

Is playing string or wind musical instruments a risk factor for temporomandibular dysfunction? A Systematic Review.

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Abstract: Aim. Medical problems specifically affecting professional musicians are commonly mentioned in the literature. The present study is aimed to evaluate, through a systematic review, the possible association between the practice of string with bow and wind musical instruments and the occurrence of Temporomandibular Dysfunction (TMD). Methods. The search for articles was conducted in PubMed/Medline, Web of Science, Scopus, Lilacs, Cochrane Library, and Open Gray databases, and there was no restriction on language or date of publication. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines were followed. The *MeSH* terms used were: “music”; “temporomandibular joint”; “temporomandibular joint disorders”; “temporomandibular joint dysfunction syndrome”; and “occupational diseases”. Cross-sectional studies, case-control, cohort and clinical trials were included that involved the practice of string with bow and wind musical instruments and the occurrence of Temporomandibular Dysfunction (TMD). Articles were previously selected by title and abstract. Qualitative evaluation was done through the Newcastle-Ottawa Scale. Results. The literature search identified 732 studies, of which 10 met the inclusion criteria, nine of them cross-sectional studies and one a clinical intervention study. The TMD prevalence ranged from 47.0% to 89.0%. Recruitment of participants took place in professional schools and orchestras, and in bands of professional musicians. All studies reported associations between TMD and the practice of musical instruments, and violinists presented higher prevalence rates when compared to other instrument groups. Conclusion. All studies pointed to a possible association between TMD and the practice of string and wind musical instruments. More longitudinal and clinical trials studies are needed to verify any possible interrelationship.

Keywords: *Music; temporomandibular joint; temporomandibular joint disorders; masticatory muscles; occupational risks.*

INTRODUCTION.

Professional musicians start the practice of musical instruments early in life and, in the search for excellence, spend several hours practicing the exercises necessary to develop an accurate technique, often neglecting physical health.^{2,3} Musical practice is seen as a playful and enjoyable activity, which may make it difficult to perceive that the execution of a musical instrument can bring some health problems to musicians.⁴

Playing a musical instrument requires intense and long-lasting studies in the theoretical and practical aspects,^{3,5,6} which can lead to the development of problems related to the musical activity that interfere

with the quality of performance, and which can even force musicians to interrupt their artistic activities temporally or definitively.^{4,7} Medical problems specifically affecting professional musicians are commonly mentioned in the literature,⁸ and among them, musculoskeletal disorders related to Temporomandibular Disorders (TMDs)^{3,4} stand out. Musical instrument practice, like wind and string instruments that are held between the shoulder and angle of the jaw, could pose an overload of the masticatory muscles as well as the orofacial skeletal system that may induce a possible TMD or worsen a pre-existing TMD.⁸

TMDs include a series of clinical problems involving chewing muscles, the temporomandibular joint (TMJ), or associated orofacial structures.^{8,9} TMD has multifactorial etiology that can be triggered by a number of factors such as changes in dental occlusion, traumatic or degenerative TMJ injuries, skeletal problems, psychological factors and deleterious habits.¹⁰ Clinical signs and symptoms of TMD are: pain in the TMJ, preauricular area or masticatory muscles, limitation or deviation of jaw movements and clicking or popping sounds during oral function.⁸ Other symptoms such as headache, neck and facial muscle pain, earache, buzzing in the ear and hearing loss have also been described.^{8,9}

Musicians are susceptible to the development of TMD.⁷ More than 80% of musicians are affected by TMD, especially violinists, violists and performers of wind instruments, since important orofacial structures are involved in the technique necessary for the sound production in these instruments.¹¹ In string-instrument players, this is due to the effects of pressure on the jaw, clenching of the masticatory muscles, and transmitted vibrations from the instrument.¹²

