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ASSOCIATION BETWEEN TEMPOROMANDIBULAR JOINT DYSFUNCTION (TMD) AND MIGRAINE IN PATIENTS PRESENTING WITH HEADACHE: AN OBSERVATIONAL STUDY

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. Temporomandibular joint dysfunction, migraine, headache, central sensitization, VAS, HIT-6, MIDAS, observational study.

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Abstract

Background: Temporomandibular Joint Dysfunction (TMD) and migraine are two highly prevalent craniofacial pain conditions, which are frequently seen together in clinical practice. The two conditions converge in the trigeminal nucleus caudalis, and central sensitization has been suggested as a common neurobiological mechanism between joint- and muscle-based nociception from the TMJ and migraine chronification. Although there is increased clinical interest, the exact nature of the relationship between TMD and migraine ,Although there is increased clinical interest, the exact nature of the relationship between TMD and migraine – whether TMD triggers migraine , migraine exacerbates TMD, both share common risk factors-remains poorly understood.
Objective: To evaluate the association between TMD and Migraine in patients presenting with headache and to compare the pain intensity, the impact of the headache, and disability due to migraine across diagnostic subgroups.
Methods: An observational study was conducted on 164 participants (age 20–60 years) at the Department of Physiotherapy, Pacific Medical College and Hospital, Bedla, Udaipur, over nine months, using purposive sampling. The participants were divided into the following diagnostic groups: Group A – TMD Only (n=35); Group B – Migraine Only (n=40); Group C – TMD + Migraine (n=55); and Group D – Other Headache (n=34). The outcome measures used were the Visual Analogue Scale (VAS), Headache Impact Test-6 (HIT-6) and Migraine Disability Assessment Scale (MIDAS). The categorical association between TMD and migraine was assessed using Chi-square testing while pain intensity, headache impact and migraine disability were compared across the four diagnostic subgroups using the Kruskal–Wallis test with Dunn's post-hoc pairwise comparisons.
Results: Group C (TMD + Migraine) recorded the highest scores on all three outcome measures — VAS 7.18 ± 0.97, HIT-6 64.72 ± 3.93, and MIDAS 27.45 ± 4.41 — all significantly higher than the other groups ($p < 0.001$). The chi-square test for the binary presence of TMD and migraine was not significant ($\chi^2 = 0.830$, $p = 0.362$, OR = 1.336, 95% CI 0.72–2.49). However, severity –based comparison showed that patients with both conditions (Group C) had significantly higher mean pain, headache impact and disability scores compared to any other group ($p < 0.001$ for all three scores), suggesting that the categorical presence/absence test underestimated the actual clinical association between TMD and migraine.
Conclusion: Although the categorical co-occurrence of TMD and migraine was not statistically significant, severity-based analyses show that the clinical burden of migraine is significantly higher in patients with TMD. Early screening and integrated management is supported by the co-existence of TMD and migraine resulting in a significantly higher clinical burden.

INTRODUCTION

Temporomandibular disorders (TMD) are a heterogeneous group of musculoskeletal and neuromuscular conditions affecting the temporomandibular joint, the muscles of mastication and associated structures. TMD is recognized as the most common cause of chronic orofacial pain of non dental origin[1]. The temporomandibular joint is a load-bearing , hinge and glide synovial joint that is used almost constantly during speech , mastication , swallowing and facial expression throughout the day and even minor mechanical or neuromuscular dysfunction of this system can have a meaningful impact on activities of daily living, sleep, nutrition and psychosocial well being[2]. Clinically, the presentation of TMD present along a spectrum : intra-articular disorders (including disc displacement and degenerative joint changes), myogenous disorders (including masticatory muscle hyperactivity and myofascial pain), and mixed presentations combining both. Its etiology is now understood to be multifactorial and not simply mechanical, with occlusal discrepancies, cervical and postural abnormalities, psychological stress and anxiety, direct or indirect trauma, hormonal fluctuation and parafunctional habits like bruxism and clenching all implicated as contributing or perpetuating factors[3].The prevalence reported across studies ranges from approximately 5% to 70% of the general population, mainly because of difference in diagnostic criteria (self – reported symptoms versus clinical examination with a standardized instrument such as the DC/TMD) the age structure of the population studied, and case definition[4,5].Despite this variability, TMD is consistently reported to be two to three times more common in women than in men, a pattern that has been linked to hormonal influences on joint laxity and pain sensitivity.

Migraine is a primary neurological headache disorder, and one of the most common and disabling condition seen in clinical practice globally, affecting an estimated 15% of the worldwide population at some time during their lives[6]. It is defined by recurrent attacks of moderate to severe, usually unilateral, pulsating headache, which are often accompanied by photophobia, phonophobia, nausea and, in a minority of patients, a preceding aura of transient focal neurological symptoms like visual scotomas or paraesthesia. Migraine consistently ranks among the leading global causes of years

lived with disability and especially among working-age people, and the burden extends well beyond the headache episode—it includes anticipatory anxiety, interictal functional disability and significant health care and productivity costs[7].

Traditionally, TMD and migraine have been treated in two distinct areas of clinical practice - dentistry and oral medicine for TMD, and neurology for migraine - but increasing anatomical and neurophysiological evidence suggests that the two conditions are not independent. The temporomandibular joint and its associated musculature are innervated mainly by the auriculotemporal and masseteric branches of the mandibular division of the trigeminal nerve (V3). The same trigeminal system, through its ophthalmic division (V1), transmits the nociceptive information from the intracranial meningeal and cerebral vascular tissues—the anatomical substrates of migraine pain[8].The afferent nociceptive signals arising from the TMJ, masticatory muscles, upper cervical structures, and meninges all converge on second-order neurons in the trigeminal nucleus caudalis within the caudal brainstem, and from where they ascend to higher pain-processing centres.[9] This shared convergence point offers a coherent mechanistic explanation of how peripheral pain in the TMJ or masticatory muscles may be perceived, referred, or misattributed as headache, and why recurrent migraine attacks - through repeated central sensitization, may lower the pain threshold of the masticatory structures with time, effectively priming the system for TMD symptom development. Central sensitisation – the state of amplified synaptic efficacy and excitability of central pain processing pathways following prolonged nociceptive input – has been specifically proposed as the shared mechanism between both conditions. In support this, patients with TMD and migraine have been found to have reduced mechanical pain thresholds, both locally at the TMJ and at distant clinically unrelated body sites, compared with patients who have either TMD or migraine alone, which is a characteristic feature of a centrally sensitized, rather than purely peripherally mediated, pain state[10].

