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ARTICLE *in* INTERNATIONAL ARCHIVES OF OCCUPATIONAL AND ENVIRONMENTAL HEALTH · DECEMBER 2013

Impact Factor: 2.2 · DOI: 10.1007/s00420-013-0923-4 · Source: PubMed

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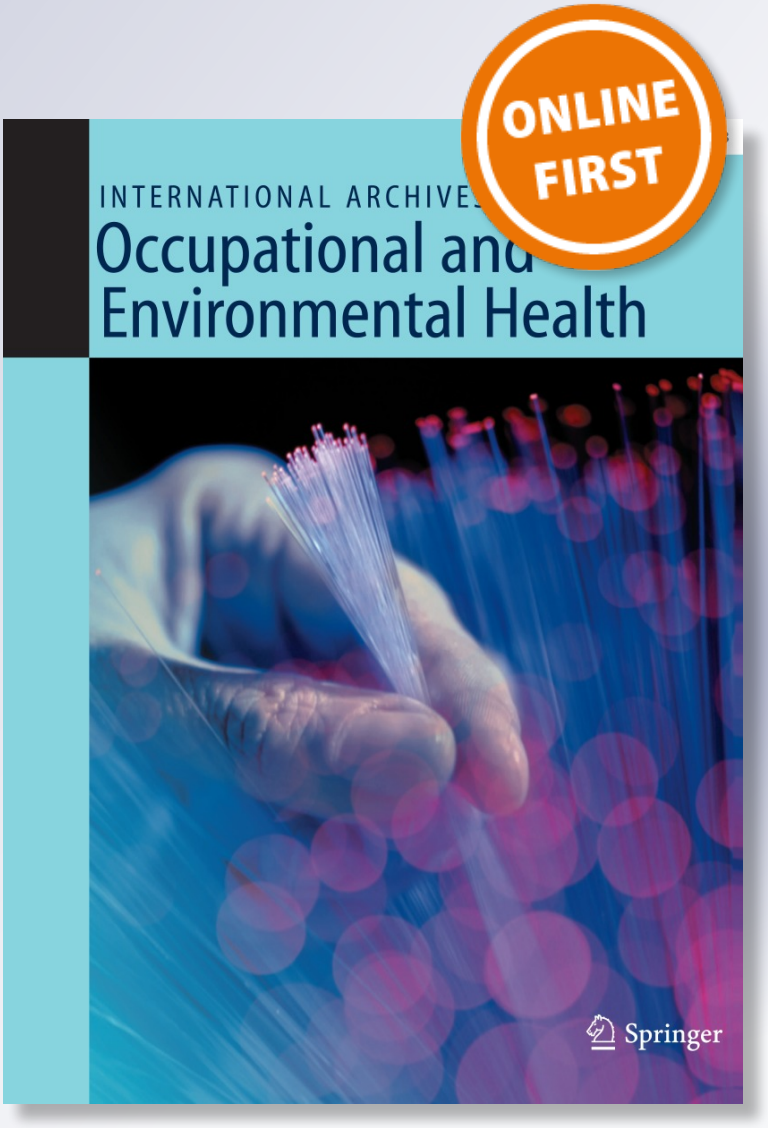
International Archives of Occupational and Environmental Health

ISSN 0340-0131

Int Arch Occup Environ Health
DOI 10.1007/s00420-013-0923-4



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DOI 10.1007/s00420-013-0923-4

ORIGINAL ARTICLE

From embouchure problems to embouchure dystonia? A survey of self-reported embouchure disorders in 585 professional orchestra brass players

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Received: 3 April 2013 / Accepted: 24 November 2013

Abstract
Objectives Data concerning embouchure problems in professional brass players are scarce. Embouchure problems can potentially lead to focal dystonia. The aim of this study was to investigate the frequency of distinct embouchure problems in professional brass players. Furthermore, the frequency of "cramping", a distinct symptom of embouchure dystonia, was evaluated in the context of established embouchure dystonia risk factors.
Methods Five hundred and eighty-five professional brass players participated in a cross-sectional study concerning embouchure problems. A self-administered questionnaire was developed to evaluate embouchure fatigue, embouchure disorders and their consequences. To study the association between risk factors and cramping (a symptom of embouchure dystonia), a log-binomial regression analysis was conducted, enabling estimation of prevalence ratios (PR) and 95 % confidence intervals (95 % CI).
Results Thirty percent (95 % CI 25.9–33.3) reported embouchure fatigue. The relative frequency of embouchure disorders was 59 % (95 % CI 54.6–63.6), with 26 % (95 % CI 22.4–29.5) reporting embouchure cramping. Embouchure disorders resulted in sick leave in 16 % (95 % CI 12.7–20.6). Female brass players (PR 2.0, 95 % CI 0.98–3.98) and musicians with a prior change in their embouchure (PR 2.4, 95 % CI 1.38–4.05) or breathing technique (PR 2.2, 95 % CI 1.25–3.72) and musicians with embouchure fatigue (PR 1.9, 95 % CI 1.18–2.93) presented more frequently with embouchure cramping than musicians with other or without risk factors.
Conclusion This study shows a high relative frequency of embouchure problems in professional brass players. Given that embouchure dystonia is often preceded by embouchure problems, these findings may assist in gaining further insight into the characteristics of embouchure dystonia and the development of preventive strategies.

Keywords Embouchure disorders · Embouchure dystonia · Embouchure fatigue · Embouchure problems · Brass players · Musculoskeletal disorders

Electronic supplementary material The online version of this article (doi:10.1007/s00420-013-0923-4) contains supplementary material, which is available to authorized users.

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Published online: 12 December 2013

Background

Professional musicians are at high risk of developing occupational disorders, with up to 86 % reporting the occurrence of playing-related musculoskeletal disorders (Fishbein et al. 1988; Leaver et al. 2011; Lockwood 1989; Middlestadt and Fishbein 1988). The prevalence of musculoskeletal disorders differs according to instrument type. Among 739 brass players, 61 % reported musculoskeletal complaints (Chesky et al. 2002). Of these, the highest proportion of musculoskeletal disorders was reported among trombone players (70 %), followed by French horn and low brass (both 62 %) and trumpet players (53 %). Problems in the orofacial region are also frequently present in musicians, especially in wind players (Rodriguez-Lozano et al. 2011; Sayegh Ghoussoub et al. 2008). Commonly reported problems include temporomandibular joint (TMJ) disorders and problems with the perioral musculature (Rodriguez-Lozano et al. 2011).

