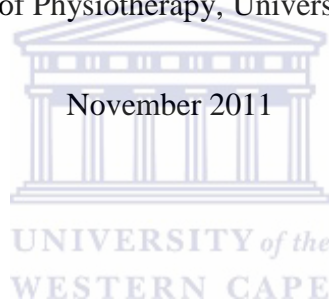


**GUIDELINES IN DESIGNING A WARM UP PROGRAM FOR THE PREVENTION
OF PLAYING RELATED MUSCULOSKELETAL DISORDER AMONG
INSTRUMENTALISTS**

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A thesis submitted in partial fulfilment of the requirements for a Masters degree in
Physiotherapy in the Department of Physiotherapy, University of the Western Cape



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ABSTRACT

Playing related musculoskeletal disorder (PRMD) is common among instrumentalists, professionals, amateurs and music students with a prevalence ranging from 39-47% with an impact on playing and performance. This is synonymous to the prevalence of musculoskeletal disorders among other work population. Risk factors such as lack of warm ups, awkward posture, long playing hours and bad techniques has been consistently indicated as risk factors influencing the incidence of PRMDs among instrumentalists.

The aim of this study is to design a warm up programme for instrumentalists. The study population and sample are instrumentalists at the Centre for Performing Arts, University of the Western Cape. A cross sectional study design with a quantitative approach was utilized in this study to determine the prevalence, severity, distribution of PRMDs and its association with quality of life. All the instrumentalists learning or playing a musical instrument of the Centre for Performing Arts was approached to participate in this study. In the first phase of the study, a self administered questionnaire was used to collect data regarding prevalence, distribution and the severity of PRMDs and health related quality of life. The instruments for this study are the standard NORDIC questionnaire for musculoskeletal disorders to determine pain distribution and prevalence, the visual analogue scale to determine the pain severity and the WHOQOL –BREF, a quality of life questionnaire and an adapted questionnaire to determine the knowledge of instrumentalists about injury prevention strategies. The second phase of the study, a systematic review of evidence was done on the pattern of warm up and practice habits of instrumentalists. The third phase of the study to design the content of the study was done using a Delphi study. The Statistical Package for Social Sciences (SPSS) was used for descriptive and inferential statistics. Chi square was used to determine the association of prevalence, distribution and severity on quality of life. Alpha level was set at 0.05. Ethical clearance and permission to conduct study was sought, written informed

consents from participants was sought clearly stating the right to participate and withdraw from study was respected and anonymity and confidentiality was be ensured.

The results of the study show that 82.4 % lifetime prevalence and current prevalence of 23.5 % among instrumental musicians in a Centre for Performing Arts. The shoulder (41.2 %), neck (29.4 %) and the wrists and hands (29.4%) are the mostly affected region on the body. The most common symptoms are tightness and soreness. However, the results of the systematic review shows that there is a lack of operational term for warm up in the performing arts and this therefore could be responsible for the variations in the influence of warm up on the prevention of PRMDs. The content of the warm up programme was designed using a Delphi study and stretching and postural awareness were included with musical warm up as part of a regular warm up exercise, although, consensus was not reached on the duration of the warm up programme. Strengthening and conditioning were included to in a different exercise program done three times per week. Education on injury prevention strategies were also included in the programme and the mode of instruction agreed on was active learning and group instruction in classroom

The role of warm up exercise in the prevention of PRMDs using this model could reduce the incidence of PRMDs. However, it is important to note that the programme should be tested in order to determine the overall effect it has on PRMDs.

DECLARATION

I declare that “Design of a warm up programme in the prevention of Playing Related Musculoskeletal Disorder among Instrumentalists” is my own work, that it has not been submitted for any degree of examination in any other university and that all the sources I have used or quoted have been indicated and acknowledged by means of complete references.

AT Ajidahun

Signature.....

November, 2011

Witness:



.....

Professor J Phillips

DEDICATION

To my dear parents Rev (Dr) & Mrs Ajidahun, to whom I am eternally grateful for the privilege of sound education and upbringing given me.



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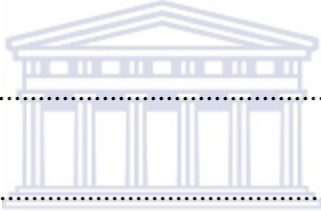
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CHAPTER ONE

INTRODUCTION

1.1. INTRODUCTION TO CHAPTER

In this chapter, relevant background on the history of performing arts medicine, its evolution over the years until the present day, the relationship between playing a musical instrument as a work related musculoskeletal disorder and its effect on musculoskeletal injury and several risk factors associated with musculoskeletal injury among musicians are discussed. This chapter discusses the motivation for this research to be carried out, highlighting the problem statement, research question, aims and objectives and significance of study. This chapter ends with the definition of terms used in the course of the study, full meaning of abbreviations and the general outline of the whole study.

1.2. BACKGROUND

Many occupations are associated with some degree of health risk and the art of music making is no exception. The very first mention of Work Related Musculoskeletal Disorder in musicians was in 1713 and this was recorded by Bernadino Ramazzini in the book “De morbis Artificum Diatriba (Diseases of Workers)” (Franco & Fusetti, 2003). He listed fifty five job occupations that can predispose the worker to musculoskeletal disorder and these occupations cuts across varieties of occupations (Franco & Fusetti, 2003).

In the early 1980’s, two concert pianists, Leon Fleisher and Gary Graffman publicly disclosed their career ending hand problem (Gaal, 2001). This acted as a

catalyst into the new trend in research over the last three decades. Journals such as: “The Medical Problems of the Performing Arts Journal, organisations such as: Performing Arts Medicine Association (PAMA), British Association for Performing Arts (BAPA), International Foundation for Performing Arts Medicine (IFPAM), also, various performing arts specialist clinics sprang up, all with the purpose of preventing and managing injuries of the performing artist, thereby creating a safer place for the performing artist to work in.

Playing related musculoskeletal disorder is prevalent in instrumental musician (Zaza, 1998). The prevalence is similar at the different level of professionalism, classical and non-classical instrumentalists, music students and teachers, professionals and non – professionals all have a similar pattern of PRMDs with the upper limbs, neck and back being mostly affected. (Abréu-Ramos & Micheo, 2007; Buckley & Manchester, 2006; Carl Zetterberg, Backlund, Karlsson, Werner, & Ollson, 1998).

Playing related health problems is the most common health problem among music students (Spahn, Richter, & Zschocke, 2002). The playing related disorders of instrumental musicians vary from skin problems, musculoskeletal and neurologic problems (Oswald, Baron, Byl, & Wilson, 1994). A range of 39 – 47 % of adult instrumental musicians and 17 % of secondary school music students complain of their health problems as musculoskeletal (Zaza, 1998). This is synonymous to the incidence of musculoskeletal disorders in other work population (Tanaka et al, 2001). The aetiology of musculoskeletal disorder of the workplace is multi-factorial; therefore, the preferred term for musculoskeletal disorder arising directly or indirectly from the workplace is termed Work Related Musculoskeletal Disorders (WRMD) and this does not define diagnosis or pathology (Hagberg, 1996). Musicians often describe

musculoskeletal problems as the presence of any of these: weakness, lack of control, tingling or other symptoms that interfere with your ability to play your instrument at the level you are accustomed to (Zaza, Charles, & Muszynski, 1998). Bragge, Bialocerkowski, & McMeeken (2006), gave the description, "as playing is the work of musicians, playing-related musculoskeletal disorders (PRMDs) is an appropriate music-specific derivative of work-related musculoskeletal disorder"

Overuse syndrome, repetitive strain injury and cumulative trauma disorders are umbrella terms used to describe playing related musculoskeletal disorder (Sadeghi, Kazemi, & Shoostari, 2004; Fry, 1987). The most common musculoskeletal problems of the performing artists are: overuse syndrome, focal motor dystonia, osteoarthritis, joint hypermobility and trauma (Hansen & Reed, 2006). Although, an earlier study by Hochberg, (1983) on occupational related hand problems in 100 musicians showed that tendinitis is the most common ailment of musicians. Recent study also showed that strains of the musculotendinous units and inflammation are the most common diagnosis of overuse syndrome and this usually affects the muscles of the distal upper limb i.e the forearm and the hand (Dawson, 2001).

Focal dystonia, a career ending playing related disorder suffered by musicians accounts for between 5 – 14 % of playing related health problems (Hochberg, 1983). It involves the involuntary painless movement of the affected limb which usually occurs at rest or when playing (Fahn, 1991). The diagnosis focal dystonia is evenly distributed among piano, string and woodwind instrumentalists and it affects the muscles of one or more fingers in the hands and embouchure in woodwind instrumentalists (Brandfonbrener, 1995).

Several risk factors have been identified as contributing to the development of PRMDs; the type of instrument played (Furuya, Nakahara, Aoki, & Kinoshita, 2006), lack of warm ups (Kaufman-Cohen & Ratzon, 2011), age and gender, awkward posture, long playing hours, bad techniques (Allsop & Ackland, 2010) and hypermobility and hypomobility (Grahame, 2007). Also, psychosocial factors also correlates grossly to the development of PRMDs (Akel & Düger, 2007). Pianists and string players have been found out to have a higher incidence of PRMDs when compared to the other type of instrument played (Furuya, Nakahara, Aoki, & Kinoshita, 2006; Rigg, Marrinan, & Thomas, 2003). In a recent study by Kaufman-Cohen & Ratzon (2011), it was found that only half of musicians devote about 10 minutes to do warm up exercises prior to playing their instrument, the study also showed that an average of 3 – 5 hours is spent daily by the musician to either practise or perform.

The morbidity of playing related injuries can only be reduced by prevention, which should be of concern to both the musicians and their managers (Lambert, 1992) and the need for a preventive model approach with respect to identified risk factor will have an immense effect in the reduction of playing related musculoskeletal disorders among musicians (Iranzo, Pérez-Soriano, Camacho, Belloch, & Cortell-Tormo, 2010). Injury prevention strategies have been developed over the years with respect to the identified risk factors.

Guptill & Zaza (2010) identified warm ups, breaks, playing position, technique, repetition and pacing as modifiable risk factors that can predispose the musician to PRMDs. Taking breaks has been found to reduce the incidence of PRMDs in professional pianists (Allsop & Ackland, 2010). The efficacy of supplementary breaks in computer data entry operators in injury reduction without

reducing overall work output (Galinsky, Swanson, Sauter, Dunkin, Hurrell, & Schleifer, 2007). Intrinsic factors such as joint hyper - mobility and hypo – mobility (Grahame, 2007), age (Dawson, 2001) and gender (Davies & Manginon, 2002) have been found to have a predisposing relationship on the incidence of PRMDs among instrumental musicians. About one quarter of musicians with PRMDs in the arm and hand also have joint hyper – mobility (Brandfonbrener, 1990). It is more common in the females than males (Brandfonbrener, 2002). Pianists have been found to have more hyper – mobility when compared to string and brass players and they usually present with overuse syndrome and joint or spinal pains but least presents with osteoarthritis when compared with musicians without joint hyper - mobility syndrome (Grahame, 2007).

The relationship between age and PRMDs is conflicting as some study shows a higher prevalence of PRMDs among the older group (Allsop & Ackland, 2010), whereas another study by (Dawson, 2001), shows a higher prevalence among the younger population. This contradiction may be due to other day to day activities such as primary or secondary occupations, which in combination to a practice schedule could predispose the musician to PRMDs (Morse, Ro, Cherniack, & Pelletier, 2000), whereas poor technique and practice load could be the major cause of the higher prevalence in the younger population.

Different instruments require different positions which can be seen with the distribution of PRMDs in the upper limbs (Abréu-Ramos & Micheo, 2007; Pak & Chesky, 2001). Proper ergonomics in relation to the instrument played and the position of the script is important, awareness of the normal curvature of the spine should be maintained at all times when playing the instrument (Guptill & Zaza, 2010). Cognitive learning which has been found to reduce repetition (Bandura & Adams,

1977). This can reduce the incidence of PRMDs when learning a piece because it reduces practice hours and thereby reduces the incidence of overuse.

The role of warm up in the prevention or reduction of PRMDs among instrumental musicians has been found to be of significance in some studies (Kaufman-Cohen & Ratzon, 2011; Davies & Manginon, 2002). The operational definition of warm up usually means musical warm up, it is a common practice among musicians to a musician and this involves the playing of scales or familiar tune before practise or performance (Zaza, 1992). Musical warm up, which involves playing of scales is different from the physical warm up. Physical warm up involves exercises of the body prior to playing the instrument and this could be a general warm up, which is a form of aerobic exercise usually done to increase the general body temperature before an activity. Specific warm up is also a form of physical warm up which is done to increase the local body temperature of the muscles that is to be used for an activity (Shellock & Prentice, 1985). It is advised to do both musical warm up and physical warm up before an activity (Guptill & Zaza, 2010).

Warming up pre-activity has significantly reduced the incidence of injury such as muscle strains and overuse injuries in sports especially football (Soligard, Nilstad, Steffen, Myklebust, & Holme, 2010; Soligard, et al., 2008). Pre – activity warm up is important in order to begin the process of conditioning the muscles to the dynamics of the activity in order to reduce the incidence of musculoskeletal injury (Kisner & Colby, 1996). Fredickson (2002), stated that muscles and tendons perform better when they are warmed up before an activity. Stretching of the neck, shoulders, arms, hands, and fingers is the common practise among musicians that perform specific warm up prior to playing, but the type, duration and pattern of stretch being performed is not reported (Buckley & Manchester, 2006).

With the growing interest in performing arts medicine all over the world, Africa is seriously lagging behind in research especially when it comes to musicians. There is paucity of literature in South Africa and Africa as a whole. A classical pianist once described music as something we are all touched by, irrespective of culture or language, everyone loves music and the whole world engages in one form of music or the other (Joel, 2011). There is a dearth of information in with regards to PRMDs in Africa. Most of the literature on research on PRMDs is from the United States of America, Canada and Australia with some research findings spreading across the Asian and European countries. Therefore, there is a need for the continent to delve into the Performing Arts Medicine research area so that there can be focus on the health of our performing artists thereby finding solutions to reduce the work musculoskeletal disorders attributed to this population. Adopting injury prevention strategies from sports such as warming up could reduce the incidence of musculoskeletal disorder among instrumentalists.

Literature did not report musicians performing a standard physical warm up protocol as a part of the warming up schedule; therefore there is a need to design a standardised warm up program that can be incorporated into practice habits of an instrumental musician which shall involve specific exercises, duration and number of repetitions. This warm up program can be isolated in order to determine the specific role of performing physical warm up exercises in the prevention or reduction of PRMDs among instrumental musicians.

1.3. STATEMENT OF THE PROBLEM

Musicians have nagging health concerns with respect to the work they do and these health conditions have an effect on playing and performance (Zaza, 1998). Various risk factors such as gender, age, instrument played, Rapid Upper Limb

Assessment (RULA), warm up has an influence on the incidence of PRMDs among instrumentalists (Kaufman-Cohen & Ratzon, 2011; Guptill & Zaza, 2010). Previous studies have focussed more on determining prevalence, identifying the risk factors, playing techniques and determining the knowledge of instrumentalists with the available prevention strategies (Allsop & Ackland, 2010; Brusky, 2009; Abréu-Ramos & Micheo, 2007). Some studies have been done to determine the incorporation of an exercise programme strengthening and conditioning in the prevention of PRMDs, warming up as an adjunct but the focus has not been on structured warming up pre-activity (Brandfonbrener, 1997) . Structured warming up pre-activity has been found to reduce the incidence of injury in football (Soligard, et al., 2008). Therefore, a warm up programme prior to playing an instrument could prevent or reduce the incidence of PRMDs.

1.4. RESEARCH QUESTION

What should be included in a warm up programme for instrumentalists?

1.5. AIM

The overall aim of this study is to create a guideline for designing a warm up program for instrumentalists.

1.6. OBJECTIVES

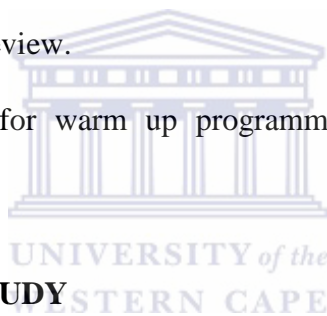
The specific objectives of this study are as follows will be in two phases:

- (a) To collect baseline data regarding PRMDs among instrumentalists at the University of the Western Cape.
- To determine prevalence of PRMDs among instrumentalists at the University of the Western Cape.

- To determine the severity of PRMDs among instrumentalists at the University of the Western Cape.
- To determine distribution of PRMDs among instrumentalists at the University of the Western Cape.
- To determine the practice habits of instrumentalists at the University of the Western Cape about injury prevention strategies.
- To determine if an association exists between PRMDs and the quality of life of instrumentalists at the University of the Western Cape.

(b) To design a warm up programme for instrumentalists:

- To collect evidence for warm up programme for instrumentalists through a systematic literature review.
- To reach consensus for warm up programme for instrumentalists through a Delphi-study.



1.7. SIGNIFICANCE OF STUDY

There is paucity of literature with regards to PRMDs among instrumental musician in South Africa and Africa as a whole. Also, there appears to be no standard physical warm up practice for instrumental musicians.

Therefore this study seeks to address the paucity of literature in South Africa and Africa as a whole with regards to the prevalence and distribution of PRMDs. Also, the knowledge of instrumentalist about prevention strategies would be assessed in this study. The design of a guideline in creating a standard warm up protocol could help in the nearest future to prevent or reduce PRMDs among instrumental musicians.

This study will enlighten health practitioners, especially physiotherapists in South Africa and Africa in general to their roles in prevention and management of

PRMDs in the still emerging world of Performing Arts Medicine. The outcome of this research may contribute to the existing injury prevention strategies.

1.8. DEFINITION OF TERMS

Playing related musculoskeletal disorder: Playing musculoskeletal disorder is defined as the presence of any these: weakness, lack of control, numbness, tingling or other symptoms that interfere with your ability to play your instrument at the level you are accustomed to (Zaza, 1998).

Performing Arts Medicine: This is a sub - speciality of occupational medicine that formally addresses the medical complaints of those who play musical instruments, sing, or dance. Common problems are those of a specific muscle-tendon unit, ranging in severity from mild pain to complete incapacitation, related to a combination of relatively repetitive movements of a limited number of muscles, and awkward position required to hold the instrument and/or weight of instrument, overuse 'syndromes', nerve impingement, and facial dystonia (Segen's Medical Dictionary, 2011).

Quality of life: The World Health Organisation defined quality of life as individuals' perceptions of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards and concerns. It measures the state of physical health, psychological, social relationships and environment. (WHO, 1996).


Joint hyper – mobility: Joint hyper-mobility is defined as an excessive range of joint movement taking into consideration age, gender, and ethnic background (Grahame, 2007).

Cumulative Trauma Disorder: Cumulative trauma disorders (CTDs) are injuries of the musculoskeletal and nervous systems that may be caused by repetitive tasks, forceful exertions, vibrations, mechanical compression (pressing against hard surfaces), or sustained or awkward positions. Cumulative trauma disorders are also called regional musculoskeletal disorders; repetitive motion disorders (RMDs), overuse syndromes, repetitive motion injuries, or repetitive strain injuries (Public Employees Occupational Safety and Health Program, 2003)

Warm up: a period or act of preparation for a game, performance, or exercise session, involving gentle exercise or practice (The Oxford Pocket Dictionary of Current English, 2009).

