Characteristics of Temporomandibular Disorders in Instrumentalists

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Characteristics of Temporomandibular Disorders in Instrumentalists

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부족한 저의 논문의 심사와 지도를 맡아주신 한동후 교수님, 이기준 교수님께도 깊은 감사를 드리고 싶습니다.

논문을 준비하고 완성하는 동안 바쁘신 와중에도 여러 도움을 주신 정아영 선생님과 오두원 선생님을 비롯한 모든 의국원 분들에게도 진심으로 감사 드립니다.

마지막으로 언제나 큰 힘이 되어주고 항상 저를 믿어주고 응원해 주시는 가족들에게 사랑을 전합니다.

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Characteristics of Temporomandibular Disorders in Instrumentalists

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It has been reported that many musicians who play musical instruments exhibit signs and symptoms of temporomandibular disorders (TMD). However, most previous studies of the association between playing instruments and TMD have considered only subjective symptoms or been limited to small populations. Furthermore, studies that employed clinical examinations and radiography only involved specific instrument groups, such as violinists, violists, or wind instrumentalists. This study therefore investigated the characteristics of TMD in instrumentalists by evaluating both subjective symptoms and clinical diagnoses in a large number of instrumentalists. Musicians from a diverse range of instrument groups completed a TMD questionnaire and underwent clinical examinations and radiography.

After excluding subjects with a history of orthodontic treatment or jaw trauma, and those who failed to complete the questionnaire, 739 instrumentalists were included in the analysis. Among those who reported at least 1 symptom of TMD, 71 subjects volunteered to visit the dental clinic (Department of Orofacial Pain and Oral Medicine, College of Dentistry, Yonsei University, Seoul, Korea) to undergo clinical examinations and radiography for the clinical diagnosis. Clinical examinations, radiographic analysis, and analysis of variables associated with TMD symptoms and clinical diagnoses were performed by an orofacial pain specialist.

Based on the obtained results, we report the following findings:

1. 76.6% of the 739 instrumentalists reported having 1 or more symptoms of TMD.
2. The most frequently reported subjective symptom in instrumentalists was a clicking or popping sound.
3. Clicking or popping sound, temporomandibular joint (TMJ) pain, muscle pain, symptoms of suspected tension-type headache (S-TTH), and symptoms of suspected migraine (S-migraine) were more common in female instrumentalists than in their male counterparts.
4. Clicking or popping sound was frequently reported by instrumentalists aged 20–29 years. Muscle pain and symptoms of S-TTH were frequently reported by instrumentalists aged 20–29 years, and 30–39 years,
5. Clicking or popping sound was frequently reported by woodwind and brass instrumentalists. TMJ pain was reported more often by upper strings and brass instrumentalists.

6. Muscle pain was more common in those with an elevated arm position (≥40° elevation of the arm while playing) than in those with a neutral arm position (<40° elevation of the arm while playing).
7. Instrumentalists with oral parafunctional habits frequently experienced TMJ pain and S-migraine.
8. The most common clinical diagnosis in instrumentalists was myalgia or myofascial pain.
9. Compared to those with <14 years of experience, instrumentalists with ≥14 years of playing experience had a higher frequency of disk displacement with reduction but a lower frequency of TMJ arthralgia.
10. Myalgia or myofascial pain was more common in instrumentalists who practiced ≥3.5 hours daily compared to those who practiced <3.5 hours daily.

Keywords: instrumentalists, temporomandibular disorders (TMD)

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I. INTRODUCTION

Temporomandibular disorders (TMD) constitute a broad group of clinical problems that involve the muscles of mastication, the temporomandibular joint (TMJ), and associated orofacial structures. Symptoms of TMD include a decreased range of motion of the mandible, pain in the masticatory musculatures, TMJ pain, joint sounds associated with function, generalized myofascial pain (MFP), and a functional limitation or deviation in jaw opening (Wadhwa and Kapila, 2008). The most frequently reported symptom of TMD is pain, which is usually located in the masticatory muscles, TMJ and/or the preauricular area (De Leeuw R, 2008). Headache is also a common symptom in individuals with TMD (Graff-Radford SB, 2007, Ballegaard V et al., 2008). Other symptoms such as neck ache, facial pain, earache,

tinnitus, and perceived hearing loss have also been described (De Leeuw R, 2008). The frequency of TMD has been reported to range from 30% to 39.2% (Goulet et al., 1995, Pow et al., 2001, Nekora-Azak et al., 2006, Gonçalves et al., 2010). In those studies, headache was not included in TMD.

The etiology of TMD is multifactorial, with neuromuscular, neurobiological, biomechanical, and biopsychosocial factors having been identified (Suvinen et al., 2005). Certain parafunctional habits such as bruxism, tooth clenching, and chewing gum are also thought to potentially increase the risk of developing TMD (Winocur et al., 2001, Karibe et al., 2003, Miyake et al., 2004, Rossetti et al., 2008). TMD are closely associated with lifestyle and occupational characteristics. In particular, it has been reported that many instrumentalists experience TMD signs and symptoms that are attributable to heavy use of the jaw or mouth, and constant tension of the head and neck muscles. Due to the high physical and psychological demands when playing musical instruments, musicians are at risk of developing various health problems (Foxman and Burgel, 2006). Many musicians practice daily for several hours, and this can result in long-term, repetitive force application to the head, mandible, and facial muscles, which may lead to malocclusion and other deformations of the stomatognathic system (Głowacka et al., 2014).