The empirical literature examining this relationship, while growing, remain inconsistent in its conclusion, and this inconsistency appeared to be closely related to the study design. Byun et al. (2020) analyzed a large Korean national health-screening cohort longitudinal follow up over

more than decade, found a significantly increased risk of incident migraine in patients with a prior diagnosis of TMD, both before and after adjustment for a wide range of metabolic and lifestyle confounder[11] . Fernandes et al.(2019) using a case control design in an adolescent population, similarly found a strong association between painful TMD and migraine, and further argued that concurrent, integrated management of both condition produced better outcomes than treating either in isolation[12]. Bizzarri et al (2024) synthesizing this literature in a systematic review and meta – analysis, concluded that patients with migraine or tension type headache are considerably more likely to deveop TMD reinforcing a bidirectional model of risk[13] .In contrast, Ashraf et al. (2022) found no evidence of an association in a population-based prospective, longitudinal study (11 years follow-up) using a Bayesian regression framework, suggesting that the null results may reflect the variability of mechanisms operating across different TMD–headache subgroups[14]. Taken together, the trend that emerges is that the association between TMD and migraine is more likely to be detected with longitudinal, cohort, and severity-sensitive study designs, whereas simple categorical, cross-sectional comparisons are more likely to yield null or marginal results. This methodological gap that the present study addresses directly: a simple categorical test is applied and compared with a severity-based statistical test in the same population, within the same cross-sectional study, allowing a direct comparison of the two analytic approaches, rather than an an indirect comparison across separate studies.

A further limitation of the existing literature is that most studies have investigated only the presence or absence of an association between TMD and migraine, the co-occurence of the two conditions within the same individual has received far less attention – and little effort has been made to quantify the additional clinical burden of the two conditions in the same patient[15]. From rehabilitation and physiotherapy point of view, this represents a valuable evidence gap – without a corresponding knowledge of the extra pain, dysfunction and disability arising from the association of the two conditions, it is of limited clinical value to establish that these two conditions co-occur. The severity and burden data and not just prevalence figures should be the parameters to inform priorities for screening and sequencing treatment in clinical practice.

This observation study was therefore designed to evaluate the association between TMD and migraine in a group of patients with headache from a physiotherapy outpatient and inpatient clinic using standardized and validated tools for the measure of pain intensity, headache related functional impact, and migraine specific disability and applying categorical and severity based statistical models.

Aim: To evaluate the association between temporomandibular disorder and headache and to determine whether TMD is associated with migraine severity and burden.

Objectives:

- To evaluate the pain intensity in individuals with TMD and headache.
- To evaluate headache related functional impact in affected individual.
- To evaluate migraine related disability across diagnostic subgroups.
- To determine the association between TMD and migraine using both categorical and severity-based models.

Hypothesis: H_0 : There is no significant association between TMD and migraine in patients presenting with headache. H_1: There is a significant association between TMD and migraine in patients presenting with headache.

MATERIAL AND METHOD

Research Design: Observational study.

Study Setting: Department of Physiotherapy, Pacific Medical College and Hospital (PMCH), Bedla, Udaipur, Rajasthan.

Sample Design: Purposive sampling.

Study Population: Patients between 20-60 years of age with a diagnosis of TMD, migraine and/or recurrent headache.

Study Duration: 9 months.

Sample Size: 164 participants were divided into 4 diagnostic groups: Group A: TMD Only (n=35), Group B: Migraine Only (n=40), Group C: TMD + Migraine (n=55), Group D: Other Headache (n=34).

Inclusion Criteria

- Pain or tenderness over the TMJ for at least one month.

- VAS pain score of 0–10.
- History of recurrent headache for at least six months.
- Multiple migraine attacks according to ICHD-3 criteria.
- Age 20–60 years.

Exclusion Criteria

- Recent fracture/surgery in the TMJ, cervical spine or dental structures (past 3 months).
- Current musculoskeletal injury of the shoulder, cervical or thoracic region.
- Structural deformity of the neck or TMJ, systemic inflammatory illness, progressive neurological disorder, malignancy, fibromyalgia, active dental/cervical infection, spinal accessory nerve palsy, and pregnancy.

Procedure: Ethical clearance was obtained from the Institutional Ethical Committee of Pacific Medical University, Udaipur according to the Declaration of Helsinki, 2013 and ICMR National Ethical Guidelines 2017. Patients were recruited from outpatient and inpatient departments, screened for eligibility (inclusion/exclusion criteria) and written informed consent was obtained. Demographic data (age, gender, occupation), anthropometric data (height, weight, BMI), vital signs and appropriate biochemical data were recorded. The intensity of the pain was evaluated with the VAS, the functional impact of the headache with the HIT-6 and the disability caused by migraine with the MIDAS.

Outcome Measures

- **Visual Analogue Scale (VAS):** 10 cm horizontal line, 0 = "no pain" to 10 = "worst imaginable pain"; 0 = no pain, 1–3 = mild, 4–6 = moderate, 7–10 = severe[16].
- **Headache Impact Test-6 (HIT-6):** 6-item validated scale with a score range of 36–78, 36–49 is little/no impact, 50–55 some impact, 56–59 substantial impact and 60–78 severe impact[17].
- **Migraine Disability Assessment Scale (MIDAS):** Disability days over the previous 90 days across work, household and social/leisure activities (Grade I = 0–5; little/no disability; Grade IV = ≥21; severe disability)[18].

