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Article

Occurrence of Cervical Spine Pain and its Intensity in Young People with Temporomandibular Disorders: a Pilot Study

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Abstract: Background: The main aim of the study was to assess the intensity and frequency of cervical spine pain in young people with temporomandibular disorders (TMD). Methods: The pilot study was conducted from June to July 2023. Inclusion criteria were: age (18-30 years), cervical spine pain (for at least 1 month) and consent to participate in the study. The study was conducted based on a physiotherapeutic examination and an original questionnaire. The pain level was assessed using the Visual Analogue Scale (VAS). Among 95 people with cervical spine pain, 51 people (53.7%) constituted the control group (without a history of temporomandibular disorders), while 44 (46.3%) people constituted the study group. Results: The mean age of people participating in the study was 22.2±2.2 years in the study group and 22.5±3.1 years in the control group. The largest group were people aged 21-25 (n=51 people, 53.7%). Patients from the study group more often experienced pain in the stomatognathic system during palpation (both in the muscle, joint and musculoskeletal groups) and had reduced mobility of the temporomandibular joints in every movement (p<0.001). People from the study group were characterized by also less mobility of the cervical spine (p<0.05), apart from extension movement (p>0.05). There was a significant relationship between temporomandibular disorders and cervical spine pain (p<0.05, chi²=10.118, df=1, r=0.31). The level of back pain was significantly higher in people from the study group (p<0.001, chi²=45.765, df=4, r=0.57). Conclusions: Our research has shown that the causes of cervical spine pain at a young age may be temporomandibular disorders, which are generally not recognized and properly treated.

Keywords: cervical pain; temporomandibular joint (TMJ); temporomandibular disorders (TMD)

1. Introduction

The temporomandibular joint (TMJ) is the movable connection between the mandible and the skull [1]. The function it performs, it is one of the most used joints in the human body. It takes an active part in articulation, chewing or swallowing food. It is a condylar, cavernous, functionally coupled joint, which makes movements take place simultaneously in both temporomandibular joints. In addition, it participates in the process of breathing or expressing emotional states [1,2]. In terms of anatomical structure, it consists of an articular fossa located in the temporal bone and a joint head located on the condylar process of the mandible. Between the above structures there is an articular disc, which divides the joint into an upper cavity (discotemporal space) and a lower cavity (discocondylar space) [1]. The temporomandibular joints are located in close proximity to the cervical spine and the missing joints, which means that they are connected to the postural system by means of numerous musculoskeletal-ligament-nerve connections. Disorders in the posture or functioning of the musculoskeletal system may cause disturbances not only in their functioning, but also affect the work of the stomatognathic system [3]. Temporomandibular disorder (TMD) is a term used to describe structural and/or functional disorders within the masticatory musculoskeletal system. They may involve joints as well as muscle or ligament structures [4]. Due to its complex etiology and the influence of many external factors, it is one of the civilization diseases. The dominant causes of

temporomandibular disorders include: psychosocial disorders (stress, depression, mental illnesses, emotional disorders) [5,6], posture defects (changes in the spine, upper limbs, lower limbs and pelvis) [7], genetic and/or developmental changes [8] or hormonal disorders [9]. The most common causes of local temporomandibular disorders are: anatomical changes in the structure of the temporomandibular joints and adjacent structures, incorrect occlusion, previous injuries (including micro-injuries), parafunctions (occlusive, non-occlusive), inflammation of the masticatory musculoskeletal system or improperly performed dental, orthodontic or prosthetic treatment [7]. The main symptoms of temporomandibular disorders are: pain (muscle and/or articular), problems with chewing food, crackling in the joint, soreness in the joint, pain in the ears and tinnitus, changes in the appearance of the face (excessive masticatory hypertrophy), headache and/or neck pain, numbness in the jaw, decreased or increased mobility of the temporomandibular joints, rubbing or clenching of the teeth during the day and/or night. The above symptoms are usually combined and do not occur individually [7,10]. A study conducted by the American Academy of Orofacial Pain shows that at least one of the symptoms of temporomandibular disorder occurs in approximately 33% of the general adult population, but many authors point out that these results range from 12 to as much as 90%. In the case of children and adolescents, this problem occurs in 40 to even 90% of people [4].

Cervical spine pain is a multifactorial disease and a health problem that affects up to 70% of the population, causing a decrease in their quality of life [12]. They are a significant socio-economic problem right after lumbar spine pain. In the vast majority of studies, it is difficult to clearly determine the cause of pain, which is a significant problem in introducing appropriate therapy [12]. According to a 2017 epidemiological study, the highest standardized incidence of cervical spine pain was recorded in East Asian regions (1029 cases per 100 000 inhabitants), while the lowest were recorded in Latin American regions (624 cases per 100 000 inhabitants). Disorders of the cervical spine were much more common in women (166 million) than in men (122.7 million). The analysis showed that the number of years lived with disability is higher in women than in men (10.0-25.1 vs. 7.4-18.9). In addition, it has been determined that the standardized age of neck pain incidence increases with age, up to 70-74 years, and then a decrease is noted [11]. The factors influencing cervical spine pain include: psychological factors, emotional stress, anxiety disorders, depression, cognitive factors, sleep problems, socioeconomic problems, concomitant neuromusculoskeletal diseases, autoimmune diseases and genetic factors [11].

