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Occupational diseases among professional orchestra musicians from the North of Portugal-

Treatment with tuina techniques

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Publications

Published articles

Sousa CM, Greten HJ, Machado JP, Coimbra, D. (2014). The prevalence of playing related musculoskeletal disorders among professional orchestra players. Música Hodie. 14(2). 111-121

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Sousa CM, Coimbra D, Machado JP, Greten HJ. (2015). Effects of self-administered exercises based on Tuina techniques on musculoskeletal disorders of professional orchestra musicians: a randomized controlled trial. Journal of Integrative Medicine. 13(5). 314-318

Sousa CM, Machado JP, Greten HJ, Coimbra D. (2016). Occupational diseases of professional orchestra musicians from the North of Portugal – a descriptive study. Medical Problems of Performing Artists. 31(1). 8–12

Sousa CM, Gonçalves M, Machado JP, Greten HJ. (2016) Treating musculoskeletal pain with Traditional Chinese Medicine techniques - A short review. Experimental Pathology and Health Sciences. 8(2). 25-28

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Submitted articles

Treating playing related musculoskeletal disorders among musicians - A systematic review. Tratamento de alterações musculoesqueléticas relacionadas com o trabalho em músicos – uma revisão sistemática da literatura – Submitted to Medical Problems of Performing Artists

Posters

Sousa CM, Machado JP, Coimbra D, Lopes-Lima M, Gonçalves M. Greten HJ. A standardized diagnostic process on TCM leads to successful acupoint selection in work related musculoskeletal disorders. 3rd to 5th October 2014. Presented in the DCFG-TCM Congress - Porto

Oral communications/ Congresses

Sousa CM, Machado JP, Greten HJ, Coimbra D. Lesões musculoesqueléticas relacionadas com o trabalho de músicos profissionais de orquestras do Norte de Portugal. 28th November 2014. I congresso de Psicofisiologia da música – Universidade do Minho

Ao meu pai, à minha mãe, à Joana, ao Tiago...
e ao Francisco que está na minha barriga…
Obrigada por tanto...

Senhor, fazei-me instrumento de vossa paz.
Onde houver ódio, que eu leve o amor;
Onde houver ofensa, que eu leve o perdão;
Onde houver discórdia, que eu leve a união;
Onde houver dúvida, que eu leve a fé;
Onde houver erro, que eu leve a verdade;
Onde houver desespero, que eu leve a esperança;
Onde houver tristeza, que eu leve a alegria;
Onde houver trevas, que eu leve a luz.

Ó Mestre, Fazei que eu procure mais
consolar, que ser consolado;
compreender, que ser compreendido;
amar, que ser amado.
Pois é dando que se recebe,
é perdoando que se é perdoado,
e é morrendo que se ressuscita para a vida eterna.

São Francisco de Assis

Ter sabedoria...
Eis o que aprendi durante toda a juventude...
Descobri, porém, que a verdadeira sabedoria não está no saber,
mas no Ser...

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Abstract

Introduction: It is a well-established fact that musicians are a prone group to suffer from occupational diseases. Literature mainly refers problems related to music performance anxiety (MPA) and playing related musculoskeletal disorders (PRMD). This research aims to describe the Portuguese scenario about this theme (Chapter V); to study the influence of the instrument type for the prevalence and intensity of PRMD (Chapter VI); to study the influence of adequate working conditions for the prevalence and intensity of PRMD (Chapter VII); to test a single tuina – Chinese manual therapy – treatment session reducing pain caused by PRMD (Chapter VIII); to test the effects of a self-management program based on tuina techniques reducing pain caused by PRMD (Publication IX).

Method: Musicians of the three professional orchestras from the North of Portugal were invited to integrate this research (n=162). After inscription, musicians were randomly allocated to the control or to the experimental group. Semi-structured interviews were conducted in order to collect epidemiologic data (n=112). Musicians presenting PRMD during 3 week received a single tuina treatment and completed a 20 days self-management tuina program. Pain intensity of PRMD was measured using verbal numeric scale (VNS) before and after the first treatment and on day 1, 3, 5, 10, 15 and 20 of the self-management program. Chi-square test was performed to analyze the associations between the occurrences of symptoms. Mann-Whitney test was performed to analyze quantitative values between groups and Wilcoxon test was performed to analyze quantitative data within groups. The Kruskal-Wallis test was used to compare VNS values within string players.

Results: Almost 94% (n=105) of the interviewed musicians presented occupational problems during the last years. Approximately one fifth (n=24) referred to suffer from MPA and 84,8% (n=95) mentioned PRMD (Chapter V). Despite there are no significant statistic values between groups, results suggested that PRMD are more common in string players (67.6% from string and 54.1% for wind) and more intense in wind players (4.3 VNS for string players and 4.7 VNS for wind players) (Chapter VI). Results suggest that the prevalence and the severity of PRMD could be reduced by adequate working conditions (pvalue = 0.021) (Chapter VII). Regarding to tuina treatment pain intensity was reduced over 91.8% into the experimental group and 7.9% into the control group after one session (Chapter VIII). During the self-management program pain was significantly lower in the experimental group compared to the control group on day 1, 3, 5, 10, 15 and 20 (Chapter IX).

Conclusion: Professional orchestra musicians from the North of Portugal are a prone group to suffer from occupational diseases mainly PRMD (Chapter V). The instrument type and adequate working conditions may influence the appearance of PRMD (Chapter VI and VII). One tuina treatment session could significantly reduce pain intensity caused by PRMD (Chapter VIII). Self-management exercises based on tuina techniques are effective reducing pain intensity caused by PRMD during 20 days (Chapter IX). Future studies with big sample size and strong measurements are needed.

Resumo

Introdução: É um facto bem estabelecido que os músicos de orquestras profissionais apresentam risco elevado de desenvolverem doenças ocupacionais, entre as quais ansiedade relacionada com a performance (PRA) e lesões musculoesqueléticas relacionadas com o trabalho (PRMD). Os objetivos principais desta investigação são descrever a situação portuguesa atual sobre esta temática (Capítulo V); estudar a influência da família do instrumento no desenvolvimento e na severidade das PRMD (Capítulo VI); estudar a influência de condições de trabalho adequadas no desenvolvimento e na severidade das PRMD (Capítulo VII); testar o efeito de um tratamento isolado de tuina - terapia manual Chinesa - na redução da dor provocada pelas PRMD (Capítulo VIII); testar um programa de auto tratamento baseado em técnicas de tuina na redução da dor provocada pelas PRMD (Capítulo XI).

Metodologia: Todos os músicos que constituem as três orquestras profissionais do Norte de Portugal foram convidados para integrarem esta investigação (n=162). Os inscritos foram divididos aleatoriamente e em igual número entre o grupo experimental e o grupo de controlo. Primeiramente foram obtidos dados epidemiológicos através de entrevistas semi-estruturadas (n=112). Os músicos que apresentavam PRMD, com a duração mínima de 3 semanas, foram sujeitos a um tratamento isolado de tuina e completaram o programa de auto-tratamento baseado em técnicas de tuina com a duração de 3 semanas. A intensidade da dor foi medida através da escala numérica de dor (VNS) antes e imediatamente após o primeiro tratamento de tuina. A intensidade da dor foi medida nos dias 1, 3, 5, 10, 15 e 20 do programa de auto tratamento. Os dados epidemiológicos foram analisados através do teste do Qi-quadrado, os dados quantitativos entre grupos foram analisados através do teste de Mann-Whitney e dentro do grupo através do teste de Wilcoxon. O teste de Kruskal-Wallis foi utilizado com o objetivo de comparar os valores de VNS entre os instrumentistas de cordas.

Resultados: Aproximadamente 94% (n=105) dos entrevistados referiram apresentar problemas ocupacionais durante o último ano. Aproximadamente um quinto (n=24) referiram MPA e 84,8% (n=95) PRMD (Capítulo V). Apesar de não se verificarem diferenças estatisticamente significativas, os resultados sugerem que as PRMD são mais comuns entre os instrumentistas de cordas (67.6% e 54.1% nos instrumentistas de cordas e de sopros respetivamente) e mais intensas nos instrumentistas de sopros (4.3 VNS nos instrumentistas de cordas e 4.7 VNS nos instrumentistas de sopros) (Capítulo VI). Os resultados também sugerem que a presença de condições de trabalho adequadas diminui

a prevalência e a severidade das PRMD (pvalue= 0.021) (Capítulo VII). Após o tratamento com tuina, a intensidade da dor diminuiu 91.8% no grupo experimental e apenas 7.9% no grupo de controlo (Capítulo VIII). Durante o programa de auto tratamento a dor manteve-se significativamente mais baixa no grupo experimental comparada com o grupo de controlo nos dias 1, 3, 5, 10, 15 e 20 (Capítulo IX).

Conclusão: Os músicos de orquestras profissionais do Norte de Portugal são um grupo propício ao desenvolvimento de doenças ocupacionais principalmente PRMD (Capítulo V). A família do instrumento e a presença de condições de trabalho adequadas podem influenciar o aparecimento de PRMD (Capítulo VI e VII. Com apenas uma sessão de tuina é possível diminuir significativamente a intensidade da dor provocada pelas PRMD (Capítulo VIII). O programa de auto tratamento baseado em técnicas de tuina é efetivo na redução da dor causada pelas PRMD durante 20 dias (Capítulo IX). São necessários estudos futuros com amostras maiores e instrumentos de medida mais robustos.

Abbreviations

ALT – Algor Leadens Theory

CAM – Complementary and Alternative Medicine

CT – Clinical Trial

MPA – Music Performance Anxiety

PRMD- Playing Related Musculoskeletal Disorders

WRMD – Working Related Musculoskeletal Disorders

RCT- Randomized Control Trial

TCM- Traditional Chinese Medicine

VNS – Verbal Numeric Scale

SD – Standard Deviation

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Thesis organization and main objectives

According to the literature musicians are frequently affected by specific occupational diseases such as performance-related anxiety and musculoskeletal disorders. Constant and repetitive movements performed without ergonomic precautions in combination with self-imposed pressures, make the musicians a vulnerable group to suffer from occupational problems (Zaza, 1998; Lockwood, 1989).

To treat those conditions western medicine uses drugs (Andreatini, Lacerda and Filho, 2001; Steenen et al., 2015), but according to Meneses et al. (2007), a great number of patients fail to respond or remains with significant residual symptoms after conventional treatment. According to the same authors, one out of three patients shows insufficient response or does not improve with standard western treatment.

The practice of the so called Complementary Alternative Medicines (CAM) is growing in Portugal in such a way that the Portuguese government was obliged to regulate their practice. Traditional Chinese Medicine (TCM) is included within the field of CAM and several studies describe their benefits in numerous conditions, including musculoskeletal pain and anxiety related symptoms.

To the best of our knowledge, Portuguese investigation within the field of musicians` health is almost inexistent. Performing arts medicine is, in fact, underestimated by the general population. Although professional orchestra musicians are highly affected by occupational problems, there isn`t enough published research related with this field in Portugal. The main objectives of this work are to describe the occupational problems affecting professional orchestra musicians from the North of Portugal and to study the effects of Chinese manual therapy – tuina - among those symptoms. To achieve this objective, several steps were performed.

A systematic review about the possible options to treat PRMD in musicians was submitted (Chapter III) and a brief review about the TCM possibilities to treat musculoskeletal pain was published (Chapter IV).

Before treating the musicians it was necessary to study which are the occupational diseases affecting musicians in Portugal. For this propose the article “Occupational diseases of professional orchestra musicians from the North of Portugal – a descriptive study” was performed (Chapter V). To study the causes of the high prevalence of PRMD among professional orchestra musicians from Northern Portugal articles titled “The prevalence of playing related musculoskeletal disorders among professional orchestra players” and “Playing-related

musculoskeletal disorders of professional Orchestra musicians from the North of Portugal: Comparing string and wind musicians – An observational epidemiological study" were also performed (Chapter VI and VII). To treat those problems tuina techniques took place. To test the effects of a single tuina treatment session reducing pain caused by PRMD and to test the effects of a self-management program based on tuina techniques reducing pain caused by PRMD articles titled "Immediate effects of Tuina techniques on working-related musculoskeletal disorders of professional orchestra musicians" and "Effects of self-administered exercises based on Tuina techniques on musculoskeletal disorders of professional orchestra musicians: a randomized controlled trial" were respectively written (Chapter VIII and IX). In the followed sections all of those articles will be presented.

In chapter I a general introduction presents epidemiologic data about the prevalence of occupational diseases among musicians (MPA and PRMD) around the world and the possible western medical solutions. TCM theory is mainly unknown and tuina treatment is also unfamiliar in western countries. For this reason, a brief report about TCM according to the Heidelberg model will also be presented.

There are several methodology issues related to this research that aren`t presented into the published articles. In chapter II subjects related to the main measurements, the diagnostic process, the connection between investigation steps, aims and study design will also be referred.

After presenting the original publications, from chapter III to chapter IX, results will be generally discussed and the main limitations of this research will also be argued. Into the last chapter general conclusions and future perspectives will be addressed.

Chapter I

General introduction

Statement of problem

According to the literature musicians are affected by several medical conditions caused by their professional activity. The main problems are associated with playing related musculoskeletal disorders (PRMD) and music performance anxiety (MPA). Problems such as hearing impairment, tinnitus and depression are also described by the literature but in a smaller scale. This is why we will not consider those problems into this work.

According to the Portuguese health ministry, a professional disease is a disorder directly caused by working conditions, that is present in the professional diseases list (Decreto Regulamentar n. º 76/2007, de 17 de Julho) and that can cause incapacity or death during the professional exercise. In Decreto Regulamentar n. º 76/2007, from 17th July, diseases caused by repetitive movements such as tendinitis, tenosynovitis and bursitis are included. Also spinal problems, such as hernias, are considered.

We define occupational diseases as health problems caused by working conditions, which can influence the professional success and cause incapacity during the professional exercise.

Music related anxiety

Anxiety is defined as a manifestation of somatic tension and arousal with symptoms such as shortness of breath, dizziness, dry mouth, trembling or shaking (Watson et al.[1,2], 1995). Since the last years the problem of music performance anxiety in musicians from several professional levels and different countries has been well documented by the literature but unfortunately, it may be underestimated by the general public. According to Vaag, Bjørngaard and Bjerkese (2015) symptoms of anxiety and depression are more prevalent in musicians than in general workers.

An important study from 1995 (Kemenade and Son, 1995) described that the majority of professional symphonic orchestra musicians from Netherlands reported experiencing or having experienced MPA symptoms that seriously affected their professional or personal lives. The musicians also referred to experience considerable anticipation anxiety days (36%), weeks (10%) or even months (5%) before the performance. A more recent study from Germany describes MPA in 15 to 19 years old music students. Results showed that about one third of the students were distinctly handicapped by their anxiety (Fehm, Schmit, 2006). Studies from 2013, performed in United Kingdom with 244 musicians from different musical genders reported that a significant majority of undergraduate and professional musicians experiences MPA (Papageorgi, Andrea and Graham, 2013).

As music performance anxiety is associated with the public presentation one may argue that this specific kind of challenge may be faced by many professions (Robert, Russel, Thomas, 1990). The almost constant obligation to present in public, at meetings, in conferences etc., may potentially contribute to elevated anxiety levels. Anxiety disorders may lead to significant disability, poor quality of life and enormous social costs resulting from absenteeism, psychiatric and pharmacological treatment, low professional work efficacy finally leading to burnout and related conditions (Meneses et al., 2007).

Studies show that anxiety and depression are strongly correlated and share some common symptoms (Watson et al.[1,2], 1995). The classical tripartite model of depression and anxiety developed by Watson et al.[1,2] (1995) divides symptoms of anxiety and depression into 3 groups: symptoms of general distress that are largely nonspecific - insomnia, restlessness, irritability, poor concentration - manifestations of anhedonia and low positive affect that are specific to depression, and symptoms of somatic arousal that are relatively unique to anxiety. Kenny and Ackermann (2015) identified a “complex relationship” between the presence of MPA/depression and the intensity of PRMD. According to them more depression means more pain intensity. Stress related signs could also include symptoms such as nervous gastritis, reflux, insomnia, pressure under the chest, panic attacks and others (Greten[1], 2013).

Despite exaggerated anxiety symptoms are deeply related to decreased performance, moderate anxiety states are reported as beneficial once they make the musicians fell more active and augment their concentration. In fact the anxiety levels tend to be lower during the concert than one hour or immediately before concert (Papageorgi, Andrea and Graham, 2013).

Playing related musculoskeletal disorders

It is well known that playing related musculoskeletal disorders (PRMD) are common in musicians. According to Zaza (1998), the prevalence of playing-related musculoskeletal disorders in musicians ranged from 39% to 87% in adult musicians and from 34% to 62% already in secondary school music students. Studies suggest that almost half of musicians experience playing related medical problems that could threaten or even end their careers (Lockwood, 1989). Cross-sectional studies from Australia with 377 professional orchestra musicians concluded that 84% had experienced PRMD and 50% reported to feel current pain (Kenny and Ackermann, 2015). Also a German study from 2015 concluded that 89.5% of professional orchestra musicians reported to experience playing related musculoskeletal pain with an intensity of 3.7 (SD 1.95).

Pain within the last 3 months was reported by 62.7 % of musicians and 40% of musicians reported considerable frequent and permanent pain (Steinmetz A et al., 2015).

This high percentage of affected musicians might be explained by several risk factors that could be impossible to control. The musicians' daily life demands the assumptions of unnatural postures and professional musicians are forced to play several hours a day describing always the same repetitive movements. These facts could highly preclude the appearance of a PRMD in a specific musician. For example, string players are the most frequently affected by PRMD and percussionists the last (Lockwood, 1989; Steinmetz A et al., 2015). Within string players violinists are more prone to suffer from neck, left shoulder and left wrist problems, frequently experience pain in more than five pain regions (Steinmetz A et al., 2015).

Additionally, individual issues specifically related to musicians' activity such as technique, years of experience, type of repertoire or individual adaptation to the instrument itself, could influence the appearance of PRMD (Frank and Mühlen, 2007; Fragelli et al., 2008; Wu, 2007; Hansen and Reed, 2006; Nyman, 2007). Individual factors such as age, gender, unhealthy habits, the lack of ergonomic precautions and preventive wellness behavior could also influence the appearance of PRMD (Paarup et al., 2011; Kenny and Ackermann, 2015; Steinmetz A et al., 2015).

Common PRMD include overuse problems such as tendinitis and peripheral nerve entrapment syndromes. Those conditions typically affect the upper extremities of the body, the neck, the back and the facial musculature. The overuse injuries cause symptoms ranging from mild pain while the musician is playing to pain severe enough to preclude any use of the affected zone. Those musculoskeletal disorders often become chronic and painful causing a decreased quality of life (Zaza, 1998; Lockwood, 1989).

Frequently, when the disease appears, the musician tries to deal with it without asking for help to their colleagues or teachers. This fact could be explained by the fear of losing the workplace and of course the implication and recommendation to stop playing (Llobet, 2004).

Possible treatments

Conventional medical solutions - MPA

To treat anxiety, western medicine uses drugs such as benzodiazepines, propranolol, buspirone, antidepressants, beta-blocking agents, antipsychotics and others (Andreatini, Lacerda and Filho, 2001; Steenen et al., 2015). According to Meneses et al. (2007), western medicine cannot solve all cases of anxiety disorders since a great number of patients fail to respond or remain with clinically significant residual symptoms after the treatment. Statistics show that one out of three patients presents an insufficient response or does not get sufficiently better with standard western treatments. Andreatini, Lacerda and Filho (2001) affirm that in Brazil just 50% of patients with anxiety disorders are successfully treated by western drugs. A recent meta-analysis about the effects of propranolol treating anxiety disorders also concluded that the quality of evidence for the efficacy of propranolol at present is insufficient to support the routine use of propranolol in the treatment of any of the anxiety disorders (Steenen et al., 2015).

Psychological strategies based in psychoanalytic and cognitive behavioral therapies (Spahn, 2015), performance psychology programs (Osborn, 2013), intensive short-term dynamic psychotherapy for severe music performance anxiety (Kenny, Arthey and Abbas, 2014), psychological programs based in cognitive restructuring, identification of strengths, goal-setting (Braden et al., 2015) seems to be effective reducing MPA. Also relaxing techniques such as Yoga (Kristen and Cope, 2013), body-oriented methods (Spahn, 2015), imagery and visualization techniques (Braden et al., 2015) and a biofeedback exercise called qigong demonstrated to reduce anxiety levels before concerts (Sousa et al., 2012).

Conventional medical solutions - PRMD

There are common treatments used by western medicine to treat musculoskeletal disorders such as rehabilitation programs and drugs. According to Curatolo and Bogduk (2000), the most common drugs used in the treatment of musculoskeletal disorders are local injection of steroids, nonsteroidal anti-inflammatory drugs, opioids, local anesthetics and drug combinations. However, the effectiveness of the drugs used in musculoskeletal pain conditions is sometimes “disappointing”. According to the authors many drugs are ineffective while others reduced pain with a modest and briefly effect. They also affirm that the effect of drugs on disability and quality of life is nil or minimal.

A literature review titled “Treating playing related musculoskeletal disorders among musicians - A systematic review” aims to describe and to compare the possible solutions to treat PRMD and it is presented into chapter III (submitted to Medical Problems of Performing Artists).

Traditional Chinese medicine as a possible solution

Traditional Chinese Medicine (TCM) is defined as “a system of sensations and findings designed to establish a functional vegetative state which can be treated with acupuncture, qigong, tuina, Chinese pharmacology and dietetics” (Greten[1], 2013 – pp 264).

According to the world health organization (2012) the use of complementary and alternative medicines (CAM), including TCM techniques is growing in the last years. According to their report, the percentage of people that use CAM at least once is 48% in Australia, 70% in Canada, 42% in USA, 38% in Belgium and 75% in France: “many developed countries are now seeing that CAM issues concerning safety and quality, licensing of providers and standards of training, and priorities for research, can best be tackled within a national policy framework. The need for a national policy is most urgent, however, in those developing countries where Traditional Medicine has not yet been integrated into the national health care system, even though much of their population depends on Traditional Medicine for health care” (page 3).

The short communication titled “Treating musculoskeletal pain with Traditional Chinese Medicine techniques – A short communication” aims to describe the effects of TCM techniques reducing musculoskeletal pain. The paper was published into the journal Experimental Pathology and Health Sciences and it is presented in chapter IV.

Traditional Chinese Medicine

Traditional Chinese medicine (TCM) in a modern understanding is a system biology that establishes the functional vegetative state of the body. The changings of this status could be treated using techniques such as acupuncture, qigong, tuina, Chinese pharmacology and dietetics. Acupuncture is based on the use of needles to stimulate some points of a conduit (group of connected points); qigong is a form of biofeedback that mixes breathing exercises with slow movements in a concentration status; tuina is the abbreviated name of tui na an mo and it refers to the Chinese manual therapy; Chinese pharmacology is the use of plants with therapeutic objectives; dietetics is the use of food and nutrition to treat a determined condition (Greten[1], 2013).

According to the Heidelberg model Traditional Chinese Medicine, like all other medicines, interprets symptoms. However, the postulates on which the symptoms and the body functions are interpreted differ to a certain degree from western medicines.

The Chinese diagnosis

Many TCM practitioners believe that the right diagnosis is the basis of optimal clinical results. Classic diagnostic procedures include the model of the “four methods”, tongue and pulse diagnoses. As tongue and pulse diagnoses theory are not essential to understand TCM main concepts, they will not be described.

The model of the “four methods” postulates that Chinese diagnose is composed by four essential elements: constitution, agent, organ patterns (orb) and the four or the eight guiding criteria. Figure 1 briefly summarizes this model:

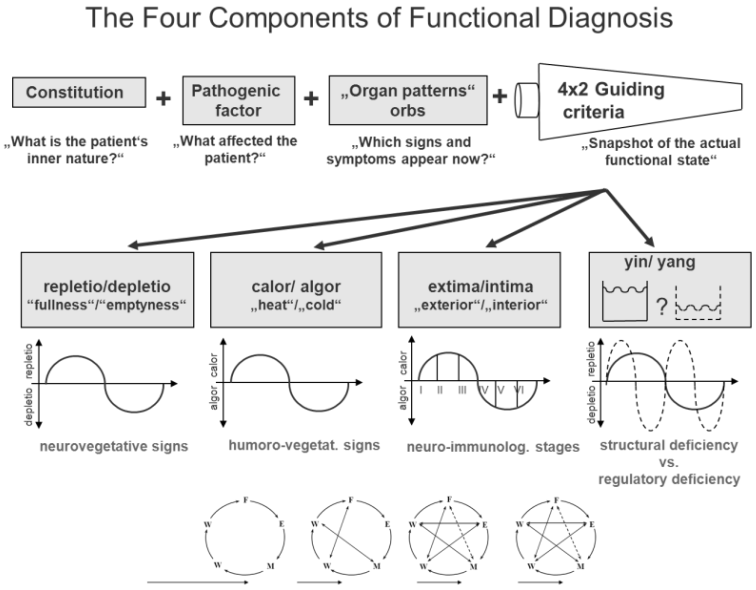


Figure 1- Chinese Diagnose (Greten[1], 2013)

Constitution

The constitution in general terms, is defined as the inner nature of the person and the tendency to express sign of an orb pattern (group of clinical signs) predominantly. As a result these functions, stored in the yin (structure), show not only functional signs but also physical changes in the person. Consequently, the constitutional type could be diagnosed by observation. There are four main constitutional types:

- Wood types: associated with phase wood: hepatic and felleal constitutions
- Fire types: associated with phase fire: cardiac and pericardiac constitution
- Metal types: associated with phase metal: pulmonary constitution
- Water types: associated with phase water: renal constitution (Greten[1], 2013)

Agents

The agents (bingyin) are the pathogenic factors or in other terms an agent is what makes the person sick. Agents can be divided into exterior (liuyin), inner (qiqing) and neutral agents (Porket, 2001).