Apart from musculoskeletal disorders in the upper extremities, orofacial region or the spine, embouchure problems in the wind section demand special attention. Brass players rely upon their embouchure, and problems involving this highly trained but fragile system may jeopardize their professional career. Chesky et al. (2002) reported on handicaps related to the embouchure system in brass players, including loss of lip control (17 %), mouth lesions (18 %), TMJ syndrome (13 %) and acquired dental malocclusion (11 %). Furthermore, it has been reported that focal dystonia may account for a serious loss of embouchure control in 2 % of wind players (Baur et al. 2011).

Focal dystonia is a task-specific movement disorder, which in musicians typically involves movement control of the fingers, hand and arm with a prevalence of approximately 1–2 % in professional musicians (Altenmuller 2003; Baur et al. 2011). The probability of developing focal dystonia depends among other factors on the type of instrument. Guitar players, pianists and brass players were reported to be at a particularly high risk of developing focal dystonia (Altenmuller and Jabusch 2010a, b). Embouchure dystonia is among the most common dystonias in musicians and may alter the coordination of the lips, tongue, lower face, jaw and breathing in brass and woodwind players (Altenmuller and Jabusch 2010a; Frucht 2009a).

Both focal hand dystonia and embouchure dystonia are associated with plastic maladaptive changes in sensorimotor networks (for a review see Munte et al. (2002) and Rosset i Llobet and Fàbregas i Molas (2010). In focal hand dystonia, fusion of digital representations has been detected in the somatosensory cortex (Elbert et al. 1998). Embouchure dystonia may be associated with sensorimotor overactivity of somatotopic face representations (Haslinger et al. 2010). Additionally, altered lip representation has been found in embouchure dystonia, underscoring abnormal somatosensory processing (Hirata et al. 2004).

Major treatment strategies comprise, e.g., anticholinergic medication, botulinum toxin injections (not in the case of embouchure dystonia) and retraining strategies (Candia et al. 1999, 2002; Frucht 2009b; Jabusch and Altenmueller 2006). Nevertheless, the majority of patients will not fully recover from embouchure dystonia (Jabusch et al. 2005).

Overuse and pain have been identified as potential triggers for focal dystonia (Altenmuller 2003; Jankovic and Shale 1989; Lederman 1991). Further risk factors for embouchure dystonia are gender, late start of instrument playing as well as age, change in mouthpiece or playing technique, breathing techniques and hereditary disposition (Altenmuller and Jabusch 2010a, b; Rossett i Llobet and Fàbregas i Molas 2010; Schmidt et al. 2006). Additionally, up to 62 % of patients with embouchure dystonia report embouchure problems and playing-related crises with deterioration of sound quality and precision of attack mechanics in special embouchure techniques (Frucht 2009a). However, there is limited knowledge of embouchure problems including embouchure dystonia in professional musicians.

The underlying hypothesis of this study was that embouchure problems in brass players belong to a continuum ranging from negligible to severe intensity and with different prognoses. Furthermore, embouchure problems might eventually result in focal (embouchure) dystonia. Thus, the aim of this study was to assess the nature and frequency of embouchure problems in professional brass players as well as differences among brass players with and without embouchure problems. In addition, we studied the association between different signs of embouchure dystonia (embouchure cramping in general as well as cramping of lips, tongue, larynx and breathing) and potential predictors.

Methods

In a cross-sectional study, professional brass players playing in classical orchestras were asked to complete a self-administered questionnaire investigating embouchure problems. Based on data from the National Orchestra Association, a total of 127 professional orchestras in Germany were identified and the questionnaires were sent to the brass sections (trumpet, horn, trombone and tuba) and recollected within a 6–8-week period (May to June 2007).

Alongside the questionnaire, the musicians received information ensuring that all data were collected anonymously and confidentially. Researchers received questionnaires without any personal data, enabling the identification of musicians (no names or orchestra affiliation). The number of brass musicians was estimated on the basis of currently available information on the number of brass positions and

number of females employed to play these instruments. The number of brass musicians at the time of the study was approximately 1817 (1,678 males and 139 females).

Participants

The response rate was 32.2 % (31.3 % of male and 43.3 % of female brass players). Five hundred and eighty-five brass players (525 males/60 females) participated in the study (154 trumpet players, 218 horn players, 175 trombone players and 36 tuba players). Two participants were employed to play both the tuba and the trombone. The majority of participating brass players was male (90.0 %), and their mean age was 42.0 years. Further demographic features are presented in Table 1.

Questionnaire

The questionnaire was developed in collaboration with a member of the National Orchestra Association, a trombone player with expertise in embouchure problems. As well as demographic information, the questionnaire asked for details concerning workload and practicing time. Concerning practicing habits, details of warming-up routines were gathered. Furthermore, identified risk factors for embouchure dystonia (gender, late onset of instrument playing as well as age, overuse, change in embouchure or breathing technique) were addressed in the questionnaire. As fatigue might be an early sign of both overuse and embouchure dystonia, information on symptoms of fatigued embouchure including musculoskeletal symptoms in the temporomandibular and shoulder–neck regions was requested, as well as information about cramping (a distinct symptom of embouchure dystonia).

Focusing on embouchure, the questionnaire therefore addressed two different symptom complexes: (a) symptoms of embouchure fatigue and (b) other embouchure disorders. Both symptom complexes are included within the umbrella term embouchure problems herein. The expression "embouchure fatigue" describes a condition primarily of tiredness of the musculoskeletal structures involved in producing the embouchure, as known to all wind players. Typical symptoms of this condition apart from muscle fatigue are further signs reflecting the strain of the instrument on the embouchure system, such as lip pain, exaggerated mouthpiece pressure, local erythema ("mouthpiece imprint"), soreness of the lip membranes due to dental pressure, tooth pain, pain or pressure in or around the larynx and pain in the jaw joint. Additionally, information on fatigue or tension in the shoulder, neck or dorsal region of the head was requested, although this reflects more general strain not limited to the embouchure system. An often-used general expression for this symptom complex is "overuse". Brass players were asked whether they frequently experience embouchure fatigue and which symptoms they experience.