Statistical Analysis: Data were analysed using SAS. Continuous variables were presented as mean ± standard deviation and

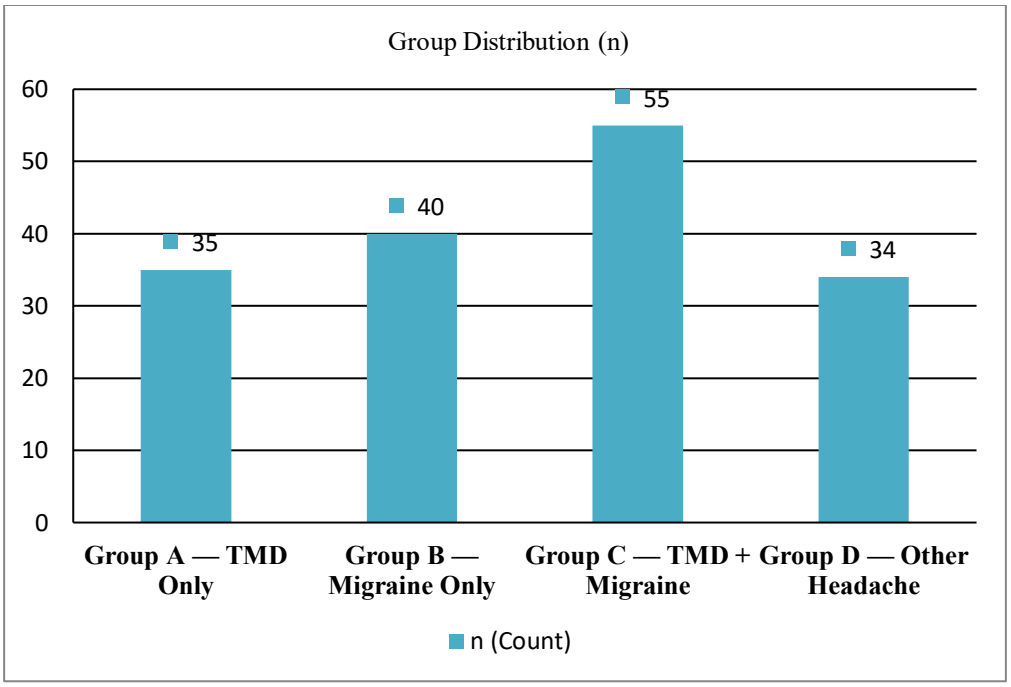
the categorical variables as frequency and percentage. A categorical association between TMD and the presence of migraine was tested using a chi-square test. Between-group differences in VAS, HIT-6 and MIDAS scores among the four diagnostic subgroups were evaluated with the Kruskal–Wallis test followed by Dunn's post-hoc pairwise comparisons when the Kruskal–Wallis test was significant. A two tailed p-value < 0.05 was considered significant.

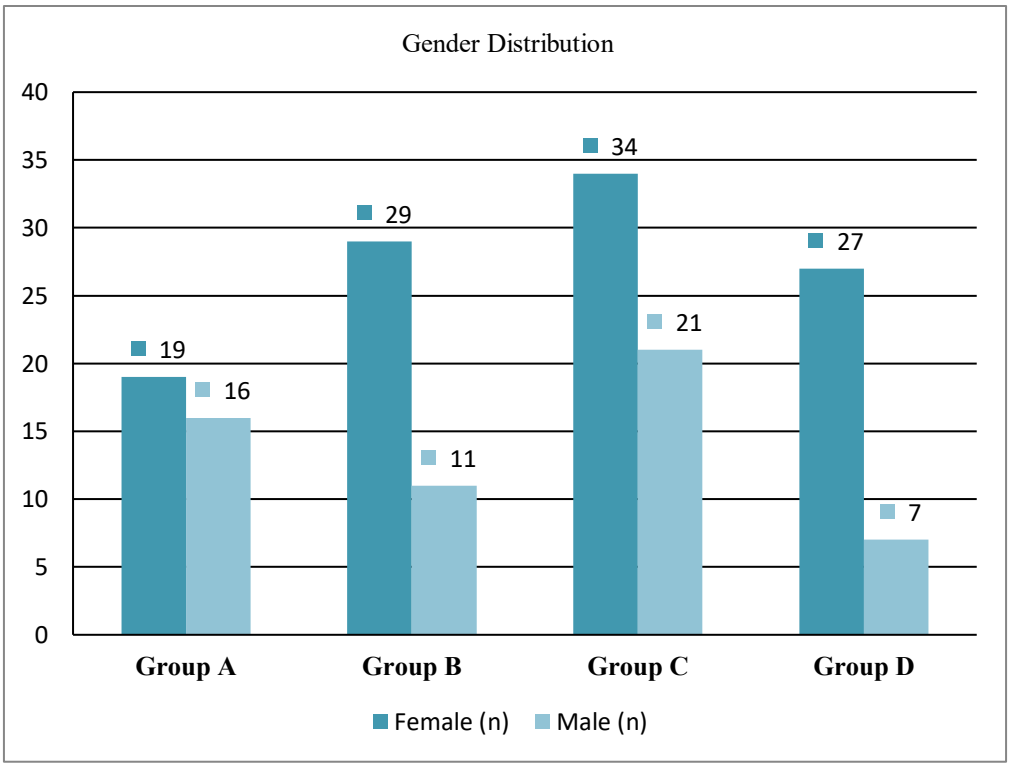
DATA ANALYSIS AND RESULTS

A total of 164 participants were enrolled and divided into four diagnostic groups. There were no significant between-group differences in age ($p = 0.312$) or BMI ($p = 0.387$) and the demographic profile was similar in each group, confirming adequate baseline matching. Overall, 66.5% of the population was female, consistent with the well-established female predominance of both TMD and migraine.

