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Abstract

Musculoskeletal symptoms, including pain, are often experienced by musicians at all levels. These symptoms may have a detrimental impact on musicians' personal and work lives, and may also impact upon the ensembles they work within. Providing musicians with appropriate, evidence-based advice regarding pain management is therefore paramount. In this review, we aim to improve the advice given to musicians regarding playing when in pain, by answering the question "should musicians play in pain?". This multidisciplinary narrative review draws upon contemporary pain science, including factors associated with poorer prognoses for those in pain, as well as the reported experiences of musicians with pain (including those who have taken time off from playing).

Our current understanding of pain science provides further support for the potential for consequences related to avoiding activities due to pain. Pain is modulated by a number of neuro-immunological processes, and is influenced by a range of psychosocial factors. Taking time off from playing might therefore not have any benefit. Importantly, one of the leading causes of a transition from acute to chronic pain is fear-avoidance behaviour (e.g. not playing when in pain); hence encouraging such behaviour cannot be supported.

Musicians who have taken time off from playing due to pain have experienced a range of consequences, including emotional and financial consequences. These experiences indicate that there are potential negative consequences related to taking time off from playing which need to be weighed against any benefits.

We conclude that musicians should not necessarily be advised to take time off from playing to manage their pain, in keeping with current best practice for pain management. Instead, we recommend that musicians be educated on contemporary pain science and when to seek treatment from a health professional for individualised advice is recommended to reduce the burden of musicians' pain.

Keywords: pain, musculoskeletal, neuroscience, musician, performing, advice

Should musicians play in pain?

Background

Musculoskeletal symptoms (MSSs) are common among musicians at all levels[1-6], with a 12 month prevalence of 85-89% and point prevalence of 57-68% among professional musicians and university music students.[4] University music students and professional musicians have a higher prevalence of MSSs compared with reference groups,[7-10] while university music students with MSSs have reported higher ratings of impairment (i.e. impact on daily life) and emotional impact of MSSs compared with medical students[11], as well as higher ratings of functional impairment specific to neck/upper limb MSSs.[12] Musculoskeletal disorders are the most common and costly type of workers' compensation claim made by musicians[13]; hence strategies to reduce the burden of musicians' MSSs, including pain, are required. A wide range of musicians' MSSs have been investigated, and include pain, soreness, discomfort, ache, tension, clicking, popping, crepitus, tightness, stiffness, reduced range of motion, loss of motor control, cramp, muscle fatigue, loss of speed, loss of endurance, swelling, redness, burning, numbness, and tingling.[14] Our review focuses specifically on pain because pain is the most commonly reported[15, 16] and investigated[14] type of MSS among musicians. Musicians with MSSs, including pain, have reported experiencing a range of consequences in both musical and non-musical aspects of their lives.[9, 17-21] Providing musicians with appropriate advice regarding pain management is therefore paramount.

It has been suggested that musicians should not play when in pain[22, 23], with evidence to suggest that some musicians adopt this recommendation.[24] There appears, however, to be a lack of evidence supporting this advice, and there are potential negative consequences from doing so. In keeping with the ideals of beneficence and non-maleficence, integral to the work of health professionals[25-28], the evidence regarding the potential negative consequences of this advice should be explored.

We therefore ask the question "should musicians play in pain?" to provide evidence-based recommendations to musicians, clinicians and public health practitioners to improve pain outcomes for musicians, and ultimately reduce the burden of musicians' pain.

Methods

A multidisciplinary, narrative review approach was adopted to answer our research question. First, we review the literature for pain mechanisms as well as risk factors for the transition from acute to chronic pain, and how this may relate to musicians. Secondly, we review the negative consequences for musicians who have taken time off from playing due to pain, and other MSSs (as the consequences of MSSs are likely the same as for pain). The latter is important as their experiences provide insight into some of the consequences faced by musicians who take time off from playing, and therefore should be considered when deciding whether musicians should or should not play in pain. Studies specific to musicians' MSSs were primarily identified through a systematic mapping review of the recent peer-reviewed literature,[29] while the broader pain science literature was also reviewed, including key comprehensive reviews.[30-33]

Pain

In this section, we briefly describe what pain is, the types of pain and pain mechanisms, so as to contextualise our argument. Readers who are interested in more comprehensive reviews

on the topic are referred to Hainline et al.[30], Bushnell et al.[31], Guo et al.[32] and Fregoso et al.[33] for further information.

