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## **Etiology and epidemiology of playing-related musculoskeletal disorders – a systematic review**

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authors or the journal.

### **Conflict of interest**

The authors declare that they have no conflict of interest.

**Keywords:** musicians; pain; muscles.

### **Abstract**

**Introduction:** Instrumentalists are exposed to numerous musculoskeletal disorders (PRMD – Playing Related Musculoskeletal Disorders) or pain (PRP - Playing Related Pain). This condition is an effect of performance requirements, numerous rehearsals and stress. Musicians often underestimate the pain and the first symptoms of the overloads that their body sends them. They usually continue to practice for many hours a day, which only enlarges the damage of tissues. Unfortunately, this approach brings them closer to disability and exclusion from their profession.

**Aims:** Overview of the latest research on concerting musicians. Gathering information on the etiology and epidemiology of PRMD and PRP among instrumentalists.

**Material and methods:** This overview is based on studies from PubMed, ResearchGate and Google Scholar's databases. In order to identify the relevant publications, the search was carried out using a combination of keywords: "musicians", "pain", "muscles". After applying the exclusion criteria, 16 assessed works were selected for the review.

**Results:** The frequency of musculoskeletal disorders related to playing a musical instrument may reach 60%, up to over 80% [1,11,14,25,31-33]. The etiology of these dysfunctions should be associated with the repetitive movements of the upper limbs, either in uncomfortable positions assumed at work or in the specific posture of the body during the performance. One should also remember about the psychological aspect, which is important in understanding the mechanism of overloading and prolonged persistence of pain among musicians. An overview of the literature showed that musculoskeletal disorder concerned women more often than men. The group of instruments that were connected with more frequent occurrence of pain were violins/violas and wind instruments. The most frequently affected body areas were: neck, back, and upper limbs. The information shown above is able to speed up diagnostics as well as proper therapy for professional musicians, which will

contribute to their faster recovery. It should also indicate the direction for future research on the prevention of the abovementioned disorders and the ergonomics of the musician profession.

**Conclusions:** Professional musicians are a group particularly exposed to the occurrence of musculoskeletal disorders associated with playing an instrument, due to the specific requirements of their work. Looking at the high prevalence of these disorders, it can be concluded that the knowledge about the etiology and the prevention of overload and pain is small, and the instrumentalists themselves do not seek help from specialists. Further research in the above-discussed problem is essential to enhance prevention and ergonomics of musician profession.

## **Introduction**

Every classical music concert is an unforgettable experience that touches one's esthetics. During a performance, it is easy to notice artistry, emotions, and involvement that musicians put in every single tone. Their professionalism is an effect of their passion and thousands of hours they have spent on training.

Instrumentalists, the musicians that deal with performative aspects of music, are at risk of many disorders related to musculoskeletal dysfunctions related to playing an instrument (PRMD – Playing Related Musculoskeletal Disorders) or to pain (PRP – Playing Related Pain) [40]. One of the first systematic reviews in this topic, carried out by Zaza C. in 1998 [39], showed that PRMD concerns from 39% up to 87% of adult instrumentalists and from 34% to 62% of students. Stress, high standards, and numerous rehearsals are the main causes of disorders mentioned above [4,38].

Playing an instrument requires a musician to sit or stand unnaturally. Depending on the type of instrument, the musician may attain an asymmetric body posture (eg violin, viola, flute, guitar) or a symmetric one (eg piano, oboe, timpani) and can play with constantly raised upper limbs (eg violin, oboe, flute) or not (eg, timpani, drums, piano). Repetitive movements of upper limbs, (mainly) sitting position during playing and lifting the weight of the instrument is a risk factor of physical overload for every musician. The pressure of upcoming concerts or contests and stress only deepen this state [16]. By analyzing the risk factors of musculoskeletal disorders mentioned above and pain caused by playing an instrument, it can be concluded that certain groups of musicians are more or less exposed to their occurrence.

Musicians often underestimate the pain and the first symptoms of the overloads that their body sends them. They usually continue to practice for many hours a day, which only enlarges the damage of tissues. Some studies reported that musician environments treat pain and disorders related to playing an instrument as a sign of weakness and incompetence [21,28]. Unfortunately, this approach brings musicians closer to disability and exclusion from their profession. Only a few musicians seek help from a doctor or physiotherapist. Often they are not aware that they can be helped in some way, whether by treatment, therapy or earlier prophylaxis. The instrumentalists who appear in the specialist's office get there with significant and chronic musculoskeletal overloads, neurological complaints and joint instability [18,35].

The aim of this literature review was to summarize the latest research on concerting musicians. The study collects information on the etiology and prevalence of PRMD and PRP among instrumentalists and describes the most common symptom locations.