Secondly, brass players were asked about further embouchure problems. This section of the questionnaire examined difficulties encountered when performing several embouchure techniques or skills. These embouchure problems usually result in impairments in performance quality, and we therefore describe them hereafter as embouchure disorders. A specific area of interest concerned the range of the instrument register, i.e., whether malfunction was confined to the high or the low pitch range or whether transitions

Table 1 Characteristics of 585 professional brass musicians

	Brass	Trumpet	Horn	Trombone	Tuba
Number of subjects	585	154	218	175	36
Gender, m/f	525/60	145/9	172/45[a]	170/5	35/1
Age in years, mean (SD)	42.0 (9.6)	41.5 (9.4)	43.0 (9.9)	41.6 (9.8)	39.8 (7.0)
Years of orchestra playing, mean (SD)	18.5 (10.1)	18.4 (9.9)	19.4 (10.2)	17.7 (10.1)	16.5 (9.4)
Start of instrument playing at age, mean (SD)	9.2 (3.0)	8.7 (2.6)	9.1 (2.8)	9.7 (3.3)	9.8 (3.4)
Decision to become a professional musician at age, mean (SD)	15.8 (3.4)	15.0 (3.3)	16.2 (3.7)	16.1 (3.2)	16.2 (2.3)
Study length at conservatory in years, mean (SD)	4.9 (1.9)	5.0 (2.1)	5.0 (1.9)	4.6 (1.8)	4.5 (2.0)
Total sick leave of 585 brass players n/ % (95 % CI)	57/9.7 (7.3–12.1)	19/12.3 (7.1–17.5)	20/9.2 (5.3–13.0)	15/8.6 (4.4–12.7)	3/8.3 (0.7–17.4)
Sick leave of 342 brass players with embouchure disorders n/ % (95 % CI)	57/16.3 (12.7–20.6)	19/19.2 (11.4–26.9)	20/14.2 (8.4–19.9)	15/16.7 (9.0–24.4)	3/25.0 (0.5–49.5)
Persistence of crisis in brass players with embouchure disorders n/ % (95 % CI)	64/18.7 (14.6–22.8)	15/15.2 (8.1–22.2)	30/21.3 (14.5–28.0)	16/17.8 (9.9–25.7)	3/25.0 (0.5–49.5)
Crisis mastered (of brass players with embouchure disorders) n/ % (95 % CI)	230/67.3 (62.3–72.2)	64/64.7 (55.2–74.1)	80/56.7 (48.6–64.9)	65/72.2 (63.0–81.5)	7/58.3 (30.4–86.2)
Duration of crisis in month, mean (SD)	41.3 (62.6)	45.4 (65.2)	37.0 (61.2)	36.9 (48.7)	64.5 (97.1)

[a] One horn player did not provide information on his/her gender. The results of the 2 musicians playing trombone and tuba are not displayed in the table

from low to high or vice versa were involved. Additionally, problems concerning holding long notes ("shaking"), tone quality ("it doesn't sound good any more") or the beginning of notes ("attack blockage") as well as problems with accuracy ("cracked notes"), breaking off of held notes, the attack in tongued passages and coordination problems of the individual playing processes were addressed.

Information about potential signs of embouchure dystonia, cramping of different areas of the embouchure (lip area, the tongue, the larynx or breathing) was also obtained.

Finally, participants were asked to summarize the possible reasons for and their reaction to their embouchure disorders, including, if present, the duration of the embouchure crisis. Furthermore, musicians were asked whether the embouchure disorder had ever resulted in sick leave.

The questionnaire is displayed in the online supplement (Table A).

Ethics

The study was conducted in accordance with the guidelines of the Declaration of Helsinki, and all participants gave consent.

Data management and analysis

Analyses were conducted using SAS® (SAS Inc., Cary, NC, USA) version 9.3. Ninety-five percent confidence intervals (95 % CI) for relative frequencies (prevalences) were estimated based on the binomial distribution and the use of the normal approximation. If the product of the sample size (n) and relative frequency (p) or $n^*(1 - p)$ was below 5, we estimated exact 95 % confidence intervals. For the comparison of prevalence between groups, log-binomial regression was used. This model provides estimated prevalence ratios (PR) and 95 % confidence intervals (95 % CI). To evaluate the association between potential predictors (gender, age at start of instrument playing, age, prior changes in embouchure technique, prior changes in breathing techniques and embouchure fatigue) and embouchure dystonia, we first used univariate log-binomial regression. Thereafter, we included all potential predictors in a multivariate log-binomial regression model to estimate the mutually adjusted effect of predictors on embouchure dystonia.

Results

Symptoms of fatigued embouchure

Thirty percent of brass players frequently experienced embouchure fatigue; trumpet and horn players were affected more often (34.4 and 33.5 %) than trombone and tuba players (25.1 and 8.1 %). Embouchure muscle fatigue and tension in the shoulder, head and neck region were reported most frequently (51.8 and 47.0 %), followed by local erythema/mouthpiece imprint as well as lip pain (29.2 and 23.9 %). Soreness of the lip mucosa due to dental pressure and problems with the teeth, larynx and jaw joint occurred in <10 % of brass players (see Table 2 for summary of all embouchure fatigue symptoms and distribution between instruments).

Frequency of embouchure disorders

A total of 58.6 % of all brass players suffered from embouchure disorders at the moment of the study, and again, trumpet and horn players were affected more frequently (64.3 and 64.7 %) than trombone and tuba players (51.4 and 33.3 %). Overall, 9.7 % of the participating 585 brass players were on sick leave due to embouchure disorders at some stage during their embouchure crisis (9.1 % of male and 15 % of female participants). In the group of brass players indicating embouchure disorders, the sick leave rate was 16.6 %. In 18.7 % of musicians, the embouchure crisis was current, whereas 67.3 % claimed to have recovered from an embouchure crisis in the past. The average length of the embouchure crisis was 41.3 months.

