Upper extremity work-related musculoskeletal injuries among chiropractic students at the Durban University of Technology

A dissertation submitted in partial compliance with the requirements for a Masters Degree in Technology in the Department of Chiropractic and Somatology at the Durban University of Technology.

By

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I, Kyle Andrew Singh, do declare that this dissertation is representative of my own work in both conception and execution (except where acknowledgements indicate to the contrary).

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M. Tech: Chiropractic (SA), PhD Anatomy

DEDICATION

To my family who have shown unwavering support and encouragement throughout this journey
&
To my Heavenly Father for blessing me with the means to undertake and complete this degree.

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ABSTRACT

Background: Chiropractic students the world over undergo rigorous training in manual therapy, specifically musculoskeletal manipulation and adjustment. These therapeutic modalities involve the use of the upper extremity to deliver its effects, usually with high velocity and force. This leaves the upper extremity vulnerable to injury, as a result of the repetitive and forceful nature of these manual techniques. Despite this risk, the research available on work-related musculoskeletal injuries of chiropractic students in South Africa is limited. This study aims to determine the prevalence of upper extremity work-related musculoskeletal injuries among chiropractic students at the Durban University of Technology, and selected risk factors associated with work-related musculoskeletal injuries.

Method: The study design was a quantitative, descriptive, self-administered questionnaire study that used the total available population. The questionnaire was adapted from a similar study and included the use of a pilot study. The questionnaire had three sections: the first for demographic data, the second was applicable for any new injury to the upper extremity from work-related tasks, and the third was applicable for any old injuries to the upper extremity that were aggravated by work-related tasks. Prevalence was estimated using 95% confidence intervals. Factors associated with injury were assessed at univariate level, using Pearson's chi-square tests and t-tests, and factors associated at the <0.1 level were selected as independent variables in a multiple logistic regression model to predict risk of injury. The odds ratios and 95% confidence intervals were reported. A stepwise backward selection method, based on likelihood ratios, was used to arrive at a final model consisting only of statistically significant risk factors ($p<0.05$). Chi-square testing and cross-tabulations were performed on the use of dominant hand and injury.

Results: Eighty-six chiropractic students (n=86) were eligible for the study, seventy-seven elected to participate in the study, giving a response rate of 93.9%. The period prevalence of upper extremity work-related musculoskeletal injuries was 59.7% (95% CI 47.93 to 70.57%). The most commonly injured

areas were the wrist (60%), shoulder (20%) and hand (17%), with majority of the injuries involving the soft tissue structures: muscle/ tendon strain (42%), ligament sprain (17%) and tendinitis (17%). Most injuries occurred during adjustive procedures (74%) and ischemic compression (19%).

None of the demographic variables showed a significant association with prevalence of injury, apart from a moderately non-significant association with year of study (p=0.080). The frequent use of electro-modalities (p=0.073) and temperature therapy (p=0.077) were suggestive of possible associations, however, were not statistically significant. The results showed no significant differences between frequency of adjustments and injury. Despite an absence of statistical significance, a trend was noted showing an increased likelihood of injury when adjusting with the dominant hand.

Conclusion: The study findings are consistent with those of similar international and local studies on the chiropractic profession (both academic training and professional), determining a high prevalence of work-related musculoskeletal injuries. The wrist was most commonly injured when performing adjustive procedures with the dominant hand. This study is in response to a call for further investigation and will help in future efforts to develop an injury preventative strategy for chiropractic training institutions.

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ABBREVIATIONS

%	Percentage
3D	Three dimensional
AHPCSA	Allied Health Professions Council of South Africa
B. Tech.	Bachelor of Technology
CASA	Chiropractic Association of South Africa
CCE	Council on Chiropractic Education
CCEI	Council on Chiropractic Education International
CDC	Center for Disease Control
CHPP301	Chiropractic Practice and Principles III
CHPP401	Chiropractic Principles and Practice IV
CHPP501	Chiropractic Principles and Practice V
CI	Confidence interval
CLCH501	Clinical Chiropractic V
DALY	Disability-adjusted life years
DUT	Durban University of Technology
ECCE	European Council on Chiropractic Education
EU-OSHA	European agency for safety and health at work
HVLA	High-velocity low-amplitude
LBP	Low back pain
M. Tech.	Master of Technology
MSD	Musculoskeletal disorders
MSI	Musculoskeletal injuries
n	Total number
N	Newtons

