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International Journal of Community Music, 2020; 13(1):103-121

The definitive, peer reviewed and edited version of this article is published in International Journal of Community Music, 13(1):103-121, 2020, http://dx.doi.org/10.1386/ijcm_00013_1

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Abstract

Musculoskeletal symptoms (MSSs) are a common problem for musicians, but the MSS burden of amateur musicians specifically is under-investigated. For the first time we sought to compare the MSS prevalence and profile (e.g. MSS location, impact) of adult amateur musicians to non-musicians. Amateur and non-musicians were asked to complete a questionnaire that collected data on their demographics, musical activities and MSS outcomes. A total of 456 participants were included, 30.9% of whom were amateur musicians. Musculoskeletal symptoms were common for both amateurs and non-musicians (96.4% and 96.1% respectively for the last 12 months). The only significant difference between the two groups was for the 12 month prevalence of head MSSs with amateur musicians having a higher prevalence than non-musicians (49.6% and 39.8% respectively, $p<0.05$). We conclude that amateur musicians do not have a substantially different MSS prevalence and profile compared to non-musicians for this university-based population.

Keywords: musician, performing arts, musculoskeletal, pain, comparative study, prevalence

Are adult amateur musicians at 'high risk' of experiencing musculoskeletal symptoms?

Background

There has been a long cross-cultural tradition of music (Honing et al. 2015). The earliest specimens of musical instruments, flutes made of bones or ivory of animals such as vultures and mammoths, date back as far as 35 000 years ago (Conard et al. 2009). While the purpose of music for humans remains unclear from an evolutionary perspective (Cross 2001, Honing et al. 2015), music remains an integral part of contemporary society. For instance, in Australia, only 10.2% of people aged 15 years or older who played an instrument or sung received income for doing so (Australian Bureau of Statistics 2019), confirming that the vast majority of Australian musicians are amateurs.

The health benefits of engaging in music are well established, both in terms of music therapy (Carr et al. 2013, Cole and LoBiondo-Wood 2014, do Amaral et al. 2016, Fusar-Poli et al. 2018, Martin-Saavedra et al. 2018, McConnell et al. 2016, Weller and Baker 2011), and in non-therapeutic settings (Clift et al. 2010, Dawson 2014, Fancourt et al. 2014, Pérez-Aldeguer and Leganés 2014, Román-Caballero et al. 2018). Active engagement in music (e.g. playing, singing) impacts psychoneuroimmunological function (Fancourt et al. 2014), and has a range of benefits, including those related to cognition (Dawson 2014, Román-Caballero et al. 2018), health, and wellbeing (Clift et al. 2010, Pérez-Aldeguer and Leganés 2014). Community music may have additional health benefits, owing to the associated social interaction (Tapson et al. 2018, White 2016), with musicians reporting benefits regarding their physical and emotional well-being (Barbeau and Cossette 2019, Coffman 2009). Indeed, some amateur musicians have reported engaging in community music to help them cope with their health conditions (Krause et al. 2016). Community music can bring together individuals of minority (and often vulnerable) groups, such as Australian Aboriginals in remote areas (Anthony et al. 2018), asylum seekers (Lenette and Weston 2016), people with learning disabilities (Hassan 2017), and the LGBTQI community (Bird 2017), which may provide health benefits for these populations. Engaging in music as an amateur, particularly in community music ensembles, is therefore likely to have a range of health benefits.

Although there are benefits from engaging in music, there are also potential harms. For instance, professional musicians have reported a range of health problems resulting from their work, most commonly musculoskeletal disorders (Stanhope et al. 2019b), however little is known about the musculoskeletal symptom (MSS) outcomes for adult amateur musicians (Stanhope et al. 2019a). One important study regarding amateur musicians revealed that, like

professional musicians, amateur adult band musicians also face a range of health problems, including MSSs (Rohwer 2008). There have also been reports of amateur musicians not continuing to engage in music, due to MSSs (Pitts et al. 2015), and therefore not experiencing the potential health and social benefits of community music.

There have been several studies that have compared the MSS outcomes of university music students or professional musicians and reference groups, which generally indicate that musicians tend to have poorer MSS outcomes (Ginsborg et al. 2009, Joseph et al. 2018, Kok et al. 2015, Kok et al. 2013a, Kok et al. 2013b, Paarup et al. 2011), although a study of choristers found that musicians had a higher prevalence of MSSs in some body regions, compared with non-musicians (Vaiano et al. 2013). Similarly, large Danish population study (Ekholm et al.) found those who engaged in music for at least an hour a day reported a lower prevalence of MSSs compared with those who did not.