In the scientific literature contains information on the relationship between cervical spine pain and temporomandibular disorders, which may include biomechanical, neurophysiological or neuroanatomical aspects [13]. The connection of the cervical spine with the temporomandibular joints shows that they have a direct impact on each other's functioning. Abnormal tension within the locomotor system of the masticatory system may be related to the position of the head and cervical spine (tension within the paraspinal muscles). The scientific literature indicates that overlapping nerve fibres in the trigeminal nucleus caudalis may have a significant impact on the work of the temporomandibular joint and cervical spine [14].

The aim of this study was to determine the prevalence of cervical spine pain in people with temporomandibular disorders aged 18-30 years. The hypothesis was that there was a relationship between cervical spine pain and temporomandibular disorders compared to a control group of people without disorders of the masticatory system. In addition, the pattern of pain compensation causes changes in the alignment of the cervical spine, which is why an attempt was made to measure the mobility of this area and within the temporomandibular joints. The analysis will confirm the above hypothesis and, consequently, justify the need to introduce appropriate, direct and targeted therapeutic treatment of people with temporomandibular disorders. The above activities will shorten and maximize the effects of therapy for people with disorders of the masticatory system.

2. Material and methods

2.1. Ethics Statement and Information about Project

The study received a positive opinion on the project issued by the Bioethics Committee operating at the Collegium Medicum of the Jan Kochanowski University (decision of 19.05.2023, No. 22/2023). Prior to the study, participants were informed about the objectives, methods, benefits, as well as risks of participating in the study. Each person gave informed, voluntary consent to participate in the study, which was documented on consent forms available for inspection by the first author. In addition, all participants in the study were covered by accident insurance (certificate no. COR401865). All procedures were carried out in accordance with the 1964 Declaration of Helsinki, as amended. The project was funded by the Jan Kochanowski University in Kielce (SUPD. RN.23.019).

2.2. Study population

This pilot study was conducted at the Faculty of Collegium Medicum of the Jan Kochanowski University in Kielce (after obtaining the consent of the University authorities) and in a private physiotherapy practice in the period from June 2023 to July 2023. A random of 100 people aged 18-30 were qualified for the study, of which 5 results were rejected due to formal deficiencies (lack of consent, lack of signature, incomplete documentation, incorrectly completed questionnaire). Among the 95 people participating in the study, 51 people (53.7%) were the control group (no history of temporomandibular disorders), while 44 (46.3%) were the study group (with a history of temporomandibular disorders).

3. Methods

The eligibility criteria for potential study participants were: age (18-30 years), cervical spine pain experienced for at least 1 month, and voluntary consent to participate in the study. The exclusion criteria were: age (under 18 or over 30 years of age), neurological diseases (in particular: stroke, multiple sclerosis, cancer, facial or trigeminal nerve palsy), traffic accident (within the last year), head or neck injuries (within the last year), head and/or neck surgeries, cervical spine pain lasting more than 12 months, regular use of analgesics and anti-inflammatory drugs, articular hypermobility, degenerative and/or rheumatoid diseases of the cervical spine, and lack of consent to participate in the study. Information on temporomandibular disorders was collected using a questionnaire recommended by the European Academy of Craniomandibular Disorders (EACD). The screening protocol contains four questions [15]:

1. Do you feel pain when you open your mouth wide or chew (at least once a week or more)?
2. Do you have pain in your temple, face, temporomandibular joint or jaw (at least once a week or more)?
3. Do you feel like your jaw is blocked or that you can't open it wide?
4. Do you get headaches more than once a week?

If the patient answered yes to more than one of the four questions, he or she was qualified to the study group, where further tests were carried out on the musculoskeletal system of the masticatory system based on the author's questionnaire, which included information on: general health, temporomandibular disorders or the Visual Analogue Scale (VAS) referring to the occurring back pain. Due to the intensity of pain experienced, patients were divided into groups: 0 - without pain; 1-3 - mild pain; 4-7 - moderate pain; 8-9 - severe pain; 10 - unbearable pain [16].

The next part of the questionnaire was a physiotherapeutic examination form, which consisted of palpation (in the temporomandibular joints, neck muscles and masticatory muscles) and examination of the range of motion of the temporomandibular joints (with the use of an electronic caliper by Fanger, measurement error ± 0.01), pain during movements within the temporomandibular joints (abduction, protrusion and right/left lateral movements), examination of the range of motion in the cervical area spine with the use of a Baseline inclinometer (product code: 4372-4405E, measurement error $\pm 0.5^\circ$) and pain during movements within the cervical spine (flexion, extension,

right/left rotation, right/left lateral flexion). The clinical examination was conducted by a physiotherapist specializing in the treatment of temporomandibular dysfunction under medical supervision. A detailed course of the study is presented in Table 1. All data were collected during a single visit, performed by the same person under standardized conditions, and devices and methods of confirmed scientific significance were used for the study [17,18].

