The Neck Disability Index Is Not Correlated with Some Parameters of Temporomandibular Disorders: A Cross-Sectional Study

Jacob N. Thorp, DHS, PT, OCS
Department of Physical Therapy
East Carolina University
Greenville, North Carolina, USA

John Willson, PhD, PT
Department of Physical Therapy
East Carolina University
Greenville, North Carolina, USA

Correspondence to:
Dr Jacob N. Thorp
East Carolina University
Department of Physical Therapy
Mail Stop 668, 600 Moye Blvd
Greenville, NC 27834, USA
Fax: (252) 744-6240
Email: thorpja@ecu.edu

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Aims: To test whether the Neck Disability Index (NDI) would indicate higher reported disability among people with neck pain, cervicogenic headache, and temporomandibular disorders (TMD) when compared to people with only neck pain or neck pain with cervicogenic headache. **Methods:** A total of 62 participants were enrolled and categorized into one of three groups: *(1)* neck pain only; *(2)* neck pain and cervicogenic headache; and *(3)* neck pain, cervicogenic headache, and TMD. NDI scores, pain, cervical active range of motion (AROM), and maximum mouth opening (MMO) were recorded for each subject. NDI scores were compared between groups using the Kruskal-Wallis test, and associations between the NDI and pain, cervical AROM, and MMO were tested using Pearson correlations. **Results:** No statistical difference in NDI score was identified among the three groups ($P = .08$). NDI scores were not correlated with MMO ($P = .17$) or TMD pain ($P = .16$), but were correlated with cervical AROM ($r = -0.635$ to -0.311), cervicogenic headache intensity ($r = 0.355$; $P = .004$), and cervical pain ratings ($r = 0.619$; $P < .001$) across all participants. **Conclusion:** Participants' perceived disabilities were not associated with TMD pain or MMO. The NDI does not seem adequate for assessing TMD symptoms. *J Oral Facial Pain Headache 2019;33:39–46. doi: 10.11607/ofph.1992*

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It has been estimated that 30% to 50% of adults have neck pain in any given year.[1] Mechanical neck pain can be caused by a specific injury or overuse. People with neck pain have reported decreased cervical active range of motion (AROM), difficulty concentrating, and limitations in daily activities at home and work. Neck pain has also been reported to cause poor oral habits, resulting in adverse effects on the temporomandibular joint (TMJ) and related structures, which can in turn result in temporomandibular disorders (TMD).[2] Poor oral habits (or parafunctional activities) include biting or chewing nonedible objects (such as pencils or fingernails), clenching of the teeth, or mouth breathing. von Piekartz and Lüdtke[3] have reported that 44.1% of patients with neck pain also have TMD.

Neurophysiologic, biomechanical, and functional associations have been identified among the head, cervical spine, and TMJ regions.[4–7] Specifically, the trigeminocervical nucleus, which is located in the upper cervical spine, has been shown to mediate neurophysiologic relationships between the cervical and craniomandibular areas.[2] This upper cervical region not only receives C1–C3 afferent inputs—which provide sensation to the skin, ligaments, and adjacent joints—but also receives afferents in cranial nerve 5. The trigeminal nerve is responsible for both motor and sensory innervation of the muscles controlling the TMJ and the face; thus, pain and dysfunction in the cervical spine can potentially affect TMD complaints, and vice versa.[2,8] Furthermore, myofascial trigger points in the cervical spine have been shown to refer pain to the facial area.[9,10] Similarly, Mellick and Mellick[11] reported relief of head and face pain following anesthetic injections into the neck muscles.

Temporomandibular disorders (TMD) are the leading cause of nondental chronic pain.[12] TMD was first accepted as a medical diagnosis by the American Dental Association in 1983. Approximately 40% of the US population experience some form of TMD symptoms at any given time.[13] Typical symptoms include audible or palpable noise during TMJ movements, pain in the lateral face and TMJ region, and painful or limited movement, which can affect a person's quality of life, including social and work interactions.[12] People with chronic TMD symptoms are more likely to have cervical pain compared to those without TMD[14]; approximately 70% of people with a primary complaint of TMD have also reported neck pain.[2]

In 1992, Dworkin and LeResche created the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD) to assist clinicians in categorizing patients with TMD.[15] Approximately 20 years later, Schiffman et al provided an updated, simplified version, the Diagnostic Criteria for TMD (DC/TMD).[16] The DC/TMD includes two separate Axes: Axis I details the physical body function and structure, and Axis II is used to describe psychosocial components. Three groups are used within Axis I: muscle disorder; disc displacement; and joint disorder. Practitioners using the DC/TMD classification model have reported excellent inter-examiner reliability for any muscle/disc disorder or joint pain.[16]