### **Material and methods**

This overview is based on studies from PubMed, ResearchGate and Google Scholar's databases. In order to identify the relevant publications, the search was carried out using a combination of keywords: "musicians", "pain", "muscles" (according to Medical Subject Headings - MeSH).

Following exclusion criteria were applied: publication older than 5 years, literature reviews, conference summaries, and case studies.

The found titles were reviewed first. The 76 works were selected. The second stage consisted of a review of abstracts, full texts, and evaluation based on the above exclusion criteria. The 60 works were rejected.

The 16 studies have been included in the literature review – table 1.

Table 1. Studies included in the literature review.

Author, title, year	Aims, material and methods, results
<p>E.R. Gasenzer et al.</p> <p>The prevalence of chronic pain in orchestra musicians</p> <p>2017</p>	<p>Aims: The study investigated the incidence of chronic pain as well as causes and mechanisms of pain chronification in orchestra musicians.</p> <p>Material and methods: 8,645 professional musicians from 132 German cultural orchestras were contacted and asked about chronic pain via an online questionnaire (DSF). The study group comprised orchestra musicians suffering from pain. The control group consisted of musicians playing the same type of instruments (same working conditions) who reported to be free of pain.</p> <p>Results: The response rate was 8.6% (740 musicians). 66.2% (n=490) out of 740 musicians who completed the questionnaire reported chronic pain. The most frequently reported localizations of pain were the body parts which are mostly involved in instrumental playing such as back (70%), shoulders (67.8%), neck (64.1%), hands and wrists (39.8%). 27.4% of the investigated musicians suffered from pain with a high degree of impairment.</p>
<p>A. Jacukowicz, A. Wężyk</p> <p>Musculoskeletal, hearing and skin problems related to playing the instrument</p> <p>2018</p>	<p>Aims: This paper aims at identifying playing-related health problems among Polish musicians and potential differences in this regard between students and professional musicians.</p> <p>Material and methods: This questionnaire study involved 255 musicians who volunteered to participate – 104 students and 151 professional musicians having music education. The study sample included 61% of women. Mean age of the participants equaled 31 years old, mean playing experience – 23 years old.</p> <p>Results: From 10% to 79% (depending on the affected body part) of the studied musicians experienced musculoskeletal problems. We found no significant differences between students and professionals as regards their musculoskeletal problems.</p>
<p>A. Steinmetz et al.</p> <p>Frequency, severity, and predictors of playing-related musculoskeletal pain in professional orchestral musicians in Germany</p> <p>2014</p>	<p>Aims: The aim of the study was to evaluate the frequency of musculoskeletal pain in professional orchestral musicians with regard to their instrument affiliation. Of special interest were pain intensity and its association with predictors such as gender, instrument group, age or stage fright.</p> <p>Material and methods: Professional orchestra players completed a self-report questionnaire to assess playing-related musculoskeletal pain and its frequency and intensity in various body regions on a numeric rating scale (NRS).</p> <p>Results: Out of 720 approached musicians, 408 were included in the sample (response rate 57 %); overall, 89.5 % had been affected by current or past playing-related musculoskeletal pain, 62.7 % reported pain in the previous 3 months, and 8.6 % reported current pain. Pain distribution and frequency varied between instrument groups. For all instrument groups, the neck was the most common pain region. About 43 % of musicians presented more than five pain regions, in</p>

	<p>particular, violin players. Approximately 40 % of musicians indicated frequent or permanent pain. Female gender and stage fright were proven to be predictors for musculoskeletal pain.</p>
<p>P. Berque et al.  Playing-Related Musculoskeletal Problems Among Professional Orchestra Musicians in Scotland: A Prevalence Study Using a Validated Instrument, the Musculoskeletal Pain Intensity and Interference Questionnaire for Musicians (MPIIQM).  2016</p>	<p>Aims: The aims of the study was to evaluate the prevalence of PRMPs (Playing-Related Musculoskeletal Problems) among professional orchestra musicians and to gather information on pain intensity and pain interference on function and psychosocial variables, using a self-report instrument developed and validated specifically for a population of professional orchestra musicians</p> <p>Material and methods: Out of 183 professional players, 101 took part in the study and completed the Musculoskeletal Pain Intensity and Interference Questionnaire for Musicians (MPIIQM).</p> <p>Results: Lifetime prevalence of PRMPs was 77,2%, the 1-year prevalence was 45,3% and point prevalence was 36,6%. Of the PRMP group, 43% reported having pain in three or more locations, most commonly the right upper limb, neck, and left forearm and elbow. However, predominant sites of PRMPs varied between instrument groups.</p>
<p>C.M. Sousa et al.  Occupational Diseases of Professional Orchestra Musicians from Northern Portugal: A Descriptive Study.  2016</p>	<p>Aims: The aim of this study was to describe the prevalence of the most common complaints affecting musicians of the three professional orchestras from Northern Portugal.</p> <p>Materials and methods: One hundred and twelve professional orchestra musicians from the 3 professional orchestras from Northern Portugal were individually interviewed about their physical and psychological complaints.</p> <p>Results: Results indicated that 93.8% of the interviewed musicians self-reported at least one working-related problem. PRMD were the most common self-reported conditions affecting 84.8% of musicians. The most affected areas are the shoulder, cervical and lumbar regions. MPA was referred to by 21.4% musicians.</p>
<p>L.M. Kok et al.  The high prevalence of playing-related musculoskeletal disorders (PRMDs) and its associated factors in amateur musicians playing in student orchestras: A cross-</p>	<p>Aims: This study aimed to evaluate playing-related musculoskeletal disorders (PRMDs) among amateur musicians playing in student orchestras.</p> <p>Material and methods: 357 members of eleven Dutch student orchestras across the Netherlands were included in this study. Sociodemographic characteristics and PRMDs were evaluated using an adaptation of the Nordic Musculoskeletal Questionnaire (NMQ) and the music module of the Disabilities of Shoulder and Hand (DASH) questionnaire.</p> <p>Results: The year prevalence of PRMDs among amateur musicians was 67.8%. Female gender, younger age, higher BMI and playing a string instrument were independently associated with a higher prevalence of PRMDs. The left shoulder</p>

