Musculoskeletal pain & dysfunction in musicians
Woldendorp, Kees Hein

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Chapter 9

General Discussion
General discussion

The overarching aims of the studies reported on in this thesis were to gain more understanding about the causation of chronic nonspecific musculoskeletal complaints (MSC) in musicians, and about appropriate measurement instruments for relevant motor functions. The information is provided in eight chapters, divided into a general introduction and two sections (Parts 1 & 2) each focusing on one of the above main subjects. Part 1 focused on the testing of correlations between three presumed etiological factors and MSC. In Part 2 the focus was on the assessment of motor functions and related body structures in musicians, in particular on the identification and development of measurement instruments. This chapter describes the main findings, the strengths and limitations and the possible implications for the fields of occupational and pain rehabilitation in general and more specifically for music medicine, including suggestions for future research.

Part 1: Causation of musculoskeletal complaints

Muscle activation pattern & musculoskeletal complaints

The aim of this study was to explore the muscle activation patterns of bassists while performing a musical task, in relation to pain complaints. Bassists who indicated pain in the last three months were compared with bassists without pain. The hypothesis was tested that the bassists with pain had a higher level of muscle activation before, during and/or after a playing task, while controlling for confounders. This hypothesis was not confirmed, as no statistically significant relationship was observed between muscle activation patterns and MSC.

Static posture & musculoskeletal complaints

The hypothesis we tested was whether a negative influence of frequent and static postures would lead to a difference in the prevalence of pain between subpopulations of bassists, viz. double bassists and bass guitarists. No statistically significant correlations were found between these postures and MSC. The study showed that the difference between playing the double bass (prolonged abduction of the left shoulder) or playing the bass guitar (with marked flexion of the right wrist) for many hours a day was not related to a higher prevalence of MSC in the corresponding areas. Bowing style, which, as far as we know, was studied here for the first time, was also unrelated to differences in the prevalence of MSC.

Variation in posture & musculoskeletal complaints

We tested the assumption that more variation in occupational load was related to a lower prevalence of MSC. The findings showed that bassists who played two or more music instruments had a higher risk of MSC in the left shoulder than those who played only one instrument. MSC in other joint areas were not statistically significantly related to greater or lesser variation, i.e. playing one or more instruments. Hence, the assumption was not confirmed.

i Musculoskeletal complaints/pain: For reasons of readability, the terms MSC and pain are used synonymously in this thesis, since the symptom pain forms the vast majority within the spectrum of complaints. If other MSC-symptoms than pain are meant, this is explicitly indicated.
Lessons learned from the studies on assumptions about musculoskeletal complaints

Assumptions about alleged causality or the contribution of physical risk factors for MSC, such as specific muscle activation patterns and occupational factors, are present in literature and among clinicians. Despite the methodological challenges and limitations, as described in the discussion sections of the individual chapters, the results of the three studies challenge theoretical and clinical assumptions in occupational, pain and music medicine.

Various explanations can be given for the outcomes of our studies:

1. Our findings can be an indication that these assumptions are incorrect or not as strong or as one-dimensional as suggested. Recently, there is increasing evidence that changes in the central nervous system - with ongoing altered sensory transmission on nociceptive stimuli (central sensitization) - appear to play a dominant role in the pathophysiology of chronic MSC. This implies less dominance of the musculoskeletal structures and locally associated biological responses in the causation model of chronic MSC in compare to acute MSC.

2. Each of the three studies focused on finding statistical correlations between one etiological factor and MSC. Although it is a common approach in research to focus on the relation between one factor and another, with hindsight it is questionable whether this approach was appropriate. A look at the dominant explanation model for the causation of MSC, i.e. the bio-psycho-social model, shows that a wide range of etiological and predisposing factors can be expected (see ‘the general introduction’ for a description of these factors based on the model of the International Classification of Functioning, Disability and Health (ICF)). Moreover, the interactions between multiple factors may be more important than single relationships. This aspect was under represented in our studies. Perhaps the etiological factors we studied only affect MSC in certain subgroups. For example, it is possible that it was only in the subgroup of people with high psychological distress that the etiological factors we studied were statistically significantly associated with MSC, and not in the total study sample.