Cervicogenic and tension-type headaches have also been shown to be commonly associated with neck pain.[3,17] Cervicogenic headache is the result of neck dysfunction that manifests into a headache. Pain in the cervical facet joints[18–21] and pathologies involving the intervertebral discs[22–24] have been shown to contribute to cervicogenic headache. Tension-type headaches have a prevalence rate of 14.2 per 1,000 people.[25] While tension-type headache can have multiple contributing factors, pain caused by cervical muscle involvement is thought to be a primary cause.[26–30]

To quantify the effects of patients' reported pain and perceived disability associated with their primary medical problems, health care providers often administer standardized questionnaires. Originally published in 1991, the Neck Disability Index (NDI) is the most commonly used disability questionnaire for people who report neck pain.[31–34] The NDI is a 10-item ordinal scale questionnaire that can be applied in both clinical and research settings.[3,17,33,34] This one-dimensional evaluation provides an objective assessment of patients' perceived disability related to their neck pain.[33–39] Each item is scored from 0 (no pain or limitations with a particular task) to 5 (severe and disabling pain or unable to complete the activity). The sum of patient responses is expressed as a percentage of the maximum possible score. A higher score indicates higher perceived disability.[31]

Although the NDI has been commonly used to assess clinical outcomes in participants with neck pain, no studies were identified that used only the NDI to assess pain in other areas of the craniofacial region. A total of six published questionnaires that assess pain and function in the craniofacial region were identified.[40–45] The Jaw Functional Limitation Scale (JFS) has been previously correlated with the NDI,[46,47] but both questionnaires were needed to assess their respective regions of pain. Additionally, the Craniofacial Pain and Disability Inventory (CF-PDI) has been reported to assess pain associated with both TMD and cervical problems.[40] While this questionnaire was strongly correlated with the NDI, 19 of its 21 questions address TMJ-related features, and the remaining 2 only ask about the frequency of neck and head pain.[40]

The aim of this study was to test whether the NDI would indicate higher reported disability among people with neck pain, cervicogenic headache, and TMD when compared to people with only neck pain or neck pain with cervicogenic headache. Knowledge of these results may provide insight into how disability relates to various pathologies of the head, TMJ, and neck region, which could be valuable in future research to study correlations of participants' perceived disability in people with pain related to both TMD and neck dysfunction. It is also important to know whether the NDI could be used to adequately assess disability regardless of whether the primary problem is neck pain, TMD, or cervicogenic headache. The use of a single questionnaire to assess the entire craniofacial region could assist in eliminating unnecessary documentation associated with multiple intake surveys.

Materials and Methods

This study was approved by the Institutional Review Board at East Carolina University in Greenville, North Carolina, USA.

Participants

The research study was explained to each participant prior to data collection, and he or she gave informed consent. All participants referred to university-based outpatient orthopedic physical therapy from June 2016 through November 2016 were considered for inclusion. The inclusion criterion was a medical diagnosis of cervicogenic headache, mechanical neck pain, and/or TMD. The same researcher (J.T.) performed the entire clinical examination and administered the NDI. This researcher is a licensed physical therapist and a board-certified orthopedic specialist who has been practicing physical therapy for 20 years and whose clinical practice specializes

in the management of chronic pain. Participants with a diagnosis of cervicogenic headache were referred by a neurologist who specializes in management of cervicogenic headache, and each participant was screened to ensure he or she met the International Headache Society (IHS) classification guidelines for secondary headache as a result of cervical involvement.[18] Jull et al[48] have also established a cluster of examination findings to differentiate cervicogenic headache from migraine or tension-type headache. This examination rubric identifies cervicogenic headache in individuals with decreased cervical AROM, pain with upper cervical segmental mobility testing, and reduced cervical muscle strength and has been reported to have 100% sensitivity and 94% specificity.[48] The current study only categorized participants with cervicogenic headache if these secondary headaches were related to cervical involvement. Inclusion of neck pain was determined when participants reported pain during cervical AROM of the neck during daily activities and also reported pain that decreased during periods of rest.

