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Original Article

Assessment of Temporomandibular Joint and Cervical Spine Disability in Individuals with Hypermobility Joint Syndrome

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ABSTRACT

Hypermobile joint syndrome (HJS) predisposes individuals to musculoskeletal issues, with temporomandibular disorders (TMDs) and cervical spine problems representing significant contributors to disability and functional impairment. This study investigated the occurrence of TMD symptoms and assessed both TMJ and neck-related disability among young adults with HJS. A two-phase survey was carried out on physical therapy students, averaging 21 years of age. Initially, participants were screened for HJS using the Beighton scale and Brighton criteria, resulting in 56 individuals classified as HJS and 60 HJS-free controls. In the second phase, all participants completed a self-reported questionnaire addressing TMD symptoms. Disability was measured via the TMD disability questionnaire (TMD-Q) and the neck disability index (NDI), while pain intensity was quantified using a numeric rating scale (NRS). Compared with controls, the HJS group reported markedly higher pain levels across headache, TMJ, and neck/shoulder regions ($p < 0.001$), along with elevated TMD-Q and NDI scores ($p < 0.001$). Strong positive associations were found between TMD-Q and NDI scores ($p = 0.0035$), TMD-Q and TMJ symptom scores ($p = 0.0047$), and between NDI and TMJ symptom scores in both HJS and control groups ($p < 0.001$). Young adults with HJS exhibit greater TMJ and cervical spine disability and heightened musculoskeletal pain. These findings highlight the need for careful TMJ evaluation prior to dental or prosthetic procedures and suggest incorporating TMJ and neck disability assessments into routine care for HJS patients, ideally within a multidisciplinary treatment framework.

Keywords: Hypermobility syndrome, Temporomandibular disorders, Joint laxity, Cervical spine, Disability

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Introduction

Hypermobility joint syndrome (HJS) is recognized as a generalized, inherited connective tissue disorder, with prevalence in the general population ranging from 2% to 57% [1]. The etiology of HJS varies among individuals and may involve disrupted protein synthesis and abnormalities in connective tissue matrix formation. Current research highlights imbalances in type I and III collagen ratios and cellular disorganization related to fibrillin, a key protein in elastic fiber formation, as important areas of investigation. Efforts are ongoing to identify all hereditary factors contributing to HJS, as the precise genetic determinants remain largely unclear [2].

HJS is primarily characterized by laxity of joint capsules and ligaments, excessive joint mobility, and multiple dysfunctions in tissues rich in connective components [1]. The condition is thought to be more common in young women, often decreasing with age, suggesting that natural aging may play a more critical role than the resolution of connective tissue anomalies [3]. HJS can significantly impair quality of life due to chronic injuries such as joint dislocations and sprains, ligament damage, persistent pain, and fatigue, which

over time may compromise musculoskeletal sensory function. Recurrent trauma can cause permanent joint surface damage, potentially leading to disability [4].

Diagnosis of HJS typically relies on the Beighton scale and Brighton Criteria, widely utilized for evaluating joint laxity [5]. The Beighton scale assesses joint mobility through five simple maneuvers, scored on a nine-point scale, with a score of ≥4 indicating hypermobility. The Brighton Criteria further incorporate clinical signs such as joint pain, spinal degenerative changes, subluxations, Marfan-like physique, skin or ocular manifestations, hernias, varicose veins, and uterine or anal prolapse; fulfilling these criteria confirms an HJS diagnosis [6]. Studies have shown that applying the Brighton Criteria achieves a high detection rate of HJS [7].

HJS may predispose individuals to temporomandibular disorders (TMDs) [8]. Early reports suggest links between certain connective tissue–related single nucleotide polymorphisms (SNPs), such as COL5A1 rs12722, and intracapsular temporomandibular joint (TMJ) disorders [9]. Individuals with connective tissue disorders often overstretch TMJ capsules and retrodiscal ligaments, and repetitive activities like wide-mouth opening or nocturnal/diurnal habits (e.g., bruxism) can result in TMJ disc displacement and orofacial pain. Data indicate that 70% of HJS patients exhibit TMJ disc displacement without reduction, which may limit maximum jaw opening to ≤30 mm without audible clicking [9, 10]. This can lead to chronic inflammation, progressive articular surface damage, structural remodeling, and osteophyte formation. TMJ hypermobility is also associated with reduced masticatory muscle function, impairing chewing in both adolescents and adults [11].