N. Dip.	National Diploma of Technology
NBCE	National Board of Chiropractic Examiners
OT	Occupational therapist
PS	Pilot Study
PT	Physical therapist
SA	South Africa
SD	Standard deviation
SM	Spinal manipulation
SMT	Spinal manipulative therapy
T	Thoracic
UE	Upper extremity
UE-WRMSI	Upper extremity work-related musculoskeletal injury
UJ	University of Johannesburg
UK	United Kingdom
USA	United States of America
WFC	World Federation of Chiropractic
WHO	World Health Organization
WRMSI	Work-related musculoskeletal injury
YLD	Years lived with disability
YLL	Years of life lost

GLOSSARY

Adjustment: A specific form of joint manipulation commonly used by chiropractors, which uses long or short leverage techniques on specific anatomic contacts. It is characterised by a low-amplitude dynamic thrust of controlled high-velocity, amplitude and direction. It is commonly associated with an audible cavitation (i.e. popping sound) (Bergmann and Peterson 2011: 85; Haldeman 2005: 743).

Joint manipulation: A manual procedure that involves a directed thrust to move a joint past the physiologic range of motion, without exceeding the anatomic limit (Bergmann and Peterson 2011: 85; Haldeman 2005: 19).

Joint mobilisation: Movement applied to a tissue, either singularly or repetitively, within or at the physiologic range of motion, without imparting a thrust or impulse, with the goal of restoring mobility (Bergmann and Peterson 2011: 85; Haldeman 2005: 930).

Manual therapy: Therapeutic procedures whereby the hands are directly in contact with the area of the body being treated e.g. massage, joint manipulation and joint mobilizations (Bergmann and Peterson 2011: 85).

Upper extremity: The anatomical region extending from the shoulder complex down to the fingertips, including the upper arm, elbow, forearm, wrist and hand (Levangie and Norkin 2011: 232).

CHAPTER ONE

INTRODUCTION

1.1 Introduction

Work-related musculoskeletal injuries (WRMSI) are very common among the healthcare profession, particularly among nursing and manual therapists, where there's continuous need to use the upper limb to perform daily tasks, as well as due to their labour-intensive and physically demanding work-activities (Vieira et al. 2016; Darragh, Campo and King 2012; Bonde et al. 2005; Cromie, Robertson and best 2000; Bork et al. 1996).

The chiropractic profession has been identified as at risk for work-related musculoskeletal injuries, due to the high physical demand on the practitioner and the application of manual therapies – including adjustment/manipulation (Lamprecht and Padayachy 2019; Holm and Rose 2006).

Chiropractic manipulation is a complex therapeutic modality that requires bimanual coordination as well as the development and refinement of proficient psychomotor skills to perform successfully. There are many biomechanical variables, i.e. preload force, thrust vector, thrust velocity and amplitude of the applied force that need to be accurately controlled to ensure a safe therapeutic outcome (Wirth et al. 2019; Bialosky et al. 2018; Byfield 2012; Triano, Descarreux and Dugas 2012; Bergmann and Peterson 2011:85; Downie, Vemulpad and Bull 2010; Herzog 2010; Gatterman 2005).

Furthermore, the acquisition of manipulative motor skills is gained through extensive practice and repetition of techniques, while simultaneously attempting to reduce execution errors. A potential risk of injury is introduced, as many of these techniques are often unfamiliar to students. During manipulative training, the neuromuscular system is susceptible to incorrect patterning arising from injuries, consequently leading to further potentially damaging effects (Wirth et al. 2019; Bialosky et al. 2018; Triano, Descarreux and Dugas 2012; Herzog et al. 2000). This necessitates the importance of chiropractic institutions to fine-

tune the conscious mind-muscle coordination, i.e. psychomotor skills, technique and strength required to properly deliver the manipulation.

There have been several studies done on practicing chiropractors that identify most WRMSIs occur within the first few years of practice (Lamprecht and Padayachy 2019; Pereira 2009; Holm and Rose 2006; Mathews 2006; Homack 2005). Studies done in North America, on chiropractic students during their undergraduate technique training, report findings that support this observation (Kizhakkeveettil et al. 2014; Ndetan et al. 2009; Kuehnel, Beatty and Gleberzon 2008; Bisiacchi and Huber 2006; Macanuel et al. 2005).

