



## ARE FATIGUE OF JOINT, NECK DISABILITY AND HEADACHE RELATED EACH OTHER IN TEMPOROMANDIBULAR DISORDERS?

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### ABSTRACT

The aim of this study was to investigate the relationship between fatigue of temporomandibular joint (TMJ), neck disability and headache in individuals who were separated into different groups according to the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD). A total of 77 subjects with TMD participated in the study. Individuals were divided into 3 groups according to the RDC/TMD; group 1: Muscle disorders (n=25), group 2: Disc displacement (n=27), group 3: Other joint diseases (n=25). After obtaining the sociodemographic information of individuals; fatigue of TMJ with the gum chewing test, neck disability with the Copenhagen Neck Functional Disability Scale (CNFDS), and headache with the Headache Impact Test (HIT-6) were assessed. In the correlation analysis of individuals with TMD; the significant low correlation among parameters.

When the current study and literature are investigated, there is a need for further research with high level of evidence.

**Keywords:** Headache, neck disability, fatigue, TMD, RDC/TMD

### 1. INTRODUCTION

TMD is a inclusionary term that contains such as pain in masticatory muscles and TMJ, headache, discomforts in jaw mobility and sounds in TMJ (Bono, Learreta, Rodriguez, & Marcos, 2014). The pain may become current different fields, such as the dental arches, ears, different regions of the head, cervical spine (Zakrzewska, 2013). TMD is mostly take place on the neck as the lateral support muscle imbalances leads to the inclination of the neck to the affected side (Kibana, Ishijima, & Hirai, 2002). In most instances, the parafunctional habits may aggravate the symptoms, and the symptoms are the reason for the increased tension of the masticatory muscles (Cuccia & Caradonna, 2009).

A painful muscle can reduce electromyographic activity in active contractions and motor unit discharge (Svensson, 2007). The cause of this reduction is the change in the agonist- antagonist movement pattern in the masticatory muscles. When maximum bite force is required, differences in affected muscles in

healthy individuals and individuals with TMD become more apparent (Ardizzone et al., 2010). Experimental and clinical studies have shown that there is a close functional relationship between the jaw and the neck sensory-motor system in temporomandibular joint activities (Eriksson, Zafar, & Nordh, 1998). This suggests that joint tiredness in individuals with TMD may be related to head and neck symptoms.

Evidence suggests that TMD is frequently associated with other head and neck conditions including cervical spine disorders and headache. 70 % of the neck pain cases are associated with TMD (Kraus, 2007; Padamsee, Mehta, Forgione, & Bansal, 1994). Neuroanatomical and functional connections between the masticatory and the cervical regions are discussed as the basis for concurrent jaw and neck symptoms (Perinetti, 2009; Wiesinger, Malke, Englund, & Wänman, 2009). Pain in the masticatory system may cause dysfunctions at the cervical column or vice versa (Kraus, 2007; Oliveira-Campelo, Rubens-Rebelatto, Martín-Vallejo, Albuquerque-Sendín, & Fernández-de-las-Peñas, 2010). In some studies supporting TMD and cervical spine relationship, it was shown that in addition to increased pain threshold of mechanical pressure in the neck region; the function of the cervical extensor muscles (Armijo-Olivo et al., 2012), neck pain with movement (Bevilaqua-Grossi, Chaves, & Oliveira, 2007; Weber et al., 2012), and pain on palpation of the cervical muscles are significantly worse in individuals with TMD (Fernández-de-Las-Peñas et al., 2009).

TMD and headache are closely related pathologies. The prevalence of headache in the general population is around 45% while the prevalence of headache in TMD individuals is between 48% and 77% (D'Urso, Serritella, Tolevski, Falisi, & Di, 2016; Glaros, Urban, & Locke, 2007; Mitirattanakul & Merrill, 2006; Stovner et al., 2007). According to some studies, there is a strong correlation between headache and TMD symptoms, such as joint sounds, pain during mandibular motion, pain in the temporomandibular region, depression, anxiety, and poor sleep quality (Caspersen et al., 2013).