In the case of violinists and violists, stabilizing the instrument in its correct posture when playing requires that the orofacial muscles work in conjunction with the neck muscles.¹¹ The positioning of the instrument is done by supporting it on the body and by the angle of the jaw, and this pressure transmits the force to the TMJ through the mandibular ramus, which causes mechanical stress in the joint (with pressure varying between 200g and 2200g).¹¹ In wind instrument players, special attention is given to the technique called embouchure, for the

production of sound. Embouchure is made by pressing a metal mouthpiece against the lips or by inserting a wedge-shaped piece mouthpiece or double palette between the lips that often lie between the teeth and the surface of the mouthpiece or palette.¹³ In addition to the pressure exerted on orofacial structures, wind instrument players also use specific techniques that require mandibular movements that compress the TMJ. These movements may be associated with the appearance of TMD signs and symptoms in wind musicians, in addition to orthodontic problems such as displacement or poor dental alignment.¹¹

This paper proposes to determine, through a systematic review, the existence of an association between the practice of musical instruments and the emergence of TMD signs and symptoms in musicians, especially violinists, violists and wind instrument players.

MATERIALS AND METHODS.

This systematic review was based upon PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-analyses) and contained the PECO elements (Population, Exposition, Comparisons, and Outcome) for conducting this study. Observational studies that evaluated musicians (P) who play an instrument (E) compared to not playing an instrument (C) and the occurrence of temporomandibular joint disorders (O) were included.

Search Strategy

The literature search was performed in PubMed, Web of Science, Scopus, Lilacs, Cochrane Library, and Open Gray databases through March 2017. There was no restriction on language or date of publication.

The *MeSH* terms used were 'Music', 'Temporomandibular joint', 'Temporomandibular joint disorders', 'Temporomandibular joint dysfunction syndrome' and 'Occupational diseases'. Two researchers (JMVS and AFCC) verified which studies met the inclusion criteria for the review and evaluated the titles and abstracts of the found articles independently. The 'AND' and 'OR' Boolean were applied to combine keywords. The variables searched were: year, country of study, type of study, objectives, sample, age group, research instrument, results and quality points.

Eligibility Criteria

Case reports, case series, descriptive studies, review articles, opinion articles, letters, and articles that did not present temporomandibular joint disorders prevalence in subjects who play an instrument were excluded.

All electronically identified records were scanned by title and abstract. The eligibility of selected studies was determined by reading titles and abstracts of articles identified from the electronic databases. Full articles were retrieved and examined when their title and abstract did not provide enough information for a definite decision. Articles appearing in more than one database search were considered only once.

Article assessment

Descriptive data such as country, local setting, study design, sample, age group of participants, research instrument and results were extracted by two reviewers (JMVS and AFCC). Quality assessment was performed by using the Newcastle-Ottawa Scale adapted for cross-sectional studies, which measures the methodological quality of a study by the number of points the study received.¹⁴ The following criteria were assessed: selection, comparability and outcome. For each criterion completed the study received scores ranging from 0 to 10.

RESULTS.

The bibliographic search identified a total of 732 papers. Duplicate studies were removed (n=35), resulting in 697 papers. After careful analysis, literature reviews (n=7), case reports/case series (n=3) and studies whose abstracts were not related to the subject were excluded (n=677). Therefore, ten studies remained, which constitute this review (Figure 1).

The articles that make up this review are characterized in Table 1. Nine are cross-sectional studies,^{4,5,7,10,15-19} and one is a intervention study.²⁰ The prevalence of TMD ranged from 47.0%¹¹ to 89.0%.¹⁶ Most studies have demonstrated a relationship between TMD and the practice of musical instruments.^{4,5,7,11,15-19} Violinists had a higher prevalence of TMD when compared to those who played wind instruments.¹¹ However, some researchers found no statistically significant difference as a function instrument type (strings and wind).⁴ Regarding treatment, an improvement in TMD symptoms was reported in professional musicians who presented myofascial pain in the masticatory muscles and limitation of mouth opening.²⁰

Table 2 shows the quality of the studies as measured by the Newcastle-Ottawa Scale adapted for cross-sectional studies.

Figure 1. Flowchart showing the results of the research and the selection procedure of the papers included for analysis.

