Chapter 1

General Introduction
Introduction

Musicians are at risk of developing health-related problems during their musical career.1-3 The majority of these problems involve musculoskeletal complaints (MSCs).1-3 Up to 93% of professional musicians will experience MSCs that interfere with their ability to play at some time during their career.1-4 The impact of MSC on a musician's career is significant, and sometimes MSCs can cause an unintended termination of their career.1-7

The physical demands on professional musicians are high. Professional pianists, for example, are capable of producing astonishingly high finger movement frequencies, of up to 1800 per minute (e.g. in Liszt’s Paganini piano etude)8 and professional wind players have to produce tones on their instruments via their mouths, with high accuracy, at a rate of over 200 beats per minute, while producing triplets with their tongues.9,10 The demands imposed on the body posture are also high; most professional musicians play their instruments for over 8 hours a day, in positions which are often ergonomically unfavourable.11 Meanwhile, the professional musicians try to push their physical limits ever further in order to raise their performance level. This is important to enhance their musical career. It is surprising to see that so many professional musicians are able to handle these high demands. Besides, it is a challenge to reduce the risk of health-related problems where possible.

Definitions

Musculoskeletal system:
Although the term ‘musculoskeletal system’11, is widely used in medicine, and therefore frequently used in this thesis, the International Classification of Functioning, Disability and Health (ICF) provides no definition of it.12 Closely related terms in the ICF domains of body functions and body structures are ‘neuro-musculoskeletal’ and ‘movement-related’ functions, and ‘structures related to movement’.12

The musculoskeletal system is responsible for maintaining posture and for facilitating movements. It provides stability and movement of the body, or parts of it. When discussing the musculoskeletal system, people often implicitly only refer to the extremities and the spinal area. However, the facial area, e.g. the moving jaw, lips and tongue, can also be regarded as an integral part of the musculoskeletal system.

Musculoskeletal complaints:
MSC can be described as pain, other sensory complaints (such as feeling heaviness in the extremities, numbness or tingling) and weakness and/or lack of control in the musculoskeletal system.6,13 The present thesis uses MSC to indicate recurrent acute, subacute and chronic complaints. The difference between acute, subacute and chronic MSC is determined by the difference of duration. In line with the international definitions of pain,13 the term ‘acute MSC’ is only used in this thesis if the complaints do not extend beyond a period of two weeks. The cut-off point between subacute and chronic MSC is set at 3 months or ‘extending beyond the expected period of healing’.14-16
Pain:
Pain is a complex, subjective phenomenon, and defining pain has been a challenge. The International Association for the Study of Pain (IASP) recently suggested that we adjust the definition of pain to ‘the unpleasant sensory and emotional experience that results from actual or impending tissue damage, or is correctly describable in terms of such damage.\textsuperscript{14}

Function/dysfunction:
Function refers to the body functions domain of the ICF.\textsuperscript{13} Body functions are the physiological functions of body systems, such as the mobility of joints. All body functions (and body structures) combined, together with the aspects of activities and participation, are defined by the general term functioning. The ability to function relates to the positive aspects of health, while disability relates to the negative aspects of health (impairments, activity limitations, and participation restrictions). Dysfunction, a widely used term in medicine, can be interpreted as the negative counterpart of function and as a synonym for the ICF terms of impairment and activity limitation. Dysfunction is defined as the abnormality or impairment in the operation of a specified body organ or system.\textsuperscript{17} An example of dysfunction in musicians is lack of instrument control.

Structure of thesis

Causality of musculoskeletal complaints in musicians

The first part of this thesis focuses on the study of associations between three physical aspects (muscle activation pattern, posture and variation in occupational load) and MSC. In view of the assumption that MSC involves a complex of many bio-psycho-social causal interactions,\textsuperscript{18-20} many factors have to be taken into account when studying these associations.

A variety of explanatory models concerning chronic MSC have been developed over the last forty years. These include biologically oriented models,\textsuperscript{21-26} psychologically oriented models,\textsuperscript{27-37} models that combine some items within a bio-psycho-social framework – such as the fear avoidance model of Lethem et al.\textsuperscript{34, 39} – and the more general bio-psycho-social models like those described by Engel, Gatchel, Wideman, Hartvigsen, and van Dijk.\textsuperscript{16,40-44} The bio-psycho-social model is now widely accepted as the most heuristic approach to MSC.\textsuperscript{42} The ICF\textsuperscript{12} is used in this thesis to present a bird’s-eye view of the complexity and dynamics of the different bio-psycho-social aspects of functioning and dysfunctioning in humans.