Table 1. Methodology of the physiotherapeutic examination.

EXAMINATION	DESCRIPTION
Palpation [1,3]	
Standardized starting position: lying position, upper and salt limbs straight, head in neutral position.	
Masseter muscle	Palpation between the zygomatic angle and the angle of the lower jaw.
Temporal muscle	Palpation in 3 parts: - anterior – above the ear and forward from it; - middle – above the ear; - posterior – above the ear and behind the ear.
Medial pterygoid muscle	Palpation on the medial side of the angle of the lower jaw with pressure towards the skull.
Digastric muscle	Palpation in 2 parts during cervical spine extension: - anterior – below the top of the chin on both sides of the floor of the mouth; - posterior – from the back of the angle of the jaw, in front of the sternocleidomastoid muscle towards the ear.
Zygomaticus minor and major muscles	Palpation inside the mouth between the upper lip and the teeth, the other hand performs palpation from the outside.
Suprahyoid and infrahyoid muscles	Gentle palpation during the movement of cervical extension of the spine and maintenance of dental contact.
Sternocleidomastoid muscles	Palpation on the lateral part of the neck, during the movement of lateral flexion of the neck to the opposite side and rotation to the same side.
Anterior/medium/posterior inclined muscles	Palpation on the lateral side of the neck, behind the sternocleidomastoid muscle.
Examination of the range of motion of temporomandibular joints [18]	
Standardized starting position: sitting position, back straight, head in neutral position.	
Abduction	Active movement measurement: distance between upper and lower incisors (sagittal movement)
Protrusion	Active movement measurement: the distance between the upper and lower incisors (movement in the transverse plane).
Lateral movement (right/left)	Active movement measurement: mandibular protrusion to the left and right, measurement of the distance between the midline of the jaw and the midline of the mandible shifted to the right or left.

Examination of the range of motion of the cervical spine [17]	
Standardized starting position: sitting position, back straight, head in a horizontal position.	
Flexion and extension	Inclinometer placed on top of the head in position 0°. Movement: flexion and extension (movement in the sagittal plane).
Rotation (Right/Left)	Inclinometer placed on the front of the forehead in position 0°. Movement: rotation to the right and left (movement in the transverse plane).
Lateral flexion (right/left)	Inclinometer placed on top of the head in position 0°. Movement: Right and Left Lateral Flexion (movement in the frontal plane)

4. Statistical analysis

Statistical analysis was performed using STATISTICA 13.3PL (StatSoft Poland, 2017; www.statsoft.pl) and in Microsoft Excel. The data were subjected to the analysis of basic statistics such as mean or standard deviations and detailed analysis using the Shapiro-Wilk test, Pearson or Spearman correlation, Mann-Whitney U test, Student's t-test or chi-square test. Statistical tests were selected based on the characteristics of the variable (quantitative, qualitative) and depending on the analysis performed. The results were assumed to be statistically significant if $p < 0.05$.

5. Results

95 people took part in the study, of which 51 were included in the control group (n=38 women, 74.5% vs. n=13 men, 25.5%), and 44 people were included in the study group (n=37 women, 84.1% vs. n=7 men, 15.9%). The mean age of the participants was 22.4 years (± 2.7), and there were no significant differences between the study group (22.2 \pm 2.2) and the control group (22.5 \pm 3.1). The largest group were people aged 21-25 (n=51 people, 53.7%), respectively 26 people in the control group (51.0%) and 25 people in the study group (56.8%). Subjects from the 18-20 age group (n=32 people, 33.7%) were classified equally in both the study and control groups (n=16 people, 31.4% and n=16 people, 36.4%, respectively). The least numerous group were people aged 26-30 (n=12 people, 12.6%). The study group was much smaller (n=3 people, 6.8%) compared to the control group (n=9, 17.6%). In addition, respondents had to answer a question about their health. In both the study group and the control group, no one described their health as poor or satisfactory (n=0, 0.0%, respectively). Most people described their health as good (n=49, 51.6%), including 22 people from the control group (43.1%) and 27 people from the study group (61.4%). 34 respondents (35.8%), including 20 people from the control group (39.2%) and 14 people from the study group (31.8%) described their health as very good. Only 12.8% of the respondents (n=12) described their health as excellent, and the vast majority of them were from the control group (n=9, 17.7%), compared to the study group (n=3, 6.8%). Detailed characteristics of the group are presented in Table 2.

Table 2. Characteristics of the group.

