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Location of Musculoskeletal Pain in Musicians According to Gender, Academic Status and Instrument

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SUMMARY

Objective. The aim is to evaluate the prevalence of musculoskeletal pain in different body locations comparing student musicians and teachers according to gender, academic status and instrument played by instrument families.
Methods. observational study carried out with student musicians and teachers of higher conservatories in Spain by means of a3 questionnaire.
Results. 552 valid responses were obtained. Cervical (57%), dorsal (40%) and the left shoulder (36%) are the areas with the highest prevalence. Women have a higher prevalence of pain in all the body regions studied. Students have a higher frequency of pain, with significant differences in almost all locations compared to teachers. By instrument families, we found differences in cervical, dorsal, both upper limbs and the jaw. Woodwind instruments as well as singers suffer most often from neck pain.
Conclusions. The cervical region has the highest prevalence of pain. Pain in women and students is more prevalent. It would be interesting to carry out an exercise program aimed at preventing the appearance of these injuries.

KEY WORDS
Academic level; body regions; musculoskeletal pain; musician; sex.

INTRODUCTION

Musicians are a group with a high predisposition to suffer musculoskeletal pain. Specifically, a recent literature review (1) indicates that the prevalence is between 9-63% of musicians analyzed cross-sectionally at the time of the study, but if the lifetime of the subjects is taken into account, the prevalence rises to 46-90% of the participants.

The causes of injury and non-injury is an area where research is making efforts to draw conclusions. However, it appears that there is no single cause for the likelihood of injury or non-injury, but that there are likely to be multiple coexisting factors that may be related to injury, such as posture (2-5), gender (6-8) as well as other intrinsic and extrinsic factors (2, 7-10) that may be related.

The posture adopted on each instrument is different, requiring the maintenance of a neutral arm position in some cases, while in others it is necessary to raise one or both arms while playing the instrument (4, 11). But in addition to the playing position, the posture adopted by each musician is also different (12), which can lead to the appearance of asym-

metrical postures (13). Instrumental practice requires the performance of repetitive movements, which can overload joints and muscles, leading to the development of musculoskeletal pain (2), but also involves the maintenance of a posture, which can be affected even when sitting for a prolonged period of time (14).

Just as in stringed instruments it is the bow that produces the sound, in wind instruments and singers it is the mouth that produces the music (15). On the other hand, on high strings, the chin rests on the instrument which rests on the left shoulder, and that position may predispose to the appearance of cervical and orofacial pain (15). This may mean that both string and wind players have a high prevalence of jaw problems (16, 17).

In relation to risk factors related to the appearance of musculoskeletal pain in musicians, it has been observed that stress, anxiety, depression, and perfectionism are related to a higher prevalence of pain (3, 18, 19). Furthermore, with regards to factors related to instrumental practice, it has been observed that lack of rest and warm-up favor the appearance of musculoskeletal injuries (3, 20). However, the effects of the number of years playing as well as the number of hours dedicated to playing the instrument are not clear (1) and this could be an important factor comparing students and teachers.

Regarding gender, the existing literature does seem to agree that female musicians have a higher prevalence of injury than male musicians (1, 5, 21). However, to the authors' knowledge, there are few studies comparing the occurrence of these injuries among students and teachers and none carried out with the population of musicians in Spain.

As a hypothesis, we think that the appearance of body pain will have different locations depending on the instrument played and that the prevalence will be different between men and women and teachers or students. The objective of the study was to evaluate the prevalence of musculoskeletal pain in different body locations comparing student musicians and teachers of higher conservatories according to gender, academic status and the instrument played by families of instruments.

MATERIALS AND METHODS

Design

An observational study was carried out by sending a questionnaire to all public higher conservatories in Spain. This study followed the guidelines for the reporting of observational studies in epidemiology (STROBE) and was conducted in accordance with the Handbook for Good Clinical Research Practice of the World Health Organization, and the principles of the Declaration of Helsinki. Ethics committee approval was not required for this study, as it involved the secondary use of clinical data that was fully anonymized and contained no identifiers or combination of identifiers that could link the information to any individual.