Participants were given a diagnosis of TMD if they met the criteria for Axis I diagnoses involving masticatory muscle disorders and/or disc displacements.[16] A diagnosis of myalgia was made if the patient had a positive history of masseter and/or temporalis muscle pain in the past month and familiar pain provocation with extraoral palpation of either of these muscles. Participants were classified with TMD involving disc displacement (Group II) if they were identified to have a palpable and/or audible reciprocal click on at least one of three trials of maximum mouth opening (MMO) and reported pain in the TMJ region in the past month. The diagnostic criteria for these TMD categories used by physical therapists have been described in a previous study.[49]

Participants had to be at least 18 years old and without a history of neck or TMJ surgery. Participants with a pacemaker were excluded, as the instrument for assessing cervical AROM included a magnet that was draped around the neck and close to the heart. The age and gender of each participant were also recorded.

Pain Assessment

For each area of reported involvement (neck pain, cervicogenic headache, and TMD), the participants were asked to provide two responses. First, the study subjects were asked to rate their average pain in the past week. Participants were given an 11-point verbal pain rating scale (VPRS) on which 0 indicated no pain and 10 indicated the worst pain imaginable. Pain associated with TMD was identified, defined as pain in the face, jaw, temple, in front of the ear, or in the ear.[15,50] Participants were also asked to report the approximate month and year of onset of their pain in each regional area. Their responses were recorded in months from the time of onset to the time of this study interview. If participants could only recall the year their pain began, the months were calculated based on the current month; for example, if the subject was being interviewed in July and he or she stated their pain began in 2007, then the onset was recorded as July 2007.

Range of Motion

Cervical AROM and MMO were measured in all participants. Prior to measuring cervical AROM and maximum mouth opening (MMO), each participant was asked to sit in a neutral posture as previously described by La Touche et al.[51] Participants sat on a chair and placed their feet flat on the floor and were given verbal instructions to "sit up straight." Additionally, tactile cues were used to ensure the external auditory meatus was in line with the acromion of the shoulder. MMO was the only motion assessed that involved the TMJ. Both the cervical AROM and MMO assessments were previously described by Norkin and White.[52]

For each motion, the participants were asked to move as far as they could tolerate. Cervical AROM was measured using a cervical range of motion device (CROM) (Performance Attainment Associates). The motions assessed in the cervical spine were flexion, extension, bending of the left side, bending of the right side, left rotation, and right rotation. The CROM has been shown to have good reliability and validity for assessing cervical motion.[53,54] Audette et al[53] reported a correlation of 0.93 to 0.98 when comparing the CROM to the Fastrak motion analysis system in all six directions of cervical AROM. Additionally, Williams et al[54] completed a systematic review and found the CROM to have good reliability for the measurement of neck AROM. A standard ruler (millimeters) was used to measure MMO. First, to determine overbite, the participant closed his or her mouth, and a horizontal line was drawn across the mandibular incisors where the maxillary incisors were noted to overlap. The amount of overbite was recorded as the distance from the horizontal line to the top edge of the mandibular incisors. Each participant was then asked to "open your mouth as wide as you can." The ruler was used to measure the vertical distance between the inferior edge of the maxillary central incisor and the corresponding edge of the superior edge of the mandibular central incisor. This distance was added to the amount of overbite to produce the final measurement for MMO. This method has been shown to have good to excellent reliability, with intraclass correlation coefficients (ICCs) ranging from 0.87 to 0.99.[55–57]

Table 1 Correlations of Neck Disability Index with Verbal Pain Rating Scale Intensity and Duration of Symptoms Across All Groups

	Correlation	
Region of pain	*r*	*P*
Neck pain		
Intensity	.619	< .001
Duration of symptoms	–.126	.32
Cervicogenic headache		
Intensity	.355	.004
Duration of symptoms	–.190	.13
TMD pain		
Intensity	–.176	.16
Duration of symptoms	–.181	.15

Neck Disability Index

The NDI was verbally administered to all participants. Each participant was told to answer the questions based on his or her status during the past week. The NDI includes seven statements related to activities of daily living, two related to pain, and one assessing concentration. Each statement, followed by the six possible answers, was read to the participant. Answers ranged from 0 (no limitations) to 5 (activity or task could not be completed). Once the participant had rated all items, the scores were totaled and expressed as a percentage of the maximum score possible. The percentage was recorded as the participants' perceived disability level. All questions were answered by all the participants. The scoring system has been previously described.[33]

The NDI has been shown to have good psychometric properties (valid, reliable, responsive) specifically for use in conservative medical management of patients with neck pain.[32–34] Young et al[32] reported a moderate reliability for the test-retest ability of the NDI (ICC: 0.64; 95% confidence interval [CI]: 0.19 to 0.84). As of late 2007, the NDI has been used in nearly 300 publications and translated into 22 languages.[33,34]

