ORIGINAL RESEARCH

Shoulder Girdle Disability, Dysfunction, and Pain in Participants with Temporomandibular Joint Disorders: A Cross-Sectional Survey on Prevalence and Associations

Micaela Weinberg, PT, MSc; Benita Olivier, PT, PhD; Siyabonga Kunene, PT, PhD

ABSTRACT

Background: There is a rising prevalence of temporomandibular disorders (TMD) and, therefore a need to improve the management of these conditions. No studies have been done to assess the possible associations between the shoulder girdle and the temporomandibular joint (TMJ) in participants with TMD. ***Objective:*** The aim of the study was to estimate the prevalence of disability, dysfunction and pain in the shoulder girdle in participants with TMD. In addition, the association between the disability, dysfunction and pain in the shoulder girdle and temporomandibular joint in participants with temporomandibular disorders was investigated. ***Methods:*** A cross-sectional study was performed where participants were invited to complete an online survey if they received a score of two or more on the TMD-pain screener. The survey included questions on demographics, the TMJ, and the shoulder girdle. ***Results:*** A total of 186 individuals with TMD participated in the study of whom, 56% ($n = 104$) reported having shoulder pain and 45% ($n = 84$) reported having previous shoulder treatment. A positive correlation was found between the level of TMD, as indicated by the mean Fonseca Anamnestic index score and the pain ($r = 0.29$, $p < 0.001$), disability ($r = 0.24$, $p = 0.001$), and total scores ($r = 0.28$; $p < 0.001$) on the Shoulder Pain and Disability index and similarly with shoulder pain at its worst ($r = 0.19$, $p = 0.009$). ***Conclusion:*** The associations found between the pain and disability of the shoulder girdle and TMJ give insight into the relationship between the two areas in participants with TMD.

Key Words: Fonseca Anamnestic index; shoulder girdle; shoulder pain and disability index; temporomandibular joint; temporomandibular disorder.

RÉSUMÉ

Historique : la prévalence de troubles temporomandibulaires (TTM) est en hausse et, par conséquent, il est nécessaire d'en améliorer la prise en charge. Aucune étude n'a été réalisée pour évaluer les associations éventuelles entre la ceinture scapulaire et l'articulation temporomandibulaire (ATM) chez les participants ayant des TTM. ***Objectif :*** estimer la prévalence d'incapacité, de dysfonctionnement et de douleur de la ceinture scapulaire chez les participants ayant un TTM. De plus, les chercheuses ont examiné l'association entre l'incapacité, le dysfonctionnement et la douleur de la ceinture scapulaire et de l'ATM chez les participants ayant des TTM. ***Méthodologie :*** étude transversale dans le cadre de laquelle les participants ont été invités à remplir un sondage en ligne s'ils recevaient un score de deux ou plus au questionnaire de dépistage de la douleur causée par un TTM. Le sondage comprenait des questions sur la démographie, l'ATM et la ceinture scapulaire. ***Résultats :*** au total, 186 personnes ayant des TTM ont participé à l'étude, dont 56 % ($n = 104$) ont déclaré souffrir de douleur à l'épaule et 45 % ($n = 84$), avoir déjà reçu un traitement pour l'épaule. Les chercheuses ont constaté une corrélation positive entre le taux de TTM, indiqué par le score moyen de l'indice anamnestique de Fonseca, et la douleur ($r = 0,29$, $p < 0,001$), l'incapacité ($r = 0,24$, $p = 0,001$) et les scores totaux ($r = 0,28$; $p < 0,001$) à l'indice de douleur à l'épaule et d'incapacité, de même que lorsque la douleur était la plus intense ($r = 0,19$, $p = 0,009$). ***Conclusion :*** les associations constatées entre la douleur et l'incapacité de la ceinture scapulaire et de l'ATM donnent un aperçu de la relation entre ces deux foyers chez des participants ayant un TTM.

Mots-clés : articulation temporomandibulaire; ceinture scapulaire; douleur à l'épaule et indice d'incapacité; indice anamnestique de Fonseca; trouble temporomandibulaire

From the: Department of Physiotherapy, Faculty of Health Sciences, University of the Witwatersrand, Johannesburg, South Africa.

Correspondence to: Micaela Weinberg, Department of Physiotherapy, Faculty of Health Sciences, University of the Witwatersrand, Johannesburg, South Africa; micaelaweinberg@gmail.com

Contributors: MW, BO and SK designed the study and edited the article. MW collected, analysed and interpreted the data.

Competing Interests: The authors declare that they have no financial or personal relationships that may have inappropriately influenced this article.

Acknowledgements: The authors thank the research assistant and staff at Micaela Weinberg Physiotherapy for their assistance with this project.

Physiotherapy Canada **2023; doi:10.3138/ptc-2023-0037**

The prevalence of temporomandibular disorders (TMD) is 10%–15% in the adult population worldwide.[22] The associated co-morbidity rate is very high with only 0.77% of people with TMD not complaining of associated pain.[15] According to the National Health Interview Analysis in the United States, of the 189,977 participants reviewed, 8,964 (4.6%) had TMD with 83% of these participants having other areas of pain.[5] The high impact of TMD and associated conditions emphasise the importance of exploring the temporomandibular joint (TMJ) and its possible associations with surrounding structures, such as the shoulder girdle.

Cervical pain is one of the common conditions associated with TMD with anatomical, biomechanical, and neurophysiological connections between the two areas. Anatomically, the TMJ and the upper cervical spine are closely located and share myofascial connections.[11] Biomechanically, there is simultaneous upper cervical extension during mouth opening and upper cervical flexion during mouth closing.[16] The neurophysiological relationship describes the convergence of the trigeminal and upper cervical afferent fibres in the trigeminocervical nucleus.[6]

Muscular connections between the acromion, clavicle, and scapula of the shoulder girdle and the cervical spine have also been well established. This is through the levator scapula, trapezius, cervical flexors and extensors which have proximal attachments to the cervical spine and distal insertions onto the shoulder girdle. Another connection is through the influence of injuries and changes in one area on the other. This is evident as participants with cervical spine degeneration have been found to have a negative impact on the alignment of the cervical spine causing a predisposition to shoulder injuries.[14]

Changes in the positioning of the shoulder girdle have the potential to create symptomatic dysfunction in the cervical and thoracic spine by causing changes in the length of the trapezius, sternocleidomastoid, and scalene muscles. The effects of the cervical spine on the shoulder girdle have also been shown. Participants with neck pain who were right hand dominant had significantly reduced right clavicle retraction, left scapular upward rotation and clavicle elevation compared to participants without cervical pain.[12]

These findings are consistent with other studies that have found participants with neck pain to have increased upper cervical extension, reduced cervical flexion and clavicle retraction. This causes an increase in compression of the articulations between the cervical and thoracic spine leading to changes in muscle activity of the trapezius and serratus anterior and neural tension in the median nerve.[30]

The high prevalence of TMD and associated disorders as well as the connections between the cervical spine and shoulder and the cervical spine and TMJ highlight the need to establish if there is a connection between the shoulder girdle and TMJ in participants with TMD. As such it was the purpose of the study to estimate the prevalence of disability, dysfunction, and pain in the shoulder girdle in participants with TMD. In addition, the association between the disability, dysfunction, and pain in the shoulder girdle and temporomandibular joint in participants with temporomandibular disorders was investigated.

