Association between temporomandibular disorders and music performance anxiety in violinists

M. I. T. Amorim and A. I. L. Jorge

1Integrated Clinic of Dentistry Post-graduation, Faculdade de Medicina Dentária da Universidade de Lisboa, Cidade Universitária, 1649-003 Lisboa, Portugal, 2Department of Occlusion, Faculdade de Medicina Dentária da Universidade de Lisboa, Cidade Universitária, 1649-003 Lisboa, Portugal.

Correspondence to: M. I. T. Amorim, Faculdade de Medicina Dentária da Universidade de Lisboa, Cidade Universitária, 1649-003 Lisboa, Portugal. E-mail: monica.amorim92@yahoo.com

Background
Professional violin playing has been associated with a predisposition to develop temporomandibular disorder (TMD). There are a number of risk factors, including physical trauma from the playing posture and the presence of parafunctional habits. Music performance anxiety (MPA) may also be a factor, as it has been associated with playing-related musculoskeletal disorders (PRMD).

Aims
To evaluate a possible association between the presence of TMD and the level of MPA in violin players.

Methods
An observational study using a written questionnaire that retrieved data related to TMD symptoms (Fonseca Anamnestic Questionnaire), MPA level (Kenny Music Performance Anxiety Inventory, K-MPAI), instrument practice time, chinrest type, sex and age. Descriptive, bivariate and logistic regression analyses were conducted.

Results
Ninety-three professional or semi-professional violinists performing in and around Lisbon, Portugal, completed the questionnaire (73% response rate). TMD was present in 50 violinists (58%). There was a statistically significant association between the presence of TMD and high MPA levels (P < 0.001) and the most anxious violinists were six times (95% confidence interval 2.51–15.33; P < 0.001) more likely to report TMD symptoms when compared with the least anxious players.

Conclusions
Violin players had a high prevalence of reported TMD symptoms, which was significantly associated with high MPA levels. It may therefore be necessary to address psychological and physical factors simultaneously in musicians who do not improve with physical therapy alone.

Key words
Music performance anxiety; temporomandibular disorder; violinists; violin players.

Introduction
Playing a musical instrument requires the execution of repetitive movements for long periods of time, often in asymmetrical or awkward postures. This renders musicians susceptible to the development of playing-related musculoskeletal disorders (PRMD) [1,2]. The term temporomandibular disorder (TMD) comprises pathologies affecting the temporomandibular joint (TMJ) and the masticatory muscles, as well as associated structures. Signs and symptoms include pain in the TMJ, pre-auricular region, cervical spine, face and/or head, muscle fatigue involving the cervical and craniofacial regions and/or the masticatory muscles, limitation to jaw mobility, jaw deviation or deflection and articular noise [3–6]. The aetiology of TMD is multifactorial, with five major factors described in the literature: occlusal condition, trauma, deep pain input, parafunctional habits and emotional stress [7]. In violin and viola players, the pressure exerted by the left side of the mandible on the chinrest requires prolonged muscular activity that may surpass the normal physiological function [8]. This has been considered a major factor for the development of TMD and bruxism in this population, leading to compression of the right TMJ and subluxation of the left TMJ [9,10]. Obata and Kinoshita [9] found that the pressure exerted on the chin propagates laterally due to the inclination of
the musician’s head, and that this could be corrected with the use of a central chinrest. However, occupational stress should also be taken into consideration when discussing the aetiology of TMD, including, in this particular population, performance anxiety. The fear of failure may cause performance anxiety in a variety of circumstances, such as public speaking, doing an exam or participating in sports or artistic activities. Performance anxiety in musicians is referred to as music performance anxiety (MPA) [11] and is recognized as a subtype of social anxiety disorder, occurring along a continuous severity scale ranging from normal stress and anxiety intrinsic to being a musician to severely disabling symptoms of terror close to panic [12]. Recent investigations have shown a significant linear association between PRMD and MPA levels [13] and that female gender and stage fright were significant predictors of experiencing orofacial pain in the previous month [14]. In professional musicians, violin players appear to be prone to developing TMD, due to physical trauma related to the playing posture, parafunctional habits while playing and the occupational stress that is present throughout the musician’s career. The purpose of this study was to ascertain if there is an association between the presence of TMD and the level of MPA in violin players, in order to develop or adapt therapeutic strategies for this population.