<p>sectional study</p> <p>2018</p>	<p>was affected more frequently in violinists and violists, whereas the right hand and wrist were more frequently affected in woodwind instrumentalists.</p>
<p>L.M. Kok et al.</p> <p>The Influence of a Sudden Increase in Playing Time on Playing-Related Musculoskeletal Complaints in High-Level Amateur Musicians in a Longitudinal Cohort Study</p> <p>2016</p>	<p>Aims: The aim of this study is to examine the causal relationship between a sudden increase in playing time among amateur musicians on the occurrence of musculoskeletal complaints in a prospective cohort study.</p> <p>Material and methods: All members of two national Dutch Students Orchestras were asked to participate in the study. These project-based orchestras, consisting of high-level amateurs, followed a nine-hour rehearsing schedule for ten consecutive days. On the first day (t0) and after one week (t1) the subjects were asked to complete a paper-based questionnaire including sociodemographic characteristics, music-related questions, questions regarding playing-related musculoskeletal complaints and the music module of the disabilities of arm, shoulder and hand questionnaire.</p> <p>Results: 59 subjects completed the questionnaire at both timepoints (response rate 47%). 9 subjects were excluded for being a music academy student, leaving 50 subjects (mean age 22.1, 72% female) suitable for analysis. During the rehearsal week, the prevalence of at least one playing-related musculoskeletal complaint increased from 28% to 80%. The most frequently affected areas were the neck, upper and lower back, hand/and or wrists and shoulders.</p>
<p>B.J. Ackermann et al.</p> <p>Sound Practice—improving occupational health and safety for professional orchestral musicians in Australia</p> <p>2014</p>	<p>Aims: This paper provides an overview of the Sound Practice project but focuses on the health findings arising from the cross-sectional survey</p> <p>Material and methods: Three hundred and seventy-seven musicians from the eight professional symphony orchestras in Australia took part in the cross-sectional study (about 70% of eligible musicians).</p> <p>Results: Eighty-four percent (84%) of musicians reported past performance-related musculoskeletal disorder (PRMD) episodes; 50% were suffering a current PRMD. PRMDs and trigger point discomfort levels were strongly associated with increasing severity of psychological issues such as depression and music performance anxiety.</p>
<p>C. I. Ioannou et al.</p> <p>Epidemiology, Treatment Efficacy, and Anxiety Aspects of Music Students Affected by Playing-Related Pain: A Retrospective Evaluation with</p>	<p>Aims: Playing-related pain (PRP) is a common problem among music students. We retrospectively assessed epidemiological factors that contributed to the manifestation of PRP and evaluated the efficacy of treatment methods used by affected music students. The long-term course of PRP symptoms was also examined, along with current (today) levels of trait anxieties.</p> <p>Material and methods: Demographic and epidemiological data of 186 music students who visited the musicians' outpatient clinic over a 5-year period were retrieved. Of these students, 122 had been diagnosed with PRP and were invited to participate (response rate 61.5%) in a follow-up online survey to: a) estimate the long-term course of their PRP symptoms, b) assess the efficacy of treatment</p>