Exterior agents are called the “as if” agents and include humor (shi), algor (han), ventus (feng), aestus (shu), ariditas (zao) and ador (huo). The main external agents are the first three – humor, algor, ventus - this is why the others will not be explained (Porket, 2001).

Humor (shi) is described as “signs and symptoms as if you had been exposed to environmental humidity, such as swollen limbs and tissues, feeling of heaviness, dyspnea, generalized pain, and others. From a western medical view, these signs may originate from pre-edema and edema” (Greten[1], 2013; pp. 260).

Algor is described as “signs and symptoms as if you had been exposed to environmental cold, such as cold skin, stiff muscles, tearing and localized pain with gradual onset. From a western medical view, these signs may originate from regional deficiencies of capillary blood flow” (Greten[1], 2013; pp. 260).

Ventus is described as “signs and symptoms as if you had been exposed to a draught of air, such as running nose and eyes, reddish mucosa, swollen tonsils, spastic muscles, pain with sudden onset. From a western medical view, these signs may originate from mast cell-substance P reflexes and old reflexes of motor control as known from fish and other species” (Greten[1], 2013; pp. 260).

Interior agents are the seven emotions: ira(nu) which means excitation; voluptas (xi) which means lust; pavor (jing) which means shock; maeror (bei) which means grief; timor (kong) which means anxiety and fear; cogitation (si) which means exaggerated thinking and mental effort; sollicitudo (you) which means dejection (Porket, 2011).

Neutral agents represent a redundant category of “heteropathic factors” and could include overwork, overeating, malnutrition between others (Porket, 2011).

Orb

The word orb refers to the Latin word “orbis” which means circle. It is a circle or group of “diagnostically significant signs and findings that are grouped and named after organs or the region where some of the symptoms take place” (pp. 263) (Greten[1], 2013). Sometimes this is referred to as the Chinese “organ teaching” which is a simplified understanding of the system. There are 12 orbs:

Hepatic – responsible for the control of excitation and flow (stress)

Felleal – suppresses impulse/ ambivalence

Cardiac – responsible for the control of emotionality and associativity

Tunuintestinal – responsible for emotional balance, could influence shoulder and ear

Pericardial – controls the drive

Tricaloric – distributes qi and fluids on body sides (superior, middle and inferior)

Pulmonary – controls the surface, breath and rhythmical functions

Crassintestinal – responsible for the surface of the guts and conduction of nourishment

Renal – responsible for regeneration

Vesical – controls the distribution of fluids in back and lower sides of the body

Stomach – responsible for digestion

Lienal – controls the assimilation and metabolism

An orb is only a group of diagnostically significant signs that include possible symptoms in the region of a western organ. Therefore an orb is only an organ-named functional pattern and not an organ (Greten[1], 2013).

Guiding criteria (bagang)

According to Porket (1995), the eight guiding criteria are the most important tools for achieving precision of diagnostic statements. The guiding criteria are four sets of polar qualities:

- Repletion (shi) and depletion (xu) meaning respectively “fullness” and “emptiness” refer to the functional capacity mostly induced by the vegetative system
- Algor and calor representing the lack or the excess of microcirculation respectively
- Intima (li) and extima (biao) defined as inner/depth aspects and outer aspects respectively
- Yin and yang defined as activity and structivity respectively

These Guiding Criteria can be understood as the teaching of body regulation as table 1 shows:

Guiding criteria	Level of Regulation	Physiological Process	Chinese perception
Repletio (fullness)	Neurovegetative Regulation	Increased activation by the nervous system	Too much capacity to function (Qi) in body and circuits
Depletion (emptiness)		Decreased activation by the nervous system	Insufficient capacity to function (Qi) in body and circuits
Calor (heat)	Humorovegetative Regulation	Increased microcirculation with pro-inflammatory effects and raised sympathetic tone	Excess activation of blood (Xue - blood and its effects)
Algor (cold)		Decreased microcirculation with lack of inflammatory effects and sympathetic tone	Insufficient activation blood (Xue - blood and its effects)
Extima (outside)	Neuroimmunological Regulation	Early stages of disease	Active defense mechanisms on the surface of the body
Intima (inside)		Late stages of disease	Active defense mechanism in the depth of the body
Yang (problem of the degree of		Control of functional tissue defect from outsider	Above the target value

unfolding function)	Cellular Mechanisms		
Yin (problem of the functional tissue)		Defect cellular control of the functional tissue	Bellow the target value

Table 1 - Guiding criteria (Greten[1], 2013)

First postulate of TCM: Yin, Yang and the phases

To explain the concept of yin, yang and the phases (traditionally called elements) it is necessary to explain the classic "water basin model" from Greten[1] (2013).

Figure 2 represents a water basin with an electric heater which is regulated by a thermostat. The graphic represents the water temperature during the time. The target temperature, in this example, is defined 37 °C.

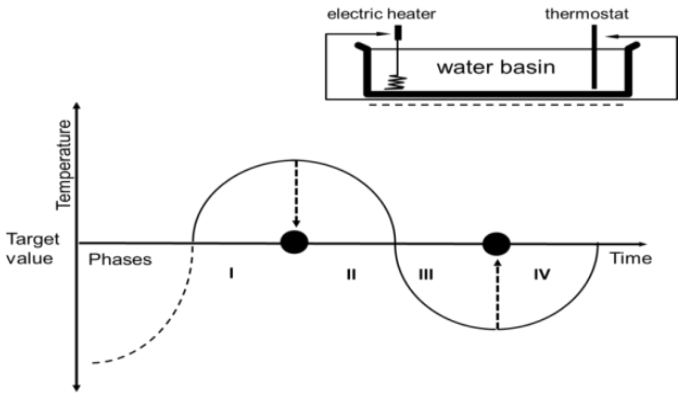


Figure 2 - Water basin model (Greten[1], 2013)

In the beginning (phase 0) the system is switched on and the water temperature rises until it reaches 37º. In stage I the thermostat will cut off the electricity to the heater but, as the heater is still warmer than the water, temperature is still growing. In stage II the temperature is decreasing until it reaches 37° and the thermostat will switch on the heater again. During stage III, despite the heater is switched on, the water temperature will decrease because the heater is colder than the water. In stage IV after some time, the heater will be warmer than the water and the temperature will rise. This procedure happens in a repetitive manner and the system will always be up and down regulated.

According to the Heidelberg model of Chinese medicine (Greten[1], 2013) values above the target value (37º in this example) are called yang and values bellow the target value are named yin. Within this model we can identify two directions within the yang and two directions within the

yin. The ascending movement within the yang (stage I of the model) is called wood; the descending movement within the yang (stage II of the model) is called fire; the descending movement within the yin (stage III of the model) is called metal; the ascending movement within the yin (stage IV of the model) is called water. The target value which is the centre of the movement responsible for down and up regulation is called Earth. Those 5 phases, generally called elements are represented by figure 3

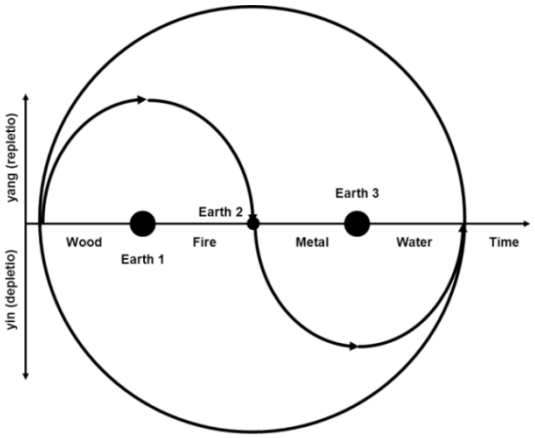


Figure 3 – Yin, Yang and Phases

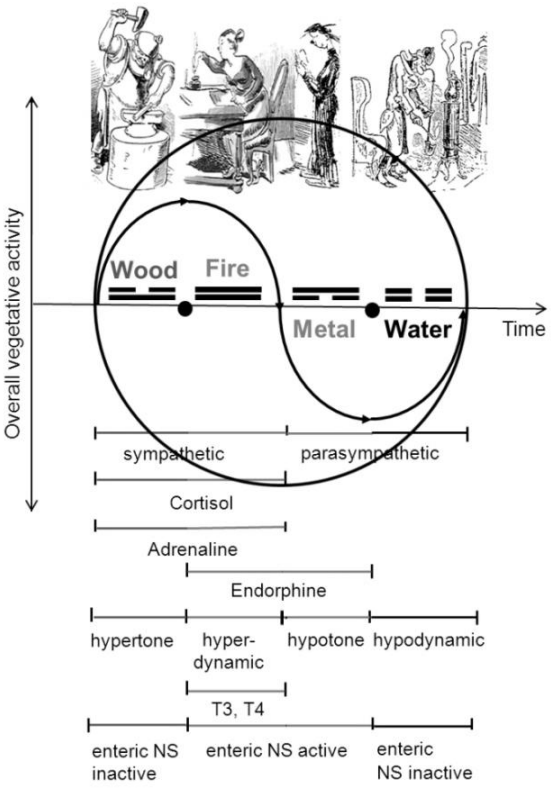


Figure 4 - Phases as vegetative tendencies

According to those postulates, the Heidelberg model (Greten[1], 2013) defines:

- Yin as bellow the target (shall be) value; descending values, such as in down regulation; lack of substrate causing instable regulation.
- Yang as above the target (shall be) value; rising values, such as in up regulation; functional, primarily regulatory problem.
- Phases as:
  - Parts of a circular process as figure 3 shows
  - Regulatory terms

- Referring to man they are vegetative functional tendencies reflecting the activity of the sympathetic (wood and fire) and parasympathetic (metal and water) nervous system; the description of muscle tonus and motion patterns by hypertonic (wood), hyperdynamic (fire), hypotonic (metal) and hypodynamic (water); the functional patterns or the renin angiotensin aldosterone system which is more active in the yang phases and less active in the yin phases as figure 4 shows
- Their manifestations are called orbs (groups of diagnostic relevant signs corresponding to the functional properties of the body region or body island). Referring to the orbs (group of signs), each phase has 2 orbs: one internal or yin orb and one external or yang orb. The internal orbs build up the qi of the phase and are the last orbs being affected by an agent. The external orbs store and distribute the qi of the phase and usually are easily affected by agents. The yin orbs are hepatic, pericardiac, cardiac, pulmonary, renal and lineal orbs. The yang orbs are felleal, tricaloric, tenuintestinal, crassintestinal, vesical and stomach orbs.

Each phase presents specific vegetative functional tendencies that people tend to demonstrate. The following table (table 3) and figure 5 to 8 describes and represent the main phase characteristics according to the Heidelberg model (Greten[1], 2013)

Phase	Description	Emotion	Orbs	Physical characteristics	Special issues
Wood	Creating potential	Ira	Hepatic	Shouting voice; Open eyes; Hypertonic muscles.	
Fire	Transformation of potential into function	Voluptas (imotional intensity)	Cardiac Pericardiac	Laughing voice; Shining eyes; Hyper functional state.	Pericardiac people are full of unrest and they are characterized by never having time. Pericardiac people are commonly cardiac with a weak yin, which have been humiliated so far that their anxiety is high.
Metal	Relaxation	Maeror	Pulmonary	Willing voice; Hanging shoulders;	This phase is responsible for the rhythmical functions

				Hypotonic muscles.	of the body, like the motion of breathing
Water	Regeneration	Timor (anxiety)	Renal	Groaning voice; Weak legs and lumbar region; Hypodynamic.	Regeneration of energy during the sleep and reproductive functions are expressions of the phase water

Table 2 - Phases characteristics

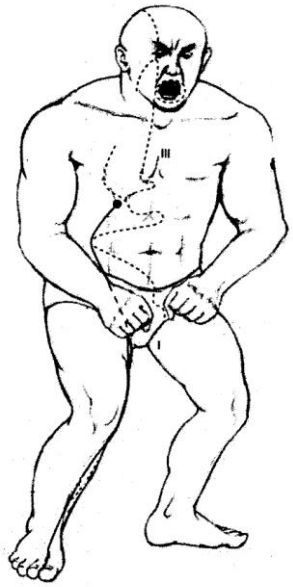


Figure 5 - Wood phase: Hepatic orb (Greten[1], 2013)

Figure 6 - Fire phase: cardiac orb (Greten[1], 2013)

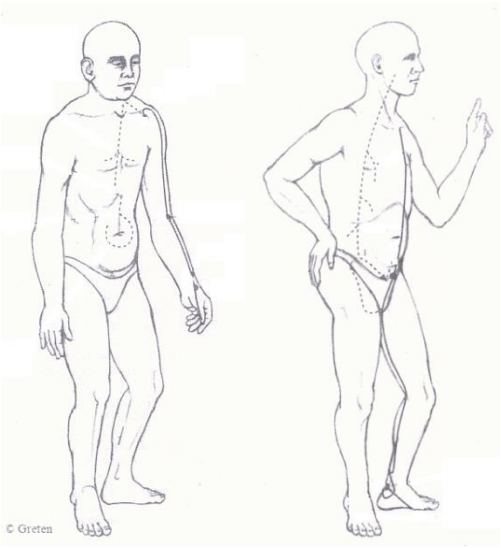


Figure 7 - Metal phase: pulmonary orb (Greten[1], 2013)

Figure 8 - Water phase: renal orb (Greten1, 2013)

The Earth is responsible for down-regulation and up-regulation. These movements can manifest clinical signs of stomach and lineal orbs. The Lienal orb is responsible for metabolism and assimilation, while the stomach orb is responsible for digestion and downwards movements.

Second postulates: The Algor Leadens Theory (ALT) – Shang Han Lun

Another tremendously important TCM theory is the Algor Laedens Theory or *Shang Han Lun* that describes how agent algor invades the body.

The ALT postulates that there are six layers of functional powers within the body. This means that when agent algor invades the body, it has to overcome these layers. These six energy layers set up six major defense mechanisms, which may lead to six stages of defense.

The energy layers comprise six technically different forms of energy (Greten[1], 2013):

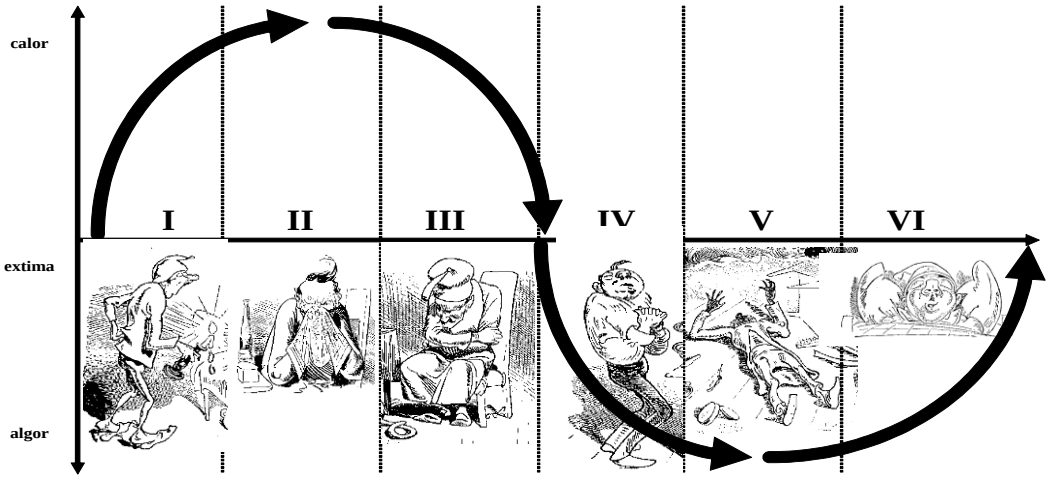
- Stage I (taiyang) - Defensive qi (wei qi), which resides within the extima (body surface) building up a first barrier against the agents;
- Stage II (yangming) – Qi within the conduit, when an agent blocks the flow of qi primarily result in pain and secondary functional disorders of the respective orb;
- Stage III (shaoyang) – Xue of the conduit, which warms the conduits and nourishes the tissues;
- Stage IV (taiyin) - Qi of the body island, which is the qi within the intima;
- Stage V (jueyin) - Xue of the body island, which is a substantial part of the body island with warming properties.
- Stage VI (shaoyin) - Yin, the functional tissue.

Qi is defined as “vegetative capacity to function of a tissue or an organ which may cause the sensation of pressure, tearing or flow” (pp. 263). From a western point of view it is comparable to the clinical effects primarily caused by vegetative system: lack of vegetative activation is called depletion, excess of vegetative activation is called repletion (Greten[1], 2013).

Xue is defined as “form of functional capacity bound to body fluids with functions such warming, moisturizing, creating qi and nitrifying a tissue” (pp. 264). From a western point of view, the clinical effects of xue can be comparable as the effects of microcirculation- guiding criteria algor means lack of microcirculation, guiding criteria calor means excess of microcirculation (Greten[1], 2013).

The figure bellow represents the six stages of ALT

« ALT » algor laedens theory	stage 1 = yang major taiyang	stage 2 = splendor yang yangming	stage 3 = yang minor shaoyang	stage 4 = yin major shaoyin	stage 5 = yin flectens jueyin	stage e 6 = yin minor taiyin



Symptoms of phases „catchword“	„Sciatic and ear pain“	„Acute sinusitis“	„Hot-cold-nausea-phase“	„Mucus and bronchitis“	„Flat-down-phase“ („pneumonia“)	convalescence

Figure 9 - ALT stages (Greten[1], 2013)

How to become sick

As referred above, a phase is a vegetative functional tendency. The stronger this tendency is, the more it is probable that the signs – orbs – occur. According to the Heidelberg model (Greten[1], 2013), there are four possibilities to become sick: deficient transition between phases, over-initiated phases, lack of antagonists and lack of yin.

When transition is deficient, normally it is due to an insufficiency from earth. The movement that is exerted by a phase must be transformed into the next phase. If earth is weak, the transformation won`t be possible and the person can be blocked into a phase and develop symptoms of this respective orb.

Phases could be over-initiated by agents like emotions, algor and others. If this agent is continuously present, the respective phase will be produced continuously and will be over-initiated causing symptoms of an orb.

A lack of antagonists is present when wood is not in balance with metal, and fire is not in balance with water. An example of this imbalance is asthma in which mostly the pulmonary orb is weak.

Lack of yin means lack of substance. Referring to the regulatory water model, this means that the temperature could change constantly producing signs of all phases and orbs

Occupational diseases in musicians according to TCM

MPA and TCM

To explain MPA we will focus on water-fire axis. As we have referred before the renal personality pattern includes regenerative vegetative functions, so in this phase there are a lack of energy and a lack of yin (cellular functional capacity). It is supposed that this makes the renal person subconsciously vulnerable and leads to the need of more emotional security. This may be called anxiety which is mostly hidden under a rational mask. Anxiety may block and may paralyze the person in a moment of challenge. Renal people tend to plan their lives and they may become nervous and anxious when unpredictable events happen. This anxiety that leads to over-rationality could be called timor, and as we have already referred, timor is the emotional state related to the renal orb and constitution (Greten[1], 2013).

Pericardiacs are frequently cardiac people with a lack of yin who have been humiliated so far that their anxiety is high. Renal types rationalize their anxiety while pericardiacs act out anxiety by constant hyperactivity. Both may be empirically stated for challenging situations like auditions and concerts, in which some individuals seem to be “paralyzed and cold” (renal pattern), whereas others are “hectic and panic” (pericardiac pattern). To diminish anxiety it is necessary to work both on fire and water patterns, and to keep people safe and secure (Greten[1], 2013).

PRMD and TCM

In western terms, pain could be caused by inflammatory mediators or trauma. According to TCM, inflammatory processes are very often associated with calor or ardor. Repetitive movements could cause micro trauma and consequently a lack of microcirculation. This is called posttraumatic algor (Greten[1], 2013, Porket, 2001).

To understand musculoskeletal pain according to TCM, it is also important to recognize the presence of the main external agents – algor, ventus and humor - because all of them can likewise cause pain. If pain is firmly localized and it is accompanied by heavy limbs and edema it is essentially caused by agent humor. If pain is constantly changing and “moving” from one joint to another it could be mainly attributed to agent ventus. If pain is intense and remains fixed to a particular site for a long time it is predominantly caused by agent algor (Porket, 2001).

This last scenario is common in musicians, who daily repeat the same movement. Posttraumatic algor could also be responsible for musculoskeletal disorders. Pain is a process

and therefore can be described as many processes by phases and ALT. According to ALT six functional defense mechanisms are overcome by the agent algor which are characterized by six typical stages, as presented before. If the agent algor persists, these stages may become chronic. They are of particular importance for the treatment of infections and immunological residual states following virus attacks. Many chronic pain diseases of the locomotors system and many musculoskeletal disorders can reasonably be described and treated by ALT model.

To treat musculoskeletal disorders it is extremely important to do a correct diagnose: constitution, agent, orb and guiding criteria.

1. The constitution of the patient can change during pain. People became more sensitive and often cardiac people change their constitution to pulmonary. Yin deficiency is frequently seen in cases of chronic pain.
2. Agents can also cause pain. Algor is most of the time responsible for musculoskeletal disorders, causing tearing pain; humor can cause dull pain associated to the decompensation of earth and sometimes associated with agent algor (stage II, IV); ventus can cause stiff pain and could be associated with agent humor; maeror, suppressed ira and other internal agents could also cause pain.
3. The affected orb depends on the type and location of symptoms.
4. Pain is usually of repletive nature.

Pain and musculoskeletal disorders could have several causes, this is why to treat them, it is needed an individual diagnose and an individual treatment procedure (Greten[1], 2013).

Tuina techniques

Tuina is the abbreviated name of the Chinese manual therapy. In fact, the original name is *tuina an mo*, the Chinese names for the different techniques. There are more than 50 classic forms of manipulation, however it will just be described the four main techniques. There are four components that could be mixed within these techniques: pressure, vibration, moving and warming component (Greten[2], 2013).

Pressure component is suppletive (augments function) in nature. Normally it is used in pain that becomes better by pressing the painful point (depletive pain). Pressure increases the activity of the area, and therefore this technique is suppletive. It is frequently used when cold increases the pain and therefore it is used when agent algor is present (Greten[2], 2013).

The vibration component is a high frequent motion technique that stretches and relaxes collagen fibers of the tissue. This component opens and liberates the tissues and therefore is dispulsive (diminish activity) by nature. It is frequently used is cases of muscle tension and contractures and consequently it is used against agent ventus ("wind") invades the body (Greten[2], 2013).

The moving component or mulsion, moves the fluids by shifting motions on the skin. Moving the hands on the epidermis, fluids move and qi can flow. This component is frequently used when edema (agent humor) is present (Greten[2], 2013).

The warming component can be obtained by friction and rubbing the point or an area. With this technique structures are warmed up. This is why this technique is used against agent algor (Greten[2], 2013).

As said before, the four main used techniques are *tui, na, an and mo*

Tui is a technique mainly used against agent ventus. *Tui* consists of pressure and vibration in a high frequency, on the point that we want to treat. This technique is dispulsive by nature because of the vibration. The pressure component could also help to eliminate agent algor (Figure 10).

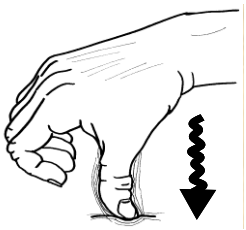


Figure 10 - Tui (Greten[2], 2013)

Na consists on pressing the area that we want to treat. Pressure is suppletive in nature, therefore this is a supletive technique. To use this technique we can pinch the area to treat with two or even five fingers, feeling the depletive area. Qi from surrounding tissue is pressed to the target point from the both sides. This could be highly suppletive. It is also used against agent algor (Figure 11).