The ICF is the international standard used to describe and measure health and disability in different cultures and settings, via a classification of health and health-related domains at both individual and group levels.\textsuperscript{12} As the functioning and disability of an individual occur in a context, the ICF also includes a list of environmental factors (Figure 1).

\textsuperscript{1} MSC/pain: For reasons of readability, the terms MSC and pain are used synonymously in this thesis, since the symptom pain forms the vast majority within the spectrum of complaints. If other MSC-symptoms than pain are meant, this is explicitly indicated.
The thesis by Baadjou\(^6\) elaborates on the specification of the ICF model for musicians with MSC, using rotator cuff tendonitis as an example (Figure 2), to illustrate the complex interplay of relevant factors relating to MSC in musicians. Despite the fact that the ICF model enables a clear description and classification of the different aspects and factors, the ICF does not explain the dynamics of the interactions between the biological, psychological and social factors in MCS.

**Assessment of physical function in musicians**

The second part of the thesis focuses on the assessment of physical functions and related body structures in musicians. Assessment of physical function in musicians is important to enable the systematic observation, classification and diagnosis of MSC and its causes, and the evaluation of interventions. The following definitions can be given (based on The Free Medical Dictionary):\(^{45}\)
Observation is the assessment of a musician’s condition or the collection of data on one or more musicians by the investigator/staff as required by protocol. In living beings, observation employs the senses. In science it can refer to the collecting of any data during the scientific activity or the recording of data using instruments. Observations can be qualitative, that is, noting only the absence or presence of a property, or quantitative, when a numerical value is attached to the observed phenomenon by counting or measuring, e.g. one shoulder is positioned five cm. higher than the other.

The Free Medical Dictionary also mentions analysis as a part of observation (‘or analysis of data’). In contrast to this, and in line with Shipman et al., we distinguish data analysis from observation, and consider it a condition for classification, diagnosis or evaluation, as described below.

Classification is the systematic arrangement into classes or groups based on perceived common characteristics; a means of giving order to a group of disconnected facts. This is the general process involved in categorization, the process by which ideas and objects are recognized, differentiated, and understood. In medical classification, data obtained in observations are processed by transforming descriptions of medical diagnoses and procedures into universal medical code numbers, e.g. functional or dysfunctional embouchure.

Diagnosis is the process of identifying the nature and cause of certain observations. Medical diagnosis is based on information from sources such as interviews with patients or their family or both, the medical history of the patient and family, findings from physical examination and clinical findings obtained by laboratory tests and radiologic studies. It is the outcome of determining which disease or condition explains a person’s symptoms and signs, e.g. a disturbance of the finger movement due to musicians’ dystonia.

Evaluation is critical appraisal or assessment; a judgment of the value, character, or effectiveness of something; measurement of progress. A broad view of evaluation in health care includes three approaches; approaches focusing on the structure or process and -depending on the focus of evaluation-the criteria or standards being used.

Evaluation is the systematic, rigorous, and meticulous application of scientific methods to assess the design, implementation, improvement, or outcomes of a programme or therapy, e.g. to reduce the flexion contracture of the finger by 15 degrees.

Aim and outline of the thesis

The studies in this thesis focused on three selected aspects of MSC in musicians, and the identification of valid assessment instruments of relevant musicians’ motor functions and related body structures in routine clinical practice. The aim of the
studies was to examine the causation of chronic non-specific MSC in musicians. We assumed that identification of valid assessment instruments would open the way for future studies on motor functions and related body structures associated with MSC. Assessment instruments that can be used in routine practice are needed to enable (large) studies among musicians. For some motor functions and related body structures, well-developed measuring methods already exist (such as EMG for muscle activity), while for others, there are partly developed measuring methods (such as those to assess posture), and for some, no validated measuring methods at all (such as to measure embouchure). Various studies were carried out to achieve the overall goal.

**Part 1: Associations between motor body functions and musculoskeletal complaints**

This part of the thesis reports on three studies to analyse correlations that might be relevant for motor body functions and related body structures, and MSC in musicians.

Many factors have been proposed as potential causes of MSC in musicians, but debate continues as to most of the predicting factors, despite an increasing number of studies. Determining a causal relationship requires meeting the Bradford Hill criteria (strength of association, consistency, specificity, temporality, biological gradient, plausibility, coherence, experiment, and analogy). In the case of MSC among musicians, no studies have been found that fulfilled all these criteria; e.g. the vast majority of studies about MSC in musicians have been cross-sectional, and we found no studies with a prospective design. In addition, most studies used substantially heterogeneously selected populations, used statistical procedures that did not include any correction for potential confounders, had small study samples, and/or provided no details about the validity and reliability of the assessment tools used. Based on the Bradford Hill criteria, we concluded that too little information was available from literature to make evidence-based statements about the causal factors of MSC in musicians.