Pain has been defined by the International Association for the Study of Pain as "an unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage".[34] There are three main types of pain: nociceptive, neuropathic and nociplastic/ algopathic/ nocipathic pain[30], as summarised in Table 1. These pain types are not necessarily discrete, and may occur in combination.[30] Musicians pain may therefore be related to their musical activities through nociception (e.g. repetitive or ongoing load) or neuropathic processes (e.g. inflammatory irritation or repetitive mechanical load leading to peripheral nerve damage), non-musical exposures (nociceptive or neuropathic), or be the result of nociplastic, algopathic or nocipathic processes. The experience of pain is complex, and has inter- and intra-individual variability, that is driven by the context, social, environmental, immunological and neurophysiological factors, psychological state, and cognitive and emotional aspects of pain.[31, 35-37]

Table 1: Brief description of the characteristics of each pain type

Pain type	Characteristics
Nociceptive pain	• Involves the activation of nociceptors (the peripheral nerve terminals that detect noxious stimuli, i.e. mechanical, thermal and chemical stimuli).[38] • Nociceptors can be triggered following an injury (e.g. sprained ankle) where the tissue damage is sudden, or via ongoing repetitive load (e.g. tendinosis) • Nociception (the encoding and processing of noxious stimuli[38]) does not necessarily lead to pain, because other processes are involved.[30] • Nociceptive pain is a type of protective mechanism, and nociceptors have been described as the 'first detection' system for body tissue.[30] • The association between the amount of nociceptor activation and the experience of pain is not necessarily linear,[30] and pain does not necessarily mean the tissue is threatened. • Inflammatory pain is a type of nociceptive pain, where the physiological changes involved in inflammation trigger nociceptors.[38]
Neuropathic pain	• Relates to a lesion in the somatosensory nervous system.[34, 38, 39] • Lesions may occur as the result of trauma (including surgery) or disease (e.g. diabetes mellitus, or stroke) in the spinal cord, nerve roots or peripheral nerves.[40] • Damage to peripheral nerves may also occur through inflammatory irritation or repetitive mechanical load[30]; hence some musical activities may lead to neuropathic pain. • Neuropathic pain does not require nociceptive activation.[30]
Nociplastic, algopathic & nocipathic pain	• Sometimes called 'dysfunctional pain'[41] • Describes pain that relates to altered nociception, without evidence of a threat or damage to tissue, nor any lesion of the somatosensory nervous system.[39] • Nociplastic pain describes pain driven by altered nociceptive pathway function[30] • Nocipathic pain, a pathological state of nociception[30] • Algoplastic pathological pain, a pain that has not been generated by injury[30] • Fibromyalgia, visceral pain disorders, and Complex Regional Pain Syndrome Type 1 are examples of conditions that appear to be driven by these pain types.[39] • Mechanisms may include central sensitisation[39], a neurophysiological construct whereby the nociceptors in the central nervous syndrome become hypersensitive.[38]

Note: see Hainline et al.[30] for a description of the clinical patterns

It is now well established that pain is a conscious event, not a sensory signal, and that [30]the relationship between tissue damage and the experience of pain is not linear.[30] Pain can occur without tissue damage, and tissue damage without pain.[42-45] For instance, abnormal anatomical findings on imaging scans occur in asymptomatic individuals[43-45], while symptomatic individuals may have no detected abnormalities.[42] There is also evidence of a poor correlation between physical test findings and "soreness, pain or discomfort" in musicians specifically.[46 31, 47, 48]As pain is not necessarily the result of tissue damage nor threatened tissue, the value of musicians taking time off from their musical activities must be

questioned. Pain is therefore a complex experience, and the drivers of pain modulation (in both directions) need to be explored in order to develop effective management strategies.