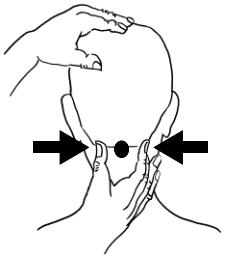


Figure 11 - Na (Greten[2], 2013)

An has just the pressure component, within one specific point and just with one finger. The difference between *na* and *an* (pinching or compression) is that the point is directly compressed without necessarily involving other areas, like in *na*. It is used against agent algor (Figure 12).

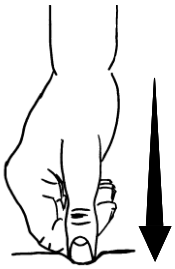


Figure 12 - An (Greten[2], 2013)

Mo consists of rubbing action which could results in red skin. This is the movement of the hand on the skin and not the skin on the fascia. Moving the blood (“xue”) activates it and removes agent humor and algor (Figure 13).

Figure 13 - Mo (Greten[2], 2013)

There is another technique called *rou* that consists in mulsion movements around the point or around one area. In this technique the skin is moved on the fascia, causing the loosening of agent humor (Figure 14).

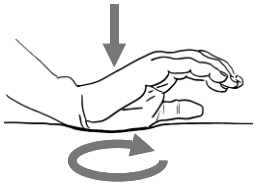


Figure 14 - Rou (Greten[2], 2013)

The tuina technique is chose according to the Chinese diagnose. The diagnose should be correctly done in order to know which structure is affected, which points must be treated and which agent must be eliminated. The diagnostic procedure is explained into the next chapter.

Chapter II

Aims and methodology

Aims, investigation questions and study design

This research aims to describe the main occupational diseases affecting professional orchestra musicians from the North of Portugal and to test the effects of a tuina single treatment and of a self-management program based on tuina techniques reducing pain caused by PRMD. The specific objectives are named into the table 3. For each objective investigation questions, study design and publication reference is presented.

Objective	Investigation question	Study design	Publication
To describe the occupational problems affecting professional orchestra musicians from the North of Portugal	Which are the main occupational problems affecting professional orchestra musicians from Northern Portugal?	Epidemiologic study	Sousa CM, Machado J, Greten HJ, Coimbra D. (2016). Occupational diseases of professional orchestra musicians from the North of Portugal – a descriptive study. Medical Problems of Performing Artists. 31(1). 8–12
To describe the playing related musculoskeletal disorders (PRMD) of professional orchestra musicians from the North of Portugal	Which are the main PRMD affecting professional orchestra musicians from Northern Portugal?	Epidemiologic study	Sousa CM, Machado J, Greten HJ, Coimbra D. (2017). Playing-related musculoskeletal disorders of professional Orchestra musicians from the North of Portugal: Comparing string and wind musicians – An observational epidemiological study. Alterações musculoesqueléticas dos músicos de orquestras profissionais do Norte de Portugal: comparação entre instrumentistas de cordas e de sopros – um estudo
To study the influence of instrument type comparing the intensity and the prevalence of PRMD in string and wind instrumentalist	Does the instrument type influence the prevalence and the intensity of PRMD?		

			epidemiológico observacional. Acta Médica Portuguesa. 30(4). 302-306
To study the influence of working conditions in the intensity and prevalence of PRMD	Does working conditions influence the prevalence and the intensity of PRMD?	Epidemiologic study	Sousa CM, Greten HJ, Machado J, Coimbra D. (2014). The prevalence of Playing related musculoskeletal disorders among professional orchestra players. Música Hodie. 14(2). 111-121
To study the immediate effects of a single Tuina treatment reducing the intensity of pain caused by PRMD	Does one single tuina treatment reduce pain intensity caused by PRMD in professional orchestra musicians?	RCT	Sousa CM, Moreira L, Coimbra D, Machado J, Greten HJ. (2015). Immediate effects of Tuina techniques on working-related musculoskeletal disorders of professional orchestra musicians. Journal of integrative medicine. 13(5). 314-318.
To study the effectiveness of a self-administered program based on tuina techniques reducing the intensity of pain caused by PRMD	Does a self-administered program based on tuina techniques reduce pain intensity caused by PRMD in professional orchestra musicians?	RCT	Sousa CM, Coimbra D, Machado J, Greten HJ. (2015). Effects of self-administered exercises based on Tuina techniques on musculoskeletal disorders of professional orchestra musicians: a randomized controlled trial. Journal of integrative medicine. 13(5). 314-318.

Table 3 - Specific objectives, study design and publications

Recruitment

Due to geographic convenience, this investigation focused on the three professional orchestras from the North of Portugal: “Orquestra Sinfónica do Porto, Casa da Música”, “Orquestra das Beiras” and “Orquestra do Norte”. The data was collected from September 2012 until June of 2013. Musicians were included according to the follow inclusion and exclusion criteria presented on table 4:

Inclusion criteria		Exclusion criteria	
General	For the RCT	General	For the RCT
Full time professional orchestra musicians	PRMD present during 3 weeks	Part time professional orchestra musician	Interaction with another kind of treatment
Written consent			Pregnancy
			Anticoagulation therapy
			Open wounds

Table 4 - Inclusion and exclusion criteria

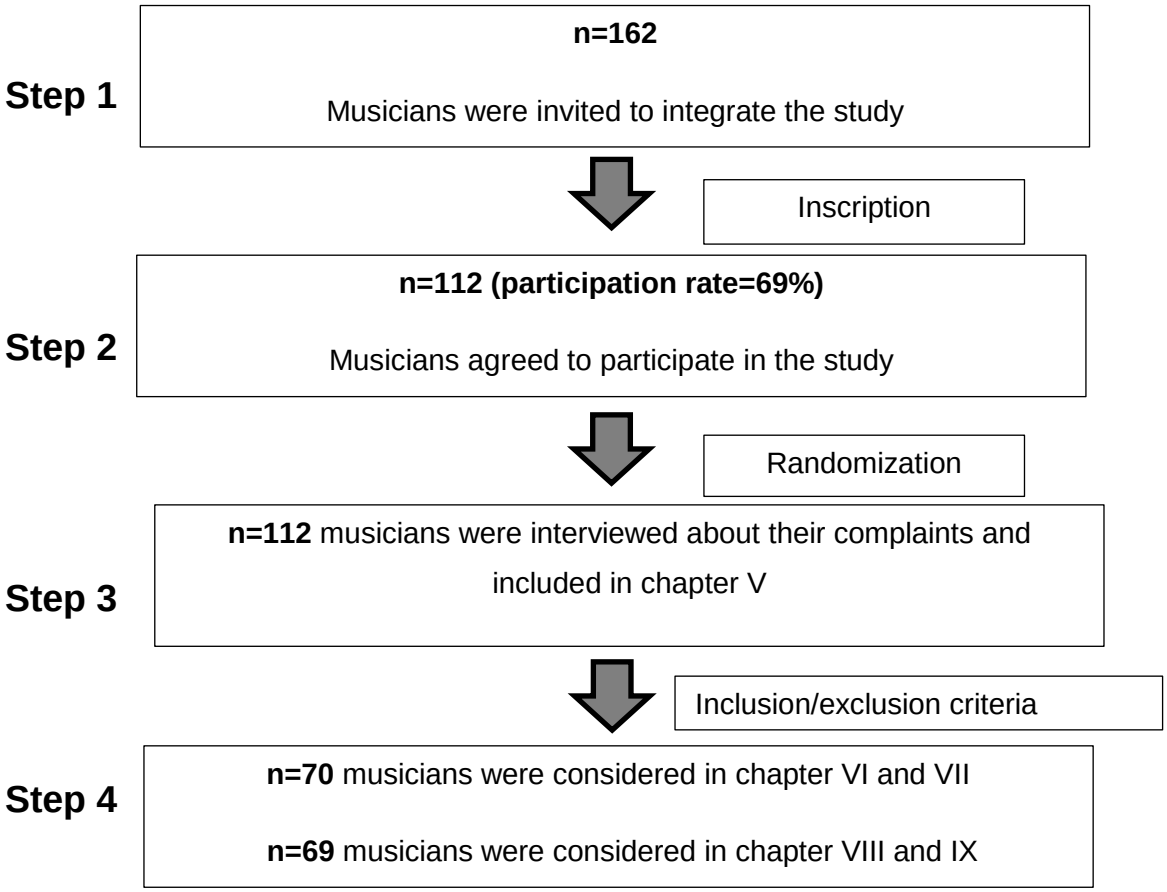
All full time musicians of the three orchestras (n=162), were invited to take part into this study. A hundred and twelve (n=112) agreed to integrate this research (participation rate = 69%). After inscription randomization by a coin flip was performed and musicians were equally distributed into the control (n=56) or into the experimental group (n=56). As this is a single blinded investigation, musicians did not know in which group they were. Once the informed consent was signed, data from the personal information, the clinical history, and the musicians’ complaints were obtained from a semi-structured individual interview.

All interviewed musicians (n=112) were considered and included in chapter V.

Musicians referring musculoskeletal pain during the moment of interview and stable for one week (n=70) were consider in chapter VI and VII.

Only musicians presenting musculoskeletal pain during the moment of interview and at least during three weeks were included in chapter VIII and IX (n=69).

The recruitment process is represented by figure 15



Step 1	Contact with the orchestras and musicians` invitation Inscription of the musicians
Step 2	Randomization by coin flip into control (n=56) and experimental (n=56) group
Step 3	During the semi-structured interview, complaints and their intensity were measured Musicians presenting pain caused by PRMD during 3 weeks stepped to the next phase
Step 4	The Chinese diagnose took place Pain intensity of the worst movement was evaluated by VNS One single real and placebo tuina treatment was performed Pain intensity of the worst movement was evaluated by VNS Real and placebo self-management exercises were tough to the musicians Musicians were recommended to repeat the exercise daily Pain intensity was measured after 1, 3, 5, 10, 15 and 20 days

Figure 15 - Recruitment process

Diagnostic process, measurements and treatment

Chinese diagnose

TCM in a modern understanding is known as a model system biology based on a logically accessible theoretical background (Greten, 2011; Greten, 2012). It may be understood as a systemic vegetative medicine and the usage of acupoints as a part of the same may be regarded as a model of a vegetative reflex therapy. TCM diagnosis may be understood as the evaluation of a functional vegetative state of the body leading to a proper selection of clinically successful acupoints (Doenitz et al., 2012; Porket, 2001). This diagnosis involves multiple methodologies including tongue and pulse diagnoses.

All musicians were individually interviewed and the described classical Chinese diagnose (Chapter I) took place: constitution, agent, orb, guiding criteria. Also classic tongue and pulse diagnose were performed and registered. The diagnose were firstly performed by a TCM practitioner with more than 30 years of experience (professor Henry Johannes Greten) and then by a TCM master with 3 years of experience (Cláudia Sousa) which received an intensive, supervised and specific training about Chinese diagnose and Tuina techniques in Heidelberg.

Despite this classic diagnostic procedure was performed, pressure sensitivity of some acupoints were also checked. It is believed that the palpation of acupoints may correlates with the findings of the classic Chinese diagnose as seen in the comparison of pressure-sensitivity of skin areas such as mu-points (alarm points) and ashi points (painful points).

It is known that acupuncture points have specific clinical functions and effects (Kraner et al., 2013; Porket, 1995). According to ancient Chinese medical theory, they are connected to deeper layers of the body which they can influence functionally by inducing “qi” flow (Greten, 2007). In a contemporary understanding, the points may be interpreted as reflex zones eliciting functional vegetative reflexes within the body (Greten, 2012). The body is a biological system with vegetative auto regulatory properties (Greten, 2012) therefore, this speculation may be further extended to the thesis that these reflex points may turn sensitive to maintain, by augmented sensory input and reflectors feedback loops, vegetative body homeostasis. If this was right, the comparison of sensitivity of acupoints may be used as an indicator of vegetative body regulation. Maybe in future investigations this hypothesis could be tested supported and perhaps considered as a valid diagnostic tool.

Semi structured interview – guide

In order to collect epidemiologic data, semi-structured interviews took place. Despite several other questions have been done, during the first evaluation epidemiologic data such as age, gender, and instrument type were assessed. The following questions were also performed:

1- Regarding now, what`s your complaints?
2- How long do you have the complaints number one, two, three…?
3- According to your sensation, was complaint number one, two, three… present during the last three weeks?
4- Regarding last year, do you have some complaint related to your work?

During the follow up interviews, on day 1 – 3 – 5 – 10 – 15 – 20 the following questions were asked:

Regarding the worst active movement related to symptom number one, two, three…:

1- How would you evaluate the pain on a scale from 1 to 10?
2- Did you do the exercises? How many times? If not why?

Verbal numeric scale or verbal numeric rating scale

The verbal numeric scale (VNS) was used in several moments to measure subjective pain intensity. According to the literature VNS is one of the most frequently scales used to evaluate pain intensity. The patients must estimate their pain in a scale from 0 to 10. 0 represents “no pain”, and 10 represents “the worst imaginable pain” (Sousa and Silva, 2005). This scale can be used with adults and children (> 9 years old) and in all patient able to use numbers to rate the intensity of their pain. As said before, 0 represents no pain, from 1 to 3 represents mild pain (nagging, annoying, little interfering with activities of daily life), from 4 to 6 represents moderate pain (interfering significantly with activities of daily life) and from 7 to 10 represents severe pain (unable to perform activities of daily life) as shown in figure 16 (McCaffery and Beebe,1993).

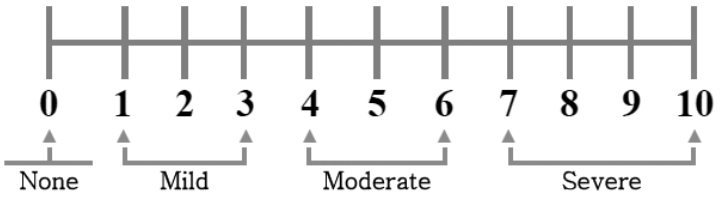


Figure 16 - Numeric rating scale (McCaffery, Beebe,1993)

The significance of verbal numeric rating scale was studied by Holdgate et al., in 2003. The authors studied the agreement between the visual analogic scale (VAS) and the verbal numeric rating scale (VNS) in measuring acute pain. From a total of 309 observations, the results showed that despite VNS scores were higher than VAS scores for paired observations, VAS and VNS were highly correlated (r=0.95). The authors concluded that VNS is a valid instrument to assess changes in pain intensity.

Tuina treatment

As explained into the first chapter, there are very different tuina techniques, and they must be chosen according to the Chinese diagnose. After the individual evaluation the most adequate points were chosen.

The points were mainly treated using *Tui* (vibration with pressure) into the selected points. It is expected that the vibrating component loosens spasms of the conduits, muscles and tendons caused by agent ventus, decreasing musculoskeletal pain. The pressure component can also eliminate agent algor. The number of points depends on the Chinese diagnose but the mean is approximately 3 points per musician.

Musicians were taught about the location of the point and about the technique to use. During the tuina procedure, they also have to control their breathing. They were advised to do the exercises twice a day or more depending on their necessity.

The control group did the same techniques as the experimental group on fake acupoints (single blind study) exactly in the middle of the thigh (right and left).

Statistical analysis

All variables were analyzed using SPSS (version 21.0, SPSS Inc., Chicago, Illinois, USA). There are 2 types of tests that we can use to conduct a statistical analysis: parametric and non-parametric tests (Fortin, 1999).

To use a parametric test the variables have to describe a normal distribution of the population and samples must be independent and random. There are two tests to analyze variables distribution: Kolmogorov-Smirnov test (large samples) or the Shapiro-Willk test (small samples). Into this research samples are independent and random, but the normal distribution of variables must be checked. According to Kolmogorov-Smirnov test and Shapiro-Willk test (chapter VII – non-adequate working conditions – n=29) variables don`t describe a normal distribution:

Chapter VI: control group p-value = 0.045 / experimental group p-value = 0.200.
Chapter VII: adequate working conditions p-value = 0.0459/ not adequate working conditions p-value = 0.318.
Chapter VIII and IX: control group p-value = 0.138 / experimental group p-value = 0.200.

Since the variables do not describe a normal distribution, we chose non-parametric tests. Although non-parametric tests are less powerful than parametric tests and relatively insensible to extreme observations, they are a valid alternative.

Analyzing the relation between variables (Chapter V)

Chi-square test is used to analyze the independence of qualitative, nominal or ordinal variables. In chapter V the associations between the distribution of complaints in different parts of the body and their relation with the played instrument was tested (p-value = 0.528).

Analyzing VNS values between two groups (Chapter VI, VII, VIII, IX)

To compare two groups, the most appropriated parametric test is the t-test for independent samples. The equivalent non-parametric test is the Mann-Witney test. The Mann-Witney test is one of the most sensitive non-parametric tests alternative to t-test. The conditions to use the Mann-Witney test are: ordinal or quantitative variables, independent samples and continuous variables. This test was used to compare VNS values between string and wind musicians (chapter

VI), between musicians playing with or without adequate working conditions (chapter VII), between the experimental and the control group before and after one tuina treatment (chapter VIII) and between both groups during the follow up, on day 1, 3, 5, 10, 15 and 20 (chapter IX).

Analyzing VNS values between more than two groups – Chapter VI

To compare VNS values between more than two groups the most appropriated test was the one-way ANOVA. The similar non-parametric test is the Kruskal-Wallis test. To use this test the variables must be continuous. Kruskal-Wallis test allows knowing the existence of one different value, but does not allow knowing which value is different and how big this difference is. This test was used in chapter VI in order to compare VNS values in violas, first and second violins,

Analyzing VNS values within groups (Chapter VIII)

To compare two measurements of the same group, the most appropriated parametric test is the paired t-test. The similar non-parametric test is the Wilcoxon test. The conditions to use the Wilcoxon test are: ordinal or quantitative variables, dependent samples and continuous variables. Wilcoxon test was used in chapter VIII to analyze VNS values within the experimental and within the control group.

Chapter III

Treating playing related musculoskeletal disorders among musicians – a systematic review

Treating Playing related musculoskeletal disorders among musicians - A systematic review

Tratamento de alterações musculoesqueléticas relacionadas com o trabalho em músicos – uma revisão sistemática da literatura

Abstract

Background: Due to specific factors, musicians are a professional group prone to suffer from playing related musculoskeletal disorders (PRMD). Musicians tend to underestimate their pain, and this factor can aggravate the severity of the problems and decrease the possibilities of treatment. The aim of this research is to describe and to compare the possible solutions to treat PRMD.

Material and Methods: The studies included into this literature review were researched in several databases until March and April 2016. Only Randomized Controlled Trials, Clinical Trials and Epidemiologic Studies with big sample sizes (n>200) were included.

Results: Ten studies reporting the effects of treatment techniques reducing pain caused by PRMD were included: 2 reporting the effects of Chinese manual therapy; 1 reporting the effects of rehabilitation techniques; 2 about preventive behavior; 5 about specific exercise programs.

Conclusions: Chinese manual therapy, massage, stretching and radial shock wave, informative courses, regular physical activity and specific exercise programs are effective reducing pain caused by PRMD. Future randomized controlled trials are needed.

Key words: Musculoskeletal disorders, professional orchestra musicians, working-related diseases

Resumo

Introdução: Devido à especificidade profissional, os músicos apresentam risco elevado de desenvolverem lesões musculosqueléticas relacionadas com o trabalho (PRMD). A tendência para desvalorizar a dor pode provocar um agravamento do problema e diminuir as possibilidades de tratamento. O objetivo desta investigação é descrever e comparar as soluções possíveis para tratar PRMD.

Material e métodos: Os estudos incluídos nesta revisão foram pesquisados durante os meses de março e abril de 2016 em bases de dados distintas. Apenas foram considerados estudos clínicos aleatórios controlados, estudos clínicos e estudos epidemiológicos incluindo amostras grandes (n>200).

Resultados: Foram incluídos 10 estudos referentes ao efeito de determinadas técnicas de tratamento na redução da dor causada pelas PRMD: 2 estudos referentes ao efeito da terapia manual Chinesa; 1 estudo relativo a técnicas de reabilitação; 2 estudos relativos à adoção de comportamentos preventivos; 5 estudos sobre programas de exercícios específicos.

Conclusão: A terapia manual Chinesa, a massagem, o alongamento, a terapia por ondas de choque, a participação em cursos formativos, a atividade física regular e a participação em programas de exercícios específicos revelaram-se eficazes na redução da dor causada pela PRMD. Verifica-se a necessidade de desenvolver estudos clínicos randomizados.

Introduction:

Playing related musculoskeletal disorders (PRMD) are very common conditions affecting musicians from several ages and professional levels[1]. According to Zaza[2] (1998) the prevalence of PRMD ranged from 39% to 87% in adult musicians and from 34% to 62% in secondary school music students. In fact musicians have higher probability of suffering from musculoskeletal problems than other professionals, specially associated with the part of the body which is used to play the instruments[3]. The most affected areas are shoulders, lumbar and cervical regions[4,5].

Several factors could explain the high prevalence of PRMD among musicians. Aspects such as inappropriate working conditions[6], prolonged repetitive movements early in their lives and careers[7], the type of instrument played[8] including the imposed asymmetric postures and the obligation to sustained the weight of the instrument[9], the technical difficulty of the repertoire that demands a certain repetitive movement[10], the years of practice that could influence the technique and the establishment of an inappropriate posture[11], an inadequate physical condition combined with unsuitable treatment of previous injuries[12] and others could influence and explain the high prevalence of PRMD among musicians.

To treat musculoskeletal pain several approaches are recommended. Options such as physical therapy (including transcutaneous electrical stimulation, ice and massage), anti-inflammatory gels or creams, acupuncture, physical and therapeutic exercises could be considered[12-14] however, the main prescribed treatments by medical doctors are rest and anti-inflammatory drugs. When those options fail, local cortisol injections or surgery are other possible solutions[15]. Preventive behavior attitudes including the use of orthotic material such as belts, changing practice habits, such as including warm up exercises, reducing the duration of practice and setting up time for breaks, seems to be very important reducing the prevalence of PRMD[14].

It is common for musicians to underestimate musculoskeletal complaints. In fact, nearly half of music students believe they have equal risk of developing a musculoskeletal problem as any other professional. This lack of information has great implications in musician's health and can lead to withhold preventive measures and instigate the development of a PRMD[8]. Although recurrent injuries and complaints are common, only approximately two thirds of the affected students search for medical assistance[13,16]. Generally, students request help and advice primarily from their instrument tutor and secondly from medical doctors, however several students who have visited medical doctors report that the recommended treatments have only partially aided overcoming the pain[13]. Musicians tend to search for medical help only when the complaints are

so severe that affect their performance, such as neurologic complaints, trauma, osteoarthritis (in older musicians), rotator cuff syndrome, wrist ganglion, tendon problems and focal dystonia[17].

Professional orchestra musicians same as elite athletes depended on their body to perform, and they are both prone to suffer from musculoskeletal pain caused by their professional activity. The main difference between them lies on the fact that athletes have access to specialized health professionals and are consistently made aware of the importance of preventing the appearance of musculoskeletal complaints. Sports medicine is highly developed and athletes have access to the best treatment options, but unfortunately there aren't many health care professionals specialized in performing arts medicine[17].

Likewise, musicians do not present the same preventive behavior as athletes do and tend to accept the pain as an existential condition[17,18]. Professional orchestra musicians are prepared to deal with high levels of physical and psychological stress. They aim to perform music at the highest level, and this outweighs potential negative consequences for their body. Usually musicians just stop playing when pain is so unbearable that starts affecting their performance. Musicians should be educated about the risks of developing PRMD and how to prevent and manage it. Early management should be supported and applied by specialized health care professionals[7,17].

Music students and professional orchestra musicians consider that being treated by a health care professional that demonstrate specialized knowledge about music, instruments playing requirements and musicians' life style specificities, establish trust and could enhance the compliance with the treatment[16]. In the same way, medical doctors consider essential to have specific knowledge to treat professional musicians and in general, they are not satisfied with the quality of medical health care provided to musicians[19].

The purpose of this research is to describe and to compare the possible solutions to treat playing related musculoskeletal problems among musicians.

Methods

Data sources and search strategies

The studies included into this review were identified during March and April 2016 through research in MEDLINE (PubMed), PEDro and Medical Problems of Performing Artists databases. Text word search of titles and key words used the following entries: Musician`s health, playing related musculoskeletal disorders, musculoskeletal pain, treating musculoskeletal pain, treating pain, exercises for musicians, prevention of pain, musicians' rehabilitation, physiotherapy for pain.