Delphi Study:

1.9. ABBREVIATIONS



CTD:	Cumulative Trauma Disorder
HRQOL:	Health Related Quality of Life
IASP:	International Association for the Study of Pain
IFPAM:	International Foundation for Performing Arts Medicine
JHS:	Joint Hyper - mobility Syndrome
MPPA:	Medical Problems of the Performing Arts
PAMA:	Performing Arts Medicine Association
PRMDs:	Playing Related Musculoskeletal Disorders

RCT:	Randomized Controlled Trial
RULA:	Rapid Upper Limb Assessment
SPSS:	Statistical Package for Social Sciences
QOL:	Quality of Life
UWC:	University of the Western Cape
VAS:	Visual Analogue Scale
WHO:	World Health Organisation

WHOQOL – BREF: World Health Organisation Quality of Life

WRMDs: Work Related Musculoskeletal Disorders



1.10. OUTLINE OF THESIS

Chapter One

This chapter includes the background of study, statement of the problem, aims and objectives and significance of the study. Also, definition of terms and full meaning of acronyms is included in this chapter. The overall objective is to design a warm up program for the prevention of PRMDs among instrumental musicians.

Chapter Two

This chapter presents a review of relevant literature in order to understand the need for the study. The literature review focuses on the evolution of playing related musculoskeletal disorders among instrumental musicians. The prevalence, the distribution and severity and its impact on health related quality of life, the risk

factors associated with PRMDs, and knowledge and awareness of musicians about injury prevention strategies is discussed in this chapter. The theoretical framework guiding injury prevention is also discussed in this chapter.

Chapter Three

This chapter considers the methodology of the research. It presents the overview and rationale of the methodology used in this study. The research settings, research design, population and sampling, data collection methods, research instruments, statistical analysis, ethical consideration are described in this chapter.

Chapter Four:

This chapter contains the results of the statistical analysis of the quantitative that seeks to answer the objectives of the first phase of the study.

Chapter Five

A systematic literature review was carried out to collect evidence for the content of a warm up programme as an injury prevention strategy for instrumentalists. This chapter outlines the procedure followed for the review and the results of the systematic literature review.

Chapter Six

After the design of the warm up programme as an injury prevention strategy for instrumental musicians, consensus was sought for the content of the warm up programme. This chapter outlines the Delphi study that was conducted to reach a consensus.



Chapter Seven

This chapter discusses the results of the previous three chapters (Chapters 4 – 6).

Chapter Eight

This chapter draws conclusions based on the study. Recommendations are also made based on the study. Limitations of the study are also outlined.



CHAPTER TWO

LITERATURE REVIEW

2.1. INTRODUCTION TO CHAPTER

This chapter gives an overview of Playing Related Musculoskeletal Disorder (PRMD) among musicians. Available literature on the evolution of performing arts medicine, the prevalence, distribution, severity and its impact on health related quality of life, risk factors and injury prevention strategies are reviewed. Common musculoskeletal problems among musicians are also discussed in this chapter. Available literature on quality of life is also reviewed. The theoretical frame work guiding injury prevention research is also presented in this chapter.

2.2. OVERVIEW OF PLAYING RELATED MUSCULOSKELETAL DISORDER (PRMD)

Joel (2011), a classical pianist and composer said, “I think music in itself is healing. It's an explosive expression of humanity. It's something we are all touched by. No matter what culture we're from, everyone loves music”. Although music cuts across every culture, the good music we are touched by is created in pain, most instrumental musicians produce and perform music with pain which is considered a norm due to the strenuous pattern of practice and performance (Abma, 2001).

Playing related musculoskeletal disorder is prevalent among professional instrumentalist, amateur and music students with a prevalence of 37 – 77 % (Zaza, 1998). It is the presence of any of these: weakness, lack of control, tingling or other symptoms that interfere with your ability to play your instrument at the level you are accustomed to (Zaza, Charles, & Muszynski, 1998). Playing related disorders in musicians can be skin lesions from contact with the instrument played such as

eczema, ulcers, submandibular lesions or neurological injuries such as nerve entrapment and focal dystonia or musculoskeletal injuries under umbrella terms like Cumulative Trauma Disorder (CTD), overuse injuries and repetitive strain injuries (Oswald, Baron, Byl, & Wilson, 1994).

In a systematic review by Zaza (1998), the incidence of PRMDs among instrumental musicians is 39-47 % of adult instrumentalists and 17 % secondary school music students. However, in a recent survey of fresh music students, 79 % complain of playing related pain (Brandfonbrener, 2009). Musicians have described PRMDs as the presence of any of these: weakness, lack of control, tingling or other symptoms that interfere with performance (Zaza, Charles, & Muszynski, 1998). Pain is the most common complaints of instrumental musicians followed by tingling and weakness (Brusky, 2009).

Several studies have been carried out on the prevalence of PRMDs in Europe, North America, Asia and Australia but there is dearth of literature in performing arts medicine in Africa. PRMDs is experienced in the various class of instrumentalists – Classical musicians, Orchestral, non – classical musicians, amateurs, music students, teachers and local instrumentalists (Allsop & Ackland, 2010; Buckley & Manchester, 2006; Sadeghi, Kazemi, Shooshtari, Bidari, & Jafari, 2004; Guphill, Zaza, & Paul, 2000). The overview of prevalence of PRMDS across the world is clearly outlined in Table 2.1.

The prevalence of PRMDs varies with respect to the instrument played with 77 % of pianists (Furuya, Nakahara, Aoki, & Kinoshita, 2006), 61.3 % of guitarist (Rigg, Marrinan, & Thomas, 2003), 60 % of brass instrumentalist, 70 % of trombone players and 53 % of trumpet players (Chesky, Devroop, & Ford, 2002), all present

with playing related musculoskeletal disorder in at least one region of their body. String instrumentalists are the most vulnerable group, the incidence of PRMDs is higher amongst this group than in other groups (Dawson, 2001).



Table 2.1: Overview of the Prevalence of PRMDs among Instrumental Musicians

Author	Country	Population	Design	Results
Kaufman-Cohen & Ratzon (2011)	Israel	Classical musician	Survey	83 %
Allsop & Ackland (2010)	Australia	Pianists	Survey	42.4 %
Sandell, Frykman, Chesky, & Fjellman-Wiklund (2009)	USA	Percussionists	Survey	77 %
Guptill & Zaza (2010)	USA	Music students	Survey	87.7 %
Brusky (2009)	Australia	Bassoon	Survey	86 %
Ranelli, Straker, & Smith (2008)	Australia	Children	Survey	67 %
Abréu-Ramos & Micheo (2007)	Puerto Rico	Orchestra	Survey	81.3 %
Buckley & Manchester (2006)	USA	Amateur	Longitudinal	54 %
Furuya, Nakahara, Aoki, & Kinoshita (2006)	Japan	Pianists	Survey	77 %

Sadeghi, Kazemi, & Shooshtari (2004)	Iran	Music students	Survey	53 %
Chesky, Devroop, & Ford (2002)	USA	Brass	Survey	60 %
Pak & Chesky (2001)	USA	Keyboard	Survey	59.2 %
Guptill, Zaza, & Paul (2000)	USA	Students	Survey	87.7 %
Roset-Llobet, Rosinés-Cubells, & Saló-Orfila (2000)	Spain	Musicians	Survey	77.9 %
Yeung, et al. (1999)	Hong Kong	Orchestra	Survey	64 %
Zaza (1992)	Canada	Music school	Survey	43 %
Newmark & Salmon (1990)	USA	Non-classical	Survey	44 %
Fry (1987)	Australia	Students	Survey	63 % F 49 % M



Classical musicians in a study by Zaza, Charles, & Muszynski (1998) described PRMDs as being the presence of any of these: weakness, lack of control, tingling or other symptoms that interfere with your ability to play your instrument at the level you are accustomed to. Several studies have shown that the distribution of PRMDs is instrument specific likewise some PRMDs symptoms are peculiar to some instrument played, although pain cuts across all the symptomatic PRMDs irrespective of the instrument played. Pain and discomfort such as tightening, aching and soreness of the body is the most common complaint among piano players (Guptill, Zaza, & Paul, 2000). Percussionists often complain of neuralgia and tremors in the upper limb (Papandreou & Vervainioti, 2010). Pain is the most common symptom among bassoon players which is followed by tingling, weakness and loss of flexibility (Brusky, 2009).

Professional musicians have identified lack of warm up, workload and work related tension as the cause of PRMDs while music students believe that bad playing technique is the cause (Zaza, 1998). Warm up prior to playing, weight of instrument, Rapid Upper Limb Assessment difference, perceived physical environment, average playing hours (Kaufman-Cohen & Ratzon, 2011), inadequate conditioning (Brandfonbrener, 1997) and adverse biomechanical structure such as hyper-mobility of joints (Grahame, 2007), age (Abréu-Ramos & Micheo, 2007) have an influence on the occurrence of PRMDs. Bad posture is seen as the most common cause of non – instrument specific pain of the back, shoulder and neck (Williamson & Thompson, 2006). About a decade ago, a retrospective study spanning over 15 years was conducted and overuse difficulties was found as the most common cause of PRMDs and the majority of those in the whose upper limb problems were due to overuse are high level performers, although several other non – musically related cause such as

trauma, arthritic problems, recreation and other problems have also been found to be the cause of musculoskeletal disorders among instrumentalists and they often could not really discern the cause of the musculoskeletal pain (Dawson, 2001).

PRMD is usually a multi – symptomatic disorder presenting with multiple symptoms such as pain, tingling, loss of flexibility and weakness at one or more site (Brusky, 2009). Although, pain is usually the most common complaint of PRMD (Guptill, Zaza, & Paul, 2000), followed by tingling and loss of flexibility and weakness are usually the least reported. Strains of the musculo - tendinous units and inflammation are the most common diagnosis of overuse syndrome and these most commonly affect the distal upper limb muscles than the proximal ones – the hand and the forearm and a typical patient present with overuse related pain are female pianist and a string players (Dawson, 2001).

The distribution of PRMD is instrument specific, a comparison between music students and their non-musical oriented counterparts showed that music students are five times more likely to have an upper extremity disorder than non – music students (Miller, Peck, & Watson, 2002). The distribution of PRMD is instrument specific. The fretting hand is the most reported region in guitarists (Rigg, Marrinan, & Thomas, 2003), shoulder and neck pain in upper string instrumentalists (Abréu-Ramos & Micheo, 2007) and pain in the fingers in pianists (Pak & Chesky, 2001). Bassoonists frequently report more PRMDs in the arms and wrists followed by the hands and the shoulders, back and chest, although many bassoonists report having PRMD in more than one site (Brusky, 2009). The distribution of PRMDs cuts across the upper extremity, neck and back with the upper extremity – hands, forearm, arm, and shoulder being the most common sites of pain and this is evenly distributed depending on the type of instrument played. Although the shoulder is a common site of pain in

many instrumentalists irrespective of the instrument played (Kaufman-Cohen & Ratzon, 2011). There is negligible or no symptoms of PRMD in the lower extremity – hips, thigh, leg and ankle.

A number of musicians have been forced to retire due to medical problems associated with the demands of their occupation (David & Smith, 1989). In a study by Zaza, Charles, & Muszynski (1998), musicians described PRMDs as the presence of any of these: weakness, lack of control, tingling or other symptoms that interfere with your ability to play your instrument at the level they are accustomed to. Musicians hardly complain of PRMDs in the lower limbs, most of the complaints are associated with the upper limbs with pain, numbness, lack of control and tingling sensation being the common complaints (Zaza, Charles, & Muszynski, 1998). Pain is usually the most common complaint of PRMDs, followed by tingling; flexibility and weakness are the least common complaints (Brusky, 2009). Even with pain being the most common complaint and symptoms, instrumentalists holds this belief that playing through pain is a part of their occupation (Abma, 2001).

Pain, being the most common complaints of PRMDs has an impact on the quality of life of musicians both physically and mentally (Antonopoulou, Alegakis, Hadjipavlou, & Lionis, 2009). In a recent study by Antonopoulou, Alegakis, Hadjipavlou, & Lionis (2009), musculoskeletal symptoms have a general effect on the HRQL using the SF – 36 especially in physical conditioning, bodily pain, vitality, general health and role of limitation. The study also shows that those who are experiencing musculoskeletal disorders have a worse HQOL than those who do not.

The World Health Organisation defined quality of life as “individuals' perceptions of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards and concerns. It

measures the state of physical health, psychological, social relationships and environment” (WHO, 1996). Quality of life over the past three decades have evolved from the measure of objective variables such as number of cars, income, house and materials things to subjective variables such as happiness, life satisfaction and health (Smith, 2000). Playing Related Musculoskeletal Disorder (PRMD), just like any other health problems has an effect on the state of health and musicians with a higher incidence of PRMD tend to have poorer health (Davies & Manginon, 2002).

A large percentage of instrumental musicians complain of playing related musculoskeletal pain (Bragge, Bialocerkowski, & McMeeken, 2006). An earlier study by Hochberg, (1983) of 100 musicians’ occupational related hand problems showed that tendinitis is the most common ailment of musicians. Hansen & Reed (2006), discussed the common musculoskeletal problems of performing art as being; overuse syndrome, focal motor dystonia, osteoarthritis, joint hypermobility and trauma. Also, in a pilot study conducted among percussionists, the most common musculoskeletal problems are tremors and neuralgia in the upper limbs, also back and head ache was found to be high (Papandreou & Vervainioti, 2010).

Overuse syndrome accounts for about 50 % of PRMDs among professional orchestra musicians (Fry, 1986). Strains of the musculo - tendinous units and inflammation are the most common diagnosis of overuse syndrome and these most commonly affect the distal upper limb muscles than the proximal ones – the hand and the forearm (Dawson, 2001). Overuse usually presents as persisting pain, tenderness and weakness or loss of fine motor control may also be present (Fry, 1987). It usually develops when the tissues are being stressed beyond their biological limits and symptoms may only be present just after or during a performance but heavy practice habits such as increase in playing times and inadequate rest can bring about an

exacerbation of the syndrome (cited by Hansen & Reed, 2006). Fry (1987) also identified genetic influence which cannot be altered, technique which is largely influenced by the teaching and its application and the duration of practice as being major risk factors in the development of overuse. It is more common in string players than in percussion and affects more of females than male musicians. A typical overuse related injury in a musician is a string musician or a female pianist (Dawson, 2001).

In the early 1980's two pianists, Leon Fleisher and Gary Graffman publicly disclosed their career ending hand problem (Gaal, 2001), due to the symptoms of the hand problems it was suggested that they could have had focal motor dystonia. Focal motor dystonia is an involuntary painless movement in the affected limb. It usually occurs when playing or at times, at rest (Fahn, 1991), although most patients complain of "impaired control" when playing the instrument (Schuele & Lederman, 2003) . It is not a common playing related problem but it accounts for between 5 – 14 % of playing health problems and it is a career ending disorder (Hochberg, 1983).

In a case retrospective study of instrumentalists diagnosed with focal dystonia at a Performing Arts Medicine Centre, the results showed that, focal dystonia is most common in men than in women and the average age of onset is thirty – eight years. It is evenly distributed among keyboard players, woodwind players and string players, affecting the muscles of one or more fingers of the hand in most musicians except for about 20 % of the instrumentalists who are wind and brass players who had muscle affectation of the embouchure (Brandfonbrener, 1995).

Joint hyper - mobility is defined as an excessive range of joint movement taking into consideration age, gender, and ethnic background (Grahame, 2007). It is more common in females than in males. (Brandfonbrener, 2002) The relationship between joint laxity and injuries is contradictory, earlier studies show that the

influence of joint laxity on wrist pain and stiffness is low when compared to other musicians (Larsson, Baum, Mudholkar, & . Kollia, 1993), while another study reports show that 19 % of musicians with hand and arm pain also has JHS (Brandfonbrener, 1990).

In a recent study conducted by (Grahame, 2007), in a performing arts clinic, JHS was identified in 40 % of musicians with the highest prevalence in pianists, then followed by string players and JHSP is lowest in brass players. He also found out that the occurrence of JHSP is higher in those that presented with overuse syndrome and joint or spinal pain while it was lowest in those with soft tissue lesions and osteoarthritis. (Grahame, 2007). Several other musculoskeletal problems such as trauma and degenerative problems which occur in other general population are also reported by musicians. (Warrington, Winspur, & Steinwed, 2002).

2.3. RISK FACTORS

Allsop & Ackland (2010), identified three major risk factors in the development of PRMDs among pianists as overuse, misuse and playing conditions factors, with intrinsic factors such as hand size, gender and age and also extrinsic factors such as practice schedule, intensity of practice, repertoire performed, physical environment being involved in the development of PRMDs. Psychosocial factors also contribute to PRMDs, the effect of practice time on PRMD is largely associated with psychosocial demands and this correlates grossly to the development of musculoskeletal symptoms (Akel & Düger, 2007).

Ranelli, Straker, & Smith (2008), further explained the risk factors associated with PRMDs in musicians as multi-factorial and this include intrinsic individual factors and extrinsic playing-related factors, and factors relating to the interaction of the individual and extrinsic factors. Several studies have identified intrinsic factors

such as gender, joint laxity, hormonal influences and the incidence of PRMDs. Some studies reports higher prevalence in females probably due to joint laxity and hormonal influences, while some studies reported equal distribution of the incidence of PRMDs (Abréu-Ramos & Micheo, 2007). Davies & Manginon (2002) found out that female string players especially have a higher incidence of PRMDs than male string players and female players of other instruments, whereas, Allsop & Ackland (2010) found out that majority of those that complain of PRMD are men. Research has shown the high incidence of upper back and neck pain among female violinists with respect to their male counterpart which could be due to the small upper body mass of the female (Roach, Martinez, & Anderson, 1994).

The prevalence of PRMDs increases with age, with older musician complaining more of PRMDs than the younger ones (Allsop & Ackland, 2010). Although, Dawson, (2001) reported a higher incidence of musically related overuse among teens and twenties when compared to the older adult, gender plays a significant influence in the rate of experience of PRMDs, with the prevalence higher in females than in males.

Extrinsic factors includes: practice hours, practice habits, playing techniques and position and instrument played. An average instrumentalist's plays for an average of about five hours a day and the lengthened duration of playing is directly proportional to the incidence of PRMD, therefore, the chances of an instrumental musician that plays for less hours of developing PRMDs is reduced (Kaufman-Cohen & Ratzon, 2011). Although, Allsop & Ackland, (2010) in another study found out that there was no significant interaction between practice hours and experience of PRMDs but there was a higher incidence of PRMDs among those that practice for

longer hours, with about 66. 7% of those that reported PRMDs practising for 21-40 hours per week.

Other risk factors in doing other day to day activities such as primary or secondary occupations or even in combination with other associated risk factors could as a result of its combination with the practice hours contribute to PRMDs (Morse, Ro, Cherniack, & Pelletier, 2000). Professional pianists have been found to take longer breaks than non – professionals and professional pianists without PRMDs take longer breaks than those with PRMDs while non-professional without PRMDs took shorter breaks than those with PRMDs. This suggests that pain could have been the reason why the non – professionals took breaks whereas, the professional pianists understands the importance of taking breaks in injury prevention (Allsop & Ackland, 2010).