A study involving 408 musicians of the Berlin and Saxony-Anhalt orchestra found that craniomandibular disorders were common, with half of the musicians reporting orofacial pain (Steinmetz et al., 2014). Another questionnaire study involving 73 musicians of a Finnish orchestra revealed that 56% of them reported at least 1 TMD symptom (Jaana Heikkilä et al., 2012). The type of instrument played may determine the occupational disorder or disease that affects a musician (Zuskin et al., 2005). For example, playing upper string instruments such as violin and viola held between the shoulder and angle of the jaw can induce TMD or aggravate

already existing TMD by overloading the masticatory muscles and orofacial skeletal system (Attallah et al., 2014). Previous studies have shown that violinists or violists often report TMD signs and symptoms (Hirsch et al., 1982, Kovero and Könönen, 1995, Rodríguez-Lozano et al., 2010). The specific playing techniques used by woodwind and brass instrumentalists involve upwards and backwards movement of the mandible, which can directly impact the TMJ and compress it so as to contribute to the development of TMD (Gualtieri, 1979). Playing a wind instrument is a complex neuromuscular task requiring increased respiration and orofacial muscle activity (Prensky et al., 1986, Howard and Lovrovich, 1989), and a questionnaire study involving Lebanon musicians found TMD in 23% of 340 wind instrumentalists (Sayegh Ghoussoub et al., 2008).

Most previous studies of the association between playing musical instruments and TMD have considered only subjective symptoms or been limited to small populations. Some studies have also carried out objective clinical examinations and radiography, but such studies were limited to examining specific instrument groups such as violinists, violists, or wind instrumentalists. Thus, the present study investigated the characteristics of TMD in instrumentalists by evaluating both subjective symptoms and clinical diagnoses by utilizing a TMD questionnaire and applying clinical examinations and radiography in a large number of instrumentalists.

II. MATERIALS AND METHODS

1. Study Population

In total, 841 people consisting of high-school and college students majoring in playing musical instruments, as well as professional orchestra members, were asked to fill out a TMD questionnaire. The instruments played included the cello, double bass, viola, violin, clarinet, saxophone, bassoon, oboe, daegeum, flute, horn, trombone, trumpet, tuba, harp, percussion, and piano. Exclusion criteria were a previous history of orthodontic treatment or jaw trauma, and failure to fill out the questionnaire completely, which left 739 subjects to be analyzed in the study. Among those who reported at least 1 symptom of TMD, 71 subjects volunteered to visit the dental clinic (Department of Orofacial Pain and Oral Medicine, College of Dentistry, Yonsei University, Seoul, Korea) to undergo clinical examinations and radiography to allow a clinical diagnosis (Figure 1). The present survey and examination were performed from March 2012 to December 2012.

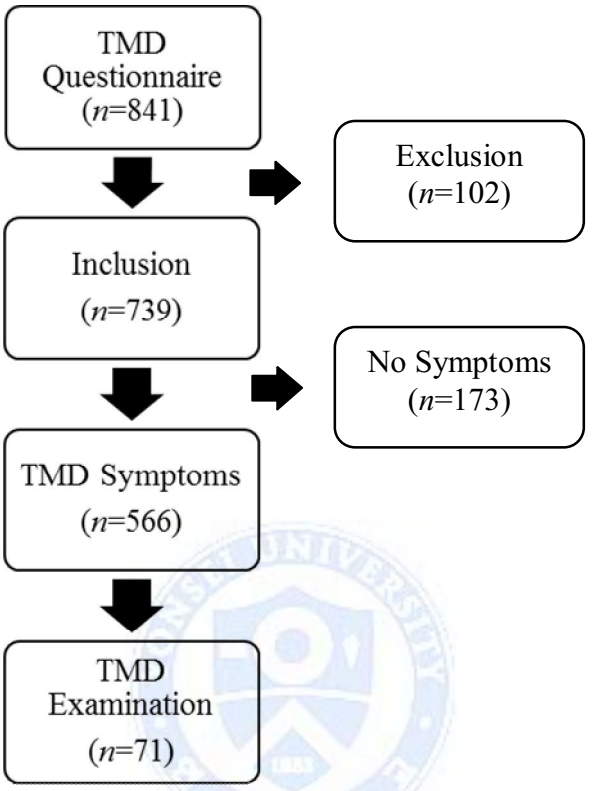

Figure 1. Flow chart of study

2. TMD Questionnaire

Various subjective symptoms were evaluated using a TMD questionnaire. The questionnaire consisted of six questions that queried the characteristics of TMJ pain, masticatory muscle pain, TMJ sound (clicking/popping or crepitus), difficulty during mouth opening, oral parafunctional habits (bruxism or clenching), and headache (Table 1) (Gonçalves et al., 2010). Information on the following background characteristics was also obtained: gender, age, the instrument played, length of playing experience, and experience of orthodontic treatment or jaw trauma. The questionnaire included some multiple-choice questions.

Table 1. TMD questionnaire

1. Have you ever had pain in the joint around your ears?
2. Have you ever had pain around your cheeks, temple, or jaw?
3. Have you ever noticed sounds while opening or closing your jaw?
1) Clicking or popping
2) Crepitus
4. Have you ever experienced any difficulties while opening your mouth to the point where two fingers can fit inside?
5. Do you suffer from any oral parafunctional habits?
1) Bruxism
2) Clenching
6. Have you ever experienced a headache?
1) Aspects of pain: throbbing / tightening
2) Site of pain: unilateral / bilateral
3) Frequency of pain: number of instances per week or per month
4) Intensity of pain: mild / moderate / severe
5) Accompanying symptoms: nausea, vomiting, photophobia, phonophobia, or worsening headache when climbing stairs

3. Clinical and Radiographic Examinations

Clinical signs of TMD were evaluated utilizing a combination of clinical and radiographic examinations to describe characteristics of the symptoms of disk displacement with reduction (DD w/ R), disk displacement without reduction (DD w/o R), TMJ arthralgia, myalgia or myofascial pain (MFP), TMJ osteoarthritis (TMJ OA), TMJ osteoarthrosis (TMJ O), tension-type headache (TTH), migraine, and other headaches (other HAs). The clinical diagnoses were made according to the Diagnostic Criteria for TMD (DC-TMD) and the third edition of the International Classification of Headache Disorders (ICHD-3). The clinical examinations included palpation of the TMJ, temporalis muscles, and masseter muscles. The intensity of TMJ or muscle pain was assessed with a visual analog scale ranging from 0 to 10. The presence of TMJ noise was evaluated. Ranges of jaw motion [maximum mouth opening (MO), protrusion, and lateral movement] were measured in millimeters using a ruler. Attrition, tongue ridging, and cheek ridging were also evaluated. Panoramic and transcranial radiography were performed. The clinical examination, radiograph test, and diagnosis were performed by a single examiner.