Another aspect of the complexity of studying relationships and possible interaction models may be the following. Although a linear relationship may be assumed in association models, non-linear relations, e.g. logarithmic or S-shaped functions, are often seen in realistic situations. These non-linear relations feature thresholds (so called tipping points), which are interrelated and change over time. When such a tipping point is reached, a clinically relevant phenomenon will occur. Interpretation of non-linear associations and interactions are even more complex as it involves non-linear statistics. Other study designs than our cross-sectional studies are then necessary to study the nature of these dynamics. The study designs used by Scheffer et al. are examples of how such tipping points – for one factor or for the interaction between multiple factors – can be identified in biology or sociology. Similar study designs exist in the field of medicine and these studies have identified similar phenomena of non-linear dynamics in e.g. neurology. Young et al. theorized how these dynamics may work for chronic pain, but without suggesting
a suitable study design.
3. The clinimetric values of the measurement instruments used may not be adequate to measure the factors we studied in relation to MSC. In the absence of reliable and valid instruments to measure all the dependent and non-dependent variables, a new questionnaire was developed to determine the characteristics of MSC, the characteristics of occupational load and most of the potential confounders. It is also questionable if surface electromyography (sEMG) is able to detect the subtle changes in muscle activation patterns related to aspects like muscle fatigue, which may be a relevant etiological feature in the causation of MSC.

4. The absence of statistical associations can also be explained by the wide inter-individual variety, e.g. in muscle activation patterns, within the samples of bassists with and without pain. It is not clear whether this means that there is no causal relation between this factor and MSC, or that there is a relation which we were unable to identify because of the relatively small number of bassists in this cross-sectional study design.

In view of the arguments mentioned in points 2, 3 and 4 above, it can be argued that it would have been difficult to disentangle the relation between etiological factors and MSC, if any, in the way we designed our studies. The lesson learned from our results is that other statistical methods and/or other study designs than cross-sectional could be used for the identification of statistically significant correlations between etiological factors and MSC. The literature does support the use of a cross-sectional study design as a first step in the identification of correlations,\textsuperscript{13-15} and this type of study design can deliver relevant information about one-dimensional relations.\textsuperscript{16,17} However, when studying multifactorial relations, as is the case when studying the causality of MSC, this approach may not be successful (see ‘Suggestions for future research’).

In view of the results of the studies, it is difficult to say what lessons can be draw for clinical practice. Substantial elements of physical training – such as maintaining a good posture, varying postures over time and learning to reduce body arousal (e.g. muscle relaxation techniques) – are included in the rehabilitation of patients with MSC. Many clinicians and patients with MSC support the value of these physical elements in rehabilitation programmes, in combination with other bio-psycho-social interventions. More studies with a different design (see ‘suggestions for further research’) are necessary to confirm or falsify the assumed causal relations. When mechanisms are sufficiently understood, appropriate interventions should be examined in order to identify the right therapy for patients with MSC, and in particular for musicians with MSC.

**Part 2: Measuring motor functions relevant for musicians**

**Main findings**
In Part 2 of this thesis the attention shifted from demonstrating causality to the identification of valid and reliable measuring instruments for physical characteristics relevant to musicians. The studies reported in this thesis must be regarded as a first
step in this direction. Since a wide range of instruments are required for measuring the physical aspects of musicianship, we decided to first evaluate some of the existing measuring instruments for their usefulness and clinimetric qualities. Depending on the stage of development of the instruments for one physical aspect, the research aims of the studies differed. For example, in the absence of an instrument for embouchure, we choose for developing a new one. Our studies regarded three relevant motor functions and related body structures in musicians, viz. posture, hand function and embouchure.

1. Posture
A systematic review was performed to provide an overview of assessment methods for sitting and standing postures in a clinical setting. Thirty-two assessment instruments were identified, grouped into 5 categories: direct or indirect visual observation, direct or indirect body measurement, and digital assessment. Based on a moderate level of evidence, a tentative recommendation was made to use a direct visual observation method for the assessment of sitting and/or standing posture, with an interval rating scale, applied by a trained observer.

2. Hand features
The reliability of the Practical Hand Evaluation (PHE) screening tool for anthropometric features of the hand was tested. The reliability of the PHE was found to be good for nearly all items, making it suitable as a measurement instrument for the anthropometrics of the hand at group level. However, the magnitude of the standard error of measurement (SEm) for the individual PHE hand items was found to be too high for identifying deviations of hand features in individual musicians, as an etiological factor in the development of MSC. Cluster analysis identified clusters of hand items, yielding a physiologically plausible clustering with respect to hand function, which may be used to reduce the number of items of the PHE in future research. Such an item reduction may improve the usability of the PHE as a measurement instrument for anthropometric features of the hand for musicians and other manual workers.