<p>Follow-up.  2018</p>	<p>methods they used, and c) assess their current trait anxiety (general and performance-related) using two standardized psychodiagnostic questionnaires. Results: Two-thirds of music students who sought medical care were affected by PRP, with most being affected during their first year of studies, and with 69% having acute rather than chronic pain. The sudden increase in practice time was the main triggering factor for PRP. Concerning the course of PRP, almost all students recovered or improved significantly. Students reported that “active” treatment methods (e.g., physical activities) were more effective than “passive” methods (e.g., oral medications). Psychodiagnostic questionnaires indicated that about 40% of PRP-affected students currently had increased levels of trait anxieties, possibly warranting further medical assistance.</p>
<p>C.I. Ioannou, E. Altenmüller  Approaches to and Treatment Strategies for Playing-Related Pain Problems Among Czech Instrumental Music Students: An Epidemiological Study.  2015</p>	<p>Aims: The current study examined the severity of playing-related pain (PRP) problems among music students at the Prague State Conservatoire, as well as the various treatment methods used by these students and how they approach and deal with these phenomena while studying. Material and methods: In total, 180 instrumental students participated and completed a paper questionnaire. Results: Of these, 88.9% reported that they had experienced PRP at least once in their lives, with 12.6% experiencing pain every time they play. The onset of PRP seemed to coincide with the transition period on entry to the conservatoire and was associated with the increase in hours of practice. Specific body regions associated with playing each particular instrument were most frequently affected, with females being more susceptible than males to the development of PRP</p>
<p>O. Topoğlu et al.  General Health Status, Music Performance Anxiety, and Coping Methods of Musicians Working in Turkish State Symphony Orchestras: A Cross-Sectional Study.  2018</p>	<p>Aims: This study assessed the general health, music performance anxiety (MPA), and coping methods of musicians working in six state orchestras in Turkey. Material and methods: All musicians working in the state symphony orchestras (n=384) were invited to participate in the study. In face-to-face interviews, the authors administered a questionnaire, which consisted of five sections: sociodemographic information, history of musical performance, health status, general health questionnaire-12 (GHQ-12), and MPA scale. Mann-Whitney U-test, Student’s t-test, and Spearman’s correlation test were used to analyze the questionnaire data. Results: The 220 musicians who participated included 121 (55%) males and 99 (45%) females, with a mean age of 42.4±11.3 yrs. For musculoskeletal symptoms, 87.6% reported at least one symptom with the most common being a pain. For general health status, the GHQ-12 showed 64% of musicians were at low risk, 18.7% at moderate risk, and 17.3% at high risk in terms of mental health. The prevalence of MPA before or during the performance was 81.8%, and 60% of musicians stated that performance anxiety negatively affected their performances.</p>
<p>C. Cruder et al.</p>	<p>Aims: The aim of this study was to describe pain location and pain extent in</p>

<p>Profiling the Location and Extent of Musicians' Pain Using Digital Pain Drawings</p> <p>2017</p>	<p>musicians using a digital method for pain drawing (PD) analysis. Additionally, the association between PD variables and clinical features were explored in musicians with pain.</p> <p>Materials and methods: One hundred and fifty-eight musicians (90 women and 68 men; aged 22.4–3.6 years) were recruited from Swiss and U.K. conservatories. Participants were asked to complete a survey including both background musical information and clinical features, the QuickDASH (QD) questionnaire, and the digital PDs.</p> <p>Results: Of the 158 participants, 126 musicians (79.7%) reported having pain, with higher prevalence in the areas of the neck and shoulders, the lower back, and the right arm. The mean percentage of pain extent was 3.1% +/- 6.5%. The mean QD score was higher for musicians with pain than for those without pain. Additionally, the results indicated a positive correlation between the QD score and pain extent, and there were significant correlations between age and pain intensity, as well as between pain extent and pain intensity.</p>
<p>V.A. Baadjou et al.</p> <p>The Musician as (In)Active Athlete?: Exploring the Association Between Physical Activity and Musculoskeletal Complaints in Music Students</p> <p>2015</p>	<p>Aims: The aim of this study was to explore the physical activity level of music students and to study its relationship with musculoskeletal complaints. A second goal was to assess associations between pain, quality of life, and disability.</p> <p>Materials and methods: This cross-sectional study among third- and fourth-year music students used an electronic survey including measures for physical activity (Short Questionnaire to Assess Health-enhancing physical activity), musculoskeletal complaints (Dutch Musculoskeletal Questionnaire), disability (Disability Arm, Shoulder, Hand questionnaire) and quality of life (Short Form-12). Students were classified as compliers or non-compliers with moderate- and vigorous-intensity physical activity recommendations. Statistical analysis was done using (non)parametric tests (t-test, Pearson chi-square test, Mann-Whitney U-test) and correlational testing.</p> <p>Results: Participants were 132 students, 63.6% female, with a median age of 23 years (range 21.3 – 25.0). 67% reported musculoskeletal complaints in the past 7 days. Their median physical activity level was 6390 MET-min/wk, and 62% and 10% of the students accomplished recommendations for moderate-intensity and vigorous-intensity physical activity levels, respectively. No significant differences were found in the prevalence of musculoskeletal complaints between students who met moderate- or vigorous-intensity physical activity recommendations and students who did not. Physical activity level was not associated with musculoskeletal complaints. Higher pain intensity was associated with a lower quality of life and higher disability.</p>
<p>K. Gohil et al..</p>	<p>Aims: The study aimed to find the prevalence of playing-related musculoskeletal disorders (PRMD) in musicians in Ahmedabad, the severity of PRMD and the</p>