Methods

The sample consisted of 93 professional or semi-professional violinists (51 male; 42 female; ranging in age from 18 to 67 [mean 33.4 and standard deviation (SD) 12.8] performing in and around Lisbon, Portugal, who met the inclusion criteria and agreed to participate in the study. The musicians were contacted either directly or through music conservatories and orchestra production staff. Random convenience sampling was performed, according to geographical proximity to the institutions and ease of communication with the musicians. Inclusion criteria were (i) professional violin players (member of an orchestra and/or conservatoire teacher) or (ii) semi-professional violin players (students in professional or higher education training) and (iii) age 18 or older. Exclusion criteria were participants who were not fluent enough in Portuguese to fully comprehend and complete the questionnaire; those who did not currently participate in music performances; those who played viola regularly (viola players have shown a higher prevalence of TMD in some studies [15,16]); or those who did not complete the questionnaire. The study protocol was evaluated and approved by the Commission of Ethics for Health of the Faculty of Dental Medicine of the University of Lisbon and each musician gave informed written consent to participate in the study.

In order to fulfil the established objectives, we decided to proceed with a cross-sectional study using written questionnaires. The surveys had four sections: (i) sociodemographic factors (age and gender); (ii) possible TMD aetiological factors (years of instrument practice, weekly hours of practice and type of chinrest used) ([16] for illustrations and description); (iii) TMD symptoms, assessed using the Fonseca Anamnestic Questionnaire; and (iv) MPA level assessed by the Kenny Music Performance Anxiety Inventory (K-MPAI).

The Fonseca Anamnestic Questionnaire has a 95% correlation with the Helkimo Anamnestic Index ($r = 0.6169, P < 0.05$) and 95% reliability in application. It is one of the few instruments available in Portuguese that assesses the severity of TMD symptoms and allows rapid, inexpensive collection of a considerable amount of information. It is composed of 10 questions about the presence of TMD symptoms, each answered ‘yes’, ‘sometimes’ or ‘no’ and scored 10, 5 or 0 points, respectively. The sum of the values obtained provides an index that classifies individuals as having no TMD (0–15 points), mild TMD (20–45), moderate TMD (50–65) and severe TMD (70–100 points) [5,6,17]. In this study, the term ‘presence of TMD’ is defined as having a final score of 20 or more points on this index.

The K-MPAI is a 40-item questionnaire, developed to assess the emotion-based theory of anxiety proposed by Barlow as it applies to anxiety in the context of musical performance. Questions are answered on a 7-point Likert scale (0 = strongly disagree to 6 = strongly agree) and higher scores indicate greater anxiety and psychological distress [18]. In 2011, the K-MPAI was validated in Portuguese, presenting high internal consistency reliability levels and acceptable replicability [19]. Slight syntactic modifications were made by the authors to adapt the inventory to European Portuguese.

The questionnaires were applied either before or after a class or rehearsal, according to the musicians’ personal schedule, between November 2014 and March 2015. After the descriptive analysis, a chi-squared test was performed to evaluate the association between TMD and MPA level, gender, age, years of practice, hours of practice per week and chinrest type, respectively. In order to do this, the variables were categorized as follows: musicians with TMD (Fonseca Anamnestic Questionnaire score ≥ 20) and musicians without TMD (<20 points), the most anxious violinists (K-MPAI score equal to or above the median value) and the least anxious (below the median score); except for chinrest type, each remaining variable was also categorized into two groups regarding the median value. Logistic regression analysis was performed using backwards and stepwise testing. Deviance analysis was performed and Nagelkerke test and Akaïke’s Information Criterion (AIC) values were computed as well. Statistical analysis was carried out using the IBM SPSS Statistics® 22 and R Studio (R version 3.2.4, for the logistic regression). Statistical significance level was set at 0.05.
Results