METHODS

Study design and participants

A cross-sectional study was conducted using a survey from June to September 2022.

Inclusion in the study required participants to score two or more on the TMD-pain screener. This screening questionnaire consists of three questions and is part of the Diagnostic Criteria for Temporomandibular Disorders (DC/TMD), a valid screener for screening of TMD. The questions ask participants about their TMJ symptoms in the past 30 days. A score of two or more is indicative of pain-related TMD.[10] No exclusion criteria were applied.

Questionnaire

The questionnaire included three sections namely demographics, questions on the TMJ and questions on the shoulder girdle. It took 10 minutes to complete. Section A was designed by the first author and consisted of questions on basic demographics, medical history, occupation, and exercise. Demographic questions included age, gender, marital status, and highest level of education. Questions on medical history asked participants about their medical conditions, if they took any medication and any previous surgery. The occupational section included the type of work, amount of time spent in front of the computer/I-pad, and amount of heavy lifting required.

Section B consisted of questions on the TMJ and a standardized TMD questionnaire, the Fonseca Anamnestic index (FAI). The questions on the TMJ were designed by the researcher to determine the range of motion (ROM), previous treatment and history of injuries to the facial region. The FAI consists of 10 questions with possible answers of yes, no, or sometimes. The answer yes receives a score of 10, sometimes a score of 5 and no a score of 0. A total score of 100 can be received. A score of 0–15 is classified as no TMD, a score of 20–40 is classified as mild TMD, moderate TMD a score of 45–65, and severe TMD a score of 70–100.[28]

Section C consisted of questions on the shoulder girdle and a standardized questionnaire, the Shoulder Pain and Disability index (SPADI). The questions designed by the researcher included hand dominance, previous shoulder injuries and treatment, presence of pain in the shoulder, and popping/clicking. The SPADI questionnaire consists of two parts, the first part is five questions and asks the participants to rate their pain during certain activities from 0 to 10. The second part is eight questions and asks the participant to rate their experience during certain tasks from 0 to 10 with zero being no difficulty and 10 being so difficult it requires help. The total score is out of 130 and is converted to a percentage.

The higher the score the worse is the shoulder pain and disability.[3] The patient acceptable symptom state cut-off for SPADI total score is 49.2 for the highest tertile and 39.4 at the lowest, for SPADI pain score is 46.4 for the highest and 36.7 for the lowest and the SPADI disability score is 46.8 compared to 25.1 for the lowest.[26]

Data collection procedure

Ethical clearance was obtained from the University of the Witwatersrand Human Research and Ethics Committee (Medical) (M2111110 MED21-11-098). The questionnaire was designed, and data was collected using the Research Electronic Data Capture (Redcap). This is an online application used to capture data.[20] The link to this questionnaire was attached to the advertisement for qualifying participants.

The invitation to participate in the study, the inclusion criteria and a link to the survey was posted on the main researcher's personal and practice's social media forums. These included Facebook and Instagram posts and WhatsApp statuses. The posts were shared and reposted by other people, which created a local and international reach.

An email was also sent to physiotherapists on the South African Society of Physiotherapy database to complete and share with their patients. The same email was sent to doctors and dentists asking them to share it with their patients. In order for people to qualify to fill out the survey and meet the inclusion criteria, a score of two or more on the TMD-pain screener was required.[10] There were no other exclusion criteria. Participation was voluntary and anonymous. Participants were asked for their email addresses if they were willing to receive more information about the third phase of the study but this was not mandatory.

Before the study commenced, a pilot study was conducted involving five participants in order to determine the length of time needed for to complete the questionnaire and if there were any ambiguities in the questionnaire.

Statistical analysis

The raw data were exported from Redcap to IBM SPSS Statistics version 28 and Microsoft Excel for interpretation. Means and standard deviations were used to analyse data that were continuous and descriptive in nature. Frequencies and percentages were used to summarize the remaining demographic data as well as the researcher's questions on the TMJ and shoulder girdle.

Graphical and statistical calculations were used to measure skewness and kurtosis of the SPADI values. The graphical techniques used were histograms and scatter plots. It was found that SPADI pain scores were normally distributed which was supported by the skewness coefficient and kurtosis values. The findings for the SPADI disability and total scores were both skewed on the graphs to the right and had coefficients above one. The mean and standard deviation variables for the individual SPADI questions are depicted in Figure 5.

Correlations between total FAI scores and SPADI pain, disability and total scores, as well as shoulder pain at its worst, were analyzed using Pearson's correlation. A perfect correlation was regarded as 1, strong as 0.7–0.9, moderate as 0.4–0.6, and weak as 0.1–0.3 in both directions.[1] An independent sample t-test was used to determine the differences between the total FAI scores in those with and without shoulder pain, previous injuries to their shoulder girdle, and presence or absence of popping/clicking of their shoulder.

Ethical considerations

The study received ethical clearance from The Human Research Ethics Committee (Medical). An information sheet on the study's objectives, risks, cost of participation, anonymity, and storage of data was included before the questionnaire began. This was followed by an informed consent section which stated that participants give consent to participate in the study by continuing to complete the questionnaire.

RESULTS

Demographics, medical history, and lifestyle

A total of 186 participants completed the questionnaire, consisting of the researcher's questions, the FAI and SPADI standardized questionnaires. The majority of participants were female with a mean (SD) age of 32.03 (± 11.96) and between the ages of 16 and 79. The full demographics of the sample are represented in Table 1.

A high portion of the sample, 60.2%, had previous surgery, with the most common being wisdom teeth removal (17.2%) and the lowest being shoulder surgeries (2.6%). Over half of the participants were taking medication, with the most common being selective serotonin reuptake inhibitors. The full information on participants' medical history is shown in Table 2.