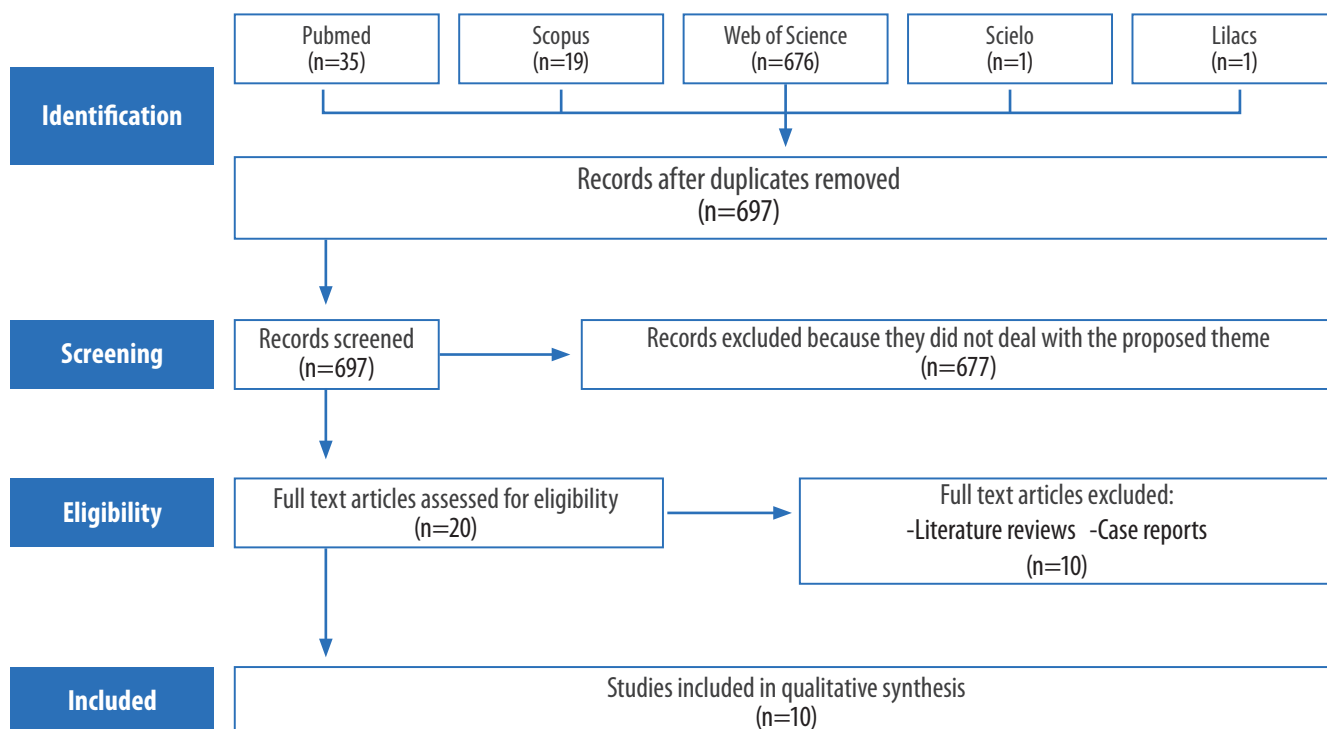


Table 1. Characteristics of studies included in the review.