Characteristics	Control group n = 51	Study group n = 44	Total n = 95	P-value
Gender, n (%)				
Male	13 (25.5)	7 (15.9)	20 (21.1)	0,117
Female	38 (74.5)	37 (84.1)	75 (78.9)	<0,001
Age (years), n (%)				
18 – 20	16 (31.4)	16 (36.4)	32 (33.7)	0,085
21 – 25	26 (51.0)	25 (56.8)	51 (53.7)	

26 – 30	9 (17.6)	3 (6.8)	12 (12.6)	
Age (mean ± SD)	22.5 (2.2)	22.2 (3.1)	22.4 (2.7)	0,52
Health, n (%)				
weak	0 (0.0)	0 (0.0)	0 (0.0)	
sufficient	0 (0.0)	0 (0.0)	0 (0.0)	
good	22 (43.1)	27 (61.4)	49 (51.6)	0,076
very good	20 (39.2)	14 (31.8)	34 (35.8)	
excellent	9 (17.7)	3 (6.8)	12 (12.6)	

Note: SD – Standard deviation; statistically significant differences in bold.

In the next part of the study, respondents answered questions about the occurrence of symptoms within the masticatory system. The majority of patients in the study reported headaches (n=54, 58.8%), of which the vast majority were controls (n=43, 95.5%). Only two people have not noticed this problem in recent times (n=2, 4.5%). In addition, the respondents often indicated pain in the masticatory muscles and/or neck (n=44, 46.3%), and in the vast majority of cases this problem occurred in the study group (n=37, 84.1%) than in the control group (n=7, 13.7%). In addition, pain or discomfort in the temporomandibular joint area was frequently reported (n=41, 43.2%), where again the vast majority were patients from the study group (n=38, 86.4%) compared to only three cases in the control group (n=3, 5.9%). Clenching of teeth, tinnitus and crackling in the joint were a very common symptom in the study group. They constituted 56.8% (n=25), 43.2% (n=19) and 45.5% (n=20) of this group respectively compared to a significantly lower occurrence in the control group (n=13, 25.5%; n=12, 23.5%; n=7, 13.7%, respectively). The respondents were least likely to report the problem of increased or decreased mobility of the temporomandibular joints (n=17, 17.9%) and numbness in the mandible (n=6, 6.3%). The above problems were definitely more often noticed by the study group (n=17, 38.6% and n=5, 11.4%, respectively) than by the control group (n=0, 0.0% and n=1, 2.0%, respectively). Detailed figures and statistical analysis are presented in Table 3.

Table 3. Symptoms of temporomandibular joint disorders.

Temporomandibular disorders– a survey questionnaire	Control group n = 51	Study group n = 44	Total n = 95	P-value
pain and/or discomfort in the TMJ area, n (%)	3 (5.9)	38 (86.4)	41 (43.2)	<0,001
pain in the chewing muscles and/or in the neck muscles, n (%)	7 (13.7)	37 (84.1)	44 (46.3)	<0,001
clicking or snapping sound in the TMJ, n (%)	7 (13.7)	20 (45.5)	27 (28.4)	<0,001
increased or decreased mobility of the TMJ, n (%)	0 (0.0)	17 (38.6)	17 (17.9)	<0,001
rubbing and/or clenching of teeth, n (%)	13 (25.5)	25 (56.8)	38 (40.0)	<0,001
numbness in the jaw area, n (%)	1 (2.0)	5 (11.4)	6 (6.3)	0,4328
tinnitus, n (%)	12 (23.5)	19 (43.2)	31 (32.6)	0,099
headaches, n (%)	12 (23.5)	42 (95.5)	54 (56.8)	<0,001

Note: TMJ – temporomandibular joint; statistically significant differences in bold.

The next part of the study was based on detailed palpation in both the study group and the control group. In each of the groups, it was possible to choose more than one option (multiple choice). During palpation of the masticatory muscles and temporomandibular joints, 57 respondents (60.0%)

reported no pain in the above locations. The vast majority of this group were subjects from the control group ($n=40$, 78.4%) than from the study group ($n=17$, 38.6%). Patients in the control group were most often diagnosed with problems with muscle pain on the left side of the face ($n=7$, 13.7%). Problems in the form of: pain in the left side of the joint ($n=1$, 2.0%), simultaneous pain in the left side of the joint ($n=2$, 3.9%), muscle pain on the right side ($n=2$, 3.9%), pain in the right side ($n=2$, 3.9%) or simultaneous pain in the muscle and joint on the right side ($n=1$, 2.0%) were reported sporadically. Patients from the study group reported symptoms during palpation in the form of: muscle pain on the left ($n=19$, 43.2%) and/or right ($n=12$, 27.3%) sides of the face or simultaneous muscle and joint pain on the left and/or right side ($n=10$, 22.7% and $n=10$, 22.7%, respectively). Less frequently, pain problems were observed only in the left ($n=6$, 13.6%) or right ($n=5$, 11.4%) temporomandibular joint (Table 4).

Table 4. Physiotherapeutic examination (palpation).