4. Data Analysis

4. 1. Analysis of subjective symptoms using the TMD questionnaire (*n*=739)

4. 1. 1. We analyzed the following variables in relation to subjective symptoms:

1) TMD symptoms were evaluated in relation to gender.

2) TMD symptoms were evaluated in relation to age. Subjects were stratified into four groups according to age: 12–19 years, 20–29 years, 30–39 years, and 40–49 years. These age ranges were chosen for consistency with the 2012 Korea National Health and Nutrition Examination Survey (KNHANES).

3) TMD symptoms were evaluated in relation to playing experience. The cohort was divided into two groups according to the length of playing experience: <10 years and ≥10 years. This cutoff corresponded to the median for the total study population.

4-1) TMD symptoms were evaluated in relation to the type of instrument: lower strings (cello and double bass), upper strings (viola and violin), woodwind (daegeum, flute, clarinet, saxophone, bassoon, and oboe), brass (horn, trombone, trumpet, and tuba), and other (harp, percussion, and piano).

4-2) TMD symptoms were also evaluated in relation to the type of wind instrument: small mouth aperture (daegeum and flute), single reed (clarinet and saxophone), and double reed (bassoon and oboe).

5) TMD symptoms were evaluated in relation to the arm position while playing. Arm position was divided into two groups: neutral arm position (<40° elevation of the arm while playing) and elevated arm position (≥40° elevation of the arm while playing). This cutoff was chosen based on the study of Nyman et al. (Nyman et al.,

2007). Instruments played with a neutral arm position included the cello, double bass, clarinet, saxophone, bassoon, oboe, horn, tuba, and piano. Instruments played with an elevated arm position included the viola, violin, daegeum, flute, trombone, trumpet, harp, and percussion.

6) TMD symptoms were evaluated in relation to presence of oral parafunctional habits such as bruxism or clenching.

4. 1. 2. The frequencies of TMD-related features (clicking or popping sound, TMJ or muscle pain, and MO limitation) in the 2012 KNHANES were compared to our outcomes.

4. 2. Analysis of diagnoses using clinical examinations and radiography (*n*=71)

4. 2. 1. We analyzed the following variables in relation to of TMD diagnoses:

1) TMD diagnoses were evaluated in relation to gender.

2) TMD diagnoses were evaluated in relation to age. Subjects were stratified into four groups according to age: 12–19 years, 20–29 years, 30–39 years, and 40–49 years.

3) TMD diagnoses were evaluated in relation to playing experience. The cohort was divided into two groups according to the length of playing experience: <14 years and ≥14 years. This cutoff corresponded to the median for the 71 included instrumentalists.

4) TMD diagnoses were evaluated in relation to the number of hours of daily practice. The cohort was divided into two groups: <3.5 hours and ≥3.5 hours. This cutoff corresponded to the median for the 71 instrumentalists. Data on the hours of daily practice were collected during the interview at the time of the clinical examinations, since this information was not included in the TMD questionnaire.

5) TMD diagnoses were evaluated in relation to the type of instrument: wind (daegeum, flute, clarinet, saxophone, bassoon, and oboe) and strings (cello, double bass, viola and violin).

6) TMD diagnoses were evaluated in relation to the arm position while playing. Arm position was divided into two groups: neutral arm position (<40° elevation of the arm while playing) and elevated arm position (≥40° elevation of the arm while playing).

7) TMD diagnoses were evaluated in relation to the presence of oral parafunctional habits such as bruxism or clenching. Moderate to severe attrition was regarded as bruxism, and moderate to severe tongue ridging or cheek ridging was regarded as clenching.

4. 2. 2. We compared the ranges of jaw motion according to the type of instrument.

For data on the 739 subjects who responded to the TMD questionnaire, mean and standard deviation (SD) values of age and length of playing experience were calculated. For data on the 71 subjects who underwent clinical examinations and radiography, mean and SD values for age, length of playing experience, and hours of daily practice were calculated.

Logistic regression analysis was applied. Potential confounders were considered: gender, age, length of playing experience, hours of daily practice, types of all instruments, types of wind instruments, arm position while playing, and the presence of oral parafunctional habits. Potential confounders were first examined by means of logistic regression analysis, and if found to be associated with the outcome of interest, the confounder was included in the succeeding analysis. The association between the variables and the outcome of interest was determined by performing logistic regression analysis adjusted for potential

confounders, and the adjusted odds ratio (adjusted OR) and 95% confidence interval (CI) were calculated.

All statistical analyses were performed using the SPSS software package (version 21.0, IBM, Armonk, NY, USA). The cutoff for statistical significance was a probability value of $p<0.05$.

III. RESULTS

1. Analysis of Subjective Symptoms Using the TMD Questionnaire

The 739 subjects who responded to the questionnaire comprised 191 men and 548 women aged from 15 years to 48 years (24.3±6.9 years, mean±SD), with a length of playing experience of 12.0±7.2 years. The study participants were 100 lower strings instrumentalists (56 cello and 44 double bass), 289 upper strings instrumentalists (63 viola and 226 violin), 169 woodwind instrumentalists (1 daegeum, 58 flute, 44 clarinet, 7 saxophone, 28 bassoon, and 31 oboe), 160 brass instrumentalists (51 horn, 49 trombone, 52 trumpet, and 8 tuba), and 21 players of other instruments (2 harp, 17 percussion, and 2 piano).