Table 1 — Group-wise Distribution of Participants

Group	Diagnosis	n	%	Female n (%)	Male n (%)
A	TMD Only	35	21.3%	19 (54.3%)	16 (45.7%)
B	Migraine Only	40	24.4%	29 (72.5%)	11 (27.5%)
C	TMD + Migraine	55	33.5%	34 (61.8%)	21 (38.2%)
D	Other Headache	34	20.7%	27 (79.4%)	7 (20.6%)
Total		**164**	**100%**	**109 (66.5%)**	**55 (33.5%)**

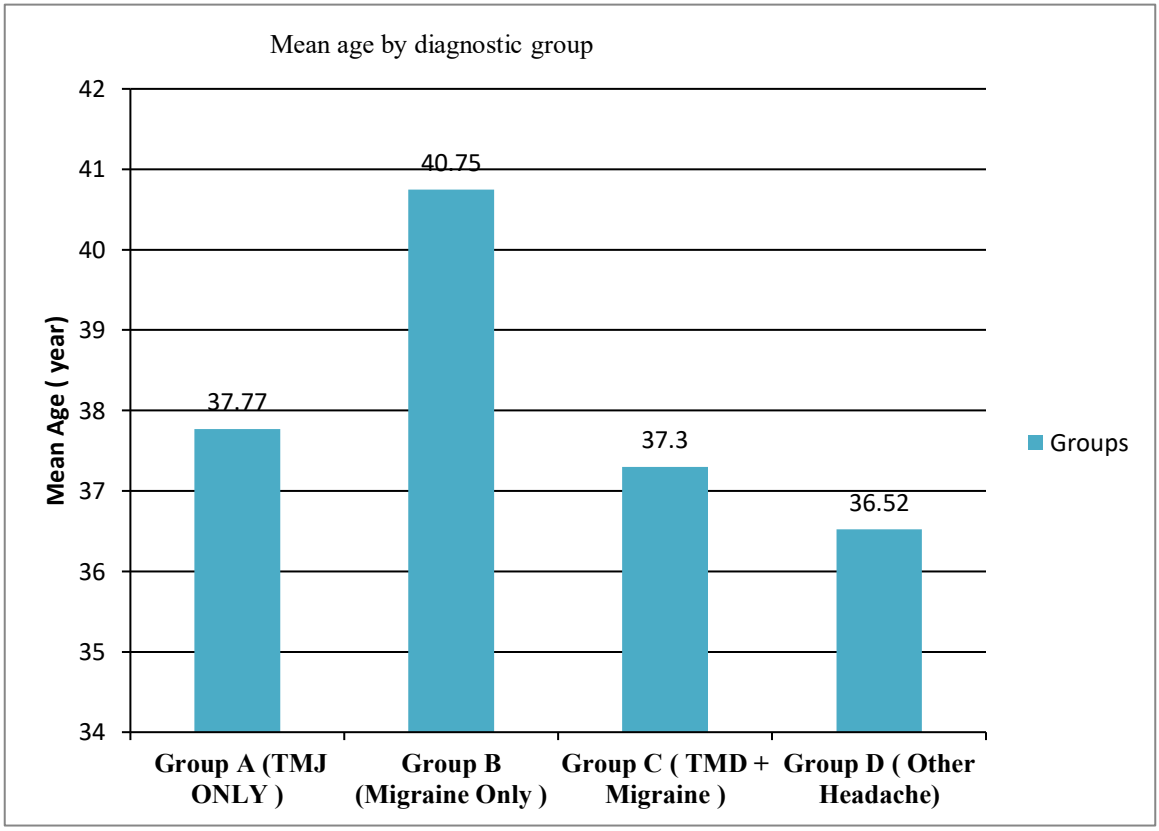


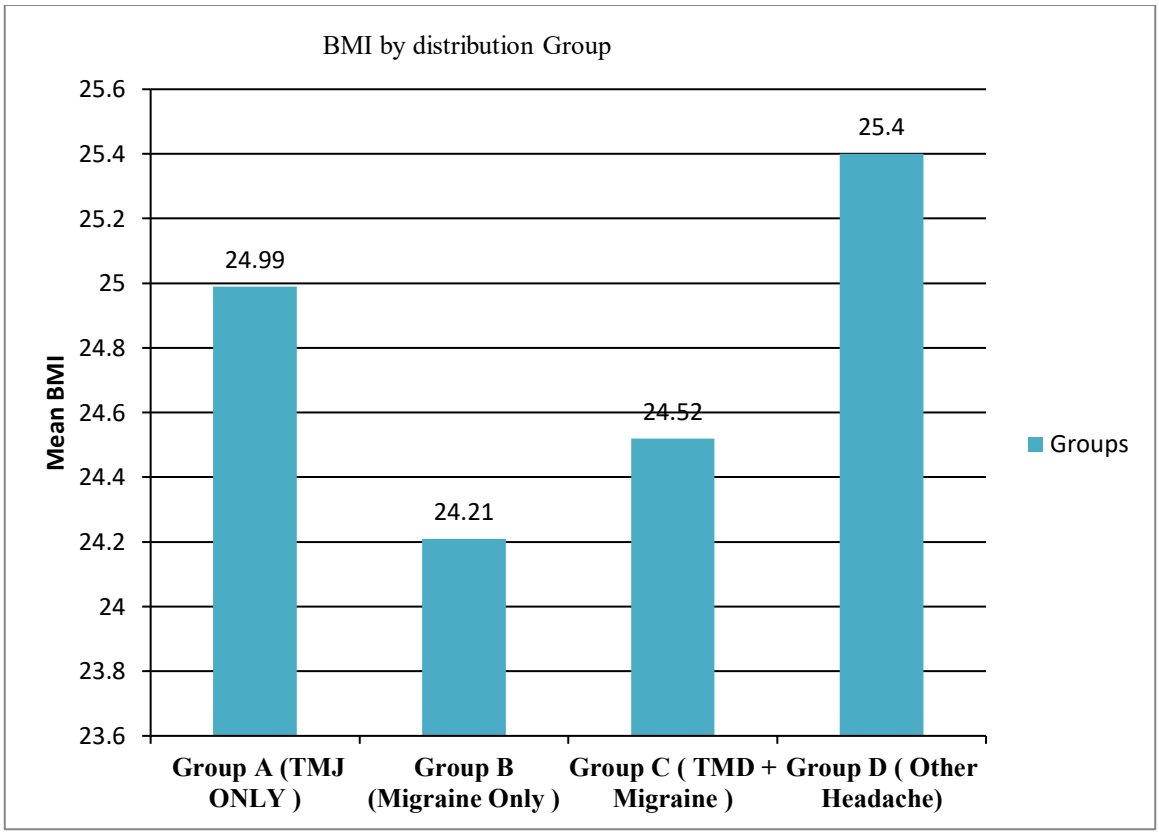


Group C (TMD + Migraine) was the single largest diagnostic group, accounting for one-third of the study population — indicating substantial clinical overlap between the two conditions.