Although evidence links HJS and TMDs, definitive studies examining their co-occurrence and underlying mechanisms remain limited, highlighting the need for further investigation, particularly at the molecular level [12]. Accordingly, this study aimed to evaluate the prevalence of TMD symptoms, along with cervical spine and TMJ disability, in individuals with HJS. We hypothesized that HJS patients are more susceptible to developing painful TMDs, which may lead to functional disability.

Material and Methods

This investigation was carried out from January 2020 to June 2022 at the Department of Rehabilitation of the Musculoskeletal System, Pomeranian Medical University in Szczecin, Poland, targeting 2nd- to 4th-year physical therapy students, with an average age of 21 years. All participants provided written informed consent prior to inclusion, and the study received approval from the Bioethics Committee (KB 0012/104/15) and financial support from a Pomeranian Medical University grant (MB-329-212/16).

Eligible participants were students aged 18–25 years without known medical conditions or disabilities. Individuals with diagnosed illnesses, age discrepancies, or who declined participation were excluded. Based on an anticipated effect size of 0.5, a statistical power of 0.95, and an alpha of 0.05, G*Power software (https://www.psychologie.hhu.de/arbeitsgruppen/allgemeine-psychologie-und-arbeitspsychologie/gpower) calculated a minimum required sample of 47 participants.

The first phase involved identifying HJS using the Beighton and Brighton scales [13, 14], with all assessments conducted by a single experienced and calibrated physical therapist. The Beighton scale evaluates joint hypermobility through five movements: passive extension of the 5th finger beyond 90°, passive thumb adduction to the forearm, elbow hyperextension beyond 10°, knee hyperextension beyond 10°, and forward bending with straight knees to place the hands on the floor. Each maneuver is scored as 0 or 1, and participants scoring ≥4 out of 9 points were classified as hypermobile. Movements were demonstrated by the examiner and performed by participants to the maximum range of motion as instructed [13].

The Brighton criteria were applied in conjunction with the Beighton test to strengthen diagnostic accuracy. Major criteria include a Beighton score of ≥4 (current or historical) and persistent pain in four or more joints for at least three months. Minor criteria encompass Beighton scores of 1–3, pain in 1–3 joints lasting three or more months, chronic back pain, spondylosis, spondylolysis or spondylolisthesis, multiple or recurrent joint dislocations/subluxations, soft tissue rheumatism (e.g., epicondylitis, tenosynovitis, bursitis), Marfanoid habitus, arachnodactyly, positive Steinberg sign, carpal tunnel syndrome, skin manifestations (striae, hyperextensibility, thinning, papillary scars), ocular features (ptosis, myopia, antimongoloid eyelid folds), varicose veins in lower limbs, hernias, rectal or vaginal/mammary prolapse, and mitral valve prolapse. HJS diagnosis was confirmed by meeting either two major criteria, one major plus two minor criteria, or four minor criteria [14].

Students who fulfilled the Brighton–Beighton requirements were assigned to the HJS group (n = 56; 16 males, 40 females), while those not meeting the

criteria formed the control group (CG; n = 60; 18 males, 42 females).

In the second phase, all participants completed standardized self-administered questionnaires assessing TMD symptoms, possible bruxism, and TMJ and cervical spine disability [15, 16]. Data were collected via paper-based surveys, which required approximately 20 minutes for completion.