3. Mouth area/embouchure
A literature review and information from experts about embouchure resulted in a proposal for a new definition of embouchure, including: a/ relevant physics, acoustics and functions of embouchure-related body structures, b/ the main methods to measure embouchure in brass playing, and c/ the development of a clinical assessment tool for embouchure in brass players (the ‘CODE of Embouchure’). The development of the CODE of Embouchure was necessary because the current methods to measure embouchure are too sophisticated to use in routine practise and/or measure only some of the embouchure-related aspects. Moreover, these methods lack a scale to quantify the observations. The content validity of the Code of Embouchure was established for nearly all of its items via a Delphi procedure involving a panel of experts drawn from all over the world.

Lessons learned from measuring motor functions relevant for musicians
Music education aims at achieving the highest musical performance level in the individual musician. Besides, teachers focus on the prevention and/or treatment
of limitations in music performance. If health problems like MSC occur, proper music education by the teachers and additional treatment by health professionals are required to resolve chronic complaints. Achieving these goals requires a systematic and evidence-based approach for individual musicians (with or without MSC) like measurement of motor functions relevant for musicians.

MSC in musicians is a major problem and at the top of the list of complaints limiting musicians in their performance.\textsuperscript{18,19} Moreover, the success rate of currently available educational methods and treatments of MSC in musicians is limited, for example regarding musician’s dystonia.\textsuperscript{20} This might be explained by the fact that the methods used in music education and music medicine are mainly based on expert opinion, with sometimes conflicting theories and approaches. This expert-opinion approach is inherent to the early stage of scientific development of these two fields.

The ability to accurately measure motor function and its related body structures in music education and music medicine is an important step to improve awareness among teachers and therapists/physicians about the physical aspects related to music performance in the individual musician, to monitor the effects of interventions and to enable comparison the effectiveness of these interventions. International consensus about the use of assessment instruments is needed to enable the comparison of study results. For none of the physical functions and related body structures tested in musicians, viz. posture, hand and embouchure, this consensus exits. For the measurement of some motor functions, like embouchure, there is even no suitable instrument available. The three measurement instruments described in Part 2 of the thesis have the potential to develop into validated clinical standards for the assessment of some of the above functions and related body structures.

1. Posture
The main lesson to be learned from our systematic review of posture assessment is that the method most commonly used in clinical practice, i.e. unstructured assessment through direct visual observation, is unreliable. Moreover, sitting and standing postures may not be assessed in a valid way with any of the available clinical methods for musicians with MSC. Whether the methods used in clinical practice are valid is unknown due to the virtual absence of validation studies of clinically usable observation methods for these postures in people with or without MSC.\textsuperscript{19}

2. Hand features
In our study on the assessment of anthropometric hand features with the PHE we found a discrepancy between reliability at group level (shown by high ICCs) and individual level (shown by high SEms). The high SEms mean that a substantial proportion of musicians (or other hand workers) would be misclassified by the PHE, because of the high level of measurement error. The literature about MSC among musicians draws several conclusions about hand features which would put a musician at risk for the development of MSC.\textsuperscript{22-29} These conclusions were based on measurements with the PHE (without realizing the above shortcoming in clinimetric properties of these instruments) or other measurement instruments (with unknown clinimetric properties). The findings of our study make it questionable whether the identified
risk features for MSC of the upper extremity (e.g. small size of digits V as measured with the PHE)\textsuperscript{22-25,28} are true risk factors. In the case of studying anthropometric hand features associated with an elevated risk for MSC, further studies are needed with a revised version of the PHE that has smaller measurement errors – as developed and tested by our research group (publication in preparation)- or another measurement instrument with good clinimetric properties.

3. Mouth function/embouchure
Our two studies about embouchure showed, on the one hand, that it was possible to describe a well-defined construct of embouchure based on physics and acoustics, and on the other hand that we were able to develop international consensus about an assessment instrument for embouchure. The Delphi approach appeared to be a useful method to create international consensus, and to identify and aggregate knowledge derived from the literature and from experts in the field of music medicine and music education.