Lifestyle questions on exercise, computer work, and heavy lifting at work are presented in Table 3. The majority of participants, 80.1%, did exercise with the most common form, aerobic, done by 86% of the sample. This was followed by 34.8% of participants doing resistance training. Despite the analgesic effect of exercising, the results showed a non-significant positive correlation between exercise and total FAI scores ($r = .011$; $p = 0.18$). There was

Table 1 Socio-Demographic Characteristics of Participants with TMD (n = 186)

Variable	n	%
Gender		
Male	19	10.2
Female	167	89.8
Marital status		
Single	75	40.3
Married	84	45.2
Divorced	7	3.8
Widow	1	0.5
Live with partner	15	8.1
Other	2	1
Level of education		
Graduated primary school	8	4.3
Graduated high school	23	12.4
Undergraduate degree	73	39.2
Postgraduate degree	74	39.8
Other	7	3.8
Occupation		
Medical personnel	84	33
Teacher	17	9
Office based job	40	21.5
Other	22	11.8
Student	28	15
Unemployed	7	3.7

also no significant correlation between the participants' work involving heavy lifting and their total score on the FAI ($r = -.024$; $p = 0.24$).

The most common amount of time spent on the computer was 2–3 hours, reported by 23.6% of the sample. This was followed by 13.9% of participants spending 8–9 hours daily. A positive, significant correlation was found between the total SPADI score and time spent on the computer ($r = -.09$; $p < 0.001$).

Temporomandibular joint disability, dysfunction, history, and pain

Specific questions were included by the researcher on the TMJ, such as any previous head and facial injuries and the ability to fit three fingers in their mouth on opening giving an indication of ROM. The answers to these questions and information on the previous management of their TMD are expressed in Table 4.

More than half of the participants, 62.9%, had received previous treatment for their TMD. Exactly half of the participants reported having received physiotherapy, with the majority having received physiotherapy only (41.3%), followed by physiotherapy in conjunction with other therapies.

Table 2 Medical History of Participants with TMD (n = 186)

Medical conditions	n	%
Yes	32	17.3
No	153	82.7
Type of medical condition		
Autoimmune	14	7.5
Fibromyalgia	2	1.1
Hypothyroidism	10	5.3
Osteoarthritis	2	1.1
Other	4	2.1
Medication		
Antidepressants:		
- SSRI	25	13.4
- SNRI	4	2.1
- Other	5	2.6
Anti-inflammatories	3	1.6
Hypothyroidism	13	6.9
Immune suppressants	6	3.2
Oral contraceptive	10	5.3
Other	11	5.9
Previous surgery		
Yes	112	60.2
No	74	39.8
Type of surgery		
Jaw/facial	11	5.9
Other	79	42.4
Shoulder	5	2.6
Wisdom removal	32	17.2

SSRI = selective serotonin reuptake inhibitors, SNRI = serotonin norepinephrine reuptake inhibitors.

The highest possible score for each question on the FAI is 10, and the total is 100. This sample had a mean (SD) score of 60.19 (± 21.03), showing that the majority of participants had moderate TMD (42.5%) followed by severe (38.7%) then mild TMD (15.6%). The highest scoring question was asking participants if they clench or grind their teeth, commonly referred to as bruxism. The mean (SD) score for this question was 8.63 (±2.83) (Figure 2), with 79% of participants answering yes and 15% answering sometimes (Figure 2).

The next highest scoring question was about participants having pain in the nape of their neck, with a mean (SD) score of 8.20 (±3.26) (Figure 2). After that, a high percentage of participants reported clicking in their jaw with 65% answering yes and 12.9% answering sometimes (Figure 2). Figures 1 and 2 depict the frequencies of the individual answers, their mean, and standard deviation.

Table 3 Exercise and Vocation of Participants with TMD (n = 186)

Exercise	n	%
Yes	149	80.1
No	37	19.9
Amount of exercise (per week)		
Once	5	2.7
Twice	34	18.3
Three	51	27.4
Four	31	16.7
Five	19	10.2
Six	8	4.3
Seven	1	0.5
Type of exercise		
Aerobic	129	69.3
Yoga/Pilates	40	21.5
Resistance/weight training	52	27.9
Other	11	5.9
Amount of computer work (hours daily)		
0–1	12	6.4
2–3	44	23.6
4–5	24	12.8
6–7	21	11.2
8–9	26	13.9
≥10	8	4.3
Occupation involving heavy lifting		
Yes	69	37.1
No	117	62.9
Amount (kg)		
0–10	24	12.8
11–20	8	4.3
21–50	7	3.8
51–80	2	1
≥81	13	6.9

Prevalence of shoulder pain in participants with TMD

More than half of the sample, 104 participants (56%), reported having shoulder pain with, 26.3% (n = 49) of participants reporting clicking/popping of their shoulders (Figure 3). Just less than half of the participants, 84 (45%), reported having received previous shoulder treatment. Of these participants, 33.3% (n = 62) had sought physiotherapy, followed by acupuncture at a much lower prevalence of 5.3% (n = 10) (Figure 4). Despite the high rate of shoulder pain and previous shoulder treatment, there was a low prevalence of 16.1% (n = 30) of those with previous shoulder injuries.

The highest scoring question on the SPADI was about participants' shoulder pain at its worst. This mean (SD) score was 4.61 (± 3.33) followed by 3.48 (± 3.11) for pain when lying on the involved arm (Figure 5). The lowest scoring questions were the difficulty associated with putting on pants (0.75 ± 1.38) and putting on a shirt with buttons (0.81 ± 1.55). The mean (SD) for the SPADI pain, disability and total scores were 14.79 (± 11.99), 11.67 (± 13.78), and 26.46 (± 24.10), respectively (Table 4).

Relationships between the TMJ and shoulder girdle

The relationships between the total FAI scores and SPADI pain, disability, and total scores as well as shoulder pain at its worst can be found in Table 5. Table 6 shows the differences in the FAI scores in participants with and without previous shoulder injuries, pain or popping/clicking of their shoulders. Positive, weak correlations were found between the level of TMD according to the total FAI scores and SPADI pain (r = 0.29; p < 0.001), disability (r = 0.24; p = 0.001), and total scores (r = 0.28; p < 0.001). There was a positive, weak correlation between pain at its worst in the shoulder and total FAI scores (r = 0.19; p = 0.009).

DISCUSSION

In this study, we investigated the relationships between shoulder and TMJ disability, dysfunction and pain as well as the prevalence of shoulder impairments and previous injuries in participants with TMD. Our results showed that in this population, there a high prevalence of shoulder impairments and an association between the shoulder girdle and TMJ. More than half of the participants with TMD had shoulder pain and a quarter had shoulder popping or clicking.

There were positive, weak correlations between the total FAI and SPADI pain, disability, and total scores, between the amount of time spent on the computer and SPADI scores as well as between shoulder pain at its worst and total FAI score.