Study selection (inclusion and exclusion criteria)

Studies included in this review satisfied the following criteria: (1) only papers translated or originally written in Portuguese or in English were considered (2) types of papers were limited to clinical trials (CT), randomized controlled trials (RCT) and epidemiologic studies including big samples sizes (n>150) (3) subjects participating in the study are students or adult musicians presenting playing related musculoskeletal pain. Studies were excluded when (1) pain was caused by cauda equina syndrome, bone rarefaction, compression fracture of a vertebral body, tumor, or fibromyalgia (2) focal dystonia is present (3) the study was written before 2000.

Quality assessment

The quality assessment was done by the authors according to the modified system used by White and Ernst[20], adapted from Jadad et al.[21]. Studies were scored from 0 to 5 points in the following criteria: Randomization – appropriated method 2 points, randomization 1 point; blinding – patient blinding 1 point, evaluator blinded to therapy 1 point; description of withdrawals and dropouts, 1 point. The quality scores will be presented for each study.

Data extraction

Data was extracted by the author using special prepared forms. For each study the extracted data included the design, randomization, blinding procedures, dropout and withdrawals descriptions, subject characteristics, treatment interventions, control procedures, samples size, main outcome measures, results and the main limitations. All important differences will be settled by discussion.

Results

After searching the referred databases, 103 records were identified and their titles and abstracts were screened. Twenty-six studies were deeply assessed for eligibility and ten studies were included. The selection process is represented into figure 1 bellow.

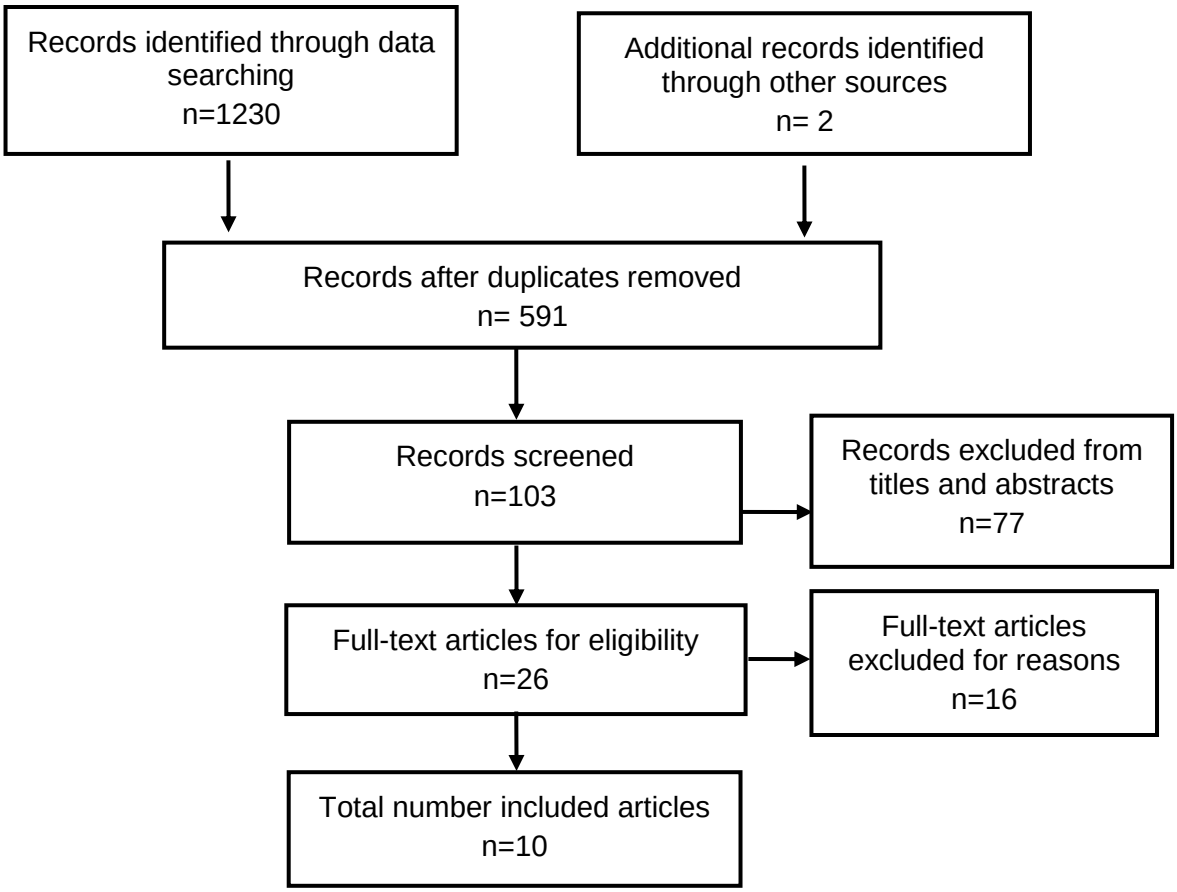


Figure 1 - Selection process

Sixteen studies were excluded because they don`t respect the inclusion criteria or because they do not present a valid or well described treatment option. Table 1 shows the list of excluded studies and the main reasons for their exclusion.

Of the included studies, five are about music students and five about professional musicians. Referring to the treatment techniques, two studies are about tuina techniques, one study is about specific techniques used in rehabilitation programs –massage, stretching and shock waves - two studies are about preventive behaviors and five studies are about exercise programs.

The main data about the included studies (author, title, quality score, population, intervention/control and results) is shown in table 2.

Authors	Title	Reason to be excluded
Molsberger and Molsbergerc (2011)[19]	Acupuncture in treatment of musculoskeletal disorders of orchestra musicians	Literature review
Hunter (2011)[22]	Integration of rehabilitation and acupuncture in the treatment of a professional musician with temporomandibular joint dysfunction	Case report
Chan and Ackermann (2014)[23]	Evidence-informed physical therapy management of performance-related musculoskeletal disorders in musicians	Literature review
Chan, Driscoll and Ackermann (2012)[24]	Development of a specific exercise program for professional orchestral musicians	Major literature review The Participants did not present PRMD
Chan, Driscoll and Ackermann (2013)[25]	The usefulness of on-site physical therapy-led triage services for professional orchestral musicians – a national cohort study	Cohort study
Ioannou and Altenmüller (2015)[13]	Approaches to and Treatment Strategies for Playing-Related Pain Problems Among Czech Instrumental Music Students - An Epidemiological Study	Epidemiological study including small sample size
Macfarlane and Rietveld (2009)[15]	A Rheumatologist Let Loose in a Performing Arts Clinic	Descriptive study based on empirical experience
Davies (2002)[26]	Musculoskeletal Pain from Repetitive Strain in Musicians: Insights into an Alternative Approach	Not RCT or CT
Brodsky and Hui (2004)[27]	An Innovative Patient-centered Approach to Common Playing-related Pain Conditions in Musicians	Case report
Foxman and Burgel[1] (2006)	Musician Health and Safety: Preventing Playing-Related Musculoskeletal Disorders	Literature review
Kenny and Ackermann (2009)[28]	Optimizing physical and psychological health in performing musicians	Not RCT or CT
Lee, Carey, Dubey et al. (2012)[29]	Intervention Program in College Instrumental Musicians, with Kinematics Analysis of Cello and Flute Playing A Combined Program of Yogic Breathing and Muscle Strengthening-Flexibility Exercises	The participants did not present PRMD

Barton and Feinberg (2008)[30]	Effectiveness of an Educational Program in Health Promotion and Injury Prevention for Freshman Music Majors	The participants did not present PRMD
Shafer-Crane (2006)[31]	Repetitive Stress and Strain Injuries: Preventive Exercises for the Musician	Literature review
Hildebrandt, Nübling (2004)[32]	Providing Further Training in Musicophysiology to Instrumental Teachers	The participants did not present PRMD
Ackermann, Adams and Marshall (2002)[33]	The effect of scapula taping on electromyographic activity and musical performance in professional violinists	The participants did not present PRMD

Table 1 – Excluded studies

Author	Title	Quality Score	Population	Intervention	Control	Results
Sousa, Moreira Coimbra et al. (2015)[34]	Immediate effects of Tuina techniques on working-related musculoskeletal disorder of professional orchestra musicians	3	Orchestra musicians	n=39 Single Tuina treatment	n=30 Single placebo Tuina treatment	After one treatment session, pain was reduced in 91.8% of the cases for the experimental group and 7.9% for the control group.
Sousa, Coimbra, Machado et al. (2015)[35]	Effects of self-administered exercises based on Tuina techniques on musculoskeletal disorders of professional orchestra musicians: a randomized controlled trial	3	Orchestra musicians	n=39 Self-administered Tuina treatment	n=30 Placebo self-administered Tuina treatment	Pain intensity was significantly reduced into the experimental group on days 1, 3, 5, 10, 15 and 20 of the follow up
Damian and Zalpour (2011)[36]	Trigger Point Treatment with Radial Shock Waves in Musicians with Nonspecific Shoulder-Neck Pain	3	Music students, tutors, and freelance musicians	n=13 massage/ stretching + shock wave	n=13 massage/ stretching + placebo shock wave	Both group have a significant pain reduction Disability index was significantly reduced in intervention group comparing with control group.
Spahn, Hildebrandt and Seidenglan (2001)[37]	Effectiveness of a prophylactic course to prevent playing-related health problems of music student	1	Music students	n=22 Informative course about “Physiology of Music and Performing Arts Medicine” – 34 hours	n=22 No intervention	Increasing of confidence on stage, posture, breathing, feelings of motion and decreased PRMD

Nawrocka, Wladyslaw, Aneta et al. (2014)[11]	Health-oriented physical activity in prevention of musculoskeletal disorders among young polish musicians	Epidemiologic study	Music school children (10-18 years old)	n=225 answered specific questionnaires about musculoskeletal pain and physical activity habits		The pain localized in neck, shoulders, upper and lower back was reported significantly more often by the participants who did not meet standard criteria for the recommended or minimal physical activity level
Chan, Driscoll and Ackermann (2014)[38]	Effect of a Musicians' Exercise Intervention on Performance-Related Musculoskeletal Disorders	1	Orchestra musicians	n=30 10 week exercise program	n=23 No intervention	Significant reduction of frequency and severity of PRMD after 10 weeks
De Greef, Van Wijck, Reynders et al. (2003)[39]	Impact of the Groningen Exercise Therapy for Symphony Orchestra Musicians program on perceived physical competence and playing-related musculoskeletal disorders of professional musicians	3	Orchestra musicians	n=17 15 week exercise program - Groningen Exercise Therapy for Symphony Orchestra Musicians	n=28 No intervention	Statistically significant increase in perceived physical competence and a decrease in PRMDs in the experimental group compared with the control group. 45% of the decrease in PRMDs was explained by an increase in physical competence.
Ackermann, Adams and Marshall (2002)[40]		4	Music students	n=9 six weeks of strength training of proximal upper-limb and trunk muscles –	n=9 six weeks of endurance training of proximal upper-limb and trunk muscles	There were no significant changes in severity and frequency of PRMD within and between groups. Perceived exertion of playing was significantly reduced, with endurance training significantly better than strength training for achieving this result.

Kava, Larson and Stiller (2010)[41]		1	Music students	n=7 Six weeks of trunk endurance exercises	n=7 Six weeks of Pilates exercises	Both groups reported significant increase in trunk extensor and lateral muscle endurance, significant decrease in pain, fatigue, and perceived level of exertion while playing an instrument. There was no differences between groups
Chan, Driscoll and Ackermann (2013)[42]	Exercise DVD effect on musculoskeletal disorders in professional orchestral musicians	1	Professional orchestra musicians	n=50 Completed a DVD exercises program during 12 weeks		Frequency and severity of PRMD was significantly reduced. Muscle strength and flexibility was improved. Perceived exertion levels during practice remained the same

Table 2 – Included studies

Tuina techniques

Tuina is the abbreviated name of *tui, na, an, mo* and it refers to Chinese manual therapy[43]. The two included studies about this technique are RCT (quality score 3) and they were written in 2015. One of them describes the immediate effect of tuina techniques[34] and the other describes the effects of a self-management program based on those techniques[35] during 20 days. Both studies concluded that tuina techniques significantly reduced pain caused by PRMD.

Rehabilitation techniques

One study about rehabilitation techniques targets to describe the effects of massage and stretching exercises with and without radial shock waves, in musicians with nonspecific shoulder-neck pain (quality score 3). Both groups reported a significant pain reduction however the group who also received radial shock waves reported a significant reduction of disability index[36].

Preventive behavior

Two articles studied the influence of an informative course about medical problems and the impact of physical activity in prevention of PRMD. The 34 hour course titled “Physiology of music and performing arts medicine” improved the posture, breathing, feeling of motion and consequently reduced the frequency and the severity of PRMD in music students[37]. Also physical activity demonstrated to be effective reducing neck, shoulder, upper and lower back pain[11].

Exercise programs

Five studies reporting the effects of an exercise program on PRMD were included. Three studies were done with orchestra musicians[38,39,42] and two studies were done with music students[40,41]. Their quality scores vary from 1 to 4 and they were written between 2002 and 2014. The program`s duration fluctuates between 6 to 15 weeks. The chosen exercises were different but all of them were aiming to increase muscle endurance and strength in order to decrease PRMD. Four studies concluded that an exercise program significantly reduced frequency and severity of PRMD[38,39,41,41]. One study reported no significant changes in frequency and severity of PRMD[40].

Discussion

The strict inclusion criteria defined that only 10 articles related to PRMD treatment were included. There are several studies about treating musculoskeletal pain in general population and in people prone to suffer from working related musculoskeletal disorders caused by repetitive movements. Those articles were not included because playing an instrument is more specialized than repeating a specific movement. Musicians have to deal with constant physical and psychological stress factors and they live in a constant competitive environment[17]. Although they consider pain a normal condition, when they have to stop playing they feel physically, emotionally and socially devastated [18].

Only studies written after 2000 were included. As medicine is in constant development it is safer to consider only the most recent studies in order to present the most updated results. Pain caused by cauda equina syndrome, bone rarefaction, compression fracture of a vertebral body, tumor, fibromyalgia or focal dystonia was excluded since it has a complex etiology and there are associated structural changes.

Several studies describe the effects of informative courses and programs of preventive exercises on changing musicians' behavior. It is established that changing risk factors can help to reduce the risk of developing a PRMD; however, only studies including musicians suffering from PRMD at baseline were included.

Two studies reporting the effect of Chinese manual therapy – tuina – treating PRMD were included[34,35]. Both of them are RCT, musicians were blinded and they are very recent. They both concluded that tuina techniques significantly reduced pain caused by PRMD.

Regarding rehabilitation techniques, several studies written before 2000 were identified, however they were excluded. A recent single blinded RCT from 2011 reported the effect of massage and stretching exercises with and without radial shock waves, in musicians with nonspecific shoulder-neck pain. The authors concluded that massage and stretching exercises and radial shock waves significantly reduced pain caused by PRMD. The main limitations is the small sample size (n= 26)[36].

Referring to preventive behaviors, two studies from 2001 and 2014 were included. The first study is a clinical trial presenting a convenience sampling. The investigation mentions the positive effects of an informative course titled "Physiology of music and performing arts medicine" reducing severity of PRMD in music students. The results also demonstrated that students reported increasing of confidence on stage, posture, breathing and feelings of motion[37]. Those last conclusions are shared by Barton and Feinberg[30] that also applied an informative course about health promotion and injury prevention strategies for college music majors. The authors concluded that after 6

weeks, students improved their self-perceived application of health promotion and injury prevention strategies.

The epidemiological study about the effects of physical activity reducing PRMD was included because of the big sample size (n=225). The authors concluded that regular physical activity showed to be effective reducing neck, shoulder, upper and lower back pain in music students[11].

Half of the included articles studied the effect of an exercise program reducing the severity and the frequency of PRMD. The studies were performed between 2002 and 2014. The program took place during 6, 10, 12 and 15 weeks, once or twice a week, during 35 to 60 minutes. Although all programs included different methods, exercises of endurance, strength and stretching were always present[38-42].

Four out of five studies concluded there was a significant reduction of severity and prevalence of PRMD[38,39,41,42]. Only Ackermann, Adams and Marshall (2002) reported no difference between groups[40]. The authors stated that there is the possibility that a six weeks period is not enough to observe changes in that parameter. Kava et al.[41] also performed the program for six weeks but the duration of the class was 60 minutes. Perhaps if Ackermann, Adams and Marshall (2002) performed the exercises during 60 minutes instead of 35 minutes, they could have been able to notice changes in pain caused by PRMD.

Other interesting conclusions are that endurance training is more effective reducing perceived exertion of playing than strength training[40]; the physical competence was always increased by any exercise program[38-42]; an exercise DVD program seems to be a convenient and safe solution to control de appearance of PRMD[42]; Pilates and trunk exercises demonstrated to be equally effective reducing PRMD[41].

The included studies presented some limitations. The randomization process was sometimes difficult because of the full-time schedule of the musicians. In those situations convenience sampling was used. One study did not use control group. The sample size was in some cases small (n=53, 45, 18, 14 and 50).

Conclusion

Results showed that tuina techniques, rehabilitation techniques - massage, stretching exercises and radial shocks wave - preventive behavior – regular physical activity, informative courses – and exercise programs are effective reducing the prevalence and the severity of PRMD. The strength evidence points to the great effect of exercises programs reducing pain caused by PRMD.

This literature review has several limitations mainly due to the included studies. Unfortunately RCT and CT reporting the effects of treatment techniques on PRMD are scarce. The majority cannot respect double blinding criteria since only the musician is blinded. The strict musicians schedule made difficult the randomization, and convenience sampling is the only possible solution to accomplish the investigation. Epidemiological studies are easier to do once they are time sparing methods. Also the sample sizes of the included studies are low. Unfortunately the analysis was limited to studies published in English and in Portuguese and this also presents a limitation since numerous studies had been carried out in various countries. Since the strength of the evidence was low or moderate rather than high, results could change through further research.

Future RCT are needed in order to study the effect of treatment techniques reducing the prevalence and the severity of PRMD.

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Chapter IV

Treating musculoskeletal pain with Traditional Chinese Medicine techniques – A short review

Short Communication

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Treating musculoskeletal pain with Traditional Chinese Medicine techniques - A short review -

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Treating musculoskeletal pain with Traditional Chinese Medicine techniques – A short review

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Abstract:

Musculoskeletal pain affects people all over the world. Many conventional solutions are in some way ineffective reducing pain only modestly and briefly. Traditional Chinese Medicine (TCM) is known as a model system biology based on a logically accessible theoretical background. The aim of this review is shortly describe the effects of acupuncture, tuina and qigong reducing musculoskeletal pain. Despite literature describes positive effects of TCM techniques reducing musculoskeletal pain, future studies are needed.

Keywords: Musculoskeletal pain, acupuncture, tuina, qigong, Traditional Chinese Medicine

Introduction:

Musculoskeletal pain is a very common condition affecting people in daily life. Epidemiological studies show that approximately 70% of people suffer from low back pain (Andersson, 1997) and 30% experience neck pain during their life (Mäkela, 1991).

Common solutions used to treat musculoskeletal complaints include rehabilitation programs and drugs such as paracetamol, a very well-known pain killer (Schnitzer, 2006). However, according to Curatolo and Bogduk (2000), many drugs are ineffective while others reduce pain only modestly and briefly and have only a minimal effect on quality of life.

Traditional Chinese medicine (TCM) in a modern understanding is known as a model system biology based on a logically accessible theoretical background (Greten, 2011). It may be understood as a systemic vegetative medicine and the usage of acupoints as a part of the same may be regarded as a model of a vegetative reflex therapy (Doenitz et al., 2012). TCM diagnosis may be understood as the evaluation of a functional vegetative state of the body leading to a proper selection of clinically successful of acupoints (Porket, 2001). The functional vegetative state could be treated using acupuncture, tuina, qigong and herbs

Acupuncture is based in the insertion of needles in specific point called Acupoints. Acupoints have specific clinical functions and effects and they are connected to deeper layers of the body influencing “qi” flow (Karner et al., 2013). Acupoints could be stimulated using acupuncture needling of using Tuina techniques (Porket, 1995). Tuina is the abbreviated name of the Chinese manual therapy (Greten[1,2] , 2013)

Qigong is named as a traditional vegetative biofeedback therapy with proven effects on vegetative mechanisms in body regulation (Sousa et al., 2012). It combines controlled breathing with slow movements in a concentrated state.

The aim of this review is shortly describe the effects of acupuncture, tuina and qigong reducing musculoskeletal pain.

TCM techniques

Acupuncture

Acupuncture is the most popular treatment of Traditional Chinese Medicine. It had their origin 3,000 years ago in China and it is practiced in most of the world. The practice of acupuncture consists of inserting needles into selected body locations

(acupuncture points). Classic texts describe 365 points located in conduits that are mapped on the surface of the body (Sierpina and Frenke, 2005).

According to Chung, Bui and Mills (2003), acupuncture is increasingly used by complementary and traditional medicine practitioners, for pain management in musculoskeletal disorders. The world health organization (2012) considers that acupuncture is indicated in several musculoskeletal disorders such as cervicobrachial syndrome, frozen shoulder, tennis elbow, sciatic pain, low back pain and osteoarthritis (in Sierpina and Frenke, 2005).

Studies were done about the general effectiveness of acupuncture relieving pain. According do Han (2004) studies have shown that different kinds of neuropeptides are released by the use of acupuncture or electroacupuncture. Those endogenous opioid peptides play an essential role in mediating the analgesic effect of acupuncture. According to the author electroacupuncture of 2 Hz accelerates the release of enkephalin, b-endorphin and endomorphin, while that of 100 Hz selectively increases the release of dynorphin.

Wu et al. (1999) have done a study aimed to characterize the central nervous system pathway for acupuncture stimulation in the human brain by using functional magnetic resonance imaging. After needling Stomach 36 and Hepatic 4 hypothalamus and nucleos accumbens became active, while rostal part of the anterior cingulate cortex, amygdala formation and hippocampal complex became deactivate. These results demonstrate that acupuncture at both points activates structures of descending antinociceptive pathway and deactivates multiple limbic areas subserving pain association – analgesia mechanism.

Several studies also refer significant decreasing of musculoskeletal pain in conditions such as low back pain (Johannes et al., 2013) and neck pain (White and Ernst, 1999).

Tuina

Tuina is the abbreviated name of the Chinese manual therapy, since the original name is *tui na an mo*, the Chinese names for the different techniques. There are more than 50 classic techniques, however there are four components that could be mixed within these techniques: pressure, vibration, moving and warming component. The right component must be chosen according to the Chinese diagnose (Greten[1,2], 2013)

There are several studies proving the positive effects of tuina techniques in various conditions, using different acupoints. According to Sousa et al.[1] (2015), tuina treatment showed to be extremely effective reducing musculoskeletal pain in orchestra musicians immediately after the first treatment. In a 21 day follow up self-management exercises based on tuina techniques, significantly diminished musculoskeletal pain

between the control and the study group and decreased pain intensity within the study group, as figure 1 shows (Sousa et al.[2], 2015).

Studies also report the benefits of tuina techniques reducing neck pain and low back pain (Hsieh et al., 2006).

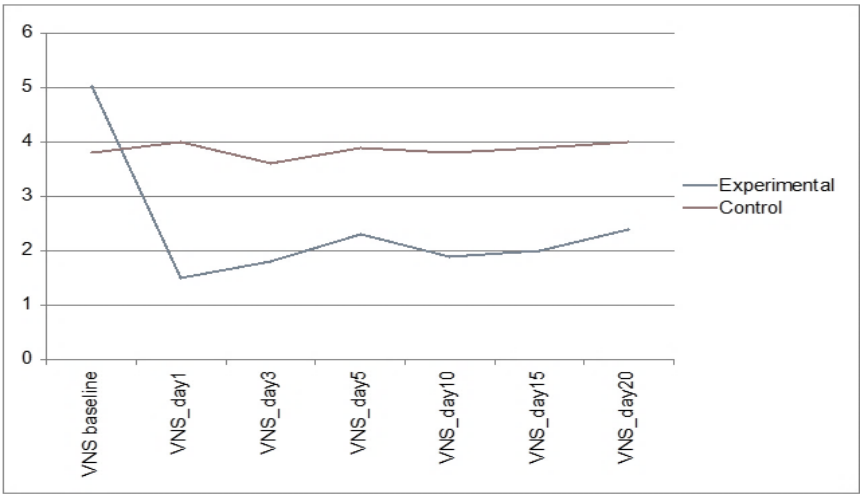

Figure 2 - Effects of self-administered exercises based on Tuina techniques on musculoskeletal disorders of professional orchestra musicians: a randomized controlled trial (Sousa et al, 2015-2)

Qigong

Greten[1] (2013) defines Qigong as a traditional vegetative biofeedback therapy and according to Dorcas and Yung (2003), Qigong was originated at least 5000 years ago. More than 1000 forms of Qigong are practiced today in China (Li, Chen and Mo, 2002). According to Li, Chen and Mo (2002), the original purpose of Qigong practice hasn`t been used for treating diseases but for preventing them. Qigong doesn`t treat just the symptom or the disease, but helps the person to restore what is called “the Qi flow”, in western terms, their capacity to adapt functionally by their vegetative nervous system.