Data collection was conducted using the following tools:

- A self-administered questionnaire capturing demographic data (age, sex, body mass index [BMI]) and participants' subjective health assessment.
- Eight close-ended questions assessing TMD-related symptoms, including headache, TMJ and preauricular pain, joint sounds, increased masticatory muscle activity, TMJ locking during mouth opening, and tooth clenching or grinding (reported by the participant or a partner). Pain intensity was quantified using the numeric rating scale (NRS).
- The TMD Disability Questionnaire (TMD-Q), designed to evaluate the functional impact of TMD symptoms on daily activities. The TMD-Q includes 10 items addressing both specialized TMJ functions (e.g., speaking, dental care, eating, social interactions) and non-specialized functions. Responses were scored from 0 (no limitation) to 4 (maximum limitation), yielding a total possible score ranging from 0 to 40, with higher scores reflecting greater functional disability [15].
- The Neck Disability Index (NDI), Polish version (NDI-PL), was used to assess cervical spine-related limitations. It comprises 10 items addressing pain intensity, lifting, reading, headaches, concentration, work, driving, sleep, and rest, scored 0–5 for each item. The total score ranges from 0 to 50, with 0–4 indicating no disability, 5–14 mild disability, 15–24 moderate disability, 25–34 severe disability, and 35–50 representing extreme disability [16].

Statistical analysis

Quantitative data are presented as mean ± standard deviation (M ± SD) and as median (Me) with 1st and 3rd quartiles. Normality of quantitative variables was assessed using the Shapiro–Wilk test, supplemented by histogram inspection and quantile–quantile (Q–Q) plots. Categorical variables were compared using Pearson's χ^2 test. For normally distributed quantitative variables, independent t-tests were applied, while non-normally distributed variables were analyzed using the Wilcoxon or Kruskal–Wallis tests. Correlations were evaluated using Kendall's tau-b (τb). All analyses were performed using R software within the RStudio environment (http://www.rstudio.com), with statistical significance set at $p < 0.05$ [17].

Results

A total of 116 participants were included, comprising 82 women (70.7%) and 34 men (29.3%). Participants were distributed across study years as follows: 52% in the second year, 29% in the third year, and 19% in the fourth year. Group characteristics and descriptive statistics are summarized in **Table 1**.

Table 1. Analysis of the age, body mass index (BMI) and the Beighton scale scores in the study group (hypermobility joint syndrome (HJS) subjects) and the control group (CG)

Variable	Group	M ±SD	min–max	Q1–Q3	95% CI	p-value
Age [years]	HJS (n = 56)	21.2 ±1.15	20–24	20–22	0.307	0.954
	CG (n = 60)	21.2 ±1.07	20-24	20–22	0.277	
BMI [kg/m2]	HJS (n = 56)	23.1 ±3.81	12.8–34.5	20.7–24.3	1.020	0.408
	CG (n = 60)	23.7 ±3.40	17.3–34.5	21.1–25.3	0.879	
Beighton scale [points]	HJS (n = 56)	7 ±1.3	4–9	6–8	0.366	<0.001*
	CG (n = 60)	0 ±0.8	0–3	0–1	0.208	

M – mean; SD – standard deviation; min – minimum; max – maximum; Q – quartile; CI – confidence interval; * statistically significant.

No significant differences were observed between the HJS and control groups in terms of age or BMI. In contrast, both Beighton and Brighton scale scores differed significantly between the groups, confirming the presence of HJS in the study cohort ($p < 0.001$) **(Table 1)**.

Regarding self-reported health, half of the HJS participants rated their health as good, 44.6 percent as adequate, 5.4% as poor, and none as very good. In the control group, 50% reported good health, 41.7% very good, 8.3% satisfactory, and none reported poor or very poor health.

Prevalence of TMD symptoms

Analysis of the self-assessment questionnaires revealed that HJS participants experienced significantly more frequent TMD-related symptoms, including pain in adjacent tissues, masticatory

dysfunction, headaches, neck and shoulder discomfort, and TMJ pain. Pain intensity was also higher in the HJS group. On the NRS, headache severity was greater in HJS participants compared to controls ($p < 0.001$); 35.7% of HJS participants reported a score of 3, whereas 68.3% of controls reported no pain. Neck and shoulder pain was also elevated in HJS individuals, with 37.5% reporting an NRS score of 5, while 75% of controls reported no pain. TMJ pain in the HJS group reached NRS levels of 4–5 in 30.4% of participants, whereas 86.7% of the control group reported no TMJ pain. Additionally, TMJ sounds ($p < 0.001$), TMJ locking during mouth opening ($p < 0.001$), and tooth clenching/grinding ($p < 0.001$) occurred significantly more often in the HJS group than in controls.