Another finding of interest was that physiotherapy was the most commonly sought treatment for both participants' TMJ and shoulder complaints. Despite the potential bias of these results due to physiotherapists playing a role in sourcing patients for this study the authors believe the number of participants sourced through this avenue may be negligible. However, further research into the types of treatment sought by patients with TMD is advised. With physiotherapy being the most common therapy, there was still a high prevalence of participants with moderate and severe TMD and shoulder pain. This highlights the need for better management of TMD and shoulder girdle dysfunction by physiotherapists. These findings suggest the inclusion of the shoulder girdle in the assessment of patients with TMD.

Demographics, medical history, and lifestyle

The higher prevalence of female participants in the sample is consistent with the findings of two systematic reviews that found TMD was significantly more common

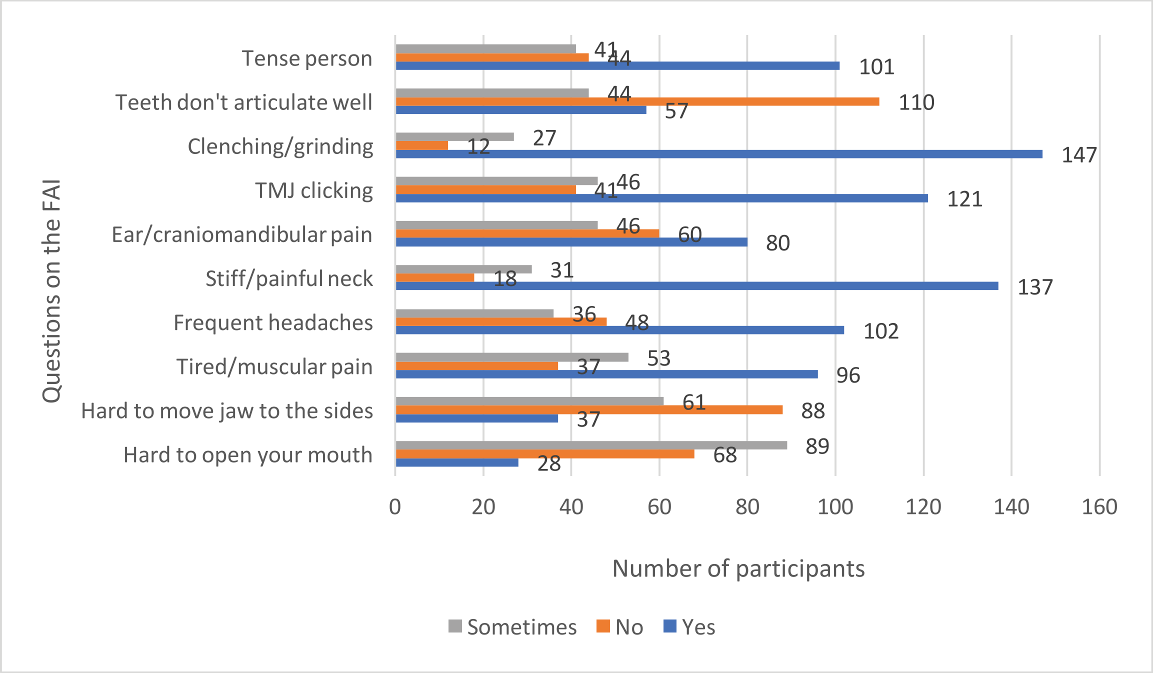

Figure 1 Participants answers to the individual FAI questions.

FAI = Fonseca Anamnestic Index, TMJ = temporomandibular joint.

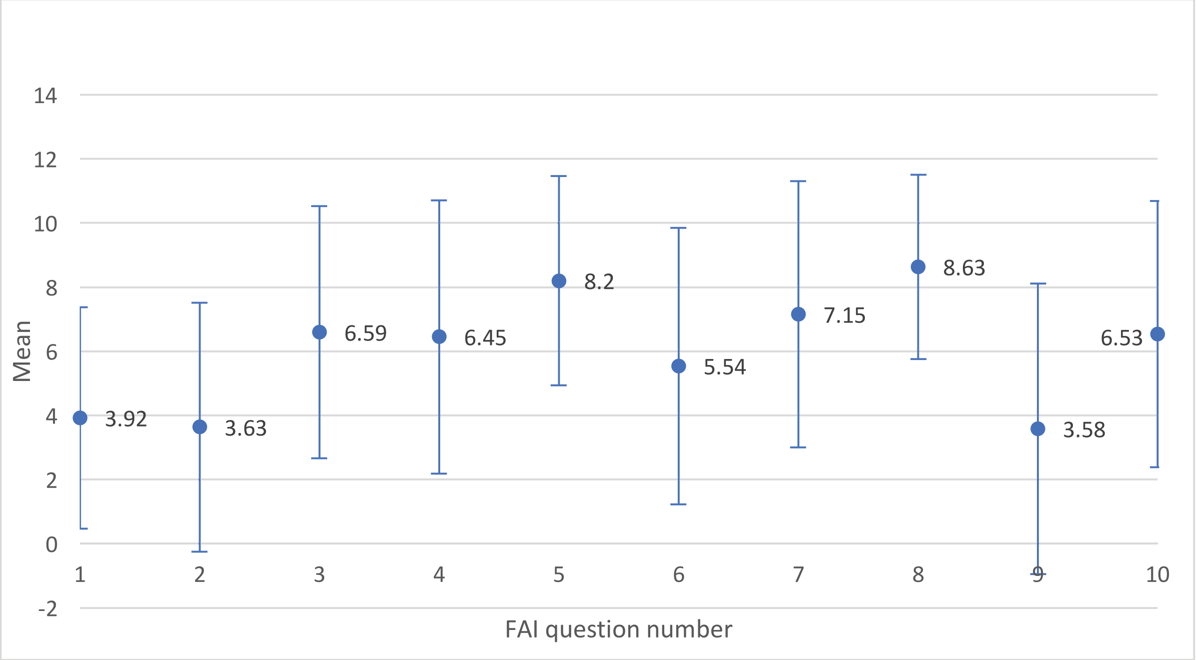

Figure 2 Scatterplot of mean and standard deviations of individual FAI questions.

1. Hard to open your mouth; 2. Hard to move mandible to the sides; 3. Tired/muscular pain when chewing; 4. Frequent headaches; 5. Stiff/painful neck; 6. Earache/pain in the craniomandibular joints; 7. TMJ clicking; 8. Clench/grind; 9. Teeth don't articulate well; 10. Tense person.

Vertical bars indicate standard deviation.

FAI = Fonseca Anamnestic index.

