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Disorders of the statics of the body and the temporomandibular joint

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SUMMARY
INTRODUCTION The temporomandibular joint is a synovial, complex (hinge-sliding) joint that connects the temporal bone with the mandible by means of an articular disc. Temporomandibular joint dysfunctions most often concern several disease entities and include various symptoms and ailments. One of the first symptoms of the disease is pain that stems from a muscle or joint. In addition, we can observe: limitations in the mobility and range of movement of the jaw, problems with chewing food, crackles in the joint, pain in pressure and touch of the muscles, earaches and noise or changes in the appearance of the face (the so-called "square face"). Any deviation from the correct body posture is called a posture defect.
OBJECTIVE The main aim of the study is to present the significant relationship between disturbed statics of the body and the temporomandibular joint, thanks to which we can explain the importance of proper planning of diagnostics as well as conducting dental and physiotherapeutic therapy.
THE WEIGHT OF THE BODCIES The materials used to write the article include scientific works from 1992-2021. The data was collected using the PubMed search engine and manual filtering. 80 publications were qualified for the analysis.
SUMMARY According to the analyzed literature, we believe that there is a relationship between disturbances in the body statics and the stomatognathic system. The complexity of the issue shows that it is important to conduct multi-directional and interdisciplinary therapy.

KEY WORDS: temporomandibular joint, dysfunctions of the temporomandibular joints, posture defects.

Admission

The stomatognathic system consists of tissue and organ structures responsible for food intake, articulation and expression of emotions. It consists of: the mandible, teeth, jaw, temporomandibular joints, muscles, ligaments and numerous blood, nerve and lymph vessels [1,2].

The temporomandibular joint is a paired structure that connects the temporal bone with the mandible with an articular disc. It is responsible for the compatibility of articular surfaces and the amortization of improperly acting forces. It is a complex synovial joint (hinge-sliding), which distinguishes it from other body structures [1,3].

The ligaments of this joint (stylomandibular, temporomandibular, wedge-mandibular, capsular and collateral - lateral and medial) provide protection against mechanical damage and prevent pathological, uncontrolled movements of the joint (passive control). Moreover, they do not participate in active movements as they do not have the ability to stretch (the presence of collagen fibers) [1].

TMJ innervation is provided by branches of the mandibular nerve: the masseter nerve and the eartemporal nerve, while the vascularization comes from the branches of the external carotid artery (most often the superficial temporal). Nutrition of the joint and protection against abrasion of the joint surfaces is conditioned by the presence of synovial fluid [3].

The active control of the temporomandibular joint is exercised by the muscles responsible for three types of movements: mandibular lifting and lowering, mandibular protrusion and retrusion, and lateral movements. Detailed characteristics are presented in Table 1. [3,4].

MOTION	MECHANISM	MOVING MUSCLES
Lowering the lower jaw	Displacement of the articular head on the articular tubercles and the articular disc forward.	- biceps muscles - the mandibular and hyoid muscles - lateral wing muscles
Lowering the jaw (closing the mouth)	Displacement of the articular head and articular disc to the base of the articular cusps.	- masseter muscles - temporal muscles - medial wing muscles

M a n d i b u l a r protrusion	Displacement of the articular head and articular disc forward and down, rotation in the long axis.	- lateral wing muscles (lower) - masseter and temporal (auxiliary) muscles
M a n d i b u l a r retrusion	Displacement of the articular head and articular disc backwards and upwards.	- temporal muscles - masseter muscles - bicuspid muscles - mental and hyoid muscles
Lateral mandible	Laterotrusion: the articular head rotates vertically, to the side and back. Mediotrusion: the articular head rotates forwards, downwards and inwards onto the articular tubercle.	Laterotrusion: - inferior lateral pterygoid muscle Mediotrusion: - medial pterygoid muscle - the hyoid-mandibular muscle

Chewing system dysfunctions

Disorders of the locomotor system of the masticatory system usually concern several disease entities and include various symptoms and ailments. One of the first symptoms of the disease is pain that originates in muscles or a joint. In addition, we can observe: limitation of the mobility and range of movement of the mandible, problems with chewing food, crackling in the joint, pressure and tactile pain in the muscles, ear pain and noise, and changes in the appearance of the face (the so-called "square face") [4,6,10] .