<p>Prevalence of playing-related musculoskeletal disorders in musicians</p> <p>2016</p>	<p>correlation between the usage of instrument per week (in hours)&amp; Cornell's musculoskeletal disorders questionnaire score and the total period of usage of the instrument (in months) &amp; Cornell's musculoskeletal disorders questionnaire score.</p> <p>Materials and methods: A survey study using convenience sampling technique was done from the music schools of Ahmedabad with 50 subjects. The subjects aged 10 to 40 years, both males and females, with the use of instruments more than 3 months were included in the study. Subjects were asked to fill a questionnaire concerning demographic data, information about music and Cornell's musculoskeletal disorders questionnaire.</p> <p>Results: 9 out of 50 (18%) musicians had musculoskeletal disorders. Out of them: 7 had wrist pain (77%), 5 had neck pain (55%), 3 had forearm pain (33%), 1 had upper back pain (11%) and 1 had leg pain (11%).</p>
<p>H. Gembris et al.</p> <p>Health problems of orchestral musicians from a life-span perspective: Results of a large-scale study</p> <p>2018</p>	<p>Aims: The aim of these study was to investigate the correlation between physical problems, preventative behaviors, and coping strategies on the one hand, and the variables of age, instrument, gender, position in the orchestra, different categories of the orchestra, and occupational stress on the other.</p> <p>Materials and methods: In total, N ¼ 2,550 musicians returned standardized questionnaires (a return rate of 26%) and N ¼ 2,536 of these questionnaires were included in the SPSS data analysis.</p> <p>Results: The results showed that more than one in two (55%) of the orchestral musicians who took part in the survey were suffering at the time from physical problems that affected their playing. The prevalence increased significantly with advancing age, and string players and harpists had an above-average frequency of experiencing physical problems. Interestingly, there was no significant correlation between the severity of problems and different health behaviors (including preventative action). Around half (49%) of the orchestral musicians said they felt the pressure to perform was intensifying, something that they partly attributed to an increase in artistic demands.</p>
<p>C. Panebianco</p> <p>Musculoskeletal and other performance related disorders in South African undergraduate music students</p> <p>2017</p>	<p>Aims: The aim of this study was to explore self-reported musculoskeletal and related health issues in undergraduate music students. A further goal was to ascertain how these problems impact students' learning and playing their instruments.</p> <p>Materials and methods: A longitudinal mixed method study was done over a period of three years with 145 undergraduate music students at the Department of Music, University of Pretoria, Pretoria, South Africa who completed a health survey, which included verbal statements to open-ended questions. The frequency and percentages of each quantitative variable were calculated using Excel software.</p> <p>Results: The results showed an overall 83% prevalence of musculoskeletal and related health problems among music students. The four most prominent problems</p>

	cited were related to inappropriate tiredness, concentration problems, sleep disturbances and headaches. Prominent musculoskeletal problems included orofacial issues such as sinus problems, and pain experienced in the lower spine, upper spine, left and right forearm. Students were generally reticent to report problems to healthcare professionals, particularly if they were not musculoskeletal in nature.
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The studies selected for this overview were evaluated in accordance with the questions presented in Table 2. The publications were scored on a 0-2 point scale and the questions were based on "The quality assessment for the diagnosis of accuracy studies (QUADAS)", which is recommended by the Cochrane Collaboration [37]. The results of the article evaluation are summarized in Table 3.

Table 2. Punctuation and questions used in publications evaluation

Questions and punctuation		
Q1	The size of the studied group	0-9 - 0 pts. 10-99 - 1 pts. > 100 - 2 pts.
Q2	Presence of exclusion criteria	None - 0 pts. Present - 2 pts.
Q3	Presence of inclusion criteria	None - 0 pts. Present - 2 pts.
Q4	Standard assessment of ailments	Other/No information - 0 pts. Interview/questionnaire - 1 pts. Standardized questionnaire - 2pts.
Q5	The group studied professional musicians	No information - 0 pts. University students/school students- 1pts. Professionals - 2pts.
Q6	Presence of a conflict of interest	Present - 0 pts. No information - 1 pts. None - 2 pts.
Q7	The presence of the consent of the local bioethics commission	No information - 0 pts. Present - 2 pts.
Punctuation: 0-8 – low evidential value, 9-11- moderate evidential value, 12-14- high evidential value.		