Playing techniques and position play a role in the distribution and severity of PRMDs (Allsop & Ackland, 2010). In a recent study by Allsop & Ackland (2010), it was observed that wrist and shoulder playing positions are of significance in the risk of developing PRMDs while there was no significance between elbow and finger positions in the experience of PRMDs by musicians. Although several studies have identified the correlation between type of instrument played and the distribution of PRMDs with the fretting hand being mostly affected by guitarists (Rigg, Marrinan, & Thomas, 2003), shoulder and neck pain in upper string instrumentalists (Abréu-Ramos & Micheo, 2007) and pain in the fingers in pianists (Pak & Chesky, 2001), arms and wrists (Brusky, 2009). Musicians often assume an abnormal posture while they play, but this abnormal posture does not translate into their normal day to day posture, a study carried to compare the posture and postural disorders between music students and medical students' shows no significance in posture when the music

students are not playing (Eijsden-Besseling, Kuijers, Kap, Stam, & Terpstra-Lindeman, 1993).

Akel & Düger (2007), in a study carried out in Turkey to determine the psychosocial risk factors of musicians, clearly discussed psychosocial factors using the Job Content Questionnaire (JCQ) as decision latitude, physical exertion, psychological job demand, physical exertion, physical load, job insecurity, depression, psychological stress variables. In another study carried out among various professional occupational groups in Finland, it was observed that musicians have a significantly higher job satisfaction than other group of professionals (Kivimäki & Jokinen, 1994). The more musicians are satisfied with work content the fewer the symptoms and incidence of musculoskeletal disorders, work task quality correlates with employees' health (Johansson & Theorell, 2003).

Psychosocial risk factors correlates with practice and playing time and psychosocial stress increases with time among musicians, with viola players being the most susceptible to psychosocial stress (Kivimäki & Jokinen, 1994). This is evident in the high prevalence of PRMDs among string instrumentalists in relation to other instrumentalists (Kivimäki & Jokinen, 1994). Viola players play more in an awkward position for a long time than other instrumentalists and this may be the cause of the high psychosocial demands of playing the instrument (Bejjani, Kaye, & Benham, 1996).

Environmental factors such as cold, temperature, cramped space, and lightening are also risk factors in making the environment not conducive for the musician (Hansen & Reed, 2006). Physical environment is a major concern for musicians has it has a great impact on working conditions. Musicians frequently

complain more about bad chairs and poor seating arrangements; string and brass instrumentalists' major concern is the cramped sitting position whereas woodwinds, percussion and harpists major concern is noise and temperature. (Harper, 2002).

2.4. INJURY PREVENTION STRATEGIES

Over the past 25 years, performing art medicine had grown from identifying the presence of PRMDs among musicians, its prevalence, and severity as it affects playing and performance and distribution, only a few studies have attempted to determine the efficacy of injury prevention interventions. Although, studies to determine the efficacy of exercise program in the prevention of PRMDs was conducted in the late 1990's and early 2000's. (Greef, Van Wijck, Reynders, Toussaint, & Hesselings, 2003; Brandfonbrener, 1997).

Research on identifying risk factors, prevention and management has been conducted by various health speciality, the medical doctors, occupational therapists and physiotherapists. Physiotherapists have been involved in the treatment of PRMDs among musicians, on site management; referral to Physiotherapy clinic and on tours, especially in Europe and USA (Milanese, 2000).

Medical professionals should explore the areas of prevention of PRMD, joint protection, education on overuse and misuse, also health education for the various age groups bearing in mind that the older musician also suffer from degenerative disorders (Warrington, Winspur, & Steinwede, 2002). Musical knowledge by the therapist is often considered by musicians as being an important aspect in treatment and rehabilitation (Guptill, Zaza, & Paul, 2000).

There was no significant effect of an exercise programme on the incidence of PRMDs but some of the participants in the experimental group reported reduced

symptoms of PRMDs. The Groningen exercise program had an perceived physical competence and a decrease of PRMDs. Participation in the Groningen exercise programme was identified as being a factor in the decrease in the experience of PRMDs. (Greef, Van Wijck, Reynders, Toussaint, & Hesselings, 2003). Guptill & Zaza (2010) identified the following modifiable risk factors to be considered in the prevention of PRMDs – warm up, breaks, posture (playing position), technique, repetition and pacing.

Musical warm up, a common practice by musicians (Zaza, 1992), which is important in preparing the body and mind for performance but the physical warm up which prepares the musculoskeletal structure for the task ahead is also important, therefore musical and physical warm up should be combined (Guptill & Zaza, 2010). Pre-activity warm up is important in order to begin the process of conditioning the muscles and joints to the proposed activity by improving muscle dynamics so as to reduce the incidence of injury (Kisner & Colby, 1996) and performance is better when muscles and tendons are warmed up before the planned activity (Fredrickson, 2002).

Structured pre-activity warm up in sports has been found to reduce the incidence of injuries especially injuries due to muscle strains, overuse injuries and injuries altogether (Soligard, et al., 2008). Brandfonbrener (1997), in a research utilizing a 5 minute warm up program prior to playing and cool down showed no statistical difference on the incidence of PRMDs but some participants in the experimental group reported significant differences. Research has shown that it takes about 10 minutes to actually warm up a tissue by active exercises and after muscle contraction, heat production is more than the resting heat continues for about 30

minutes which implies that after warm up, activity should commence within 30 minutes so that the muscle does not return to its pre-contraction state (Ganong, 2003).

Warming up the muscle increases tissue temperature which subsequently increases the rate of nerve conduction thereby increasing the rate of muscular contraction, increase in blood flow to the periphery which complements the rate of oxygen absorption and thereby increasing facilitation of the oxidative process during the activity (Kisner & Colby, 1996). Mild warm up has been found to prevent the accumulation of lactic acid in the muscles and inhibit a reduction in pH thereby preventing acidosis which has been found to be a major cause of muscle fatigue in intense exercise (Kato, Ikata, Takai, Takata, Sairyo, & Iwanaga, 2000). Studies regarding the influence of warm up on performance related pain needs to be researched in order to find out the relationship between these two (Yoshimura et al, 2008). The major components of an effective warm up in sports participation involves preliminary exercise with large muscle groups leading to elevation of core temperature, stretching of key muscles to ensure adequate range of motion for full intense movement pattern, slow velocity limited ranges to establish coordination and tempo of segmented movements and execution of motion at optimal velocity and intensity that rehearse desired motor patterns (Vandervoort, 2009).

Taking breaks as a practice habit is found to reduce the incidence of PRMDs among professional pianists (Allsop & Ackland, 2010). Evidence does not prescribe the duration or frequency of breaks among musicians (Guptill & Zaza, 2010). Taking breaks has also shown its efficacy in the prevention of injuries and supplementary breaks does not have reduce overall work output (Galinsky, Swanson, Sauter, Dunkin, Hurrell, & Schleifer, 2007). Guptill & Zaza (2010), also suggests that students should be encouraged to practice two kinds of breaks, the micro – break which requires the

instrumentalist to pause for about thirty second when practising a musical piece and longer breaks away from the instrument which requires the instrumentalist to rest and relax the muscles involved in the playing the instrument, changing posture is also an important component of longer breaks.

Playing position is an indicator on the distribution of PRMD as several instruments require different postural position (Abréu-Ramos & Micheo, 2007; Pak & Chesky, 2001). Guptill & Zaza (2010) advised on proper ergonomic positions in relation to the size of instrument, which should be complementary to the physical stature of the instrumentalist and the position of the music script should be at a comfortable as the height of the music sheet could encourage poor posture. All instrumentalists should be aware of the normal curvature of the spine and these curves should be maintained in whichever position the player assumes to play the instrument, they should learn to move with the music as required by the instrument instead of keeping a static posture while playing (Guptill & Zaza, 2010).

Repetition is an integral part of playing an instrument and all instruments require some form of consistent repetition. Repetitive movement is also a risk factor for injuries. There are ways to reduce injury induced repetition, learning the correct movements slowly, so it can be relied on at a higher speed (Guptill & Zaza, 2010). Cognitive learning of a piece has been found to reduce repetition and the role of cognitive learning and visualising of performance helps to improve quality of performance (Bandura & Adams, 1977).

In a study conducted among University students on practices and knowledge about injury prevention, results showed that posture and proper body mechanics was the most common education received by the students (Blackie, Stone, & Tiernan,

1999). Most of students have received a form of injury prevention education either formally or informally from teachers, colleagues, workshops, articles, books, internet, formal training (University), although majority of the students in a high school received injury prevention education from either their teachers, colleagues or at workshops (Redmond & Tiernan, 2001).

The preventive education received by musicians does not really translate into practice, only about half of musicians dedicate time to perform some form of warm up exercises prior to playing, when compared to the religious way of performing the musical warm up routine which to a large extent is highly encouraged by music teachers (Kaufman-Cohen & Ratzon, 2011). Music students believe that playing through pain is part of the demands of the profession and therefore this results into increase in practice time which subsequently results into music related overuse injury (Abma, 2001; Fry, 1987).

Therefore in as much as practicing and playing is important, music students should be educated and monitored in ensuring that they conform with injury prevention strategies such as physical warm up, taking breaks, proper technique, repetition and posture just as they understand the importance of musical warm up (Guptill & Zaza, 2010 ; Zaza, 1992).

2.5. THEORETICAL FRAMEWORK

The theoretical framework in sports injury prevention designed by Van Mechelen (1992) was used as a guide in this study. This sports injury prevention framework is in five (5) stages, which includes the following: a detailed understanding of the aetiology of injuries, development of interventions to directly address the identified mechanisms of injury, formal testing of these interventions

under controlled conditions (i.e., efficacy research), understanding of the sporting and individual athlete behaviours context in which the interventions are to be implemented, potential modification of interventions to take this implementation context into account (Finch, 2006).

The first three stages of the framework was used as a guide in this study and it is evident in the stages of the research – a detailed understanding of the aetiology of injuries and a development of interventions to directly address the identified mechanisms of injury. Formal testing of the intervention under controlled conditions is not within the scope of this study. The focus of this research is to design an intervention programme that directly addresses an identified mechanism of injury.

2.6. SUMMARY OF CHAPTER

The review of literature above indicates the prevalence of PRMDs among instrumental musicians and the interplay of various risk factors that could predispose an instrumental musician to musculoskeletal disorder.

It is also apparent that injury prevention strategies addressing the various extrinsic and intrinsic risk factors could reduce or prevent PRMDs. This literature review also shows the dearth of information about PRMDs in South Africa and Africa as a whole. This study is also attempted to design a warm up exercise programme as an injury prevention strategy in the prevention of PRMDs among instrumental musicians. The methodology used in designing the warm up programme is discussed in the following chapter, chapter three.

CHAPTER THREE

METHODOLOGY

3.1. INTRODUCTION TO CHAPTER

This chapter provides an overview and rationale for the methodology used in the first phase of the study. Research setting and design, study sample, instrument used, validity and reliability of instrument used, data collection methods, procedure and ethical considerations are aspects discussed in this chapter.

3.2. RESEARCH SETTING

The research setting is at the Centre for Performing Arts, University of the Western Cape, located in the Western Cape province of South Africa. The centre is currently a non – academic unit of the University, where certificates, diplomas or degrees are not conferred by the University. However, people from all spheres of life can acquire additional qualifications by following the programmes offered at the centre. At present the students register for examinations of Guildhall Trinity College London and The Associated Boards of the Royal School of Music. Music tuition is currently offered in the following instruments – euphonium, piano, flute, recorder, guitar, trombone, pipe organ, trumpet, violin and bass guitar.

3.3. RESEARCH DESIGN

This is a descriptive cross sectional study utilizing quantitative research methods to investigate the prevalence, severity and distribution of PRMDs among instrumentalists and its association with quality of life and also the knowledge of instrumental musicians about injury prevention strategies. This study design is best suited for this study because it data collection requires only one contact with the study

population regarding the outlined objectives of the study – to determine prevalence, severity, distribution, knowledge and its association with quality of life (Kumar, 2005).

3.4. POPULATION AND SAMPLING

Music students and teachers at the School of Performing Arts, University of Western Cape were the research population. All music students and teachers were approached for participation in this study and this includes forty (40) students and eight (8) teachers. The population were either playing or learning to play or teaching how to play a particular instrument at the Centre for the Performing Arts, UWC.

3.5. DATA COLLECTION METHODS

The following instruments were used to determine the prevalence, severity and distribution of PRMDs and the quality of life of instrumentalists and also their knowledge about injury prevention strategies.

3.5.1. Research Instruments

Data was collected with a self administered questionnaire consisting of four different scales. The first part is a self administered questionnaire designed by Blackie, Stone, & Tiernan (1999) to determine the knowledge of University piano music students about injury prevention. This questionnaire is in two parts with the first part focussing on practice habits and the second part focussing knowledge of the students about playing related injury prevention strategies. It contains open and closed ended questions.

The second part is the WHOQOL-BREF, an abbreviated version of the WHOQOL-100 developed by the World Health Organization used to assess the quality of life of individuals (WHO, 2004). This instrument consists of two sections;

the first section requires information about age, gender, educational level and marital status while the second section consists of 26 items with Likert - like questions ranging from not at all (1) to an extreme amount (5) assessing an individuals' perception of related quality of life. The quality of life is assessed in four domains - physical, health, psychological, social relationships and the environment.

The third part is the Nordic Musculoskeletal Questionnaire (NMQ) for analysis of musculoskeletal symptoms is a self administered questionnaire that measures the musculoskeletal symptoms presented in an occupational setting, this includes close ended questions which seeks to determine the prevalence and distribution of musculoskeletal disorders over a period of time (Kuorinka, et al., 1987).

The fourth section is the visual analogue scale (VAS), a linear scale and it is designed to present to the respondent a rating scale with minimum constraints, respondents mark the location on the 100 millimetre line corresponding to the amount of pain they experienced (Myles, Troedel, Boquest, & Reeves, 1999). This gives them the greatest freedom to choose their pain's exact intensity. The visual analogue scale (VAS) correlates well with acute pain (Revill, Robinson, Rosen, & J, 1976) with an error of about $\pm 20\text{mm}$ (Campbell & Patterson, 1998). It also gives the maximum opportunity for each respondent to express a personal response style.

3.5.2. Reliability and validity of Instruments

Reliability is the ability of an assessment tool under the same conditions to give the same result when the same assessment tool is repeated (Bless & Higson-Smith, 2000), while validity is the capacity of the assessment tool to measure what it is intended to measure (Silverman, 2000). The content validity of the questionnaire on

practice habits and knowledge about injury prevention strategies was tested with a pilot survey and it was reviewed by a piano faculty member, the final survey was revised based on the feedback (Blackie, Stone, & Tiernan, 1999). The WHOQOL – BREF instrument has been test and retested by WHO in several studies with several population with internal consistency by Cronbach's alpha's for domains: physical (0.82), psychological (0.81), social (0.68) and environment (0.80) (Skevington, Lofty, & Connel, 2004).

Nordic Musculoskeletal Questionnaire (NMQ) has been tested and retested and it is a widely used questionnaire in determining the prevalence and distribution of work place musculoskeletal disorder (Dickinsona, Campiona, Fostera, Newmana, O'Rourkea, & Thomasa, 1992). Sensitivity and specificity has been found to be highly repeatable with kappa score that ranges from 0.63 – 0.90 (Palmer, Smith, Kellingray, & Cooper, 1999). The Visual Analogue scale's reliability in the measurement of pain is (Intraclass correlation Coefficient) 0.97, 90 % of pain ratings can be reproduced within 9 mm (Bijur, Silver, & Gallagher, 2001).

3.5.3 Procedure

Ethical clearance to conduct research was sought from the Senate Research Grants and Study Leave Committee at the University of the Western Cape. Also, permission was sought from the World Health Organization to use research instrument and permission to use WHOQOL – BREF was granted by the WHO. Permission was sought from the Director of the School of Performing Arts, to conduct the research within the premises and to approach the students and teachers to be participants. For students under the age of eighteen, informed consent was sought from their parents. The objectives and importance of study was then clearly explained to each of the participant one after the other and those willing to participate were

recruited. Freedom to withdraw, confidentiality of information and anonymity was also clearly explained, after which the participants were asked to sign an informed and written consent form. Data was collected using the questionnaires in English as soon as permission was granted by the Senate Research grants and study leave committee at the University of the Western Cape and the Director of the School of Performing Arts. Instruments were administered at the School of Performing Arts, UWC.

Music students learning or playing a musical instrument was identified by the Secretary, School of Performing Arts. The point of distribution and collection was via the Secretary, School of Performing Arts; the researcher carefully explained the details of how the questionnaires were to be filled in case any of the students have questions. Forty Eight (48) questionnaires were distributed by the secretary. Students and teachers were required to fill the questionnaires. Follow up was done in terms of calls and follow up visits at the Centre for the Performing Arts. Finally, twenty (20) questionnaires were returned yielding a response rate of 41.67 %. Data was collected and stored on a SPSS spreadsheet for analysis.

3.6. DESIGN OF THE GUIDELINES OF A WARM UP PROGRAM

This was done in three stages:

Phase I – Survey: Baseline data on the prevalence, distribution, severity of PRMDs, knowledge about injury prevention strategies and quality of life and was collected from music students and teachers at the School of Performing Arts. The instruments used are listed in 3.5.1 and the procedure of collection is explained in 3.5.3.

Phase II – Systematic Review: A systematic review of both local and international literature was done to inform the warm up program to be designed. This was done to determine the current injury prevention strategies with regards to warm up and

exercise being done by instrumentalists and this formed the basis of the Delphi study which seeks to determine the guideline and content of the injury prevention program.

Phase III – Delphi study: A Delphi Study, via e-mail was used to determine the guidelines of the warm up program.

Details of the procedure of stages II and III is discussed in Chapters 5 and 6 respectively.

3.7. DATA ANALYSIS

The Statistical Package for Social Sciences (SPSS) was used for descriptive and inferential statistics. The questionnaires were translated into statistical figures by strictly adhering to the rules and guidelines of the questionnaires. Using the WHOQOL –BREF, domain two where two participants were not calculated because two questions were not answered (WHO, 1996). A 100 mm ruler was used to measure the pain severity of participants on the Visual Analogue scale (VAS) to the nearest one decimal point in millimetre (mm).

Data was analysed using both descriptive and inferential statistics and alpha level was placed at 0.05. Descriptive statistics of mean and standard deviation of age, average practice hours per week, years of experience, pain and quality of life was analysed. Frequencies of gender, type of instrument played, educational level, practice habits – stretch before practice, stretch after practice, musical warm up and the application of heat was analysed. Also, the frequencies of the prevalence, distribution, symptoms of PRMDs and the awareness and knowledge of the participants about injury prevention strategies was analysed.

Associations between demographic data such as age, gender, and instrument played, years of experience and the prevalence of PRMDs was analysed. Associations between practice habits such as practice hours per week, practice habits (stretch before, stretch after practice and musical warm ups) and the prevalence of PRMDs was analysed. Associations between pain severity and quality of life; prevalence of PRMDs and quality of life was also analysed. Associations were analysed using the Chi square and p value was reported for Pearson Chi square or Fishers exact test. Alpha level is set at 0.05.