Among them, 566 participants (76.6%) reported having 1 or more symptoms of TMD. The most frequently reported symptom was a clicking or popping sound (*n*=338, 45.7%), followed by symptoms of suspected other headaches (S-other HAs; *n*=194, 26.3%), TMJ pain (*n*=177, 24.0%), muscle pain (*n*=156, 21.1%), symptoms of suspected migraine (S-migraine; *n*=152, 20.6%), symptoms of suspected tension-type headache (S-TTH; *n*=62, 8.4%), crepitus sound (*n*=51, 6.9%), and MO limitation (*n*=1, 0.1%) (Table 2, Figure 2). Headache-associated symptoms reported in response to survey questions were expressed by adding “symptoms of suspected” and “S-” in front of the headache diagnoses. In contrast, headache diagnoses made based off symptoms reported during the interview portion of the clinical examination were expressed as is, without the addition of “suspected symptoms of” and “S-”.

No symptoms were reported by 173 of the 739 participants (23.4%). When excluding headache from the list of symptoms used to diagnosis TMD, 453 participants (61.3%) reported having 1 or more symptoms of TMD.

Table 2. Frequency of subjective symptoms in 739 subjects (Patients could report more than 1 subjective symptom.)

	n / total	%
Clicking or popping	338 / 739	45.7
MO limitation	1 / 739	0.1
TMJ pain	177 / 739	24.0
Muscle pain	156 / 739	21.1
Crepitus	51 / 739	6.9
S-TTH	62 / 739	8.4
S-migraine	152 / 739	20.6
S-other HAs	194 / 739	26.3

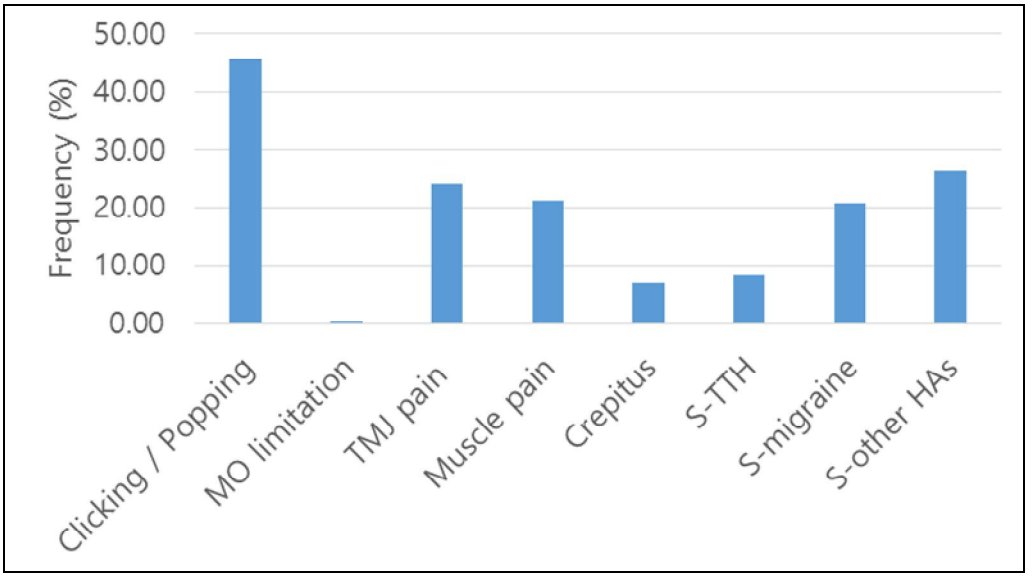

Figure 2. Frequency of subjective symptoms in 739 subjects (Patients could report more than 1 subjective symptom.)

Evaluations of the associations between the TMD symptoms and the variables produced the outcomes described below.

1. 1. Clicking or popping sound

Among all the variables, gender, age, type of instrument, and the presence of oral parafunctional habits were included in the succeeding analysis and they were statistically significant predictors of a clicking or popping sound. Clicking or popping sound was 1.7 times more frequent in females than in males. Compared with adolescents (aged 12–19 years), a clicking or popping sound was about 1.6 times more frequent in subjects aged 20–29 years. Compared with lower strings instrumentalists, a clicking or popping sound was about 1.8 and 2 times more frequent in woodwind and brass instrumentalists, respectively. Clicking or popping sound was about 1.9 times more frequent in the presence of oral parafunctional habits (Table 3).

Table 3. Logistic regression analysis of the potential predictors of a clicking or popping sound

	Adjusted OR	*P*–value	95% CI
gender			
male	reference		
female	1.721	0.004*	1.192–2.485
age			
12–19 years	reference		
20–29 years	1.565	0.020*	1.073–2.283
30–39 years	1.463	0.139	0.883–2.424
40–49 years	0.662	0.303	0.302–1.451
type of instrument			
lower strings	reference		
upper strings	1.375	0.198	0.846–2.235
woodwind	1.781	0.031*	1.055–3.006
brass	2.033	0.010*	1.189–3.478
other	0.982	0.972	0.362–2.667
oral parafunction			
no	reference		
yes	1.862	<0.001*	1.337–2.594

* $p<0.05$ indicates statistical significance

1. 2. MO limitation

No variables were associated with the presence of MO limitation.

1. 3. TMJ pain

Among all the variables, gender, age, type of instrument, and the presence of oral parafunctional habits were included in the succeeding analysis. Among them, gender, type of instrument, and the presence of oral parafunctional habits were statistically significant predictors of TMJ pain. TMJ pain was 1.8 times more frequent in females than in males. Compared with lower strings instrumentalists, TMJ pain was about 3.2, 2.8, and 3.2 times more frequent in upper strings, woodwind, and brass instrumentalists, respectively. TMJ pain was about 1.8 times more frequent in the presence of oral parafunctional habits (Table 4).

1. 4. Muscle pain

Among all the variables, gender, age, arm position while playing, and the presence of oral parafunctional habits were included in the succeeding analysis. Among them, gender, age, and arm position while playing were statistically significant predictors of muscle pain. Muscle pain was 1.9 times more frequent in females than in males. Compared with adolescents (aged 12–19 years), muscle pain was about 2 and 2.5 times more frequent in subjects aged 20–29 years and 30–39 years, respectively. Muscle pain was about 1.5 times more frequent was in instrumentalists with an elevated arm position than in those with a neutral arm position (Table 5).