A study by Kuehnel, Beatty and Gleberzon (2008), investigating the prevalence of injury among five international chiropractic colleges, noted a significantly lower prevalence reported by the African college when compared to the other participating colleges. The difference in results was attributed to a limited explanation of various cultural differences, e.g. the willingness of a student to report an injury or the definition of an injury varying between cultures. The study called for further research to be conducted to support this rationalisation.

A further limitation noted by Kuehnel, Beatty and Gleberzon (2008) was the non-uniformity among university course duration and training. For instance, South African students are required to complete a Masters thesis to obtain their qualification, which takes on average seven years, i.e. five years course work and two years for Masters completion (Allied Health Professions Council of South Africa 2020; European Council for Chiropractic Education 2020); exposing them to vastly more time in training when compared to their North American counterparts who are required to complete a Doctor of Chiropractic degree (DC), which runs for four years (Council of Chiropractic Education USA 2020; National Board of Chiropractic Examiners 2020).

Furthermore, the South African chiropractic programme instructs the use of the diversified technique, a technique shown to have the highest prevalence among any other techniques for WRMSI’s (Ndetan et al. 2009). These notable

differences warrant further investigation into the limitations previously mentioned.

1.2 Research aim

This study aims to determine a profile of upper extremity work-related musculoskeletal injuries, among chiropractic students at the Durban University of Technology.

1.3 Problem statement

There is a need for additional research with regards to student chiropractors and the WRMSIs of the upper extremity they encounter during their undergraduate training. The studies within the existing body of literature are limited, and highlight the need for research to be conducted at various international chiropractic educational and training institutions.

1.4 Research objectives

- To determine the period prevalence of upper extremity work-related musculoskeletal injuries among chiropractic students
- To determine selected risk factors (demographic related and occupational related) associated with chiropractic students and upper extremity work-related musculoskeletal injuries

1.5 Rationale

There is a paucity of current available literature, with regards to WRMSI of the upper extremity in chiropractic students. A recent study conducted by Lamprecht and Padayachy (2019) found that chiropractors practicing in the eThekwini municipality reported experiencing WRMSIs within the first five years of practice. Furthermore, it was described that injuries to the upper extremity – specifically the hand and wrist – were more prevalent than any other anatomical area (Lamprecht and Padayachy 2019).

It has been well documented that exposure to risk factors, such as repetitive motion, excessive force, awkward and/or sustained postures, predispose chiropractors to the development of WRMSI (Lamprecht and Padayachy 2019; Holm and Rose 2006; Rupert and Ebete 2004). Chiropractic students are exposed to many of the risk factors as their professional counterparts, as well as academic stress compounded by the completion of a clinical internship (Kizhakkeveettil et al. 2014; Kuehnel, Beatty and Gleberzon 2008).

The results of this study will identify the common areas affected by WRMSIs associated with the upper extremity and aid future efforts in designing a comprehensive protocol for injury prevention amongst training chiropractors.

1.6 Hypothesis

Chiropractic students at the Durban University of Technology will have a high prevalence of upper-extremity work-related musculoskeletal injury.

1.7 Delimitations

Due to the nature of this study, the researcher relies on the participants to have answered the questionnaire honestly and to the best of their ability, to recall the injurious event, therefore allowing the research to be the best approximation of upper-extremity work-related musculoskeletal injuries incurred by the participants.

1.8 Conclusion

This chapter serves to only introduce the problem and setting briefly, with the following chapter outlining the key concepts – as well as expanding on the current related literature that will lend some understanding to the rationale of this study.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter serves to introduce and discuss the relevant background information on the study from the available literature.

2.2 Work-related musculoskeletal injuries

Musculoskeletal Disorders (MSDs) are disorders or injuries (MSIs) that affect the human body's movement or musculoskeletal system, i.e. muscles, tendons, ligaments, joint complexes, nerves, etc. These injuries develop over time and can be episodic (lasting for brief periods at a time) or chronic (continuously lasting for longer periods). Though they are seldom life-threatening conditions, they do significantly impair the quality of one's life. Due to the low mortality rate, healthcare systems underestimate the impact and burden of MSDs on the growing global population (Hoy et al. 2015).

An analysis of the data from the World Health Organization (WHO) Global Health Estimates database, taken from 2000-2015, in five-year intervals, has shown a steady increase in MSDs among the global population (Sebbag et al. 2019). In 2015, MSDs were the second cause of disability globally, after psychiatric disorders (World Health Organization 2016).