3.8. ETHICAL CONSIDERATION

Ethical clearance was sought and granted by the Senate Research grants and study leave committee at the University of the Western Cape. Written informed consent of the participants was requested which included explicit information on the objectives and aims of the research, their right to withdraw, anonymity and confidentiality of information. The results of this study will be made available to participant. Participants with injury were advised and referred to a Physiotherapy clinic or a Medical Doctor.

3.9. SUMMARY OF CHAPTER

In this chapter, the methodology of the first phase of the study was clearly outlined. This included the population and sampling, description of the instruments used, a brief outline of data analysis of the quantitative analysis was provided. The results of the first phase of the study are outlined in the next Chapter. The methodology and results of the 2nd and 3rd phase of this study is outlined in Chapters 5 and 6 respectively.

CHAPTER FOUR

RESULTS

4.1. INTRODUCTION TO CHAPTER

This chapter contains the statistical analysis results of the quantitative study that attempted to answer some of the objectives of this study. The chapter is organized such that it follows the listing of the objectives of the study. Each objective or hypothesis will be restated and the summary of the results will be stated.

The first phase of this study attempted to collect baseline data among musical instrumentalists – the prevalence, distribution, severity of PRMDs among this population and also their knowledge about injury prevention strategies. Below follows a brief exposition on the demographic characteristics of respondents, practice habit, prevalence, severity and distribution of PRMDs, the knowledge of instrumental musicians about injury prevention strategies and the associations between the demographics, practice habits and prevalence of PRMDs and health related quality of life.

4.2. DEMOGRAPHIC CHARACTERISTICS OF RESPONDENTS

The demographic characteristics of the study sample are summarized in Table 4.1, Figure 4.1 and 4.2. A total of twenty (20) questionnaires were returned out of the fifty questionnaires distributed. A total of twenty (20) questionnaires were analysed in this data given the response rate to be 40 %. Follow up was done on the non – respondents but the questionnaires were neither completed nor returned.

The majority (80%) of the participants were female. The age of the study sample ranged from 10 to 52 years ($X = 19.70$, $S.D = 12.36$). Half (50%) of the study

sample play a string instrument and the mean number of playing years is 5.75. Half (50%) of the study samples' highest education is primary school.

Table 4.1 Demographics characteristics of Instrumental musicians

	N	%	Minimum	Maximum	X	S.D
Age			10	52	19.70	12.36
Years of experience			0.5	43	5.75	10.29

4.3. PRACTICE HABITS OF RESPONDENTS

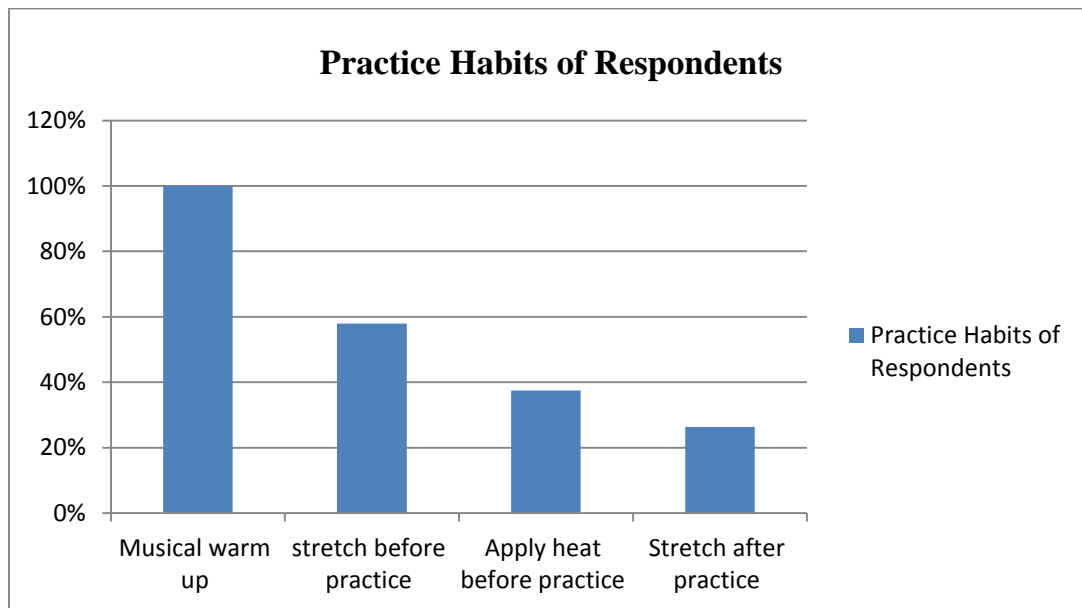
Participants were requested to report on their practice habits i.e. practice hours, stretching before and after practice, musical warm up, application of heat. The practice habit of respondents are summarised in Table 4.2 and Figure 4.1

Practice hours of respondents ranged from two (2) to fourteen (14) hours ($X = 16.08$, $S.D = 3.31$). Eleven (57.9%) of the respondents reported to stretch before they practice or play the musical instrument while eight (42.1 %) reported no stretching. All (100%) the respondents do perform musical warm ups.

Table 4.2: Practice Habits of Respondents

	Minimum	Maximum	Mean	S.D
Practice Hours/week	2.00	14.00	16.08	3.31

Figure 4.1: Practice Habits of Respondents

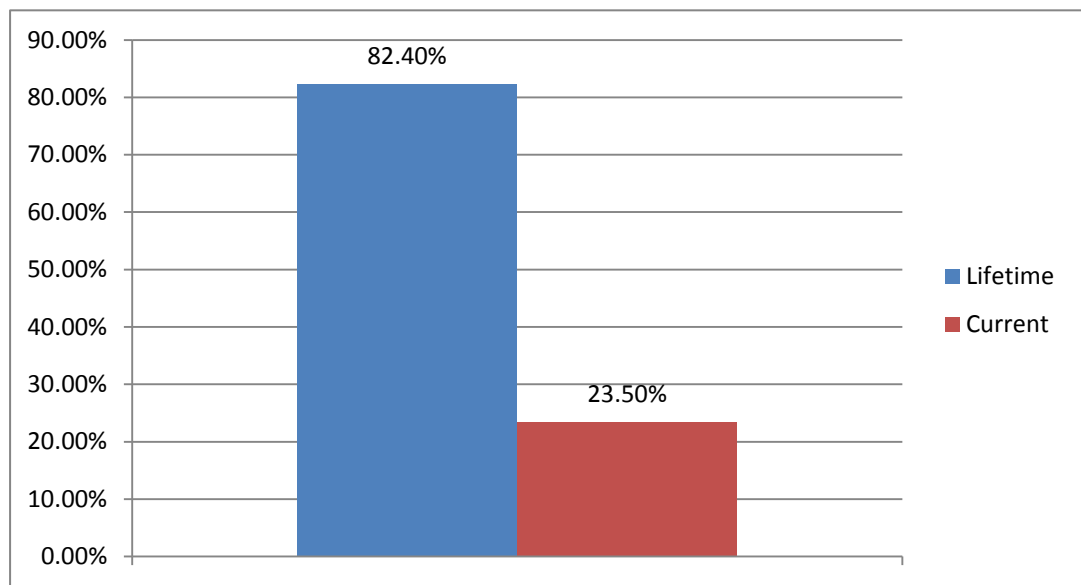


x – practice habits; y – percentage of participants

4.4. PREVALENCE OF PRMDs AMONG INSTRUMENTAL MUSICIANS

The Nordic Questionnaire was used to determine the musculoskeletal problems discomfort, aches and pain in the last 12 months. The respondents report the lifetime prevalence (over a period of 12 months) of PRMDs as 82.4 % and current prevalence (in the last seven days) as 23.5 %. All the males 100 % (4) have reported to have experienced PRMDs as against 76.2 % of females that reported experiencing PRMDs in their lifetime. The prevalence of PRMDs is summarised in Figures 4.2 and 4.3. The current and lifetime prevalence of PRMDs with respect to the instrument played is summarised in Figure 4.4

Figure 4.2: Percentage lifetime and current prevalence of PRMDs among Instrumental Musicians



x- prevalence of PRMDs; y – percentage of participants

Figure 4.3: Percentage prevalence of PRMDs with respect to gender

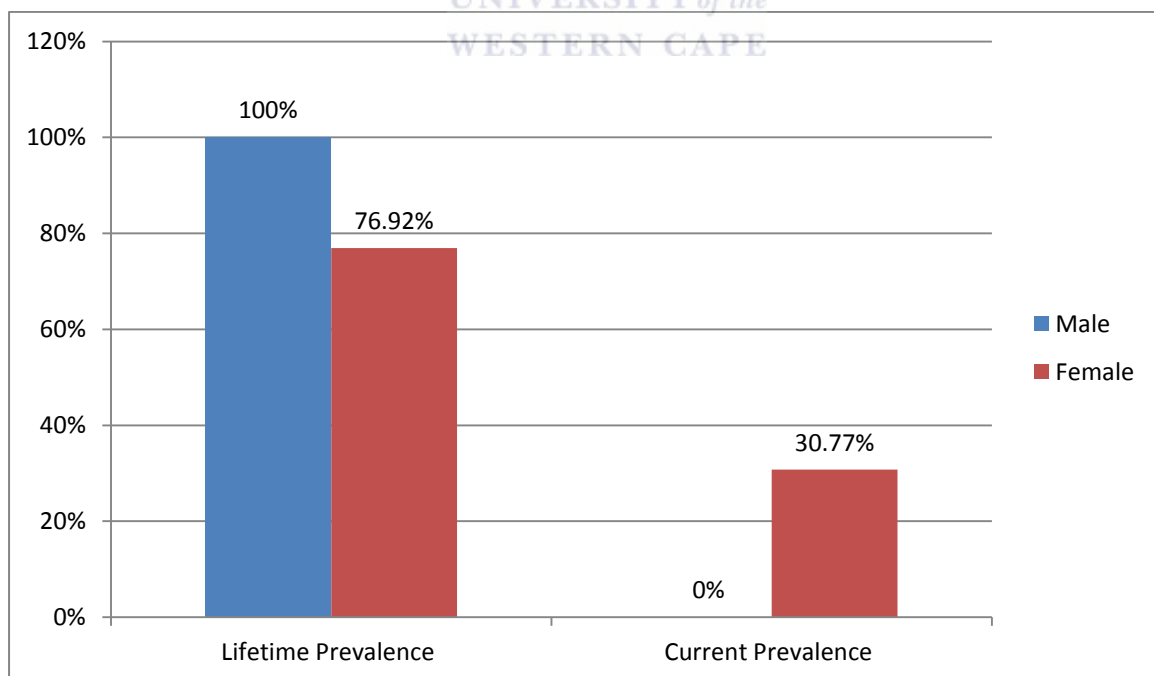
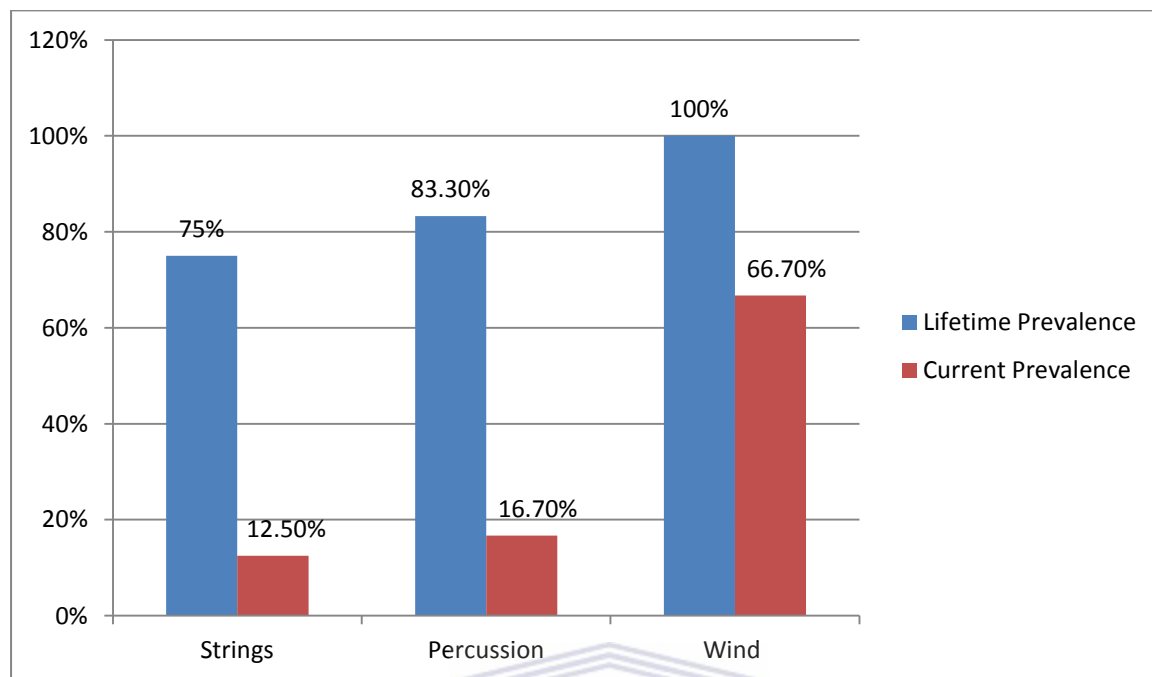


Figure 4.4: Percentage of prevalence of PRMDs with respect to Instrument played



4.5 DISTRIBUTION OF PRMDs

The distribution of PRMDs was described using the Nordic questionnaire and the shoulder was the most common site of ache, pain or discomfort (41.2%) followed by the neck and the wrists/hands (29.4 %). The lower extremity was the least affected with the knees being the most affected site in the lower limb (18.8 %) while the ankles were not affected. Both shoulders (17.6 %) and the left wrist (17.6 %) is the most reported site of ache/pain or discomfort. The distribution is described with a graph on Figure 4.5 and Figure 4.6

Figure 4.5: Percentage of distribution of PRMDS

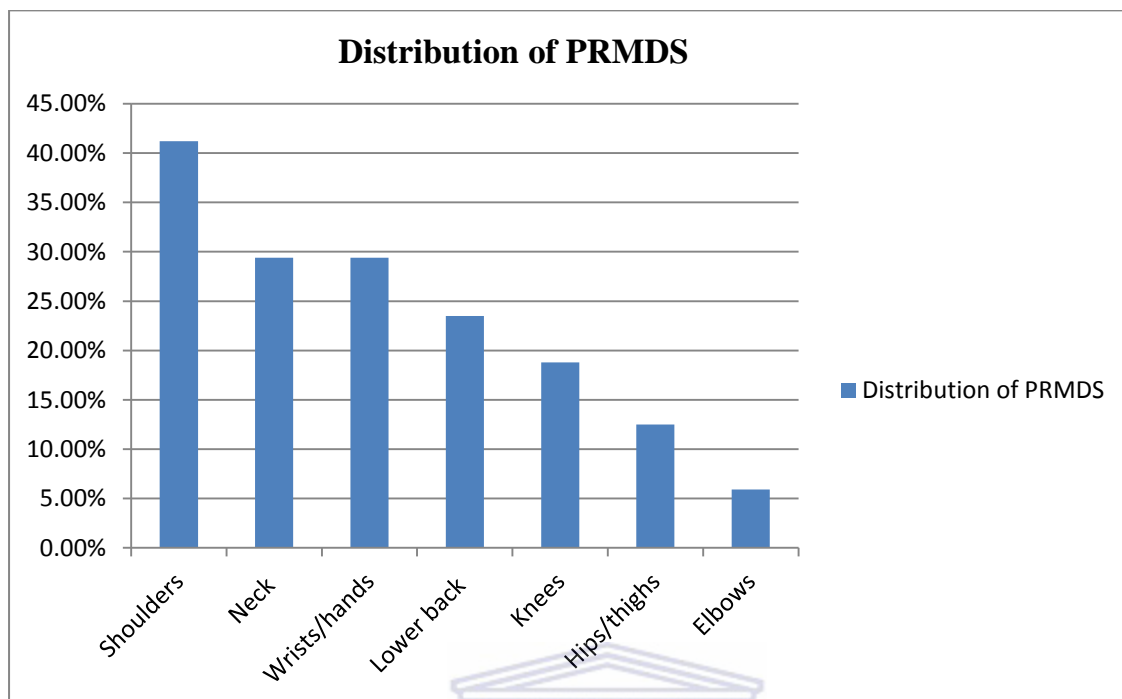
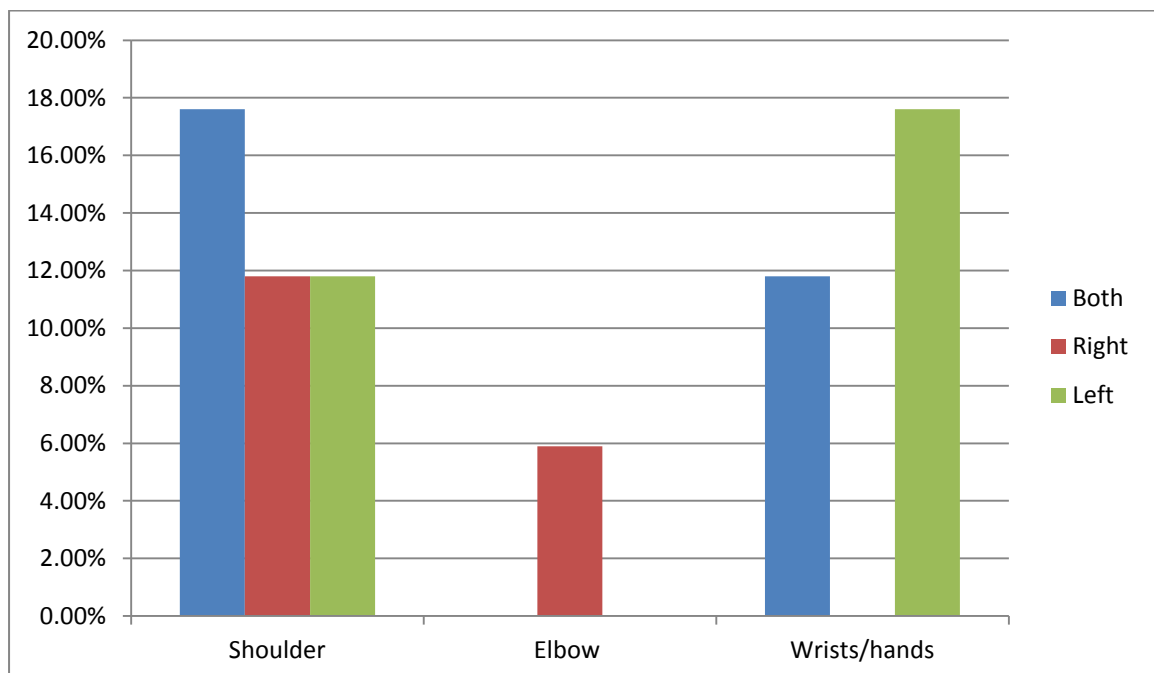