Authors	Year	Country of study	Type of study	Objectives	Sample	Age group	Research instrument	Results
Yasuda <i>et al.</i> ¹⁶	2016	Japan	Cross-sectional	Analyzing if a non-professional instrument can affect musculoskeletal function; Whether the development of TMD varies according to the type of instrument; time of practice, experience with the instrument, height, weight and body mass index (BMI) of the musician. To compare the mandibular and cervical muscles activity to estimate which types of instruments are most likely associated with TMD.	210 high school students (35 men and 175 women) who played wind instruments.	Mean: 14 years	Questionnaire; Muscle activity test (electromyography).	- Prevalence of TMD was 89%. - TMD rate in wind instrument players was 34.8% higher than those who did not play wind instruments.
Lacerda <i>et al.</i> ⁷	2015	Portugal	Cross-sectional	To determine the prevalence of joint TMD in students of wind instruments and to evaluate the associated risk factors.	41 wind instrument students.	13 to 22 years; Mean (17.4 years)	Questionnaire (RDC/TMD); Clinical examination.	- 68.3% had TMD. - Condyle/disk dysfunctions 46.3%. - Degenerative dysfunctions 43.9%.
Jang <i>et al.</i> ¹⁵	2015	South Korea	Cross-sectional	To evaluate the symptoms and clinical signs of TMD and to investigate the association between playing an instrument and TMD.	803 musicians (185 men and 618 women); 70 volunteers who reported at least one TMD symptom were examined and X-rayed. These participants were divided into: Wood, Metals and Strings according to the type of instrument.	15 to 55 years; Mean (24.2 years)	Questionnaire; Clinical and radiographic examinations.	- 75.9% reported one or more TMD symptoms. - Of the 70 musicians examined, 29.7% presented popping; 18.9% TMJ pain; 30.5% had myofascial pain and 27.8% reported disc displacement with reduction. - There was no statistically significant difference between participants according to the type of instrument.
Pampel <i>et al.</i> ⁵	2014	Germany	Cross-sectional	Verify if playing a musical instrument predisposes to TMD.	102 individuals: 33 male musicians; 33 patients with TMD and 36 healthy individuals.	≥ 18 years	Clinical examination; Questionnaire	- Musicians showed a higher occurrence of popping in TMJ.
Steinmetz <i>et al.</i> ¹¹	2014	Germany	Cross-sectional	To investigate the frequency of craniomandibular disorders in professional orchestra musicians and their association with musculoskeletal pain in different regions of the body.	408 professional orchestra musicians (236 men and 172 women)	---	Questionnaire	- 26% reported TMJ pain, 31% had bruxism, 40% had tightening, 16% jaw locking and 30% tooth/jaw pain. - Violinists demonstrated above average rates among all musicians for all symptoms of craniomandibular disorders.

Rodríguez-Lozano <i>et al.</i> ¹⁷	2010	Spain	Cross-sectional	To study the prevalence of TMD signs and symptoms in a group of musicians; To analyze possible differences between men and women in the prevalence of TMD signs and symptoms; To determine if there is a relationship between TMD signs and symptoms and the number of hours or years of instrument practice.	41 musicians (20 men and 21 women); Control group with 50 healthy people who have never studied dentistry or played musical instruments.	14 to 47 years; Mean: 33.2 years	Questionnaire Based on RDC /TMD; Clinical and radiographic examination.	- 2.4% reported pain at maximum mouth opening, 29.3% had difficulty reaching maximum mouth opening, 17.1% had jaw locking, and 51.2% mentioned TMJ sounds. No radiographic changes were found. No association was observed between TMD signs and symptoms and the number of hours of practice per week or hours of practice per year.
Stechman Neto <i>et al.</i> ⁴	2009	Brazil	Cross-sectional	To verify the prevalence of TMD signs and symptoms in wind and string instruments musicians.	92 musicians (82 men and 10 women), 70 played wind instruments and 22 played string instruments (violin and viola).	18 to 58 years	Questionnaire	- Grinding teeth: 41.4% wind; 45.4% strings. - Headache: 37.1% wind; 45.4% strings. - TMJ pain: 27.1% wind; 18.1% strings. - Difficulty opening mouth: 21.4% wind; 18.1% strings. - ATM noises: 38.5% wind; 54.5% strings. - Presence of buzzing: 37.1% wind; 31.8% strings.
Kovero <i>et al.</i> ¹⁹	1996	Finland	Cross-sectional	To investigate whether violin practice affects the frequency of TMDs; Radiologically observe abnormalities in TMJ condyles in adolescents.	31 music students (27 men and 4 women)	11.4 to 18.2 years; Mean: 13.7 years;	Clinical examination; Radiological examination; Interview on how to play and support the instrument.	- 58% of violinists presented symptoms suggestive of TMD. - 25.8% TMJ pain when opening the mouth. - 25.8% TMJ pain when chewing. - 12.9% TMJ locking. - 22.5% TMJ noise. - 16.1% TMJ stiffness. - 70.9% pain in the muscles of face, temple, neck or shoulders. - 16.1% bruxism. - 22.5% tightening. - 58.0% other parafunctional habits.
Kovero <i>et al.</i> ¹⁸	1995	Finland	Cross-sectional	To investigate whether professional violinists and violists have more TMD signs and symptoms or abnormalities on TMJ condyles.	26 professional violinists and violists (13 men and 13 women); Control group selected among people who underwent routine dental treatment and did not play violin or viola.	22 to 58 years; Mean: 37 years.	Questionnaire; Clinical examination; Radiography of TMJs.	- 19.2% TMJ pain when opening the mouth. - 15.3% ATM locking. - 42.3% TMJ noise. - 15.3% stiffness or tiredness in TMJ. - 11.5% pain in the muscles of face or temples. - 19.2% headache. - 30.7% bruxism. - 38.4% tightening. - 38.4% other parafunctional habits. - Radiographically, no significant differences were observed between groups.
Steinmetz <i>et al.</i> ²⁰	2009	Germany	Interventional study	To investigate the effect of treatment with an oral splint in cases of TMD in reducing pain and symptoms in professional musicians.	30 professional musicians with TMD symptoms (12 men and 18 women)	17 to 63 years; Mean: 36.1 years	Intraoral splint (Michigan Splint) on the jaw, to use at night and while playing instruments.	- 80% of musicians experienced a significant improvement of symptoms due to the use of the splint.