Physiotherapy examination	Control group $n = 51$	Study group $n = 44$	Total, $n = 95$
without facial pain, n (%)	40 (78.4)	17 (38.6)	57 (60.0)
muscle pain on the left side, n (%)	7 (13.7)	19 (43.2)	26 (27.4)
pain in the joint on the left side, n (%)	1 (2.0)	6 (13.6)	7 (7.4)
muscle and joint pain on the left side, n (%)	2 (3.9)	10 (22.7)	12 (12.6)
muscle pain on the right side, n (%)	2 (3.9)	12 (27.3)	14 (14.7)
pain in the joint on the right side, n (%)	2 (3.9)	5 (11.4)	7 (7.4)
muscle and joint pain on the right side, n (%)	1 (2.0)	10 (22.7)	11 (11.6)

In the next part of the study, detailed measurements of the range of motion of the temporomandibular joints were made with the use of electronic calipers. In the control group, significantly higher results were recorded in terms of performed movements. Mandibular abduction in the control group averaged 42.3 ± 14.8 mm, and pain during movement was reported by only one person (2.0%). In the control group, the range of this movement was significantly lower (30.9 ± 8.2 mm), and pain during movement was noted in 19 people (43.2%). Protrusion movement was performed to a greater extent in the control group (8.2 ± 2.1 mm) than in the study group (4.6 ± 1.9 mm), and pain during movement was reported by 2 people (3.9%) from the first group and as many as 27 people (61.4%) from the study group, respectively. Similar relationships are visible when performing lateral movements. In the control group, lateral movement to the left and right was in a similar range (9.2 ± 1.7 mm and 9.8 ± 1.1 mm, respectively), and pain was reported by only 1 person (2.0%) during lateral movement to the right. In the study group, both lateral movement to the left and right was to a lesser extent (8.3 ± 1.3 mm and 7.8 ± 1.8 mm, respectively). Pain during lateral movement to the left was reported by 12 people (27.3%) and by 10 people (22.7%) to the right. Figures and statistics are presented in Table 5.

Table 5. Mobility of the temporomandibular joints.

Mobility of the temporomandibular joint	Control group	Study group	P-value
	n = 51	n = 44	
Abduction (mean ± SD)	42.3 mm (14.8)	30.9 mm (8.2)	<0,001
Pain, n (%)	1 (2.0)	19 (43.2)	
Protrusion (mean ± SD)	8.2 mm (2.1)	4.6 mm (1.9)	<0,001
Pain, n (%)	2 (3.9)	27 (61.4)	
Lateral movement to the left			
(mean ± SD)	9.2 mm (1.7)	8.3 mm (1.3)	<0,001
Pain, n (%)	0 (0.0)	12 (27.3)	
Lateral movement to the right			
(mean ± SD)	9.8 mm (1.1)	7.8 mm (1.8)	<0,001
Pain, n (%)	1 (2.0)	10 (22.7)	

Note: SD – Standard deviation; statistically significant differences in bold.

The last part of the study was the measurement of the range of motion of the cervical spine using a Baseline inclinometer. Significantly better results were recorded in the respondents from the control group than those from the study group. In the flexion and extension control group, the average range of motion was $45.6 \pm 12.1^\circ$ and $74.1 \pm 5.6^\circ$, while in the study group it was $40.1 \pm 9.9^\circ$ and $65.2 \pm 6.3^\circ$, respectively. Cervical spine flexion pain was reported in 1 control group (2.0%) and 10 patients in the study group (22.7%). Pain during extension was reported by 1 person (2.0%) from the control group and 9 people from the study group (20.5%). Left rotation was better in both the control group ($68.9 \pm 8.2^\circ$) and the study group ($61.7 \pm 10.9^\circ$) compared with the slightly weak right-hand rotation ($67.5 \pm 12.7^\circ$ in the control group, $59.1 \pm 11.2^\circ$ in the study group). Pain during right rotation was reported by 2 subjects (3.9%) from the control group and 8 subjects (18.2%) from the study group. On the other hand, during the left rotation, no person from the control group reported abnormalities, while in the study group it was 8 respondents (18.2%). In the case of lateral flexion movement to the right and left sides, identical results were noted in the study group (mean $45.3 \pm 7.9^\circ$, $45.3 \pm 7.4^\circ$), and pain during movement was reported by 5 people (11.4) and 6 people (13.6), respectively. Better results were presented by people from the control group, where the lateral flexion movement to the right side was on average $50.7 \pm 8.7^\circ$, and to the left side $52.5 \pm 8.5^\circ$. Pain was reported by 3 people (5.9%) and 1 person (2.0%), respectively. The data are shown in Table 6.

Table 6. Mobility of the cervical spine.

Mobility of the cervical spine	Control group	Study group	P-value
	n = 51	n = 44	
Flexion (mean ± SD)	45.6° (12.1)	40.1° (9.9)	<0,05
Pain, n (%)	1 (2.0)	10 (22.7)	
Extension (mean ± SD)	74.1° (5.6)	65.2° (6.3)	0,139
Pain, n (%)	1 (2.0)	9 (20.5)	
Rotation to the right			
(mean ± SD)	67.5° (12.7)	59.1° (11.2)	<0,05
Pain, n (%)	2 (3.9)	8 (18.2)	
Rotation to the left side			
(mean ± SD)	68.9° (8.2)	61.7° (10.9)	<0,05
Pain, n (%)	0 (0.0)	8 (18.2)	
Side bend to the right			
(mean ± SD)	50.7° (8.7)	45.3° (7.9)	<0,05
Pain, n (%)	3 (5.9)	5 (11.4)	
Side bend to the left			
(mean ± SD)	52.5° (8.5)	45.3° (7.4)	<0,05
Pain, n (%)	1 (2.0)	6 (13.6)	

Note: SD – Standard deviation; statistically significant differences in bold.