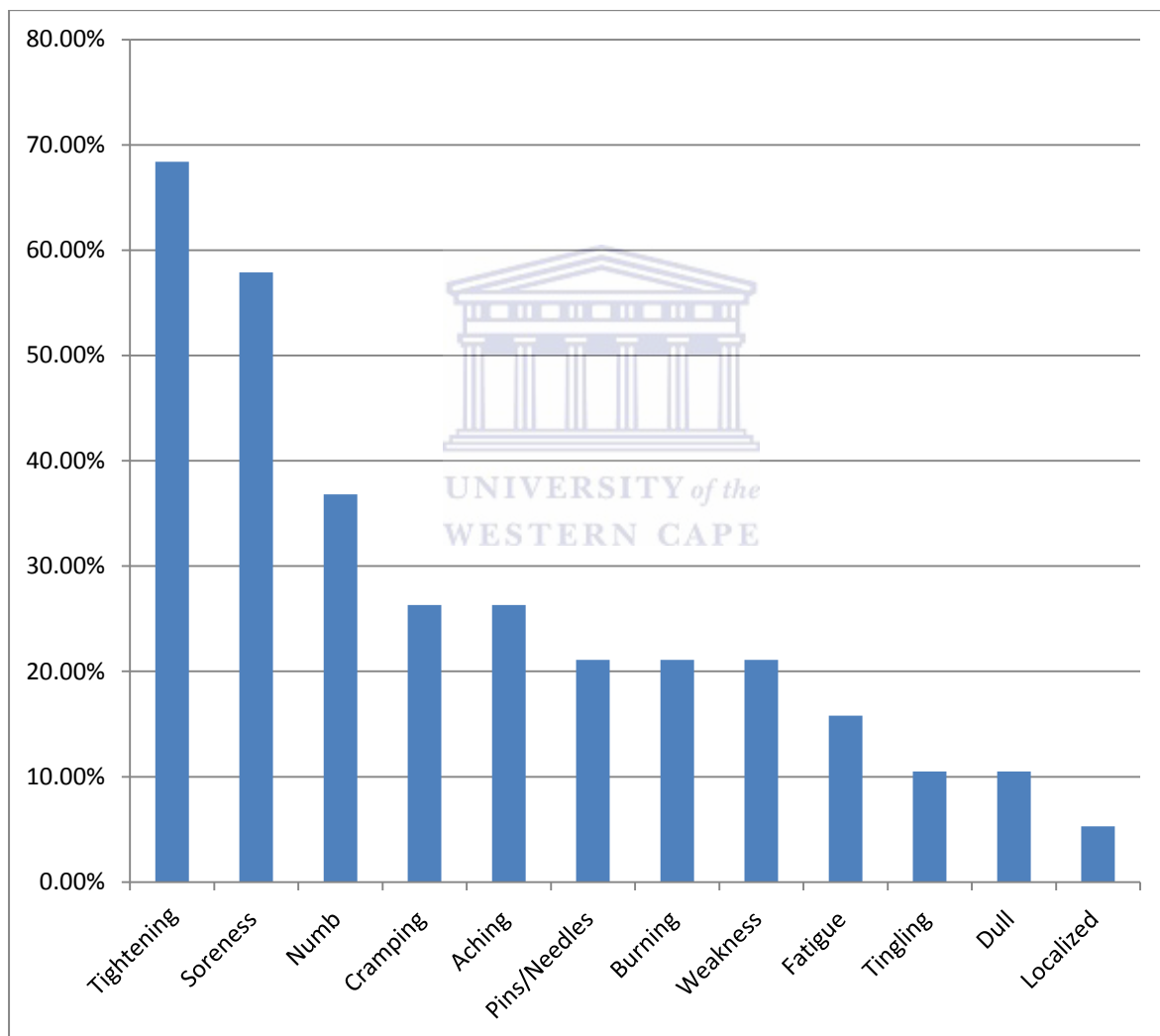
Figure 4.6: Percentage distribution of PRMDs in the Right and Left Upper Extremity



4.6. SYMPTOMS OF PRMDS

Participants were requested to describe the symptoms associated with their PRMDs. This is illustrated in Figure 4.9. Most of the participants described their symptoms as ‘tightening’ (68.4 %) followed by soreness (57.9 %) while the least described symptoms is ‘pain or discomfort is localized’ (5.3 %).

Figure 4.7: Symptoms of PRMDs by respondents



x- symptoms of PRMDs; y – percentage of participants

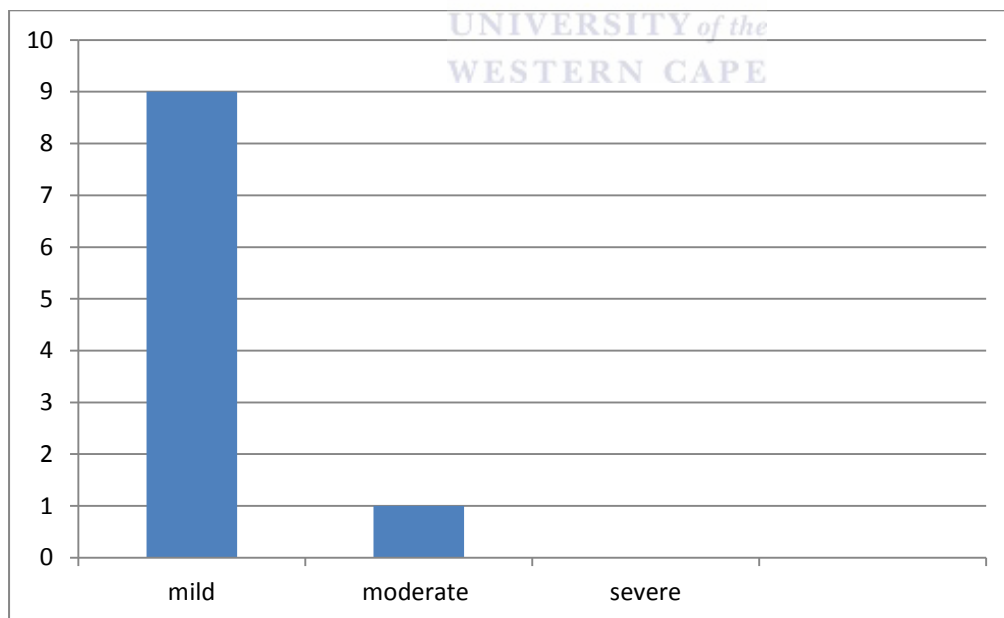
4.7. SEVERITY OF PRMDS

The Visual Analogue Scale was used to measure pain severity. The maximum score in mm was 39 mm while the lowest score was 0. The result is summarized in Table 4.3. Figure 4.10 outlines the result in mild, moderate and severe, going by the categorisation by Kelly (2001), mild is less than 30 mm, moderate 31 mm to 69 mm and severe is 70 mm and above.

Table 4.3: Severity of Pain using the Visual Analogue Scale

	(n)	Minimum	Maximum	Mean	SD
Pain severity	13	0.00	39	15.08	13.57

Figure 4.8 Frequency (n) of the severity pain



4.8. DURATION OF ONSET OF PRMDS

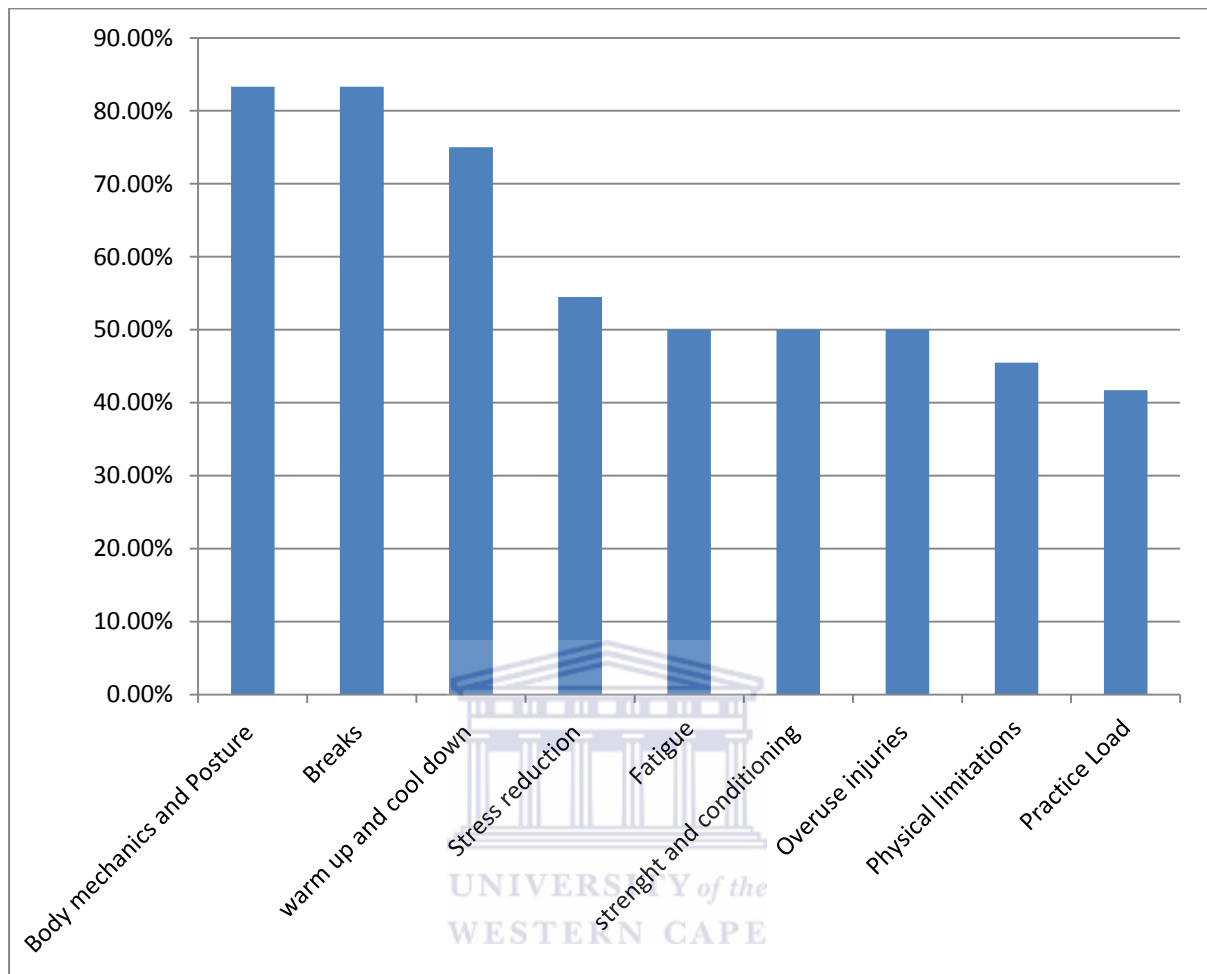
Participants were asked to give the duration of play or practice (in minutes) before the onset of the symptom of PRMDs. The minimum number of minutes played before the onset of symptoms is 10 minutes while the maximum is 120 minutes.

4.9. KNOWLEDGE OF RESPONDENTS ABOUT INJURY PREVENTION

Participants were asked about their awareness by injury prevention strategies which they have learnt over the years from any source. This is illustrated in Figure 4.10. Majority of the participants (83.3 %) are aware about proper body mechanics and posture and the importance of breaks and followed by awareness about the importance of warm up and cool down (75 %) while increasing practice load gradually is the least (41.7 %) injury prevention strategy the respondents are not aware of.



Figure 4.9: Knowledge about Injury Prevention Strategies



x- education topics on injury prevention; y-percentage of participants

4.10 ASSOCIATION BETWEEN DEMOGRAPHICS AND PREVALENCE OF PRMDS

The association between independent demographic variable such as age, gender, and instrument played, years of experience practice hours/ week and the dependent variable, prevalence of PRMDs was done using the Pearson Chi square and the associations were not significant with Alpha level is set at 0.05. The result is summarized in Table 4.4.

Table 4.4: Association between demographics and prevalence of PRMDS

	Prevalence of PRMDs	
	Lifetime	Current
Age	0.647	0.451
Gender	0.421	0.300
Instrument Played	0.624	0.150
Years of experience	0.167	0.782
Practice hours/week	0.385	0.587
Fishers exact test (1 sided)		

4.11. ASSOCIATION BETWEEN PRACTICE HABITS, SEVERITY AND PREVALENCE OF PRMDS

The association between practice habits such as stretch before and after practice, and the application of heat and severity and prevalence of PRMD, there is no significant difference between the independent and the dependent variables. The result is summarized in Table 4.5.

Table 4.5: Associations between practice habits, prevalence of PRMDS and

Pain severity

	Prevalence		Severity
	Lifetime	Current	
Stretch before practice	0.728	0.555	0.425
Stretch after practice	0.676	0.670	0.452
Apply heat before practice	0.185	0.659	0.213

Fishers exact (1 sided) – For lifetime and current prevalence of PRMDs

Pearson chi square (Asymp significant 2 – sided) for severity of PRMDs

4.12. PERCENTAGE SCORE AND RAW QUALITY OF LIFE SCORES OF PARTICIPANTS

Participants were asked about their quality of life using the WHOQOL-BREF which measures four domains: domain 1 – physical health, domain 2 – psychological, domain 3 – social relationships, domain 4 – environment. The scores are reported in the raw data and the transformed (percentage) form. This is illustrated in Table 4.6.

Table 4.6: Percentage and raw Quality of Life scores of participants

	Raw		Transformed	
	X	S.D	X	S.D
Physical Health	28.52	2.63	76.90	9.39
Psychological	24.63	3.04	79.90	9.69
Social Relationships	10.95	3.24	65.62	27.32
Environment	31.95	4.88	72.53	15.68

4.13 ASSOCIATION BETWEEN QUALITY OF LIFE AND PAIN SEVERITY AND PREVALENCE OF PRMDS

Inferential statistics of Pearson Chi square was used to determine the association of between the independent variables and the dependent variables. The association between quality of life and prevalence of PRMDs shows no significance ($p > 0.05$). The association between pain severity and quality of life shows no significance ($p > 0.05$). The association between age and quality of life shows no significance ($p > 0.05$). The result is outlined in Table 4.8.

Table 4.7: Associations between quality of life and PRMDs

	PRMDs	Pain severity	Age
Physical Health	0.171	0.161	0.692
Psychological	0.668	0.377	0.267
Social relationships	0.909	0.148	0.143
Environment	0.854	0.240	0.114

P –value is significant * < 0.05

4.14. SUMMARY OF CHAPTER

This objective of this study is to collect a baseline data on the prevalence, distribution and severity of PRMDs and also the knowledge of musicians about injury prevention strategies in a School of Performing Arts in the University of the Western Cape, in order to design a warm up exercise program in the prevention PRMDs among this population.

A significant percentage of the respondents investigated have a lifetime prevalence of PRMDs and the distribution of PRMDs is primarily in the upper extremity and the back. Also, a significant percentage of respondents have awareness about injury prevention strategies. Due to the high prevalence of PRMDs among musicians, an injury prevention strategy is pertinent in order to reduce or prevent the incidence.

The next chapter outlines the methodology and results of the 2nd phase of this study – the systematic review of literature on pattern of warm up and practice habits among instrumental musicians.

CHAPTER FIVE

SYSTEMATIC REVIEW OF LITERATURE

5.1. INTRODUCTION TO CHAPTER

This chapter outlines the need, systematic methodology and results of a systematic review conducted in order to determine the pattern of warm up and practice habits of instrumental musicians. The systematic review is the second part of a three stage project which seeks to design a warm up program in the prevention of PRMDs among instrumental musicians.

5.2. OVERVIEW ON PRACTICE HABITS AND PATTERN OF WARM UP

Several studies have sought to identify the various risk factors associated with the experience of PRMDs among instrumental musicians but evidence on the influence of exercise, warm up and stretch prior to playing the instrument in the development of PRMD is inconclusive (Kaufman-Cohen & Ratzon, 2011; Brandfonbrener, 1997).

The influence of age, gender, instruments played, playing positions and techniques have all to a large degree been associated with PRMDs and several recommendations on how to reduce these effects on PRMDs have been suggested and implemented. Physical warm up or exercise in the musician is hardly practised when compared to the regular adherence by musicians to musical warm up therefore, the need to review literature on the practices of musicians with regards to physical warm up and its effect on PRMDs is important (Kaufman-Cohen & Ratzon, 2011; Guptill & Zaza, 2010; Allsop & Ackland, 2010).

A systematic review by Herbert & Gabriel (2002), to determine the effects of stretching prior to and after exercise on the risk of developing muscle soreness was found to have no significant reduction on the incidence of musculoskeletal injury. Meanwhile recent research in football has shown the effects of structured warm up programme has a significant effect in the reduction of musculoskeletal injury among footballers. (Soligard, Nilstad, Steffen, Myklebust, & Holme, 2010; Soligard, et al., 2008). This suggests that structured warm up or an exercise programme in relation to the physical activity instead of the general stretch and warm up could reduce the risk of musculoskeletal injury.

Musicians are prone to musculoskeletal injury as result of their 'work'. (Abréu-Ramos & Micheo, 2007; Zaza, 1998). Risk factors associated with PRMDs among instrumentalists are intrinsic and extrinsic factors such as gender, age, playing position, techniques, warm ups have all been associated with the incidence of PRMDs (Kaufman-Cohen & Ratzon, 2011; Bragge, Bialocerkowski, & McMeeken, 2006).

No systematic review has been done to clearly identify the role, pattern and practice of warm ups, stretch or exercise prior to playing as playing a significant role in the development of PRMDs among instrumental musicians. It is therefore important to systematically review existing literature on the role physical warm ups and exercise have in the development of PRMDs among instrumental musicians.

5.3. AIMS AND OBJECTIVE

The main objective of this systematic review is to identify physical warm up routine and practice habits among musicians or instrumentalists and the role of warm up as a risk factor in playing related musculoskeletal disorder.

5.4. RESEARCH QUESTION

What is the pattern, practice and role of warm up practised among instrumental musicians?

5.5. SELECTION CRITERIA

The population must be instrumentalists with an intervention that clearly focuses on the prevalence of PRMDs and practice habits of instrumentalists. The role of the practice habits in the prevention of PRMDs should also be an integral part of the selection criteria. The above criteria is done in accordance to the stepwise process designed by the University of Mcaster used evidence based medicine which is known as 'PICO'. Also, the articles must fulfil the inclusion criteria highlighted below:

- Article must be peer reviewed academic research study
- Article was published in English Language.
- Article is cross-sectional, longitudinal or intervention study.

5.6. STUDY SELECTION

The studies for review are cross sectional, cohort and intervention studies, using human participants and should be among musicians. The studies should clearly identify, warm up or exercise as a risk factor influencing the experience of PRMDs among instrumental musicians. Articles must be peer reviewed and must be written in English. Outcome measures are warm up or exercise or stretch and PRMDs.

Thirteen databases and one art journal were searched from the inception of the database till date. The databases searched are: MEDLINE, Scopus, SAGE online, Academic premier, Sport discuss, Google scholar, science direct, CINAHL, Rehabilitation and sport, health and academic nursing. The hand searched journal is the journal for the medical problems of the performing arts.

Keywords used for the search are: “warm up”, exercise, musculoskeletal and musicians. The Boolean search methods using “OR” and “AND” was employed in this manner “Warm up” OR exercise AND musculoskeletal AND musician.