Table 4. Logistic regression analysis of the potential predictors of TMJ pain

	Adjusted OR	*P*–value	95% CI
gender			
male	reference		
female	1.817	0.012*	1.140–2.896
age			
12–19 years	reference		
20–29 years	1.478	0.092	0.939–2.326
30–39 years	1.162	0.633	0.627–2.151
40–49 years	0.523	0.258	0.170–1.607
type of instrument			
lower strings	reference		
upper strings	3.200	0.001*	1.571–6.516
woodwind	2.810	0.007*	1.321–5.978
brass	3.203	0.003*	1.488–6.897
other	1.813	0.367	0.498–6.595
oral parafunction			
no	reference		
yes	1.825	0.001*	1.265–2.632

* $p<0.05$ indicates statistical significance

Table 5. Logistic regression analysis of the potential predictors of muscle pain

	Adjusted OR	*P*–value	95% CI
gender			
male	reference		
female	1.883	0.009*	1.169–3.033
age			
12–19 years	reference		
20–29 years	2.042	0.006*	1.221–3.414
30–39 years	2.487	0.005*	1.310–4.722
40–49 years	1.245	0.686	0.431–3.594
arm elevation			
<40°	reference		
≥40°	1.505	0.039*	1.021–2.218
oral parafunction			
no	reference		
yes	1.431	0.064	0.979–2.092

* $p<0.05$ indicates statistical significance

Clicking or popping, and TMJ or muscle pain were more common in the present study than in the 2012 KNHANES, while MO limitation was less common (Table 6).

Table 6. Frequencies of clicking or popping, MO limitation, and TMJ or muscle pain according to age in the 2012 KNHANES versus the present study

	2012 KNHANES		Present study	
	n / total	%	*n* / total	%
Clicking or popping				
12–19 years old	207 / 685	30.2	63/ 166	38.0
20–29 years old	221 / 604	36.6	214 / 428	50.0
30–39 years old	246 / 1017	24.2	50 / 107	46.7
40–49 years old	151 / 1022	14.8	11 / 38	28.9
Total	825 / 3328	24.8	338 / 739	45.7
MO limitation				
12–19 years old	69 / 685	10.1	0 / 166	0.0
20–29 years old	96 / 604	15.9	1 / 428	0.2
30–39 years old	107 / 1017	10.5	0 / 107	0.0
40–49 years old	50 / 1022	4.9	0 / 38	0.0
Total	332 / 3328	10.0	1 / 739	0.1
TMJ or muscle pain				
12–19 years old	63 / 685	9.2	43 / 166	25.9
20–29 years old	70 / 604	11.6	178 / 428	41.6
30–39 years old	73 / 1017	7.2	38 / 107	35.5
40–49 years old	56 / 1022	5.5	8 / 38	21.1
Total	262 / 3328	7.9	267 / 739	36.1

1. 5. Crepitus sound

No variables were associated with a crepitus sound.

1. 6. Symptoms of suspected tension-type headache (S-TTH)

Among all the variables, gender and age were included in the succeeding analysis and they were statistically significant predictors of S-TTH. S-TTH was 2.1 times more frequent in females than in males. Compared with adolescents (aged 12–19 years), S-TTH was about 2.3 and 3.3 times more frequent in subjects aged 20–29 years and 30–39 years, respectively (Table 7).

Table 7. Logistic regression analysis of the potential predictors of S-TTH

	Adjusted OR	*P*–value	95% CI
gender			
male	reference		
female	2.117	0.046*	1.013–4.422
age			
12–19 years	reference		
20–29 years	2.314	0.046*	1.014–5.276
30–39 years	3.330	0.014*	1.278–8.680
40–49 years	0.686	0.729	0.081–5.777

* $p<0.05$ indicates statistical significance

1. 7. Symptoms of suspected migraine (S-migraine)

Among all the variables, gender and the presence of oral parafunctional habits were included in the succeeding analysis and they were statistically significant predictors of S-migraine. S-migraine was 1.6 times more frequent in females than in males. S-migraine was about 2.1 times more frequent in the presence of oral parafunctional habits (Table 8).

Table 8. Logistic regression analysis of the potential predictors of S-migraine

	Adjusted OR	*P*–value	95% CI
gender			
male	reference		
female	1.629	0.037*	1.029–2.578
oral parafunction			
no	reference		
yes	2.081	<0.001*	1.435–3.017

* $p<0.05$ indicates statistical significance

1. 8. Symptoms of suspected other headaches (S-other HAs)

Among all the variables, gender and age were included in the succeeding analysis. Among them, age was statistically significant predictor of S-other HAs. Compared with adolescents (aged 12–19 years), S-other HAs was about 1.6 and 3.4 times more frequent in subjects aged 20–29 years and 40–49 years, respectively (Table 9).

Table 9. Logistic regression analysis of the potential predictors of S-other HAs

	Adjusted OR	*P*–value	95% CI
gender			
male	reference		
female	1.458	0.066	0.975–2.181
age			
12–19 years	reference		
20–29 years	1.640	0.030*	1.050–2.559
30–39 years	1.591	0.119	0.887–2.853
40–49 years	3.397	0.002*	1.589–7.265

* $p<0.05$ indicates statistical significance

No TMD symptoms were significantly related to the length of playing experience or the type of wind instrument (small mouth aperture, single reed, and double reed).

2. Analysis of Diagnoses Using Clinical Examinations and Radiography

The 71 subjects who underwent clinical examinations and radiography comprised 9 men and 62 women aged from 17 years to 48 years (25.1±6.9 years), with a length of playing experience of 13.5±7.0 years; they practiced for 3.8±1.5 hours daily. These subjects were 32 wind

instrumentalists (1 daegeum, 7 flute, 2 clarinet, 3 bassoon, 5 oboe, 3 horn, 2 trombone, 7 trumpet, and 2 tuba) and 39 string instrumentalists (2 cello, 1 double bass, 7 viola, and 29 violin).