As with professional musicians, amateur musicians may be at risk of MSS outcomes due to the biomechanical exposures associated with playing (e.g. elevated hands, repetitive movements). Amateur musicians might be at particular risk as they may have: more intermittent exposure (e.g. playing only when time allows); less formal music training for as long; and/or lack access to protective strategies potentially applied through organisations that train musicians and tertiary education institutions (e.g. ergonomic chairs, education sessions regarding MSSs). Furthermore, amateur musicians' engagement in musical activities may be less regular than professional musicians or university music students, which may place them at increased risk of MSSs, particularly when engaging in weekly rehearsals (e.g. community band) that may go for several hours. Amateur musicians should, therefore, be considered as a group potentially at risk of higher MSS outcomes than non-musicians, however no such comparative study has been conducted, to our knowledge (Stanhope et al. 2019a). The findings of such a study would inform whether engagement in musical activity might be increasing the risk of MSS outcomes, or whether the MSSs amateur musicians experience reflect the profile of the general population, where MSSs are also common (Widanarko et al. 2011).

The purpose of our study was therefore to compare the prevalence and profile of MSSs between amateur musicians and non-musicians, to determine the impact of engaging in musical activities on MSSs and make recommendations for their management at a community level

drawn from a sample of university staff and students. Focusing on university staff and students allowed us to determine the impact of engaging in musical activities, by comparing people from the same population, who engaged in different activities.

Methods

Our study compared the prevalence and profile of MSSs between amateur musicians and non-musicians drawn from a sample of university staff and students. Focusing on university staff and students allowed us to compare people from the same population, who engaged in different activities.

Recruitment and sample

Amateur musicians were defined as those who engaged in musical activity (playing an instrument, singing, conducting, teaching or being a drum major) in the last 12 months (but who were not employed to do so), and who were not members of the Music Teachers' Association or the Musicians' Union (because these musicians were considered professionals). Non-musicians were defined as those who had not engaged in musical activity (excluding listening) in the last 12 months.

A cross-sectional survey of staff and students at The University of Adelaide, in Adelaide, South Australia was conducted in May/June 2016. Eligibility criteria for participants were as follows: (i) aged 18 years or more; and (ii) current science student at the university and/or a staff member within the three targeted faculties (arts, science and health science). Participants were excluded if they were currently studying music at university or employed as a music teacher or performing musician (i.e. singer, instrumentalist, conductor or drum major).

Potential participants were contacted via email with a brief explanation of the project, information sheet, and a link to the questionnaire (via Survey Monkey). Participants who completed the questionnaire within two weeks were entered into a prize draw, as an incentive for participation.

Students were drawn from the Faculty of Science, and staff from the Faculties of Arts, Sciences, and Health and Medical Sciences at the University, excluding staff from the Conservatorium of Music. As our study is one of the first to investigate amateur musicians, and the first to compare the MSS outcome profile between amateur musicians and non-musicians (Stanhope et al. 2019b), we sought a sample where anticipated a relatively high proportion would engage in musical activities, with other differences between amateur musicians and non-musicians. University students and staff provided such a sample. Science

students were selected because they are a large student group with relative homogeneity in the tasks undertaken within their studies, and which none of the researchers taught. In keeping with ethical principles, and the sample size calculation reported below, we did not want to recruit more students than were required; hence we restricted our student sample to science students. Staff were recruited more broadly, owing to smaller numbers. The three faculties were selected because each had shown an interest in the project, and it was anticipated that the three faculties would provide a sufficient sample size for the project.

Analyses of study power indicated that a sample size of at least 102 participants per group was required to detect a 20% difference in prevalence, with 80% power at a 5% level of significance.