Table 2. Distribution of studies according to Newcastle-Ottawa Scale adapted.

Authors	Year	Outcomes (Maximum 3 stars)	Selection (Maximum 5 stars)	Comparability (Maximum 2 stars)	Quality Points (total)
Yasuda <i>et al.</i> ¹⁶	2016	2	4	1	7
Lacerda <i>et al.</i> ⁷	2015	3	5	1	9
Jang <i>et al.</i> ¹⁵	2015	2	3	1	6
Pampel <i>et al.</i> ⁵	2014	2	4	1	7
Steinmetz <i>et al.</i> ¹¹	2013	2	5	1	8
Rodríguez-Lozano <i>et al.</i> ¹⁷	2010	3	4	1	8
Stechman Neto <i>et al.</i> ⁴	2009	2	3	1	6
Kovero <i>et al.</i> ¹⁹	1996	2	4	2	8
Kovero <i>et al.</i> ¹⁸	1995	2	4	2	8

DISCUSSION.

TMDs appear to be a significant problem affecting musicians, being most prevalent among violin, viola, trumpet, trombone, and tuba players.³ While the incidence of TMD symptoms for musicians is similar to that of the general population, these symptoms are activated and accentuated with music performance or practice.¹² This study observed an association between the practice of musical instruments and the occurrence of TMD.^{4,5,7,11,15-19} This may be related to the individual performance characteristics and type of instrument played,^{6,8} since when performing the technique to physically support string instruments such as the violin and viola, the musician exerts pressure on the chin extending to the TMJ through the jaw^{6,20} while in wind instruments, the different instrument parts that come into contact with the mouth exert pressure in different ways on teeth, lips and jaw.^{6,13} Additionally, musicians are often required to adopt a non-physiological posture, as the classic musicians' sitting position is rigid and motionless with restricted movement.⁵

Four studies used the Research Diagnostic Criteria questionnaire (RDC/TMD), or versions based on this instrument.^{5,7,11,17} The Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD) is a widely used diagnostic protocol in TMD research.^{21,22}

TMJ sounds such as popping and crackling were the most prevalent symptoms.^{4,15,17,18} Regarding muscle pain, previous research reported deep masseter pain as the most prevalent (51.4%),⁵ while the most prevalent symptom was

pain in the muscles of face, temple, neck or shoulders.¹⁹ For some students, condyle/disc dysfunctions are the most prevalent symptoms among musicians,⁷ whereas for others, it is tooth/jaw pain.¹¹