[30]Pain modulation may explain why there is not a simple relationship between tissue damage (and potential damage) and the experience of pain. Modulation occurs through various processes in the peripheral and central nervous systems[30], and relevant neurological changes include both the anatomy and function of the nervous system[31] (see Bushnell et al.[31] for a comprehensive review). Several of the brain regions involved in the processing of pain (or the stimuli resulting in pain, e.g. the somatosensory[49], prefrontal[49], and anterior cingulate cortices[49], the insula[49], amygdala[50, 51], nucleus accumbens[50, 51], periaqueductal grey[52], thalamus[49], and the cerebellum[49]) are also involved in a range of other processes (including sensory processing[53-56], executive functioning (e.g. attention)[54, 56, 57], memory[54, 56, 58], emotion (including fear)[59-62], motivation[58, 59], motor control[53, 57, 59], and descending pain modulation[63]). The multiple functions of these brain regions may explain the role that contextual cues[64], non-nociceptive sensory input[64], and affective and cognitive factors[31] play in the modulation of pain. Furthermore, associations between changes in some of these brain regions and emotional and cognitive representation of pain have been identified in those with chronic pain[65], providing further support for the important role that psychosocial factors may play in the pain experience, particularly the transition from acute to chronic pain.

There are several differences between the brains of musicians and non-musicians[66-69], with some of these differences including having a larger somatosensory cortex[68] and cerebellum[69], as well as greater insula connectivity[70] - changes associated with pain processing.[49] Musicians also have sensory processes which have been described as maladaptive, as musicians without chronic pain have sensory processing similar to those of non-musicians experiencing chronic pain.[71] The neurological differences between musicians and non-musicians may contribute to the higher prevalence of MSSs among musicians compared with reference groups.[7-10]

Musicians may be more likely to experience pain of greater intensity than any tissue damage indicates, compared with the general population, owing both to neurological differences, and to musicians having a higher prevalence of sleep problems[72] and psychological distress[73] (both pain moderators). If musicians' pain is driven by psychosocial factors, such as distress, then avoiding musical activities is arguably unlikely to lead to an improvement in pain outcomes.

Distraction also diminishes the intensity of pain, and has been used for both acute (e.g. during medical procedures) and chronic pain.[74, 75] Indeed, playing a musical instrument may serve as a pain-reducing distraction. Musicians, for instance, have reported that they did not experience pain while playing, but experienced pain soon after stopping.[76] Playing a musical instrument therefore may have analgesic effects.

Another process of particularly relevance to musicians that may alter an individual's response to mechanical loading is the up-regulation of nociception.[30] This up-regulation may occur due to low-level inflammation whereby the threshold of mechanical nociception is reduced; hence mechanical demands which would previously not have triggered nociceptors now do, which may lead to an increase in the level of pain experienced with a previously unpainful experience.[30] Low-level inflammation may be due to load exceeding the tissue's capacity, but also other factors such as ongoing stress and sleep deprivation.[30] Another issue with ongoing, repetitive load that exceeds the tissue's capacity, is the establishment of a cycle of inflammation-repair-remodelling-inflammation.[30] This cycle can alter the mechanical

properties of tissues which may in turn alter nociceptive activation[30], and may therefore be of particular relevance to musicians.

Fear-avoidance behaviour is of particular importance to whether musicians should play in pain, given this behaviour relates directly to not playing when in pain. While nociceptive pain is a protective mechanism, the lack of direct relationship between tissue damage and pain indicates that it is not a valid indicator of damage or potential damage. Individuals may however inaccurately believe that certain activities or actions may result in injury, and fear the sensation of pain.[77] These inaccurate beliefs may lead to the avoidance of the 'dangerous' activity, which may in turn contribute to deconditioning and disability.[77] While the impact of fear-avoidance on musicians' pain has not been examined[29], fear-avoidance behaviour is a driver of pain modulation, and is associated with the transition from acute to chronic pain in other populations.[78] Furthermore, fear-avoidance behaviour is associated with a poorer prognosis[79] and treatment outcomes in the general population, particularly when the fear-avoidance behaviour is not addressed as part of the treatment.[80] Advice to musicians regarding not playing while experiencing pain may re-inforce the individual's inaccurate beliefs, and lead to fear-avoidance behaviour, and ultimately poorer pain outcomes, including chronic pain.