Questionnaire development

A new questionnaire was developed specifically for this project (Stanhope 2019). Participants were asked a range of demographic questions including their age, gender, height and weight, postcode, typical daily sitting time, and work patterns (e.g. number of employers, hours of work in the last 7 days). Students were also asked to indicate the program they were enrolled in (i.e. their degree, e.g. Bachelor of Science), the year of their study (e.g. first year, second year), and whether they were full- or part-time students. Full-time students at The University of Adelaide refers to 12 units of study, which is approximately 40 hours per week of structured and/or independent study. Items regarding MSS outcomes were selected based on a review of data collection methods for musicians' MSS outcomes (Stanhope et al. 2019c). The Nordic Musculoskeletal Questionnaire (Kuorinka et al. 1987) was modified for this study by adding items for the head, orofacial, and chest/ abdomen regions to the original nine body regions (Figure 1). Participants were asked whether they had experienced ache, pain or discomfort in the last 12 months and the last 7 for each of these 12 body regions. Participants were also asked to indicate the body side of their MSSs in the last 7 days for each body region.

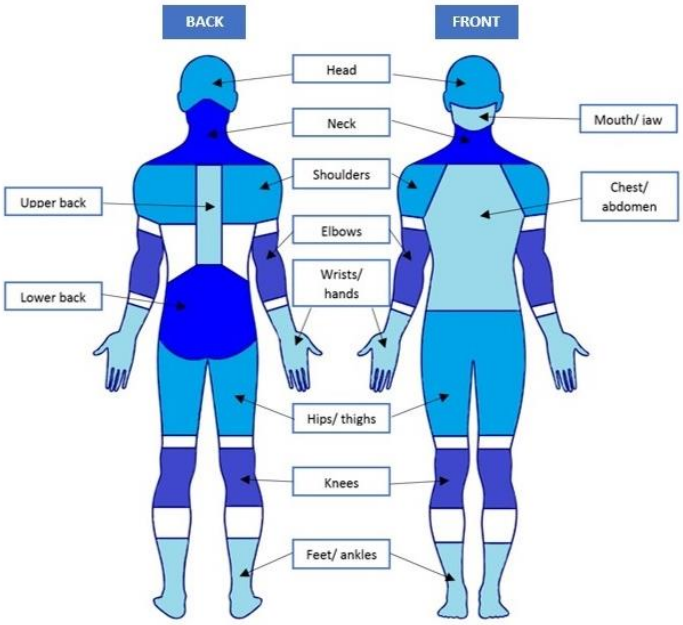

Figure 1: Body chart used to collect data on musculoskeletal symptom location in the last 12 months and 7 days as part of the modified Nordic Musculoskeletal Questionnaire

Participants who reported MSSs in the last 12 months were asked to indicate the consequences experienced, including changes to their work/study due to their MSSs or leave from work/ study due to MSSs, based on equivalent items from the Extended Nordic Musculoskeletal Questionnaire (Dawson et al. 2009). Participants were also asked whether they had consulted a health professional and/or engaged in self-management for their MSSs in the last 12 months.

Participants who reported MSSs in the last 7 days were asked to rate the intensity of pain on average, on an 11-point numeric rating scale (NRS), with the anchors 0 “no pain” to 10 “pain as bad as you can imagine”, as recommended by Dworkin et al. (Dworkin et al. 2005), and in accordance with the Brief Pain Inventory-Intensity Scale (Cleeland and Ryan 1994) (reviewed elsewhere (Stanhope 2016)). Pain intensity ratings made on 11-point NRSs are considered valid and reliable (Ferreira-Valente et al. 2011).

Participants reporting MSSs in the last 7 days were also asked to indicate the level to which the MSSs had impacted on their daily lives and in an emotional context. Ratings were developed using items from the Brief Illness Perception questionnaire, with “ache, pain or discomfort” substituted for “illness” as recommended for this questionnaire (Broadbent et al. 2006). The Brief Illness Perception questionnaire has been used to compare MSSs between university music and medical students previously (Kok et al. 2013a) and is considered valid and reliable (Broadbent et al. 2006, Broadbent et al. 2015). Approval for this modification was granted by Elizabeth Broadbent.

The questionnaire was pilot-tested prior to distribution to determine face validity, and participants' perceptions regarding the ease of completion and the time taken to complete the questionnaire. Modifications were made to the questionnaire based on the feedback received, before testing with the next participant.