Table 2 — Demographic Characteristics of the Study Population

Variable	Group A (n=35)	Group B (n=40)	Group C (n=55)	Group D (n=34)	Total (n=164)	p-value
Age, mean ± SD (yrs)	37.77 ± 11.99	40.75 ± 11.55	37.30 ± 11.11	36.52 ± 8.63	38.09 ± 10.97	0.312
Female, n (%)	19 (54.3%)	29 (72.5%)	34 (61.8%)	27 (79.4%)	109 (66.5%)	—
Male, n (%)	16 (45.7%)	11 (27.5%)	21 (38.2%)	7 (20.6%)	55 (33.5%)	—
BMI, mean ± SD (kg/m²)	24.99 ± 3.25	24.21 ± 3.47	24.51 ± 3.31	25.40 ± 3.52	24.73 ± 3.38	0.387





The clinical characteristics of the study population, namely the duration of TMJ symptoms, headache frequency and migraine sub types distribution by group are presented in the companion paper (Prajapati et al., "Clinical Burden and Physiotherapy Management of Temporomandibular Joint Dysfunction with Comorbid Migraine").

OUTCOME MEASURE RESULTS

Table 1. Group C recorded a headache frequency of 15.90 ± 4.40 days/month - approaching the internationally recognised chronic migraine threshold of 15 days/month used to define chronic migraine- nearly double the frequency seen in Group B alone.

Table 3 — VAS Score Distribution by Group

VAS Category	Group A	Group B	Group C	Group D	Total

Mild (0–3)	0 (0.0%)	3 (7.5%)	0 (0.0%)	6 (17.6%)	9 (5.5%)
Moderate (4–6)	23 (65.7%)	30 (75.0%)	6 (10.9%)	27 (79.4%)	86 (52.4%)
Severe (>6)	12 (34.3%)	7 (17.5%)	49 (89.1%)	1 (2.9%)	69 (42.1%)
Mean ± SD	5.72 ± 1.11	5.01 ± 1.10	**7.18 ± 0.97**	3.97 ± 1.18	5.68 ± 1.62

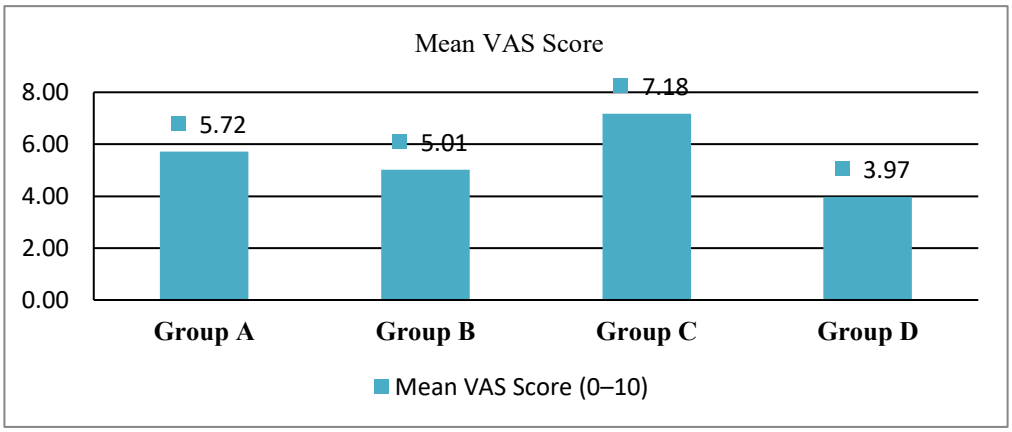


Table 4 — HIT-6 Score Distribution by Group

HIT-6 Category	Group A	Group B	Group C	Group D	Total
Little/No Impact (36–49)	0 (0.0%)	9 (22.5%)	0 (0.0%)	22 (64.7%)	31 (18.9%)
Some Impact (50–55)	18 (51.4%)	21 (52.5%)	0 (0.0%)	10 (29.4%)	49 (29.9%)
Substantial Impact (56–59)	7 (20.0%)	8 (20.0%)	3 (5.5%)	1 (2.9%)	19 (11.6%)
Severe Impact (≥60)	10 (28.6%)	2 (5.0%)	52 (94.5%)	1 (2.9%)	65 (39.6%)
Mean ± SD	56.02 ± 4.55	52.70 ± 4.35	**64.72 ± 3.93**	47.70 ± 5.14	56.77 ± 8.26