Statistical Analyses

Following data collection, participants were categorized into one of three groups based on their subjective pain complaints: *(1)* neck pain only; *(2)* neck pain and cervicogenic headache; and *(3)* neck pain, cervicogenic headache, and TMD. The Kruskal-Wallis test was used to compare NDI scores and ages between groups with Dunn-Bonferroni post hoc tests in the case of a significant Kruskal-Wallis test result. The correlations between the NDI scores and cervical AROM, MMO, pain, and duration of symptoms were evaluated using Pearson correlation coefficients. Significance was set at $\alpha = .05$ for all statistical analyses. SPSS version 22 was used to perform the statistical analyses.

Results

Participants

A total of 62 participants met the inclusion criteria and agreed to participate. The entire study population included 18 males and 44 females. Group 1 had 17 participants with a mean (± standard deviation [SD]) age of 57.53 ± 9.55 years. The 30 participants in group 2 reported a mean age of 50.63 ± 17.46 years. The remaining 15 participants, comprising group 3, had a mean age of 39.47 ± 17.45 years. Participants in group 3 were significantly younger compared to those in group 1 (Dunn-Bonferroni post hoc test $P = .002$), but not compared to group 2 ($P = .13$). The age of the participants in group 1 was not different than in group 2 ($P = .21$). Across all participants, age was not correlated with NDI score ($r = 0.049$, $P = .70$).

NDI scores for groups 1 to 3 were 29.24% ± 17.17%, 38.62% ± 17.65%, and 27.47% ± 11.25%, respectively. There was no significant difference in NDI scores among the three groups ($P = .08$). NDI scores were not significantly correlated with TMD pain ($P = .16$) or MMO ($P = .17$). Additionally, NDI scores were not correlated with duration of symptoms for neck pain, cervicogenic headache, or TMD; however, they were positively correlated with both neck pain intensity ($r = 0.619$; $P < .001$) and cervicogenic headache pain rating ($r = 0.355$; $P = .004$) across all participants. Tables 1 and 2 provide additional details of correlation findings for NDI with duration of symptoms across all participants and with VPRS by group. Negative correlations were significant between NDI scores and all cervical AROM measurements ($r = -0.31$ to -0.64; $P \leq .01$). Table 3 provides additional details on correlations of NDI scores with cervical AROM and MMO across all participants.

Correlations Within Group 1

The mean neck pain in the past week reported by participants in group 1 was 4.41 ± 2.48, and this value was positively correlated with the NDI scores ($r = 0.51$; $P = .04$). The mean duration of neck pain was 15.71 ± 18.64 months, and this was not correlated with NDI scores ($P = .12$).

Negative correlations were observed between NDI scores and cervical AROM measures ($r = -0.30$ to -0.665; $P = .004$ to $.04$) and MMO ($r = -0.53$; $P = .03$). Only cervical right rotation was not correlated with NDI scores ($r = -0.30$; $P = .24$).

Correlations Within Group 2

Participants in group 2 reported a mean VPRS neck pain of 5.37 ± 2.51, and this was positively correlated with the NDI ($r = 0.67$; $P = .001$). The mean

Table 2 Correlations of Neck Disability Index with Verbal Pain Rating Scale and Duration of Symptoms by Group

Group	Neck pain[a]	Duration of neck pain symptoms[b]	Cervicogenic headache[a]	Duration of cervicogenic headache symptoms[b]	TMD pain[a]	Duration of TMD symptoms[b]
1	4.41 ± 2.48; r = 0.514; P = .04	15.71 ± 18.64; r = 0.396; P = .12	NA	NA	NA	NA
2	5.37 ± 2.51; r = 0.665; P = .001	23.03 ± 47.03; r = 0.038; P = .84	4.37 ± 1.99; r = 0.514; P = .004	16.10 ± 41.65; r = 0.149; P = .43	NA	NA
3	3.4 ± 2.1; r = 0.3; P = .28	119.67 ± 124.11; r = −0.392; P = .15	4.13 ± 2.1; r = 0.463; P = .08	113.73 ± 124.66; r = −0.49; P = .06	2.53 ± 1.81; r = 0.106; P = .71	71.27 ± 50.88; r = −0.075; P = .79

[a]Values are mean ± standard deviation measured on 11-point VPRS.
[b]Values are mean ± standard deviation measured in months.

cervicogenic headache intensity was reported to be 4.37 ± 1.99, and this value was positively correlated with the NDI (r = 0.51; P = .004). The mean duration of neck pain for group 2 was 23.03 ± 47.03 months, and this was not correlated with the NDI (P = .84). Group 2 reported a history of cervicogenic headache for 16.10 ± 41.65 months, which was not correlated with the NDI (P = .43). This group had negative correlations with all cervical AROM and the NDI (r = −0.17 to −0.65; P = .001 to .01). Additionally, no correlation was found between NDI score and MMO (P = .37).