The most frequently diagnosed disease was myalgia or MFP (*n*=59, 83.1%), followed by DD w/ R (*n*=54, 76.1%), TMJ arthralgia (*n*=44, 62.0%), migraine (*n*=19, 26.8%), other HAs (*n*=6, 8.5%), TMJ OA or TMJ O (*n*=6, 8.5%), TTH (*n*=4, 5.6%), and DD w/o R (*n*=1, 1.4%) (Table 10, Figure 3).

Table 10. Frequency of clinical diagnoses in 71 subjects (Multiple diagnoses per patient were possible.)

	n / total	%
DD w/ R	54 / 71	76.1
DD w/o R	1 / 71	1.4
TMJ arthralgia	44 / 71	62.0
Myalgia or MFP	59 / 71	83.1
TMJ OA or TMJ O	6 / 71	8.5
TTH	4 / 71	5.6
Migraine	19 / 71	26.8
Other HAs	6 / 71	8.5

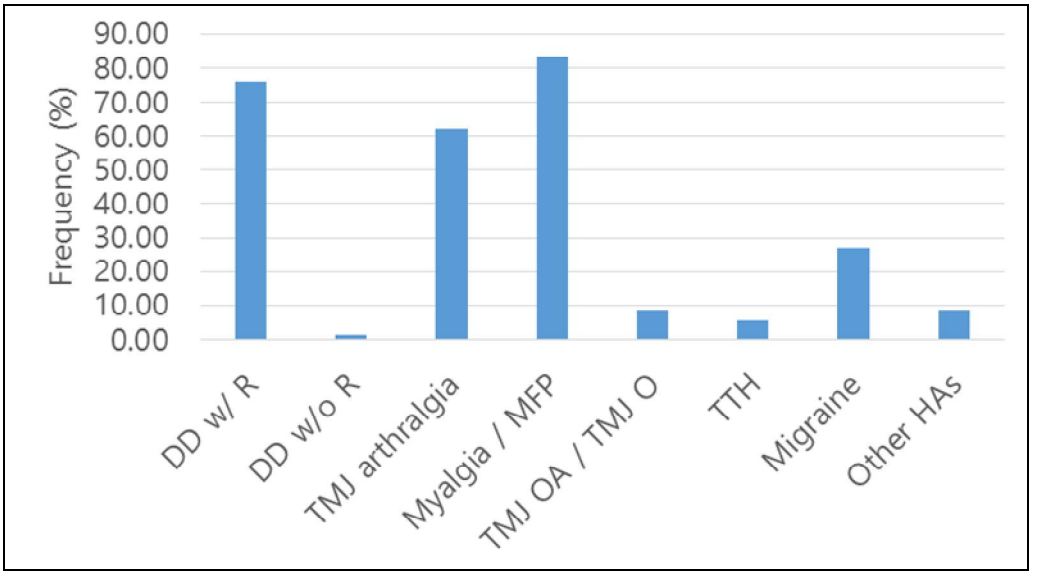

Figure 3. Frequency of clinical diagnoses in 71 subjects (Multiple diagnoses per patient were possible.)

Evaluations of the associations between the TMD diagnoses and the variables produced the outcomes described below.

2. 1. DD w/ R

Among all the variables, length of playing experience was included in the succeeding analysis and it was statistically significant predictor of DD w/ R. DD w/ R was 3.5 times more frequent in those with ≥14 years of playing experience than in those with <14 years of playing experience (Table 11).

Table 11. Logistic regression analysis of the potential predictor of DD w/ R

	Adjusted OR	*P*–value	95% CI
playing experience			
<14 years	reference		
≥14 years	3.491	0.037*	1.077–11.316

* $p<0.05$ indicates statistical significance

2. 2. DD w/o R

No variables were associated with DD w/o R.

2. 3. TMJ arthralgia

Among all the variables, gender and length of playing experience were included in the succeeding analysis and they were statistically significant predictors of TMJ arthralgia. TMJ arthralgia was about 5.2 times more frequent in females than in males, and was less common in those with ≥14 years of playing experience than in those with <14 years of playing experience (Table 12).

2. 4. Myalgia or MFP

Among all the variables, gender and daily hours of practice were included in the succeeding analysis. Among them, daily hours of practice was statistically significant predictor of myalgia or MFP. Myalgia or MFP was 4.6 times more frequent in those practicing for ≥3.5 hours daily than in those with <3.5 hours of daily practice (Table 13).

Table 12. Logistic regression analysis of the potential predictors of TMJ arthralgia

	Adjusted OR	*P*–value	95% CI
gender			
male	reference		
female	5.230	0.043*	1.057–25.868
playing experience			
<14 years	reference		
≥14 years	0.247	0.012*	0.083–0.734

* $p<0.05$ indicates statistical significance

Table 13. Logistic regression analysis of the potential predictors of myalgia or MFP

	Adjusted OR	*P*–value	95% CI
gender			
male	reference		
female	7.224	0.094	0.716–72.872
daily practice			
<3.5 hours	reference		
≥3.5 hours	4.609	0.043*	1.049–20.243

* $p<0.05$ indicates statistical significance

2. 5. TMJ OA or TMJ O

No variables were associated with the presence of TMJ OA or TM O.

2. 6. TTH

Among all the variables, arm position while playing was included in the succeeding analysis but it was not statistically significant predictor of TTH (Table 14).

Table 14. Logistic regression analysis of the potential predictor of TTH

	Adjusted OR	*P*–value	95% CI
arm elevation			
<40°	reference		
≥40°	0.096	0.071	0.008–1.218

2. 7. Migraine

No variables were associated with the presence of migraine.

2. 8. Other HAs

No variables were associated with the presence of other HAs.

The maximum MO, protrusion, and lateral movements did not differ significantly between the two instrument groups (Table 15).