Although it is speculated that most Qigong forms bring health benefits, medical Qigong is a small and specialized area of Qigong that has been specifically developed for treatment and cure of diseases (Chen and Yeung, 2002).

Qigong consists primarily of meditation, physical movements and breathing exercises. Qigong masters developed the skill of feeling the sensation of Qi and work with it using their mind and intention (Sancier, 1996).

Chinese studies claim that Qigong, a traditional vegetative biofeedback therapy, helps to relax mind, muscles, tendons and joints by exercises involving physical movements, focused meditation, breathing and self-massage. It is speculated that as the injured tissues become more relaxed, vasoconstriction would decrease and blood

circulation increase. This phenomenon could promote the removal of metabolic waste and increase delivery of pain killers such as endorphins (Sanciers and Hole, 2001).

In fact, practicing Qigong may favorably affect many functions of the body, permitting the reduction of the drugs` dosage. Studies suggest that Qigong provides greater health benefits than the use of drug therapy alone in certain cases (Sanciers, 1999). Qigong also contributes to the reduction of cortisol level, heart rate and subjective perception of anxiety (Sousa et al., 2012)

Conclusion

There are several studies reporting the positive effects of TCM techniques in different conditions and illnesses such as musculoskeletal pain. Although TCM techniques are used by millions of people, the scientific proof of Tuina, Qigong and Acupuncture related effects are poor for several reasons.

Unfortunately the great majority of studies use treatment protocols. According to the Chinese Diagnosis, to treat the same conditions, it is necessary to individually evaluate the patient and develop a unique treatment plan. In several studies the TCM methods are not properly and uniformly defined. The indications of the treatments only rarely allocate to western diagnoses and their details are not sufficiently explained. In some cases the effects are difficult to objectify. Besides subjective scores, studies do not reach scientific standards due to poor evaluation, lack of controls, or poor type of data. Also the absence of blinding cannot eliminate the possible placebo effect.

As practitioners we empirically observe the great results of TCM techniques in conditions such as musculoskeletal pain. However empirically knowledge is important, it is not enough to make science. Future studies are needed to scientifically proof the effects of TCM techniques reducing musculoskeletal pain.

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Chapter V

Occupational diseases of professional orchestra musicians from Northern Portugal – a descriptive study


Article

Occupational Diseases of Professional Orchestra Musicians from Northern Portugal

A Descriptive Study

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Occupational diseases of professional orchestra musicians from Northern Portugal – a descriptive study

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Abstract

Background: Owing to repetitive movements and to a very stressful and competitive lifestyle, musicians are a group which may be prone to suffer from occupational diseases. According to the literature, musicians are mainly affected by two types of occupational diseases: music performance anxiety (MPA) and playing-related musculoskeletal disorders (PRMD). The aim of this study was to describe the prevalence of the most common complaints affecting musicians of the three professional orchestras from Northern Portugal.

Methods: One hundred and twelve professional orchestra musicians from the 3 professional orchestras from Northern Portugal were individually interviewed about their physical and psychological complaints.

Results: Results indicated that 93.8% of the interviewed musicians self-reported at least one working-related problem. PRMD were the most common self-reported conditions affecting 84.8% of musicians. The most affected areas are the shoulder, cervical and lumbar regions. MPA was referred to by 21.4% musicians.

Conclusion: The present work covers about 40% of all Portuguese professional orchestra musicians. We hope that this study raises awareness of the importance of focusing on the problem of the high prevalence of professional diseases among musicians. This is a matter for concern and future studies focusing on work-related problems among professional orchestra musicians in Portugal are needed.

Keywords: PRMD, music performance anxiety, musculoskeletal disorders, professional orchestra musicians

Background

According to the Portuguese Health Ministry, an occupational disease is a condition directly caused by working conditions that can lead to incapacity or death during performance of the occupation[1].Diseases caused by repetitive movement such as tendinitis, tenosynovitis, bursitis or problems of the vertebral column, among others, are included. According to the literature, musicians are mainly affected by two types of professional disorders: music performance anxiety (MPA) and playing-related musculoskeletal disorders (PRMD)[2,3].

Musical performance anxiety

Music performance anxiety has a varied range of interdependent influences, both at physiological level and cognitive, emotional or behavioural level. Perhaps this is why it is difficult to form a single definition both owing to its multi-factor nature and to the fact that the term has unsatisfactorily connotations with the term "stage fright"[4]. According to Lehmann et al.[5] the sources of music performance anxiety can originate from the musician himself, and the degree to which musicians tackle their task or the situation. This is in line with Robert et al.[6] who reinforces the fact that MPA deals with the presentation of the individual in public. A number of studies show that one third of music students became anxious before playing in public, 22% had already failed an exam because of MPA and 20% consider stage fright a severe problem[7]. Furthermore, MPA may affect about 16% of orchestral musicians[8] but it also affects musicians from all types of music and degrees of proficiency[4]. However, whatever perspective we adopt, according to Kenny and Osborn (2006) the problem of MPA is clearly underestimated[9].

Additionally, it is widely known that anxiety disorders may lead to significant disability, poor quality of life and enormous social costs resulting from absenteeism, or low professional work efficacy and the consequent burnout and related conditions[10].
To treat anxiety, Western medicine uses drugs such as benzodiazepines, buspirone, antidepressants, beta-blocking agents or antipsychotics[11]. In fact a fifth of music students admit to taking beta-blockers to control their states of anxiety[7]. However, one out of three patients presents an insufficient response or does not get better with these treatments[10].Alternatives such as breathing exercises and self-control techniques such as Qigong are used and considered to be useful by musicians[12].

PRMD

The prevalence of playing-related musculoskeletal disorders (PRMD) in musicians has also been studied for several years, with a significant increase from studies demonstrating that almost half of musicians experience playing-related medical problems that could threaten or even end their careers[3]. The prevalence of playing-related musculoskeletal disorders in musicians ranges from 39% to 87%[2]. Recent data claims that 50% to 76% of musicians are affected by PRMD[13]. Referring exclusively to professional orchestra musicians, a study involving 485 orchestra musicians referred to a prevalence of PRMD of 42%[14]. An astonishing number from a British symphonic orchestra demonstrated that 86% of elite professional musicians admitted to having experienced musculoskeletal pain during the last year[15].

PRMD mainly affect the upper extremity of the body including the vertebral column and the upper limbs[16,17]. Injuries from overuse cause symptoms ranging from mild pain while the musician is playing to pain severe enough to preclude any use of the affected zone. Those musculoskeletal disorders often become chronic and painful causing a decreased quality of life[2,3,18].

PRMD have multifactorial causes and several risk factors could contribute to their onset. An inadequate individual technique, the musician's physical characteristics, repertoire, study habits, years of playing experience, psychological stressors, lack of preventive wellness behaviours, awkward static or dynamic postures, repetitive movements or previous trauma could explain the high prevalence among musicians[19-22]. PRMD have emotional, physical, financial, occupational and social consequences to the musician's life[23]. According to Zaza et al[23] their effect on playing is one of the most often-cited consequences for musicians. In fact, PRMD adversely affect musicians' ability to play to their optimum level[24,25].

To treat musculoskeletal pain, musicians could complete rehabilitation programs or take medicines such as paracetamol, a very commonly-used pain-killer[26] but the efficiency of pharmacological treatments is sometimes disappointing[27]. Rehabilitation programs are usually added with the recommendation to stop playing, with data showing that approximately one third of affected musicians have to stop playing for a period of time[28].Consequently, the fear of being replaced and losing their workplace may well be responsible for the dangerous attitude of ignoring pain and continuing to play without asking for help from colleagues or teachers[29,30].

Unfortunately, literature on the subject is scarce at national level in Portugal and to our knowledge there are no studies on this important theme in musicians of professional orchestras. From the official information, we can observe that the teaching

and practising of music in Portugal is growing and as a consequence, the number of professional musicians is also growing, which is why it is becoming very important to study their working conditions and working-related complaints. This study represents the first step in understanding the reality of the situation facing Portuguese orchestra musicians, in order to improve their quality of life.

Methods

The aim of this research was to describe the most common diseases affecting musicians of the three professional orchestras from Northern Portugal. Mainland Portugal has eight professional orchestras. Therefore, the present study covers 40% of the professional orchestra musicians in Portugal.

Due to geographic convenience, the present study focused on the three professional orchestras of Northern Portugal (*Orquestra Sinfónica do Porto Casa da Música, Orquestra Filarmónica das Beiras* and *Orquestra do Norte*), representing the totality of the professional orchestras in this region. All musicians of the three orchestras - a total of 162 - were asked to take part in this study, which 112 agreed to do. The participation rate was therefore of 69%.

Data from the personal information, the clinical history and the musicians' complaints were obtained from an individual semi-structured interview. The diagnosis of playing-related complaints was performed by a physiotherapist who interviewed and physically examined the musicians.

Chi square test were performed in order to analyses the association between the occurrence of symptoms in different parts of the body and the played instrument using SPSS (version 23.0, SPSS Inc., Chicago, Illinois, USA).

This research was carried out after the approval of the Ethical Commission of Institute of Biomedical Sciences Abel Salazar - University of Porto was granted, and all the participants signed and gave their informed consent according to the Helsinki declaration.

Results

Sample characteristics

As indicated in Table 1 below, our sample comprised 112 participants (n=112), 37 female and 75 male, with an average age of 37.8 years and a standard deviation (SD) of 9.4.

N	Male	Female	Age	Portuguese
112	75	37	37.8 (SD=9.4)	61

Table 1 - Sample characteristics

71 out of 112 played string instruments, 37 played wind instruments and 4 played percussion instruments (Table 2 and Table 3).

Violin	Viola	Cello	Double bass	Harp
33	13	13	11	1

Table 2 - String musicians

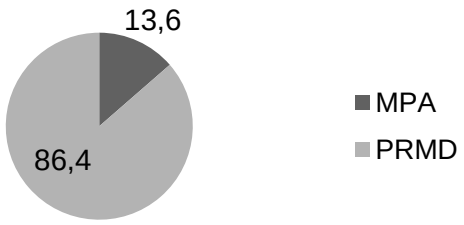
Flute	Clarinet	Oboe	Bassoon	Horn	Trombone	Trumpet	Tuba	Percussion
6	4	4	3	7	7	5	1	4

Table 3 - Wind and percussion musicians

General overview: Self-reported complaints

93.8% (n=105) of the participants reported an occupational disease totalling 214 complaints. Of the aforementioned 214 complaints, 13.6% were related to Music Performance Anxiety and 86.4% were playing-related musculoskeletal disorders.

Graphic 1 below represents the percentage of MPA and PRMD.



Graphic 1 - Self-reported complaints

MPA

21.4% (n=24) reported to experience MPA during the last year. 16.1% (n=18) of the musicians referred to currently experience states of anxiety both before and during the concert, 8.9% (n=10) also admitted to taking or having taken medicines to control their anxiety, namely a betablocker.

Musculoskeletal complaints

84.8% (n=95) of musicians referred to experience PRMD. From the complaints present during the interview 56.8% affected the vertebral column, mainly the cervical (26.6%) and the lumbar regions (24.3%). The shoulder joint represents 27% of the self-reported PRMD (16.2% left shoulder and 10.8% the right shoulder), as shown in table 4 below.

Upper right limb			Upper left limb			Vertebral column			Face	
Shoulder	Arm/ Forearm	Wrist/ hand/ finger	Shoulder	Arm/ Forearm	Wrist/ hand/ finger	Cervical	Dorsal	Lumbar	TMJ	Lips
10.8%	1.6%	4.3%	**16.2%**	3.2%	4.9%	**26.6%**	5.9%	**24.3%**	1.1%	1.1%
16.7%			24.3%			56.8%			2.2%	

Table 4 - Distribution of self-reported musculoskeletal complaints

According to chi square test the distribution of complaints in different parts of the body is not related with the played instrument (p value= 0.528). Although by looking at the distribution of complaints per type of instrumentalist, results suggest that there is a tendency for some common PRMD to be associated with the instrument type. 42% of the violinists self-reported musculoskeletal pain in the left shoulder and 24% in the right shoulder. Pain in the cervical region was also reported by 52% and pain into the lumbar region was reported by 42% of the violin players.

46% of the viola players also stated they felt cervical pain related to practising their instrument. The cellists' results show that 54% mentioned cervical pain and 46% referred to lumbar pain. The number of wind musicians is very low, but results also show a tendency towards some frequent PRMD according to the instrument played. As far as flutists are concerned, 66% mentioned pain in the left shoulder and 83% self-reported cervical problems. Also 71% of trombone players claimed to have lumbar pain. The other values were not considered because of the small sample size.

Discussion

Results show that 93.8% of the musicians interviewed self-reported working-related problems. The most frequently mentioned problems were related to musculoskeletal disorders, reported by 84.8% of the subjects. Our data is similar to the information obtained in other countries. In Spain, a study involving 1613 musicians of

different ages and at different professional levels demonstrated that 79% of them suffered from physical problems related to their professional activity[29].Another study of 485 orchestra musicians from Australia referred to a prevalence of PRMD of about 42%[14]. Data from Germany indicates that 86.3% of 1432 string instrument players reported PRMD[31]. Brazilian studies suggest a prevalence of PRMD of 68%, 70% and 94%[19,32,33]. Also, as previously stated, 86% of elite professional musicians from British symphonic orchestras admitted to having musculoskeletal pain during the last year[15].

MPA was reported by 21.4% of the musicians. All over the world studies suggest that musicians are often affected by MPA. For example, in the Netherlands the majority of symphonic orchestra musicians reported experiencing or having experienced performance-related anxiety seriously enough to affect their professional or personal lives. They also reported considerable anticipation anxiety days (36%), weeks (10%) or even months (5%) before the performance[34]. A more recent study from Germany concluded that one third of the students from 15 to 19 felt that their MPA was distinctly debilitating[35]. Also the study by Fishbein et al.[8] carried out on 48 American orchestras involving more than 2200 musicians reported similar results, with 25% of musicians reporting stage fright, a higher percentage than the one reported in our sample.

Our data indicates a lower rate of MPA than the aforementioned studies in the literature. It may well be that since this is a very delicate subject, musicians did not feel comfortable talking about it, at least in this current Portuguese context. As this data came from self-reported complaints, we can speculate that using a standardized diagnostic protocol our data could be different and perhaps the percentage of affected musicians could be even higher. It is known that anxiety problems could significantly affect performance[24,25]. Additionally, the highly-competitive environment within those orchestras could explain the possible fear of talking about a subject that could be regarded as a sign of professional weakness.

While the affected regions are independent of the played instrument, shoulder (27%), cervical (26.5%) and lumbar (24.3%) pain were the most self-referred. Our results tally with classical studies such as the aforementioned by Fishbein et al.[8]. According to these studies, the most affected regions in musicians are neck (22%), cervical (16%), lumbar (22%) and shoulder (20%). They also affirm that injuries in the fingers (16%), hand (14%), wrist (10%) and elbow (10%) are common. According to their data 60% of PRMD are localized in the shoulder/arm region. More recent research with musicians from several levels of achievement also concluded that 67% of all pain symptoms in musicians are localized within the shoulder/arm/hand region, 13% within lumbar and 6% within cervical regions[36]. A recent study specifically about PRMD in orchestra musicians

referred to a high prevalence of shoulder pain (55%), lower back pain (49%), upper back pain (42%) and neck pain (39%)[37].

Although there is no evidence that the instrument type affects the distribution of complaints in different parts of the body (p value= 0.528) results suggest that left shoulder, cervical and lumbar pain are common in violinists. Our data is in line with the conclusions of Lederman[38]. According to the author, violinists are particularly affected by left arm problems. Also Nyman et al.[39] affirm that musicians working in an elevated arm position, such as violinists and violists, present high prevalence of neck-shoulder pain. According to our data, violists are also a group prone to suffer from cervical problems.

Strokes and Reid[40] analysed the upper limb movement in the bowing arm of string-playing musicians. According to them, cellists are prone to suffer from neck and shoulder symptoms because of the increased shoulder movement in the upper register of the Cello. In other study and from a different perspective, as cellists play in a neutral arm position, they are not so prone as a group to suffer from neck-shoulder pain[39].Our data also indicates that cervical and lumbar pain were common complaints among cellists.

Regarding woodwind musicians, our results suggest that flutists may be mainly affected by left shoulder and cervical pain. This data correlates with the conclusions of Nyman et al[39].As flutists play in an elevated arm position, they are a group prone to suffer from neck–shoulder pain. Our results are thus in line with those of Lederman[38] in which 44% of woodwind musicians presented pain in the right arm, 20% in the left arm and 35% in both. Moreover, our results also indicate that flutists are mainly affected by left arm problems. The data collated by Lederman[38] is related to all woodwind musicians and not only to flutists. He also affirms that, for example, the weight-bearing right thumb and hand of oboists and clarinettists are very frequently affected. Maybe this fact contributes to the numbers he presented. Regarding oboists and clarinettists, our results are not conclusive because none of the inquired musicians referred to that problem.

As far as the brass wind musicians are concerned, studies concluded that left arm problems are the most common disorders[38].With regard to that specific instrumentalist group, our results only show that trombone players were prone to suffer from lumbar pain.

Conclusion

To our knowledge this is the first study about occupational diseases among professional musicians in Portugal and covers an average of 40% of all Portuguese professional orchestra musicians. One of the limitations of this research is the absence of validated questionnaires to grant greater validity and reliability to conclusions about states of anxiety and PRMD. The orchestra managers alerted us to the probable low successful participation rate of this methodology, but our main goal was to become closer to the musicians and to establish a doctor/patient relationship of confidence and trust. Further research will include the administration of standardized questionnaires adapted to the Portuguese population.

We hope that this study raises awareness to the importance of focusing on the problem of the high prevalence of professional diseases among musicians. According to our results almost 94% of all musicians interviewed reported some kind of occupational complaint. This data is indeed astonishing and must therefore be taken into due account.

Musicians have to assume unnatural postures, play for several hours a day and deal with the stress of a very competitive environment. This is a matter for concern and future studies focusing on working-related problems among professional orchestra musicians in Portugal are needed.

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Chapter VI

Playing-related musculoskeletal disorders of professional Orchestra musicians from the North of Portugal: Comparing string and wind musicians – An observational epidemiological study

ARTIGO ORIGINAL

Playing-Related Musculoskeletal Disorders of Professional Orchestra Musicians from the North of Portugal: Comparing String and Wind Musicians

Alterações Musculoesqueléticas dos Músicos de Orquestras Profissionais do Norte de Portugal: Comparação entre Instrumentistas de Cordas e Sopros

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Playing-related musculoskeletal disorders of professional Orchestra musicians from the North of Portugal: Comparing string and wind musicians – An observational epidemiological study

Alterações musculoesqueléticas dos músicos de orquestras profissionais do Norte de Portugal: comparação entre instrumentistas de cordas e de sopros – um estudo epidemiológico observacional

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Abstract

Introduction: It is well known that musicians are a group prone to suffer from playing-related musculoskeletal disorders (PRMD). Professional orchestra musicians play for several hours a week and have to fight against pain caused by their profession. The aim of this study was to explore and describe self-reported complaints among professional orchestra musicians and to compare its intensity and prevalence between string and wind instruments.

Material and Method: Hundred and twelve (n=112) professional orchestra musicians from the three main professional orchestras from the North of Portugal were individually interviewed about the prevalence and the intensity (measured by Verbal Numerical Scale - VNS) of their PRMD.

Results: About two third (62.5%) of the interviewed musicians presented PRMD during the time of the interview. Despite there are no significant statistic values between groups, results suggested that PRMD are more common in string players and more intense in wind players.

Discussion: Referring to the prevalence of PRMD, our data is in line with other studies from different countries. More than half of professional orchestra musicians in the North of Portugal are playing with a mild to moderate pain.

Conclusion: Future studies focusing on working-related problems among professional orchestra musicians in Portugal would be useful to better describe the problem of occupational diseases among performing artists.

Keywords: Musculoskeletal pain, occupational disease

Resumo

Introdução: A literatura estabelece claramente que os músicos são um grupo com elevado risco de desenvolvimento de lesões musculosqueléticas relacionadas com o trabalho (PRMD). Os músicos profissionais de orquestra trabalham diariamente durante várias horas e deparam-se frequentemente com a dor como consequência da sua profissão. O presente estudo pretende descrever a prevalência e a severidade das PRMD que afetam os músicos de orquestras profissionais do Norte de Portugal, comparando instrumentistas de cordas e de sopros.
Material e métodos: Cento e doze (n=112) músicos das três orquestras profissionais do Norte de Portugal foram entrevistados individualmente de forma a determinar a prevalência e a intensidade da dor (medida pela escala verbal numérica de dor - VNS) das suas PRMD.
Resultados: Aproximadamente dois terços (62,5%) dos músicos entrevistados apresentou PRMD durante a entrevista. Apesar de não se verificarem diferenças estatisticamente significativas, os resultados obtidos sugerem que as PRMD são mais frequentes nos instrumentistas de cordas e mais intensas nos instrumentistas de sopro.
Discussão: Os resultados referentes à prevalência de PRMD são similares a resultados de outros estudos realizados em diferentes países. Mais da metade dos músicos de orquestras profissional no Norte de Portugal apresentam diariamente dor leve a moderada.
Conclusão: Verifica-se a necessidade de realização de investigações futuras com o objetivo de estudar com maior profundidade os problemas profissionais que afetam os músicos em Portugal.

Introduction

It is well known that musicians are frequently affected by specific professional diseases like playing-related musculoskeletal disorders (PRMD).[1] Constant and repetitive movements performed without ergonomic precautions in combination with self-imposed pressures, make musicians a vulnerable group to suffer from working-related diseases.[2]

Research shows a high prevalence of PRMD that can affect musicians seriously enough to influence the peak of their career.[3] In fact, almost half of the musicians experience playing-related medical problems that could threaten or end their careers.[4] The prevalence of playing-related musculoskeletal disorders is well documented. Studies from Zaza (1998) state that the percentage of affected musicians ranged from 39% to 87%. More recent data states that the percentage of affected musicians varies between 64% and 94%.[5-9]

Common PRMD of musicians include overuse complaints, entrapment neuropathies and occupational hand cramp[10] that frequently affect the upper part of the body including neck, shoulder, arm and wrist.[11-13] Those injuries can cause symptoms ranging from slight to severe pain.[4] Individual technique, musician characteristics e.g. age and gender, the repertoire, study habits and years of playing experience, psychological stressors, lack of preventive wellness behaviours, previous trauma, environmental conditions and other variables could contribute to the development of PRMD.[14-17]

The instrument type also seems to contribute to the onset of PRMD.[18] The instrument's weight and the imposed posture could influence the prevalence of musculoskeletal injuries among musicians.[14] Studies about the lateralization of upper extremity disorders in instrumentalists showed that string, woodwind and brass instrumentalists present a different prevalence of injuries in different sides of the body.[9] Research also shows that instruments imposing asymmetric postures e.g. violin, viola, flute, and others also contribute to the assuming of unhealthy postures by the musician.[19] Musicians playing in an elevated arm position are more prone to suffer from PRMD in the upper limb than musicians playing in a neutral arm position.[20]

There are several research studies around the world about the prevalence of PRMD among string and wind musicians. Studies from Lockwood[4] concluded that string players are the most commonly affected by musculoskeletal disorders and percussionists the least. Recent studies are not completely conclusive about which instrument group is the most prone to suffer from PRMD. Some authors affirm that string instrumentalists are more prone to suffer from PRMD[9, 21] and wood wind players the least [22] but in contrast

Llobet[8] (2004) affirms that percussionists are the most affected by PRMD, followed by wind and string players.

Musicians frequently tend to underestimate their problems, ignoring pain and symptoms requiring treatment or rest.[23] The recommended time of rest ranged from 2 to 7 days depending on the complaints.[24] Approximately one third of the affected musicians have to stop playing during a period of time.[3] Frequently, when the disease appears, musicians try to deal with it, without asking for help to their colleagues. This behaviour could be explained by the fear of losing the workplace and of course the implication and recommendation to stop playing.[8]

To our knowledge, the epidemiology of PRMD among musicians has never been studied in professional Portuguese orchestras. The aim of this study was to explore and describe self-reported complaints among professional orchestra musicians and to compare its intensity and the prevalence between string and wind instruments. Due to geographic convenience only orchestras from the North of Portugal were considered.

Material and methods

Due to geographic convenience 162 professional orchestra musicians from the 3 main professional orchestras of the North of Portugal (*Orquestra Sinfónica do Porto Casa da Música, Orquestra Filarmónica das Beiras* and *Orquestra do Norte*) were asked to take part into this observational epidemiological study. Of those, 112 agreed to participate and the participation rate was consequently of 69%. Only musicians working in full time in the selected orchestras were invited to participate and therefore included.