Analysis

Participants who reported engaging in any musical activity (i.e. playing an instrument, singing, conducting or being a drum major) in the last 12 months were considered 'amateur musicians'. All data were analysed in Stata 14 (StataCorp 2015). Pain intensity ratings were dichotomised such that ratings of 5-10 were considered "moderate/severe" pain, based on the cut-points suggested for 'healthy' community adults (Palos et al. 2006). The MSS impact and emotional impact were also dichotomised, in this case using median cut-points. Descriptive statistics were used for participant characteristics, including MSS prevalence and consequences. The MSS outcomes were compared using binary logistic regression, with a 5% level of significance. Forward and backward stepwise regression procedures were used in the development of the final model. Model selection was guided by the Akaike Information Criterion (Akaike 1974).

Ethical considerations

The project received approval from The University of Adelaide Human Research Ethics Committee (protocol number H-2015-279). The University of Adelaide also has a separate approval process for studies involving students, which was followed for this project. The data were not identifiable. Participants who elected to participate in the prize draw or requested a summary of the study findings provided either a telephone number or an email address so that they could be contacted. These details were removed from the questionnaire immediately, and were stored separately from the questionnaire, so that the data were de-identifiable.

Results

A total of 456 participants were included in the study, 141 of whom (30.9%) were classified as amateur musicians. The demographics of the samples are reported in Table 1. Of the 84 participants who engaged in musical activity in the last 7 days, 76.1% reported 0-5 hours of activity, 17.9% reported 5-10 hours, and 6.0% reported 10 or more hours. In the last 7 days, of these 84 musicians, the majority were engaged in singing (57.3%), while others played guitar (or similar; 40.7%), keyboard (37.0%), woodwind (7.4%), brass (3.7%), bowed string instruments (3.7%), or percussion (6.2%).

Table 1: Sample demographics

	Amateur musician (n=141)	Non musician (n=315)	p-value
Age in years (median, interquartile range)	21 (19-29)	28 (20-44)	<0.001***
Female (%)	67.1	68.9	0.712
Body mass index (median, interquartile range)	22.5 (20.3-24.8)	22.9 (20.8-26.2)	0.160
Typical daily sitting time (%)			0.346
<8 hours	67.0	61.1	
>8 hours	33.0	38.9	
Socioeconomic status (%)			0.994
1	26.1	25.8	
2	25.4	24.5	
3	24.6	25.8	
4	23.9	23.9	
Current university student (%)	75.9	57.1	<0.001***
Number of employers in the last 12 months	1 (1-2)	1 (1-2)	0.459
Number of employers in the last 7 days	0 (0-1)	1 (0-1)	0.001**
Hours worked in the last 7 days	0 (0-28)	8 (0-38)	<0.001***

Notes: *p<0.050, **p<0.010, ***p<0.001

Prevalence of musculoskeletal symptoms

The 12 month prevalence of MSSs overall (i.e. in any body region) among amateur musicians was 96.4% compared to 96.1% for non-musicians (non-significant difference). The majority of participants in both groups reported MSSs in the neck, shoulder and lower back regions (Table 2). Adjusting for potential confounders, the only significant difference between the groups was for 12 month prevalence of MSSs in the head region (adjusted odds ratio (AOR) 1.546, 95% confidence interval (CI) 1.012-2.361), p=0.044).

For the 7 day prevalence of MSS, 75.9% of amateur musicians reported MSSs overall (i.e. in any body region) compared to 84.1% of non-musicians (Table 2). There were no significant differences in the adjusted analysis between amateur and non-musicians for any of these 7 day MSS outcomes.

Table 2: Percentage (95% confidence interval) of amateur musicians and non-musicians reporting musculoskeletal symptom outcomes in particular body regions.