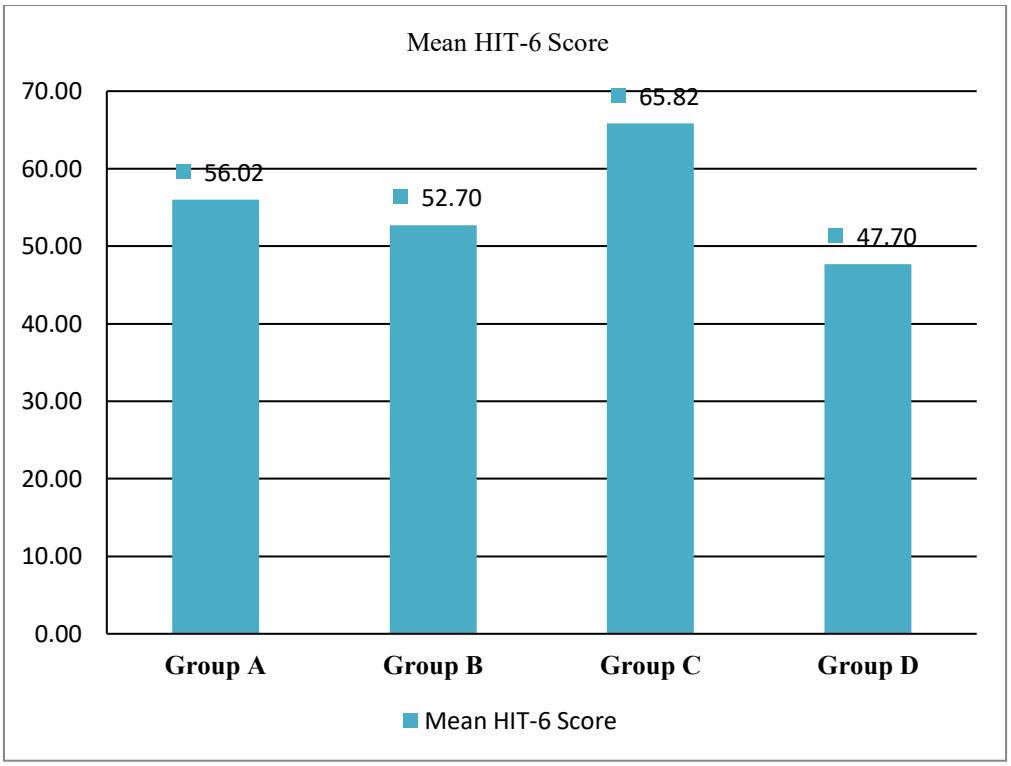


Figure 4.10 — HIT-6 Impact Category Distribution by Group (Stacked Bar)

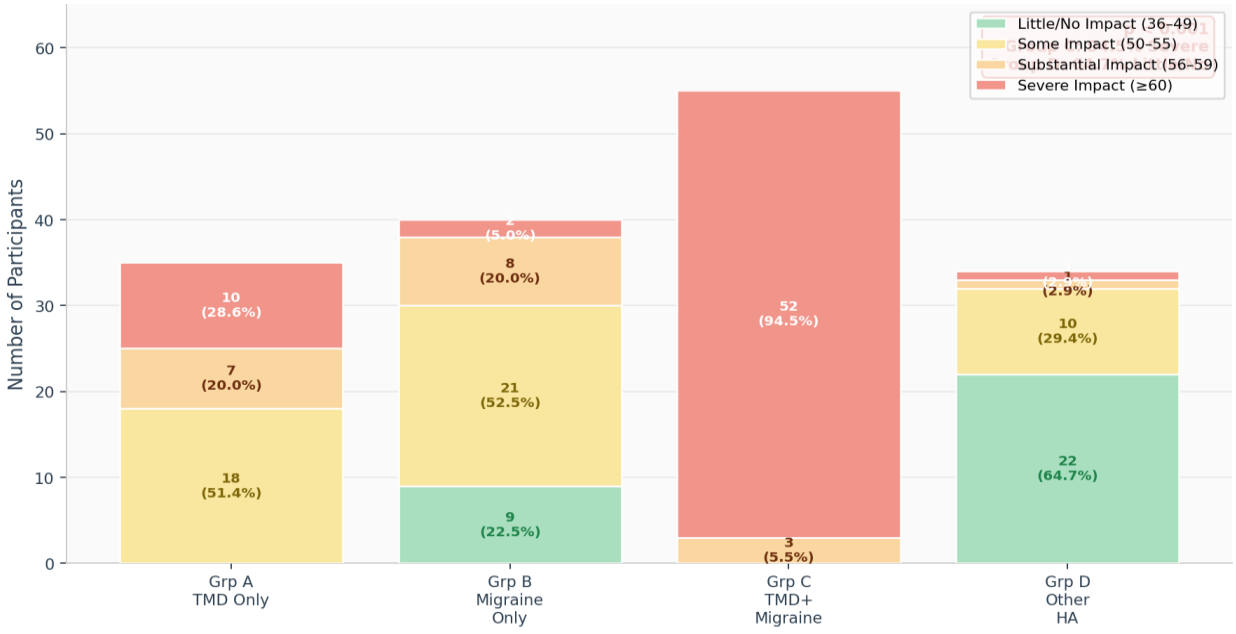


Table 5 — MIDAS Score Distribution by Group

MIDAS Grade	Group A	Group B	Group C	Group D	Total
Grade I — Little/No (0–5)	2 (5.7%)	6 (15.0%)	0 (0.0%)	23 (67.6%)	31 (18.9%)
Grade II — Mild (6–10)	10 (28.6%)	11 (27.5%)	0 (0.0%)	8 (23.5%)	29 (17.7%)
Grade III — Moderate (11–20)	23 (65.7%)	21 (52.5%)	3 (5.5%)	3 (8.8%)	50 (30.5%)
Grade IV — Severe (≥21)	0 (0.0%)	2 (5.0%)	52 (94.5%)	0 (0.0%)	54 (32.9%)
Mean ± SD	11.74 ± 3.92	11.37 ± 5.19	**27.45 ± 4.40**	4.32 ± 3.89	15.38 ± 10.03