Consequences of having time off due to pain

Musicians typically do not want to take time off from playing, and fear being given such advice by health professionals.[81] Musicians work in a competitive industry[82], characterised by unstable employment[83] and constant criticism[84], with a stigma regarding pain.[22] There are several consequences for musicians who disclose their pain experiences to others, particularly when they take time off from playing.

[22]Musicians who have taken time off from playing have described feeling a loss of identity and self-worth, as well as feelings of 'letting down the team', isolation, and depression.[22] These consequences are potentially more influential in musicians than other occupational groups for several reasons. For example, musicians begin their training in their childhoods[85, 86] and being a musician becomes a strong part of their identities[18, 22, 81, 87] - arguably more so than most other occupational groups. Playing music is not only a career, but also a recreational activity for musicians that provides a form of communication and socialisation.[19] Furthermore, musicians have been described as 'subjective careerists'[84], for they are driven by internal factors or a 'calling' to participate in their career.[88] There are therefore clear potential negative consequences involved in advising musicians to take time off from playing, which must be weighed against the benefits, especially when provided as generic public health advice.

Taking time off from playing may threaten musicians' employability and financial security, given the competitive nature of the industry[82], and the stigma related to pain.[22] Further, musicians typically have precarious employment. For example, in Australia 86% of professional musicians work in a self-employed or freelance capacity[83], so many are unlikely to be able to access sick leave and/or workers' compensation. These entitlements are not available to those who are self-employed, and while they are available for freelance musicians who are employed by another entity, the fear of damaging their reputations and future employability may prevent musicians from accessing these entitlements. Even musicians working for a reliable employer have reported such concerns.[20] Without accessing sick leave and/or workers' compensation, musicians may struggle financially if not playing. They

typically have low incomes, for instance in Australia musicians' total weekly incomes are lower than for other artists and the general population (including those who are not working).[89] Taking even a short break from work may therefore have significant financial consequences. Recommending that musicians take time off from playing when in pain may therefore have both financial and career consequences.[22]

For musicians employed in ensemble work, there may be additional negative consequences from taking leave for pain and/or other MSSs, particularly given the point prevalence of MSSs among professional musicians and university music students is as high as 57-68%.[4] With such a high prevalence of MSS (including pain), it would be impractical for all musicians with pain to take time off from playing, especially considering the complex musical relationships in ensemble playing (e.g. orchestras, that do not have understudies or replacements trained up to fill in for musicians on leave.[29, 90] Although impractical for these ensembles, this problem in itself is not sufficient to recommend that musicians keep playing when in pain, but should be included with other considerations when determining whether musicians should play in pain.

Discussion

The current evidence regarding pain mechanisms and predictors of chronicity, as well as musicians' experiences with having time off from playing due to pain, indicate that musicians, in most cases, should continue to play in pain. Our findings are in conflict with some of the present advice given to musicians.[22, 23] This evidence-practice gap is not only present in the care of musicians, but also the general population.[91]

Both current pain science, and evidence regarding musicians' pain, indicate that public health advice directed towards musicians should not include suggestions that they do not play when experiencing pain. This recommendation is in keeping with best practice for managing musculoskeletal pain, where the maintenance of normal physical activity should be encouraged.[92] Musicians are more likely to experience pain of greater intensity than any tissue damage indicates, compared with the general population, owing to neurological differences, and musicians having a higher prevalence of sleep problems[72] and psychological distress[73] (both pain moderators). If this is the case, taking time off from playing would not be anticipated to alter the musicians' pain. Indeed, because a range of negative consequences of having time off have been reported, their pain may increase with time off, thereby further exacerbating pain through the encouragement of fear-avoidance behaviour. Public health advice suggesting that musicians should not play while in pain is therefore potentially damaging.