	Amateur musicians	Non-musicians
Musculoskeletal symptoms in the last 12 months		
Overall	96.4 (91.6-98.5)	96.1 (93.3-97.8)
Head	49.6 (41.4-57.9)	39.8 (34.5-45.4)
Orofacial	28.1 (21.2-36.1)	24.6 (20.1-29.7)
Neck	73.4 (65.4-80.1)	67.6 (62.2-72.6)
Shoulder	65.5 (57.2-72.9)	60.2 (54.6-65.5)
Elbow	14.4 (9.5-21.3)	18.1 (14.2-22.8)
Wrist/ hand	45.3 (37.2-53.7)	39.5 (34.2-45.1)
Upper back	46.8 (38.6-55.1)	46.6 (41.1-52.2)
Chest/ abdomen	21.6 (15.5-29.2)	15.9 (12.2-20.4)
Lower back	67.6 (59.4-74.9)	70.6 (65.2-75.4)
Hip/ thigh	38.1 (30.4-46.5)	38.5 (33.2-44.1)
Knee	35.3 (27.7-43.6)	45.0 (39.5-50.6)
Ankle/ foot	41.0 (33.1-49.4)	35.6 (30.4-41.1)
Musculoskeletal symptoms in the last 7 days		
Overall	75.9 (68.1-82.2)	84.1 (79.7-87.8)
Chronic	33.3 (26.0-41.6)	40.8 (35.5-46.5)
Chronic among those with musculoskeletal symptoms	44.2 (35.0-53.9)	48.8 (42.7-55.0)
Moderate/severe pain among those with musculoskeletal symptoms	11.8 (6.8-19.6)	16.4 (12.3-21.5)
Head	20.9 (14.9-28.4)	23.3 (19.0-28.3)
Orofacial	11.5 (7.2-18.0)	11.5 (8.4-15.5)
Neck	46.0 (37.9-54.4)	47.6 (42.1-53.2)
Shoulder	43.2 (35.2-51.5)	39.6 (34.3-45.2)
Elbow	6.5 (3.4-12.0)	9.9 (7.0-13.8)
Wrist/ hand	27.3 (20.6-35.4)	22.4 (18.1-27.3)
Upper back	27.3 (20.6-35.4)	28.4 (23.7-33.7)
Chest/ abdomen	8.6 (5.0-14.6)	7.0 (4.7-10.5)
Lower back	45.3 (37.2-53.7)	51.1 (45.6-56.6)
Hip/ thigh	22.3 (16.1-30.0)	25.9 (21.3-31.0)
Knee	24.5 (18.0-32.3)	27.8 (23.1-33.0)
Ankle/ foot	22.3 (16.1-30.0)	23.3 (19.0-28.3)
Consequences of musculoskeletal symptoms in the last 12 months[a]		
Changes to work/study	10.5 (6.2-17.2)	9.0 (6.1-12.9)
Leave from work/study	16.3 (10.7-23.9)	19.4 (15.2-24.5)
Consulted a health professional	55.6 (47.1-63.9)	60.5 (54.8-65.9)
Engaged in self-management	89.5 (93.0-93.7)	84.1 (79.5-87.9)

Notes: Chronic: Musculoskeletal symptoms on most days for at least the last 3 months. Moderate/severe pain: ratings of pain on average of 5-10 on an 11-point numeric rating scale from 0 “no pain” to 10 “pain as bad as you can imagine”.

Consequences of musculoskeletal symptoms

Of the participants who reported MSSs in the last 12 months, the majority of musicians in both groups had consulted a health professional and had engaged in self-management for their MSSs (Table 2). There were no statistically significant differences between the two groups, regarding work/ study consequences, consulting a health professional, or engagement in self-management.

Participants who reported MSSs in the last 7 days rated the impact of their MSSs on daily life as well as the emotional impact. The median ratings of the impact on daily life for both groups was 3 (interquartile range 2-5 for both groups), and 2 for emotional impact (interquartile range 1-4 for both groups). There were no statistically significant differences between the groups for either rating.

Gender-specific results

Sub-analyses by gender were also performed (see Appendix for the prevalence estimates). For males, after adjusting for confounders, there were significantly lower odds ratios for amateur versus non-musicians in the 12 month prevalence of knee MSSs (AOR 0.371, 95% CI 0.160-0.860, p=0.021), and 7 day prevalence of MSSs overall (i.e. in any body region; AOR 0.408, 95% CI 0.179-0.927, p=0.032). Among males who reported MSSs in the last 12 months, there was also a significantly higher odds ratios for use of self-management strategies for amateur versus non-musicians (AOR 6.008, 95% CI 1.494-24.154, p=0.012). For those reporting MSSs in the last 7 days, there was a significant difference in the proportion of amateur versus non-musicians who reported a high impact on daily life (AOR 2.810, 95% CI 1.078-7.327, p=0.035). For females, there were significant differences between amateur and non-musicians for the 12 month prevalence of MSSs in the head (AOR 2.058, 95% CI 1.231-3.440, p=0.006), neck (AOR 1.939, 95% CI 1.044-3.602, p=0.036), and chest/ abdomen (AOR 1.931, 95% CI 1.045-3.567, p=0.036) regions. There were no significant differences in the 7 day prevalence of MSSs, nor the consequences in the last 7 days and 12 months.