Participants

The management team of the 21 public high conservatories in Spain were contacted, obtaining approval to participate in the study in 15 of them. This participation consisted of sending an email with the information corresponding to the study as well as the link to be accessed by those musicians who wished to participate. The inclusion criteria of participants were: 1) being between 18 and 65 years old, 2) being a teacher or student at the time of the study in one of the conservatoires invited to participate, and 3) belonging to the field of musical performance. Before starting the study, the number of participants necessary for the sample to be representative of the population of musicians likely to participate was calculated based on the number of students and teachers indicated by the conservatoires, obtaining a result of 362 musicians (calculating with a confidence level of 95% and a margin of error of 5%).

Interventions

A questionnaire was designed, reviewed by a group of experts including professional musicians, physiotherapists and a philologist, with a partial analysis of the responses being carried out in this study. The questionnaire was posted on Google Forms and the access link was available for 1 month between January and February 2021.

Variables

Socio-demographic data (including age, gender and current situation), instrument played and questions about the presence of pain as well as its location were asked using a body drawing divided into 12 anatomical regions (cervical, dorsal, lumbar, shoulders/arms, elbows/forearms, wrists/hands/fingers, head, jaw and diaphragm).

Statistical analysis

Frequency as well as percentage calculation of quantitative variables was performed. In addition, the Chi-square test was used to establish the existence of an association between gender, academic status and instrument family with respect to each body location. The confidence level considered was 95%. Statistical analysis was performed using SPSS version 21.0 statistical software.

RESULTS

After applying the inclusion criteria, a total of 552 valid responses were obtained (of the 560 responses received, 2 were eliminated because of age criteria and 6 because they did not belong to the branch of musical performance). The final sample includes 435 students and 117 teachers. The mean age of the participants was 26.8 years (SD 10.6; range 18-65 years), being 43.7 years (9.5) in teachers and 22.2 years (4.6) in students. The distribution by instrument is shown in **table I**. There is an association between the

Table I. Distribution of participants according to instrument, gender and academical status.

Family	Instrument	Gender		Academical status	
		Men n (%)	Women n (%)	Professor n (%)	Student n (%)
Bowed string	Violin	21 (3.8%)	57 (10.3%)	11 (2.0%)	67 (12.1%)
	Viola	5 (0.9%)	12 (2.2%)	3 (0.5%)	14 (2.5%)
	Viola da gamba	1 (0.2%)	1 (0.2%)	2 (0.4%)	0 (0.0%)
	Cello	8 (1.5%)	24 (4.3%)	7 (1.3%)	25 (4.5%)
	Double bass	3 (0.5%)	6 (1.1%)	3 (0.5%)	6 (1.1%)
	Total	38 (6.9%)	100 (18.1%)	26 (4.7%)	112 (20.3%)
Guitar	Guitar	22 (4.0%)	11 (2.0%)	6 (1.1%)	27 (4.9%)
	Electric guitar	3 (0.5%)	0 (0.0%)	0 (0.0%)	3 (0.5%)
	Total	25 (4.5%)	11 (2.0%)	6 (1.1%)	30 (5.4%)
Piano	Piano	35 (6.3%)	51(9.2%)	33 (6.0%)	53 (9.6%)
	Organ	4 (0.7%)	2 (0.4%)	2 (0.4%)	4 (0.7%)
	Total	39 (7.1%)	53 (9.6%)	35 (6.3%)	57 (10.3%)
Woodwind	Oboe	9 (1.6%)	17 (3.1%)	2 (0.4%)	24 (4.3%)
	Clarinet	21 (3.8%)	25 (4.5%)	10 (1.8%)	36 (6.5%)
	Bassoon	4 (0.7%)	10 (1.8%)	2 (0.4%)	12 (2.2%)
	Flute	7 (1.3%)	34 (6.2%)	3 (0.5%)	38 (6.9%)
	Recorder	1 (0.2%)	2 (0.4%)	2 (0.4%)	1 (0.2%)
	Saxophone	13 (2.4%)	17 (3.1%)	2 (0.4%)	28 (5.1%)
	Total	55 (10.0%)	105 (19.0%)	21 (3.8%)	139 (25.2%)
Brass	French horn	10 (1.8%)	7 (1.3%)	3 (0.5%)	14 (2.5%)
	Trumpet	27 (4.9%)	4 (0.7%)	8 (1.4%)	23 (4.2%)
	Tuba	6 (1.1%)	0 (0.0%)	3 (0.5%)	3 (0.5%)
	Bombardino	1 (0.2%)	1 (0.2%)	0 (0.0%)	2 (0.4%)
	Trombone	24 (4.3%)	2 (0.4%)	8 (1.4%)	18 (3.3%)
	Total	68 (12.3%)	14 (2.5%)	22 (3.8%)	60 (10.9%)
Percussion	Percussion	15 (2.7%)	7 (1.3%)	4 (0.7%)	18 (3.3%)
	Total	15 (2.7%)	7 (1.3%)	4 (0.7%)	18 (3.3%)
Others	Voice	3 (0.5%)	9 (1.6%)	1 (0.2%)	11 (2.0%)
	Accordion	1 (0.2%)	1 (0.2%)	0 (0.0%)	2 (0.4%)
	Harp	0 (0.0%)	8 (1.4%)	2 (0.4%)	6 (1.1%)
	Total	4 (0.7%)	18 (3.2%)	3 (0.6%)	19 (3.5%)
		244 (44.1%)	308 (55.9%)	117 (21.2%)	435 (78.8%)