The most frequently reported signs of embouchure disorders were attack blockages at the start of notes (29.6 %), problems within the high tone register (29.4 %) and problems with accuracy resulting in "cracked notes" (28.9 %). Cramping, a potential symptom of focal dystonia, was present in 26 % of brass players, with horn and trumpet players being the most frequently affected, at 30.3 % and 28.6 %, respectively (followed by 21.1 % of trombone and 13.9 % of tuba players). Cramping was reported most frequently in the lips (13 %). Twenty-five percent of brass players experienced problems with tone quality ("it doesn't sound good any more") and 23.9 % with "shaking" while holding long notes. Table 3 presents all signs of embouchure disorders and their distribution between instruments.

Prior to any current embouchure disorders, 15.7 % had changed their embouchure technique and 19 % had changed their breathing technique (see Supplementary Table C). Further data on practice habits and workload, the reaction of musicians to embouchure disorders and group differences in relation to embouchure disorders are presented in the online supplement (Tables B, C and D).

Estimated adjusted prevalence ratios for risk factors of embouchure dystonia

A log-binomial regression analysis of the established risk factors for focal embouchure dystonia (gender, age of starting instrument, age, prior changes in embouchure technique, prior changes in breathing technique, embouchure fatigue)

Table 2 Relative frequency of symptoms of embouchure fatigue

Embouchure fatigue	All instruments n/ % (95 % CI)	Trumpet n/ % (95 % CI)	Horn n/ % (95 % CI)	Trombone n/ % (95 % CI)	Tuba n/ % (95 % CI)
Frequently fatigued embouchure	173/29.6 (25.9–33.3)	53/34.4 (26.9–41.9)	73/33.5 (27.2–39.8)	44/25.1 (18.7–31.6)	3/8.3 (1.8–22.5)
Muscle fatigue	303/51.8 (47.7–55.8)	82/53.2 (45.4–61.1)	123/56.4 (49.8–63.0)	87/49.7 (42.3–57.1)	10/27.8 (13.1–42.4)
Lip pain	140/23.9 (20.5–27.4)	44/28.6 (21.4–35.7)	49/22.5 (16.9–28.0)	45/25.7 (19.2–32.2)	2/5.6 (1.8–22.5)
Local erythema/mouthpiece imprint	171/29.2 (25.5–32.9)	53/34.4 (26.9–41.9)	66/30.3 (24.2–36.4)	46/26.3 (19.8–32.8)	6/16.7 (4.5–28.8)
Soreness lip mucosa due to dental pressure	56/9.6 (7.2–12.0)	18/11.7 (6.6–16.8)	27/12.4 (8.0–16.8)	10/5.7 (2.3–9.2)	1/2.8 (0.7–18.7)
Tooth pain	36/6.2 (4.2–8.1)	8/5.2 (1.7–8.7)	17/7.8 (4.2–11.4)	10/5.7 (2.3–9.2)	1/2.8 (0.7–18.7)
Pain/pressure larynx	31/5.3 (3.5–7.1)	10/6.5 (2.6–10.4)	12/5.5 (2.5–8.5)	6/3.4 (0.7–6.1)	3/8.3 (1.8–22.5)
Pain jaw joint	27/4.6 (2.9–6.3)	5/3.2 (0.4–6.0)	11/5.0 (2.1–8.0)	8/4.6 (1.5–7.7)	3/8.3 (1.8–22.5)
Tension shoulder/neck/head	275/47.0 (43.0–51.1)	65/42.2 (34.4–50.0)	117/53.7 (47.1–60.3)	81/46.3 (38.9–53.7)	12/33.3 (17.9–48.7)
Other[a]	78/13.3 (10.6–16.1)	23/14.9 (9.3–20.6)	30/13.8 (9.2–18.3)	20/11.4 (6.7–16.1)	5/13.9 (2.6–25.2)

Questions concerning the occurrence of the different symptoms of embouchure fatigue were open to all brass musicians whether they experience embouchure fatigue frequently or occasionally. The results of the 2 musicians playing trombone and tuba are not displayed in the table

[a] Brass players had the chance of indicating further symptoms they experience in embouchure fatigue (e.g., swollen lips, hoarseness, swollen palate)

focusing on the embouchure disorders "cramping", "lip cramping", "tongue cramping", "larynx cramping" and "cramping of breathing" (embouchure dystonia is primarily described by musicians and experts using these expressions) was performed. The results showed that females had a 98 % (PR 1.98) higher frequency of embouchure "cramping", along with musicians with prior changes in embouchure (PR 2.37) or breathing technique (PR 2.16) and musicians reporting embouchure fatigue (PR 1.86). The age and age at which they started playing the instrument had less of an effect (PR 1.13 and 1.24, respectively). Analysis of the different areas of cramping revealed an even higher PR of 2.11 for females and a PR of 1.61 for the age at start of instrument playing for the outcome "larynx cramping". Prior changes in embouchure technique were associated with a threefold higher frequency of "larynx cramping" (PR 3.28) and "tongue cramping" (PR 2.92). Prior changes in breathing technique were associated with a threefold higher frequency of "cramping of breathing" (PR 3.15), whereas there was no association with prior changes in embouchure technique (PR 0.77). Finally, brass players reporting embouchure fatigue had a twofold higher frequency of "tongue cramping" (PR 1.98) and "lip cramping" (PR 1.93).

A log-binomial regression analysis of the same predictors and the outcome "embouchure disorders" showed no association. Table 4 shows the prevalence ratios of the logistic analysis for the outcome "cramping". Tables for the outcomes "lip cramping", "tongue cramping", "larynx cramping" and "cramping of breath" are presented in the online supplement (Tables E–G).

Analysis of gender differences

Female brass players (9 trumpet, 45 horn, 5 trombone, 1 tuba) were younger (37.7 vs. 42.4 years), had played for a shorter time in the orchestra (14.0 vs. 18.9 years) and had decided to become a professional musician later (at 16.7 vs. 15.8 years) than male brass players. Females also reported a higher number of embouchure fatigue symptoms (2.6 vs. 1.8). The duration of the embouchure crisis was nevertheless distinctly shorter than in male brass players (29.1 vs. 44.2 months). No differences were seen in warming-up characteristics.