Dysfunctions within the temporomandibular joint concern approx. 40-60%, and at least one symptom is reported by 41% of respondents. Much more often this problem is diagnosed in city dwellers and in women aged 20-40. There is also a significant increase in the prevalence of TMD in children aged 7-11 (30-60%) and over 80% in people over 18 years of age. The factors exacerbating

disorders in the temporomandibular joints include: stress, family problems, trauma in the head / neck area, bruxism, malocclusion or posture [7-10].

Disorders of body statics

Body posture is an individual, individual feature of each person represented by a figure. It develops on a neurological, emotional, environmental and bone-joint-ligament-muscular basis. The following factors play a significant role in the development of attitude: genetic factors, age, sex, race, but also the type of build or character [4, 11].

The correct body posture can be determined by the following characteristics: a)
spinous processes of the spine in one line,
b) parallel positioning of the shoulder blades, shoulders, collarbones, iliac spines and knees, c)
pelvis in a neutral position,
d) symmetrical waist triangles,
e) adequate arching of the chest,
f) ergonomic head position (zygomatic bone in line with the sternum),
g) proper positioning of limbs and feet [11, 12].

Any anomaly from the correct body posture is called a posture defect. In the literature, we find numerous divisions of this dysfunction, but most often we use the breakdown into acquired and congenital defects. The first of them result from the influence of pathological factors in utero (toxic - poisoning, infections, mechanical). On the other hand, the latter are caused by the action of external factors after giving birth to a child. We can distinguish environmental factors - sedentary work, lack of physical activity; morphological factors - abnormal muscle tone and physiological factors - subconscious assumption of an incorrect position [4, 11-13].

The most common disorders of the body statics include: a)
in the sagittal plane:
- round back,
- concave back,
- round-concave back,
- flat back;
b) three-plane curvature of the spine - scoliosis;
c) chest defects:
- chicken chest, -
funnel-shaped chest;
d) pathological position of the neck and nape (including torticollis);
e) asymmetrical blade arrangement or winged blade;
f) defects of lower limbs and feet:
- valgus or varus knees,
- flat, flat-valgus, horse, clubfoot or hollow foot [11].

In the case of disorders within the masticatory system, it is important to pay attention to the type of bite and the posture pattern adopted. They were described by Hall, and quoting from the work by Liem and Dmochowska-Lisak, we distinguish between the front and rear standards. The first of them is characterized by deepened cervical lordosis, increased tension in the back muscles and ligaments, blockage at the level of Th11 - Th12 and excessive tension in the L - S area. sacroiliac joints. There are also significant changes in the cardiovascular and visceral systems [7, 17].

The latest epidemiological data show that disturbances in body statics occur in 30-60% of children and adolescents. The Center of Health Information Systems (CSIOZ) presented information that

17.4% of spinal deformities were diagnosed in children aged 0-18 years, and 56-57% of them were scoliosis [14]. Changes in the chest, pelvis and limbs concern 45-55% of children [15].
According to the report of the Ministry of Health from 2019, the amount of sugar consumed in Poland is systematically growing, and thus the group of people struggling with overweight is growing. This problem significantly correlates with the constantly progressing increase in body statics disorders among children, adolescents and adults [16].

Objective of the work
The main aim of the study is to present the significant relationship between disturbed statics of the body and the temporomandibular joint, thanks to which we can explain the importance of proper planning of diagnostics and conducting dental and physiotherapeutic therapy.

Materials and methods
The materials used to write the article include scientific works from 1992-2021. The data was collected using the PubMed search engine and manual filtering. 80 publications were qualified for the analysis and further analyzed.

The main part of the issue
In recent years, many people have studied the various factors that affect body posture and the temporomandibular joint. Among them, we can mention, among others emotional state, respiratory tract, positioning of the head and neck, muscle tension, ear disorders, crackling joints or disturbances in body statics. We will devote our work to the latter, relying on professional literature [20].
The myofascial system plays an important role in influencing the stomatognathic system. Fascia is a fibrous connective tissue that surrounds the body, protecting it, nourishing and stabilizing the organs in the right position. Its innermost layer is equipped with myofibroblasts and receptors: chemical, thermal, mechanical, pain or deep feeling. This system is important because it has the ability to contract automatically, which can affect the tension transmitted to other parts of the body, thereby affecting posture. This phenomenon was described by Myers, who showed the existence of myofascial tapes [18-20].
In the publication by Simons et. al. we can find information on muscle disorders in the case of temporomandibular joint dysfunction. He noticed a correlation between the shortening of the extensor muscles of the posterior segment of the neck (suboccipital muscles, trapezius muscles, semispinal muscles, lobes) and sternocleidomastoid muscles and disorders of the stomatognathic system [27, 77]. In patients with disorders of the temporomandibular joints, the increased tension of the sternocleidomastoid muscle is a significant change. Overloading the muscles of the neck flexors weakens the muscles of the antagonists, which in turn leads to the protraction of the head and the shallowing of the lordosis in the cervical region [28]. This thesis was confirmed by other researchers who reported that trapezius muscle hypersensitivity and pain in the anterior slanted muscle trigger points, and more than half had increased tenderness within the MOS [25, 29].
An important issue worth mentioning in this work are the active trigger points. Behind this term are muscle fibers with excessive tension, which are hypersensitive to pressure. Its activation causes tenderness and pain that can be projected onto other parts of the body. According to studies, in the case of stomatognathic system disorders, they are found in the masticatory muscles, neck and shoulders, especially in women with TMD myofascial pain [79]. Patients with increased muscular tenderness of the masticatory system significantly more often showed pain when the muscles of the neck were pressed than patients without muscle tenderness of the temporomandibular system.