TMJ disability

Responses to the TMD-Q highlighted significant differences between groups for items addressing verbal communication (Q1; $p < 0.001$), normal daily activities (Q3; $p < 0.001$), social/recreational activities (Q4; $p < 0.001$), non-specialized jaw functions (Q5; $p < 0.001$), sexual function (Q6; $p < 0.001$), response to treatment (Q8; $p < 0.001$), auditory/vestibular symptoms (Q9; $p < 0.001$), and dizziness (Q10; $p < 0.001$). HJS participants were more likely to report at least one of these functional limitations, with varying severity, compared to controls (Supplementary material available from the corresponding author).

Cervical spine disability

Using the NDI, significant differences were noted between HJS and control groups for items concerning pain intensity (Q1; $p < 0.001$), lifting objects (Q3; $p < 0.001$), reading (Q4; $p < 0.001$), headache (Q5; $p < 0.001$), concentration (Q6; $p < 0.001$), work (Q7; $p < 0.001$), sleep (Q9; $p < 0.001$), and rest (Q10; $p < 0.001$). Overall, cervical spine disability was more pronounced in the HJS group: 73.2 percent reported mild disability and 26.8 percent moderate disability, whereas 83.3% of controls had no disability and 16.7 percent reported mild disability (Supplementary material available from the corresponding author).

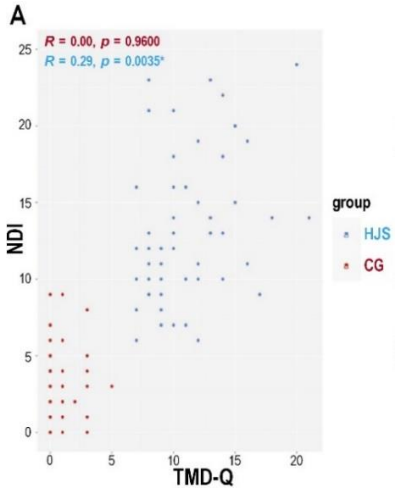
A detailed statistical summary of TMD-Q, NDI, and NRS outcomes is provided in **Table 2**.

Table 2. Comparison of Temporomandibular Disorder (TMD) Disability Questionnaire (TMD-Q), Neck Disability Index (NDI), and Pain Intensity (Headache, Neck and Shoulder Girdle, and Temporomandibular Joint - TMJ) in Study and Control Groups

Variable	Group	Mean ± SD	Range (min–max)	Median (Q1–Q3)	p-value
TMD-Q Score	HJS (n = 56)	10.9 ± 3.4	7–21	10 (8–13)	<0.001*
	CG (n = 60)	0.7 ± 1.1	0–5	0 (0–1)	
NDI Score	HJS (n = 56)	12.9 ± 4.7	6–24	12 (10–15)	<0.001*
	CG (n = 60)	2.8 ± 2.2	0–9	2 (1–4)	
Headache Intensity (NRS)	HJS (n = 56)	3.4 ± 1.4	0–6	3 (3–4)	<0.001*
	CG (n = 60)	1.1 ± 1.7	0–5	0 (0–2)	
Neck and Shoulder Girdle Pain Intensity (NRS)	HJS (n = 56)	4.6 ± 1.3	0–7	5 (4–5)	<0.001*
	CG (n = 60)	0.9 ± 1.6	0–5	0 (0–1)	
TMJ Pain Intensity (NRS)	HJS (n = 56)	4.3 ± 1.1	2–7	4 (4–5)	<0.001*
	CG (n = 60)	0.4 ± 1.1	0–4	0 (0–0)	

*statistically significant.

Individuals with HJS experienced considerably greater pain according to the NRS ($p < 0.001$), with headaches, neck and shoulder discomfort, and TMJ-related pain consistently exceeding levels reported by the control group. Additionally, functional limitations measured by the TMD-Q and NDI were more pronounced in the HJS participants ($p < 0.001$). The interrelationships between TMD-Q outcomes, NDI scores, and musculoskeletal symptoms in both the HJS and control groups are depicted in **Figure 1**.