different instrument families and their distribution by sex ($\chi^2 = 92.254$, $p < 0.001$), with a higher percentage of women in bowed string and woodwind, while in brass there is a predominance of men.

We asked about the existence of pain in any of the twelve body locations studied, all of them located in the upper half of the body. As can be seen in **figure 1**, the cervical region is the most prevalent (57.2%), followed by the dorsal region (39.7%), the left shoulder (36.2%), the lumbar region (35.1%) and the right shoulder (33.2%).

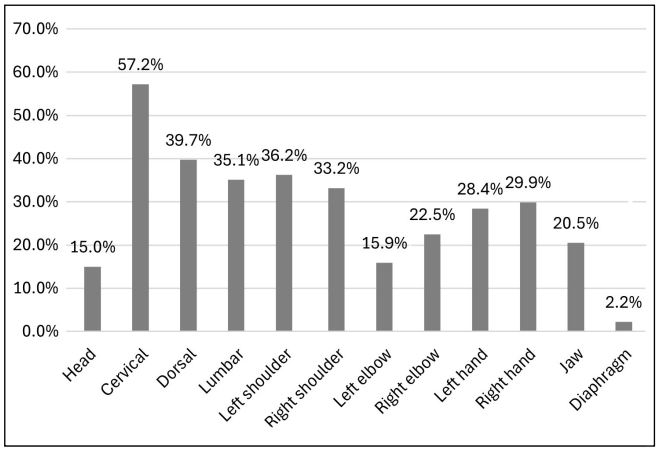


Figure 1. Prevalence of pain according to location.

Analyzing the results obtained according to sex, it is observed that women have a higher prevalence of pain in all the body regions studied, with the left elbow and the diaphragm being the only body regions that did not show statistically significant differences between the two sexes (**table II**). **Table II** also shows the percentages of subjects having pain in the different locations, in the different groups (men, women, teachers and students) studied.

In all the regions studied, the students had the higher frequency of pain, although significant differences could be seen in the head, in the three regions of the spine (cervical, dorsal and lumbar), in the shoulder and left hand, in the right hand and in the jaw (**table II**).

When asked about the region of greatest pain of all indicated pain, we found that a quarter of the participants indicated the cervical spine as the area with the most pain. In addition, 119 participants indicated more than one area of greatest pain.

Finally, looking at pain according to the instrument played, we find that in all families, except for percussion players, the

Table II. Prevalence of pain by body location according to gender and academic status (percentage of occurrence and comparison between groups) as well as the area reported with the most pain.