No statistically significant differences were found among researchers for radiological findings.^{15,17-19} One research study reported the use of electromyography as a tool to analyze muscle activity during instrument performance by musicians.¹⁶

Most studies focused on European countries such as Germany,^{5,11,20} Finland,^{18,19} Portugal,⁷ and Spain.¹⁷ It is assumed that a greater number of studies concentrated in Europe as this continent has a solid tradition of concert music, being considered the cradle of the symphony orchestra.²³

Four studies have pointed to time of musical practice as a factor related to the appearance of TMD signs and symptoms in these individuals.^{7,16,18,19} However, in violinists, age and number of years of instrument practice were not correlated with TMD symptoms.¹⁷ Some studies have observed that there is no statistically significant difference in instrument type and TMD prevalence,^{4,15} but above-average rates of cranio-mandibular disorders were observed in violinists when compared to all other groups of instruments studied.¹¹

Most studies did not show statistically significant differences between sexes regarding the presence of TMD in musicians.^{4,5,11,15-19} In cases of articular TMDs,

particularly those involving disc ante-position with reduction, women presented a higher prevalence (58.3%) when compared to men (17.2%).⁷

Among the studies that mentioned the place of recruitment of participants, schools, orchestras, and professional music bands were identified. Analyzing the place of recruitment of each study is important because one can select subjects with a longer time of exposure to the instrument (career musicians) or shorter time (young students), which may generate quite different results regarding the occurrence of TMD.

Regarding the quality of the studies included in the review, although the Newcastle-Ottawa Scale was used, the risk of the bias for the selected articles cannot be estimated, since the scale does not present a quality categorization according to the score achieved for each evaluated criterion (Selection, Outcomes, Comparability) and for the final score.

A small number of papers and a lack of homogeneity

in the results presented do not permit a meta-analysis about the proposed issue. Therefore, other controlled and randomized clinical trials with a larger sample size, longer follow-up periods,^{8,9} and more adequate definitions of participants are needed to increase the strength of scientific evidence. In addition, once the dental literature has shown that quality of life is influenced by various conditions,^{24,25} it is important that further better-quality studies be developed to analyze the quality of life of musicians with temporomandibular joint disorders.

CONCLUSION.

The studies pointed to a possible association between the practice of string and wind musical instruments and the presence of TMD signs and symptoms. More longitudinal and clinical trials studies are needed to verify any possible interrelationship.

REFERENCES.