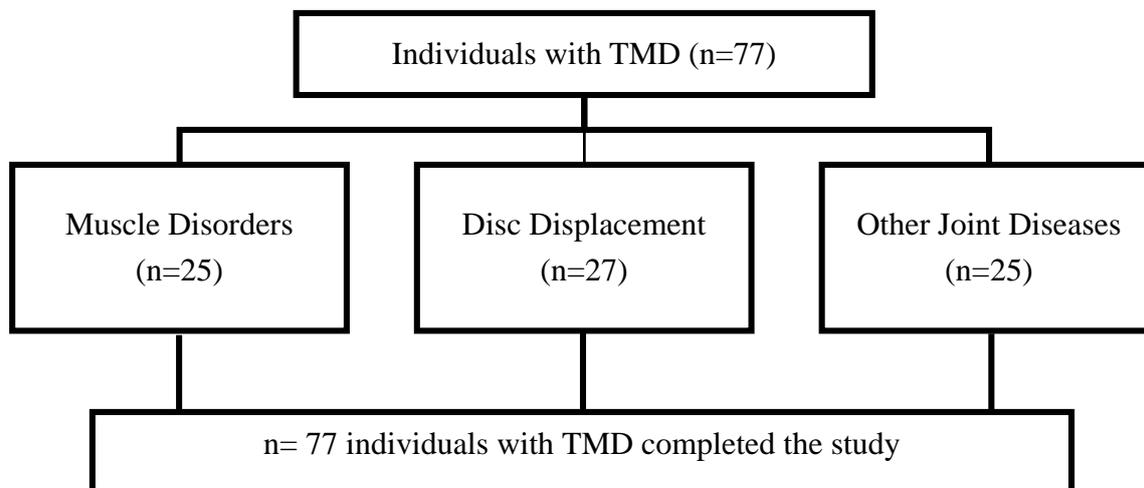
It is important to identify changes in motor behavior that can be seen in individuals who suffer from TMD. It is especially important to know the worsening of pain while chewing (von Piekartz & Lütke, 2011), the difficulties in jaw movement (Bevilaqua-Grossi, Chaves, De Oliveira, & Monteiro-Pedro, 2006), and the fatigue of the masticatory (Vitiello, Bonello, & Pollard, 2007). In addition to these, it is thought that the parameters related to TMD may be related to each other. Considering these situations, the aim of this study was to examine the relationship between fatigue of TMJ, neck disability, and headache in individuals divided into different groups according to TMD/RDC.

## **2. METHODS**

### **2.1. Sample Size**

This study was carried out on 77 individuals who applied for the first time to the Department of Oral and Maxillofacial Surgery, Faculty of Dentistry, at Ondokuz Mayıs University (OMU), between April 2017 and July 2017, and who were diagnosed with TMD by an oral and maxillofacial surgeon. Power analysis was performed by the statistician to determine the number of individuals included in the study. At the end of the power analysis, it was calculated that 90% power with 95% reliability could be obtained when at least 75 people (at least 25 people from each group) were included.

The individuals who were included in the evaluation, were separated into 3 groups according to RDC/TMD, radiographic and clinical evaluation: 1<sup>st</sup> group (n=25) with muscular disorders, 2<sup>nd</sup> group (n=27) with disc displacement, 3<sup>rd</sup> group (n=25) with other joint diseases. There were no breaks given during the assessment, and 77 individuals completed the study (Figure 1). The individuals who voluntarily participated in the study, and who were in one of RDC/TMD group classifications were included in the study. Individuals who had an acute trauma history or an operation history in TMJ who were not in any of the RDC/TMD classifications, who had a neurologic or psychiatric disorder, a trigeminal or postherpatic neuralgia presence, or a dental or orofacial infection were excluded from the study.



**Figure 1.** Participant flowchart

The study was evaluated by Ondokuz Mayıs University's Clinical Studies and Ethical Committee (No: 2017/83), and accepted to be ethically appropriate. Each individual was informed on the method and purpose of the study, and a voluntary consent form was signed for their participation in the study. For individuals under 18 years old, a consent form was signed by a parent.

## 2.2. Individual Evaluation Form

For determining the sociodemographic properties of individuals, information on age, gender, height, weight, Body Mass Index (BMI), complaint periods, side of chewing, bruxism, and teeth malocclusion were questioned.

## 2.3. Fatigue of Temporomandibular Joint

Gum chewing test was applied to evaluate fatigue of TMJ. Gum (3x1 grams) was chewed by individuals for 5 minutes. Fatigue levels in joint were assessed with the Visual Analogue Scale (VAS) (Häggman-Henrikson, Österlund, & Eriksson, 2004; Yoshida, Lobbezoo, Fueki, & Naeije, 2012).