In the last part of the survey, the respondents answered about their cervical spine pain and the level of its intensity. 85.3% of the subjects (n=81) in the study reported cervical spine pain in the past month. The absence of upper back disorders was noted in 14.7% (n=14) of the respondents. Problems were much more common in the study group (n=43, 97.7%) than in the control group (n=38, 74.5%). Cervical pain was not reported by only 1 person (2.3%) in the study group and 13 people (25.5%) in the control group. The relationship was statistically significant ($p < 0.05$, $\chi^2 = 10.118$, $df = 1$) and the strength of the compound was average ($r = 0.31$). The intensity of cervical spine pain was assessed using the Visual Analogue Scale (VAS). The mean level of pain intensity in the control group was 1.6 ± 0.8 , while in the study group it was 4.7 ± 3.2 and a statistically significant relationship was noted ($p < 0.001$). None of the respondents (both control and subject) described their pain as unbearable. Severe pain was noted only in the study group (n=13, 29.5%), while in none of the control group (n=0, 0.0%). Moderate pain was more common in the study group (n=20, 45.5%) than in the control group (n=4, 7.8%). Mild pain was reported by the highest number of patients from the control group (n=34, 66.7%) and slightly less from the study group (n=10, 22.7%). The relationship was statistically significant ($p < 0.001$, $\chi^2 = 45.765$, $df = 4$), and the strength of the relationship was mean ($r = 0.57$). Detailed figures and statistics are given in Table 7.

Table 7. Cervical spine pain and its intensity.

Variable	Control group n = 51	Study group n = 44	Total n (%)	P-value
The cervical spine pain,				
<i>n (%)</i>				
Yes	38 (74.5)	43 (97.7)	81 (85.3)	<0,05*
No	13 (25.5)	1 (2.3)	14 (14.7)	
Intensity of pain in the cervical spine				
(the VAS Scale), n (%)				
0				
1-3	13 (25.5)	1 (2.3)	14 (14.7)	
4-6	34 (66.7)	10 (22.7)	44 (46.3)	
7-9	4 (7.8)	20 (45.5)	24 (25.3)	<0,001**
10	0 (0.0)	13 (29.5)	13 (13.7)	
	0 (0.0)	0 (0.0)	0 (0.0)	

* $\chi^2 = 10.118$, $df = 1$, $r = 0.31$ – average strength of the compound; ** $\chi^2 = 45.765$, $df = 4$, $r = 0.57$ – mean strength of the compound.

6. Discussion

Temporomandibular disorders are a multifactorial and multi-stage process. The analysis of the available scientific literature is not homogeneous in terms of the prevalence of this problem. It is estimated that the problem occurs in 3 to even 12% of the population [19,20], but there are also studies determining the frequency of TMD at the level of even 15.6-16.2% [21]. In the Polish scientific literature, it has been noted that this problem may occur in 26.5% [20] to even 48.9% [22] of people living in these areas. The diversity of diagnostic criteria, the size of the groups, the age of the participants in the study or the occurrence of comorbidities may have a significant impact on the epidemiological differences in the occurrence of temporomandibular disorders [18]. The authors of the above report qualified 95 people for their study, of which 44 people (46.3%) reported disorders within the musculoskeletal system. The study was significantly more women (n=75, 78.9%) than men (n=20, 21.1%). In addition, women ($p < 0.001$, n=37, 38.9%) were more likely to report problems with the masticatory motor system than men ($p > 0.05$, n=7, 7.4%). The investigated literature confirms that temporomandibular disorders are much more common in women than in men. The most commonly described ratio is 2:1, but there is also a much higher ratio in the range of 3-4:1 [7,10,22,23,25]. The

mean age of the participants was 22.4 (± 2.7) and the differences between the groups were not statistically significant ($p > 0.05$). In the control group, the mean age was 22.5 ± 2.2 , and in the study group, 22.2 ± 3.1 . Temporomandibular symptoms are most common between 20 and 40 years of age, but pain problems are most often reported between 30 and 40 years of age [24,25]. Other researchers determined higher average age values of people participating in the study ranged from 33.0 years to even 38.9 years [26,27]. In the case of the authors of the above studies, as well as the studies of Wolan-Nieroda and co-authors [28], only people from the age group of 18-30 years were qualified for the analysis, which may slightly distort the view on the occurrence of particularly painful forms of temporomandibular disorders. In the scientific literature, there was no information on the subjective assessment of the health status of people with temporomandibular disorders. Our own research showed that people with temporomandibular disorders most often described their health as good ($n=27$, 61.4%) or very good ($n=14$, 31.8%), and least often as excellent ($n=3$, 6.8%). Similar results were obtained in the control group ($n=22$, 43.1%; $n=20$, 39.2% and $n=9$, 17.7%, respectively). None of the people in the study described their health as poor or sufficient.