1. Bejjani FJ, Stuchin S, Brown P. Occupational disorders of string players, pianists, harpist and guitarists. *J Bone Joint Surg Orthopaedic Transactions*. 1984;8:133.
2. Ziporyn T. Pianist's cramp to stage fright: the medical side of music-making. *JAMA*. 1984;252:985-9.
3. Bejjani FJ, Kaye GM, Benham M. Musculoskeletal and neuromuscular conditions of instrumental musicians. *Arch Phys Med Rehabil*. 1996;77(4):406-13.
4. Stechman Neto J, de Almeida C, Rodrigues Bradasch E, Corteletti LC, Silvério KC, de Aguiar MM, Mendes J. Occurrence of signs and symptoms of temporomandibular dysfunction in musicians. *Rev Soc Bras Fonoaudiol*. 2009;14(3):362-6.
5. Pampel M, Jakstat HA, Ahlers OM. Impact of sound production by wind instruments on the temporomandibular system of male instrumentalists. *Work*. 2014;48(1):27-35.
6. Głowacka A, Matthews-Kozanecka M, Kawala M, Kawala B. The impact of the long-term playing of musical instruments on the stomatognathic system - review. *Adv Clin Exp Med*. 2014;23(1):143-6.
7. Lacerda F, Barbosa C, Pereira S, Conceição Manso M. Estudo de prevalência das disfunções temporomandibulares articulares em estudantes de instrumentos de sopro. *Rev Port Estomatol Med Dent Cir Maxi*. 2015;56(1):25-33.
8. Attallah MM, Visscher CM, van Selms MK, Lobbezoo F. Is there an association between temporomandibular disorders and playing a musical instrument? A review of literature. *J Oral Rehabil*. 2014;41(7):532-41.
9. Ajanović M, Tosum S, Kamber-Ćesir A, Đonlagic A, Kazazić L, Hamzić A. Prevalence of signs and symptoms of temporomandibular disorder in patients with posttraumatic stress disorder. *Pesq Bras Odontoped Clin Integr*. 2014;14(1):43-8.
10. Pereira KNF, Andrade LLS, Costa MLG, Portal TF. Sinais e sintomas de pacientes com disfunção temporomandibular. *Rev CEFAC*. 2005;7(2):221-8.
11. Steinmetz A, Zeh A, Delank KS, Peroz I. Symptoms of craniomandibular dysfunction in professional orchestra musicians. *Occup Med*. 2014;64(1):17-22.
12. Taddey JJ. Musicians and temporomandibular disorders: prevalence and occupational etiologic considerations. *Cranio*. 1992;10(3):241-4.
13. Yeo DK, Pham TP, Baker J, Porters SA. Specific orofacial problems experienced by musicians. *Aust Dent J*. 2002;47(1):2-11.
14. Wells GA, Shea B, O'Connell D, Welch V, Losos M, Tugwell P. The Newcastle-Ottawa Scale (NOS) for assessing the quality of nonrandomized studies in meta-analyses. Canada: Department of Epidemiology and Community Medicine, University of Ottawa; 2003.
15. Jang JY, Choi YC, Bae JH, Kim ST. Signs and symptoms of temporomandibular disorders in instrumental performers. *J Dent Rehabil Appl Sci*. 2015;31(2):86-95.
16. Yasuda E, Honda K, Hasegawa Y, Matsumura E, Fujiwara M, Hasegawa M, Kishimoto H. Prevalence of temporomandibular disorders among junior high school students who play wind instruments. *Int J Occup Med Environ Health*. 2016;29(1):69-76.
17. Rodríguez-Lozano FJ, Sáez-Yuguero MR, Bermejo-Fenoll A. Prevalence of temporomandibular disorder-related findings in violinists compared with control subjects. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod*. 2010;109(1):e15-9.
18. Kovero O, Könönen M. Signs and symptoms of temporomandibular disorders and radiologically observed abnormalities in the condyles of the temporomandibular joints of professional violin and viola players. *Acta Odontol Scand*. 1995;53(2):81-4.
19. Kovero O, Könönen M. Signs and symptoms of temporomandibular disorders in adolescent violin players. *Acta Odontol Scand*. 1996;54(4):271-4.
20. Steinmetz A, Ridder PH, Methfessel G, Muehe B. Professional musicians with craniomandibular dysfunctions treated with oral splints. *Cranio*. 2009;27(4):221-30.

21. Dworkin SF, LeResche L. Research diagnostic criteria for temporomandibular disorders: review, criteria, examinations and specifications, critique. *J Craniomandib Disord.* 1992;6(4):301–55.
22. Câmara-Souza MB, Figueredo OMC, Maia PRL, Dantas IS, Barbosa GAS. Cervical posture analysis in dental students and its correlation with temporomandibular disorder. *Cranio.* 2017;1–6.
23. Bertero CO. Orquestras Sinfônicas: uma Metáfora Revisitada. *Rev Adm Empres.* 2001;41(3):84–8.
24. Kozmhinsky VMR, Heimer M, Goes PSA. Sociodemographic factors and oral health conditions related to the impact on the quality of life of adolescents. *Pesq Bras Odontoped Clin Integr.* 2016;16(1):35–42.
25. Samohyl M, Nadazdyova A, Hirjak M, Stanciak J, Argalasova L, Vondrova D, Hirosova K, Jurkovicova J. Impact of Orthodontic Treatment on Oral Health-Related Quality of Life in the Slovak Republic: A Cross-Sectional Study. *Pesq Bras Odontoped Clin Integr.* 2017;17(1):e3773.