Pain	Men n (%)	Women n (%)	Sig.†	Professor n (%)	Student n (%)	Sig.†	Most pain n (%)
Head	26 (10.7%)	57 (18.5%)	0.010**	10 (8.5%)	73 (16.8%)	0.027*	6 (1.1)
Neck	104 (42.6%)	212 (68.8%)	< 0.001**	54 (46.2%)	262 (60.2%)	0.006**	140 (25.4)
Dorsal	83 (34.0%)	136 (44.2%)	0.016*	33 (28.2%)	186 (42.8%)	0.004**	87 (15.8)
Lumbar	72 (29.5%)	122 (39.6%)	0.014*	27 (23.1%)	167 (38.4%)	0.002**	67 (12.1)
Left shoulder	66 (27.0%)	134 (43.5%)	< 0.001**	33 (28.2%)	167 (38.4%)	0.042*	88 (15.9)
Right shoulder	57 (23.4%)	126 (40.9%)	< 0.001**	35 (29.9%)	148 (34.0%)	0.402	85 (15.4)
Left elbow	32 (13.1%)	56 (18.2%)	0.106	18 (15.4%)	70 (16.1%)	0.853	31 (5.6)
Right elbow	34 (13.9%)	90 (29.2%)	< 0.001**	19 (16.2%)	105 (24.1%)	0.069	49 (8.9)
Left hand	59 (24.2%)	98 (31.8%)	0.048*	21 (17.9%)	136 (31.3%)	0.005**	42 (7.6)
Right hand	58 (23.8%)	107 (34.7%)	0.005**	19 (16.2%)	146 (33.6%)	0.000**	51 (9.2)
Jaw	37 (15.2%)	76 (24.7%)	0.006**	15 (12.8%)	98 (22.5%)	0.021*	27 (4.9)
Diaphragm	4 (1.6%)	8 (2.6%)	0.443	1(0.9%)	11 (2.5%)	0.270	0 (0.0)

Significance < 0.05; **significance < 0.01; †Chi-square test.

Table III. Body location according to instrument family.

Pain	Bowed string (n = 138)	Woodwind (n = 160)	Brass (n = 82)	Percussion (n = 22)	Guitar (n = 36)	Piano (n = 92)	Others (n = 22)	Sig.†
Head	28 (20.3%)	24 (15.0%)	14 (17.1%)	1 (4.5%)	2 (5.6%)	9 (9.8%)	5 (22.7%)	0.099
Neck	86 (62.3%)	103 (64.4%)	36 (43.9%)	10 (45.5%)	17 (47.2%)	50 (54.3%)	14 (63.6%)	0.028*
Dorsal	66 (47.8%)	69 (43.1%)	29 (35.4%)	6 (27.3%)	10 (27.8%)	35 (38.0%)	4 (18.2%)	0.041*
Lumbar	53 (38.4%)	61 (38.1%)	19 (23.2%)	8 (36.4%)	14 (38.9%)	30 (32.6%)	9 (40.9%)	0.299
Left shoulder	70 (50.7%)	61 (38.1%)	24 (29.3%)	4 (18.2%)	12 (33.3%)	24 (26.1%)	5 (22.7%)	0.001**
Right shoulder	58 (42.0%)	57 (35.6%)	20 (24.4%)	6 (27.3%)	12 (33.3%)	27 (29.3%)	3 (13.6%)	0.044*
Left elbow	31 (22.5%)	17 (10.6%)	9 (11.0%)	8 (36.4%)	8 (22.2%)	13 (14.1%)	2 (9.1%)	0.006**
Right elbow	28 (20.3%)	47 (29.4%)	3 (3.7%)	12 (54.5%)	9 (25.0%)	22 (23.9%)	3 (13.6%)	0.000**
Left hand	50 (36.2%)	44 (27.5%)	10 (12.2%)	14 (63.6%)	13 (36.1%)	24 (26.1%)	2 (9.1%)	0.000**
Right hand	42 (30.4%)	66 (41.2%)	8 (9.8%)	10 (45.5%)	11 (30.6%)	25 (27.2%)	3 (13.6%)	0.000**
Jaw	25 (18.1%)	42 (26.2%)	21 (25.6%)	0 (0.0%)	3 (8.3%)	14 (15.2%)	8 (36.4%)	0.004**
Diaphragm	1 (0.7%)	6 (3.8%)	2 (2.4%)	0 (0.0%)	0 (0.0%)	1 (1.1%)	2 (9.1%)	0.124

Significance < 0.05; **significance < 0.01; †Chi-square test.

most frequent location of pain is the cervical region. In the case of woodwind, brass players and pianists, the next most commonly reported region was the dorsal area. For bowed string players, it was the left shoulder and for guitarists it was the lumbar region. For percussionists, the left hand and the right elbow were the most commonly reported regions of pain. Analyzing the occurrence of pain in each of the areas according to the instrument, it was found a significant difference in the cervical spine, dorsal spine, both upper limbs and the jaw (**table III**).