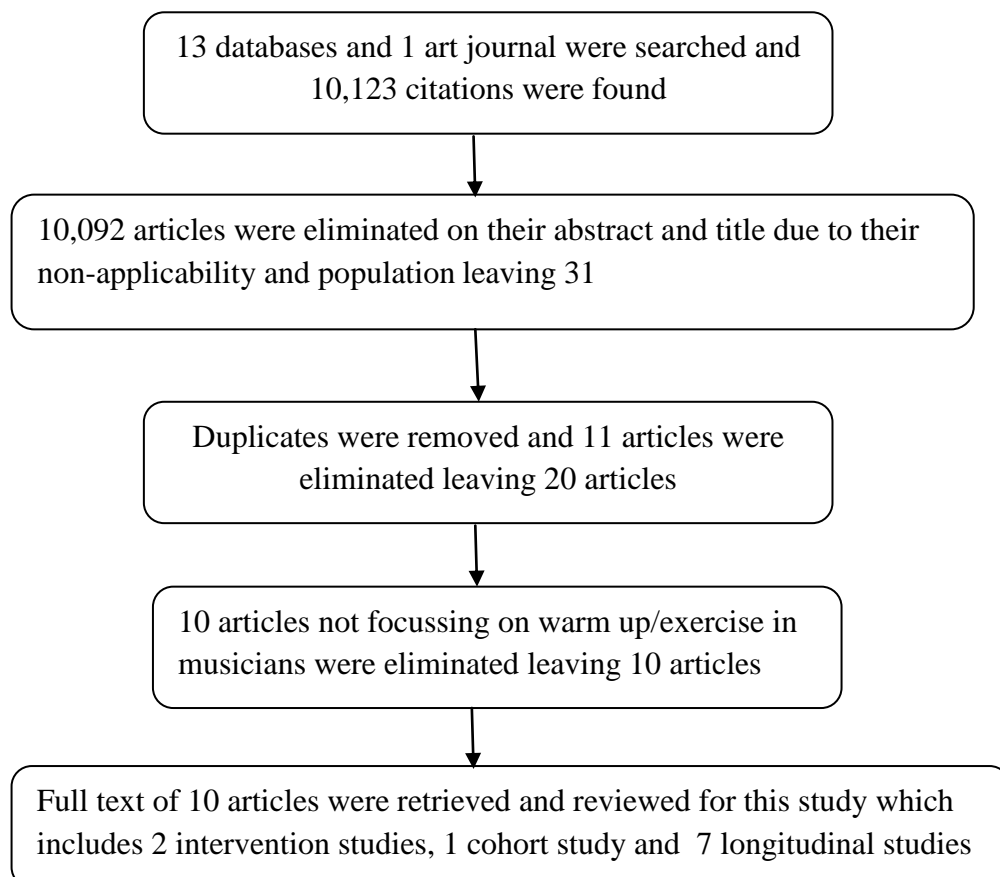


Table 5.1: Database searched

Database type	Database name	Citations
Medical	Medline	1293
	CINAHL	813
	Sportdiscus	4515
	Academic premier	865
	Health source: nursing & academic	218
	Rehabilitation & Sports	308
Others	Psych - articles	74
	Google scholar	1330
	SAGE online	26
	Science direct	267
	Scopus	25
Journals	ERIC	353
	Medical problem of performing arts	36
Total		10, 123

A total of 10, 123 articles were reviewed based on the title and abstract, 10, 092 articles were excluded due to the population which is not specific to musicians and its non applicability to playing related musculoskeletal disorder, injury prevention utilising warm up and exercise therefore leaving 31 articles. Duplicates were removed from the 31 articles remaining which reduced the number to 20. Full text of twenty articles was reviewed by two independent reviewers for their eligibility in the study. The eligible articles are those that meet the inclusion criteria which are: the primary or secondary aim of the study is to determine the “physical warm up” or exercise or stretch as a risk factor in experiencing PRMD and the population must be instrumental musicians. The study must utilise an appropriate methodology to gather information and relevant statistical analysis in determining the correlation and association of warm up or exercise or stretch in the experience of PRMDs among instrumental musicians.

Figure 5.1: Summary of outcome of all retrieved papers



5.6.1. Hierarchy of Evidence

The validity of a research varies based on the method used in data acquisition and analysis. Several other important factors are considered in determining the hierarchies in current research, effectiveness which is whether the intervention works as intended, acceptability of the intervention on the population, also a third factor is the feasibility of implementation of the intervention with respect to the population. (Evans, 2003). Therefore, the hierarchy was developed in order to incorporate the feasibility and acceptability of the research evidence just as important as the effectiveness of the intervention in order to ensure proper and success at implementation of the research especially in the healthcare industry (Evans, 2003).

Systematic reviews of randomised control trial are the best evidence for the effectiveness of an intervention due to the diversity of evidence from various population and settings thereby minimizing the risk of error or bias and also ensuring generalizing of the effectiveness of intervention. Single randomised controlled trials also provide good evidence and due to the methodology, the risk of error and bias is reduced but it is ranked lower than the systematic review because of its peculiarity to a single population, idiosyncrasies such as study site and the staffs of such population can have an impact on the results of the intervention.

Internal and external validity of RCT when compared to observational study is different and this difference is highly important in evidence base practice. Internal validity which measures the comparisons in the outcomes between groups can be easily associated with the intervention whereas external validity is refers to generalizability of the result of a study in a wider population (Elwood, 1998).

RCTs have a high internal validity due to the randomisation process and strict inclusion and exclusion criteria but the external validity is low due to the narrowness of the population which does not really reflect the general population. (Evans, 2003). Whereas, observational studies have a lower internal validity because its hard to solely attribute a differences between groups to an intervention due to its lack of randomisation and broad inclusion criteria. Since, observational studies reflect the real population its external validity is high (Evans, 2003). However, comparisons of randomized controlled trials and observational studies have shown that the results of RCTs are similar to the findings in observational studies (Benson & Hartz, 2000; Concato, Shah, & Horwitz, 2000).



Figure 5.2: Hierarchy of evidence: ranking of research evidence evaluating health care interventions (Evans, 2003)

	Effectiveness	Appropriateness	Feasibility
Excellent	Systematic reviews Multi centre studies	Systematic reviews Multi centre studies	Systematic reviews Multi centre studies
Good	RCT Observational study	RCT Observational study Interpretive study	RCT Observational study
Fair	Uncontrolled trials Before and after studies Non-randomized control trials	Descriptive studies Focus groups	Descriptive studies Before and after studies Focus groups
Poor	Descriptive studies Case studies Expert opinions	Expert opinions Case studies	Expert opinions Case studies

Therefore, with respect to internal and external validity of observational studies and RCTs that both have their own role in the evaluating evidence (Evans, 2003). The differences in population, preferences, mode of intervention and population and study site characteristics may be responsible for the disparity in findings, a synthesis of evidence can complement each other's strength and weakness (McKee, Britton, McPherson, Black, Sanderson, & Bain, 1999).

The selected articles is hereby arranged in the hierarchy of evidence with the two RCT at the top followed by the cohort study and then by the cross sectional studies.

5.6.2. Methodological Quality Assessment

All eligible articles were subject to methodological quality assessment using the critical review form for quantitative studies for the cross sectional studies and RCTs (Law, Stewart, Pollock, Letts, Bosch, & Westmorland, 1998) and critical appraisal skill programme assessment for cohort studies (CASP, 2004). The articles were reviewed by two independent reviewers for methodological quality assessment.

Critical review form for quantitative studies is used to rigorously assess the randomised controlled trial, this is a 15 item tool which assess methodological rigor and bias within a study using yes, no and not addressed (Law, Stewart, Pollock, Letts, Bosch, & Westmorland, 1998). Selection bias, follow up and measurement bias which are important aspects of an intervention study is rigorously assessed in this appraisal tool (National Health and Medical Research Council, 2000). Scores of 1 for yes, 0 for no and not addressed were arbitrarily assigned. Overall rating score is expressed as a total of 15 with scores of 10 – 15 considered as good quality while 7 – 10 is

considered as of reasonable quality while scores below 7 is considered as poor quality.

The critical appraisal skills programme quality assessment for cohort studies and this is a 12 item critical review with questions answered in “yes”, “no” or can’t tell (CASP, 2004). Scores of 2 for “yes”, 1 for “can’t tell” and 0 for “no” were arbitrarily assigned. Overall rating score is expressed over 24 with scores 20 – 25 as good quality, 15 – 20 as reasonable quality and <15 is considered to be of poor quality. The quality scores are presented in Tables 5.3, 5.4 and 5.5 for RCTs, cross sectional studies and the cohort study respectively.



Table 5.3: Methodological score for Randomised Controlled Trials

Reference	Hierarchy	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Score
Greef, Van Wijck, Reynders, Toussaint, & Hesselning (2003)	RCT	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	13/15
Brandfonbrener (1997)	RCT	1	1	1	0	1	1	1	1	0	0	1	1	1	1	1	12/15
Buckley & Manchester (2006)	Cohort	2	2	2	2	2	2	2	2	2	2	1	2	2			23/24
Kaufman-Cohen & Ratzon (2011)	Cross sectional	1	1	1	0	0	1	0	1	1	1	1	1	1	1	1	12/15
Yoshimura, Fjellman-Wiklund, Paul, Aerts, & Chesky (2008)	Cross sectional	1	1	1	1	1	1	0	1	0	1	0	1	1	0	0	10/15
Abr��u-Ramos & Micheo (2007)	Cross sectional	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	14/15
Davies & Manginon (2002)	Cross sectional	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	14/15
Redmond & Tiernan (2001)	Cross	1	1	1	0	1	1	0	0	0	1	1	1	1	1	1	11/15
Yeung, et al., (1999)	Cross	1	1	1	0	1	1	0	1	1	1	1	1	1	0	1	12/15
Blackie, Stone, & Tiernan (1999)	Cross	1	1	1	1	1	1	0	1	1	0	1	1	1	1	1	13/15

5.6.3. Data Extraction

Data was extracted on demographics (age, gender, and response rate), sample population, prevalence and distribution of PRMDs, warm up exercise practices and statistical test to establish the role of warm up exercise among musicians. Table 5.6 shows the information extracted from the 10 articles on study design, population, age, gender and the prevalence, incidence and distribution of PRMDs. Table 5.7 shows extracted information on the practice and pattern of warm up exercise practised and taught by musicians and statistical significance of the influence of warm up exercises on the prevalence of PRMDs.



Table 5.6: Study design, population, prevalence and incidence rates

Reference	Population	Demographics	PRMDs	Quality
Greef, Van Wijck, Reynders, Toussaint, & Hesseling (2003)	Orchestra	Experimental (Mean age: 46.5 yrs) (Male - 11, Female - 11) Control (Mean age: 46 yrs) (M 21, F 7) Response Rate: 63 %	Not reported	13/15
Brandfonbrener (1997)	Orchestra	Age and gender was not reported. Experimental (177 participants) Control (138 participants) Response rate: 40.8 %	Experimental (67.44 %) Control (53.62 %) Distribution was not reported.	12/15
Buckley & Manchester (2006)	Non – recreational Instrumentalists	Age (10 – 87 years) Male - 45 Female – 66 Response rate – 68 %	Lifetime – 54 % Point – 21 % Neck, shoulder, elbow, Foream, wrist, hand & fingers	23/24
Abréu-Ramos & Micheo (2007)	Orchestra	Mean age – 37.9 years Male – 75.7% Female – 24.3 % Total no of participants – 75 Response rate – 90.4 %	81.3 % (Back, neck, upper extremity, shoulder)	14/15
Davies & Manginon (2002)	Professional Instrumentalists	Age (18 – 72 yrs) Male 135 Female 105 Response rate – 45 %	50 % Distribution was not reported	14/15
Blackie, Stone, & Tiernan (1999)	Piano students	Age was not reported Male – 4 Female – 12 Response rate – 64 %	93 % Hands, wrists and back	13/15
Kaufman-Cohen & Ratzon (2011)	Classical Musicians	Age (26 – 66 yrs) Male – 49 % Female – 51 %	83 % (shoulder, back and neck)	12/15

Table 5.6 (continued)

Reference	Population	Demographics	PRMDs	Quality
Yeung, et al. (1999)	Orchestra	Mean age (with PRMD - 26.32 yrs; Without PRMD – 33.14 yrs) Male – 30, Female – 9 Response rate – 23 %	64.1 % Most common areas: Shoulder/upper arm (52%) Neck (32 %).	12/15
Redmond & Tiernan (2001)	Piano teachers	Age (23 – 69 yrs) Male 1 Female 41 Response rate – 28 %	not reported	11/15
Yoshimura, Fjellman-Wiklund, Paul, Aerts, & Chesky (2008)	Piano teachers	Age (15 – 75 yrs) Male 17 %, Female 83 % Response rate – 63 %	90 % Distribution was not reported.	10/15

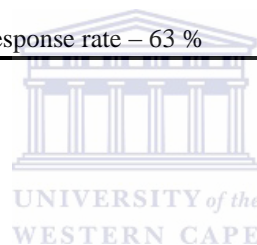


Table 5.7: Pattern and type of warm up exercise

Reference	Hierarchy	Warm up/Exercise	Statistical Tests	Results
Greef, Van Wijck, Reynders, Toussaint, & Hesseling (2003)	RCT	General warm up Specialised exercises Focussed on special Movements while playing	MANOVA	Increase in perceived physical competence and a decrease in PRMD ($r^2=0.44$)
Brandfonbrener(1997)	RCT	Education on human body Postures. Strengthening & Flexibility exercises, Warm up and cool down	Descriptive statistics	No significant difference in the incidence of PRMD between the control and Experimental groups.
Buckley & Manchester (2006)	Cohort	Warm up activities include, stretching of shoulders, neck, arms, hand and fingers.	Descriptive	No significant difference between injured and Non-injured groups
Abreu-Ramos & Micheo (2007)	Cross sectional	Warm up routine, cool down Stretching to alleviate symptoms	Descriptive	90.3 %, 93.3 %, 100 % 90.9 % and 100 % of Viola, cello, brass, Woodwinds & Percussion respectively

Table 5.7: Pattern and type of warm up exercise (Continued)

Reference	Hierarchy	Warm up/Exercise	Statistical Tests	Results
Davies & Manginon (2002)	Cross sectional	Warm up/breaks	Univariate analysis	Ergonomic problems, Warm up/breaks & noise were significant in isolation but were no longer significant when measured with stronger influences.
Blackie, Stone, & Tiernan (1999)	Cross sectional stretching	Education on warm up, cool down	Descriptive	25%, 37.5 % taught Strenghtening and warmup, strenght& conditioning. 20%, 27% &40 % use stretching Strengthening & Warm up.
Kaufman-Cohen & Ratzon (2011)	Cross sectional	Warm up exercises prior to playing	Correlation analysis	Warm up is significant (p <0.01)
Yeung, et al.(1999)	Survey	Warm up and regular exercises	Student t-test & Chi square	regular exercise is a significant predictor of PRMD (p<0.05).



Table 5.7: Pattern and type of warm up exercise (Continued)

Reference	Hierarchy	Warm up/Exercise	Statistical Tests	Results
Redmond & Tiernan (2001)	Cross sectional	Education on warm up, strenghtning, specific stretching and flexibility exercises.	Descriptive	Participants with more experience are more likely to teach Stretching exercises.
Yoshimura, Fjellman-Wiklund, Paul, Aerts, & Chesky (2008)	Cross sectional	Physical warm up is considered as stretching	Correlation analysis	Warm up habit is positively correlated with pain



5.7. RESULTS

A total of 10, 123 citations were extracted from the 13 databases, journals and websites. 10, 092 articles were excluded due to their non – applicability to the population described, the population was not specific to musicians. Duplicates were removed leaving a total of 20 articles and ten were further excluded from the study because they did not meet all the inclusion criteria, the primary or secondary outcome measures were not focussed on warm up or exercise as a risk factor in PRMDs. Ten articles were eligible for this review which includes two intervention studies, one cohort study and seven cross sectional studies. Quality assessment of the ten eligible articles was done using standardised critical review tools and it is described in Tables 4, 5 and 6. All the eligible articles were selected for review because they all meet the quality assessment cut off score of >7 for RCTs and cross sectional study and > 15 for cohort study.

The age range of participants in the eligible articles ranges from 10 years to 87 years (Buckley & Manchester, 2006). One article did not report gender ratio (Brandfonbrener, 1997). Meanwhile five of the remaining nine articles reported more participation from females than males (Kaufman-Cohen & Ratzon, 2011; Yoshimura, Fjellman-Wiklund, Paul, Aerts, & Chesky, 2008; Buckley & Manchester, 2006; Redmond & Tiernan, 2001; Blackie, Stone, & Tiernan, 1999) while the other four reported more participation from males than females (Abréu-Ramos & Micheo, 2007; Greef, Van Wijck, Reynders, Toussaint, & Hesselings, 2003; Davies & Manginon, 2002; Yeung, et al., 1999).

The population of participants in the ten studies cuts across piano students and teachers to orchestras, professional musicians, classical musicians and non – recreational instrumentalists. The response rate of participants in the studies is as low

as 23 % (Yeung, et al., 1999) and as high as 90.4 % (Abréu-Ramos & Micheo, 2007). 4/5 of the total articles recorded a response rate of at least 40 %.

There is a wide range of prevalence of PRMDs which ranges from 50 % (Davies & Manginon, 2002) to 93 % (Blackie, Stone, & Tiernan, 1999). Two articles did not report the prevalence of PRMDs in their population (Greef, Van Wijck, Reynders, Toussaint, & Hesselning, 2003; Redmond & Tiernan, 2001) as shown in Table 5.6. Five articles reported the distribution of the symptoms of PRMDs and the distribution is limited to the upper extremities, neck and back (Kaufman-Cohen & Ratzon, 2011; Abréu-Ramos & Micheo, 2007; Buckley & Manchester, 2006; Blackie, Stone, & Tiernan, 1999; Yeung, et al., 1999).

Table 5.7 summarises the pattern, practice and education of warm up exercises employed in injury prevention. Education on the injury prevention strategy utilising warm up exercises, strengthening and conditioning, human body movements was measured in four articles (Greef, Van Wijck, Reynders, Toussaint, & Hesselning, 2003; Redmond & Tiernan, 2001; Blackie, Stone, & Tiernan, 1999; Brandfonbrener, 1997). The practice of warm up before playing was measured in six articles (Kaufman-Cohen & Ratzon, 2011; Yoshimura, Fjellman-Wiklund, Paul, Aerts, & Chesky, 2008; Abréu-Ramos & Micheo, 2007; Buckley & Manchester, 2006; Davies & Manginon, 2002) and the two RCTs also measured the practice of warm up after education (Greef, Van Wijck, Reynders, Toussaint, & Hesselning, 2003; Brandfonbrener, 1997). Six of the ten articles reported statistical significance reporting the p-value while the other three articles described the results the percentages. One article described the statistical significance without reporting the p-value (Brandfonbrener, 1997).