Methodological considerations about parts 1 and 2 of the thesis
Various research methods were included in the studies described in this thesis: three cross-sectional studies, three studies on clinimetrics (including a reliability study, a Delphi study and a systematic review), and a descriptive study about construct building. Each study design has its own strengths and weaknesses, which were described in the discussion sections of the individual chapters. Recurrent and overlapping themes in the successive studies of Part 1 are described below. The diversity in designs of the studies in Part 2 do not provide for common strengths or limitations.

Strengths
Bassists were found to be a very suitable population to test assumptions regarding MSC, for four reasons: (1) bassists are among the professional musicians with a high prevalence of pain,\textsuperscript{30,31} (2) the bass is the only instrument which can be played in two varieties (i.e. the bass guitar and double bass) leading to two different postures; (3) within the group of double bassists there is another more subtle difference in occupational load, i.e. two ways of bowing; and (4) a substantial proportion of bassists play more than one instrument. As a consequence, using samples of bassists to test assumptions about the causality of motor function aspects in MSC enables the creation of subgroups with similar bio-psycho-social characteristics at group level, but with clear differences in occupational load.

Limitations
Three potential limitations of the studies in Part 1 of this thesis can be identified: the relatively small size of the study samples, the risk of having missed potential confounders, and the use of a self-report questionnaire.

1. Size of the study samples:
Although the size of our study samples of bassists was larger than those in other studies about bassists reported in the literature, a larger study sample might have yielded different results. It is a rule of thumb\textsuperscript{13} that sufficient statistical power of a
study requires at least ten participants for each factor included in the model. The statistical model in our studies included 24 factors. As a consequence, the study sample sizes of 36 bassists in our first study and 141 bassists in the second and third meant that the statistical power of our studies was limited. The recent literature on multifactorial composite models recommends a minimum of 250 participants. In future studies with the same aim, the study sample size should therefore be nearly doubled.

2. **Missing potential confounders:**
A potential limitation of the studies may be that not all potential confounders were included. Although in preparation for our studies we did an extensive literature search to identify factors related to MSC, it is possible that we missed relevant biological, psychological and/or social factors, such as those related to the phenomenon of central sensitization. There is little literature about these aspects regarding musicians. Further studies may identify such factors, which can then be added to the statistical model.

3. **Self-reported questionnaires:**
Self-reported questionnaires are an accepted method to assess sample characteristics, and are in fact the only way to gain information about the level of pain. There are three disadvantages of their use in our studies which should be mentioned. Firstly, there was a lack of validated pain questionnaires in the field of music medicine when we started our studies, also reported by Baadjou. The existing pain questionnaires may not be suitable for the specific situation of musicians, as they lack questions about music-related characteristics. As a consequence of this problem, we had to use a self-constructed questionnaire, which had not been validated in other studies. Secondly, self-reporting on MSC, functioning and changes in performances over time has its limitations. It is known from the literature that self-reports differ from the actual performance. In our studies, for example, it can be argued that the substantial percentage of reported work-related limitations in combination with the low level of numeric rating scale (NRS) as reported by most of the included bassists, might indicate for underreporting of the real experienced intensity of MSC by these bassists. This phenomenon of lower psychometric values of low NRS scores in musicians with pain is also reported by others. Thus, if musicians tend to underrate their intensity of MSC, a more objective way of pain measurement might have influenced the outcome of the studies. It is therefore recommendable to include objective physical and/or functional measurements to the questionnaires in future studies. Moreover, reporting about functioning in the past or differences between now and the past is difficult for many people as they may not remember the level of complaints in the past. As a consequence, frequent data sampling would have been necessary to get reliable and valid information. Thirdly, it is unclear to what extent we may have introduced selection bias with our online-based questionnaire. Although there are many advantages of using a survey-based questionnaire, it is known that the response rate for such questionnaires is lower than for postal surveys. The difference in response rate probably depends on how the survey-based procedure is organized for the participants. The influence, in terms of both direction and extent, of this potential selection bias on the outcomes of the studies is not known,
as is explained in the discussion section of the study about the association between posture and the locations of MSC (Chapter 3).

**In conclusion**

The first overarching aim of the studies in Part 1 of this thesis was to gain more understanding about the causation of chronic nonspecific MSC in musicians. The second aim (of the studies in Part 2 of the thesis) was to gain more knowledge about appropriated measurement instruments for relevant motor functions in musicians. Based on the results and the limitations of the studies in Part 1 of this thesis it must be concluded that it is yet too early to conclude whether one of the three studied physical factors (muscle activation pattern, sustained ergonomically unfavourable postures, and level of variation in occupational load) at their own play a dominant causal role in chronic MSC.