Additionally, there was a coexisting reduction in the range of motion of the temporomandibular joint [30-32].
The etiology of temporomandibular joint dysfunction is multidirectional and the most important aspect is the holistic approach to the patient. The main goal is to make an appropriate diagnosis and start therapy early. An important issue in the assessment of body posture is the special consideration of the position of the cervical spine. The connection of the head, neck and shoulders through the musculoskeletal system, as well as the fascial or nervous system, may transfer symptoms from one part of this chain to another [19].
Huggare noted that in patients qualified for TMJ treatment, head protraction, reduced size of the upper cervical vertebrae, flattened skull base and deepened cervical lordosis occurred significantly more frequently [21]. In a detailed assessment of the position of the ear section in relation to the C7 vertebra, in the case of disorders of the temporomandibular joint - the head is excessively protruding forward [33, 34].
Gonzalez's extended research has determined that when the head is shifted forward, it extends the upper cervical spine C1-C3 and lordosis deepens in the C4-C7 segment [23]. Similar conclusions were drawn by other researchers who confirmed that the position of the head influences disorders in the masticatory system [22,24,25,35]. In opposition to the above studies, the results of independent observations carried out by teams of Sonnensen, Hackney, Visscher [34, 36, 37, 78] were presented. They did not notice any significant correlation between head positioning and temporomandibular joint dysfunctions, while Weber believes that TMD is caused by the associated V pathway of the cranial nerve [38].
People with TMD show greater pain in the cervical region and exhibit greater postural asymmetry, and pain in the jaw has a potential relationship with postural stability disorder [80]. According to Walczyńska-Dragon, there is a correlation between TMD treatment and the reduction of pain in the cervical spine and the improvement of the range of motion [26]. An interesting relationship was noticed by Saddu, who during the research divided patients into two groups: with disorders of muscle origin and of joint origin. In the case of muscular dysfunction, the cervical lordosis worsens and there is no relationship between the head position and the temporomandibular joint [39]. An important issue to be discussed in the case of TMD is the "whip lash" disorder. It occurs during a traffic accident, when, after hitting the rear of the car, force forces the head to tilt uncontrollably backwards, and then back to tilt the head forward. The results of numerous studies show that the proper functioning of the neck is essential for the proper functioning of TMJ. An experiment carried out on 300 patients after the above-mentioned injury showed that 86% of respondents had symptoms of temporomandibular joint dysfunction in the form of clicks, blockage and inflammation [40,41].
In the literature, we often find the term "triad of abnormalities", which includes facial muscle pain, dysfunction of the temporomandibular joints and disorders in the cervical spine. Tomei and Bragatto noticed a significant dependence. The first of them assessed the incidence of back pain and the occurrence of TMD among drivers and police employees. His work confirmed that the higher incidence of problems in the cervical and lumbar spine was found in the first study group and was correlated with TMJ. In contrast, the second one observed an increase in the occurrence of TMD in women working in the office in a seated position. This information allows conclusions to be drawn that the lack of exercise may exacerbate spinal symptoms, but also disrupt the work of the temporomandibular joint [42-44].
The hyoid bone connects to the mandible through the suprahyoid muscles, conditioning its proper elevation and lateral displacement. The correctness of this relation is ensured by the appropriate tension mm. chewing, and pathogenic changes in this area can affect the entire body. Long-term disturbances in this area may affect the body posture, perpetuating the disturbance in the CNS,