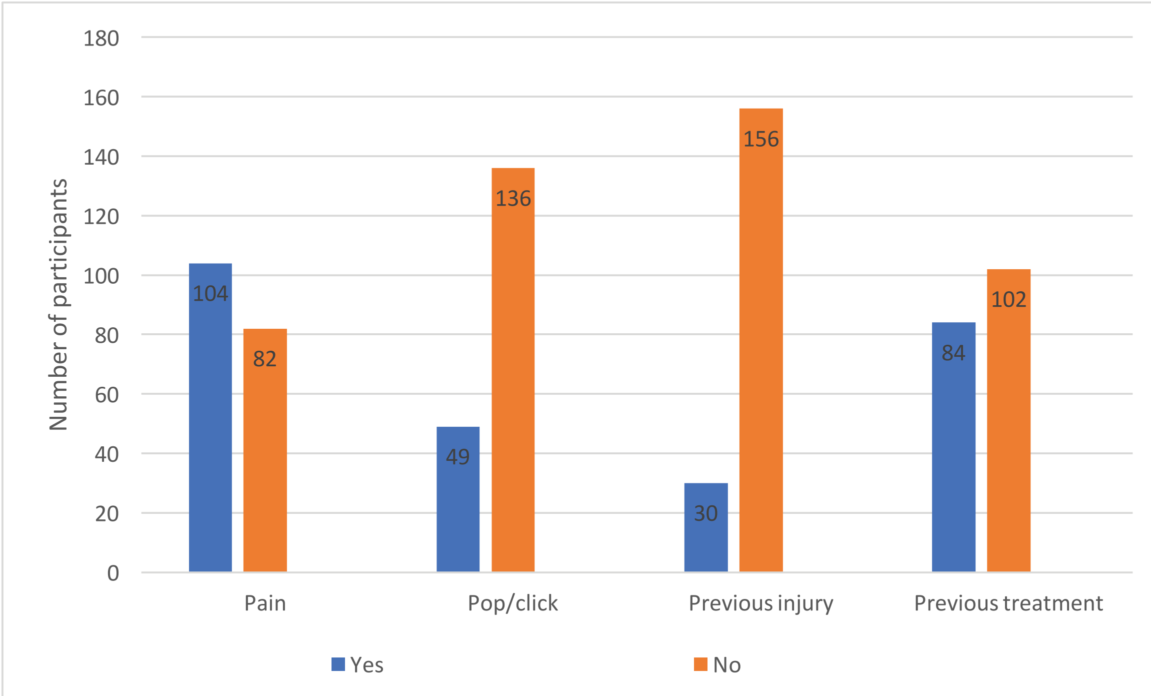

Figure 3 Signs, symptoms and previous history of shoulder function in participants.

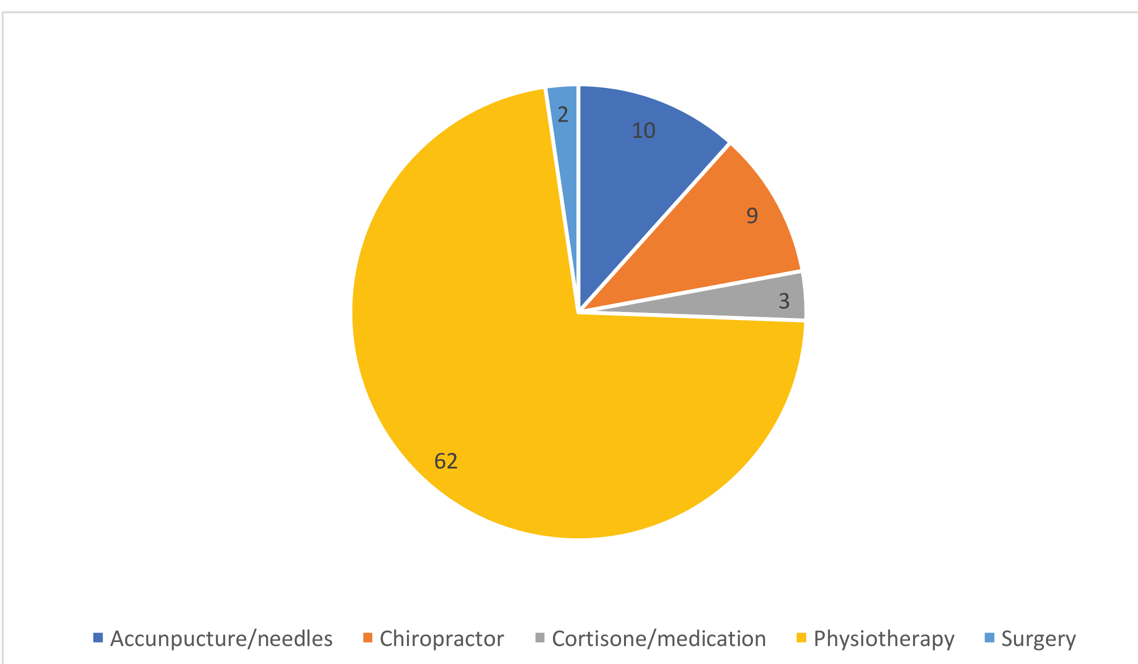

Figure 4 Previous treatment modalities for shoulder dysfunction in participants with TMD (%).

in females compared to males.[4,21] The reasons for this include hormonal factors, differences in pain sensitivity, higher levels of work stress, depression, and anxiety in women.[4]

The mean age of the present sample is broadly supported by the research with the prevalence of TMD being the highest in the 20–40-year-old age group and decreasing with increasing age. The proposed reasoning for this is the onset of TMD is directly related to stress and the highest level of stress and productivity occurs during the 20–40-year age period.[17]

Analysis of the medical results showed that wisdom tooth extraction was the most common surgery reported by participants. The reason for this could be the extensive