Thirty percent of female brass players (and 29.6 % of male brass players) frequently experienced embouchure fatigue. With the exception of lip pain, all specific fatigue symptoms were reported with a higher frequency in female brass players (see Table 5).

Additionally, female brass players reported embouchure disorders more frequently than male brass players (65 vs. 57.8 %). The majority of embouchure disorders were experienced more frequently among female than male brass players (see Table 5).

Prior changes in embouchure techniques were reported by 10.3 % of female brass players (vs. 16.5 % of males) and prior changes in breathing technique by 2.5 % of female brass players (vs. 21.1 % of males). Fifteen percent of female vs. 9.1 % of male players somewhere in their career reported taking sick leave due to embouchure disorders, 20.5 vs. 13.8 % of males reported persistence of the crisis, and 61.5 vs. 70 % of male players stated that the embouchure crisis was over.

Discussion

Data regarding embouchure problems in musicians are scarce. In the present study, data were collected from 585 professional brass players with special emphasis on embouchure disorders. Overall, approximately 60 % of

Table 3 Relative frequency of embouchure disorders

Embouchure disorders	All instruments n/ % (95 % CI)	Trumpet n/ % (95 % CI)	Horn n/ % (95 % CI)	Trombone n/ % (95 % CI)	Tuba n/ % (95 % CI)
Embouchure disorders (total)	343/58.6 (54.6–62.6)	99/64.3 (56.7–71.9)	141/64.7 (58.3–71.0)	90/51.4 (44.0–58.8)	12/33.3 (17.9–48.7)
High range	172/29.4 (25.7–33.1)	73/47.4 (39.5–55.3)	65/29.8 (23.7–35.9)	30/17.1 (11.6–22.7)	3/8.3 (1.8–22.5)
Low range	92/15.7 (12.8–18.7)	26/16.9 (11.0–22.8)	37/17.0 (12.0–22.0)	23/13.1 (8.1–18.1)	6/16.7 (4.5–28.8)
Flexibility	40/6.7 (4.8–8.9)	10/6.5 (2.6–10.4)	17/7.8 (4.2–11.4)	11/6.3 (2.7–9.9)	1/2.8 (0.7–18.7)
Low to high	55/9.4 (7.0–11.8)	14/9.1 (4.6–13.6)	31/14.2 (9.6–18.9)	10/5.7 (0.1–9.7)	0
High to low	43/7.4 (5.2–9.5)	10/6.5 (2.6–10.4)	17/7.8 (4.2–11.4)	14/8.0 (4.0–12.0)	2/5.6 (1.8–22.5)
Both directions	84/14.4 (11.5–17.2)	29/18.8 (12.7–25.0)	29/13.3 (8.8–17.8)	21/12.0 (7.2–16.8)	4/11.1 (3.1–26.1)
Holding long notes (“shaking”)	140/23.9 (20.5–27.4)	38/24.7 (17.9–31.5)	56/25.7 (19.9–31.5)	39/22.3 (16.1–28.5)	7/19.4 (6.5–32.4)
Tone quality	147/25.1 (21.6–28.6)	49/31.8 (24.5–39.2)	56/25.7 (19.9–31.5)	39/22.3 (16.1–28.5)	3/8.3 (1.8–22.5)
Beginning of notes (attack “blockage”)	173/29.6 (25.9–33.3)	51/33.1 (25.7–40.6)	80/36.7 (30.3–43.1)	37/21.1 (15.1–27.2)	5/13.9 (2.6–25.2)
Accuracy (cracked notes)	169/28.9 (25.2–32.6)	56/36.4 (28.8–44.0)	65/29.8 (23.7–35.9)	42/24.0 (17.7–30.3)	6/16.7 (4.5–28.8)
Breaking off long notes	88/15.0 (12.1–17.9)	31/20.1 (13.8–26.5)	37/17.0 (12.0–22.0)	19/10.9 (6.2–15.5)	1/2.8 (0.7–18.7)
Attack in tongued passages	83/14.2 (11.4–17.0)	28/18.2 (12.1–24.3)	31/14.2 (9.6–18.9)	21/12.0 (7.2–16.8)	3/8.3 (1.8–22.5)
Cramping	152/26.0 (22.4–29.5)	44/28.6 (21.4–35.7)	66/30.3 (24.2–36.4)	37/21.1 (15.1–27.2)	5/13.9 (2.6–25.2)
Lip cramping	76/13.0 (10.3–15.7)	23/14.9 (9.3–20.6)	31/14.2 (9.6–18.9)	21/12.0 (7.2–16.8)	1/2.8 (0.7–18.7)
Tongue cramping	51/8.7 (6.4–11.0)	11/7.1 (3.1–11.2)	27/12.4 (8.0–16.8)	11/6.3 (2.7–9.9)	2/5.6 (1.8–22.5)
Larynx cramping	40/6.8 (4.8–8.9)	12/7.8 (3.6–12.0)	15/6.9 (3.5–10.2)	11/6.3 (2.7–9.9)	2/5.6 (1.8–22.5)
Cramping of breathing	61/10.4 (8.0–12.9)	15/9.7 (5.1–14.4)	29/13.3 (8.8–17.8)	14/8.0 (4.0–12.0)	3/8.3 (1.8–22.5)
Coordination	69/11.8 (9.2–14.4)	17/11.0 (6.1–16.0)	24/11.0 (6.9–15.2)	26/14.9 (9.6–20.1)	2/5.6 (1.8–22.5)
Other[a]	32/5.5 (3.6—7.3)	11/7.1 (3.1–11.2)	11/5.0 (2.1–8.0)	8/4.6 (1.5–7.7)	1/2.8 (0.7–18.7)

[a] Brass players had the chance of indicating further symptoms of embouchure disorders they experience (e.g., failing notes, pin and needles in the lip). The results of the 2 musicians playing trombone and tuba are not displayed in the table

Table 4 Log-binomial regression analysis for embouchure dystonia risk factors and the outcome "cramping" in general