which after some time may be considered by the body as normal [19,45]. In the case of TMD, the position of the hyoid bone is important, and Paco and Ekici paid special attention to this in their research. The results provided evidence that TMD is not associated with craniocervical dysfunction, but with the position of the hyoid bone and craniofacial morphology, and the reduction of this pathology may be due to appropriately selected orthodontic treatment [46, 47, 76].
The shoulder girdle may also have an indirect influence on the temporomandibular joint. The front head position and shoulder extension are common posture disorders in adolescents. This defect is more common in girls, and neck and shoulder pain is caused by the growth of the breasts in adolescence and hiding them from their peers for fear of being ridiculed (dysmorphobia). Stress, anxiety and depression may exacerbate the discomfort of the temporomandibular joint [48,49]. Detailed observation of TMJ and posture showed that 83.3% of respondents were diagnosed with high shoulder positioning, and the risk of TMD in people with shoulder asymmetry is approximately 6% [22, 31, 50, 51].
In the experimental group of studies carried out by Zonnenberg, there was a relationship between the asymmetry of the shoulder line, pelvis and occlusion. It should be added that similar studies were carried out by Kulesa-Mrowiecka and did not confirm the above thesis. There was no correlation between the position of the pelvis and the temporomandibular joint [52,53]. Extension of the above studies proved that there is no correlation between arm positioning, articular noise and pain during TMJ palpation [54].
In opposition to the above studies, de Wijer's theory that patients with TMD and patients with cervical spine disorders did not differ significantly in terms of pain and palpation of the shoulder girdle. This study showed that detailed diagnosis of the spine does not allow to differentiate the origin of the ailments and the observation of the upper quarter of the body should be performed in patients with advanced changes in TMJ [56]. Patients with TMD who constantly keep their head and shoulders over-protracted have a chance of great improvement if appropriate dental treatment, physiotherapy and self-therapy are implemented [51].
The function of the pelvis and sacroiliac joints is important for the work of the entire body because they are responsible for shock absorption. Overloading or damaging one joint shifts the weight of the body to the opposite side. If this pathological position is not corrected, one lower limb is shortened and the spine becomes deformed. The tensions generated during this pathology shift the contractions upwards and involve the masseter and temporal muscles, causing excessive tooth abrasion on that side and problems with the temporomandibular joint [56, 57].
The formation of posture defects is a complex and multi-stage phenomenon. Currently, they are considered a civilization problem due to the sedentary lifestyle, but also the lack of parental control over children spending time in front of the computer. The pathomechanism begins with bone misalignment that causes asymmetric muscle tension. This situation contributes to the formation of compensatory changes in the position of the spine and head, causing disturbances in the statics of the body [13, 76].
The relationship between mandibular displacement and scoliosis was studied by Ikemitsu et. al. They confirmed the relationship between scoliosis and TMD, but did not show any association with lateral displacement of the mandible [58]. This research was extended in 2017 by Nakashima. The results showed that 11.4% of respondents had a curvature above 10 ° Cobb and there was a correlation between the deviation of the mandible and scoliosis [59].
In her doctoral dissertation, Laskowska conducted a study of the frequency of malocclusion in adolescents with idiopathic scoliosis. In these people, more frequent occurrence of dysfunctions of the motor system of the masticatory apparatus was found, moreover, in 31.2% of respondents, the presence of cracks in the joint was found. Additionally, conclusions were drawn that lumbar scoliosis predisposes to the formation of an open bite, and thoracic scoliosis - to a cross bite [60,61].

The research results clearly show that in patients with scoliosis above 10 ° who performed exercises based on the Pilates system for 8 weeks, the curvature was reduced and the range of TMJ motion increased [62]. Some researchers find no association between postural defects and disorders of the temporomandibular joints [63,64,78].

Interdisciplinary studies on body posture and dental and ENT disorders were carried out on a group of 94 patients aged 7-14 years. A statistically significant correlation was found between the occurrence of kyphosis in the thoracic section and the position of the mandible. This relationship was more common in boys and was associated with pharyngeal obstruction [65].

In patients with disorders of the temporomandibular joints with anterior displacement of the articular disc, posterior pelvic rotation, lumbar hyperlordosis, extension in the thoracic spine and opposite rotation of the head opposite the mandible with open mouth are more common [66].

In his work, Bonato investigated the relationship between pain in TMJ and the transmission of pain to other joints. The hip, knee, ankle, shoulder, elbow and wrist joints were examined in 337 patients. The thesis was formulated that there is a relationship between the presence of transferred pain, diseases of muscles and joints, and the temporomandibular joint. People with TMD are 5.5 times more likely to develop diseases of other joints than people without disorders [67]. In opposition to these studies, Perez-Belloso did not find a direct relationship between the masticatory system and the lower limb [68].