Table 15. Ranges of jaw motion according to the type of instrument

	Wind (*n*=32)	String (*n*=39)	Total (*n*=71)	*P*–value
Range of motion (mean, mm)				
Maximum MO	49.3	49.0	49.1	0.830
Protrusion	7.6	7.1	7.3	0.345
Lateral movement	7.4	7.0	7.2	0.484
Right	6.8	6.7	6.8	0.846
Left	8.0	7.2	7.6	0.310

IV. DISCUSSION

This study investigated the characteristics of TMD in instrumentalists by evaluating both subjective symptoms and clinical diagnoses by utilizing a TMD questionnaire, clinical examinations, and radiography in a large number of instrumentalists. Of the 739 subjects who completed the questionnaire, 566 (76.6%) reported that they had at least 1 TMD symptom. When excluding headache from the list of symptoms used to diagnosis TMD, 453 participants (61.3%) reported having 1 or more symptoms of TMD. In previous studies the frequency of TMD among the general population has ranged from 30% to 39.2% (Goulet et al., 1995, Pow et al., 2001, Nekora-Azak et al., 2006, Gonçalves et al., 2010). In those studies, headache was not included in TMD. The present results therefore indicate that the frequency of TMD symptoms is much higher in instrumentalists than in the general population.

Comparing our study population of instrumentalists with that of the 2012 KNHANES, which involved the general Korean population, reveals that the frequencies of clicking or popping sound, and TMJ or muscle pain were higher in the current study. This may be due to instrumentalists being affected by stressful circumstances and improper posture while playing. However, the frequency of MO limitation was not higher in the instrumentalist population, which could be due to the different wording of the questionnaires or to inconsistencies in the perception of symptoms. The questionnaire used in the present study asked ‘Have you ever experienced any difficulties while opening your mouth to the point where two fingers can fit inside?’ whereas the 2012 KNHANES questionnaire asked ‘Have you ever experienced any difficulties, pain, or jaw locking while opening your mouth?’ Furthermore, there are many cases where patients misperceive their symptoms. For example, patients often report

difficulties or pain during MO and complain of MO limitation, even when they actually are able to open their mouths properly. There are also cases where patients mistake clicking or popping for jaw locking.

TMD are reportedly 1.5 to 2 times more frequent in females than in males (Le Resche, 1997). In the present study, the frequencies of clicking or popping sound, TMJ pain, muscle pain, S-TTH, and S-migraine differed significant with gender. These symptoms were 1.6 to 2 times more frequent in women than in men, which is similar to the frequency observed in the general population (Le Resche, 1997).

TMD are more common in young people. In the present study, the frequencies of clicking or popping sound, muscle pain, S-TTH, and S-other HAs differed significantly with age. Clicking or popping sound was more common in participants aged 20–29 years, and muscle pain and S-TTH were more common in participants aged 20–29 years and 30–39 years. In particular, S-other HAs were more common in those aged 40–49 years.

Franco et al. reported headache as being more common in individuals with TMD, with migraine being the most common headache subtype, followed by TTH and then other types of headache (Franco et al., 2010). In the present study, of those who received clinical examinations and were diagnosed with headache, migraine was the most common type of headache. No significant relationship was found between type of instrument and presence of headache.

The frequencies of clicking or popping sound and TMJ pain differed significantly with the type of instrument. Clicking or popping sound was more common in woodwind and brass instrumentalists, while TMJ pain was more frequent in upper strings and brass instrumentalists. Joint problems developed frequently in wind instrumentalists and it is thought that the act of performing the instrument may play a contributory role by increasing intraarticular pressure.

Jaana Heikkilä et al. reported that TMJ sounds and facial pain were more common in wind instrumentalists, due to the head and neck muscles being involved in the production of sound with a wind instrument (Jaana Heikkilä et al., 2012).

Muscle pain differed significantly with the arm position while playing in the present study. The frequency of muscle pain was higher in instrumentalists playing with an elevated arm position than in those playing with a neutral arm position. This is probably related to the posture adopted while playing. When musicians of instruments requiring elevated arm position sustain poor posture, a continuous deep pain input persists and may induce neck and shoulder pain as well as a secondary effect of inducing facial muscle pain. TMJ pain appears frequently in upper string instrumentalists may be related to the finding where instrumentalists requiring elevated arm position were observed to have greater rates of muscle pain. As a result of muscle pain, intraarticular pressure may be increased and induce TMJ pain. It has been shown that symptoms of TMD are activated and accentuated by playing and practicing as well as by nonergonomic working conditions (e.g., poor posture and muscle tension) (Taddey, 1992).

The frequency of craniomandibular disorders is reportedly particularly high in viola and violin players, reaching 74% in previous studies (Hirsch et al., 1982, Kovero and Könönen, 1995, 1996, Rodríguez-Lozano et al., 2010) and 83% in the current study. Viola and violin players adopt a specific way of holding the instrument to one side of the body, causing more frequent problems on one side of the orofacial region than on the other (Kovero and Könönen, 1995, Steinmetz et al., 2009). Cases of premature TMJ degeneration and impact on bony facial structures have also been described in violists and violinists (Herman, 1974, Okner et al., 1997). Attallah et al. reported that clinical signs of TMD are more common in professional players than in their matched controls, and that playing the viola and violin seems to be a factor associated with TMD (Hirsch et al., 1982, Kovero and Könönen, 1995, Rodríguez-Lozano et

al., 2010). This may be attributed to the mechanical overload placed on the orofacial region (Steinmetz et al., 2006) or due to the tendency to push the mandible toward the contralateral TMJ while playing the viola and violin (Hirsch et al., 1982, Kovero, 1989). By stabilizing the instrument with the chin, players exert pressure on the chin rest and mandible toward the right TMJ, resulting in mechanical stress to the joint (Kovero et al., 1997).

Steinmetz et al. reported that lower strings instrumentalists whose playing technique does not involve orofacial structures reported fewer TMD symptoms, suggesting the presence of non-playing-related causes of TMD, such as stress, stage fright, or other psychological factors (Steinmetz et al., 2014).