## 2.4. Neck Disability

The Copenhagen Neck Functional Disability Scale (CNFDS) was used to assess the neck disability of individuals. It is a scale that assesses how neck pain affects the function of the neck, which consists of 15 questions. Questions 1 and 5 assess the severity of pain; questions 2-10 assess the disability in daily activities; questions 6, 9, 11, 13 and 14 assess social interaction and recreational activities; question 15 assesses the person's future perception of neck pain. Scoring: the questions 1-5 are "Yes" = 0, "Occasional" = 1 "No" = 2; the questions 6-15 are "Yes" = 2, "Occasional" = 1 "No" = 0. Total Score: 0 points = minimal disability, no disability; 30 points = maximum disability. The reliability and validity of the Turkish version of CNFDS was tested (Yapali, Günel, & Karahan, 2012).

## 2.5. Headache

The Headache Impact Test-6 (HIT-6) was used to question the headache symptoms of individuals. This test, consisting of 6 items, assesses the problems that arise due to headache in a wide range. It provides quantitative information on migraine and headache based on the patient's self-report. The scores of the scale are between 36 and 78. 1<sup>st</sup> degree score  $\leq 49$  means there is no influence, 2<sup>nd</sup> degree 50-55 means moderate effect, 3<sup>rd</sup> degree 56-59 has significant effect and 4<sup>th</sup> degree  $\geq 60$  is considered as severe effect. The Turkish translation of HIT-6 was performed (<http://www.headachetest.com/HIT6translations.html> HIT-6TM Turkey (Turkish) version, 2000).

## 2.6. Statistical Analysis

The data was analyzed using SPSS statistical package software. The continuous variables were expressed as average  $\pm$  standard deviation and the categorical variables were expressed as number and percentage. Whether the variables were appropriate to normal distribution or not was analyzed with the Shapiro-Wilk test. The differences between categorical variables were also analyzed using the Chi-square analysis. The relationships between numerical variables were analyzed with the Spearman correlation analysis. The levels of correlations are specified (Mukaka, 2012). In all analyses,  $p < 0.05$  was accepted to be statistically significant.

## 3. RESULTS

A total of 77 individuals who were classified according to RDC/TMD as only muscle disorders [group 1 (n=25)], only disc displacement [group 2 (n=27)], only osteoarthritis or osteoarthrosis [group 3 (n=25)] were included in the study. In order to ensure homogeneity in the groups, the individuals who only had single diagnosis were included. For the consistency of the assessment, individuals with multiple diagnosis were excluded.

**Table 1.** Descriptive Data Related to Age, Weight, Height, BMI and Some Symptoms of Individuals

		Muscle Disorders (n=25)	Disc Displacement (n=27)	Other Common Diseases (n=25)	Total (n=77)	P
Age (year)	Mean $\pm$ S.D.	25.52 $\pm$ 7.61	24.59 $\pm$ 7.82	48.6 $\pm$ 8.62	32.69 $\pm$ 13.64	<b>0.0001*</b>
Gender	Female Male	16 (%64) 9 (%36)	21 (%77.78) 6 (%22.22)	22 (%88) 3 (%12)	59 (%76.62) 18 (%23.38)	0.132
Kilogram (kg)	Mean $\pm$ S.D.	65.44 $\pm$ 12.57	65.26 $\pm$ 13.69	70.36 $\pm$ 12.92	66.97 $\pm$ 13.12	0.295
Height (cm)	Mean $\pm$ S.D.	167.96 $\pm$ 10.29	165.52 $\pm$ 6.9	161.88 $\pm$ 8.67	165.13 $\pm$ 8.92	0.118
BMI (kg/m <sup>2</sup> )	Mean $\pm$ S.D.	23.18 $\pm$ 3.69	23.66 $\pm$ 4.05	25.77 $\pm$ 4.33	24.19 $\pm$ 4.13	0.059
Complaint period (month)	Mean $\pm$ S.D.	22.36 $\pm$ 36.62	19.78 $\pm$ 29.96	20.12 $\pm$ 36.45	20.73 $\pm$ 33.93	0.91
Side of disorder	Right Left Bilateral	5 (%20) 7 (%28) 13 (%52)	10 (%37.04) 11 (%40.74) 6 (%22.22)	5 (%20) 13 (%52) 7 (%28)	20 (%25.97) 31 (%40.26) 26 (%33.77)	0.111
Presence of bruxism	Yes No	19 (%76) 6 (%24)	12 (%44.44) 15 (%55.56)	12 (%48) 13 (%52)	43 (%55.84) 34 (%44.16)	<b>0.046*</b>
Teeth malocclusion	Yes No	22 (%88) 3 (%12)	22 (%81.48) 5 (%18.52)	22 (%88) 3 (%12)	66 (%85.71) 11 (%14.29)	0.744
Side of chewing	Right Left Bilateral	12 (%48) 7 (%28) 6 (%24)	13 (%48.15) 7 (%25.93) 7 (%25.93)	9 (%36) 11 (%44) 5 (%20)	34 (%44.16) 25 (%32.47) 18 (%23.38)	0.682