Discussion

The present study is the first to directly compare MSS outcomes between amateur musicians and non-musicians. Almost all (96.4%) amateur musicians reported MSSs in the last 12 months, and 75.9% reported MSSs in the last 7 days. However, these results were not significantly different from those for a comparable group of non-musicians. The findings of our study indicate that amateur musicians have similar MSS outcomes to non-musicians, suggesting that musical activity in itself, at least in an amateur context, is not strongly associated with MSSs.

Musculoskeletal symptoms were most commonly reported in the neck, shoulder, and lower back regions for both amateur and non-musicians for both the 12 month and 7 day periods. The only significant difference between amateur and non-musicians was for the 12 month prevalence of head MSSs, for which amateur musicians reported a higher prevalence. Male musicians reported a significantly lower 7 day prevalence of MSSs overall compared with the reference group; a finding consistent with the Danish comparative study (Ekholm et al. 2016) which compared those who engaged in an hour or musical activity a day with those who did not. This difference was not observed in the female comparison. Regarding MSSs in specific body regions, male musicians reported a lower 12 month prevalence of knee MSSs, while

females reported a higher 12 month prevalence of head, neck and chest/abdomen MSSs. Interestingly, there were no such differences in the 7 day prevalence. It is unclear whether these gender-specific results relate to different biomechanical exposures related to different types of musical activities with a gender bias, or whether musical activity has a protective effect for males, but an adverse effect for females. Understanding the relationship between biomechanical factors related to musical activity and MSS outcomes would help to explain these results.

Based on the findings of our study, there is no evidence to support the need for preventive strategies or interventions that are specifically directed at adult amateur musicians. Nonetheless, the generalisability of our findings should be further explored. Generalisability may be limited given that groups were drawn from a population of university staff and students, hence our findings might not be generalisable to child or older amateur musicians. Similarly, the majority of amateur musicians in our study engaged in a low total number of hours of musical activity in the last week, hence we were unable to determine whether amateur musicians who engaged in more musical activity may be at increased risk of MSS outcomes. There were also relatively low numbers of woodwind, brass, bowed string and percussion instrumentalists, with guitar, piano and singing being the predominant musical activities. This bias may influence our results; both in terms of the biomechanical demands specific to their instruments, as well as the genres and ensembles they tend to engage with (Stanhope and Weinstein 2019). To better inform whether community musicians specifically need to consider MSS prevention and management, future studies should compare people engaged in community music, with appropriate comparison groups.

The findings of this study indicate that amateur musicians, particularly those engaging in fewer than five hours of musical activity a week, do not have markedly different MSSs profiles to non-musicians. This contrasts with the higher MSS burden experienced by university music students and professional musicians. We therefore conclude that musical activity is a safe leisure time activity, at least as far as the risks of developing MSSs are concerned. However, further research is required on the prevalence and profile of MSSs of other types of amateur musicians compared with non-musicians.

Acknowledgements

The authors would like to thank colleagues in the School of Public Health at the University of Adelaide who provided feedback on the questionnaire design. JS was a recipient of an Australia Government Research Training Program Scholarship, and a SafeWork SA WHS Supplementary Scholarship (funded by the South Australian Government). SafeWork SA and the South Australian Government do not endorse the content of this material and the views expressed herein do not represent the views of SafeWork SA or the South Australian Government.

Appendix: Gender-specific demographics and findings

Table A1: Demographics of male participants

	Amateur musician (n=47)	Non musician (n=98)	p-value
Age in years (median, interquartile range)	22 (19-28)	26 (19-41)	0.249
Body mass index (median, interquartile range)	23.15 (21.05-24.62)	23.09 (21.37-25.17)	0.914
Typical daily sitting time (%)			0.273
<8 hours	61.8	50.0	
>8 hours	38.2	50.0	
Socioeconomic status (%)			0.296
1	23.9	18.6	
2	28.3	22.7	
3	19.6	25.8	
4	28.3	33.0	
Current university student (%)	78.7	66.3	0.129
Number of employers in the last 12 months	1 (1-1)	1 (1-1)	0.119
Number of employers in the last 7 days	0 (0-1)	0 (0-1)	0.176
Hours worked in the last 7 days	0 (0-11)	0 (0-38)	0.108