The studies in Part 2 of the thesis resulted in more information about the clinimetrics of existing measurement instruments for two motor functions presumed to be relevant for musicians (posture and hand anthropometry), usable for routine practise. Based on the results from the systematic review about the assessment of global posture in routine practise, it can be advocated to use a direct visual observation method of posture in combination with interval scores by a trained observer. If assessment of the hand characteristics is the intention, the PHE may be a sufficient measurement instrument to measure on group level. Measurement on an individual level is yet not advocated because of the substantial SEM. A new construct of embouchure together with an overview of the underlying physics, body functions and related body structures of embouchure enabled the first stages of development of a measurement instrument for embouchure in clinical practise.

However, a restriction should be made upon the clinical relevance of the outcomes of the studies of Part 2 of this thesis; despite the progress achieved in increasing knowledge about measuring instruments in musicians, still, there is too little knowledge about the validity of measuring the particular body functions and related body structures in relation to MSC among musicians. That validity aspect fell outside the scope of this thesis.

**Suggestions for future research and research infrastructure**

The findings of our studies result in many new questions and suggestions for future research and the research infrastructure.

**Causality of musculoskeletal complaints**

Because of the before mentioned limitations of the studies in this thesis, further, and probably different, research is needed to gain insight into what are the most important factors in the physical field as the cause - or combination of causes - of MSC. It is hypothesized that the framework of the ICF2 can serve as an excellent foundation for further studies on causality of MSC. This model illustrates the complexity of the interactions between the many possible biological, psychological
and social factors involved in MSC in musicians in their context. However, there are two shortcomings in the ICF model to mention when using this model in future studies among musicians. Firstly, several musician-related body-functions are not defined in the ICF (for example the definition of embouchure or breath support. Secondly, the dominance of the medical perspective of the ICF can be an obstacle in studying health related issues in musicians in the fields of music education and music rehabilitation/occupational medicine. As argued before, workers in these fields share similar functional aims and goals in their approach of musicians. Alternative ICF schemes with more dominance of the aspect ‘Personal factors’ and ‘participation’ may help to lower this potential barrier.

One of the explanations for the findings of the studies in Part 1 of the thesis, i.e. not finding a relation between MSC and the etiological factors we studied, was that our study design did not include the dynamical system theory and its closely related non-linear dynamical five-stage systems model for pain. These models can be a starting point for future studies about the causality of MSC. The dynamical system theory suggests the ability to adjust for a gradual change in intensity of one factor or a combination of factors, till a tipping point is reached. In the case of factors that may cause the development or persistence of chronic MSC: if the intensity is lower than the tipping point, no chronic MSC will occur, but after an increase of the intensity above the tipping point it will.

The five-stage system model may be used in future studies to explain the different stages in chronic pain and the dynamics within each stage, as explained by Young et al. Moreover, studies focusing on identifying the characteristics of this five-stage system model of the development and persistence of chronic MSC may identify whether these stages exist and, if so, can determine the accuracy of these different stages. The study designs needed for both lines of research should be in line with suggestions for small-sample studies. Studies to identify tipping points in the process of development or persistence of MSC should also be in line with suggestions for small-n studies:

1. Longitudinal small-size studies with individual level analysis.
2. Intensive repetition of data sampling over time, including potential confounders.
3. The use of measurement instruments with suitable psychometric values.
4. The use of strong quantitative theoretical models underlying the causal relationship to be tested.
5. Effective control of error variance.

In practice this means that small-n studies among musicians should involve a maximum of four to ten participants, with a data sampling frequency of several dozens or up to 400 times over a long period of time, depending on the research question and based on the above requirements. This data sampling among musicians should be done with reliable measurement instruments which can detect the small differences between risk-carrying and non-risk-carrying phenomena, e.g. the very complex high-frequency movements needed to play at a professional level. Small-
size studies with a limited number of participants will result in greater variation of the data in comparison to large samples.\textsuperscript{13} This is a possible advantage in the early detection of subgroups of musicians using different motor strategies during playing.\textsuperscript{16} Instead of performing such small-n studies, future research on the causality of MSC can also be performed with larger samples. In line with what has been reported by others,\textsuperscript{13,16,43} this type of studies would then have to use very large samples. Just as small-sample studies, these large studies should be founded on a well-defined theory, and use accurate, valid and reliable instruments within a longitudinal prospective cohort design. The follow-up time of such cohort studies should preferably be at least 20-30 years, depending on the research aim. For example, musicians’ dystonia often develops after decades of playing. It will be clear that this type of large-sample studies would only be possible in a suitable research structure and only by means of multi-centre studies with sufficient financial support. This is a major challenge, made even bigger by the fact that music medicine lacks sufficient financial support due to its small and relatively new position in the spectrum of medical disciplines. The various societies for performing arts medicine might offer an opportunity to join forces and set up such a study.