Ninety-three violin players from 19 orchestras, conservatories and performing ensembles were included in the study, accounting for a response rate of at least 73% (to the authors knowledge, at least 15 musicians performed in several of the included locations, accounting for 35 in total; as such, the calculations were performed for a total target sample of 127 actual violin players). Participants ranged in age from 18 to 67 (mean 33.4, SD 12.8) and 51 (55%) were male. Experience of practice ranged from 6 to 60 years (mean 24.2, SD 13) and hours of practice per week ranged from 2 to 63 (mean 25.1, SD 13.4). The most used chinrest types were over the tailpiece (58%, n = 54), Dresden (32%, n = 30) and other types (7%, n = 6), with only three musicians using the central chinrest (3%). Fifty players (54%) were classified as having TMD, 48% (n = 45) had mild TMD and 5% (n = 5) had moderate TMD. TMD frequency was higher in females (55% versus 53%). A higher percentage of mild TMD was found in male musicians (49% versus 48%), but females reported moderate TMD more frequently than males (7% versus 4%).

TMD was more prevalent in younger musicians, defined as ages 18 to 30, accounting for 61% (n = 28) of TMD cases. The most frequent TMD symptoms (sum of answers yes and sometimes) were perception of being a tense or anxious individual, neck pain or stiffness, frequent headaches, TMJ sounds while chewing or opening the mouth and habitual teeth clenching or grinding (Table 1). MPA scores ranged from 37 to 181 (median 104 points, mean 107, SD 30). The highest mean scores were observed in females (110.4 versus 104.2 in males), with 95% confidence interval (CI) 100.19–120.53 and 96.36–112.03, respectively, and in younger musicians (aged 18 to 30: 115.0 versus 99.1 in older musicians), 95% CI 106.51–123.53 and 90.4–107.82, respectively. The most frequent symptoms were perception of being a tense or anxious individual, neck pain or stiffness, frequent headaches, TMJ sounds while chewing or opening the mouth and habitual teeth clenching or grinding (Table 1). MPA scores ranged from 37 to 181 (median 104 points, mean 107, SD 30). The highest mean scores were observed in females (110.4 versus 104.2 in males), with 95% confidence interval (CI) 100.19–120.53 and 96.36–112.03, respectively, and in younger musicians (aged 18 to 30: 115.0 versus 99.1 in older musicians), 95% CI 106.51–123.53 and 90.4–107.82, respectively.

The most frequent symptoms were the same and equally ordered regardless of MPA level (most or least anxious groups). The following groups had higher TMD frequency: female players (55% versus 53% in males), younger players (61% versus 55% in players aged over 30), musicians with <20 years experience (55% versus 52% in more experienced players), violinists who practised for fewer than 22 h per week (54% versus 53% in those practising for longer) and those who used an over the tailpiece chinrest model (57% versus 50% in Dresden chinrest users and 44% in users of other models). However, only the association between TMD presence and MPA level presented statistically significant differences (P < 0.001, Table 2).

An additional analysis was performed after eliminating the three most frequent TMD symptoms from the data: perception of being a tense or anxious individual, neck pain or stiffness and frequent headaches. For this additional analysis, two new TMD symptom groups were created: musicians with the most symptoms (questionnaire score equal to or above the median value) and musicians with the fewest symptoms (below the median value). Even so, statistical significance was maintained for the previous association (P < 0.05). Binary logistic regression was performed and no statistically significant effect or confounding was found. Values for odds ratios (ORs) when adjusting the model for all the variables are presented in Table 3. A further model was obtained, according to which the most anxious musicians presented an OR of 6.03 (95% CI 2.51–15.33, P < 0.001). Deviance analysis supported adequate fit for the data. AIC = 115.49 and ~22% of the response variable variance is explained by the model (Nagelkerke $R^2 = 0.22$).