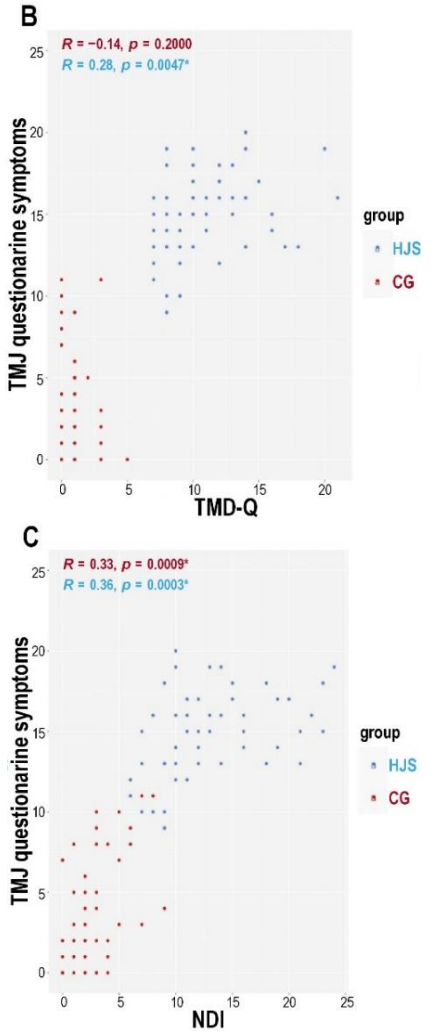


Figure 1. Relationships between TMJ and cervical spine disability: (A) correlation between TMJ disability and cervical spine disability, (B) correlation between TMJ disability and the total number of reported TMJ and adjacent tissue symptoms, and (C) correlation between cervical spine disability and the total number of reported TMJ and adjacent tissue symptoms. *Indicates statistical significance

In participants with HJS, there was a significant positive relationship between TMD-Q and NDI scores ($p = 0.0035$; **Figure 1A**) as well as between TMD-Q scores and the number of reported TMJ-related symptoms ($p = 0.0047$; **Figure 1B**), indicating that greater TMJ dysfunction was associated with increased cervical spine disability and more pronounced orofacial complaints. A strong positive correlation was also observed between NDI scores and TMJ symptom counts in both the HJS group and controls ($p < 0.001$ for both; **Figure 1C**).

Discussion

The findings suggest that individuals with HJS are markedly more likely to experience headaches, neck discomfort, and painful TMDs compared with non-hypermobile controls ($p < 0.001$). Within the HJS group, nearly all participants reported cervical spine and TMJ pain, 94.6% reported headaches, 80.4% had TMJ sounds, 33.9% experienced locking of the jaw, and 66.1% reported tooth clenching or grinding. All of these symptom frequencies were significantly higher than those observed in the control group ($p < 0.001$).

These observations support previous reports. Abbot *et al.* noted an increased prevalence of neck pain in hypermobile individuals [18], while other studies indicated that headaches, including migraines, occur more frequently in this population than in healthy controls [19, 20]. Chiodelli *et al.* emphasized the importance of closely monitoring TMD occurrence in hypermobile individuals, particularly in larger study cohorts, and found that TMJ and preauricular pain were more common in HJS patients [21]. Kavuncu *et al.* reported that nearly 80% of TMD patients exhibited hypermobility [22], with Pasinato *et al.* documenting similar findings (64.71%) [23]. Furthermore, myofascial pain without limitations in mouth opening was more prevalent in hypermobile individuals (81.82%) than in non-hypermobile controls (58.33%) [23].

Our study also revealed a high occurrence of masticatory movement disorders, including bruxism and tooth clenching, among HJS participants. Previous work by Westling and Mattiasson suggested that sleep-related masticatory movements may exert a more pronounced negative effect on hypermobile individuals [24]. Harkins and Cueva found that women with both HJS and masticatory parafunctions were more likely to present intraoral TMD symptoms, indicating a synergistic impact on TMJ dysfunction ($p < 0.001$) [25]. These findings highlight the need for careful monitoring and management of bruxism in HJS patients, as it may accelerate ligament injury and TMJ deterioration compared to non-hypermobile individuals [25].