5.8. CONCLUSION

The results of the systematic review shows the high prevalence of PRMDs with a minimum reported of 50 % (Davies & Manginon, 2002), which is synonymous to the results of an earlier systematic review conducted (Zaza, 1998). The distribution of the complaints of PRMDs among this group of people is common in the upper extremities, back and neck are the most usually site of discomfort in instrumental musicians and this could be due to the work pattern and type of instrument played (Kaufman-Cohen & Ratzon, 2011; Abréu-Ramos & Micheo, 2007; Buckley & Manchester, 2006; Blackie, Stone, & Tiernan, 1999; Yeung, et al., 1999). Also, there is a lack of operational definition of warm up among instrumentalists thereby making it difficult to distinguish between musical warm up and physical warm up. These gray areas of warm up thereby informed the content of the Delphi study which seeks to design the guideline in creating a standard warm up protocol.

Further result of the findings of the systematic review is discussed in synthesis with the result of the survey and Delphi study in Chapter Seven with the results of the first and second stage of the research.

5.9. SUMMARY OF CHAPTER

This chapter explained and outlined in details the procedure used in conducting a systematic review. The result of the systematic review is also outlined in this chapter. The process and results of the Delphi study which is the third stage of the study to design a warm up programme is discussed in the next chapter, Chapter 6. The result of the three stages of study is discussed in chapter 7.

CHAPTER SIX

DELPHI STUDY

6.1. INTRODUCTION TO CHAPTER

This chapter outlines the procedure used in exploring the content of the warm up programme for instrumental musicians. It outlines the stepwise results of the rounds conducted before consensus was reached.

6.2. INTRODUCTION

The role of warm up or physical exercise in the prevention of PRMDs among instrumental musicians has been identified over the years (Kaufman-Cohen & Ratzon, 2011; Davies & Manginon, 2002). However, its role could not be ascertained due to the non – standardised practice and pattern of the warm up exercise and physical exercise. Stretching is usually considered as a physical warm up whereas the mode and type of stretching is not specified (Buckley & Manchester, 2006). The role of a standardised exercise programme in the reduction of physical exertion while playing a musical instrument was found to reduce the incidence of PRMDs among an orchestra group (Greef, Van Wijck, Reynders, Toussaint, & Hesselings, 2003). Therefore, a well planned and standardised warm up exercise programme could reduce the incidence of PRMDs among instrumental musicians.

The overall aim of this is to design a warm up program as an injury prevention strategy to prevent the PRMDs among instrumental musicians. In order to design a the warm up programme, a delphi study which is the “systematic solicitation and collation of judgments on a particular topic through a set of carefully designed sequential questionnaires interspersed with summarized information and feedback of

opinions derived from earlier responses” (Delbecq, Van de Ven, & Gustafson, 1975, p. 10), is required. Opinions of experts in the field of performing arts medicine are required in order to standardise the content of the warm up as an injury prevention programme.

The origins of Delphi study dates as far back as the 1950’s. It was developed by RAND Corporation for a US sponsored military project by Dalkey and Helmer (1963). There are four basic features of a Delphi study, anonymity of participants which allows the participants to express their views without undue pressure to conform with ideas from the group, iteration which allows participants to refine their views in view of the progress of the results, controlled feedback which informs every participants of the other participants view and statistical aggregation of group response (Rowe & Wright, 1999). The Delphi process as discussed by Skulmoski, Hartmann, & Krahn, (2007), in a three round delphi process involves, develop the research question, design the research, research sample, develop delphi round one questionnaire, delphi pilot study, analyse round one result, develop round two questionnaire, release and analyse round two questionnaire, develop round three questionnaire, release and analyse round three questionnaire, verify and generalize research results.

The focus of this study is to design a warm up programme as an injury prevention strategy in the prevention of PRMDs among instrumental musicians, and the scope of this study is just to design and not verify and generalize the research results.

6.3. METHODS

This Delphi study was conducted in three phases. The first phase was to determine the content of the warm up programme using an online survey. The Delphi

study was used to obtain an informed consensus from a group of experts in the performing arts medicine selected across the world from the PAMA directory.

6.3.1. Participants

Participants were experts with experience in the field of research and managing injuries of the performing artists. They were purposively selected to be members of the panel via the PAMA member directory. Written informed consent was obtained from each of them. The criteria for selection into the Delphi study were researchers and clinicians involved in the performing arts medicine anywhere in the world. Participants were sent an e-mail requesting their consent to participate in the Delphi study. Twenty (20) experts in the field of performing arts medicine were invited for this study. These included medical doctors, physiotherapists, an occupational therapist, an exercise physiologist and professional musicians; all were either involved in performing arts medicine research or treatment of the performing artists. Fourteen (14), 70 % responded, to the request, of these, six (6) gave various reasons for not being able to participate in the study. These reasons were mostly time constraints. However, eight (8) of the experts agreed to participate in the study. Although, eight (8) experts agreed to participate in the Delphi study, only seven (7) responded with their details regarding occupation, areas of speciality and years of experience. Anonymity of the participants was ensured. The details of these experts are summarised in table 6.1. The mean number of years practice experience in the performing arts medicine was 9.14 years (3 – 12 years). 85.71 %, six (6) of the participants are involved in the treatment and research in the performing arts medicine while 14.2 %, one (1) of the participant is a freelance musician. This includes three (3) medical doctors, two (2) physical therapists and one (1) occupational therapist. Table 6.1 illustrates the characteristics of the selected participants.

Table 6.1 Characteristics of Panel of Experts

S/N	Years of Experience	Occupation	Speciality	Focus in Performing Arts
1	11 years	Occupational Therapist	Occupational Therapist	Musicians' injuries, upper extremity, occupational health
2	6 years	Medical Doctor	Sports Medicine, performing arts medicine, physical medicine and rehabilitation	Dance Injury Prevention
3	10 years	Freelance Musician	Bassoon and Chamber music	Research health of wind instrumentalists
4	10 years	Physical therapist	Performing arts medicine	Musculoskeletal Injury of Instrumentalists
5	12 years	Medical Doctor	Consultant Rheumatologist	Musculoskeletal problems
6	12 years	Medical Doctor	Orthopaedic Surgery	Dance (Ballet)
7	3 years	Physical Therapist	Physical therapist/ Hand therapist	Stress management and health promotion

6.3. 2. Instruments

A self administered questionnaire was designed based on the results of the systematic review on practice habits of instrumental musicians. The questionnaire was reviewed by two independent researchers for face and content validity which led to minor changes being made. The questionnaire is a nine (9) question questionnaire with the first question determining to know the years of experience and primary occupation and specialty. The remaining questions broods on the content of the warm up programme: type of exercise, duration, area of body to be “warmed up”, inclusion of musical warm up in the programme and education on injury prevention strategies.

Table 6.2 outlines the questions included in the questionnaire

Table 6.2: Content of the survey questionnaire

Item	Description
1	What is your occupation, area of speciality and years of experience?
2	Which of the following should be included in the warm up injury prevention program: stretching, aerobic exercise, strengthening and conditioning?
3	Should instruction on the correct technique of item 2 be included in the program?
4	Should musical warm up be included in the warm up programme?
5	What should be the duration of the warm up programme per session?
6	Describe the frequency of the warm up programme?
7	Which region of the body should the warm up programme, be focussed on?
8.	Which of the following education topics should on injury prevention should be included in the warm up injury prevention program? Education on: breaks, body mechanics and posture, warm up, recognition of risk factors, cool down, stress reduction, strengthening, conditioning, increasing practice load gradually and physical limitation when choosing repertoires
9.	What is your opinion on the mode of instruction of Item 8?

6.3.3. Data Collection and Procedure

The survey was conducted using Survey Monkey, an online survey site that can be used to design, collect and analyse surveys. The 9 – item questionnaire was sent as a link to the eight (8) experts individually, anonymity was ensured. Consensus was set at 65 % for an item to be included in the warm up programme.

6.4. RESULTS

The result of the three rounds of the Delphi study will be presented. The results of items 2-9 will be discussed. The results of item 1 has been summarised in table 6.1.

6.4.1. First Round of Delphi study

The response rate for the first round of the Delphi study was 87.5 %, seven (7) of the eight (8) participants responded. Consensus was reached on two items on the survey. All (100 %) the participants agreed that the correct technique of the warm up program as an injury prevention strategy should be taught. Consensus was also reached on the inclusion of musical warm up as part of the warm up exercise programme. The result of the first round of the Delphi study is further illustrated in Table 6.3.

On the content of the warm up programme, the inclusion of conditioning, stretching and strengthening as part of an injury prevention programme was agreed on by the participants, aerobic exercise was excluded from the content of the warm up programme. However, postural awareness was suggested by one member of the panel as part of the warm up programme. Physical conditioning and core strengthening were suggested by two members of the panel to be included as an injury prevention program to be done on a more regular basis outside the warm up programme.

Consensus was not reached on the content of the warm up programme in the first round of the Delphi study. This was further considered in the second round of the study.

Consensus was not reached on the duration of the warm up programme prior to practice or playing, as 42.9 % of experts agreed on 10 minutes and 15 minutes while 14.3 % agreed on the duration of the warm up to be 20 minutes. The duration was further considered in the second round of the study. Experts were asked to, 'Describe the frequency of the program?' All the participants gave their various suggestions on the frequency and duration of the warm up exercise before practice or playing. The various opinions are further considered in the second round of the study. Consensus was not reached on the region of the body on which the warm up exercise programme should be focussed on. Majority of the experts agreed on the focus of the warm up programme to be on the whole body (57.9 %), while the neck, head and lower extremity have the least scores (14.3 %). On the content of the injury prevention education topics, consensus was not reached on the content of the injury prevention education programme, importance of avoiding fatigue or doing light practice when fatigued was not agreed upon to be included in the education programme . This was further considered in the second round of the study.

Participants were asked about their opinion on the mode of instruction of the education topics and consensus was reached on classroom, one on one and the use of handouts as a mode of instruction. Active learning and group instruction in classroom were suggested by two participants respectively and this was further considered in the second round of the study.

Table 6.3: Results of First Round of Delphi Study

Item	Agree	(n)	Opinion
2	Content of warm up		Postural awareness
	<i>Stretching</i>	85.7 %	6
	<i>Strengthening</i>	85.7 %	6
	<i>Conditioning</i>	71.4 %	5
	<i>Aerobic exercise</i>	57.1 %	4
3	Correct Technique	100 %	7
4	Musical warm up	71.4 %	5
5	Duration of warm up		
	<i>5 – 10 minutes</i>	42.9%	3
	<i>10 – 15 minutes</i>	42.9 %	3
	<i>15 – 20 minutes</i>	14.3 %	1
6	Frequency of the programme	-	-
7	Focus of the warm up on body region		
	<i>Whole body</i>	57.1 %	4
	<i>Upper extremity, back and neck</i>	42.9%	3
	<i>Back</i>	28.6%	2
	<i>Lower extremity</i>	14.3%	1
	<i>Upper extremity</i>	14.3%	1
	<i>Neck</i>	14.3 %	1
	<i>Back</i>	14.3 %	1

Six participants suggested that warm up should be done before every practice session while two suggested that conditioning should be done three times per week, one suggested that the warm up programme should be done four times per week.

Table 6.3: Results of First Round of Delphi Study (contd)

Item	Agree	(n)	Opinion
8 Education on Injury prevention			
Breaks	100 %	6	
Body mechanics & posture	100 %	6	
Warm up	100 %	6	
Increasing practice load	100%	6	
Recognition of risk factors	83.3 %	5	
Cool down	66.7 %	4	
Stress reduction	66.7 %	4	
Physical limitation	66.7 %	4	
Strengthening	66.7%	4	
Conditioning	66.7 %	4	
Light practice when fatigued	50 %	3	
9 Mode of Instruction of Item 8			
Classroom	100 %	7	
One on one	100 %	7	
Handouts	85.7 %	6	
Internet	42.9 %	3	
Television	0 %		

Active learning and group instruction in classroom followed by reinforcement by the teachers was suggested

6.4.2. Second Round of Delphi Study

The second round of the study however focuses on the emerging opinions and the various other areas where consensus was not reached in the first round. The survey in the second round was structured based on the response of the first round. Six (6) out of the eight (8) participants responded to the survey of the second round of the Delphi study. Table 6.3 illustrates the results of the second round of the Delphi study.

Consensus was reached on the content of the warm up programme, regular strengthening and conditioning exercises, frequency of the strengthening, region of the body where warm up program should be focussed on and conditioning exercises and mode of instruction of injury education programmes. Consensus was reached on the content of the injury prevention programme; the participants agreed that stretching, conditioning, postural awareness and strengthening. Strengthening and conditioning should be done regularly thrice a week, postural awareness and stretching are to be done before every practice session.

All six (100%) the participants agreed that warm up should be done before every practice session but consensus was not reached on the duration of the warm up, three (60%) agreed that it should be done between 5 – 10 minutes while two (40 %) agreed that it should be done between 10 – 15 minutes. However, to further reach consensus on the duration of the study a third was conducted. All six (100 %) of the participants agreed that the conditioning and strengthening should be done as a regular exercise for instrumental musicians and consensus was reached on the frequency of the strengthening and conditioning exercise programme.

Consensus was reached on the region of the body which the programme should be focused on, five (5) 83.3 % agreed that the programme should focus on the whole body. The opinion of the participants on the mode of instruction of the injury prevention education topics, group instruction in the classroom (83.3%) and active learning (83.3%) reached consensus. Consensus was not reached on the content of the education topics to be included as part of the injury prevention education programme, one of the participants suggested that education on nutrition should be included in the programme. This was further considered in the third round of the study. Items where consensus was reached is highlighted in bold.



Table 6.4: Results of Second Round of Delphi Study (n = 6)

Item	Agree	(n)	Opinion
1	Content of the injury prevention		Nutrition
	<i>Stretching</i>	100 %	6
	<i>Postural awareness</i>	100 %	6
	<i>Strengthening</i>	83.3 %	5
	<i>Conditioning</i>	83.3 %	5
2	Warm up should be done	100 %	6
	Prior to playing		
3	Duration of warm up exercise		
	<i>5 – 10 minutes</i>	60 %	3
	<i>10 – 15 minutes</i>	40 %	2
	<i>15 – 20 minutes</i>	0 %	0
4	Strengthening & Conditioning as		
	Regular exercise	100 %	6
5	Frequency of Item 4		
	<i>Three times per week</i>	66.7 %	4
	<i>Two times per week</i>	66.7 %	1
	<i>Once a week</i>	16.7 %	1
6	Focus of warm up on body region		
	<i>Whole body</i>	83.3 %	5
	<i>Neck, upper limbs & back</i>	33.3 %	2
7	Mode of Instruction of the education		
	topics on injury prevention		
	Active learning	83.3%	5
	Group instruction in classroom	83.3 %	5
	Handouts	50 %	3
	One on one	16.7 %	1

6.4.4. Third Round of Delphi study

Consensus was sought on the areas where consensus was not reached in the first and second round of the study, the duration of warm up exercise and the content of educational topics on injury prevention as part injury prevention education programme. Six (6) out of the eight (8) participants responded to the survey. The debate over the duration of the warm up program with the inclusion of the musical warm up continued, consensus was not reached. However, the result suggests that the duration could be within 5 – 15minutes.

Consensus was reached on the inclusion of education on nutrition to be part of the education programme as an injury preventive strategy. Therefore, the injury prevention education topics agreed upon are as follows, importance of taking breaks, proper body mechanics and posture, importance of warm up, importance of cool down, importance of stress reduction, recognition of risk factors of overuse injuries, importance of increasing practice load gradually, importance of strengthening, importance of conditioning, education on physical limitations when choosing a repertoire and nutrition.

Table 6.5: Results of Third Round of Delphi Study (n=6)

Item	Agree	(n)	Opinion
1	Duration of warm up		
	5 – 10 minutes	50 %	3
	10 – 15 minutes	50 %	3
2	Nutrition as part of education topics		
	Yes	66. 7%	4
	No	33.3%	2

6.5 DISCUSSION

Consensus was reached in the first round of the study on the inclusion of musical warm up as part of the pre-activity warm up programme and the teaching of the correct technique of the content of the warm up programme. However, on the content of the warm up program consensus was not reached, the inclusion of aerobic exercise was not considered importance by majority of the participants and it was therefore excluded from the programme. Postural awareness and frequent conditioning was suggested by the experts. Strengthening and conditioning was agreed upon in the second phase by the experts to be done three times per week and that postural awareness and warm up exercise should be done prior to playing. The eventual effective impact of strengthening and conditioning exercises can only be seen over a period of time (Ackermann, Adams, & Marshal, 2002). The focus of the warm up programme with respect to the body region was agreed upon in the second phase of the study, the experts agreed that the focus of the warm up program should be on the whole body, despite evidence showing that the upper extremities, neck and

back the usually the most common affected sites of PRMDs (Abréu-Ramos & Micheo, 2007).

Areas of education on injury prevention strategies as described initially by Blackie, Stone, & Tiernan (1999) was agreed on by the experts in the third phase of the study. The importance of breaks, proper body mechanics and posture, importance of warm up, importance of cool down, importance of stress reduction, recognition of risk factors of overuse, importance of increasing practice load gradually, importance of strengthening and conditioning, importance of identification of physical limitations when choosing a repertoire and education on nutrition were included in the injury education prevention programme. Active learning and group instruction in the classroom were agreed on by the experts to be the mode of instruction of the education programmes. However, the duration of the warm up to be done prior to playing could not be agreed up on in the three phases of the study, but the range of the warm up programme according to the results at the three phases shows that the warm up could be done preferably between 5 – 15 minutes.

6.6 SUMMARY OF CHAPTER

This chapter has discussed the method and results of the Delphi study to design the content of a warm up injury prevention programme. Emerging themes on the inclusion of strengthening and conditioning as a regular exercise to be done three times per week, and warm up exercise should be done before every practise session. Consensus was reached on the various education topics to be taught as an injury prevention strategy. The next chapter, chapter 7, discusses the synthesize results of the three phases of the study.

CHAPTER SEVEN

DISCUSSION

7.1. INTRODUCTION TO CHAPTER

This chapter presents a discussion of the results of the preceding three chapters – the results of the baseline data on PRMDs among instrumental musicians, results of a systematic review on practice habits and pattern of warm up and the results of the Delphi study to design a warm up programme as an injury prevention strategy. As outlined in Chapter One, the aim of this study to design a warm up programme in the prevention of PRMDs among instrumental musicians and this was done in three (3) stages. In the first stage, baseline data on prevalence, distribution and severity of PRMDs, also awareness about injury prevention strategies was collected from music students and teachers at a Centre for Performing Arts. In the second phase of the study, a systematic review of literature was conducted to inform the pattern of warm up exercise and practice habits of instrumental musicians. A Delphi study was conducted in the third phase of the study to design the content of the warm up programme itself. This chapter however discusses the results of all the three phases of the study

7.2. PREVALENCE, SEVERITY AND DISTRIBUTION OF PRMDS

In a conference in 2004, four major areas of health concern among musicians were identified and addressed. These included: neuromusculoskeletal health which involves the physical body such as nerve entrapments and pain in the muscle and tendon units, vocal health, hearing conservation which involves dealing with noise and psychological health dealing with issues as performance anxiety (Palac, 2008). However, the focus of this study is based on just one of the identified health issues of

the musician, the neuromusculoskeletal health which is referred to as PRMDs. Musculoskeletal disorders in instrumental musicians are a problem in Europe, America and Australia and it is important to know the severity and prevalence of PRMDs in Africa especially in South Africa. The results of this study show a high prevalence of PRMDs among instrumental musicians in a School of Performing art in Cape Town, South Africa, with a lifetime prevalence rate of 82.4 % and a current prevalence rate of 23.5 %. This is synonymous to the prevalence of PRMDs among instrumental musicians in earlier studies, 77% (Sandell, Frykman, Chesky, & Fjellman-Wiklund, 2009), 83.6 % (Abréu-Ramos & Micheo, 2007), 54 % (Buckley & Manchester, 2006), 87.7 % (Guptill, Zaza, & Paul, 2000), and in a similar sample size 93 % (Blackie, Stone, & Tiernan, 1999). The results of the systematic review also show a lifetime prevalence of PRMDs, 50% as the least reported (Davies & Manginon, 2002) and 93% as the most reported prevalence (Blackie, Stone, & Tiernan, 1999). Only one article reported a point prevalence of 23% (Buckley & Manchester, 2006). This is similar to the result of the systematic review earlier conducted which shows a point prevalence rate of 39 % - 87 % in adult musicians and 32 % - 64 % in secondary school students (Zaza, 1998).