Discussion

The principal findings are of a significant association between the presence of TMD and a high level of MPA, with no significant interaction or confounding between the independent variables. The most frequent TMD symptoms were perception of being a tense or anxious individual, neck pain or stiffness, frequent headaches, TMJ sounds while chewing or opening the mouth and habitual teeth clenching or grinding.

### Table 1. Answers to the Fonseca Anamnestic Questionnaire

<table>
<thead>
<tr>
<th>Question</th>
<th>No, n (%)</th>
<th>Sometimes, n (%)</th>
<th>Yes, n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Do you find it difficult to open your mouth?</td>
<td>85 (91)</td>
<td>8 (9)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>2. Do you find it difficult to move your jaw from side to side?</td>
<td>88 (95)</td>
<td>5 (5)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>3. Do feel muscle pain when you chew?</td>
<td>78 (84)</td>
<td>15 (16)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>4. Do you feel headaches often?</td>
<td>54 (58)</td>
<td>33 (36)</td>
<td>6 (6)</td>
</tr>
<tr>
<td>5. Do you usually experience neck pain or stiffness?</td>
<td>36 (39)</td>
<td>40 (43)</td>
<td>17 (18)</td>
</tr>
<tr>
<td>6. Do you feel pain in the ear or TMJ area?</td>
<td>62 (67)</td>
<td>28 (30)</td>
<td>3 (3)</td>
</tr>
<tr>
<td>7. Have you noticed any articular noise when chewing or opening your mouth?</td>
<td>58 (62)</td>
<td>22 (24)</td>
<td>13 (14)</td>
</tr>
<tr>
<td>8. Do you have a habit of clenching or grinding your teeth?</td>
<td>57 (61)</td>
<td>17 (18)</td>
<td>19 (21)</td>
</tr>
<tr>
<td>9. Do you feel that your teeth do not articulate (close) properly?</td>
<td>72 (78)</td>
<td>5 (5)</td>
<td>16 (17)</td>
</tr>
<tr>
<td>10. Do you consider yourself a tense or anxious individual?</td>
<td>25 (27)</td>
<td>48 (52)</td>
<td>20 (21)</td>
</tr>
</tbody>
</table>
The response rate of the target sample was 73%, reducing possible selection bias, and even after removing the three most frequent symptoms from the analysis, the association between TMD and MPA remained significant. However, the use of a symptom-based questionnaire for TMD classification does not exclude the need for clinical examination or diagnostic tests, essential for the confirmation of any existing pathology, and may possibly have resulted in overestimating the presence of TMD or its symptoms. The questionnaire also did not address other systemic pathologies or TMD symptoms present before violin playing, which may have resulted in under-reporting of MPA, particularly in high-calibre musicians who may fear adverse consequences of reporting symptoms. An earlier study found that musicians had concerns about the career implications of reporting symptoms related to PRMD despite assurances of anonymity [20]. Although MPA would probably not appear to be as career limiting as a PRMD, filling out the K-MPAI in the working environment may have introduced a possible social desirability bias.

Recently, Steinmetz et al. [14] applied the RDC/TMD questionnaire to a sample of 408 orchestra musicians and observed that violin players reported TMD symptoms more frequently than other musicians. It was also noted that stage fright and gender were statistically significant predictors (P < 0.05) of having experienced orofacial pain during the previous month. However, a response rate of 57% did not allow for the exclusion of selection bias.

Our results also show a higher frequency of TMD in female violin players. However, no statistically significant differences were found. Similarly, Rodríguez-Lozano et al. [10] found a higher frequency of TMD in female violinists, although not statistically significant. Nevertheless, in 1995, Kovero and Könnönen [21] found, in a sample of violin and viola players, a statistically significant association between female gender and both TMD symptom severity and TMJ sounds. Differences in the study methodology and the fact that the latter study had a sample of which 38% were viola players makes it difficult to extrapolate any conclusions.