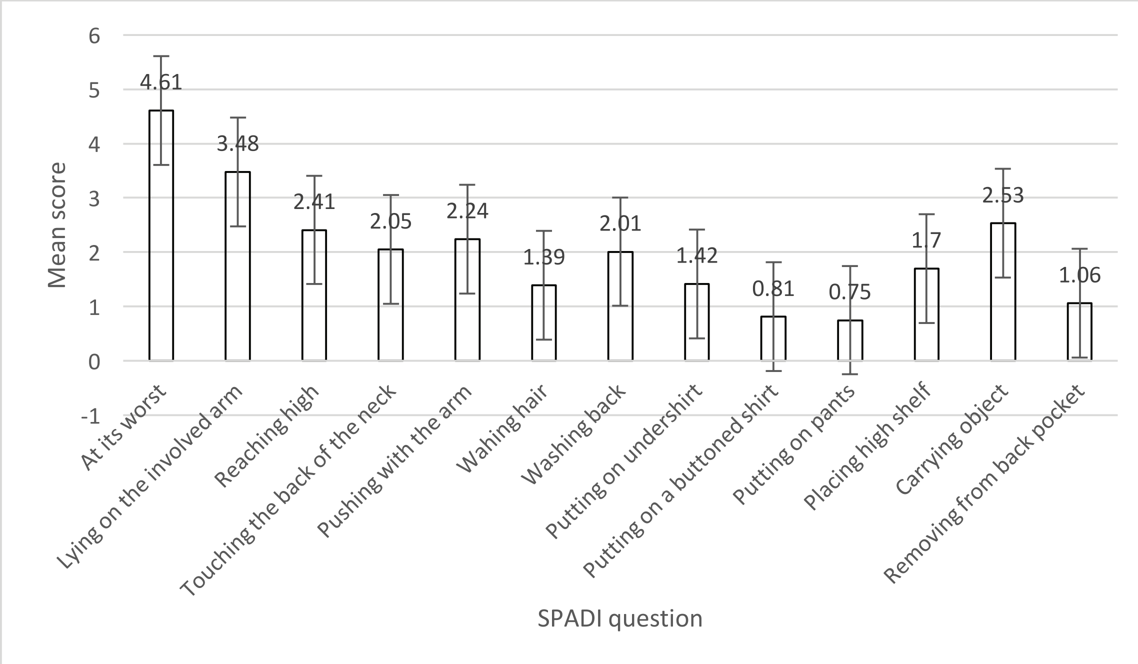

Figure 5 Mean and standard deviations of individual SPADI questions. Vertical bars indicate standard deviation.

Table 4 Previous History, Functional Limitations, Severity of TMD and SPADI Scores in Participants with TMD (n = 186)

Previous TMJ treatment	*n*	%	Mean (SD)
Yes	117	62.9	-
No	69	37	-
Type of treatment			
Acupuncture/needles	9	4.8	-
Bite plate	13	6.9	-
Botox	11	5.9	-
Chiropractor	7	3.7	-
Medication	7	3.7	-
Other	5	2.6	-
Physiotherapy	93	50	-
Surgery to the TMJ	3	1.6	-
Combinations of treatment			
Botox only	2	1	-
Chiropractor	3	1.6	-
Occlusal splint only	3	1.6	-
Physiotherapy only	77	41.3	-
Physiotherapy and botulinum toxin	7	3.7	-
Physiotherapy and chiropractor	5	2.6	-
Previous blow/injury to face/head/chin			
Yes	49	26.3	-
No	133	71.5	-
Insert three fingers with mouth open	3	1.6	
Yes	157	84.4	-
No	29	15.6	-
FAI score	-	-	60.19 (± 21.03)
Severity of TMD			
No TMD	6	3.2	-
Mild TMD	29	15.6	-
Moderate TMD	79	42.5	-
Severe TMD	72	38.7	-
SPADI scores			
SPADI pain score	-	-	14.79 (± 11.99)
SPADI disability score	-	-	11.67 (± 13.78)
SPADI total score	-	-	26.46 (± 24.10)

FAI = Fonseca Anamnestic index; SPADI = shoulder pain and disability index, TMD = temporomandibular disorders, TMJ = temporomandibular joint.

mouth opening required and considerable lateral forces on the mandible, increasing the risk of TMD. Even though the prevalence of TMD post wisdom extraction varies among different studies from 0.7% to a much higher incidence of 34%, the results are similar in that there is a higher prevalence of TMD after wisdom removal.[7]

Contrary to previous studies, in the current study no correlation was found between the use of anti-depressants, specifically selective serotonin reuptake inhibitors and bruxism.[9] A potential reason for no correlation between this drug and clenching being found in this

Table 5 Correlations between SPADI Subscales, Total Scores, and Shoulder Pain at its Worst and Total FAI Scores (n = 186)

Shoulder variables	Pearson correlation co-efficient (r) and confidence intervals	*p* value
SPADI pain	0.29 95% CI = [0.16, 0.42]	< 0.001
SPADI disability	0.24 95% CI = [0.09, 0.37]	0.001
Total SPADI	0.28 95% CI = [0.14, 0.48]	< 0.001
Pain at its worst	0.19 95% CI = [0.05, 0.33]	0.009

FAI = Fonseca Anamnestic index; SPADI = Shoulder Pain and Disability index.

Table 6 Comparisons between FAI Scores in Participants with and without Previous Shoulder Injury, Pain, or Popping/Clicking (n = 186)

		Presence of previous shoulder injury, pain or popping/clicking			
Shoulder variables	Number of responses	Yes Mean (SD)	No Mean (SD)	95% CI*	*p* value
Presence of previous shoulder injury	Yes: 30 No: 155	60.00 (± 24.84)	60.22 (± 20.31)	-6.56, 8.508	0.799
Presence of shoulder pain	Yes: 103 No: 82	61.92 (± 20.59)	57.99 (± 21.500)	-8.882, 2.259	0.242
Presence of shoulder popping/clicking	Yes: 48 No: 137	62.14 (± 22.85)	59.49 (± 20.39)	-8.491, 4.167	0.501

*Independent *t* test.

FAI = Fonseca Anamnestic index; SD = standard deviation.

sample is the effects of bruxism from this class of antidepressants are seen within four months of starting the drug.[9] The TMD- pain screener that was used for inclusion into the current study questioned the presence of participants' symptoms specifically in the past 30 days.

Using a computer for 4 hours or more a day had a significant contribution to the development of TMD symptoms and a 2-hour increase in computer time led to an increase in symptoms by double or triple.[27] Significant correlations were found between time spent on the computer and SPADI scores in the current population of participants with TMD. This shows another possible link between disability of the shoulder girdle and TMD as participants who spent more time on the computer were more likely to have higher pain and disability in their shoulders the longer, they spent on the computer.

Temporomandibular joint disability, dysfunction, history, and pain

Conservative management of TMD is the first choice for the majority of people with the dysfunction.[19] Most participants reported having received physiotherapy for their TMD and despite this, there was still such a high prevalence of the presence and severity of TMD. In accordance with the present results, a systematic review found 85%–90% of people chose non-invasive treatment options for management of this condition. In the current study, half reported receiving physiotherapy, which has been found to improve ROM of the TMJ more so than dry needling and exercise therapy.[19] This, among other reasons, could be the reason why the majority of the participants were able to fit three fingers on mouth opening.