Disorders of the masticatory motor system may affect both the muscular and/or osteoarticular systems. The most common symptoms of stomatognathic system disorders are crackling in the temporomandibular joints (26.7%) [29] and headaches (21.7%-56.5%) [29–32]. People with disorders of the masticatory system are more likely to present headache problems in the form of migraines than people without TMD [32]. Similar results of the study were presented by the authors of the above article, where headaches were more often reported by people from the study group ($n=42$, 95.5%) than from the control group ($n=12$, 23.5%), and the result was statistically significant ($p < 0.001$). In addition, the scientific literature indicates that headaches affect women more often than men (1.7:1), and students are much more prone to headaches [33]. Abnormal muscle tension in the masticatory muscles and/or neck may have a significant impact on the occurrence of headaches. It is estimated that this pathology occurs in 32.2% [31] to even 97.3% [34,35] of people with temporomandibular disorders. Our own research also confirms the above relationship ($p < 0.001$; control group, $n=7$, 13.7%; study group, $n=37$, 84.1%). Another important aspect analyzed in studies is pain or discomfort in the TMJ area, and this problem is noted in up to 36% of people [31]. This relationship was also evident in our own research ($p < 0.001$, $n=38$, 86.4% of the subjects). It is worth mentioning that the scientific literature often discusses the potential relationship between temporomandibular disorders and bruxism. According to researchers, there is a relationship between these variables [36] and bruxism is reported from 17.9% [37] to as much as 96.6% of people with TMD [36]. Our study supports the above theory ($p < 0.001$), but there were no such large differences in numbers and percentages (control group, $n=13$, 25.5%; study group, $n=35$, 56.8%). In the case of suspected disorders of the masticatory system, it is important to perform a comprehensive assessment of the patient, including an otolaryngological examination. There is scientific evidence that tinnitus is more common in people with temporomandibular disorders. It is estimated that the problem may affect from 11.4% [38] to as much as 60.7% [39]. However, other systematic reviews indicate that the prevalence of tinnitus in people with TMD can range from 3.7% to as much as 70% [40]. Our own studies do not confirm statistical significance ($p > 0.05$), and the differences between the groups were not significant (23.5% of the control group vs. 43.2% of the study group). It is worth noting that in addition to all of the above symptoms, patients may also report popping and/or skipping within the TMJ. They may occur in as many as 14.3% to as much as 52% of people with TMD [41], which was also noted by the authors of the above article ($p < 0.001$, control group, $n=7$, 13.7% vs. study group, $n=20$, 45.5%). Despite numerous disorders of the temporomandibular joints, patients report problems with chewing food (about 26%) or problems with opening the mouth (9.7%), but they are reported more often in older age groups (about 50 years).

The results of the study obtained by the authors in the field of detailed physical examination within the musculoskeletal system of the masticatory organ and the cervical spine allow to conclude that there are significant differences between the control group and the study group. Patients from the study group were characterized by more frequent pain during palpation (both in muscle, joint and musculoskeletal groups). In addition, decreased mobility of the temporomandibular joints in

each movement was noted (abduction, $p < 0.001$; protrusion, $p < 0.001$; lateral movement to the left, $p < 0.001$; lateral movement to the right, $p < 0.001$) and more frequent reporting of pain during their performance than in the control group. It is also worth noting that the subjects in the study group were characterized by lower mobility of the cervical spine, and the results obtained were statistically significant ($p < 0.05$), except for extension movement ($p > 0.05$). By focusing exclusively on young people, we have been able to eliminate many comorbidities that could significantly affect our research results. Similar studies, also conducted in the 18-30 age group, were conducted by Wolan-Nierod and co-authors [28], but on a smaller number of patients (control group, $n=30$; study group, $n=30$). The results obtained by them are similar to those obtained by the authors of the above work. People with TMD achieved lower measurements of temporomandibular joint mobility and cervical spine. Statistically significant correlations concerned lateral flexion to the right or left and rotation to the right or left. In addition, there was a statistically significant reduction in TMJ mobility in each movement ($p < 0.001$). The analysis did not investigate the protrusion movement. Similar results were also obtained by Kitsoulis and co-authors, who emphasized that people with disorders within the masticatory motor system achieved lower scores when measuring TMJ mobility [42]. A study by Ferreira and co-authors showed that people with TMD experienced reduced mobility of the cervical spine during flexion and extension movements, and poorer outcomes when performing the flexion and rotation test and the craniocervical flexion test (all $p < 0.05$). It is worth noting that the study was conducted only in a group of women, and the results correlated with pain and poor neck muscle function, which was also noted by the authors of the above studies [43]. In addition, researchers note that patients with TMD are more likely to have segmental limitations or tender trigger points within the muscles than in control groups [44,45].