Table 3. Publication evaluation

Author	Title	Punctuation							Result
		1	2	3	4	5	6	7	
E.R. Gasenzer et al.	The prevalence of chronic pain in orchestra musician	2	0	2	2	2	1	2	11
A. Jacukowicz, A. Weżyk	Musculoskeletal, hearing and skin problems related to playing the instrument	2	2	2	2	2	1	2	13
A. Steinmetz et al.	Frequency, severity and predictors of playing-related musculoskeletal pain in professional orchestral musicians in Germany	2	2	2	1	2	1	2	12
P. Berque et al.	Playing-Related Musculoskeletal Problems Among Professional Orchestra Musicians in Scotland: A Prevalence Study Using a Validated Instrument, the Musculoskeletal Pain Intensity and Interference Questionnaire for Musicians (MPIIQM)	2	2	2	2	2	2	2	14
C.M. Sousa et al.	Occupational Diseases of Professional Orchestra Musicians from Northern Portugal: A Descriptive Study	2	0	2	1	2	1	2	10
L.M. Kok et al.	The high prevalence of playing-related musculoskeletal disorders (PRMDs) and its associated factors in amateur musicians playing in student orchestras: A cross-sectional study	2	2	2	2	1	2	2	13
L.M. Kok et al.	The influence of a Sudden Increase in Playing Time on Playing-Related Musculoskeletal Complaints in High-Level Amateur Musician in a Longitudinal Cohort Study	1	2	2	2	1	2	2	12
B.J. Ackermann et al.	Sound Practice—improving occupational health and safety for professional orchestral musicians in Australia	2	2	2	1	2	2	2	13
C. I. Ioannou et al.	Epidemiology, Treatment Efficacy, and Anxiety Aspects of Music Students Affected by Playing-Related Pain: A Retrospective Evaluation with Follow-up.	2	0	2	1	1	2	2	10
C.I. Ioannou, E. Altenmüller	Approaches to and Treatment Strategies for Playing-Related Pain Problems Among Czech Instrumental Music Students: An Epidemiological Study.	2	2	2	1	1	1	0	9
O. Topoğlu et al.	General Health Status, Music Performance Anxiety, and Coping Methods of Musicians Working in Turkish State Symphony Orchestras: A Cross-Sectional Study.	2	0	2	1	2	2	2	11
C. Cruder et al.	Profiling the Location and Extent of Musicians' Pain Using Digital Pain Drawings	2	2	2	2	1	2	2	13
V.A. Baadjou et al.	The Musician as (In)Active Athlete?: Exploring the Association Between Physical Activity and Musculoskeletal Complaints in Music Students	2	2	2	2	1	1	2	12

K. Gohil et al.	Prevalence of playing-related musculoskeletal disorders in musicians	1	2	2	2	1	1	0	9
H. Gembris et al.	Health problems of orchestral musicians from a life-span perspective: Results of a large-scale study	2	2	2	2	2	2	0	12
C. Panebianco	Musculoskeletal and other performance related disorders in South African undergraduate music students	2	0	2	1	1	2	2	10

## Results

According to the evaluation criteria adopted in the review, the following studies are of high evidential value: A. Jacukowicz and A. Weżyk [17]), A Steinmetz et al. [32], P. Berque et al. [7], L.M. Kok et al. (both studies) [19, 20], B.J. Ackermann et al. [1], C. Cruder et al. [9], V.A. Baadjou et al. [5] and H. Gembris et al. [11]. Research: E.R. Gasenzer et al. [10], C.M. Sousa et al. [31], C.I. Ioannou et al. [15], C.I. Ioannou and E. Altenmüller [14], O. Topoğlu et al. [33], K. Gohil et al. [13] and C. Panebianco [25] were rated as having a moderate evidential value.

All studies mentioned above point on the high frequency of musculoskeletal disorders associated with musician profession. A. Steinmetz et al. [32], C.M. Sousa et al. [31], B.J. Ackermann et al. [1], C.I. Ioannou and E. Altenmüller [14], O. Topoğlu et al. [33], H. Gembris et al. [11] and C. Panebianco [25] determined their prevalence at a minimum of 80%, while A. Jacukowicz and A. Weżyk [17], P. Berque et al. [7], C. Cruder et al. [9] at least 70%. 60% were noticed by E.R. Gasenzer et al. [10], L.M. Kok et al. [19], C.I. Ioannou et al. [15] and V.A. Baadjou et al. [5].

Nine studies provide information on the relationship between pain caused by playing an instrument and gender. A. Steinmetz et al. [32], P. Berque et al. [7], L.M. Kok et al. [19], C.I. Ioannou and E. Altenmüller [14], C. Cruder et al. [9] and H. Gembris et al. [11] point on the higher frequency of complaints among women, and C. Panebianco [25] among men. B.J. Ackermann et al. [1], as well as C.I. Ioannou et al. [15] did not observe gender dependence.