Based on controversial reports, an experiment was conducted to present the relationship between the stomatognathic system and body posture. Posturographic parameters were highly variable and were similar in the study group and the control group. Accordingly, it was concluded that there was no correlation between TMD and attitude [69]. Nota, who conducted research on postural stability and TMJ, reached a different conclusion. According to him, rocking parameters and rocking speed are higher in the group of people with temporomandibular disorders, which indicates a significant difference in postural stability, especially in people with myogenic TMD. Additionally, a significant increase in the pressure of the feet on the ground on the side of the problematic joint can be seen [70,71].

The body weight of each person should be distributed over the largest possible surface. The foot is shaped under the influence of contact with the ground, and its correct arching ensures appropriate biomechanics of the whole body. By examining the pressure of the foot and the center of gravity, the researchers led by Sakaguchi analyzed the distribution of occlusal forces. It was concluded that changing the position of the lower jaw affects body posture, and that body posture affects the position of the lower jaw. This relationship was not shown by the Ferrario study, where no changes in foot pressure and center of gravity were observed in women with TMD. [72.73].

According to Maeda et. al. the difference in limb length affects body posture. These conclusions were drawn during an experimental study of changing position using orthopedic insoles applied to the heel. A correlation was noticed when the right foot was lifted and when the bite force was shifted to the same side. In the literature, we also find information about the functional correlation between the masticatory muscles and changes in the sole of the foot. TMJ disorders can be transmitted through the myofascial tapes and cause the plantar arches of the foot to reposition itself in the form of a valgus or flat foot. Contrary to these studies, Saito did not notice any significant differences in the structure of the foot and the presence of TMD [19,66,74,75]

Summary

According to the analyzed literature, we believe that there is a relationship between disturbances in the body statics and the stomatognathic system. The complexity of the issue shows that it is important to conduct multi-directional and interdisciplinary therapy. Focusing on only one structure may not produce the measured results, so it is important to look at the patient holistically. Such

therapy should involve the cooperation of a physiotherapist, orthopedist, dentist, but also an ENT specialist or a psychologist. Only joint and comprehensive treatment planning can help in the ailments with which the patient is struggling, especially if it is a complex problem in the motor system of the masticatory system.

Literature:

[1] Bochenek A., Reicher M. Anatomia człowieka. wyd. PZWL, Warszawa 2010, wydanie XI; tom I.

[2] Sokołowska-Pituchowa J. (red) Anatomia człowieka. wyd. PZWL, Warszawa 2005, wydanie VIII.

[3] Moore K., Dalley A., Agur A. Anatomia kliniczna. wyd. MedPharm Polska, Wrocław 2015, wydanie I; tom I.

[4] Gorzechowski K. Rehabilitacja stomatologiczna. wyd. KARGO, Białystok 2016, wydanie I. [5] Oleszek-Listopad J., Szymańska J. Dysfunkcja układu ruchowego narządu żucia – aktualny stan wiedzy. Medycyna Ogólna i Nauki o Zdrowiu 2018; 24 (2): p. 82–88.

[6] Oleszek-Listopad J., Robak B., Szymańska J. Etiologia i epidemiologia dysfunkcji układu ruchowego narządu żucia. Hygeia Public Health 2019, 54 (2): p. 92-96.

[7] Dmochowska–Lisak K. et. al.: Związek między dysfunkcją stawu skroniowo-żuchwowego a zaburzeniami postawy ciała w aspekcie tensegracji – przegląd piśmiennictwa, Art Dent 2018, 69, p. 150-160.

[8] Gauer R., Semidey M. Diagnosis and treatment of temporomandibular disorders; Am Fam Physician 2015; 91 (6), p. 378–386.

[9] Okeson J. Leczenie dysfunkcji skroniowo-żuchwowych i zaburzeń zwarcia; wyd. Czelej 2018, wydanie II, p. 114-116.

[10] Kurpiel P., Kostrzewa-Janicka J. Dysfunkcja układu ruchowego narządu żucia – etiologia i klasyfikacja schorzeń. Przegląd piśmiennictwa. Nowa Stomatologia 2/2014, p. 95-99.

[11] Wilczyński J. Korekcja wad postawy człowieka; wyd. Anthropos, Starachowice 2005, p. 20-23.