In an individual semi-structured interview, done within the orchestra installations, PRMD and its intensity (measured by Verbal Numeric Scale-VNS) were registered. Only playing-related injuries diagnosed by a physiotherapist were considered. Only symptoms present during the time of the interview, capable to be evaluated, were considered. The data was collected between September of 2012 and June of 2013.

This study was performed after the Ethical approval from the Institute of Biomedical Sciences Abel Salazar - University of Porto. All the participants signed and gave their informed consent according to the Helsinki declaration.

Measurements

The numeric verbal scale (VNS) for pain intensity is one of the most frequently scales used to evaluate pain intensity. Patients estimate their pain on a scale from 0 to 10.[25] 0 represents no pain, from 1 to 3 represents mild pain (nagging, annoying, little interference with activities of daily life), from 4 to 6 represents moderate pain (interferes significantly with activities of daily life) and from 7 to 10 represents severe pain (unable to perform activities of daily life). This scale can be used with adults and children (> 9 years old) and in all patients able to use numbers to rate the intensity of their pain.[26] The significance of the verbal numeric rating scale was studied by Holdgate et al.[27] in 2003, and the authors concluded that VNRS is a valid instrument to assess changes in pain intensity

Data analyses

VNS values were analyzed using SPSS (version 21.0, SPSS Inc., Chicago, Illinois, USA). The Mann-Whitney test was performed to analyse the difference in VNS values between string and wind musicians, and between metal and wood winds. The Kruskal-Wallis test was used to compare VNS values between 1st violins, 2nd violins and violas.[28]

Results

Sample characteristics

Table 1 shows the sample characteristics and the distribution of musicians according to instrument, age and gender.

	n	Male	Female	Age
Total	112	75	37	37.8 (SD=9.4)
String players	71	40(56%)	31(44%)	37.7(SD=9.8)
Wind players	37	31(83.8%)	6(16.2%)	36.2(SD=9)

Table 1 - Sample characteristics

Self-reported complaints

70 out of 112 musicians (62.5%) claimed to have PRMD during the time of the interview. Table 2 shows the number of affected musicians and their complaints.

	String						Wind		Percussion	total
Instrument	1st violins	2nd violins	Violas	Cello	Double bass	Harp	Wood	Brass		
n interviewed	16	16	14	13	11	1	17	20	4	112
n self-reporting PRMD	13	11	11	6	6	1	8	12	2	70
n of reported complaints	21	27	17	11	9	3	14	20	4	126
% of affected musicians	81.2%	69.8%	78.6%	46.2%	54.5%	100%	47.1%	60%	50%	
Number of complaints per musician	1.3	1.7	1.2	0.8	0.8	3	0.8	1	2	
Number of complaints per affected musician	1.6	2.5	1.5	1.8	1.5	3	1.75	1.7	2	
% of affected musicians	67.6%						54.1%		50%	
Number of complaints per musician	1.2 complaints/musician						0.9 complaints/ musician		2 complaints/ musician	
Number of complaints per affected musician	1.8						1.7		2	

Table 2 - Self reported complaints according to the instrument type

As the number of percussionists is too small, it will not be considered in this analysis. Table 2 shows that string instrument players are most frequently affected by PRMD with 67.6% of affected musicians against 54.1% of wind instrument players. Results also show that the number of complaints per musician is higher in string instruments (1.2 complaints per musician) than in wind musicians (0.9 complaints per musician). Analysing the number of complaints per affected musician, data shows a minimal difference between groups.

Considering data within the results for string instrumentalists shows that first violinists are the most frequently affected by PRMD with an average of 81.2%, followed

by violas (78.6%), second violins (69.8%), double bass (54.5%) and cello players (46.2%). However the number of complaints per musician and the number of complaints per affected musicians is higher among the second violins (1.7 and 2.5 respectively). As regards wind instruments, results show that brass wind players are the most affected (60%) and present more complaints per musician (1) than wood wind players. The difference between the number of complaints per musician and the number of complaints per affected musician is almost nil.

Pain intensity - VNS values

During the interview, musicians subjectively measured their pain using VNS. Table 3 shows the means of those values.

	1st violins	2nd violins	Violas	Cello	Double bass	Wood	Brass	Percussion
Mean	4.4	3.8	5.0	4.4	4.2	4.7	4.7	5.3
Standard deviation	2.3	2.1	1.9	1.0	1.6	2.0	2.1	3.2
p value	0.703					0.606		small sample size (n=4)
Mean	4.3					4.7		
Standard deviation	1.9					2.0		
p value	0.328							small sample size (n=4)

Table 3- Pain intensity measured by VNS

Comparing data between string and wind players, results show that wind instrumentalists self-reported higher pain intensities than string players, however this is not a significant value (p value=0.328).

Within string instruments, viola players are the most affected with highest intensity pain (VNS=5). They are followed by the first violins (VNS=4.4), the cellists (VNS=4.4), the double bass players (VNS=4.2) and second violins (VNS=3.8). Comparing values, this is not a significant difference (p value=0.703).

Within the wind instruments group, there are no differences in pain intensity between brass and wood instruments (p value=0.606)

Discussion

Results show that 62.5% of the interviewed musicians suffer from acute PRMD with an average of 5 to 3.8 VNS. This result is astonishing since the participants are still playing in the orchestra. Those data demonstrate that more than half of professional orchestra musicians in the North of Portugal are playing with a mild to moderate pain. Maybe they are used to pain because they live in such a competitive environment that they cannot stop playing. According to Llobet[8], musicians try to deal with their working-related problems in secret because they fear stopping playing and consequently losing their jobs.

Due to the low number of percussion players, our data just allows a comparison between string and wood instruments. Results show that string players (67.1%) are more affected by PRMD than wind players (54.1%). Our results are in line with the conclusions of Lockwood[4], Lederman[9], Heming[3] and Cohen and Ratzon[21]. VNS values suggest that wind players present more intense pain than string instrumentalists (4.3 VNS in string players and 4.7 VNS in wind players). This perhaps indicates that, although this is not statistically significant, wind players present more intense complaints and string players are more prone to suffer from PRMD.

Within string players, results show that musicians playing first violin are the most affected followed by violas and second violins. According to Nyman et al.[20], musicians playing in an elevated arm position are more prone to suffer from PRMD than musicians playing in a neutral arm position. This perspective explains why violins and violas are more affected than double bass and cello instrumentalists.

Regarding pain intensity within the group of string players, violas presented the highest VNS values. Studies report that individual technique, the musician's characteristics and the instrument itself could influence the appearance of PRMD.[14,15,16,22] The weight of the instrument and the asymmetric posture imposed by the instrument type also contribute to the appearance of PRMD.[14] Despite the fact that viola players assume an asymmetric posture which makes them prone to suffer from PRMD, they have to face the weight of the instrument. A viola is heavier than a violin and this minor aspect may influence the intensity of PRMD.

Within the wind players group, brass winds are more frequently affected by PRMD (60%) than wood wind players (47.1%). Paarup et al. [22] also concluded that wood wind players are the less affected by PRMD. We can again report that metal instruments are heavier than wood instruments and maybe this fact can explain our data.[14] In terms of pain intensity, there are no differences between them.

Conclusion

To our knowledge this is the first study comparing the intensity and prevalence of PRMD among wind and string musicians of professional orchestras in Portugal. Despite our study covers all the professional orchestras from the North of Portugal, Centre, South and Islands are still missing into this research. In the same way, participation rate is 69%. Those facts also limit our conclusions

Pain intensity is always difficult to measure. VNS values are from subjective pain perception that changes according to the individual characteristics of the person. Our results must be analysed considering this limitation. VNS is simple to use and it does not consume many time, which is why we choose it to measure subjective pain intensity in this research.

According to our results, approximately two thirds of professional orchestra musicians from the North of Portugal suffer from PRMD. Pain is more prevalent in sting players but more intense in wind players. Although our results could not be generalized, we hope to raise awareness of the importance of PRMD among professional orchestra musicians in Portugal. Although this is a very common theme all over the world, Portuguese society is not aware of the problems of performing artists.

Future studies focusing on working-related problems among professional orchestra musicians in Portugal would be useful to better describe the extent of the problem and the type of occupational diseases among performing artists in Portugal.

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Chapter VII

The prevalence of playing related musculoskeletal disorders among professional orchestra players

SOUSA, C. M. G.; GRETEN, H. J.; MACHADO, J; COIMBRA, D. The Prevalence of Playing-related Musculoskeletal Disorders (PRMSD) Among...
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The Prevalence of Playing-related Musculoskeletal Disorders (PRMSD) Among Professional Orchestra players

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The prevalence of playing-related musculoskeletal disorders (PRMD) among professional orchestra players

A prevalência de lesões músculo esqueléticas relacionadas com o trabalho (LMERT) entre músicos de orquestras profissionais

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Abstract: The prevalence of playing-related musculoskeletal disorders (PRMD) among musicians is high and several causes, such as the quality of working conditions, are described as an important variable that can influence their onset. The aim of this research was to study the influence of adequate working conditions on the prevalence and on the intensity of PRMD. Three professional orchestras from the Northern Portugal were invited to take part into the study. They were then divided into two groups according to their working conditions. Group A was considered to present adequate working conditions and group B was not. PRMD and its intensity, measured by Verbal Numeric Scale (VNS), were registered through an individual semi-structured interview. Group B presented a higher percentage of self-reported PRMD complaints (67.4%) than group A (59.4%). VNS values were also significantly higher in group B (VNS=5.1) than in group A (VNS=4.0) (p value= 0.021). Results suggest that the prevalence and the severity of PRMD could be reduced by adequate working conditions.

Key words: Working conditions, playing-related musculoskeletal disorders, orchestra musicians, working related problems, professional musicians

Resumo: A prevalência de lesões músculo esqueléticas relacionadas com o trabalho (LMERT) entre os músicos é elevada e vários fatores, incluindo a qualidade das condições de trabalho, são descritas como variáveis importantes que podem influenciar o seu aparecimento. O objetivo deste estudo foi investigar e estudar a influência das condições de trabalho sobre a prevalência e sobre a intensidade das LMERT entre os músicos de orquestras profissionais. Foram convidadas a integrar o estudo três

orquestras profissionais do Norte de Portugal. Os músicos participantes foram divididos em dois grupos de acordo com as suas condições de trabalho. O grupo A foi considerado como apresentando condições de trabalho adequadas e o grupo B foi considerado como não apresentando condições de trabalho adequadas. A prevalência das LMERT e a sua intensidade, medida pela escala verbal numérica de dor (EVN), foram registadas através de uma entrevista semiestruturada individual. Os músicos que constituíam o Grupo B apresentaram maior prevalência de LMERT (67,4%) do que os músicos do grupo A (59,4%). Os valores da EVN também foram significativamente mais elevados no grupo B (EVN= 5,1) comparativamente ao grupo A (EVN = 4,0) (p = 0,021). Os resultados sugerem que as condições de trabalho influenciam a prevalência e a intensidade das LMERT em músicos de orquestras profissionais.

Palavras-chave: Condições de trabalho, lesões músculo esqueléticas relacionadas com o trabalho (LMERT), músicos de orquestra, músicos profissionais

Background

The prevalence of playing-related musculoskeletal disorders (PRMD) among musicians is well documented by the literature (Ostwall et al., 1994). Lockwood (1989) reported that almost 50% of musicians experience PRMD to a level that could threaten or end their careers. According to Zaza (1998) the percentage of affected musicians ranged from 39% to 87% in adult musicians and from 34% to 62% in secondary school music students. More recent data states that 50% to 76% of musicians are affected by PRMD (Heinan, 2008). An Australian study that involved 485 orchestra musicians referred to a 42% prevalence of PRMD (Fry, 1996) while 86% of elite professional musicians of British symphonic orchestra claimed to have suffered some type of musculoskeletal pain during the last year (Leaver, Harris and Palmer, 2011).

However, in spite of the historical importance of such statistics it is clear that the problem of PRMD among musicians is far from being solved, since the numbers have remained almost the same over several years. Common solutions used to treat musculoskeletal complaints include rehabilitation programs and drugs such as paracetamol, a very well-known pain killer (Schnitzer, 2006). In fact, 49% of orchestra musicians mention the use of paracetamol to control their pain and 64% had been examined or treated by a health care professional, such as a physiotherapist (Paarup et al., 2011). However, according to Curatolo and Bogduk (2000), many drugs are ineffective while others reduce pain only modestly and briefly and have only a minimal effect on musicians' quality of life. Other strategies include rehabilitation programs, and the recommendation to stop playing, with approximately one third of the affected musicians having to stop playing for a period of time (Heming, 2004).

PRMD may bring emotional, physical, financial, occupational and social consequences to a musician's life (Zaza, Charles and Muszynski, 1998). The fear of losing their work might be responsible for the dangerous attitude of ignoring pain, the symptoms requiring treatment or the necessary rest (Suskin et al. 2005; Llobet, 2004; Shafer-Crane 2006). The consequence of this behaviour may be the development of acute to chronic conditions. Indeed, musculoskeletal disorders often become chronic and painful causing decreased quality of life (Zaza, 1998; Lockwood, 1989). Data shows that 73% of orchestra musicians mention the need to change their way of playing, 55% reported feeling difficulty in daily activities at home, and 49% reported having difficulty in sleeping (Paarup et al., 2011). PRMD may also have a negative impact on the quality of the musician's performance and Ackermann et al. (2012) and Zaza et al. (1998) suggest that PRMD adversely affect the musician's ability to play to their optimum level.

According to the Portuguese Health Ministry, an occupational disease is a condition directly caused by working conditions that can lead to incapacity or death during performance of the occupation (Decreto regulamentar nº76/2013). Unfortunately, perhaps because of the fact that performing arts are so much a part of everyday life, they are not regarded as a perceived occupation and job (Lederman, 2003). However, like many other occupational diseases, PRMD have multifactorial causes and several risk factors that could contribute to their onset.

As common occupational diseases, factors such as awkward static or dynamic postures, repetitive movements, unhealthy habits, the lack of ergonomic precautions and preventive wellness behaviour, age, gender or stressful environments could influence their onset (Costa and Vieira, 2010; Paarup et al, 2011). Additionally, individual issues specifically related to musicians' activity such as technique, number of years of experience, type of repertoire, previous trauma, or the individual adaptation to the instrument itself, could influence the appearance of PRMD (Frank and Mühlen, 2007; Fragelli et al., 2008; Wu, 2007; Hansen and Reed, 2006; Nyman, 2007). As previously mentioned, it is also known that organizational management and working environment could influence the prevalence of PRMD. The extremely competitive environment, the self-imposed pressures, the average of playing hours, inadequate material resources or warm-up before playing could highly influence the development of PRMD (Cohen and Ratzon, 2011).

Zander et al. (2002) identified 3 main groups of risk factors that can preclude the development of PRMD: environmental aspects, physical demands and activities, and personal characteristics. Environmental aspects include temperature, confined spaces, space layout, equipment, equipment layout or configuration, surfaces (floor) and lighting. Physical demands include aspects such as long-duration activities with inadequate rest. Personal characteristics include e.g. psychological stress, age and gender.

If some of those causes and risk factors such as the musicians' individual characteristics could not be changed, variables related to environmental aspects and working conditions within the orchestra framework, such as adequate material resources, could be ameliorated. Recent studies alert that providing adequate working conditions could reduce the appearance of PRMD (Shafer-Crane, 2006; Zander et al., 2002). For instance, depending on the problem, ergonomic instrument modifications may influence the prevalence of musculoskeletal pain. To avoid diseases related to incorrect body posture, which can influence the appearance of muscle or spinal injuries, it is necessary to keep the body in an ergonomically recommended posture during a musical performance. To control this problem, the chair should be adapted to the musician's

individual characteristics. It must be supportive in order to maintain a proper posture that allows a view of the conductor (Heinan, 2008; Suskin et al, 2005).

Light and temperature conditions in the rehearsal and concert room can also influence the onset of PRMD. Poor light conditions could cause eyestrain and cool temperatures slow nerve conduction, making the finger response harder and diminishing finger sensitivity (Hansen and Reed, 2006; Norris, 2011).

The possibility of taking breaks during practice is also very important. Taking short breaks during long practice could contribute to reducing the appearance of musculoskeletal pain (Zaza and Fareweel, 1997, Zander et al., 2002). In addition to this, Suskin et al. (2005) suggest that warming-up, strengthening, stretching and breathing exercises before performance are considered to be good healthy habits to prevent PRMD among musicians. According to the authors, regular health examination by a doctor must also be included within those preventive strategies. The orchestra management should provide regular medical examination in order to diagnose health problems such as hearing affections, psychological stress and physical complaints.

Musicians are exposed to high music volumes that could threaten their hearing acuity and cause hearing impairment. Therefore, the orchestra should provide individual solutions to hearing protection in order to prevent future damage (Royster, Royster, and Killion, 1991; Hansen and Reed, 2006; Behar, Wong, and Kunov, 2006; Russo et al., 2013)

As previously stated, the fear of losing their work place is one of the main causes for the neglecting attitude that characterizes professional musicians. Consequently, a stable work contract could modify this dangerous behaviour and perhaps could have a positive influence on the chronicity of PRMD. Maybe if musicians know that their job is secure, they start treating their injury at an earlier stage.

According to Allemendiger (1996), managers and artistic directors are in the challenging position of providing stability to the orchestra. Creating opportunities, promoting the professional development of musicians, controlling the fairness and efficacy of the recruitment/selection process, dealing with the conception of authority and promoting adequate financial and material resources are some of the variables that could influence the working stability of musicians.

By analysing all these preventive strategies, one could define adequate working conditions as:

- The presence of ergonomic chairs exclusively made to respect the individual characteristics of the musician, stable light and temperature conditions and a fixed rehearsal room;
- The possibility of taking adequate breaks during rehearsal;

- The possibility of using hearing protection;
- The possibility of having regular health examinations to prevent hearing impairment and the appearance of PRMD;
- A stable work contract.

Method

The aim of this research was to ascertain whether there is an association between the defined adequate working conditions and the prevalence and severity of playing-related musculoskeletal complaints. The inclusion criteria to consider that the orchestra has adequate working conditions were as below:

- The presence of ergonomic chairs exclusively made to respect the individual characteristics of the musician,
- Fixed rehearsal room,
- Stable light and temperature conditions in the rehearsal room
- Adequate breaks during rehearsal
- Possibility of using hearing protectors
- Regular health examinations
- Stable work contract

Three professional orchestras from Portugal were invited to take part in this research, totalling 162 professional orchestra musicians. To be included into the study musicians must comply with the following inclusion criteria:

- Musculoskeletal pain present at the time of the interview and stable for at least seven days
- Diagnosis of PRMD by a physiotherapist

In an individual semi-structured interview PRMD and their intensity (measured by Verbal Numeric Scale-VNS) were registered. The data was collected between September of 2012 and June of 2013 after ethical approval and the informed consent of all participants, in accordance with the Helsinki declaration.

The verbal numeric scale (VNS) for pain intensity is a valid instrument to assess changes in pain intensity and it is one of the most frequently used pain scales (Holdgate et al, 2003). The person estimates their pain on a scale of 0 to 10 (Sousa and Silva, 2005). 0 represents no pain, from 1 to 3 represents mild pain, from 4 to 6 represents moderate pain and from 7 to 10 represents severe pain.

VNS values were analysed using SPSS (version 21.0, SPSS Inc., Chicago, Illinois, USA). The Mann-Whitney test was performed to analyse the difference of VNS values between groups (Fortin, 1999).

Results

Recruitment

- 1st inclusion criteria

One out of the three professional orchestras complied with the inclusion criteria and 69 out of 89 (77.5%) musicians agreed to participate into the study- Group A

Two out of three professional orchestras did not comply with the inclusion criteria and of those 43 out of 73 (68.9%) musicians participated in this research – Group B

- 2nd inclusion criteria

41 out of 69 (59.4%) musicians of group A complied with the inclusion criteria and 29 out of 43 (67.4%) musicians of the group B complied with the inclusion criteria.

The recruitment procedure is represented in the following flow chart (Figure 1).

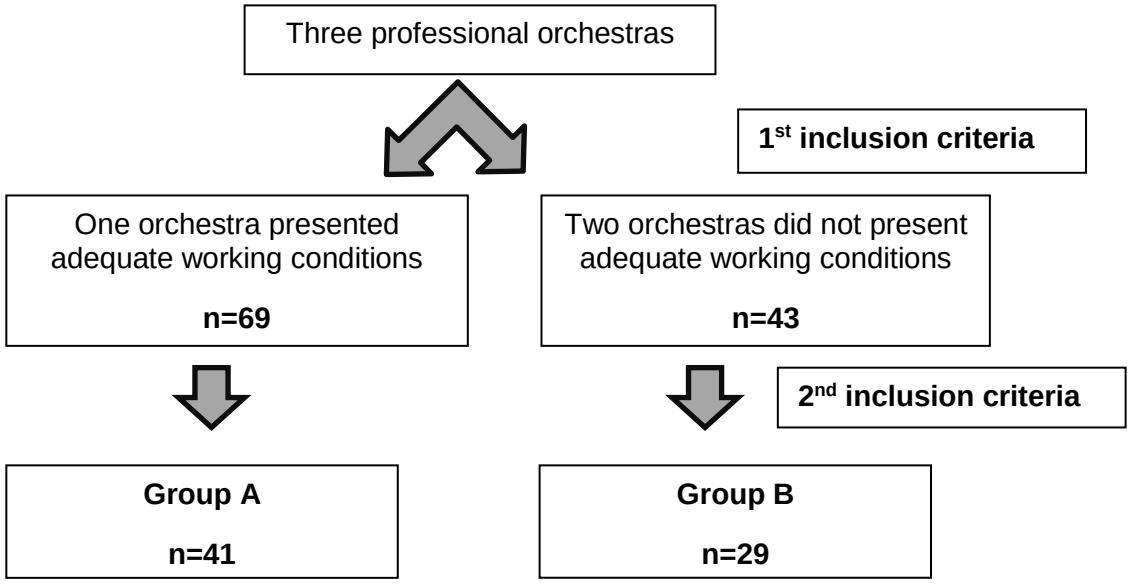

Figure 1 - Recruitment flow chart

Sample characteristics

The following table (table 1) contains the sample characteristics.

	Age	Gender
Group A (n=41)	41.7 (SD=8.9)	14 women (34%)
Group B (n=29)	31.8 (SD=7)	11 women (38%)

Table 1- Sample characteristics

Prevalence of self-reported PRMSC

As shown in table 2, group B has a higher percentage of self-reported PRMSC (67.4%) than group A (59.4%). However, the number of complaints per affected musician is higher in group A (1.9 against 1.6).

	interviewed	Self-reporting PRMSC	% of affected musicians	Number of reported complaints	Complaints/ Musician	Complaints/ affected musician
Group A	n= 69	n=41	59.4%	79	1.1	1.9
Group B	n=43	n=29	67.4%	47	1.1	1.6

Table 2 - prevalence of self-reported PRMSC

Pain intensity

As shown in table 3 and figure 2, pain measured by VNS was higher in group B (VNS=5.1) than in group A (VNS=4.0). According to Mann Witney test, this difference is statistical significant (pvalue=0.021).

	Group A	Group B
VNS	4.0 (SD=1.9)	5.1 (SD=1.9)

Table 3 - Pain intensity

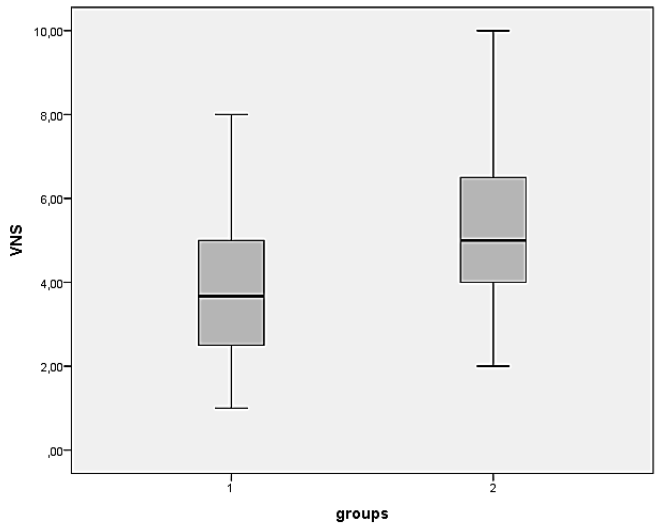

Figure 2- Distribution of VNS values between groups

Discussion

Results show a higher prevalence of PRMD among group B. The difference between groups is 8%. This value suggests that working conditions may influence the prevalence of playing-related musculoskeletal disorders among professional orchestra musicians. Although the percentage of affected musicians is higher in group B, the number of self-reported complaints per affected musician is higher in group A. Despite the fact that the difference between groups is almost nil (0.3), it is important to consider that those data came from interviews and the complaints were self-reported by the musicians. According to Suskin et al. (2005), Shafer-Crane (2006) and Llobet (2004) the recommendation to stop playing and the fear of losing their work could be responsible for a dangerous tendency to ignore pain and symptoms requiring treatment or rest. It is also important to consider that group A has more stable working contracts than group B. In this way, we can speculate that perhaps the musicians of group B tend to ignore some of their complaints because they fear losing their jobs.