\* $p < 0,05$  statistically significant difference; BMI: Body Mass Index; S.D.: Standart deviation; kg:Kilogram; cm: Santimeter; kg/m<sup>2</sup>: Kilogram/Meter<sup>2</sup>

Descriptive statistical values related to age, gender, weight, height, BMI, and some symptoms of the individuals were presented in Table 1. All of the 77 individuals in the study, female 59 (% 76.62), male 18 (% 23.38) with average age of 32.69  $\pm$  13.64. When age according to the groups were analyzed, ages of the individuals in group 3 were noticed to be significantly higher rather than the ones in group 1 and group 2 ( $p < 0.001$ ). The high that was age of individuals in group 3 with osteoarthritis and osteoarthrosis

was a expected outcome. There was no difference between the three groups in weight, height and BMI of values ( $p>0.05$ , Table 1).

**Table 2.** Correlation table for individuals with TMD

All individuals (n=77)	After chewing gum test (right)	After chewing gum test (left)	CNFDS	HIT-6
After chewing gum test (right)	1.000	<b>0.227*</b>	<b>0.323**</b>	<b>0.277*</b>
After chewing gum test (left)		1.000	0.155	<b>0.290*</b>
CNFDS			1.000	<b>0.491**</b>
HIT-6				1.000

\*\* $p<0,01$  statistically significant correlation; \* $p<0,05$  statistically significant correlation; CNFDS: Copenhagen Neck Functional Disability Scale; HIT-6: Headache Impact Test-6; Spearman Correlation Analysis

In the total of 77 individuals with TMD, there was a significant low correlation between fatigue of TMJ and neck disability ( $r=0.323$ ,  $p=0.004$ ), between fatigue of TMJ and headache ( $r=0.277$ ,  $p=0.015$  (right side);  $r=0.290$ ,  $p=0.011$  (left side)), and between neck disability and headache ( $r=0.491$ ,  $p=$ ) ( $p<0.05$ , Table 2.).

**Table 3.** Correlation Table for Group 1

Muscle Disorders (n=25)	After chewing gum test (right)	After chewing gum test (left)	CNFDS	HIT-6
After chewing gum test (right)	1.000	<b>0.580**</b>	0.057	0.247
After chewing gum test (left)		1.000	0.230	0.323
CNFDS			1.000	<b>0.432*</b>
HIT-6				1.000

\*\* $p<0,01$  statistically significant correlation; \* $p<0,05$  statistically significant correlation; CNFDS: Copenhagen Neck Functional Disability Scale; HIT-6: Headache Impact Test-6; Spearman Correlation Analysis

Table 3 displays that there was a significant low correlation between neck disability and headache ( $r=0.432$ ,  $p=0.031$ ) in group 1.

**Table 4.** Correlation Table for Group 2

Disc Displacements (n=27)	After chewing gum test (right)	After chewing gum test (left)	CNFDS	HIT-6
After chewing gum test (right)	1.000	0.166	<b>0.562**</b>	0.329
After chewing gum test (left)		1.000	0.201	0.149
CNFDS			1.000	<b>0.521**</b>
HIT-6				1.000

\*\* $p < 0,01$  statistically significant correlation; \* $p < 0,05$  statistically significant correlation; CNFDS: Copenhagen Neck Functional Disability Scale; HIT-6: Headache Impact Test-6; Spearman Correlation Analysis

It was found that the significant moderate correlation between neck disability and headache ( $r = 0.521$ ,  $p = 0.005$ ), and between neck disability and fatigue of TMJ ( $r = 0.562$ ,  $p = 0.002$ ) in group 2 ( $p < 0.05$ , Table 4.).

**Table 5.** Correlation Table for Group 3

Other Common Diseases (n=25)	After chewing gum test (right)	After chewing gum test (left)	CNFDS	HIT-6
After chewing gum test (right)	1.000	0.088	0.388	0.238
After chewing gum test (left)		1.000	-0.085	0.321
CNFDS			1.000	<b>0.533**</b>
HIT-6				1.000

\*\* $p < 0,01$  statistically significant correlation; \* $p < 0,05$  statistically significant correlation; CNFDS: Copenhagen Neck Functional Disability Scale; HIT-6: Headache Impact Test-6; Spearman Correlation Analysis

There was a significant moderate correlation between neck disability and headache ( $r = 0.533$ ,  $p = 0.006$ ) in group 3 ( $p < 0.05$ , Table 5.).