Correlations Within Group 3

Group 3 reported the lowest cervical VPRS and NDI scores of 3.4 ± 2.1 and 27.47 ± 11.25, respectively. However, the NDI was not correlated with VPRS scores related to the cervical spine (P = .28), cervicogenic headache (P = .08), or TMD (P = .71). The mean duration of neck pain was 119.67 ± 124.11 months. These participants reported a mean history of cervicogenic headache for the past 113.73 ± 124.66 months and a mean duration of TMD pain for 71.27 ± 50.88 months. The mean reported TMD pain intensity was 2.53 ± 1.81. The NDI was only correlated with cervical extension (P = .02; r = −0.591). The other ranges of cervical motion were not significantly correlated with the NDI (P = .07 to .94). Additionally, neither MMO (P = .93) nor pain (P = .71) were correlated with the NDI scores in group 3.

Discussion

The aim of this study was to test whether the NDI would indicate higher reported disability among people with neck pain, cervicogenic headache, and TMD when compared to people with only neck pain or neck pain with cervicogenic headache. The present study showed significant inverse correlations of the NDI with all cervical AROM across all participants. The

Table 3 Correlation Between Cervical Active Range of Motion (AROM) and Neck Disability Index (NDI) Across All Participants

		Correlation with NDI	
Movement	AROM	r	P
Left side–bending[a]	34.16 ± 11.02	−0.43	.001
Right side–bending[a]	31.81 ± 12.25	−0.55	.001
Left rotation[a]	52.42 ± 16.24	−0.39	.001
Right rotation[a]	51.71 ± 16.38	−0.31	.01
Flexion[a]	40.68 ± 15.79	−0.51	.001
Extension[a]	44.21 ± 18.29	−0.64	.001
MMO[b]	41.7 ± 11.92	−0.17	.17

MMO = maximum mouth opening.
[a]Values are mean ± standard deviation measured in degrees.
[b]Value is mean ± standard deviation measured in millimeters.

NDI score was also correlated with both neck pain and cervicogenic headache intensity ratings for all participants; that is to say, participants who reported increased neck pain and cervicogenic headache intensity also reported increased perceived disability. However, TMD pain and MMO were not correlated with perceived disability among any of the participants.

The NDI scores were not significantly different between any of the groups. There was a 9.4% difference in NDI scores between groups 1 and 2 (29.24% and 38.62%, respectively; P = .12). It is notable that this difference in NDI scores was both statistically insignificant and less than the minimum clinically important difference needed to detect a significant change.[58] This suggests that the number of affected body regions does not influence NDI scores in a statistical or clinically relevant manner.

The results of this study also showed that group 3 reported the lowest score (least amount of perceived disability) compared to the other two groups. One explanation could be due to the fact that the NDI does not ask any questions related to TMD or oral functions. Another potential reason that the NDI was not correlated with group 3 was that the participants in

group 3 also reported the lowest mean neck pain intensity on the VPRS (3.4) compared to the other two groups (4.41 and 5.37 for groups 1 and 2, respectively). The present study supports the evidence that the NDI has been designed to assess only neck pain and its related impact on function.

It has been previously established that the peak occurrence of TMD is between the ages of 20 and 40 years.[59] In the present study, participants with TMD (group 3) had a mean age of 39.47 years, which was 18 and 11 years younger than groups 1 and 2, respectively. Participants in group 2 were younger than in group 1, but also reported a higher NDI score; thus, age did not appear to be a factor in NDI scores in the current study. Additionally, while neck AROM has been shown to decrease with age,[60] none of the questions on the NDI are related to cervical movement. The groups in the present study were not matched for age or gender. Age across all participants was not correlated with NDI score.

Previous studies have used multiple intake questionnaires to correlate disability scores in participants reporting pain in several body regions. The NDI and JFS have been previously correlated when used to assess patients' perceived dysfunction relating to pain in the head, neck, and TMJ regions.[46] The JFS, originally developed to measure global functional limitations related to TMD,[45] is a 20-item standardized test with good reliability and validity for assessing limitations in chewing, mandibular mobility, and both verbal and emotional expression.[45] The questionnaire has three subcategories associated with mastication, vertical jaw mobility, and emotional and verbal expression.