Regarding age, the youngest violin players presented TMD more frequently (n = 28, 61%). Although no
significant association was found, these findings supported the results of Heikkilä et al. [22] who found that TMD symptoms decreased from 100 to 0% with the increase of age from 20 to 60 in string players.

It might be expected that years of experience would be associated with prevalence of TMD. However, we did not find a statistically significant association for these variables. Likewise, Rodriguez-Lozano et al. [10] also found no significant association between TMD and years of violin practice.

The violin players in this sample practised a mean of 25 h per week (SD 13.4), which was considerably less than the findings of Hirsch et al. [16] (mean 35 h, SD 10) and Kovero and Könönen [21] (mean 36 h). Only two publications in the literature explore a possible relationship between weekly playing time and TMD signs or symptoms in professional violinists [10,21]. Kovero and Könönen [21] found a positive correlation between the number of playing hours per week and symptom severity, prevalence of painful masticatory muscles, prevalence of painful masticatory muscles on the right side and pain during mandibular movement. The present study did not find a significant association between TMD and weekly playing hours, which was consistent with the results of Rodriguez-Lozano et al. [10]. However, these results may reflect a need to explore other factors that may be involved in the development of TMD, such as taking breaks or performing stretching exercises during instrument practice. It is also important to underline that the data relating to practice time is only an estimate given by the musicians and may not be accurate, especially as it varies between weeks.

In 1982, Hirsch et al. [16] found that 8% (n = 5) of the string players in their sample used central chinrests, all of whom were viola players. Three of them had no TMD signs and did not report any symptoms. The remaining two, who reported having used non-central chinrests previously, exhibited a mandibular deviation of ≤2 mm (mean 5.5, SD 2.5). However, the authors did not mention any kind of statistical analysis on the possible association between chinrest type and TMD symptoms or signs.

Only three violin players from this sample used central chinrests. As such, it was decided to group them with the users of other types of chinrests in order to assemble a group of at least nine elements. With this approach, no statistically significant association was found between the presence of TMD and type of chinrest used.

Ackermann et al. [13] found a significant association between PRMD symptoms and high MPA levels and advised that it may be necessary to approach the psychological and physical aspects simultaneously in musicians who do not show improvement with physical therapy. In the light of our results, it is plausible to infer that these indications may extend to TMD as well. Ackermann et al. [13] suggested that therapists should not overvalue psychological factors in physical injury, and that the latter should be the main focus of therapy. Other authors recommend physical exercises and postural training, constructed specifically for musicians, for minimizing TMD symptoms in this population [10,23].

Regarding MPA-focused therapy, cognitive-behavioural therapy seems to be the only approach that has had consistently positive results in reducing MPA levels [23]. However, Kenny [23] also emphasizes that the interventions that result in an improvement in performance quality are the most desirable, due to their self-reinforcing, confidence-enhancing effect, eliminating the need for further treatment.

Future study that includes clinical examination and follow-up evaluations of the effect of TMD therapy alone and combined with MPA-focused therapy in anxious violinists is recommended. The authors would also like to point out that the questions asked were not limited to a time period, although musicians were asked to answer according to recent experiences, and that the frequency of musical performances could also be a relevant variable to consider.

Key points

- The most anxious violinists were six times more likely to report temporomandibular disorder symptoms compared with the least anxious.
- The most frequent temporomandibular disorder symptoms were perception of being a tense or anxious individual, neck pain or stiffness, frequent headaches, TMJ sounds while chewing or opening the mouth and habitual teeth clenching or grinding.
- There was no evidence of a statistically significant association between temporomandibular disorder and chinrest type.

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Conflicts of interest

None declared.

References

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