Notes: *p<0.050, **p<0.010, ***p<0.001

Table A2: Percentage (95% confidence interval) of male amateur musicians and non-musicians reporting the musculoskeletal symptom outcomes

	Amateur musicians	Non-musicians
Musculoskeletal symptoms in the last 12 months		
Overall	91.1 (78.4-96.7)	94.9 (88.2-97.9)
Head	26.1 (15.4-40.7)	29.6 (21.3-39.4)
Orofacial	17.4 (8.9-31.2)	19.4 (12.7-28.5)
Neck	58.7 (44.0-72.0)	58.2 (48.1-67.6)
Shoulder	47.8 (33.8-62.2)	52.0 (42.1-61.8)
Elbow	19.6 (10.4-33.6)	19.4 (12.7-28.5)
Wrist/ hand	47.8 (33.8-62.2)	36.7 (27.7-46.8)
Upper back	34.8 (22.4-49.6)	48.0 (38.2-57.9)
Chest/ abdomen	13.0 (5.9-26.3)	17.3 (11.0-26.2)
Lower back	56.5 (41.9-70.1)	66.3 (56.3-75.0)
Hip/ thigh	32.6 (20.6-47.4)	26.5 (18.7-36.2)
Knee	21.7 (12.1-36.0)	41.8 (32.4-51.9)
Ankle/ foot	37.0 (24.3-51.7)	31.6 (23.1-41.5)
Musculoskeletal symptoms in the last 7 days		
Overall	66.0 (51.3-78.1)	82.7 (73.8-89.0)
Chronic	34.8 (22.4-49.6)	33.7 (24.9-43.8)
Chronic among those with musculoskeletal symptoms	53.3 (35.7-70.2)	41.0 (30.6-52.3)
Moderate/severe pain among those with musculoskeletal symptoms	13.3 (5.0-30.9)	10.4 (5.2-19.6)
Head	8.7 (3.3-21.1)	13.3 (7.8-21.6)
Orofacial	2.2 (0.3-14.1)	9.2 (4.8-16.8)
Neck	32.6 (20.6-47.4)	42.9 (33.4-52.9)
Shoulder	26.1 (15.4-40.7)	30.6 (22.2-40.5)
Elbow	10.9 (4.6-23.7)	10.2 (5.5-18.0)
Wrist/ hand	30.4 (18.8-45.2)	21.4 (14.4-30.7)
Upper back	17.4 (8.9-31.2)	29.6 (21.3-39.4)
Chest/ abdomen	2.1 (0.3-14.1)	11.2 (6.3-19.2)
Lower back	34.8 (22.4-49.6)	49.0 (39.2-58.9)
Hip/ thigh	19.6 (10.4-33.6)	13.3 (7.8-21.6)
Knee	17.4 (8.9-31.2)	25.5 (17.8-35.1)
Ankle/ foot	21.7 (12.1-36.0)	18.4 (11.8-27.4)
Consequences of musculoskeletal symptoms in the last 12 months[a]		
Changes to work/study	7.7 (2.5-21.5)	4.7 (1.7-11.8)
Leave from work/study	15.4 (7.0-30.4)	10.6 (5.6-19.2)
Consulted a health professional	48.8 (33.9-63.8)	49.5 (39.4-59.6)
Engaged in self-management	92.7 (79.5-97.6)	

Notes: Chronic: Musculoskeletal symptoms on most days for at least the last 3 months. Moderate/severe pain: ratings of pain on average of 5-10 on an 11-point numeric rating scale from 0 “no pain” to 10 “pain as bad as you can imagine”. The median (interquartile ranges) for ratings were as follows: pain intensity on average for amateur musicians was 2 (1-4) and for non-musicians was 2 (1-3), impact on daily life for amateur musicians was 3.5 (3-6) and for non-musicians 3 (1-4), and emotional impact for amateur musicians was 2 (1-5) and for non-musicians was 1 (0-3).