There is still no single position in the scientific literature on the influence of posture on the occurrence of temporomandibular disorders [46]. It is estimated that spinal pain may occur in up to 48% of people with temporomandibular disorders, and its cervicogenic origin is much higher in the group of people with TMD [14]. In addition, the subjects confirm that there is a relationship between painful TMD and cervical spine pain [47] and a correlation between TMD and limited mobility and cervical spine pain [34]. Research conducted by Walczyńska-Dragon shows that a comprehensive physiotherapeutic and dental approach is important in the treatment of people with TMD. The implementation of appropriate splint therapy resulted in a reduction in cervical spine pain and increased mobility. In addition, it is worth mentioning that there was an improvement in the efficiency of the masticatory motor system [26]. It is worth noting that an incorrect position of the head (in protraction) may be a factor in the formation of TMD [48] and cause pain in the cervical spine or temporomandibular joints [49]. In addition, muscle tension in the stomatognathic system may affect changes in postural control due to numerous neurological, proprioceptive, muscular, articular or ligamentous connections [50]. In contrast to the above studies, the results of the analysis by Weber and co-authors, conducted in a group of women aged 19 to 35, stand in contrast to the above studies. Studies show that the coexistence of cervical spine symptoms and temporomandibular disorders may be more related to the innervation of the trigeminocervical complex than to deviations in body posture [51]. Another team of researchers came to similar conclusions, determining that there is no relationship between the occurrence of symptoms of temporomandibular disorders and curvatures of the cervical spine [52]. In addition, the results of the study do not support the thesis that body posture can exacerbate or cause symptoms of temporomandibular disorders. However, these results were conducted on small groups, which had a significant impact on the result obtained [53]. Significant attention is paid to the occurrence of pain in Pedroni syndrome [54], where some of the respondents at the time of assessment assessed the intensity of pain as mild (35.5%) or bothersome (21.42%). In addition, none of the participants reported any pain or described the pain as horrible or excruciating during the assessment. The authors of the above study also noted a higher intensity of pain in people with temporomandibular disorders than in those in the control group ($p < 0.001$, $\chi^2=45.765$, $df=4$).

An important role in the treatment of people with temporomandibular disorders is the introduction of interdisciplinary therapy based on the cooperation of: dentists, physiotherapists,

speech therapists or doctors of other specialties (orthopaedists, laryngologists or neurologists). Numerous articles draw attention to the cooperation of several specialists in order to achieve maximum therapeutic effects allowing the patient to return or improve their daily functioning. It is important to remember that musculoskeletal and ligamentous disorders are not a problem affecting only one region of the body. Usually, the problem is compensated for in another area of the human body, which is why it is so important to have a holistic approach to the problem with which the patient reports [4,12,15,34,55].

7. Constraints

The studies provided important information on the incidence of cervical spine pain in people with temporomandibular disorders, but there are limitations that may affect the reception of the tests. Firstly, there is an unequal study and control group, which can mislead readers despite their high statistical significance. Studies of a larger population may provide more reliable results, but due to the time constraints of the study and limited resources, it was not possible to enroll a group of more than 100 people. In addition, it is worth mentioning that each person was examined by one physiotherapist. The inclusion of more specialists in the examination would allow for more efficient testing, but it could differ in the extent to which it is carried out. A significant obstacle may be the narrow age range of people qualified for the study (18-30 years), which is why the authors declare their willingness to continue the above research, paying particular attention to the increase in the number of groups, a wider selection of age groups and the inclusion of additional variables in the study. In addition, the assessment of pain was limited only to VAS, and enriching the study with other, more extensive scales (for example, the Neck Disability Index) may provide a broader picture of the nature of cervical spine pain. In addition, measurements of the mobility of the cervical spine and temporomandibular joints could be carried out with more advanced tools, but this would entail much higher research costs. In addition, only a few institutions in Poland have such research facilities and employ appropriately trained staff. This study was based on the use of open-source tools that are reliable and common in clinical practice. This study focused on the estimation of the incidence and intensity of cervical spine pain in people with temporomandibular disorders, ignoring aspects of the impact of pain on quality of life. According to the authors, this topic exceeded the scope of this topic of the publication and it was decided that it would be the subject of the next report.

8. Conclusions

According to population studies, temporomandibular disorders occur in 3 to 12% of the population [19,20] and pain in the cervical spine may affect up to 70% of the population [12]. Disorders within the locomotor system of the masticatory organ are a multifactorial disorder, and patients with this problem are often condemned to concomitant symptoms. The analysis showed that among the 95 people participating in the study, 85.4% reported problems in this area ($n=81$), of which almost all people in the study group struggled with this problem ($n=43$, 97.7%). The analysis of the available literature and our own research allow us to conclude that there is a relationship between temporomandibular disorders and cervical spine pain ($p<0.05$, $\chi^2=0.118$, $df=1$, $r=0.31$). It is worth mentioning that the level of pain is significantly higher in the study group ($p<0.001$, $\chi^2=45.765$, $df=4$, $r=0.57$). In addition, the results of the study show that patients with TMD present significantly lower ranges of motion of the temporomandibular joints and the cervical spine compared to those in the control group. It is important to implement properly planned physiotherapeutic activities and patient education in the field of combating cervical spine diseases. The results of the study suggest that further research is needed to develop the most effective treatment strategies.

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