As far as pain intensity measured by VNS is concerned, results clearly show a statistical difference between groups (pvalue=0.021). Group B (VNS=5.1) states more intense musculoskeletal pain than group A (VNS=4.0). Those results also tally with the hypothesis that working conditions may influence the severity of PRMD. Nevertheless, those values are concerning because musicians are working with moderate pain.

Literature states that PRMD could be explained by several causes and several risk factors could preclude their appearance. Individual musicians' characteristics like age and gender have a strong influence on the prevalence of PRMD. Women are more affected than men and increased age is also a risk factor to their development (Paarup et al., 2011, Lobet, 2004, Russo et al., 2013). Regarding gender our sample is equivalent, and thus we can affirm that the difference between pain intensity could not be explained by this variable.

In our sample the difference between ages in group A and B is 10 years. A study performed with 1613 musicians of different ages and professional levels demonstrated that 90% of the musicians aged between 30 and 40 were affected by physical problems, compared with 55% in adults aged from 20 to 30 (Llobet, 2004). According to this information, it could be expected that older musicians present a higher prevalence and severity of PRMD than younger musicians. In terms of the age variable it was expected that group A presented more PRMD than group B. This was not the case and the highest percentage of PRMD in group B may well be explained by the influence of adequate working conditions preventing PRMD, since musicians in Group B are younger but work under worse working conditions.

Considering another perspective, it is known that the individual technique could also contribute to musculoskeletal pain. Although we are aware of the difficulty to define a good individual technique, we can speculate that perhaps older musicians present a technique which is more adequate to the function they perform than younger musicians and therefore this variable could also have influenced our results.

According to Warrington (2002) PRMD must be analysed by three different pathological groups: "trauma" "degenerative" and "non-specific pain". The author states that there are no differences between ages in the prevalence of PRMD caused by trauma. Degenerative conditions are most common over the age of 40, but “non-specific arm pain" is much higher in musicians under 25. Thus, although age could help to explain our results, there are several variables which are impossible to control.

Conclusion

According to our results, the high prevalence and intensity of playing-related musculoskeletal disorders is associated with less adequate working conditions, suggesting their important role in professional musicians’ health and well-being. In fact, it is documented that PRMD have multifactorial causes and risk factors, and that adequate working conditions proved to be an important variable to promote good quality of life.

Although adequate working conditions are important to promote a good working environment, other variables should be considered. As Allmendiger (1996) suggested, the orchestra management board should provide financial and adequate material resources. Providing adequate working conditions such as stable work contracts, the aforementioned ergonomic chairs, or adequate rehearsal rooms could be expensive. But it is our belief that the investment may prove worthwhile when the expected number of sick leaves decreases. However, the monetary factor is not the most important at play. Institutions and the individuals that work in them have a lot to gain if a healthy orchestra is to be promoted and it is everyone’s moral and ethical duty to promote the healthiest possible working environment.

Although it is known that PRMD have multifactorial causes, it is difficult to isolate and to study only one of those causes, risk factor or variables. Our results do not allow the establishment of a direct cause-effect relationship between adequate working conditions and the prevalence and intensity of PRMD. We are aware that variables like gender, age, repertoire or individual technique could not be changed or controlled by us and that they could have influenced our results. This fact represents the main limitation of our study and further studies are needed to ameliorate our conclusions.

Nevertheless, our results tally with the hypothesis that adequate working conditions may influence the prevalence and the severity of PRMD in professional orchestra musicians. Working conditions could be changed. Providing adequate material and stable work conditions is an ethical duty of both employers and their co-workers. The orchestra management has also the ethical duty of preserving quality of life, promoting health and avoiding illnesses among musicians and promoting responsible health behaviour among them. With this research we hope to have raised awareness about the importance of adequate working conditions, especially when research at a national level in Portuguese orchestras is so scarce.

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Chapter VIII

Immediate effects of Tuina techniques on working-related musculoskeletal disorders of professional orchestra musicians

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• Research Article

Immediate effects of Tuina techniques on working-related musculoskeletal disorder of professional orchestra musicians

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Immediate effects of Tuina techniques on working related musculoskeletal disorders of professional orchestra musicians

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Abstract

Background: Musicians are a prone group to suffer from working-related musculoskeletal disorders (WRMD). Conventional solutions to control musculoskeletal pain include pharmacological treatment and rehabilitation programs but their efficiency is sometimes disappointing.
Objective: The aim of this research is to study the immediate effects of tuina techniques on WRMD of professional orchestra musicians from the North of Portugal.
Design, setting, participants and interventions: We performed a prospective, controlled, single blinded, randomized study. Professional orchestra musicians with diagnose of WRMD were randomly distributed into the experimental group (*n*=39) and into the control group (*n*=30). During an individual interview, Chinese diagnose took place and treatment points were chosen. Real acupoints were treated by Tuina techniques into the experimental group and non-specific skin points were treated into the control group. Pain was measured by verbal numerical scale before and immediately after intervention.
Results: After one treatment session, pain was reduced in 91.8% of the cases for the experimental group and 7.9% for the control group.
*Conclusions***:** Although results show that Tuina techniques are effectively reducing WRMD in professional orchestra musicians of the North of Portugal, further investigation with stronger measurements, double blinding designs and bigger simple sizes are needed.
Keywords: diagnosis (TCM), stress, Tuina, musicians, musculoskeletal disorders

Introduction

Working-related musculoskeletal disorders (WRMD) are complex syndromes involving multiple joints and muscles. They are believed to be caused by repetitive movement patterns and as a result of psychosocial factors such as stress, anxiety and others[1-4]. Musicians are known as a group of patients suffering from repetitive movements and psychological stress to an extreme level, and therefore an ideal professional group at risk of developing WRMD[5,6].

The prevalence of playing-related musculoskeletal disorders (PRMD) in musicians is being studied for several years, with studies demonstrating that almost half of musicians experience PRMD that could highly damage their careers[6]. Studies show that the prevalence of PRMD in musicians ranges from 39% to 87%[5]. Recent data from the British symphonic orchestra reported that 86% of elite professional musicians assumed to have musculoskeletal pain during the last year[7].

Conventional medicine solutions to control musculoskeletal pain include rehabilitation programs or pharmacological treatment such as paracetamol[8] but the efficiency of those medicines is sometimes disappointing[9]. Approximately one third of the affected musicians receive recommendations to stop playing during a period of time[10]. The fear of being replaced and losing their workplace may be responsible for adopting the dangerous attitude of ignoring the pain and continue to play without asking for advisement from colleagues, teachers or health professionals[11,12]. Often the WRMD become chronic and painful in such a way that will affect the performance and the musician`s quality of life[6,11].

Traditional Chinese medicine (TCM) in a modern understanding is known as a model system biology based on a logically accessible theoretical background[13]. It may be understood as a systemic vegetative medicine and the usage of acupoints as a part of the same may be regarded as a model of a vegetative reflex therapy. TCM diagnosis may be understood as the evaluation of a functional vegetative state of the body leading to a proper selection of clinically successful of acupoints[14,15]. Acupoints have specific clinical functions and effects[16,17] and they are connected to deeper layers of the body influencing “qi” flow[18]. Acupoints could be stimulated using acupuncture needling or using Tuina techniques[19].

Tuina is the abbreviated name of the Chinese manual therapy. In fact, the original name is *tui na an mo*, the Chinese names for the different techniques. There are more than 50 classic forms of manipulation and four components that could be mixed within these techniques: pressure, vibration, moving and warming component[20].

Several studies show the effectiveness of Tuina in different conditions like, stress and anxiety[21],stiff neck[22], low back pain[23,24], pain caused by lumbar intervertebral disc protrusion[25] and others.

The purpose of this research is to study the immediate effects of Tuina treatment of WRMD on professional orchestra musicians from the north of Portugal.

Methods

Design and study group

The study was performed as a prospective, controlled, single blinded, randomized experiment. All the participants signed and gave their informed consent according to the Helsinki declaration and this research was approved by the Ethical Commission of Institute of Biomedical Sciences Abel Salazar, University of Porto.

Musicians from the three professional orchestras from the North of Portugal (*Orquestra Nacional do Porto Casa da Música, Orquestra Filarmónica das Beiras and Orquestra do Norte – Portugal)* were invited to integrate the research (*n*=162). Of those, 112 agreed to participate and were randomly distributed into the experimental or into the control group (randomization by flow a coin) as Figure 1 shows.

Into this investigation only WRMD present during the moment of the evaluation were included. According to the Portuguese Ministry of Health, a professional disease is a condition directly caused by working conditions that can origin incapacity or death during the professional exercise [26]. Diseases caused by repetitive movement such as tendinitis, tenosynovitis, bursitis or problems of the spine, among others, are included. The inclusion of the complaint into the present research and the diagnostic of WRMD were done according to these criteria. After the first interview, 69 out of 112 full field the inclusion criteria; 39 were assigned to the experimental group and 30 to the control group.

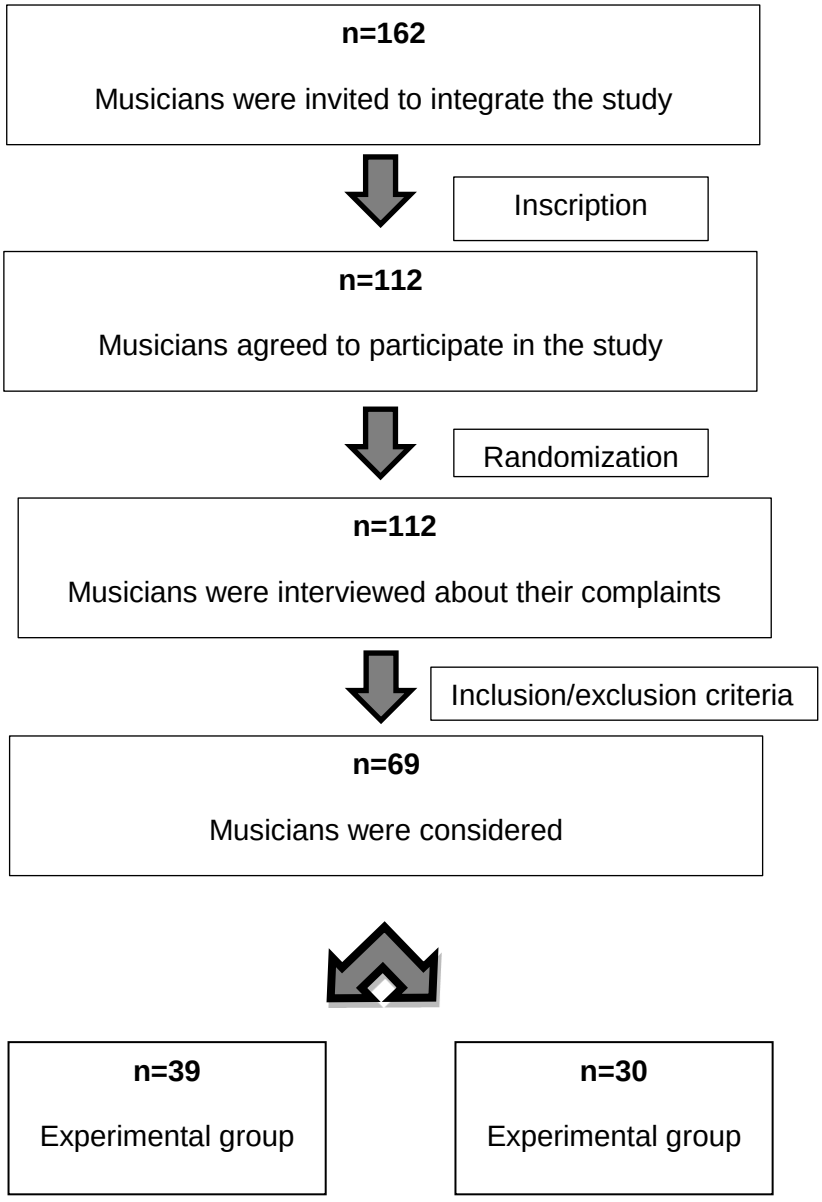

Figure 1 - Recruitment flow chart

Measurements

The verbal numeric rating scale (VNS) for pain intensity is one of the most frequently used scales to evaluate pain intensity. The patients estimate their pain in a scale from 0 to 10, considering that 0 represents no pain, from 1 to 3 represents mild pain (nagging, annoying, interfering minimally with activities of daily living), from 4 to 6 represents moderate pain (interfering significantly with activities of daily living) and from 7 to 10 represents severe pain (disabling, unable to perform activities of daily life). This scale can be used with adults and children (> 9 years old) and in all patient able to use numbers to rate the intensity of their pain[27]. The significance of verbal numeric rating scale was studied by Holdgate et al., in 2003[28]. The authors studied the agreement

between the visual analogic scale (VAS) and VNS in measuring acute pain, and measure the minimum clinically significant change in VNS. From a total of 309 observations, the results showed that VAS and VNS were highly correlated (r=0.95), however the VNS was significantly higher than the VAS for the paired observations. The authors concluded that VNS is a valid instrument to assess changes in pain intensity.

Intervention

Data from the personal information, the clinical history and the musicians' complaints were obtained by semi-structured interviews. Complains and the respective pain intensity of the worst movement were evaluated by VNS at the baseline. After tongue and pulse diagnose performed by a practitioner with more than 30 years of experience, treatment points were selected. Tuina treatment was performed by a master of TCM with 3 years of experience, which received an intensive and specific training on Tuina techniques. Pain was mainly treated by Tuina techniques (consisting of pressure and vibration in a high frequency) of real acupoints in the experimental group and of non-specific skin points on the thigh in the control group in the same manner and intensity. The amount of treated acupoints depends on the Chinese diagnose and they were treated during approximately 5 min per point. Just one treatment session was performed. Pain intensity was measured by VNS immediately after the treatment, to assess immediate effects. As this was a single blinded study the participants did not know in which group they were included.

Statistical analyses

Data were analyzed using IBM SPSS Statistics v.22. The Wilcoxon test was performed to analyze data within groups and Mann-Whitney test was used to analyze data between groups [29]. $P<0.05$ was considered significant.

Results

Sample characteristics

Our sample was composed by 69 musicians randomly divided into the experimental (n=39) and into the control group (n=30). Both groups were equivalent in terms of demographic data and played instruments (Table 1).

Group	*n*	Male	Female	Age (mean ± standard deviation, years)	String	Wind	Percussion
Experimental	39	26 (67%)	13 (33%)	38.9±9.4	27 (69%)	11 (28%)	1 (3%)
Control	30	18 (60%)	12 (40%)	36±9.5	22 (73%)	7 (23%)	1 (4%)

Table 1 - Sample characteristics

From the complaints present during the interview 56.8% affected the spine, mainly the cervical (26.6%) and the lumbar regions (24.3%). The shoulder joint represents 27% of the self-reported PRMD (16.2% left shoulder and 10.8% right shoulder).

Pain intensity scores

The mean of pain intensity measured by VNS at baseline was 5.03±1.87 with a maximum of 8 and a minimum of 2 for the experimental group and 3.80±1.80 with a maximum of 7.5 and a minimum of 1 for the control group (Table 2). According to Mann-Whitney test both groups are equal at the baseline (P=0.510).

After treatment VNS values decreased to 0.41 ± 1.03 with a maximum of 5 and a minimum of 0 into the experimental group and to 3.50 ± 1.78 with a maximum of 7 and a minimum of 1 into the controls (Table 2).

Groups	VNS mean before treatment	VNS mean after treatment
Experimental	5.03 ± 1.87	0.41 ± 1.03
Control	3.80 ± 1.80	3.50 ± 1.78

Table 2 - VNS mean before and after treatment

According to Mann-Whitney test after the first treatment there was a statistical significant difference between groups (P≤0.001). Within the experimental group, pain was reduced by an average of 91.8% (P≤0.001) whereas within the control group pain was reduced 7.9% (P=0.008) (Figure 2).

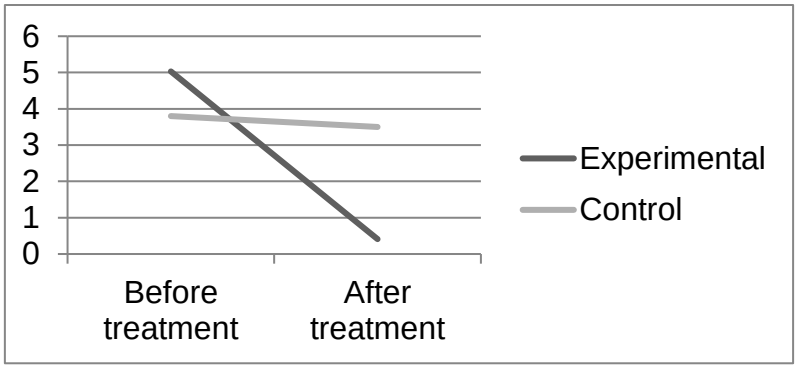

Figure 2 – Score variation in verbal numeric rating scale before and after treatment

Discussion

According to our results tuina techniques demonstrated to be effective reducing musculoskeletal pain in professional orchestra musicians. Analyzing data between groups, results show a statistical significant difference between the experimental and the control group immediately after the first treatment ($P \leq 0.001$).

Several investigations demonstrate the effectiveness of Tuina reducing musculoskeletal pain[22-25]. In this research we used tui techniques to control musculoskeletal pain. Tui consists of pressure and vibration in a high frequency. It is expected that the vibrating component loosens spasms of the conduits muscles and tendons caused by agent ventus, decreasing musculoskeletal pain as the results showed[19]. Ventus is defined as signs and symptoms as if we had been exposed to a draught of air, such as spastic muscle, warm skin and tense muscles. From a western medical view, these symptoms may originate from mast cell substance P reflexes and old reflexes of motor control as known from fish and other species[20,21]. According to our data, musculoskeletal pain was reduced by an average of 91.8% into the experimental group.

We can speculate that the Chinese diagnose performed at the baseline could highly contribute to those expressive results. According to the Heidelberg model of Chinese medicine, diagnose is the most important aspect of Chinese Medicine. If the diagnose is correct, the success of therapy is highly increased. Chinese diagnose must be individual and the use of treatment protocols must be rejected[18-20]. Within this research we excluded the usage of protocols, and treatment points were chosen according to the actual functional vegetative state of the musicians.

We are aware that this option does not allow a complete standardized investigation, nevertheless we believe that the use of protocols could diminish the success rate of results.

Despite musculoskeletal pain was reduced almost 92% into the experimental group, and only almost 8% into the control group results showed a significant statistical difference within the experimental ($P \leq 0.001$) and within the control group ($P=0.008$). We consider that the statistical differences within the control group are not clinically expressive or relevant to the daily practice comparing with the enormous difference expressed by the experimental group. We can also speculate that musicians expected to get better with Tuina treatment and this result could be the expression of minimum placebo effects.

The lack of follow-up data is an assumed limitation of our study, although the aim of this research was to study only the immediate effects of Tuina techniques in WRMD of professional orchestra musicians.

Conclusion

According to our results tuina techniques demonstrated to be effective reducing WRMD in professional orchestra musicians of the North of Portugal.

As this is only a single blinded study, we cannot exclude the intention to treat of the TCM doctor. In future investigations, double blinding techniques must be used.
Despite pain is a subjective parameter to measure, we are aware that we used one scale only. In future researches stronger pain measurements could be added.

We speculate that, these results could be reproduced in other professional groups exposed to repetitive movements such as supermarket cashiers, industry employments, and others. Further randomized controlled trials based on this methodology could be performed in different conditions and professional groups allowing bigger sample sizes.

Acknowledgements

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Competing interests

The authors declare that they have no competing interests.

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Chapter IX

Effects of self-administered exercises based on Tuina techniques on musculoskeletal disorders of professional orchestra musicians: a randomized controlled trial.

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• Research Article

Effects of self-administered exercises based on Tuina techniques on musculoskeletal disorders of professional orchestra musicians: a randomized controlled trial

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Effects of self-administered exercises based on tuina techniques on musculoskeletal disorders of professional orchestra musicians: A randomized controlled trial

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Abstract

Background: Musicians are frequently affected by playing related musculoskeletal disorders (PRMD). Common solutions used by Western medicine to treat musculoskeletal pain include rehabilitation programs and drugs, but their results are sometimes disappointing.

Objective: To study the effects of self-administered exercises based on Tuina techniques on the pain intensity caused by PRMD of professional orchestra musicians, using verbal numeric scale (VNS).

Design, setting, participants and interventions: We performed a prospective, controlled, single-blinded, randomized study with musicians suffering from PRMD. Participating musicians were randomly distributed into the experimental (*n*=39) and into the control (*n*=30) groups. After an individual diagnostic assessment, specific Tuina self-administered exercises were developed and taught to the participants. Musicians were instructed to repeat the exercises every day for 3 weeks. Pain intensity was measured by VNS before the intervention and after 1, 3, 5, 10, 15 and 20 d of treatment. The procedure was the same for the control group, however the Tuina exercises were executed in points away from the commonly-used acupuncture points.

Results: In the treatment group, but not in the control group, pain intensity was significantly reduced on days 1, 3, 5, 10, 15 and 20.

Conclusion: The results obtained are consistent with the hypothesis that self-administered exercises based on Tuina techniques could help professional musicians

controlling the pain caused by PRMD. Although our results are very promising, further studies are needed employing a larger sample size and double blinding designs.

Keywords: Tuina, musculoskeletal disorders, randomized control trial

Background

It is an established fact that musicians are frequently affected by specific work-related musculoskeletal disorders[1]. According to Zaza[2], the prevalence of playing-related musculoskeletal disorders (PRMD) in musicians ranged from 39% to 87% in adult musicians and from 34% to 62% in high school music students. More recent data suggest that the percentage of affected musicians ranged between 64% and 94%[3–7].

Common PRMD include overuse complaints, entrapment neuropathies and occupational hand cramp[8]; areas of frequent complaint include the neck, shoulder, arm and wrist[9–11]. Those injuries can cause symptoms ranging from slight to severe pain[12]. The combination of a variety of stressors, including unrelieved muscular tension, repetitive movements, lack of ergonomic precautions and preventive wellness behaviors, self-imposed pressures and psychological stressors, musicians' individual characteristics, previous trauma, environmental conditions could individually or in concert contribute to the development of PRMD[13–16].

Common solutions used by Western medicine to treat PRMD include rehabilitation programs and drugs, such as local injection of steroids, non-steroidal anti-inflammatory drugs, opioids, local anesthetics and drug combinations[17,18]. Almost half (49%) of orchestra musicians admit to use paracetamol to control their symptoms[19], however many drugs are ineffective at reducing pain, and only offer modest and brief improvements to the musicians' quality of life[18]. More than half (64%) of orchestra musicians also report they had been examined or treated by a health care professional, like a physiotherapist[19]. In many rehabilitation programs, it is recommended that the musician refrain from playing[20] for 2 to 7 days, depending on the complaints[21].

Frequently, as the disease develops, musicians tend to underestimate their symptoms. This fact could possibly be explained by the fear of losing their job, or professional setbacks resulting from reduced practice schedule required by rehabilitation programs[22].

Traditional Chinese medicine (TCM) is defined by the Heidelberg model as a system of sensations and findings designed to establish the functional state of the body[23,24]. This state could be treated using acupuncture, Chinese pharmacotherapy, Qigong, dietetics or Tuina[25].

Tuina is the abbreviated name of the Chinese manual therapy *tui na an mo*. There are more than 50 classic techniques, however there are four components that could be mixed within these techniques: pressure, vibration, moving and warming. The proper component must be chosen in accordance with the TCM diagnosis[26].

Despite the absence of strong methodological research into the effects of tuina therapy in pain conditions, studies suggest that tuina can diminish musculoskeletal pain. A literature review done by Kong et al.[27] indicates that tuina can provide effective treatment for patients with low back pain. According to Cen et al.[28], tuina techniques and a home-based self-administered exercise program can significantly reduce neck pain. Tuina techniques also have been effective in pain conditions such as cervical spondylosis[29], lumbar intervertebral disc herniation[30] and labor[31].

The aim of the present research is to study the effects of a self-management program, based on tuina exercises, on pain intensity caused by PRMD in professional orchestra musicians.

Methods

Design and study group

The study was a prospective, controlled, single blinded, randomized experiment approved by the Ethical Commission of Institute of Biomedical Sciences Abel Salazar - University of Porto.