Table A3: Demographics of female participants

	Amateur musician (n=95)	Non musician (n=217)	p-value
Age in years (median, interquartile range)	21 (19-30)	29 (20-45)	<0.001***
Body mass index (median, interquartile range)	21.97 (20.20-25.59)	22.78 (20.70-26.36)	0.104
Typical daily sitting time (%)			0.761
<8 hours	70.3	68.0	
>8 hours	29.7	32.0	
Socioeconomic status (%)			0.943
1	26.9	29.0	
2	23.7	25.4	
3	28.0	25.8	
4	21.5	19.8	
Current university student (%)	74.7	53.0	<0.001***
Number of employers in the last 12-months	1 (1-2)	1 (1-2)	0.870
Number of employers in the last 7 days	0 (0-1)	1 (0-1)	0.002**
Hours worked in the last 7 days	0 (0-30)	15 (0-38)	<0.001***

Notes: *p<0.050, **p<0.010, ***p<0.001

Table A4: Percentage (95% confidence interval) of female amateur musicians and non-musicians reporting the musculoskeletal symptom outcomes

	Amateur musicians	Non-musicians
Musculoskeletal symptoms in the last 12 months		
Overall	98.9 (92.8-99.9)	96.7 (93.2-98.4)
Head	61.7 (51.5-71.0)	44.5 (38.0-51.3)
Orofacial	34.0 (25.2-44.2)	27.0 (21.4-33.4)
Neck	80.9 (71.6-87.6)	72.0 (65.6-77.7)
Shoulder	74.5 (64.7-82.3)	64.0 (57.3-70.2)
Elbow	11.7 (6.6-19.9)	17.5 (13.0-23.3)
Wrist/ hand	43.6 (33.9-53.8)	40.8 (34.3-47.5)
Upper back	53.2 (43.1-63.1)	46.0 (39.3-52.8)
Chest/ abdomen	26.6 (18.6-36.5)	15.2 (10.9-20.7)
Lower back	73.4 (63.5-81.4)	72.5 (66.1-78.1)
Hip/ thigh	41.5 (32.0-51.7)	44.1 (37.5-50.9)
Knee	41.5 (32.0-51.7)	46.4 (39.8-53.2)
Ankle/ foot	42.6 (32.9-52.8)	37.4 (31.1-44.2)
Musculoskeletal symptoms in the last 7 days		
Overall	81.1 (71.9-87.7)	84.8 (79.4-89.0)
Chronic	33.3 (24.5-43.5)	44.1 (37.5-50.9)
Chronic among those with musculoskeletal symptoms	41.3 (30.8-52.8)	52.2 (44.9-59.5)
Moderate/severe pain among those with musculoskeletal symptoms	11.0 (5.6-20.5)	19.1 (13.9-25.7)
Head	27.7 (19.5-37.6)	27.9 (22.3-34.3)
Orofacial	17.0 (10.7-26.0)	12.6 (8.7-17.7)
Neck	53.2 (43.1-63.1)	49.8 (43.1-56.4)
Shoulder	52.1 (42.0-62.0)	43.7 (37.2-50.5)
Elbow	4.3 (1.6-10.8)	9.8 (6.4-14.5)
Wrist/ hand	25.5 (17.7-35.3)	22.8 (17.7-28.9)
Upper back	33.0 (24.2-43.1)	27.9 (22.3-34.3)
Chest/ abdomen	11.7 (6.6-19.9)	5.1 (2.8-9.0)
Lower back	51.1 (41.0-61.0)	52.1 (45.4-58.7)
Hip/ thigh	24.5 (16.8-34.2)	31.6 (25.7-38.2)
Knee	27.7 (19.5-37.6)	28.8 (23.2-35.3)
Ankle/ foot	22.3 (15.0-31.9)	25.6 (20.2-31.9)
Consequences of musculoskeletal symptoms in the last 12 months[a]		
Changes to work/study	11.6 (6.4-20.3)	10.9 (7.2-16.1)
Leave from work/study	23.3 (17.9-29.8)	17.6 (10.9-27.3)
Consulted a health professional	65.5 (58.7-71.8)	59.1 (48.9-68.7)
Engaged in self-management	88.2 (79.9-93.3)	87.7 (82.4-91.6)

Notes: Chronic: Musculoskeletal symptoms on most days for at least the last 3 months. Moderate/severe pain: ratings of pain on average of 5-10 on an 11-point numeric rating scale from 0 “no pain” to 10 “pain as bad as you can imagine”. The median (interquartile ranges) for ratings were as follows: pain intensity on average for amateur musicians was 2 (1-4) and for non-musicians was 3 (1-4), impact on daily life for amateur musicians was 3 (2-5) and for non-musicians 4 (2-5), and emotional impact for amateur musicians was 3 (1-4) and for non-musicians was 2 (1-5).

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