**Measurement of motor function in musicians**

To decide which measurement instruments can adequately assess musicians, all clinical properties of the known assessment instruments, including validity, reliability and responsiveness, should be known. It takes many years to determine all of these characteristics even for one measurement instrument.\textsuperscript{13,44} Determining criterion validity requires a suitable gold standard. The measurement instruments studied in this thesis may be a first step. For example, the system of the CODE of Embouchure can develop to a quantitative method for the assessment of embouchure. The hand assessment laboratory of Leijnse\textsuperscript{45}, the high speed neuro-imaging and oral area sampling methods of Vaquero et al.\textsuperscript{46} and Bertsch et al.\textsuperscript{47} respectively, and the three dimensional motion capture assessment systems of Goebel et al.\textsuperscript{48,49} Traser et al.\textsuperscript{49} Ancillao et al.\textsuperscript{50} and Jabusch et al.\textsuperscript{51} are examples of measurement instruments that may become gold standard procedures in the measurement of motor function in musicians.

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musicians. However, because of the complexity of their use and their costs, they will perhaps only be available in a few university laboratories.

A systematic, formalized and strong connection between the fields of music medicine and music education is necessary to enable large prospective cohort studies among musicians, and to facilitate an exchange of knowledge between the two fields. Study designs, such as the two studies about embouchure in this thesis, are useful to bridge the gap between music medicine and music education. At this moment, this connection is restricted to a few individuals.

**Final remarks**

Two final remarks can be made on the process of improving music education and music medicine.

1. Professional musicians perform their music in a job setting. Like other workers, they need support from occupational health care to prevent health problems and professional support when (limitations related to) health problems are present. The effectiveness of the prevention and treatment of MSC in musicians is currently far from optimal. An important cause appears to be a lack of awareness and/or lack of attention for the circumstances of professional and semi-professional musicians among practitioners of occupational medicine: e.g. many musicians suffering limitations in their playing are not recognized as such by occupational therapists.

There are several reasons for this lack of attention, such as:

a. **Self-employed status.** Many musicians are not served by occupational medicine services because they do not play in an orchestra or another institution offering occupational health and safety service.

b. **Aspects of non-musical work situations.** Many musicians need additional jobs to earn a living. The occupational health and safety services offered by companies they work for, but also the musicians themselves, often fail to realize that the limitations experienced in this additional employment may be related to the musical activities. This is also true for the many amateur musicians who play music as a leisure activity.

c. **Taboos on talking about limitations in music performance.** Professional musicians do not like to talk about their complaints because they are anxious about losing their job or their next engagement. Many musicians also use avoidance behaviour strategies related to strong acceptance problems of their limitations in playing, if they have severely disabling MSC. Most professional musicians have been playing from early childhood on, and as such music is a part of their nature. Being forced to stop playing music because of limitations in playing is not something what they can imagine could happen to them.

Detailed knowledge about the specific work situation of musicians is necessary in occupational medicine. It is worth recommending that the field of occupational medicine should develop specific prevention and reintegration programmes for professional musicians. Therefore, intensive longitudinal monitoring of the
potential occupational causes for MSC in musicians and the results of interventions are necessary. This approach will also provide knowledge whether therapies and recommendations for non-musicians\textsuperscript{56-59} are valid for musicians.

2. Health care professionals in the field of music medicine and teachers working in music education may benefit from the knowledge available in sports medicine and sports education. Implementing knowledge about training principles from sports in the field of music may facilitate better prevention of health problems. Examples of training principles in sports which may be helpful are temporization of playing time, periods of rest before important performances, warming up/cooling down before or after playing, and mental training for performance-related stress situations. Moreover, the systematic implementation of guidance for professional musicians by expert therapists and/or doctors, as happens in professional sports, may be an important step to improve the health situation of professional musicians.

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