#### 4. DISCUSSION

The results of present study which was performed to investigate the relationship between fatigue of TMJ, neck disability, and headache in patients with TMD in different groups according to RDC/TMD showed a significant correlation between these parameters.

Kılınç et al. (Kılınç, Ulusoy, & Ergun, 2015) has examined the acute effect of muscular fatigue formed in the cervical region in healthy women to the TMJ region. It has been noted that the pain threshold and resting tiredness will have an acute negative effect on the maximum painless mouth opening. It has also been found that fatigue on the chewing muscles increases after the fatigue protocol. Haggman-Henrikson et al. (Häggman-Henrikson et al., 2004) have measured the endurance of chewing muscles with gum chewing test by comparing whiplash with TMD and healthy individuals. It has been emphasized that decreased functional capacity in the jaw and neck muscles is associated with fatigue. In present study, all individuals with TMD had a significant correlation between fatigue of TMJ and the CNFDS score, and between fatigue of TMJ and headache. Although muscular tiredness had a negative effect on neck mobility, it was observed that controlled and continuous chewing movements biomechanically relieved TMJ in these individuals.

Studies in the literature suggest that there is a strong correlation between neck disorders and TMJ dysfunction. It has been noted that changes in one of these conditions can affect the other (Olivo et al., 2010; A Silveira, Gadotti, Armijo-Olivo, Biasotto-Gonzalez, & Magee, 2015). Silveira et al. (Anelise Silveira, Armijo-Olivo, Gadotti, & Magee, 2014) found a strong correlation between neck and jaw disorders in their study performed on 20 women with TMD. Gill-Martinez et al. (Gil-Martínez et al., 2016) showed a correlation between craniofacial disorder, neck disorder and headache. In current study, there was a correlation between neck disability and fatigue of TMJ, and between neck disability and headache in individuals with TMD. This relationship is expected as a result of the muscular, biomechanics and functional connections.

TMD and headache association are bidirectional. The presence of headache increases TMD prevalence and presence of TMD increases headache prevalence (Speciali & Dach, 2015). While the prevalence of

headache in the general population is around 45%, the prevalence of headache in the population with TMD ranges from 48% to 77% (19). Di Paolo et al. (Di Paolo et al., 2017) found that the prevalence of headache was 67.3% in individuals with TMD. The etiologic theory proposed for the relationship between headache and TMD is that the dysfunction of the masticatory system can occur as a result. Lynn and Mazzocco (Lynn & Mazzocco, 1993) have defined the existence of the interaction between the structures of the craniomandibular complex. They noted that when there is an imbalance between muscle groups, physiological changes that cause tension type headache symptoms occur. Goncalves et al. (Gonçalves et al., 2013) has found that the headache and TMD relationship in muscular form is higher than the other forms of TMD. As a result of present study, it was observed that there was a correlation between headache and neck disability, and between headache and fatigue of TMJ in individuals with TMD. The TMJ is innervated by the trigeminal nerve. This nerve also plays a role in motor and sensory innervation of the muscles that control the joint. Although innervation is mainly provided by the auriculotemporal nerve, deep temporal and masseteric nerves provide additional innervation (Okeson, 2014). It is thought that the sensitivity of nociceptive receptors may increase by fatigue occurring in the masticatory muscles, and this condition may lead to headache due to the central hyperexcitability of the neurons in the dorsal horn of the spinal cord by affecting the trigeminal nucleus.

The fact that we do not have a control group is a limitation of current study. Differences with the control group can reveal clearer data. However, the study was conducted with the consideration that the parameters mentioned were affected by individuals with TMD. Studies should also be conducted on the control group. Another limitation is that measurement methods are subjective. There is a need for extensive studies to be done with more objective measurements.

## 5. CONCLUSIONS

Based on this study, evaluated parameters in individuals with TMD showed significant low and moderate correlations with each other. When the current study and literature are investigated, there is a need for further research with high level of evidence.

### Clinical Relevance

This study points out that different groups of temporomandibular disorders are related to many parameters. Health professionals should be aware of these conditions.

### Authors' Contributions

HA: has the main responsibility for the study and manuscript preparation, she designed the study and controlled the data collection. MS: designed and controlled the study. BB: is a member of the department, and her ideas helped. All authors read and approved the final manuscript.

### Conflict of Interest

The authors declare that they have no conflict of interest.

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