[12] Kasperczyk T. Wady postawy ciała, diagnostyka i leczenie; wyd. Kasper, Kraków 2001, p. 9-12, 42-70.

[13] Wawrzyniak A. et. al. Wady postawy u dzieci i młodzieży jako jeden z głównych problemów w rozwoju psychosomatycznym; Pediatr. Med. Rodz. 2017, 13 (1), p. 72–78.

[14] Sprawozdanie o działalności i pracujących w ambulatoryjnej opiece zdrowotnej. MZ-11. Available from: http://www.csioz.gov.pl [31.05.2021]

[15] Górecki A. et. al.: Profilaktyka wad postawy u dzieci i młodzieży w środowisku nauczania i wychowania – rekomendacje ekspertów. Pol Ann Med 2009; 16, p. 168–177.

[16] Sprawozdanie Ministerstwa Zdrowia nt. „Cukier, otyłość – konsekwencje". Avaliable from: www.gov.pl [31.05.2021]

[17] Liem T: Praxis der kraniosakralen osteopathie; 3 Aufl Stuttgart Hippokrates 2009.

[18] Schleip R. et. al. Active fascial contractility: Fascia may be able to contract in a smooth muscle-like manner and thereby influence musculoskeletal dynamics. Med Hypotheses. 2005; 65 p. 273-277.

[19] Myers T. Taśmy anatomiczne meridiany mięśniowo-powięziowe dla terapeutów manualnych i specjalistów leczenia ruchem.; Db Publishing 2015, wyd. 3.

[20] Cuccia A. et. al. The relationship between the stomatognathic system and body posture. Clinics. 2009; 64 (1) p. 61-66.

[21] Huggare J. A. et. al. Head Posture and Cervicovertebral and Craniofacial Morphology in Patients with Craniomandibular Dysfunction.; The Journal of Craniomandibular & Sleep Practice 1992, 10 (3) p. 173-179.
[22] Munchoz W. et. al. Body Posture Evaluations In Subjects with Internal Temporomandibular Joint Derangement.; Cranio 2009, 27 (4) p. 231-242.
[23] Gonzalez H. et. al. Forward Head Posture: Its Structural and Functional Influence on the Stomatognathic System, a Conceptual Study.; Cranio 1996; 14 (1) p. 71-80.
[24] Nicolakis P. et. al. Relationship Between Craniomandibular Disorders and Poor Posture.; Cranio 2000; 18(2) p. 106-12.
[25] Śmiga-Witas A. et. al. Relationship between temporomandibular and cervical spine disorders.; Protet. stomatol., 2011, LXI, 6, 466-475.
[26] Walczyńska-Dragon K. et. al. Correlation between TMD and Cervical Spine Pain and Mobility: Is the Whole Body Balance TMJ Related?; BioMed Research International Volume 2014; p. 1-7.
[27] Simons D. et. al. Myofascial pain and dysfunction: the trigger point manual.; Baltimore: Williams &Wilkins; 1999, Vol 1. 2nd ed.
[28] Skaggs D. Temporomandibular dysfunction: chiropractic rehabilitation.; Journal of Bodywork and Movement Therapies, 1 (4), July 1997, p. 208-213.
[29] De Laat A. et. al. Correlation between cervical spine and temporomandibular disorders.; Clin Oral Investig 1998 Jun; 2 (2) p. 54-57.
[30] Stiesch-Scholz M. et. al. Comorbidity of internal derangement of the temporomandibular joint and silent dysfunction of the cervical spine.; J Oral Rehabil. 2003 Apr; 30 (4) p. 386-391.
[31] Pedroni C. Prevalence study of signs and symptoms of temporomandibular disorders in university students; J Oral Rehabil 2003; 30 (3), 283-289.
[32] Cuenca-Martínez F. et. al. Craniocervical and Cervical Spine Features of Patients with Temporomandibular Disorders: A Systematic Review and Meta-Analysis of Observational Studies.; J Clin Med. 2020 Aug 30; 9 (9) p. 2806.
[33] Lee W. et. al. The relationship between forward head posture and temporomandibular disorders.; J Orofac Pain 1995, 9 (2) p. 161-167.
[34] Sonnesen L. Temporomandibular disorders in relation to craniofacial dimensions, head posture and bite force in children selected for orthodontic treatment.; Eur J Orthod 2001, 23 (2) p. 179-192. [35] Johnson G. The correlation between surface measurement of head and neck posture and the anatomic position of the upper cervical vertebrae.; Spine (Phila Pa 1976) 1998 Apr 15; 23 (8) p. 921-927.
[36] Hackney J. Relationship between forward head posture and diagnosed internal derangement of the temporomandibular joint.; J Orofac Pain 1993, 7 (4) p. 386-390.
[37] Visscher C. et. al. Prevalence of cervical spinal pain in craniomandibular pain patients.; Eur J Oral Sci 2001 Apr; 109 (2) p. 76-80.
[38] Weber P. et. al. Cervical spine dysfunction signs and symptoms in individuals with temporomandibular disorder.; J Soc Bras Fonoaudiol 2012; 24 (2) p. 134-139.
[39] Saddu S. et. al. The Evaluation of Head and Craniocervical Posture among Patients with and without Temporomandibular Joint Disorders- A Comparative Study; J Clin Diagn Res 2015 Aug; 9 (8) p. 55-58.
[40] Eriksson P. et. al. Jaw-neck dysfunction in whiplash-associated disorders.; Arch Oral Biol. 2007 Apr; 52 (4) p. 404-408.
[41] Friedman M. et. al. The craniocervical connection: a retrospective analysis of 300 whiplash patients with cervical and temporomandibular disorders.; Cranio 2000 Jul; 18 (3) p. 163-167. [42]