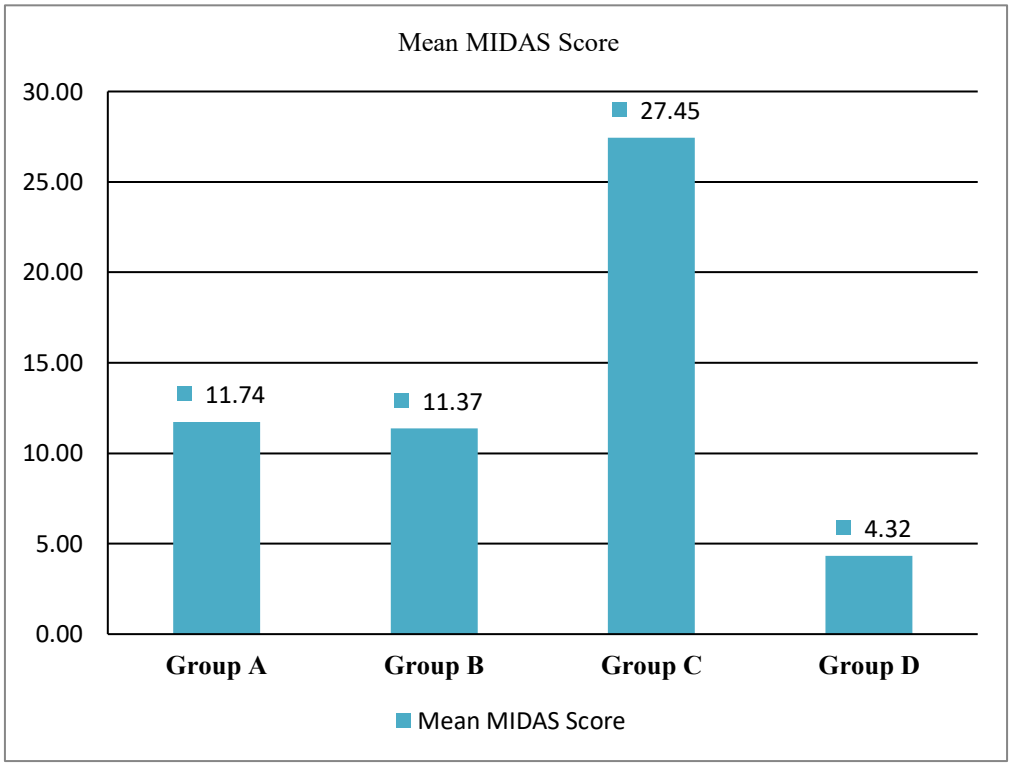
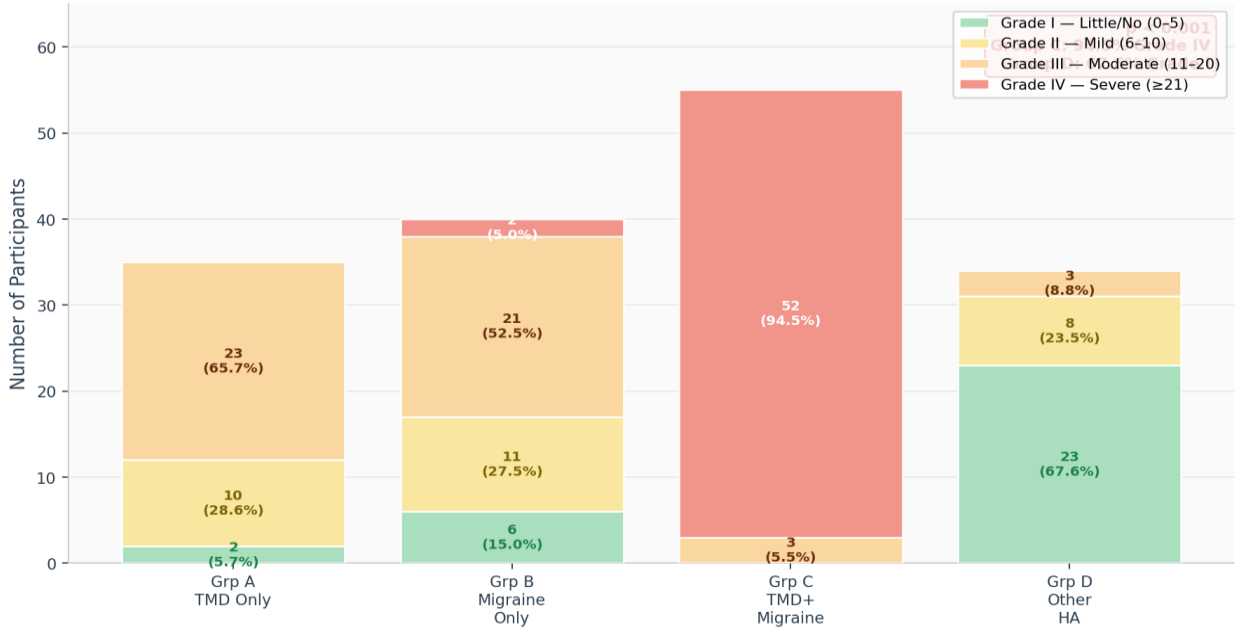


Figure 4.12 — MIDAS Disability Grade Distribution by Group (Stacked Bar)



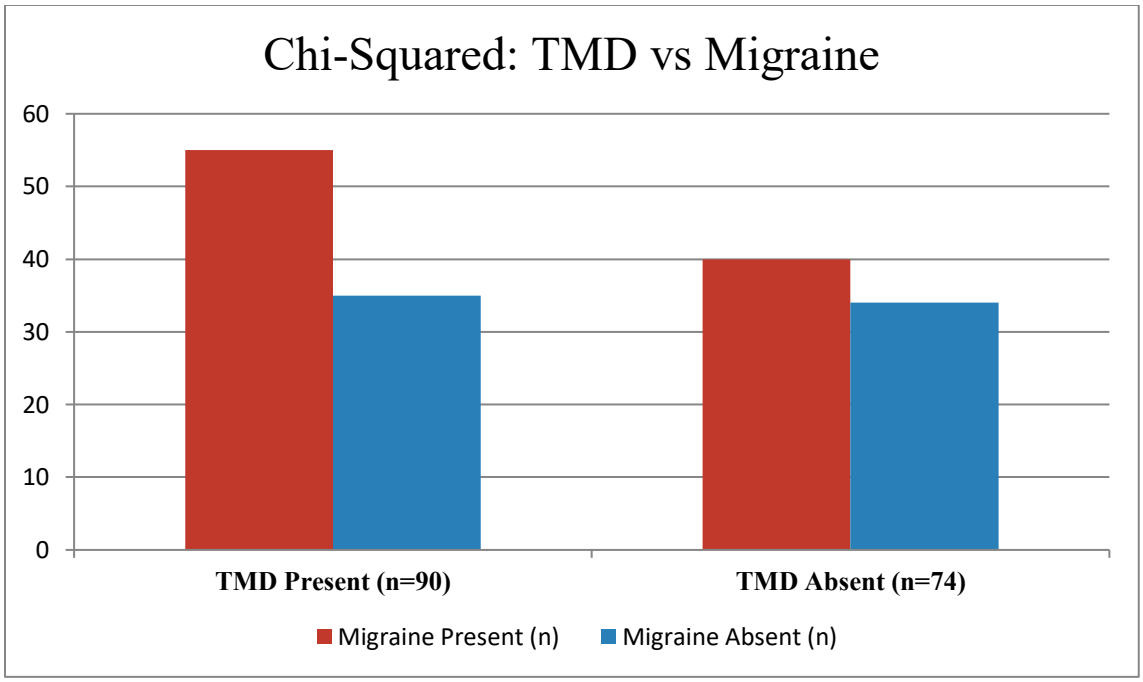
All inter-group difference across VAS, HIT-6 and MIDAS were statistically significant by Kruskal-Wallis test ($p < 0.001$), with Dunn`s post – hoc comparison confirming that Group C scored significantly higher than Group A,B and D on every measure.