Most studies point out that musculoskeletal problems affect mainly string players (especially violins and violas) [7,9-11,13,14,17,19,25,32] and also wind players (mainly woodwind) [1,7,10,14], although according to some authors, the last group is affected less [9,19]. Only two studies showed a significant relationship between the occurrence of pain and

the play on keyboard instruments [14,25].

Literature review showed that the most common complaints caused by playing musical instruments include neck [5,7,9,10,13,17,19,20,25,31-33], back [10,14,17,19,20,25] - especially lower back [5,9,31-33] and upper limbs. Within them, the pain problems concern especially the arms / shoulders [1,5,9,10,15,17,19,20,25,32], the forearms [7,13,15], wrists and / or hands [5,9,13-15,17,19,20,25,32]. Some studies indicate lateralization of symptoms depending on the part of the body and / or type of instrument [7,9,19,25,32].

## **Discussion**

### **Frequency of pain and its cause**

All studies included in the overview show a high frequency of musculoskeletal disorders among musicians. A. Steinmetz et al. [32], C.M. Sousa et al. [31]0, B.J. Ackermann et al. [1], C.I. Ioannou and E. Altenmüller [14], O. Topoğlu et al. [33], H. Gembris et al. [11] and C. Panebianco [25] determined this level to a minimum of 80%. Such a condition may be caused by performance requirements that are posed to musicians. These include: repetitive movements of the upper limbs, work in uncomfortable positions, eg with raised arms, or a specific pose during the performance (asymmetrical, standing or sitting).

The dependence of repetitive movements of the upper limbs on the occurrence of musculoskeletal disorders is confirmed in Shiri R. et al. [30] studies carried out on the Finnish population (4,783 people were included). By studying an occurrence and determinants of lateral and medial epicondylitis Shiri R. et al. discovered a dependence between this condition and repetitive movements of upper limbs. Nicoletti S. et al. [23] noticed the connection of these ailments with repetitive movement by examining the employees hired in the furniture industry. It may explain the dependence observed in this overview, as frequent, repetitive movements occur in the work of professional musicians. Similar conclusions can be drawn from the work of Gobba F. et al. [21], who leaned over the risks of repetitive activities in the work of health care and demonstrated their impact on the formation of overloads in the neck, upper limbs, and their girdles. Miranda H. et al. [22], studying the general Finnish population, proved that the physical load at work, including repetitive movements, increased the risk of shoulder disorders. Andersen J.H. et al. [2] examined employees of service and industrial

companies for risk factors of musculoskeletal disorders. The results of their work showed that highly repetitive movements contribute to shoulder pain.

The correlation between work in uncomfortable positions and / or forced posture and the occurrence of pain has also been demonstrated in the above-mentioned studies, i.e. in the works of the following authors: Miranda H. et al. [22], Andersen J.H. et al. [2] and Nicoletti S. et al. [23]. The conclusions drawn from these studies confirm the results of this review.

The psychological aspect, such as psychological strain caused by performance requirements, rehearsals or numerous concerts, as well as anxiety and depression, may also affect the formation and maintenance of musculoskeletal pain among musicians. It is confirmed in Bongers P.M. et al. [8], who noticed that high levels of occupational stress, as well as high work demand, were associated with upper limb problems. Andersen J.H. et al. [3] investigating neck and shoulder pain in workers performing monotonous, repetitive work, showed that high demand for work was a risk factor for these ailments. Similar conclusions can be found in Ratzlaff C.R., Gillies J.H., and Koehoorn M.W. [27]. It has been proven that stress and physical work demands are associated with repeated upper limb injuries in Canadian full-time employees. A study by Tsang A. et al. [34] on chronic pain in developed and developing countries (42,249 people) showed that they may be associated with anxiety-depression spectrum disorders. According to the above-described studies, Andersen J.H. et al. [2] low job satisfaction predisposes pain of the neck and shoulder.

### **Sex's influence on ailments associated with playing an instrument.**

A. Steinmetz et al. [32], P. Berque et al. [7], L.M. Kok et al. [19], C.I. Ioannou and E. Altenmüller [14], C. Cruder et al. [9] and H. Gembris et al. [11] research have determined that female musicians are more likely to suffer from musculoskeletal disorders pain related to playing a musical instrument. This fact is explained by Pieretti S. et al. [26] studies, which showed that women suffer from pain, especially chronic pain, more often and more severely than men. Confirmation is also found in Ratzlaff C.R., Gillies J.H. and Koehoorn M.W. [27] who noticed that the female sex is associated with recurrent upper limb injuries among Canadian workers. Work of Paller Ch.J. et al. [24], as well as Bartley E.J. and Fillingim R.B. [6] describes that women experience greater clinical pain, more severe than men, and show increased sensitivity to experimental pain. A study by Tsang A. et al. [34] on chronic pain among the residents of developing and developed countries showed that female sex and older

age are in correlation with an increased level of chronic pain. However, Schiltewolf M. and Pogatzki-Zahn E.M. [29] studies question the dependence of pain and female sex and describe that women are not so different from men when comparing several modalities of experimental pain. This would confirm the results presented by B.J. Ackermann et al. [1] and C.I. Ioannou et al. [15], which do not indicate gender differences in the pain experienced by musicians.