We are not suggesting that musicians be expected to play while in pain, but rather that this advice should be provided on an individual level. In a clinical setting, health professionals can determine the extent (or presence) of any tissue damage and/or inflammation, the intensity and degree of chronicity of a musicians' pain, as well as any other contributing factors (e.g. pain beliefs, distress, sleep problems). Based on an individual assessment, a health professional may deem it appropriate to suggest that a musician stop playing for a period of time, or reduce the amount that they are playing. This decision should involve the musician, and clinicians should be aware of the potential consequences of this advice. In addition to the concerns raised in this review, clinicians should be aware that some musicians may try to 'make up' lost practice time after being granted permission to commence playing again. A plan to pace back into playing should therefore also be discussed.

As previously mentioned, there is a range of non-biomechanical factors that may be contributing to a musicians' pain, including pain beliefs, stress, distress, and sleep problems. If present, these factors should be addressed by a health professional, potentially within a multi-disciplinary team; an approach that should not be unique to musicians. Musicians do have unique concerns however, and addressing other contributing factors provide a more effective approach than focusing on these unique concerns.

Rather than suggesting that musicians stop playing when in pain, we recommend that musicians be educated about what pain is and how best to manage it (including when to see a health professional) as a public health strategy. To date no study of musicians has investigated the effect of this kind of education on musicians' pain <reference removed for blinding>. Pain education has however been investigated in workplace settings and reportedly improved work ability[93], reduced sick leave[93-95] and number of visits to healthcare professionals[93] resulted in lower ratings of the 'bothersomeness' of pain[93] and reduced feelings of sadness/depression.[93] The evidence regarding pain education for those with chronic pain is mixed regarding pain and disability with pooled estimates indicating no clinically significant benefit, however significant reductions were reported in catastrophisation and kinesiophobia.[96] These findings may indicate that pain education may be more useful as a public health strategy, particularly before the individual experiences chronic pain.[96] Pain education is in line with current best practice for musculoskeletal pain management[92], and public health recommendations.[97] We therefore suggest that public health pain education interventions for musicians be developed, evaluated, and effectively implemented, to reduce the burden of musicians' pain.

As highlighted here, musicians experience a range of negative consequences when they have pain, particularly if they take time off. Many of these consequences appear to be driven by stigma and a fear of 'retribution'. Some musicians will have to take time off, and others may fear that they will have to do so in the future. By changing the culture of silence around musicians' pain, and by providing a supportive environment whereby musicians with pain are not simply seen as being unreliable and having poor technique, some of the factors that may increase a musicians' risk of transitioning from acute to chronic pain may be reduced. Such factors are likely to include emotional distress[65], and fear-avoidance behaviour[78], and ameliorating these adverse influences would also likely improve quality of life generally.

The findings of our review may be generalisable to other groups. As outlined above, encouraging people to maintain normal physical activity is in line with current best practice for musculoskeletal pain management.[92] The additional consequences musicians experience when taking time off from playing may also be experienced by other groups. For instance, occupational groups characterised by precarious employment, particularly in competitive industries, are likely to experience similar issues to musicians should they take time off due to their pain. Furthermore, musicians share many similarities with sports people (including dancers), particularly regarding the close ties between their identity and career.[98] Nevertheless there are several differences which may influence musicians' experience and management of pain.[99] For instance, even though dancers have reported similar negative emotional consequences to musicians regarding having time off due to pain and/or injury[98, 100], a key difference is that dancers, like sportspeople[99], normalise pain; they expect and work through pain.[98, 100] Dancers are also arguably more likely to experience injuries with tissue damage than musicians, given the physical loads encountered, which may limit the

applicability of our recommendations to other occupational groups, even when there are similarities in career and emotional consequences.

Conclusion

While some musicians may require time off from their playing due to pain, this should not be provided as generic public health advice. Contemporary multidisciplinary evidence indicates that such advice is not appropriate. Not only may taking time off from playing be unnecessary, it may encourage fear-avoidance behaviour, and result in a range of negative consequences for musicians. By not playing, the pain experience may be exacerbated and the risk of transitioning from acute to chronic pain increased. Educating musicians regarding contemporary pain science and when to seek treatment from a health professional for individualised advice is recommended to reduce the burden of musicians' pain.

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<removed for blinding>

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