**Aim**

The aim of the first part of the thesis was to test common assumptions about muscle activation patterns and static working postures, and how they might contribute to MSC in musicians. The following research questions were addressed:

1. Are muscle activation patterns of musicians during a musical task related to MSC? (Chapter 2):  
   Do bassists suffering from pain have higher muscle activation levels or increased muscle fatigue during playing and/or in the period of rest before and after playing, as compared to bassists without pain?  

2. Is the prevalence of MSC related to sustained ergonomically unfavourable postures in musicians? (Chapter 3):
a. Do double bassists have a higher prevalence of MSC in the shoulder area relating to the neck side of the instrument, or lower prevalence of MSC in the wrist area relating to the box side of the instrument, than bass guitarists, in view of their different playing postures?

b. Do German style bowers have a higher prevalence of musculoskeletal complaints in the wrist area of the bowing arm compared to French style bowers, because of their different bowing technique?

3. Is there a difference in the prevalence of MSC due to differences in occupational load between musicians? (Chapter 4):

Is the prevalence of MSC in the joint areas of the upper body among bassists playing at least two types of instruments similar to that among bassists playing only one type of bass instrument?

Part 2: Measuring motor functions relevant to musicians

The literature and clinical practice of performing arts medicine lack sufficient measurement instruments to assess motor functions and related body structures in musicians. Three presumed relevant motor functions in musicians are posture, hand function and mouth function (for wind players):

1. **Posture**: Playing an instrument is often performed in asymmetric postures for many hours a day, with static loads on the back and shoulder girdle area, usually in combination with extreme positioning of the joints of the upper extremities. Our study focused on identifying the best measurement tool from the literature, among the wide range of available methods, to enable reliable and quick measurement of universal posture in routine practice.

2. **Hand function**: The hands of musicians play chords and/or difficult melody lines accurately and at high speed, with sometimes widely spread out fingers because of the size or construction of the instrument. Screening of the anthropometric characteristics of the hand may be relevant to detect characteristics at risk for the development of MSC in the hand. The study aimed to identify the reliability of the only hand screening instrument reported on in the literature.

3. **Mouth function**: In wind playing the mouth area has to perform difficult and very precise movements, often at high speed. For some of these functions, like producing a sound on a wind instrument (embouchure), it was not even clear which body structures and body functions are involved (and in what way). Without this knowledge, it is impossible to identify the relevant aspects to measure, and to find associations between certain characteristics of the mouth area and MSC (like embouchure problems). No clear description of the construction of embouchure was available, nor of the related motor functions and body structures, and/or how to measure these aspects in routine practice. Measuring embouchure required the development of a new assessment tool for embouchure, based on the fundamental principles of sound production in wind instruments.
Aim

The aim in the second part of this thesis was to identify or develop valid and clinically useful measurement instruments for the assessment of posture, hand features and embouchure in musicians. Four studies were performed on measuring motor body function and related body structures in musicians:

1. The study about the assessment of posture aimed to provide an overview of the clinimetric and feasibility properties of the assessment methods for static standing and/or sitting posture in a routine clinical setting, and to interpret the findings for clinical practice (Chapter 5).

2. The study about hand features aimed to determine if the Practical Hand Evaluation (PHE) was a reliable screening instrument for the anthropometric features of the hand (Chapter 6). Subsidiary aims were:
   a. testing the intra- and inter-rater reliability for the PHE items,
   b. testing the measurement error and the potential impact of this measurement error on the classification of PHE items,
   c. testing the influence of gender, joint hyperlaxity and measurement order on the reliability,
   d. exploring the feasibility of reducing the number of items in the PHE.

3. The studies about embouchure aimed to:
   a. provide a narrative overview of embouchure based on information from different scientific and clinical fields, as a first step towards the construction of a reliable, valid and practical multi-item method to assess embouchure for brass players (Chapter 7).
   b. determine the content validity of an assessment instrument for embouchure (named the 'CODE of Embouchure'), which covers the main aspects of the construct of embouchure in brass players (Chapter 8).

Discussion

The thesis concludes with a discussion of the results, including the strengths and limitations of the studies, the implications and relevance of the results, and suggestions for further studies.

References


Part I

Assumptions about musculoskeletal complaints in musicians