Analysis	Exposure	Prevalence ratio	95 % confidence interval
Univariate	Gender (ref.: males)	1.32	0.90–1.95
	Age (increment: 5 years)	1.09	1.02–1.17
	Start of instrument playing at age (increment: 2 years)	1.10	1.01–1.19
	Prior changes in embouchure technique	2.42	1.82–3.22
	Prior changes in breathing technique	2.13	1.59–2.86
	Embouchure fatigue	1.78	1.36–2.33
Multivariate adjusted[a]	Gender (ref.: males)	1.98	0.98–3.98
	Start of instrument playing at age (increment: 2 years)	1.24	0.83–1.86
	Age (increment: 5 years)	1.13	1.00–1.27
	Prior changes in embouchure technique	2.37	1.38–4.05
	Prior changes in breathing technique	2.16	1.25–3.72
	Embouchure fatigue	1.86	1.18–2.93

[a] Adjusted for gender, start of instrument playing, age, prior changes in embouchure technique, prior changes in breathing technique, embouchure fatigue

brass players reported embouchure disorders. Within instrument groups, those playing high-register instruments such as horn and trumpet were affected most often (64.7 and 64.3 %). Additionally, 29.9 % of musicians reported frequently experiencing symptoms of fatigued embouchure. Again, trumpet and horn players were affected most frequently (34.4 and 33.5 %). In terms of the consequences of embouchure disorders, 9.7 % of all brass players and 16.3 % of those reporting embouchure disorders at the moment of the study stated that they were incapable of performing at a certain stage in their embouchure crisis. Nineteen percent of the musicians reported persistence of the embouchure crisis, whereas 67.3 % claimed to have mastered the crisis. The average duration of embouchure crisis was 41.3 months.

Female brass players were 1.98 times more likely to experience cramping than their male colleagues. Furthermore, female brass players experienced the majority of embouchure disorders more frequently than their male colleagues. Brass players with prior changes in embouchure or breathing techniques experienced an up to threefold higher frequency of cramping. Embouchure fatigue was associated with an up to twofold higher frequency of cramping.

Medical problems in 739 brass instrumentalists were investigated by Chesky et al. (2002), including problems within the embouchure system such as loss of lip control, mouth lesions, TMJ syndrome and acquired dental malocclusion. Notwithstanding, embouchure problems were not the main focus of their study.

Our data are consistent with the findings of Chesky et al. (2002), demonstrating higher rates of musculoskeletal complaints in horn and trumpet players compared to trombone and tuba players. Additionally, their study evaluated some of the typical problems encountered within the embouchure region, especially the loss of lip control. Again, loss of lip control was most frequently found in trumpet (23.9 %) and horn players (18 %), underscoring our findings of a higher susceptibility to embouchure problems in these instrument groups. Overall, Chesky et al. reported loss of lip control in 16.8 % of brass players. In comparison, embouchure cramping was reported by 26 % of brass players participating in the present study.

In the present investigation, it became apparent that embouchure problems may comprise a complex variety of disorders. Therefore, by focusing solely on loss of lip coordination or cramping, one might miss various additional embouchure disorders that might be described by musicians. Collecting information on a wide range of embouchure problems is essential, given that the phenomenon of embouchure dystonia is frequently preceded by disturbances in embouchure mechanics (Frucht 2009a). In the largest study investigating embouchure dystonia to date, Frucht (2009a) examined 89 brass and woodwind players with embouchure dystonia. Eleven percent of those patients with embouchure dystonia reported a prior history of problems with their embouchure mechanics. Loss of embouchure control, clarity of articulation and involuntary movements of the lips, jaw or tongue while playing the instrument were reported as initial symptoms. Typically, symptoms of embouchure dystonia started in a specific pitch range (69 %) and spread into neighboring registers over time. Frucht described six different phenotypes of embouchure dystonia which became manifest as embouchure tremor, lip-pulling, lip-lock, jaw and tongue dystonia or Meige syndrome (involuntary dystonic movements of the upper and lower face) (Frucht 2009a). The present data from 585 professional brass players reveal distinct impairments in the embouchure system. These could in part be

Table 5 Gender differences of embouchure fatigue and embouchure disorder symptoms

	Female	Male
Age/years (SD)	37.7 (8.1)	42.4 (9.7)
Years of orchestra playing (SD)	14.0 (8.5)	18.9 (10.1)
Decision to become a professional musician at age (SD)	16.7 (3.0)	15.8 (3.4)
Duration of embouchure crisis in month (SD)	29.1 (25.8)	44.2 (65.3)
	Female n/ % (95 % CI)	Male n/ % (95 % CI)
Sick leave due to embouchure crisis	9/15.0 (6.0–24.0)	48/9.1 (6.7–11.6)
Persistence of embouchure crisis	8/20.5 (7.8–33.2)	42/13.8 (10.0–17.8)
Embouchure crisis over	24/61.5 (46.3–76.8)	212/70.0 (64.8–75.1)
Prior changes in embouchure techniques	4/10.3 (0.7–19.8)	50/16.5 (12.3–20.7)
Prior changes in breathing technique	1/2.5 (2.4–7.5)	64/21.1 (16.5–25.7)
Embouchure fatigue	18/30.0 (18.4–41.6)	155/29.6 (25.7–33.5)
Muscle fatigue	40/66.7 (54.7–78.6)	263/50.2 (45.9–54.5)
Tension shoulder/neck/head	39/65.0 (52.9–77.1)	236/45.0 (40.8–49.3)
Local erythema/mouthpiece imprint	24/40.0 (27.6–52.4)	147/28.1 (24.2–31.9)
Lip pain	11/18.3 (8.5–28.1)	129/24.6 (20.9–28.3)
Soreness lip mucosa due to dental pressure	10/16.7 (7.2–26.1)	46/8.8 (6.4–11.2)
Tooth pain	8/13.3 (4.7–21.9)	28/5.3 (3.4–7.3)
Pain/pressure larynx	6/10.0 (2.4–17.6)	25/4.8 (2.9–6.6)
Pain jaw joint	4/6.7 (2.7–18.4)	23/4.4 (2.6—6.1)
Embouchure disorder	39/65.0 (52.9–77.1)	303/57.8 (53.6–62.1)
Beginning of notes (“attack blockage”)	26/43.3 (30.8—55.9)	147/28.1 (24.2–31.9)
High range	24/40.0 (27.6–52.4)	148/28.2 (24.4–32.1)
Accuracy (“cracked notes”)	14/23.3 (12.6–34.0)	155/29.4 (25.7–33.5)
Cramping	20/33.3 (21.4–45.3)	132/25.2 (21.5–28.9)
Lip cramping	11/18.3 (8.5–28.1)	65/12.4 (9.6–15.2)
Tongue cramping	7/11.7 (3.5–19.8)	44/8.4 (6.0–10.8)
Larynx cramping	6/10.0 (2.4–17.6)	34/6.5 (4.4–8.6)
Cramping of breathing	5/8.3 (1.3–15.3)	56/10.7 (8.0–13.3)
Tone quality (“it doesn’t sound good any more”)	16/26.7 (15.5–37.9)	131/25.0 (21.3–28.7)
Holding long notes (“shaking”)	16/26.7 (15.5–37.9)	124/23.7 (20.0–27.3)
Low range	12/20.0 (9.9–30.1)	80/15.3 (12.2–18.3)
Breaking off of held notes	11/18.3 (8.5–28.1)	77/14.7 (11.7–17.7)
Both directions of transition	10/16.7 (7.2–26.1)	73/13.9 (11.0-16.9)
Attack in tongued passages	14/23.3 (12.6—34.0)	69/13.2 (10.3–16.1)
Coordination of the individual playing processes	10/16.7 (7.2–26.1)	59/11.3 (8.6–14.0)
Transition from low to high	8/13.3 (4.7–21.9)	47/9.0 (6.5–11.4)
Transition from high to low	2/3.3 (0.4–11.5)	41/7.8 (5.5-10.1)
Flexibility	7/11.7 (3.5–19.8)	32/6.1 (4.1–8.2)