The main cause of MSDs is the performance of strenuous work-related tasks (Middlesworth 2020). As defined by the Center for Disease Control (CDC), work-related musculoskeletal injuries (WRMSI) are MSD conditions in which:

1. The work environment and performance of work contribute significantly to the condition; and/or
2. The condition is made worse or persists longer due to work conditions (CDC 2020).

The worldwide burden of WRMSI can be quantified using disability-adjusted life years (DALYs). DALYs are a combination of years lived with disability (YLD) and years of life lost (YLL) through premature death (WHO 2020). Essentially, DALY is expressed as the cumulative number of years lost due to illness, disability or early death (WHO 2020; Sebbag et al. 2019). It is estimated that within the 15 years from 2000-2015, 80 million to 107 million DALYs have been lost due to WRMSI (Sebbag et al. 2019; WHO 2016).

It is therefore a burden of disability rather than premature death that WRMSI poses, along with substantial economic ramifications. For instance, as the working population ages, there is increasing economic need for later retirement, i.e. people tend to retire later so as to make more money (Oakman and Wells 2016), however, once injured and away from work, older workers take longer to return and have been shown to require further periods of absence from work following injury (Bevan 2015; Berecki-Gisolf et al. 2012). This results in considerable healthcare and compensation expense to the industry, in addition to loss of income and early retirement of the employer (Van Rijn et al. 2014; Lahelma et al. 2012).

Sebbag et al. (2019) observed a strong correlation between countries that have a higher gross domestic profit per capita, i.e. higher-earning countries, and a higher burden of WRMSI. This is supported by the European agency for safety and health at work (EU-OSHA), showing Germany, Denmark, France and Finland among the countries reporting high worker-MSD injuries (EU-OSHA 2019:7).

Safe Work Australia reported WRMSI costs in 2012-2013, totaling more than $24 billion, and 125 000 compensation claims in 2015-2016, resulting in incapacity and absenteeism from work for a week or more (Oakman, Clune and Stuckey 2019:10). In the years 2018-2019, Great Britain saw 498 000 workers suffering from WRMSI, both new and long standing injuries (Health and Safety Executive 2019:2). This was further exacerbated by the loss of 6.9 million working days due to WRMSI conditions (Health and Safety Executive 2019:4).

Common areas affected by WRMSIs are (WHO 2019; Hoe et al. 2012):

- Lower back
- Neck
- Wrist and/ or hand
- Shoulder

The Global Burden of Disease 2010 report ranks lower back pain as the leading cause of disability, ahead of 290 other conditions (Hoy et al. 2015). Nevertheless, more recent studies highlight the growing prevalence of upper extremity injury in the working population ranging from 19% to 30% (Hoe et al. 2012).

While no agreed classification exists, upper extremity work-related musculoskeletal injuries (UE-WRMSIs) commonly involve the neck and upper limbs, which include the shoulders, upper arms, elbows, forearms, wrists, and hands (Occhionero, Korpinen and Gobba 2014; Hoe et al. 2012; Buckle and Devereux 2002). These structures are most often involved during various work tasks across many professions, while being exposed to repetitive and/ or forceful actions, such as twisting, bending, pulling and squeezing (National Institute of Occupational Safety and Health 2018; Occhionero, Korpinen and Gobba 2014).

UE-WRMSIs can be divided into specific conditions and non-specific conditions. Specific conditions have clear diagnostic criteria and pathological findings (Table 2.1) (Occhionero, Korpinen and Gobba 2014; Hoe et al. 2012; Buckle and Devereux 2002).

Table 2.1: Specific UE-WRMSIs

Specific condition	Example
Tendon related disorders	Tendonitis, Tendonosis
Peripheral nerve entrapment	Carpal tunnel syndrome
Neurovascular/ vascular disorders	Hand-arm vibration syndrome
Joint/ joint capsule disorders	Osteoarthritis

However, with non-specific conditions, the main complaint is pain and/ or

tenderness, with limited or no pathological findings (Occhionero, Korpinen and Gobba 2014; Hoe et al. 2012; Visser and van Dieën 2006), such as delayed onset muscle soreness (DOMS) (Lewis, Ruby and Bush-Joseph 2012).

