33897/fujd.v6i1.479

FUNDING DISCLOSURE
The author received no financial support for the research, authorship, and/or publication of this article.

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