All the male participants in this study reported a lifetime prevalence of PRMDs whereas 76.92 % of the female participants reported a lifetime prevalence of PRMDs. None of the male participants complained of any current symptom of PRMDs while 30.77 % of the female participants reported current symptoms of PRMDs. Gender, age, instrument played, years of experience and practice hours does not have a significance on the prevalence of PRMDs. This contradicts evidence that has shown that the type of instrument played and gender have a significant role in the occurrence of PRMDs, with the string players and females more predisposed to

PRMDs (Davies & Manginon, 2002). However, Allsop & Ackland (2010) reported that the majority of those that complain of PRMDs are men. Comparisons should nevertheless be made with caution due to the larger number of female participant in this study, 80 % were females, while 20 % were males.

The distribution of symptoms is common in the upper extremities, back and neck, with the shoulders (41.2 %), wrists and hands (29.4 %) being the most common affected site in the upper extremities, the neck and the back; the lower limbs and elbow least affected. Evidence from the systematic review also shows that the upper extremities, neck and back are the most usually site of discomfort in instrumental musicians and this could be due to the work pattern and type of instrument played (Kaufman-Cohen & Ratzon, 2011; Abréu-Ramos & Micheo, 2007; Buckley & Manchester, 2006; Blackie, Stone, & Tiernan, 1999; Yeung, et al., 1999). The participants in this study reports the strings (violins) as the most common instrument played (50 %), followed by the percussion (piano) (35%). This is similar to other studies, which have shown that the shoulder is the most common site of discomfort for the upper string instrumentalists (Abréu-Ramos & Micheo, 2007) and the wrists and hands are the most common site of discomfort for the pianists (Pak & Chesky, 2001). This may account for the higher distribution of symptoms in the shoulder, wrists and hands. Non instrument specific pain or discomfort at the neck, back and shoulder is usually a result of bad posture and positioning (Williamson & Thompson, 2006).

Tightening (68.4 %) and soreness (57.9 %) are the most common symptoms of PRMDs, also less than 40 % of participants reported numb, cramps, aching, pins and needles, burning, weakness, fatigue, tingling, dull and localized (5.3 %). This corresponds to a similar study carried out on University piano students which reports

that tightening, aching, soreness, localized pain are the most common symptoms of PRMDs affecting these students, numb and chronic symptoms are the least reported (Blackie, Stone, & Tiernan, 1999). Pain and tenderness is a common symptom of overuse syndrome suggests that majority of the participants in this study could be suffering from overuse syndrome with respect to the common reported symptoms tightening and soreness, which is due to the repetitive activity over a variable course of time (Hartmann, 2011). Pain severity is mild among the participants in this study, the mean pain score is 15.08 mm. Pain severity was categorised into 30 mm or less as mild, 31 mm to 69 mm and 70 mm or more as severe (Kelly, 2001; Collins, Moore, & McQuay, 1997). Correlation shows there was no significance between the severity of PRMD and quality of life among the participants in this study. The average onset before the duration of pain was 34.2 minutes, which is synonymous to a similar study conducted among University piano students (Blackie, Stone, & Tiernan, 1999). However, the belief held by music instrumentalists that playing with pain is a norm could affect the reporting of playing related symptoms and the symptoms are usually under – reported (Spahn, Strukely, & Lehmann, 2004; Abma, 2001). The influence of other activities such as frequent computer usage on the prevalence and distribution of PRMDs should not be overlooked, musculoskeletal disorders is suggested not be uniquely caused by work. Several other factors could influence the prevalence of MSD and its distribution. Other occupations that involves regular computer use also presents with similar pattern of musculoskeletal disorder as the instrumental musician, with the upper extremity is usually the most affected (Pascarelli & Hsu, 2001).

7.3 PRACTICE HABITS

The mean average practice hour per week for the participants in this study was 16.08 hours per week. This is synonymous to similar studies, musicians often perform

an average of 2 hours per day (Pascarelli & Hsu, 2001; Blackie, Stone, & Tiernan, 1999), workload and practice hours usually increases when preparing for solos or concerts (Pascarelli & Hsu, 2001). In this study practice hours does not have an effect on the prevalence of PRMDs. This contradicts recent evidence that shows the positive correlation of practice hours in the predicting PRMDs among instrumental musicians (Kaufman-Cohen & Ratzon, 2011). Due to the workload and the need for practice, reducing practice hours might not be a feasible feat but taking breaks could be a significant factor in reducing PRMDs. A study on non-classical musicians how shows that more than half (53%) took breaks during practice (Buckley & Manchester, 2006). Taking supplementary breaks has been found to reduce level of discomfort in non – musicians without reducing the overall level of productivity (Galinsky, Swanson, Sauter, Dunkin, Hurrell, & Schleifer, 2007).

All the participants perform musical warm ups. This is synonymous to evidence on the practice of musical warm up among instrumental musicians, which is usually been taught by most music teachers (Guptill & Zaza, 2010). The majority of the musicians usually engage in the playing of scales or a familiar tune prior to practice or performing (Buckley & Manchester, 2006). More than half (57.9 %) of the respondents perform one form of stretching or the other before practice. The type of warm up done by the musicians cannot be ascertained. Evidence from the systematic review shows that the pattern and content of the warm up been practised by the musicians cannot be defined due to the lack of operational definition of the warm up itself, some consider stretching as warm up while others consider playing of scales as warm up (Abréu-Ramos & Micheo, 2007; Buckley & Manchester, 2006). Guptill & Zaza (2010), recommended that the musical warm up popularly done by musicians

should be incorporated with the physical warm up which has to do with pre-activity exercise done before playing.

However, in designing the warm up programme, the panel agreed on the importance of a physical warm up which includes stretching and postural awareness. The duration of the warm up programme was debated between 5 – 15 minutes. Although in sports, the minimum duration for a recommended general warm up is 20 minutes, in order to allow for sufficient blood circulation to occur before engaging in the activity (Ganong, 2001). It is worth noting here that the mode of injury sustained differs, overuse syndrome due to repetition is the most common injury sustained (Dawson, 2001; Fry, 1986). In a systematic review earlier conducted on the role of stretch on musculoskeletal injury concludes that stretching prior to an exercise has little or no effect on muscle soreness and overuse injuries but it does reduce the risk of sustaining muscle strain injuries (McHugh & Cosgrave, 2010) .

7.4. KNOWLEDGE ABOUT INJURY PREVENTION STRATEGIES

More than half of the participants in this study are aware about body mechanics and posture, the importance of taking breaks, the importance of warm up and cool down and stress reduction as injury prevention strategies especially. Half of the participants are aware about fatigue, recognition of risk factors for overuse injuries, importance of strength and conditioning. Less than half of the participants are aware of the importance of physical limitation when choosing a repertoire and increasing practice load gradually. This contradicts a similar study with piano students, one – quarter of the students' reports to have been taught importance of warm up and 37.5 % of the students reports to have been taught importance of strengthening and conditioning, the use of these prevention strategies was found to be low among the students which corresponds to the percentage taught (Blackie, Stone,

& Tiernan, 1999). However, the practice of these injury prevention strategies cannot be ascertained due to the model of the study.

The results of the systematic review shows that teachers with more experience are more likely to teach stretching exercises as a preventive measure for PRMDs (Redmond & Tiernan, 2001), although the role of education and practice of the various education on injury prevention strategies is contradictory. However, reports of the intervention studies reviewed in the systematic literature review shows the role of general warm up, specialised exercises and focussed movements involved while playing to have an effect in reducing physical exertion which has a direct influence in the reduction of PRMDs (Greef, Van Wijck, Reynders, Toussaint, & Hesselings, 2003). Education on human body postures, warm up and cool down, strengthening and flexibility exercises was reported not to have a significant effect in the reduction on PRMDs but there was a percentage reduction in the reported incidence of PRMDs among the population in the study (Brandfonbrener, 1997).

Consensus was reached by experts in the Delphi study on the inclusion of the following education topics to be taught as part of the injury prevention programme; the importance of taking breaks, proper body mechanics and posture, the importance of warm up, the importance of cool down, the importance of stress reduction, recognition of risk factors of overuse injuries, the importance of increasing practice load gradually, the importance of strengthening, the importance of physical limitation when choosing a repertoire and the importance of conditioning. Consensus was not reached on avoiding or light practice when fatigued.

Education on increasing practice load gradually was the least area in which music students and teachers were aware of in the cross sectional study, 41.7 %. This

suggests that the focus of injury prevention in the performing arts is not on increasing practice load gradually which is synonymous to the belief by musicians that playing with pain is a norm (Abma, 2001) or maybe the isolated role of practice load on the prevalence of PRMDs cannot be ascertained. However, music students differ from other student population in their attitude towards in a higher degree of health impairment and their enhanced commitment to work (Spahn, Strukely, & Lehmann, 2004). Consensus was reached on the mode of instruction to be classroom group discussion and active learning in order to teach music students the various injury prevention strategies.

The importance of health promotion among instrumental musicians should be emphasized at the early stages of music education; “the key strategy of health promotion is aimed at informing, influencing and assisting both individuals and organizations so that they be more active in matters affecting mental and physical health”. Health Promotion in Schools of Music in collaboration with Performing Arts Medicine Association offered a strategic framework for schools of music to become the primary settings for health promotion among musicians. In the declaration, four recommendation were made, and this includes adoption of a health promotion framework, develop and offer an undergraduate “occupational health” for all music majors, educate students about hearing loss as part of an ensemble based instruction and finally assist students through active engagement with Health Care Resources which involves sound and effective referral system for music students, when and where to go when they have problems (Health Promotion in Music Schools, 2004).

The utilisation of preventive measures has been found to be influenced by the type of instrument played. The string players and the singers are more likely to utilise preventive measures than the pianists and the wind instrumentalists; asymmetry of

position has been associated with this in high string players and the protection of the voice of singers from overwork has been associated with prevention in singers (Spahn, Burger, Hilderbrandt, & Seidenglanz, 2005).

7.5 WARM UP

The participants in this study all engage in musical warm up while only 57.9 % perform one form of stretching or the other before practice. There was no significant relationship between ‘stretches before practice’ and the prevalence of PRMDs. This is synonymous with evidence from a systematic review on the role of stretching in the prevention of musculoskeletal injury where stretch was reported not have a significant effect in injury prevention (McHugh & Cosgrave, 2010). Notwithstanding it is worth noting that the population in the review are more of athletes than other occupations and the mechanism of injury among athletes and instrumental musicians is not necessarily the same. The type of stretching practiced by the participants in this study cannot be ascertained, studies have shown the lack of operational definition of warm up exercise being engaged in by musical instrumentalists, as it is considered as musical or physical and it could be any of these or both (Guptill & Zaza, 2010; Buckley & Manchester, 2006).

The role of warm up in injury prevention in the systematic review conducted among instrumental musicians is contradictory as evidence shows that general warm up and specialised exercises over a period of time reduces perceived exertion and thereby reduces the incidence of PRMDs (Greef, Van Wijck, Reynders, Toussaint, & Hesselings, 2003), whereas correlation analysis in other cross sectional studies shows that warm up has no significant effect in the risk of developing PRMDs (Buckley & Manchester, 2006; Davies & Manginon, 2002). Regular exercise and warm up prior to playing is a significant predictor of PRMD in some other studies (Kaufman-Cohen &

Ratzon, 2011; Yeung, et al., 1999). Physical warm up considered as stretching was positively correlated with pain in another study (Yoshimura, Fjellman-Wiklund, Paul, Aerts, & Chesky, 2008). However, the content of the warm up was not described in the cross sectional studies, but the randomised controlled trials described the pattern of warm up and exercise done by the participants in the study. Therefore, the need to design a standard warm up programme in order to determine its role in the prevention of playing related musculoskeletal injury is important in order to justify the contradictions.

The warm up programme was designed with a Delphi study, the method and results were outlined in Chapter Six (6). Experts in the field of Performing Arts Medicine reached a consensus on the content of the warm up programme as an injury prevention strategy for instrumental musicians. Consensus was reached by the experts that musical warm up should be done with physical warm up exercises. This could be as a result of the popularity of musical warm up among musicians and its common practice (Guptill & Zaza, 2010; Zaza, 1992), which if combined with physical warm up exercise could help motivate the regular practice of warm up exercises.

The content of the programme includes stretching, strengthening and conditioning, but the inclusion of general aerobic exercise was not agreed upon. However, consensus on stretching and postural awareness of the whole body were further reached to be the warm up exercise which should be done with the musical warm up before every practice session. Strengthening and conditioning exercise should be a regular exercise pattern, and the participants in the Delphi study agreed that strengthening and conditioning should be done regularly three times per week. Education on injury prevention strategies should also be taught with the mode of instruction to be active learning and group discussion in the classroom. The content of

the warm up programme and mode of instruction is synonymous to the content of the exercise programme in some other studies which includes and the focus on the whole body, there was a reduction in the perceived exertion which ultimately led to a reduction in the prevalence of PRMDs (Greef, Van Wijck, Reynders, Toussaint, & Hesselings, 2003). In another study, there was no significant effect of the program on the prevalence of PRMDs, however, there was a reduction in the prevalence of PRMDs in the control group (Brandfonbrener, 1997). Although, in the injury prevention programme on strength and endurance training among music students over a period of six weeks, the focus of the programme is in the upper extremities alone. There was no significant effect of the exercise on the risk of developing PRMDs and the author suggests that six weeks might not be sufficient to determine the effect of the exercise programme (Ackermann, Adams, & Marshall, 2002).

Consensus was not reached on the duration of the warm up prior to practice; the majority of the participants agreed on warm up to be between 5 – 10 minutes while the rest agreed that it should be within 10 – 15 minutes. This was the same result in the second and third round of the study; saturation was reached. This shows that the comfortable warm up time frame could be between 5 – 15 minutes, however further research needs to be done in order to be able to accommodate warm up prior to playing and musical warm up within the normal practice hours, although, a study reported that musicians devoted an average of 10 minutes to warm up prior to playing (Kaufman-Cohen & Ratzon, 2011).

The Delphi experts agreed that strengthening and conditioning should be done at least three times per week regularly as an injury prevention strategy. However, in a study where the role of strengthening and endurance training in the prevention of PRMDs in the upper extremity, no significant effect was found over a period of six

weeks, the author suggests that if done regularly over a longer period of time, there could be a significant reduction in the prevalence of PRMDs. Six weeks is too short a time for a significant effect to be seen (Ackermann, Adams, & Marshal, 2002).

7.6. SUMMARY OF CHAPTER

The prevalence, severity and distribution of PRMDs as well as awareness about injury prevention strategies were discussed with evidence. The practice habits of instrumental musicians and the content of the warm up programme which is in three phases – the pre – practice/playing warm up programme, the regular strengthening and conditioning programme and education on injury prevention strategies. The next chapter concludes and suggests recommendations and give the limitations encountered in this study.



CHAPTER EIGHT

CONCLUSION

8.1. CONCLUSION

Playing related musculoskeletal disorders is prevalent among instrumental musicians and it cuts across various types of instruments played. Although the impact on quality of life may be mild, eventual repercussion on the health of the individual as a whole is a problem. The art of music making can be made pain free if the various risk factors associated with the incidence of PRMDs are identified and the various injury prevention strategies are taught and reinforced at the early stage in the profession. Musculoskeletal injuries can be reduced as it is seen in recent times in sports whereby various injury prevention strategies are employed in order to make the sport injury free (Soligard, Nilstad, Steffen, Myklebust, & Holme, 2010; Soligard, et al., 2008).

This study is aimed at creating the guidelines in designing a warm up programme as an injury prevention strategy to reduce the prevalence of PRMDs among instrumental musicians. This was done in three phases. Firstly, the prevalence, distribution, severity of PRMDs among music students and teachers at a Center for Performing Arts was identified, also the knowledge of the participants about various injury prevention strategies and their practice habits was identified. Secondly, a systematic literature review was conducted with the aim of systematically reviewing existing literature on the practice habits, pattern of warm up, and education about injury prevention strategies in order to inform the content of the questionnaire for the

Delphi study. Thirdly, a Delphi study was conducted in order to determine the content of the warm up injury prevention program.

Various factors were discussed in this study as having an influence of the PRMDs. However, the role of a well structured and planned warm up exercise programme in conjunction with the existing injury prevention program such as taking breaks, postural awareness, proper playing techniques, reducing repetition and pacing could have a significant effect in reducing the prevalence of PRMDs (Guptill & Zaza, 2010). Isolating warm up exercise without the inclusion of the other injury prevention strategies might not yield a significant overall eventual positive result.

The warm up exercise programme as an injury prevention strategy was designed in three categories, firstly, it comprises of pre – activity warm up of stretch and postural awareness, and secondly, strengthening and conditioning exercise which should be done three times per week and thirdly, education of instrumental musicians on various injury prevention strategies.

A collaborative multidisciplinary role between the health professionals and musicians in order to prevent and reduce injuries is important, with each party understanding their professional boundaries, health professionals diagnose and treat playing related problems while music teachers provide pedagogy found on music principles to produce music (Palac, 2008). However, the role of the health professionals should not be limited to just diagnoses and treatment of injury, a holistic approach should be employed in the management of PRMDs among instrumental musicians.

8.2. RECOMMENDATIONS

Further research should be done to determine the effect of the warm up programme which includes the warm up prior to playing, regular strengthening and conditioning exercises and education on injury prevention strategies on the prevalence and severity of PRMDs among instrumental musicians.

8.3 LIMITATIONS

The results of this study should be interpreted in the light of the following limitations:

- i. Data of the first phase of the study was collected by means of a self administered questionnaire and results were thus biased in self reports. Furthermore, the researcher went to great length to ensure confidentiality and anonymity.
- ii. Data in the first phase of the study were analysed cross-sectionally, thereby limiting the ability to make causal inferences. An individual with a PRMD might not necessarily complain of PRMD in the future. Therefore caution should be exercised in interpreting the results of a cross-sectional study when it is not a longitudinal study.
- iii. The sample is relatively homogenous. This did not include instrumental musicians who do not play in a school setting and the majority of the musicians being teenagers and the small sample of the study, generalising findings to other population especially the older population is limited.
- iv. The accuracy of the group decision in the Delphi study is unclear and due to the anonymity of the participants and the short time frame, lack of accountability and hasty decision making and these could influence the result of the Delphi study.

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