Matheus R. et. al. The relationship between temporomandibular dysfunction and head and cervical posture; J Appl Oral Sci 2009; 17 (3) p. 204-208.
[43] Bragatto M. et. al. Associations among temporomandibular disorders, chronic neck pain and neck pain disability in computer office workers: a pilot study; J Oral Rehabil 2016; 43 (5) p. 321-332.
[44] Tomei A. et. al. Spinal and temporo-mandibular disorders in male workers of the State Police.; Acta Odontologica Scandinavica 2013, 71 (3-4) p. 671-675.
[45] Dupas P. Dysfunkcja czaszkowo-żuchwowa. Od diagnozy - po szynę zgryzową.; PZWL, Warszawa 2009, wyd. 1.
[46] Paço M. et. al. Orthodontic Treatment and Craniocervical Posture in Patients with Temporomandibular Disorders: An Observational Study.; Int J Environ Res Public Health. 2021 Mar; 18(6) p. 32-49.
[47] Ekici O. Relationship of temporomandibular joint disorders with cervical posture and hyoid bone position.; The Journal of Craniomandibular & Sleep Practice, Published online: 18 May 2021. Avaliable from: www.tandfonline.com [31.05.2021]
[48] Ruivo R. et. al.;. Cervical and shoulder postural assessment of adolescents between 15 and 17 years old and association with upper quadrant pain.; Braz. J. Phys. Ther. Aug 2014, 18 (4) p. 364-371.
[49] Lemos G. et. al. Prevalence of temporomandibular dsorders and association with psychological factors in students of undergraduate Dentistry students.; Rev Cubana Estomatol. 2015; 52 (4) p. 22-31.
[50] Espinosa de Santillana I. et. al. Frequent postural alterations in patients with different types of temporomandibular disorders.; Rev Salud Publica (Bogota) May-Jun 2018; 20 (3) p. 384-389.
[51] Wright E. et. al. Usefulness of posture training for patients with temporomandibular disorders.; J Am Dent Assoc 2000 Feb, 131 (2) p. 202-210.
[52] Zonnenberg A. et. al. Body posture photographs as a diagnostic aid for musculoskeletal disorders related to temporomandibular disorders (TMD).; Cranio 1996 Jul, 14 (3) p. 225-232. [53] Kulesa-Mrowiecka M. et. al. Assessment of temporomandibular joint dysfunctions and the position of pelvis.; J Orthop Trauma Surg Rel Res 3 (33) 2013, p. 48-52.
[54] Ramón Fuentes F. et. al. Influence of body posture in the prevalence of craniomandibular dysfunction.; Rev. méd. Chile 1999, 127 (9) p. 1079-1085.
[55] de Wijer A. et. al. Symptoms of the cervical spine in temporomandibular and cervical spine disorders; J Oral Rehabil 1996; 23 (11) p. 742-750.
[56] Masayuki S. Japońska metoda leczenia Yumeiho., Umea Shinoda-Kuracejo, Kraków 1997, p. 6-9.
[57] Dolecki M. Ciało a zgryz., Avaliable from: http://iaortho.pl/wp-content/uploads/2019/01/Cia%C5%82o-a-zgryz_2013_na-www.pdf [19.03.2021]
[58] Ikemitsu H. et. al. The relationship between jaw deformity and scoliosis; Oral radiol 2006; 22 (1) p. 14–17.
[59] Nakashima A. et. al. The relationship between lateral displacement of the mandible and scoliosis.; Oral Maxillofac Surg 2017 Mar, 21 (1) p. 59-63.
[60] Laskowska M. Częstość i postacie wady zgryzu u dzieci i młodzieży ze skoliozą idiopatyczną. Rozprawa doktorska – streszczenie.; Warszawa 2012, p. 2-5.
[61] Laskowska M. et.al. Zaburzenia anatomiczno-czynnościowe narządu żucia a wady zgryzu u dzieci i młodzieży ze skoliozą idiopatyczną.; Forum Ortod 2015; 11 (4) p. 254-264.
[62] Park Y. et. al. Change of range of motion of the temporomandibular joint after correction of mild scoliosis.; J Phys Ther Sci 2014 Aug, 26 (8) p. 1157-1160.