### **Instrument type's influence on ailments associated with playing an instrument.**

Literature overview showed that musculoskeletal disorders or pain associated with playing the instrument most often concerns violin / viola musicians [7,9–11,13,14,17,19,25,32] and wind instruments [1,7,10,14]. This may be due to specific performance requirements, such as playing with raised arms, statically held for a long time, repetitive movements (mainly the wrist, fingers, and forearm), asymmetric arrangement of upper limbs (especially playing the violin, viola and the flute) and psychological factors. This thesis is based on above-mentioned studies, which concern repetitive moves [2,12,22,23,30], specific, forced posture and uncomfortable positions during work [2,22,23], or psychological risk factors for pain and musculoskeletal disorders [2,3,8,27,34].

### **Location**

The research included in the overview showed that the complaints caused by playing the instrument include mainly the neck [5,7,9,10,13,17,19,20,25,31–33], back [10,14,17,19,20,25], and upper limbs [1,5,7,9,11,13–15,17,19,20,25,32]. It has been proven by the studies mentioned previously, which were referred to below.

Gobba's study F. et al. [12] referring to healthcare professionals describe that the prevalence of disorders of the neck, shoulders and wrist/hands (especially carpal tunnel syndrome) is increased by people with repetitive work. Andersen J.H. et al. [2] confirmed that highly repetitive work predisposes to shoulder pain, lifting heavy objects and long-term staying in one place predisposes to problems with the lower spine, and low job satisfaction predisposes to a pain in the neck and the shoulder. Ratzlaff C.R., Gillies J.H., and Koehoorn M.W. [27] have proven that musculoskeletal disorders associated with repetitive work affect the upper body in the first place and the spine in the second place. They mainly affect the wrist/hand, arm, and elbow. Nicoletti S. et al. [23] research carried out on employee hired in furniture industry confirmed this relationship. It also highlighted the posture as a risk factor

for musculoskeletal disorders. Andersen J.H. et al. [3] found a connection between a pain in the neck and the shoulder and highly repetitive work activities, matched with high physical demands, which is also observed in the professional environment of musician-instrumentalists. Research by Shiri R. et al. [30] carried out on the Finnish population shows the relationship between repetitive arm movements and more forceful activities and the occurrence of the lateral and medial epicondylitis. Research by Miranda H. et al. [22] shows the connection between shoulder pain and repetitive movements of the shoulder in men, and work in uncomfortable positions in women. Researchers stress that the physical load at work increases the risk of long-term disorders of the shoulder area. Bongers P.M. et al. [8], Ratzlaff C.R., Gillies J.H., and Koehoorn M.W. [27] indicate the dependence of work-related stress and high professional requirements on the occurrence of problems in the upper limbs. In the opposition, there are studies by Walker-Bone K. et al. [36], which show that the pain of the upper limb and shoulder girdle is common among adults in the general population.

According to the results of this study, it can be assumed that the frequency of musculoskeletal disorders associated with playing a musical instrument can be 60% [5,10,15,19], and even reach up to 70% [7,9,17], or over 80% [1,11,14,25,31–33]. The etiology of these dysfunctions should be sought in the repetitive movements of the upper limbs, in work in uncomfortable positions, e.g. with raised arms, or in a specific posture of the body during playing (asymmetrical, standing or sitting). One should also remember about the psychological aspect, which is important in understanding the mechanism of overloading and prolonged persistence of pain among musicians. This review of the literature showed that musculoskeletal disorders more often concerned women than men. Violins/violas and wind instruments players are also more often exposed for the occurrence of pain. The most frequently affected areas were: neck, back, and upper limbs. The above information is able to speed up diagnostics and proper therapy for professional musicians, which will contribute to their faster recovery. It should indicate the direction for future research on the prevention of the abovementioned disorders and the ergonomics of the musician profession.

## **Conclusion**

Professional musicians are a group particularly exposed to the occurrence of musculoskeletal disorders associated with playing a musical instrument, due to the specific

requirements of their work. Looking at the high prevalence of these disorders, it can be concluded that the knowledge about the etiology and the prevention of overload and pain is small, and the instrumentalists themselves do not seek help from specialists. It is easy to conclude that further research, focused on the means of prevention and ergonomics of musician profession is necessary.

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