Musicians with oral parafunctional habits had a significantly higher frequency of TMJ pain and S-migraine in this study. Previous studies found that certain parafunctional habits such as bruxism, tooth clenching, and chewing gum might increase the risk of developing TMD (Winocur et al., 2001, Karibe et al., 2003, Miyake et al., 2004, Rossetti et al., 2008).

The most frequent clinical diagnosis in the present study was myalgia or MFP. While 83.1% of the 71 subjects had clinical signs of myalgia or MFP, only 57.7% of the 71 subjects reported muscle pain, which is the equivalent subjective symptom of myalgia or MFP. This finding suggests that instrumentalists often confuse muscle pain with joint pain, resulting in an underreporting of the former. Musicians also often undervalue or hide their problems and neglect signals to rest or seek medical care (Zuskin et al., 2005). These factors may result in them not receiving appropriate treatment, resulting in an elevated frequency of TMD symptoms among affected musicians.

The relationship between hours of practice and TMD is still unclear. While some studies have found a correlation between the number of hours of practice per week and signs of TMD in violinists (Kovero et al., 1997), others have found no association between the appearance of

TMD in violinists and either the total duration of playing or the hours of practice (Rodríguez-Lozano et al., 2010). In the present study, the frequencies of TMJ arthralgia and DD w/ R differed significantly with the length of playing experience, with instrumentalists who had played for ≥14 years reporting a higher frequency of DD w/ R but a lower frequency of TMJ arthralgia. It is thought that pain, unlike disks which persist once displaced, is adaptable as time elapses; and thus instrumentalists may be capable of adjusting their methods of playing to remove painful strain on the joint.

The frequency of myalgia or MFP was also significantly related to the number of hours of practice daily, with myalgia or MFP being more common in those who practiced ≥3.5 hours daily. This may be due to overuse and tension of the muscle, so that reducing the playing time could alleviate TMD and other symptoms caused by muscle overuse.

The main limitations of this study are the inclusion of a predominantly female population. Although a large number of instrumentalists was included, the results may have been biased since TMD are known to be more common in women. This also meant that we could not clearly define whether TMD were due to instrumental playing or to the effects of gender. Future studies involving controlled populations of instrumentalists are needed to reduce the possibility of gender bias.

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V. CONCLUSION

76.6% of the 739 instrumentalists reported having 1 or more symptoms of TMD.

The most frequently reported subjective symptom in instrumentalists was a clicking or popping sound and the most common clinical diagnosis in instrumentalists was myalgia or myofascial pain.

Clicking or popping sound was frequently reported by woodwind and brass instrumentalists and TMJ pain was reported more often by upper strings and brass instrumentalists. Muscle pain was more common in those with an elevated arm position (≥40° elevation of the arm while playing) than in those with a neutral arm position (<40° elevation of the arm while playing).

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ABSTRACT (in Korean)

악기연주자의 측두하악장애 특성

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악기연주와 측두하악장애의 연관성에 관한 여러 연구들이 있어왔으나 앞선 연구들은 대부분 대상자의 주관적 증상을 바탕으로 한 설문을 통한 것이거나 대상자의 수가 적었다. 임상 검사와 방사선 검사를 병행한 연구도 있었으나 비올라나 바이올린, 관악기 등 특정 악기에 한해서만 이루어졌다.

본 연구에서는 다양한 종류의 많은 악기연주자를 대상으로 측두하악장애 설문지 조사, 임상 검사 및 방사선 검사를 시행하여 측두하악장애와 관련된 주관적 증상과 임상적 진단들을 평가하고, 이를 토대로 악기연주자의 측두하악장애 특성에 관하여 알아보았다.

841 명의 악기연주자에게 측두하악장애 관련 설문지 조사를 한 후 교정이나 턱의 외상 경험이 있는 경우 또는 설문에 불완전한 대답을 한 경우를 제외하여 총 739 명이 연구에 포함되었다. 739 명 중 하나 이상의 측두하악장애 증상을 보고한 연주자 중에서 임상 검사 및 방사선 검사를 원하는 71 명의 자원자를 내원시켜 1 명의 구강안면통증 전문의에 의해 최종 진단을 내렸다. 또한 주관적 증상과 임상적 진단에 영향을 주는 여러 요인들에 따른 특성을 살펴보았다.

이 연구를 통해 다음과 같은 결과를 알 수 있었다.

1. 악기연주자 739 명 중 76.6% 에서 하나 이상의 측두하악장애 증상을 보고하였다.
2. 악기연주자의 가장 흔한 주관적 증상은 턱관절음이었다.
3. 여성연주자는 남성연주자보다 턱관절음, 턱관절의 통증, 근육의 통증, 긴장성 두통이 의심되는 증상, 편두통이 의심되는 증상이 더 빈번했다.
4. 턱관절음은 20 대 연주자에서, 근육의 통증, 긴장성 두통이 의심되는 증상은 20 대와 30 대 연주자에서 빈번했다.
5. 턱관절음은 목관과 금관악기 연주자에서, 턱관절의 통증은 upper strings 와 금관악기 연주자에서 빈번했다.
6. 팔을 40° 이상으로 드는 자세로 연주하는 그룹은 40° 미만 그룹보다 근육의 통증을 더 많이 보고하였다.
7. 구강 부기능적 습관을 가진 연주자는 습관이 없는 연주자에 비해 턱관절의 통증과 편두통이 의심되는 증상을 더 많이 보고하였다.

8. 악기연주자의 가장 흔한 임상적 진단은 근육통 또는 근막동통이었다.

9. 악기를 연주한 경험이 14 년 이상 되는 그룹은 14 년 미만 그룹보다 정복성 관절원판변위는 더 빈번한 반면, 턱관절통은 더 줄어들었다.

10. 하루연습시간이 3.5 시간 이상인 연주자는 3.5 시간 미만인 연주자보다 근육통 또는 근막동통이 더 빈번하게 나타났다.

핵심되는 말 : 악기연주자, 측두하악장애