2.3 Pathophysiology of WRMSI

Based on the conceptual model developed by Barbe and Barr (2006), on the tissue and behavioral changes associated with WRMSI, three primary pathways are identified:

(1) CNS reorganization

(2) Tissue injury, and

(3) Tissue reorganisation

Figure 2.1: Tissue and behavioural changes associated with WRMSI (Adapted from Barbe and Barr 2006)

For the purposes of this study, we will only be focusing on the tissue changes and not the behavioural changes.

The primary pathways arise as a consequence of repetitive and/or forceful

tasks. Tissue injury occurs, leading to acute inflammation, which activates cellular mechanisms related to healing. However, the recurring cycle of tissue trauma induced by repetitive forceful activity impedes cellular repair (McCance and Huether 2019:1428).

This stimulates a chronic inflammatory response with associated immune cell activity, causing secondary tissue injury and resulting in a fibrogenic response. Injured tissues release cytokines (proteins involved in mediating the immune response, inflammation, bone resorption, etc.) into the blood stream stimulating a systemic and global response leading to tissue reorganization (McCance and Huether 2019:1428; Visser and van Dieën 2006).

Pathological remodeling occurs due to the widespread increased macrophage presence, along with local and distant tissue sensitization. The fibrotic changes along with the pathological remodeling result in a reduced tissue biomechanical tolerance (McCance and Huether 2019:1428; Visser and van Dieën 2006). Motor and sensory changes, including pain, develop as a consequence – the extent of which is dependent on duration and forcefulness of task performance.

Central nervous reorganization as described by Barr, Barbe and Clarke (2004) refers to the neuroplasticity resulting from the performance of highly repetitive tasks, both in the presence and the absence of chronic pain, peripheral tissue inflammation, and/or peripheral nerve compression. The neuroplasticity (neurological ability to form and reorganise synaptic connections in response to injury, learning or experience) interferes with normal sensation and motor control, further exacerbating the effects of continued exposure to repetitive tasks.

These pathways have several interaction points and interconnections (Figure 2.1), which ultimately lead to pain, discomfort and, in severe cases, the loss of motor and/or sensory function.

2.4 Risk factors associated with WRMSI

A systematic review of the literature by da Costa and Vieira (2010) outlined several factors associated with WRMSI, such as:

- Repetitive motion
- Excessive force
- Awkward and/or sustained postures, such as bending, reaching, rotating and straightening

A more recent review of the literature by Vieira et al. (2016) proposed the following additional risk factors:

- Lifting or transferring dependent patients
- Performing manual therapy
- Treating excessive amounts of patients per day
- Limited recovery times
- Age: younger
- Gender: female

Though these factors are not primarily harmful, continual repetition has the potential for injury, which may be compounded by the speed and force of the movements and the limited recovery period between injuries (Health and Safety Executive 2019:2; Vieira et al. 2016; Holm and Rose 2006; Bonde et al. 2005; Cromie, Robertson and Best 2000; Bork et al. 1996). Several authors have suggested a higher risk for injury among young female workers (Vieira et al. 2016; Pereira 2009; Holm and Rose 2006; Bork et al. 1996). These factors usually act collectively to cause injury to the musculoskeletal system.

Therefore, professions performing continual repetitive movement with force directed through smaller body parts, i.e. hand/ wrist, along with a work-pace not permitting adequate recovery time, are at increased risk of developing WRMSIs (Vieira et al. 2016; Darragh, Campo and King 2012; da Costa and Vieira 2010; Downie et al. 2010; Ndetan et al. 2009b; Bonde et al. 2005).

2.5 WRMSI in Healthcare specialists

Many healthcare professions perform regular daily activities that fall within the risk factors for WRMSI. For instance, there is a higher prevalence of WRMSI in manual therapists, due to their labour-intensive and physically demanding work-activities (Vieira et al. 2016; Ndetan et al. 2009a; Cromie et al. 2000; Bork et al. 1996).

Occupational therapists (OTs), physical therapists (PTs) and chiropractors share common therapeutic practices, such as patient transfers, repositioning and lifting; and manual therapy – such as mobilisation techniques, passive stretching techniques, soft tissue work and orthopedic techniques (Anderson and Oakman 2016; Vieira et al. 2016; Darragh, Campo and King 2012). These professions have also been shown to share similar prevalence's of WRMSI.