considered as early symptoms or signs of embouchure dystonia: attack blockages, problems in the high register, difficulties with accuracy, tone quality, shaking while holding long notes and flexibility or specific playing techniques (attack in tongued passages). In contrast, signs of cramping (lip, tongue, larynx, breathing) may suggest the presence of embouchure dystonia in up to 26 % of players.

The finding of a female preponderance of cramping contrasts with the higher prevalence of focal dystonia in males (male/female ratio 4:1) (Altenmuller and Jabusch 2010b). Furthermore, latest findings indicate a worse treatment outcome for females as compared with males suffering from embouchure dystonia (Lee A, Eich C, Jabusch HC, Altenmüller E. Long term outcome in musicians’ dystonia. A follow-up study in 360 musicians. Manuscript in preparation). These results are consistent with our finding that a higher percentage of female brass players have been on sick leave because of embouchure disorders (15 %

females vs. 9.1 % males). However, nonresponse might be an alternative explanation of our findings.

Additionally, musicians with prior changes in embouchure or breathing techniques were 2.11 and 1.69 times more likely to experience cramping of the lips and even up to three times more likely to develop cramping of the tongue or breathing. Furthermore, embouchure fatigue was associated with an up to twofold higher frequency of cramping of the lips and tongue. Interestingly, extrinsic factors such as workload (practicing time and length of orchestra service) or time and character of warming-up routines did not differ between musicians with and without embouchure disorders. Nevertheless, musicians with embouchure disorders were older, had started to play their instrument later and had played longer in the orchestra than those without such problems. This is consistent with recent results showing the later start of instrumental playing and longer cumulative practice time including higher workloads in affected musicians (Schmidt et al. 2013), as well as perfection traits and attitudes, and anxiety (Jabusch et al. 2004).

Musicians reporting embouchure disorders were found to have more frequent symptoms of fatigued embouchure than those without such symptoms. This is of specific relevance considering that local pain frequently (up to 9 %) precedes focal dystonia in general (Jabusch and Altenmueller 2006). In fact, dystonia and chronic pain conditions show similar abnormal cortical processing of sensory function and cortical reorganization (Delmaire et al. 2005). Furthermore, repetitive movements in overtrained monkeys have been reported to induce both pain symptoms and dystonic movements (Byl et al. 1996). Therefore, musicians and therapists should be aware that signs of fatigued embouchure and embouchure disorders might result in focal dystonia, as the association of embouchure fatigue and cramping suggests. Although we cannot define the precise frequency of embouchure dystonia in our sample solely based on a questionnaire, the high frequency of embouchure disorders in brass players requires attention. Those brass players who stated that they were incapable of performing due to embouchure disorders are indeed highly likely to be suffering from embouchure dystonia (9.7 % of the participating brass players). Nevertheless, the majority (67.3 % of musicians reporting embouchure disorders) seem to master their embouchure crisis.

Study limitations

First, although the large number of responses gave a broad picture of the perceived problems, these symptoms were not verified via an actual clinical investigation by a movement disorder specialist. Furthermore, our questionnaire was not validated. Also, risk factors such as affected family members (Schmidt et al. 2006), perfection traits or anxiety (Jabusch et al. 2004) were not addressed in this questionnaire.

Nevertheless, the questionnaire used in the present investigation might help to detect early signs and symptoms of embouchure dystonia. Notwithstanding, further studies are warranted to establish a reliable screening tool for embouchure dystonia.

Second, there is the possibility of selection bias. It is possible that musicians experiencing embouchure problems might have been motivated to return the questionnaire and participate in the study.

Selection bias, the small number of brass-playing females (predominantly playing horn) and the higher response rate of females might also have influenced the somewhat unexpected gender differences. Therefore, further studies should be performed on this topic.

Notwithstanding, it is possible that attempts to optimize the embouchure and breathing technique prior to the embouchure crisis are an early reaction to subtle embouchure problems. Therefore, it is not possible to determine whether changes in embouchure or breathing technique are the cause of or a reaction to embouchure disorders.

Further investigations and follow-up of the responding brass players and clinical investigations are planned.

Conclusion

In summary, this study presents a large and unique data set regarding the embouchure problems of professional brass players. The high frequency of embouchure disorders in brass players has stimulated further research evaluating the characteristics of development and final outcome in a follow-up study. To determine the exact prevalence of embouchure dystonia, a clinical examination would be required and should be included in further study designs.