Chi-Squared Analysis

Table 6 — Contingency Table: TMD vs. Migraine

	Migraine Present	Migraine Absent	Row Total
TMD Present	55 (61.1%)	35 (38.9%)	90
TMD Absent	40 (54.1%)	34 (45.9%)	74
Column Total	95 (57.9%)	69 (42.1%)	164

Result: $\chi^2 = 0.830$, df = 1, p = 0.362 (not significant), OR = 1.336 (95% CI: 0.72–2.49)



The binary presence/absence association was not significant. This is consistent with Ashraf et al. (2022) who also found no significant association between TMD-related pain and migraine during a follow-up, and attributed this to the variety of mechanisms underlying various TMD–headache subtypes[14]. A chi-square test is only a measure of co-occurrence, and cannot measure severity or chronicity, which is why the severity-based outcome measures above are of crucial importance in addition to the chi-square test.

DISCUSSION

This observational study assessed the association between TMD and migraine in 164 patients presenting with headache using categorical (chi-square) and severity-based (Kruskal–Wallis) analyses. Demographic matching across groups (age p=0.312, BMI p=0.387) contributes to the internal validity for between-group comparisons.

The marked predominance of females (66.5% overall) is similar to the established epidemiology of both conditions – Buse et al (2013) reported migraine is approximately three times more common in women compared to men[19] and TMD exhibits a comparable sex disparity, presumably linked to hormonal (estrogenic) influences.

The headache frequency of Group C (15.90 ± 4.40 days/month) is close to the ICHD-3 criterion for chronic migraine, and nearly double of Group B (migraine only).

consistent with findings of Byun et al. (2020) Longitudinal findings that TMD severity may modulate headache frequency[11]. Similarly, the 2.17-point VAS difference for Group C vs Group B is greater than the commonly cited minimum clinically important difference (~2 points) on a 0-10 scale; and is consistent with the case-control study by Fernandes et al. (2019) that showed that painful TMD is significantly associated with migraine, and that the concurrent management of both conditions is superior to managing the condition in isolation[12].

The HIT-6 and MIDAS result showed the same pattern : 94.5% of group C scored in the severe category on the HIT-6 and the majority scored in grade IV on the MIDAS compared with single digit percentages for group B. The 16.08-point MIDAS difference between the two groups is the largest observed between any two groups in this study and represents more than twice the disability contributed by migraine alone – consistent with Ballegaard et al. (2008) who reported that a large proportion of headache patients suffer from TMD-attributable disability[20].

The non- significant chi – square result (p = 0.362) initially appear to contradict these findings, but reflect a well known limitation of binary categorical testing: it captures presence and absence , not severity, duration, or functional consequence. Ashraf et al (2022) in a population-based cohort , reported a non- significant association between TMD related pain and incident migraine and attributed it to heterogeneous TMD headache mechanism[14] .The severity – based findings address this apparent tension:although TMD and migraine did not co-occur more often than chance in simple categotrical term, patient with both conditions carried a disproportionately higher burden of pain, headache impact, and disability than either condition alone.This combination – a non-significant categorical association alongside a strong severity based association, mirrors pattern seen for pain severity within the TMD group suggesting that TMD influences migraine cumulatively, consistent with the central sensitization model proposed by Grossi, Lipton and Bigal[21]. As the present findings are cross-sectional , this pattern should be interpreted as evidence compounded clinical burden rather than of causal or temporal relationship.

These findings carry direct implications for physiotherapy practice. Physiotherapists

should routinely screen for TMJ dysfunction in headache or migraine and vice versa so that interventions can be coordinated and delivered early. This is particularly important because TMD appear to function more as a peripheral nociceptive driver than as merely an incidental complication.

CONCLUSION

The overall crude association between TMD and migraine was not statistically significant, but severity-graded analysis shows that the association was strong: patients with coexisting TMD and migraine had the highest scores in the pain, headache-impact, and disability compared with all other diagnostic groups studied. TMD appears to be a consistent peripheral nociceptive factor that both the severity of migraine and increasing the risk of migraine 'chronicity', although the cross sectional design means it remains unclear whether this reflects a temporal or causal relationship. These findings support routine bidirectional screening for TMD in migraine patients and for migraine in TMD patients, and justify the early integration of physiotherapy into the management of this comorbidity.

Limitations: Purposive (non-probability) sampling may limit generalizability and introduce selection bias; limited sample size; cross-sectional design limits causal and temporal inference; reliance on self-reported questionnaires; limited follow-up.

Recommendations: Larger, multi-centre, prospective longitudinal studies with defined follow-up periods should allow for time-to-event analysis of migraine risk in TMD patients, imaging and biomechanical assessment should be included and cervical spine and postural contributions to the relationship between TMD and migraine should be explored.

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