Despite most participants having full range of movement of the jaw, the overall FAI scores were higher than previous research. However, in those studies unlike this current study, participants were not included if they had previous head/neck trauma, were undergoing orthodontics or the presence of inflammatory conditions.[29] This shows that these changes and conditions may play a role in the worsening of the severity of TMD.

Another reason for the worse severity of TMD in this current study was that majority of participants reported clenching or grinding. This was significantly higher than other studies that reported a prevalence of clenching in 33.9% of participants with TMD and 11.2% in participants without TMD. However, the mean age was higher in that group and as previously discussed, the prevalence of bruxism decreases with age. This study was also done in Germany compared to the current study with majority of participants living in South Africa indicating the potential of a higher prevalence of bruxism in the South African population.[24]

The prevalence of clenching in students without TMD was 36.5% which is higher than the standard non-TMD population.[8] This study consisted of a high portion of students and health workers. Higher levels of stress have been found in medical/health science students compared to their age-matched peers. Significantly higher levels of stress, anxiety, depression, job-related pressure, and anxiety were found in participants who grind and clench compared to those who do not.[22]

The strong connection between psychological factors and TMD is through the dopaminergic system. This is through cortisol and stress, causing initiation of bruxism in the day and perpetuation of grinding at night. It has also been shown that the majority of people with anxiety adopt the parafunctional habits of clenching and grinding.[2]

The next highest scoring question was the presence of neck pain. The bidirectional relationship between cervical pain and TMD has been well established. The severity of cervical pain has been found to increase with the severity of TMD.[15,23] The results of the current study corroborate with these findings as more than three quarters of participants reported neck pain, with the majority having moderate and severe TMD.

The reason for the high levels of cervical pain in these participants is based on the central sensitisation theory. There is an upregulation of the trigeminal nucleus, which causes widespread pain with reduced inhibitory signals and increased sensitisation of nociceptive receptors. This leads to hyperalgesia and allodynia and may be a possible explanation of the association between the pain in the TMJ and shoulder girdle found in this study.[2]

Prevalence of shoulder pain in participants with TMD

Just more than half of the participants with TMD reported having shoulder pain, which is higher than the 1-month prevalence of shoulder pain in the general population (18%–31%).[13] Of these 766 participants, there was a mean age of 49 and therefore was an older sample than the current study. These findings show that participants of a younger age group had a higher prevalence of shoulder pain compared to another group who were older in age, showing the potentially higher prevalence of shoulder pain in participants with TMD.

Relationships between the TMJ and shoulder girdle

The TMJ and shoulder pain and disability values in the current study were similar to those who were survivors of head/neck cancer, which were also significantly higher than participants without head/neck cancer. In the same study, an increased perception of a swallowing impairment was significantly correlated to a reduction in shoulder strength.[18] It is encouraging that similarly to the current study, another study[18] found a significant correlation between SPADI pain and disability and FAI scores.

The mean SPADI scores of participants in this study were slightly higher than participants with shoulder pain after seeking treatment and much lower than before seeking treatment.[25] This shows that the intensity of shoulder pain and disability in participants with TMD were lower than those with active shoulder pain. The lowest scoring items on the SPADI were putting on pants and buttoning a shirt. In both of these activities, minimal shoulder range is required. Therefore, higher levels of pain and disability of the shoulder were found as the demand on the shoulder increased in terms of range and strength.

This is seen as the scores increased from questions referring to reaching from their back pocket to washing their hair, with the highest scores being activities that demanded more load, such as carrying a heavy object. This indicates the possibility that the effects of dysfunction of the TMJ on the shoulder girdle are more apparent when the shoulder is under greater load. This hypothesis and the exact mechanism of the greater impact on the greater load required needs to be further explored.

Further research needs to be done on the prevalence of shoulder girdle impairments and their association with the TMJ in participants without TMD. An objective assessment of the shoulder girdle and TMJ needs to be done in participants with and without TMD. This needs to include an assessment of the shoulder girdle in various positions with increasing demand in participants with TMD. Further research also needs to be done to establish the prevalence of other areas of pain in patients with TMD, and whether the level of shoulder pain and disability is higher than those.

Strengths and limitations

This research was a cross-sectional design using a survey, and participants were invited to participate if they had TMD according to the TMD screening questionnaire. Therefore, participants may not have had an accurate diagnosis of TMD due to the lack of clinical examination. Strengths of this study are the large sample size, the reach to different populations worldwide and the inclusion of previously well-validated standardized questionnaires.

CONCLUSION

The relationships between the level of TMD severity, shoulder girdle pain, and disability demonstrate a connection between pain and disability caused by shoulder problems and pain and disability caused by TMD. It is recommended that participants with TMD are screened for the presence of shoulder pain and an assessment framework of the shoulder girdle in this population is developed.

REFERENCES

1. Akoglu H. User's guide to correlation coefficients. *Turk J Emerg Med*. 2018;18(3):91–3. https://doi.org/10.1016/j.tjem.2018.08.001. PMID: 30191186
2. Alkhudhairy M, Al Ramel F, Al Jader G, et al. A self-reported association between temporomandibular joint disorders, headaches, and stress. J Int Soc Prev Community Dent. 2018;8(4):371–80. https://doi.org/10.4103/jispcd.JISPCD_177_18. PMID: 30123773