In particular, woodwind instruments players (oboe, bassoon, flute and saxophone) as well as singers were the most frequent sufferers of neck pain. In the case of the jaw, the highest prevalence was found in singers, saxophonists, bassoonists and violists (**table IV**).

DISCUSSION

This study aims to evaluate the prevalence of musculoskeletal pain in different body regions according to gender, academic status and the instrument played. From the results, its main contributions are: 1) it is the first study carried out at the level of higher conservatories in Spain that compares data between students and teachers as far as the authors are aware, 2) women have a higher prevalence of pain in all the body regions studied and 3) students have a higher prevalence of pain in almost all the locations compared to teachers.

Prevalence by region

Looking at the prevalence by region, we find in our study that the cervical area has the most prevalent pain, followed by the rest of the back (dorsal and lumbar) and both shoulders. This pain may be due to the use of the upper limbs during instrumental practice, requiring proximal stabilization for control of distal mobility. These results seem to confirm those found in previous studies. Viljamaa *et al.* (6) and Steinmetz *et al.* (7) also establish the highest prevalence in the neck and Vastamäki *et al.* (22) in the back. In addition, the next most prevalent body region of pain is established as both shoulders (6,7,22). Berque *et al.* (23) find a higher prevalence in the neck and the entire right upper limb. However, Steinmetz *et al.* (7) also points to the left wrist as one of the most prevalent locations.

In a study by Kok *et al.* (24) studying the prevalence of pain with increasing hours of instrumental practice, they find that pain increases significantly throughout the back, shoulders and hands, while there was only a slight difference in the lower limbs.

Table IV. Prevalence of neck and orofacial pain by instruments.

Instrument	Neck pain		Orofacial pain	
	n	%	n	%
Violin	48	61.5	17	21.8
Viola	11	64.7	6	35.3
Viola da gamba	1	50.0	0	0.0
Cello	21	65.6	1	3.1
Double bass	5	55.6	1	11.1
Guitar	16	48.5	3	9.1
Electric guitar	1	33.0	0	0.0
Piano	48	55.8	13	15.1
Organ	2	33.3	1	16.7
Oboe	20	76.9	6	23.1
Clarinet	22	47.8	12	26.1
Bassoon	11	78.6	5	35.7
Flute	27	65.9	7	17.1
Recorder	2	66.7	0	0.0
Saxophone	21	70.0	12	40.0
French horn	9	52.9	5	29.4
Trumpet	12	38.7	8	25.8
Tuba	4	66.7	1	16.7
Bombardino	1	50.00	0	0.0
Trombone	10	38.5	7	26.9
Percussion	10	45.5	0	0.0
Voice	10	83.5	6	50.0
Accordion	1	50.0	1	50.0
Harp	3	37.5	1	12.5

Prevalence by sex

The results obtained indicate that the prevalence of pain is higher in women in all the body regions studied. Similar results are obtained by Viljamaa *et al.* (6) in which women show a higher prevalence, with the exception of the fingers having a higher prevalence of pain in men, and in the study by Berque *et al.* (23) which point out that only upper back pain shows a higher prevalence in men.

We also note that the prevalence of elbow pain is more than twice as high in women in general and that gender differences are significant in almost all regions studied. However, Rodríguez-Romero *et al.* (25) compare the occurrence of pain in the last month according to sex, finding differences in the neck and lower back, but not in the shoulders or the upper back.

The distribution of participants by instrument families according to gender is significant. This may be due to the fact that there is a certain predisposition to play some instruments depending on whether you are a man or a woman. Specifically, string players (26) and woodwind players (27) are more commonly female, while brass players are predominantly male (28), which is consistent with the data found in our study. Studies with percussionists (29,30) show a much higher participation of male percussionists. In our sample there are no differences in percussionists, but the percentage is very small in both groups and does not allow conclusions to be drawn.