The JFS and NDI have been shown to be significantly correlated in people with neck pain and TMD.[46,47] Olivo et al[47] identified a significant correlation between the JFS and the NDI. The study assessed 154 participants with neck pain with and without TMD, and the authors reported that participants with both neck pain and TMD had NDI scores 19 points higher compared to participants with only neck pain; however, participants were excluded if they had either abnormal MMO or cervical AROM, reported taking medication that would affect the musculoskeletal system (anti-inflammatories, muscle relaxants, etc), or had postural abnormalities. These exclusion criteria were in contrast to the present study, which specifically measured and recorded both cervical AROM and MMO. Cervical facet hypomobility and the trigeminal cervical nucleus have both been identified as contributors to orofacial pain.[61–63] The present study measured cervical AROM to determine whether this variable would contribute to participants' TMD complaints and subsequent NDI score. Additionally, it is well established that myofascial pain and dysfunction can contribute to craniofacial pain.[64]

La Touche et al recently developed a 21-item questionnaire to assess a person's pain and disability related to pain complaints in the craniofacial and cervical regions.[40] The CF-PDI was developed for Spanish-speaking patients and was identified to strongly correlate with the NDI. However, only one question on the CF-PDI asks specifically about neck pain, 19 ask about pain and/or function related to the TMJ, and the remaining question inquires about the frequency of cervicogenic headaches. The authors also noted that health care providers need to consider the importance of including the NDI when examining patients with craniofacial pain.[40]

In the current study, duration of pain in any of the areas of complaint was not correlated with NDI score in any of the groups. Participants in the first two groups reported neck pain duration for 16 months and 23 months, respectively. Participants in group 2 reported cervicogenic headaches for approximately 16 months prior to their enrollment in this study. Participants in group 3 reported a much longer duration of symptoms for both cervicogenic headaches and neck pain compared to the other two groups. The American Academy of Orofacial Pain has reported that people are treated by 5.3 clinicians on average before seeing an orofacial pain specialist.[12] Patients with TMD often require treatment from multiple medical practitioners[49]; specifically, these patients often have associated psychosocial issues.[16] People with chronic TMD have been reported to be physiologically over-reactive, which can lead to substantial psychosocial stressors compared to people without TMD.[65] Mongini et al[66] reported a strong correlation between people who reported muscle tenderness in their jaw and neck with a high prevalence of anxiety and MMO. In a recent study, Beasley et al[67] reported that cognitive behavioral therapy and/or exercise were effective for long-term management of chronic pain. Given this information, it is plausible that participants with TMD in the current study reported less neck pain and headache intensity, since they had previously received behavioral pain management or treatment from other health care providers.

Masticatory muscle pain is the most common TMD complaint.[13] This type of chronic pain may alter a person's perception of his or her pain experience and involves central sensitization, which has also been observed with other chronic pain conditions, such as neuropathic pain.[13] Allodynia and hyperalgesia are symptoms associated with central sensitization. Allodynia occurs when a painful response is reported following a nonpainful stimulus, and hyperalgesia is an exaggerated pain response to a painful stimulus. The current study used the recommended 2 to 4 lbs of force to assess pain provocation of both the masticatory muscles and the TMJ.[16] This amount of force

has been described as "slight blanching of the pad of the distal phalanx."[49] Since the current study did not screen or control for central sensitization, participants experiencing allodynia and/or hyperalgesia may have yielded false positives in the diagnoses of TMD. In contrast, in the case of neuropathic pain, the examination schematic that was used in the current study typically does not provoke the participant's symptoms.[49]

The current study did not show a significant difference in NDI scores among the three groups. Additionally, NDI scores were not correlated with either TMD pain or MMO in participants with TMD. The present findings suggest that the NDI score does not appear to be influenced by TMD. Additionally, the alpha level was not adjusted for this study, despite testing for correlations between many dependent variables. Therefore, interpretation of the results should be made with the understanding that the potential for Type I error is higher than .05 for the secondary purpose of this study. Future research is needed to develop a valid and reliable standardized assessment questionnaire that would be appropriate for assessing patient-perceived disability in those reporting neck pain, cervicogenic headaches, and TMD. The test should include both self-reported measures and objective clinical variables that relate to both the craniofacial and cervical regions.[40]

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