Given that embouchure dystonia is often preceded by embouchure problems, these findings may assist in gaining further insight into the characteristics of embouchure dystonia and the development of preventive strategies.

Acknowledgments The authors would like to thank Martin Majewski from the National Orchestra Association for his help in the development and distribution of the questionnaire.

Conflict of interest The authors declare that they have no conflict of interest.

References

Altenmuller E (2003) Focal dystonia: advances in brain imaging and understanding of fine motor control in musicians. Hand Clin 19(3):523–538

Altenmuller E, Jabusch HC (2010a) Focal dystonia in musicians: phenomenology, pathophysiology and triggering factors. Eur J Neurol 17(Suppl 1):31–36. doi:10.1111/j.1468-1331.2010.03048.x

Altenmuller E, Jabusch HC (2010b) Focal dystonia in musicians: phenomenology, pathophysiology, triggering factors, and treatment. Med Probl Perform Artist 25(1):3–9

Baur V, Jabusch HC, Altenmuller E (2011) Behavioral factors influence the phenotype of musician's dystonia. Mov Disord Official J Mov Disord Soc 26(9):1780–1781. doi:10.1002/mds.23654

Byl NN, Merzenich MM, Jenkins WM (1996) A primate genesis model of focal dystonia and repetitive strain injury: I. Learning-induced dedifferentiation of the representation of the hand in the primary somatosensory cortex in adult monkeys. Neurology 47(2):508–520

Candia V, Elbert T, Altenmuller E, Rau H, Schafer T, Taub E (1999) Constraint-induced movement therapy for focal hand dystonia in musicians. Lancet 353(9146):42. doi:10.1016/S0140-6736(05)74865-0

Candia V et al (2002) Sensory motor retuning: a behavioral treatment for focal hand dystonia of pianists and guitarists. Arch Phys Med Rehabil 83(10):1342–1348

Chesky K, Devroop K, Ford J (2002) Medical problems of brass instrumentalists: prevalence rates for trumpet, trombone, French horn, and low brass. Med Probl Perform Artist 17:93–98

Delmaire C et al (2005) Disorganized somatotopy in the putamen of patients with focal hand dystonia. Neurology 64(8):1391–1396. doi:10.1212/01.WNL.0000158424.01299.76

Elbert T et al (1998) Alteration of digital representations in somatosensory cortex in focal hand dystonia. NeuroReport 9(16):3571–3575

Fishbein M, Middlestadt S, Ottati V, Straus S, Ellis A (1988) Medical problems among ICSOM musicians: overview of a national survey. Med Probl Perf Art 3(1):1–8

Frucht SJ (2009a) Embouchure dystonia—portrait of a task-specific cranial dystonia. Mov Disord Official J Mov Disord Soc 24(12):1752–1762. doi:10.1002/mds.22550

Frucht SJ (2009b) Focal task-specific dystonia of the musicians' hand–a practical approach for the clinician. J Hand Ther Official J Am Soc Hand Ther 22(2):136–142; quiz 143 doi:10.1016/j.jht.2008.11.006

Haslinger B, Altenmuller E, Castrop F, Zimmer C, Dresel C (2010) Sensorimotor overactivity as a pathophysiologic trait of embouchure dystonia. Neurology 74(22):1790–1797. doi:10.1212/WNL.0b013e3181e0f784

Hirata Y, Schulz M, Altenmuller E, Elbert T, Pantev C (2004) Sensory mapping of lip representation in brass musicians with embouchure dystonia. NeuroReport 15(5):815–818

Jabusch HC, Altenmueller E (2006) Focal dystonia in musicians: from phenomenology to therapy. Adv Cogn Psychol 2:207–220

Jabusch HC, Muller SV, Altenmuller E (2004) Anxiety in musicians with focal dystonia and those with chronic pain. Mov Disord Official J Mov Disord Soc 19(10):1169–1175. doi:10.1002/mds.20110

Jabusch HC, Zschucke D, Schmidt A, Schuele S, Altenmuller E (2005) Focal dystonia in musicians: treatment strategies and long-term outcome in 144 patients. Mov Disord Official J Mov Disord Soc 20(12):1623–1626. doi:10.1002/mds.20631

Jankovic J, Shale H (1989) Dystonia in musicians. Semin Neurol 9(2):131–135. doi:10.1055/s-2008-1041316

Leaver R, Harris E, Palmer K (2011) Musculoskeletal pain in elite professional musicians from British symphony orchestras. Occup Med 61(8):549–555

Lederman RJ (1991) Focal dystonia in instrumentalists: clinical features. Med Probl Perform Artist 6:132–136

Lockwood AH (1989) Medical problems of musicians. N Engl J Med 320(4):221–227. doi:10.1056/NEJM198901263200405

Middlestadt SE, Fishbein M (1988) Health and occupational correlates of perceived occupational stress in symphony orchestra musicians. J Occup Med Official Publ Indust Med Assoc 30(9):687–692

Munte TF, Altenmuller E, Jancke L (2002) The musician's brain as a model of neuroplasticity. Nat Rev Neurosci 3(6):473–478. doi:10.1038/nrn843

Rodriguez-Lozano FJ, Saez-Yuguero MR, Bermejo-Fenoll A (2011) Orofacial problems in musicians: a review of the literature. Med Probl Perform Artist 26(3):150–156

Rossett i Llobet J, Fàbregas i Molas S (2010) Musician's Dystonia. A practical manual to understand and take care of the disorder that affect the ability to play. DMG Panamir, Rome

Sayegh Ghoussoub M, Ghoussoub K, Chaaya A, Sleilaty G, Joubrel I, Rifai K (2008) Orofacial and hearing specific problems among 340 wind instrumentalists in Lebanon. Le J Med Libanais Lebanese Med J 56(3):159–167

Schmidt A et al (2006) Dominantly transmitted focal dystonia in families of patients with musician's cramp. Neurology 67(4):691–693. doi:10.1212/01.wnl.0000230148.00035.f9

Schmidt A, Jabusch HC, Altenmueller E, Kasten M, Klein C (2013) Challenges of making music: what causes musician's dystonia? JAMA Neurology:in press