[63] Manfredini D. Dental occlusion, body posture and temporomandibular disorders: where we are now and where we are heading for.; J Oral Rehabil. 2012 Jun; 39 (6) p. 463-471.
[64] Kononen M. et. al. Are temporomandibular disorders associated with postural disorders? Abstracts of Society for Oral Physiology Store Kro Group 1999 p. 8-9.
[65] Šidlauskienė M. et. al. Relationships between Malocclusion, Body Posture, and Nasopharyngeal Pathology in Pre-Orthodontic Children.; Med Sci Monit, 2015; 21 p. 1765-1773. [66] Saito E. et. al. Global body posture evaluation in patients with temporomandibular joint disorder.; Clinics (Sao Paulo) 2009, 64 (1) p. 35-39.
[67] Bonato L. et. al. Association between temporomandibular disorders and pain in other regions of the body.; J Oral Rehabil. 2017 Jan, 44 (1) p. 9-15.
[68] Perez-Belloso A. et. al. Influence of Dental Malocclusion on Body Posture and Foot Posture in Children; A Cross-Sectional Study; ealthcare (Basel) 2020 Nov 14; 8 (4) p. 485.
[69] Perinetii G. et. al. Dental malocclusion and body posture in young subjects: a multiple regression study.; CLINICS 2010; 65 (7) p. 689-695.
[70] Nota A. et. al. Postural stability in subjects with temporomandibular disorders and healthy controls: A comparative assessment.; J Electromyogr Kinesiol 2017 Dec, 37 p. 21-24.
[71] Souza J. et. al. Global body posture and plantar pressure distribution in individuals with and without temporomandibular disorder: a preliminary study.; J Manipulative Physiol Ther. Jul-Aug 2014, 37 (6) p. 407-414.
[72] Sakaguchi K. et. al. Examination of the Relationship Between Mandibular Position and Body Posture.; Cranio 2007, 25 (4) p. 237-249.
[73] Ferrario V. et. al., Occlusion and centre of foot pressure variation:is there a relationship? J Prosthet Dent. 1996; 76 p. 302-308.
[74] Maeda N. et. al. Effects of Experimental Leg Length Discrepancies on Body Posture and Dental Occlusion.; Cranio 2011, 29 (3) p. 194-203.
[75] Valentino B. et. al. Correlation between interdental occlusal plane and plantar arches. An EMG study.; Bull Group Int Rech Sci Stomatol Odontol, Jan-Apr 2002, 44 (1) p. 10-13.
[76] Frączak B. et. al. Wady postawy a staw skroniowo-żuchwowy. Przegląd piśmiennictwa. Magazyn Stomatologiczny, 4/2020, p. 62-65.
[77] Bracco P. et. al. Effects of different jaw relations on postural stability in human subjects.; Neurosci Lett 2004 Feb 19; 356 (3) p. 228-230
[78] Amaral F. et. al. Cervical spine range of motion, posture and electromyographic activity of masticatory muscles in temporomandibular disorders.; Fisioter Mov. 2020, 33 p. 1-16.
[79] Fernández-de-Las-Peñas C. et. al. Referred pain from muscle trigger points in the masticatory and neck-shoulder musculature in women with temporomandibular disoders.; J Pain 2010 Dec; 11 (12) p. 1295-1304.
[80] Ries L. et. al. Analysis of the postural stability in individuals with or without signs and symptoms of temporomandibular disorder; Braz Oral Res Oct-Dec 2008; 22 (4) p. 378-383.