Prevalence by academic status

In our study, we find that students have a higher prevalence of pain, which may be due to the demands of the classes and the need to obtain good results in instrumental practice, as the sample is made up of university musicians. Stanek *et al.* (31) agree that the prevalence in students (75% women and 64% men) is higher than in teachers (57% and 52% women and male respectively).

Regarding the location, our sample of teachers presented greater pain in the cervical, both shoulders and dorsal regions, data similar to those found by Fjellman-Wiklund and Sundelin (32).

Prevalence by instrument/families

By instrument families, in our study we agree with Stanek *et al.* (31) that the neck and left shoulder are the regions with the highest prevalence of string pain, coinciding with the side holding the instrument. The data for high strings most commonly show pain in the neck (23,33) and both elbows/forearms (23). While on the lower strings we find that the prevalence is lower than in the other instrument families (23), but also that back pain is more prevalent (33). This difference in string players may be due to the difference between having to raise their arms or not to hold the instrument and move the bow.

Our sample of woodwind players suffer more pain in the central area (cervical and dorsal) while for Berque *et al.* (23) and Abréu-Ramos and Micheo (33) it is the upper limb, and especially the wrists and hands and specifically the right side (31).

The brass players questioned present more pain in the cervical and dorsal region, while for Berque *et al*. (23) it is the neck and lower back, and for Stanek *et al*. (31) it is the mouth region.

Percussionists in our sample suffer more pain in the distal part of the upper limb. Coinciding with those analysed by Stanek *et al*. (31) This may be due to the speed and the large number of movements they have to make with their wrists when playing the different instruments.

And finally, specifically by instrument, in the last year, the neck, shoulders or both are the most commonly reported pain regions in the majority of instruments (6). In our sample, the highest prevalence of neck pain was reported by singers (84%), bassoonists (79%) and oboists (77%), data higher in number but similar in instrument to those found by Viljamaa *et al*. (6), where violinists (37%), bassoonists (28%) and oboists (28%) had the highest prevalence. But regardless of the instrument played, Kok *et al*. (4) found no differences in the upper limb locations studied when comparing musicians who play with the arm in neutral position *versus* those who play with the arm raised.

In agreement with Yasuda et al. (34) and Jang et al. (35), we found that wind players have more temporomandibular problems than other players. Furthermore, wind and upper string players are more likely to have temporomandibular joint pain than lower string players (35).

As strengths, the large sample size allows us to provide relevant information that can be extrapolated to musicians with similar characteristics. In addition, the clinical implication is to provide knowledge about the main musculoskeletal injuries in musicians, which can be relevant for musicians themselves in order to know and prevent them as well as for health professionals when dealing with their treatment.

In preparing this study, the authors are aware that there are certain limitations. The online questionnaire data collection tool implies a possible reduction in the sample size, which despite being representative, could be larger, as it is possible that not all musicians who could have received it have done so, or even that some have received it but have not completed it. In addition, as these are subjective questions about pain, it is possible that there is a greater predisposition to participate in those people who have or present some kind of previous injury, with the consequent participation bias. Furthermore, as it is a retrospective questionnaire, there could be a memory bias in the participants. On the other hand, the small sample size of some instruments has made comparative analysis between specific instruments difficult.

CONCLUSIONS

Women have a higher prevalence of pain in all the body regions studied, with a significant difference with respect to men in practically the whole body. According to the academic situation, a higher prevalence is observed in students compared to teachers, with a statistically significant difference in most of the body regions. We found that the neck is the most frequently painful region in all instrument groups except percussionists. In particular, woodwind instruments as well as singers suffer most often from neck pain and singers, saxophonists and violists from jaw pain.

In future research, it would be interesting to carry out an exercise program specifically designed for musicians and aimed at preventing the occurrence of these injuries, in order to analyze the effects on the incidence and intensity of pain caused by these musculoskeletal disorders.

FUNDINGS

None.

DATA AVAILABILITY

Data are available under reasonable request to the corresponding author.

CONTRIBUTIONS

CR, YI, MP: conceptualization, methodology, writing – review & editing. CR, MP: formal analysis. CR: investigation, writing – original draft. YI, MP: project administration.

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CONFLICT OF INTERESTS

The authors declare that they have no conflict of interests.

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