Regarding TMJ pain, our results demonstrated a clear difference between HJS participants and controls, in line with Pasinato *et al.*, who found mouth-opening difficulties to be significantly more common in hypermobile subjects ($p = 0.0279$) [23], although Winocur *et al.* did not report such an association in adolescent girls [26].

In addition, TMJ disability was more pronounced among HJS patients, and higher TMD-Q scores correlated with a greater number of reported TMJ and surrounding tissue symptoms ($p = 0.0047$). To date,

there appears to be no prior research evaluating TMJ disability in the context of HJS using TMD-Q, making direct comparisons limited. Nonetheless, the observed association supports the notion that hypermobility may act as an additional factor contributing to TMJ dysfunction when TMD symptoms such as pain, joint sounds, or functional limitations are present.

The present study demonstrated that individuals with HJS are more susceptible to cervical spine disability compared with healthy controls, as supported by statistically significant findings. A strong positive correlation between NDI scores and TMJ symptom questionnaire results was observed in both the HJS group ($p < 0.001$) and controls ($p < 0.001$), suggesting that ligament laxity may be considered a hereditary condition affecting connective tissue systemically. These findings imply reduced functional efficiency of ligaments supporting the cervical spine in hypermobile individuals, with proprioceptive deficits, increased susceptibility to myofascial pain, and a higher risk of spinal trauma likely contributing to the elevated prevalence and severity of cervical spine disability [27].

Despite the evident functional interplay between TMJs and the cervical spine, few studies have investigated these biomechanical relationships. Kashif *et al.* reported a significant association between TMDs and cervical spine disability as measured by NDI ($p < 0.001$) [28]. Lee *et al.* observed greater frequency and intensity of neck pain among HJS participants compared with non-hypermobile subjects (frequency: $p = 0.020$; intensity: $p = 0.001$) [29]. Conversely, Keser *et al.* found no correlation between cervical spine degeneration (assessed via MRI), neck pain (VAS), and NDI scores in HJS patients; however, their study population (aged 20–50 years) differed considerably from the younger cohorts examined in most other studies [30].

To our knowledge, this is the first study to identify a positive correlation between TMJ disability (TMD-Q) and cervical spine disability (NDI) in HJS patients ($p = 0.0035$), highlighting the importance of further research in larger, more diverse populations.

The findings underscore the value of assessing TMD in hypermobile patients, as timely and targeted interventions may help reduce the impact of TMJ and cervical dysfunction. Routine clinical evaluation of TMJ and cervical spine disability should be integrated into care for individuals with joint hypermobility, who benefit from long-term, multidisciplinary management involving both clinicians and therapists.

Finally, the data suggest that screening for HJS is particularly important among physical therapy students, who are exposed to high levels of physical stress in their training and professional practice. Early detection of hypermobility can facilitate the prompt implementation of preventive and therapeutic strategies, including ergonomic adjustments, proprioceptive exercises, and other individualized interventions, which should be applied as clinically indicated to mitigate the consequences of HJS.

Limitations

This study relied on self-reported data, which may have affected the accuracy of participant responses. Furthermore, HJS diagnosis was based solely on two widely accepted questionnaires—the Beighton scale and Brighton criteria—without molecular confirmation. While these tools are standard in clinical practice, the growing accessibility of genetic testing for connective tissue disorders could allow for earlier, more precise, and individualized identification of hypermobile patients [31, 32]. Another limitation was the absence of a DC/TMD assessment and a standardized method for evaluating TMJ dysfunction. Future research should incorporate larger participant samples, molecular testing, DC/TMD questionnaires, and three-dimensional imaging to improve the recognition of TMDs and support the implementation of targeted therapeutic strategies for individuals with HJS.

Conclusions

Patients with HJS are at increased risk of developing painful TMDs, headaches, and cervical spine discomfort, which over time may contribute to TMJ and cervical spine disability.

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