One hundred and sixty-two professional orchestra musicians from the three professional orchestras from the North of Portugal (*Orquestra Sinfónica do Porto Casa da Música, Orquestra Filarmónica das Beiras and Orquestra do Norte)* were invited to participate in the research. Of those, 112 agreed to be screened and were randomly distributed into experimental or control group (randomization by coin flip).

Of those, 69 cooperated and fulfilled the inclusion criteria of exhibiting playing related musculoskeletal disorders, as diagnosed by a physiotherapist. The musculoskeletal pain also must present during at least three weeks. Thirty-nine musicians (n=39) were included into the experimental group and 30 musicians into the control group. The recruitment process is exposed into the following flow chart (Figure 1).

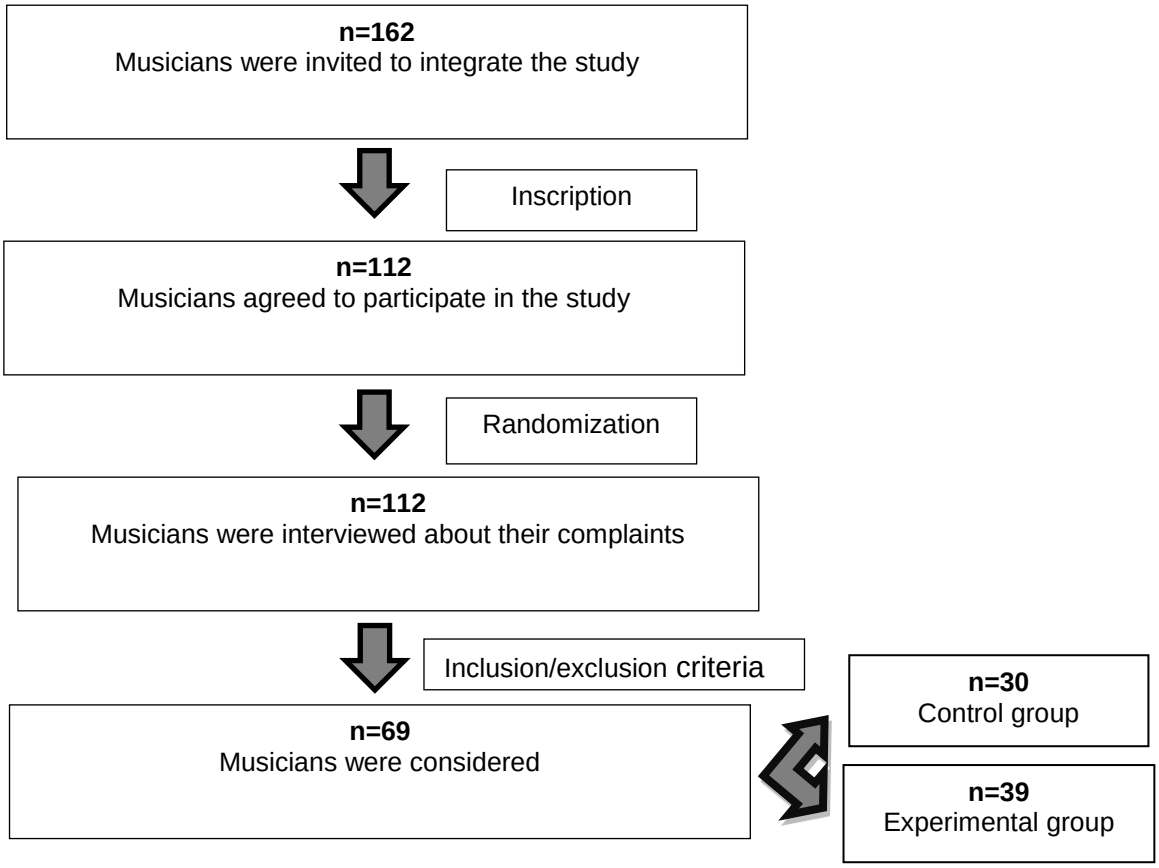

Figure 1- Recruitment flow chart

Intervention

Specific complaints and their respective pain intensity were assessed through VNS, and by semi-structured baseline interviews. After a practitioner with more than 30 years of experience performed tongue and pulse diagnoses, treatment points were selected.

Tuina exercises were based mainly on tui techniques (consisting of high frequency pressure and vibration) on the selected points. Point location and the tui technique were individually taught to all participants for self-management of PRMD. Musicians were recommended to repeat the exercises twice a day or more often, according to their requirements.

Pain intensity (measured by VNS) and the frequency of practice were appraised by telephone after 1, 3, 5, 10, 15 and 20 days. If the participant communicated any doubt regarding performance of the prescribed exercises, an appointment was arranged immediately. The control group procedure was the same, but the tuina exercises were done in points away from the commonly used acupuncture points. As this was a single blinded study, the participants did not know which treatment they received.

Statistical analyses

The Mann-Whitney test was used to analyze data between groups during the different days of the follow-up evaluations [32]. The analysis was done using SPSS 22 (version 22.0, SPSS Inc., Chicago, Illinois, USA).

Results

Sample characteristics

The study population included 69 musicians distributed into experimental (*n*=39) and control groups (*n*=30). As showed in Table 1, groups were equivalent in terms of demographic data and played instruments.

Group	*n*	Male	Female	Age	String	Wind	Percussion
Experimental	39	26 (67%)	13 (33%)	38.9 +/-9.4	27 (69%)	11 (28%)	1 (3%)
Control	30	18 (60%)	12 (40%)	36 +/- 9.5	22 (73%)	7 (23%)	1 (4%)

Table 1 Sample characteristics

Of the complaints reported during the patient intakes, 56.8% affected the spine, mainly the cervical (26.6%) and the lumbar regions (24.3%), and 27% affected the shoulder joint (16.2% left shoulder and 10.8% right shoulder). Complains affecting the arm, forearm, wrist, hand, fingers and face were less common, together comprising 16.2% of complaints.

Pain intensity

Baseline pain was measured using VNS. The experimental group presented an average of 5.03(standard deviation=1.87) VNS while the control group presented an average of 3.8 (standard deviation=1.8) (Figure 2). The values at baseline were not statistically different (*P* =0.51).

As Table 2 shows, pain was significantly lower in the experimental group compared to the control group on day 1 (*P* <0.000 1), day 3 (*P* <0.000) and day 5 (*P* =0.002). The difference between groups is significant on day 10 (*P*<0.000), on day 15 (*P* <0.000) and on day 20 (*P* =0.004).

Group	*n*	VNS value					
		Day 1	Day 3	Day 5	Day 10	Day 15	Day 20
Experimental	39	1.5+/-2.0	1.8+/-1.8	2.3+/-1.9	1.9+/-1.7	2.0+/-1.8	2.4+/-2.0
Control	30	4.0+/-2.0	3.6+/-1.9	3.9+/-2.1	3.8+/-2.1	3.9+/-2.2	4+/-2.3

Table 2 - VNS values

Results showed that VNS values of patients in the treatment group was variable, but dropped 70% on day 1 and remained low throughout the 20-day experimental period (Tables 2 and 3). Within the control group, pain remained fairly constant throughout the experimental period (Figure 2).

Groups	VNS day1	VNS day3	VNS day5	VNS day10	VNS day15	VNS day20
Experimental	- 70%	- 64%	- 44%	- 62%	- 60%	- 52%
Control	+ 5%	- 5%	+ 2%	0%	+ 2%	+ 5%

Table 3 - Pain variation within groups

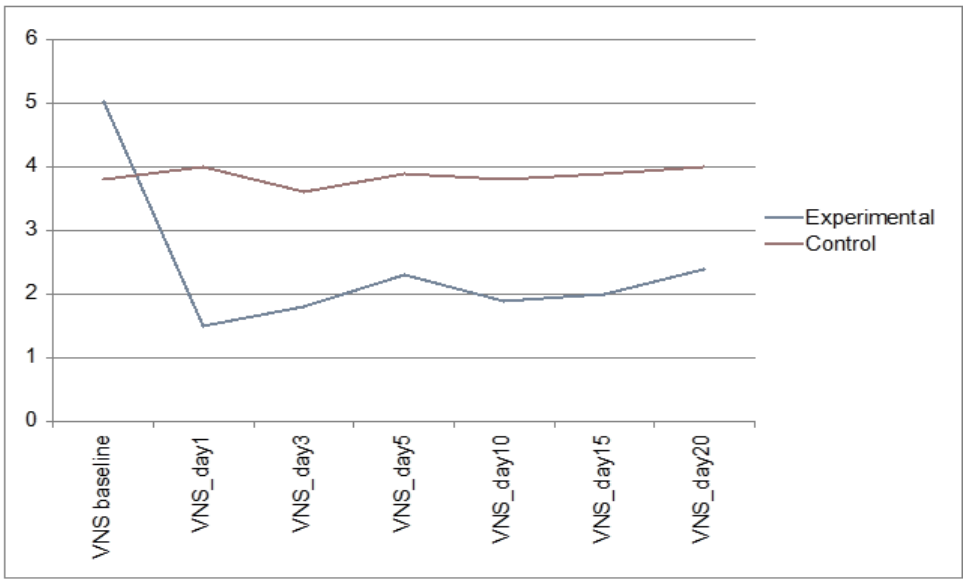

Figure 2 – VNS values variation across time

Discussion

According to our results, self-administered exercises based on tuina techniques effectively reduced pain caused by PRMD in professional orchestra musicians.

At baseline the control and the experimental groups presented similar pain intensity. On days 1, 3, 5, 10, 15 and 20 the treatment group had significantly lower VNS values than the control group (Table 2, 3).

Within the experimental group, pain reduction was always greater than 44%. Within the control group, pain was reduced by a maximum of 5% but also increased by 5% on day 1 and on day 20.

We consider that all the exercises were done with acceptable tui techniques on the correct acupoints.

Our results may have several explanations. In our sample 56.8% of the complaints were related to pain in the spine. According to the literature, tuina techniques are especially effective at reducing lumbar and cervical pain[27–30].

Into this research we rejected the usage of treatment protocols. According to the Heidelberg model of Chinese medicine, the application of protocol treatments highly reduces the success of the treatment[23–26]. The treatment points were chosen according to the individual Chinese diagnose. We can speculate that the rejection of a treatment protocols could highly contribute to our results.

The prescribed exercises were mainly based on tui techniques. According to the literature, the pressure vibrating components of those techniques help to loosen spasms of muscles and tendons. From a Western medical view, these symptoms may be caused by mast cell substance P[25,26].

We advised the musicians to repeat the exercises twice a day or as required, according to their needs. During the first week most of the participants repeated the exercises twice a day. After one week most of the musicians of the experimental group felt much better and repeated the exercises just once a day. Musicians of the control group were slightly demotivated and often did not perform the exercises on a daily basis. We always encouraged both groups to repeat the exercises daily but the compliance of the control group was inferior to the experimental group.

Conclusion

According to our results, self-administered exercises based on tuina techniques effectively reduced musculoskeletal pain caused by PRMD in professional orchestra musicians from the North of Portugal.

In this study only the musicians were blinded, thus we cannot exclude the intention to treat of the TCM doctor as a confounding factor. In future investigations, double-blinding techniques must be used.

As pain is a subjective parameter, the use of only one scale is not ideal; future investigations will need to have more robust response variables.

Clearly further studies of the efficacy of Tuina techniques for treatment of professional groups exposed to repetitive movements, such as supermarket cashiers and factory workers, would help to promote this treatment modality as a safe and effective replacement or complement to drug-based therapy.

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Competing interests

The authors declare that they have no competing interests.

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Chapter X

General discussion

Occupational diseases – Portuguese Scenario

The first step of our research was to study and to describe the occupational diseases affecting professional orchestra musicians from the North of Portugal. After describing their main problems, PRMD were treated during a single tuina session. After this first treatment, musicians completed a self-management program based on tuina techniques. The discussion of our data was addressed in the included reviewed publications. This chapters aims to give a global view of this intense work and only the main themes are discussed.

In the beginning of this investigation we expected to find several musicians suffering from PRMD and MPA. Our results showed that 93.8% (n=105) of the interviewed musicians self-reported at least one occupational problems in the last year (chapter V). As the participation rate was 69%, 31% of musicians did not include our data and this is an uncontrollable limitation of our research. We can speculate that if the participation rate was 100%, the percentage of affected musicians could be different and maybe lower.

The most commonly reported problems during the last year were related to musculoskeletal disorders, reported by 84.8% (n=95) of the subjects (Chapter V).

Our data is similar to the information obtained in other countries such as Spain (79%) (Llobet, 2004), Germany (86.3% and 89.5%) (Blum, 1995 and Steinmetz et al., 2015), Brazil (68%, 70% and 94%) (Frank and Muhler, 2007; Kaneko, Lianza and Dawson, 2005; Oliveira and Vezzá, 2010), Australia (84%) (Kenny and Ackermann, 2015) and United Kingdom (86%) (Leaver, Harris and Palmer, 2011). The differences between studies results could be explained by the diversity of instruments when collecting data. In our study we considered self-reported complaints. Also the different types of musicians could have influence results. From the mentioned studies only data from United Kingdom refers to professional orchestra musicians.

MPA was reported by 21.4% (n=24) of the musicians (Chapter V). Our data indicates a lower rate of MPA than the studies all over the world. For example in Netherlands the majority of symphonic orchestra musicians reported experiencing or having experienced performance-related anxiety seriously enough to affect their professional or personal lives (Kemenade and Son, 1995) and in Germany one third of the students from 15 to 19 felt that their MPA was distinctly debilitating (Fehm and Schmit, 2006). As indicated in our study (Chapter V) we can speculate that since this is a very delicate subject among Portuguese orchestra musicians, they could not feel comfortable talking about it.

During the time of the interview 70 musicians presented PRMD and only 24 presented MPA. As the percentage of MPA was lower than expected, our research excluded MPA and focused only in PRMD.

Describing PRMD

Affected areas

According to our data PRMD manly affect the shoulder joint (27%), cervical (26.5%) and lumbar (24.3%) regions (Chapter V). Our results are similar to the presented by the literature. According Fishbein et al. (1988) the most affected body regions in musicians are shoulder (20%), cervical (16%) and lumbar (22%) regions. More recent research from Steinmetz A, Seidel W, Muche (2010), also concluded that 67% of all pain symptoms in musicians are localized within the shoulder/arm/hand region, 13% within lumbar and 6% within cervical regions. Cohen and Ratzon (2011), in a study specifically about PRMD in orchestra musicians referred to a high prevalence of shoulder (55%), cervical (42%) and lumbar pain (49%).

According to our data there are no evidences that the instrument type could affect the distribution of complaints in different parts of the body (p value= 0.528) (Chapter V). However results suggest that some instrumentalists are prone to suffer from specific conditions:

- Left shoulder, cervical and lumbar pain are common in violinists: According to Lederman (2003) violinists are particularly affected by left arm problems. Also Nyman et al. (2007) affirm that musicians playing in an elevated arm position, such as violinists and violists, present high prevalence of neck-shoulder pain. According to Steinmetz et al. (2015) violinists are prone to suffer from neck, left shoulder and left wrist pain
- Cervical and lumbar pain are common complaints among cellists: According to Strokes and Reid (1999) cellists are prone to suffer from neck and shoulder symptoms because of the increased shoulder movement in the upper register of the Cello.
- Flutists may be mainly affected by left shoulder and cervical pain: According to Nyman et al. (2007) as flutists play in an elevated arm position, they are a prone group to suffer from neck–shoulder pain.

Intensity of pain (Chapter VI)

According to our knowledge only one research from 2015 measured pain intensity using VNS among professional orchestra musicians and the presented results are similar to ours. Musicians reported to experience playing related musculoskeletal pain with an intensity of 3.7 (SD=1.95). It is also interesting to refer that within the same research, 62.7 % of musicians reported to feel pain during the last 3 months and 40% reported considerable frequent and permanent pain (Steinmetz A et al., 2015). According to our results:

1. Comparing string and wind players - Referring to the severity of PRMD results show that 62.5% (n=70) of the musicians interviewed suffer from acute PRMD with an average from 5 to 3.8 VNS. Although string players reported an average of 4.3 VNS and wind players 4.7 VNS, this is not a significant difference (p value=0.328).
2. String players - Results show no significant differences within string players (p value=0.703). Our data show that violas presented the highest VNS values (5.0), followed by first violins (4.4), cellists (4.4), double bass players (4.2) and second violins (3.8). The higher pain intensity among violas and first violins could be the consequence of the imposed elevated arm position (Nyman et al., 2007). Despite the asymmetric posture musicians have to support the weight of the instrument (Frank and Mühlen, 2007). A viola is heavier than violin and we can speculate that this minor aspect may influence the intensity of PRMD. Second violins present the minor VNS value. In orchestra, first violins usually play more technical difficult repertoire than second violins. Considering that the technical difficulty of the repertoire could influence the appearance of a PRMD maybe this fact could explain the difference between pain intensity among first and second violins.
3. Wind players - In terms of pain intensity, there are no differences between wind instrumentalists (4.7 VNS). According to the assumption that instrument weight could preclude the appearance of PRMD (Frank A, Mühlen, 2007), it will be expected that Brass wind musicians could present more intense pain than wood wind.

Prevalence of pain (Chapter VI)

1. Comparing string and wind players - Although this is not significant, results show that string players (67.1%) are more affected by PRMD than wind players (54.1%). Our results are in line with the conclusions of Lockwood (1987), Lederman (2003), Heming (2004), Cohen and Ratzon (2011) and Steinmetz et al., 2015).

2. String players - Within string players, results show that musicians playing first violin are the most affected (81.2%) followed by violas (78.6%), second violins (69.8%), double bass (54.5%) and cellists (46.2%). Once again musicians playing in an elevated arm position are more prone to suffer from PRMD than musicians playing in a neutral arm position (Nyman et al., 2007).
3. Wind players - Within the wind players group, brass winds are more frequently affected by PRMD (60%) than wood wind players (47.1%). Our conclusions are similar to the conclusions of Paarup et al. (2011). We can again report that metal instruments are heavier than wood instruments and maybe this fact can explain our data (Frank and Mühlen, 2007).

Working conditions (Chapter VII)

The criteria to consider that the orchestra has adequate working conditions is well established and explained in chapter VII. The inclusion criteria are:

- The presence of ergonomic chairs exclusively made to respect the individual characteristics of the musician,
- Fixed rehearsal room,
- Stable light and temperature conditions in the rehearsal room
- Adequate breaks during rehearsal
- Possibility of using hearing protectors
- Regular health examinations
- Stable work contract

One out of three orchestras completed the inclusion criteria of adequate work conditions.

According to our data, inadequate working conditions could influence the prevalence and intensity of PRMD among professional orchestra musicians from the Northern Portugal. Group A with adequate working conditions, presented a prevalence of 59,4% of PRMD and group B with inadequate working conditions presented a prevalence of 67,4%..

Regarding pain intensity measurements, results clearly show a statistical difference between groups (pvalue=0.021). Group A presented an average of 4.0 VNS and group B presented 5.1 VNS.

Treatment techniques and follow up program (Chapter VIII and IX)

According to our results tuina techniques demonstrated to be effective reducing musculoskeletal pain in professional orchestra musicians immediately after one treatment session (pvalue≤0.001) and included in a self-management program during 20 days (0.000>p value>0.004).

According to the literature tuina techniques demonstrated to be effective reducing musculoskeletal pain. In order to standardize investigation, the majority of research uses treatment protocols. According to the Heidelberg model of Chinese medicine diagnose must be always performed before treatment and the use of treatment protocols must be rejected (Greten, 2012). Within this research we excluded the usage of treatment protocols and treatment points were chosen according to the actual functional vegetative state of the musicians. We can speculate that the Chinese diagnose performed at the baseline could highly contribute to our expressive results

After the first tuina treatment pain caused by PRMD was reduced almost 92% into the experimental group, and only almost 8% into the control group (Chapter VIII). Despite both reductions are statistical significant (pvalue ≤ 0.001 into the experimental group and pvalue =0.008 into the control group), we consider that statistical differences within control group are clinically inexpressive comparing with the amazing difference of experimental group. Despite this is a single blinded study, we also cannot exclude the possible placebo effect.

Regarding to the self-management program results show that within the experimental group, pain attenuation was always superior to 44%. Within the control group pain was reduced in a maximum of 5% but also increased 5% on day 1 and on day 20 (Chapter IX). The difference between groups was always significant for all days. Musicians were advised to repeat the exercises twice a day or according to their need. During the follow-up musicians from the experimental group repeated the exercises daily but musicians of the control group felt unmotivated and often did not performed the exercises.

Our data suggests that tuina techniques could highly decrease pain intensity caused by PRMD of professional orchestra musicians from the North of Portugal.

Limitations

Unfortunately the three included orchestras were chosen because of geographic convenience. This represents the first limitation of our study. As this is a non-funded investigation, it was not possible to study orchestras from the whole Portugal. For economic reasons it was also impossible to randomly chose the included orchestras. Due to this limitation, our conclusion could not be generalized. Despite this fact, after musicians' invitation and inscription, they were randomly and equally allocated to the control and to the experimental group. Before the interview they were already allocated to their investigation groups, this is the reason for unequal groups in chapter VIII and IX.

This is a single-blinded investigation. Despite musicians did not know in which group they are, placebo effect could not be ignored and totally controlled. The investigator was not blind and we cannot exclude the intention-to-treat of the TCM doctor. To reverse this limitation, double blind design should be developed in future research.

Regarding to measurements, semi structured interviews were chosen to collect epidemiologic data. Pain intensity was measured using verbal numerical scale (VNS). As a subjective parameter, pain intensity is always difficult to measure. Pain perception changes according to the individual characteristics of the person. VNS is simple to use and it does not consume many time, which is why we choose it to measure subjective pain intensity in this research. In future research stronger pain measurements must be added.

The usage of validated questionnaires to provide greater validity and reliability to our conclusions would be of tremendous importance. When this work was firstly projected, stronger measurements were included. After the first contact with the involved orchestras, their managers alert us to the probable low participation rate of this methodology. According to them musicians are very busy people and they will not spend time feeling in evaluation forms and questionnaires. For this reason, the methodology was simplified and measurements had to change. The second possible strategy was to provide an appointment with the semi-structured interview in order to augment the participation rate. We tried to establish a doctor-patient relationship of confidence and trust.

Although it is known that PRMD have multifactorial causes, it is difficult to isolate and to study only one of those causes, risk factor or variables. There are very uncontrollable variables. Our results do not allow the establishment of a direct cause-effect relationship between adequate working conditions and the prevalence and intensity of PRMD. We

are aware that characteristics like gender, age, repertoire or individual technique could not be changed or controlled by us and that they could have influenced our results.

Unfortunately VNS values do not present a normal distribution of variables and we were obliged to use non-parametric tests. As said into the methodology chapter, non-parametric tests are less powerful than parametric tests. In future researches big sample sizes could be add.

Chapter XI

Conclusions and future perspectives

The main conclusions are addressed in the peer-reviewed articles, although the following topics summarize them:

- Professional orchestra musicians from Northern Portugal are a prone group to suffer from occupational diseases, mainly PRMD (Chapter V)
- The instrument type could influence the appearance of PRMD in professional orchestra musicians from the North of Portugal and, according to our results, string musicians are more prone to suffer from by PRMD than wind musicians (Chapter VI)
- Adequate working conditions could significantly influence the prevalence and the intensity of PRMD of professional orchestra musicians from the North of Portugal (Chapter VII)
- Tuina techniques could significantly reduce pain intensity caused by PRMD in just one treatment session, in professional orchestra musicians from the North of Portugal (Chapter VIII)
- Self-management exercises based on tuina techniques could significantly reduce pain intensity caused by PRMD during 20 days, in professional orchestra musicians from the North of Portugal (Chapter IX)

To our knowledge this is the first Portuguese work about occupational diseases among professional orchestra musicians. Although this is a very common theme all over the world, Portuguese society is not aware to the problems of performing artists. The astonishing number of 94% of affected musicians is a matter for concern and must be taken into account. Musicians have to assume unnatural postures, play for several hours a day, and deal with the stress of a very competitive environment. Future studies focusing on working-related problems among professional orchestra musicians in Portugal are needed. Into this research we develop the theme of PRMD. MPA should also be studied in future research.

According to our data, the prevalence and intensity of playing-related musculoskeletal disorders is associated with less adequate working conditions, suggesting their important role in professional musicians' health and well-being. We hope that the orchestra managers could promote good quality of life improving musicians working conditions.

The effect of tuina treatments controlling pain caused by PRMD are well documented into this research. We can speculate that this program could be used in other professional groups exposed to repetitive movements such as supermarket cashiers, industry employments, and others. Our self-management program based on tuina techniques is safe and effective, inexpensive and could replace or complete drug-based therapy

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