3. Breckenridge JD, McAuley JH. Shoulder pain and disability index (SPADI). *J Physiother*. 2011;57(3):197. https://doi.org/10.1016/S1836-9553(11)70045-5. PMID: 21843839
4. Bueno CH, Pereira DD, Pattussi MP, Grossi PK, Grossi ML. Gender differences in temporomandibular disorders in adult populational studies: a systematic review and meta-analysis. J Oral Rehabil. 2018;45(9):720–9. https://doi.org/10.1111/joor.12661. PMID: 29851110
5. Byun SH, Min C, Yoo DM, Yang BE, Choi HG. Increased risk of migraine in patients with temporomandibular disorder: a longitudinal follow-up study using a National Health Screening Cohort. Diagnostics (Basel). 2020;10(9):724. https://doi.org/10.3390/diagnostics10090724. PMID: 32962244
6. Castien R, De Hertogh WA. Neuroscience perspective of physical treatment of headache and neck pain. Front Neurol. 2019;10(276). doi: 10.3389/fneur.2019.00276. PMID: 30972008.
7. Chen YW, Chi LY, Lee OKS. Revisit incidence of complications after impacted mandibular third molar extraction: a nationwide population-based cohort study. PLoS One. 2021;16(2):e0246625. https://doi.org/10.1371/journal.pone.0246625. PMID: 33617575
8. Flueraşu MI, Bocşan IC, Ţig IA, Iacob SM, Popa D, Buduru S. The epidemiology of bruxism in relation to psychological factors. Int J Environ Res Public Health. 2022;19(2):691. https://doi.org/10.3390/ijerph19020691. PMID: 35055514
9. Garrett AR, Hawley JS. SSRI-associated bruxism: A systematic review of published case reports. *Neurol Clin Pract*. 2018;8(2):135–41. https://doi.org/10.1212/CPJ.0000000000000433. PMID: 29708207
10. Gonzalez YM, Schiffman E, Gordon SM, Seago B, Truelove EL, Slade G, Ohrbach R. Development of a brief and effective temporomandibular disorder pain screening questionnaire. J Am Dent Assoc. 2011;142(10):1183–91. https://doi.org/10.14219/jada.archive.2011.0088. PMID: 21965492
11. Grondin F, Hall T, Laurentjoye M, Ella B. Upper cervical range of motion is impaired in patients with temporomandibular disorders. Cranio. 2015;33(2):91–9. https://doi.org/10.1179/0886963414Z.00000000053. PMID: 25919749
12. Helgadottir H, Kristjansson E, Mottram S, Karduna A, Jonsson H. Altered alignment of the shoulder girdle and cervical spine in patients with insidious onset neck pain and whiplash-associated disorder. J Appl Biomech. 2011;27(3):181–91. https://doi.org/10.1123/jab.27.3.181. PMID: 21844606
13. Juel NG, Natvig B. Shoulder diagnoses in secondary care, a one-year cohort. BMC Musculoskelet Disord. 2014;15:89. https://doi.org/10.1186/1471-2474-15-89. PMID: 24642168
14. Katsuura Y, Bruce J, Taylor S, Gullota L, Kim HJ. Overlapping, masquerading, and causative cervical spine and shoulder pathology: a systematic review. Global Spine J. 2020;10(2):195–208. https://doi.org/10.1177/2192568218822536. PMID: 32206519
15. Kim D, Ko SG, Lee EK, Jung B. The relationship between spinal pain and temporomandibular joint disorders in Korea: a nationwide propensity score-matched study. BMC Musculoskelet Disord. 2019;20(1):631. https://doi.org/10.1186/s12891-019-3003-4. PMID: 31884949
16. Mansilla-Ferragut P, Fernández-de-las Peñas C, Alburquerque-Sendín F, Cleland JA, Boscá-Gandía JJ. Immediate effects of Atlanto-Occipital joint manipulation on active mouth opening and pressure pain sensitivity in women with mechanical neck pain. J Manipulative Physiol Ther. 2009;32(2):101–6. https://doi.org/10.1016/j.jmpt.2008.12.003. PMID: 19243721
17. Mazzetto MO, Rodrigues CA, Magri LV, Melchior MO, Paiva G. Severity of TMD related to age, sex and electromyographic analysis. Braz Dent J. 2014;25(1):54–8. https://doi.org/10.1590/0103-6440201302310. PMID: 24789293
18. Ortiz-Comino L, Fernández-Lao C, Speksnijder CM, et al. Upper body motor function and swallowing impairments and its association in survivors of head and neck cancer: a cross-sectional study. PLoS One. 2020;15(6):e0234467. https://doi.org/10.1371/journal.pone.0234467. PMID: 32559241
19. Paço M, Peleteiro B, Duarte J, Pinho T. The effectiveness of physiotherapy in the management of temporomandibular disorders: a systematic review and meta-analysis. J Oral Facial Pain Headache. 2016 Summer;30(3):210–20. doi: 10.11607/ofph.1661. PMID: 27472523
20. Patridge EF, Bardyn TP. Research Electronic Data Capture (REDCap). Jmla. 2018;106(1). https://doi.org/10.5195/jmla.2018.319
21. Ryan J, Akhter R, Hassan N, Hilton G, Wickham J, Ibaragi S. Epidemiology of temporomandibular disorder in the general population: a systematic review. *ADOH*. 2019;10(3). https://doi.org/10.19080/ADOH.2019.10.555787
22. Saczuk K, Lapinska B, Wawrzynkiewicz A, et al. Temporomandibular disorders, bruxism, perceived stress, and coping strategies among Medical University students in times of social isolation during outbreak of COVID-19 pandemic. Healthcare (Basel). 2022;10(4):740. https://doi.org/10.3390/healthcare10040740. PMID: 35455915
23. Sanchla AD, Shrivastav S, Bharti L, Kamble R. Comparative evaluation and correlation of pain pattern in neck musculature observed in mild, moderate, and severe temporomandibular joint disorder cases as compared to non-temporomandibular joint disorder cases. Cureus. 2022;14(10):e30099. https://doi.org/10.7759/cureus.30099. PMID: 36381943
24. Sierwald I, John MT, Schierz O, et al. Association of temporomandibular disorder pain with awake and sleep bruxism in adults. J Orofac Orthop. 2015;76(4):305–17. https://doi.org/10.1007/s00056-015-0293-5. PMID: 26123732
25. Thoomes-de Graaf M, Scholten-Peeters W, Duijn E, et al. The responsiveness and interpretability of the shoulder pain and disability index. J Orthop Sports Phys Ther. 2017;47(4):278–6. https://doi.org/10.2519/jospt.2017.7079. PMID: 28158958
26. Tran G, Dube B, Kingsbury SR, Tennant A, Conaghan PG, Hensor EM. Investigating the patient acceptable symptom state cut-offs: longitudinal data from a community cohort using the shoulder pain and disability index. Rheumatol Int. 2020;40(4):599–605. https://doi.org/10.1007/s00296-019-04486-3. PMID: 31797040
27. Tsukagoshi K, Nishiyama A, Masahiko S. Association between symptoms of temporomandibular disorders and duration of computer use in a working population in Japan. *Int J Dental Oral Health*. 2017;3(5). https://doi.org/10.16966/2378-7090.243
28. Yaman D, Alpaslan C, Kalaycioğlu O. Investigation of asymptomatic temporomandibular disorders with Fonseca anamnestic index in clinical practice. *Acta Odontologica Turcica*. 2021;38(3):62–7. https://doi.org/10.17214/gaziaot.815831
29. Xiao CQ, Wan YD, Li YQ, et al. Do temporomandibular disorder patients with joint pain exhibit forward head posture? A Cephalometric study. *Pain Res Manag*. 2023;2(2023):1–11. https://doi.org/10.1155/2023/7363412. PMID: 36776487
30. Yip CHT, Chiu TTW, Poon ATK. The relationship between head posture and severity and disability of patients with neck pain. *Man Ther*. 2008;13(2):148–54. https://doi.org/10.1016/j.math.2006.11.002. PMID: 17368075