Earlier studies by Bork et al. (1996), Cromie et al. (2000) and 68% by Glover et al. (2005) have reported relatively high lifetime prevalence's of WRMSI among PTs: 61%, 91% and 68% respectively. The authors collectively report the low back, neck and shoulder as the areas most injured during work activities (Glover et al. 2005; Cromie at al. 2000; Bork et al. 1996).

In a study investigating the prevalence of WRMSI among PTs and OTs over a three-year period, Darragh, Huddlestone and King (2009) reported an almost identical overall prevalence of 33.5% for OTs and 33.0% for PTs. The two professions shared common areas of injury, i.e. low back, neck, hand and shoulder. Darragh, Huddlestone and King (2009) further determined comparable injury incidence rates of 16.5/100 (OTs) and 16.9/100 (PTs).

This observation was further noted by Jang et al. (2006), who found 71% of massage therapists experienced at least one work-related injury, of which the thumb and wrist were the most commonly injured areas. This was not surprising as massage therapists spend more time performing forceful and sometimes

awkward hand manoeuvres during their therapy than other manual therapists (Darragh, Huddlestone and King 2009; Holm and Rose 2006; Jang et al. 2006).

It can therefore be surmised that most common areas of injury tend to be associated with specific job-related tasks of each occupational population. This is supported by a recent systematic analysis of the literature by Anderson and Oakman (2016) to determine prevalence and risk factors for WRMSI in Allied health professionals. These included professions such as PTs, OTs, chiropractors, speech pathologists, prosthetists and orthotists, dieticians, sonographers, social workers, osteopaths, audiologists, radiologists, exercise physiologists and perfusionists. For example, OTs, PTs and chiropractors performing manual therapy reported pain and discomfort in the fingers and hands, while sonographers reported the highest prevalence of shoulder injuries (Anderson and Oakman 2016).

This stands to support the proposed causal relationship between manual therapy and the reported prevalence of WRMSI, concerning the hand and wrist (Rozenfeld et al. 2010; Campo et al. 2009; Darragh, Huddlestone and King 2009; Holm and Rose 2006; Bork et al. 1996).

2.6 Chiropractic

The World Federation of Chiropractic (WFC) defines chiropractic as:

"A healthcare profession concerned with the diagnosis, treatment and prevention of mechanical disorders of the musculoskeletal system and effects of these disorders on the functions of the nervous system and general health. Manual treatment is emphasized and includes spinal adjustments and other joint and soft-tissue manipulation," (World Federation of Chiropractic 2001).

Chiropractors diagnose and treat the human body by the application of manipulation/ adjustments, manual, mechanical and dietetic methods, including the use of therapeutic modalities, orthotics, supportive appliances and diagnostic X-ray (AHPCSA). Chiropractors are primary healthcare providers

(under the Act 63 of 1982) specialising in the diagnosis and non-invasive treatment of neuro-musculoskeletal conditions (AHPCSA 2020, CASA 2020).

A primary tenet of chiropractic is the use of the adjustment in treatment of neuro-musculoskeletal conditions. An adjustment is defined as a manual technique that uses the application of force and leverage, directed and concentrated at specific anatomical areas or joints, to bring about a therapeutic effect, usually an increase in range of motion and pain relief (Byfield 2012; Triano, Descarreaux and Dugas 2012; Herzog et al. 2010; Gatterman 2005; Swinnen et al. 1993). These manoeuvres are performed with a high velocity and low amplitude (HVLA), to move a joint beyond its physiological range of motion taking care not to surpass the anatomical limit (Bergmann and Peterson 2011; Gatterman 2005).

The adjustment or manipulation is highly complex and requires bimanual, i.e. left and right sides, coordination of both upper and lower limb, as well as postural control to administer safely and effectively (Triano, Descarreaux and Dugas 2012; Herzog et al. 2010; Swinnen et al. 1993). When applied to the spinal column, it is referred to as spinal manipulation (SM) or spinal manipulative therapy (SMT).

For instance, during a simple SM (e.g. Figure 2.2 A), the practitioner performs a timely body weight transfer off from the lower limbs to the upper extremities, as force is transmitted to the patient via the hand, with minor postural change (Bergmann and Peterson 2011:201). Whereas during a more complicated SM (e.g. Figure 2.2 B) the practitioner couples timed body weight transfer, muscular effort, and asymmetric postures – while simultaneously controlling patient positioning (Bergmann and Peterson 2011:249).

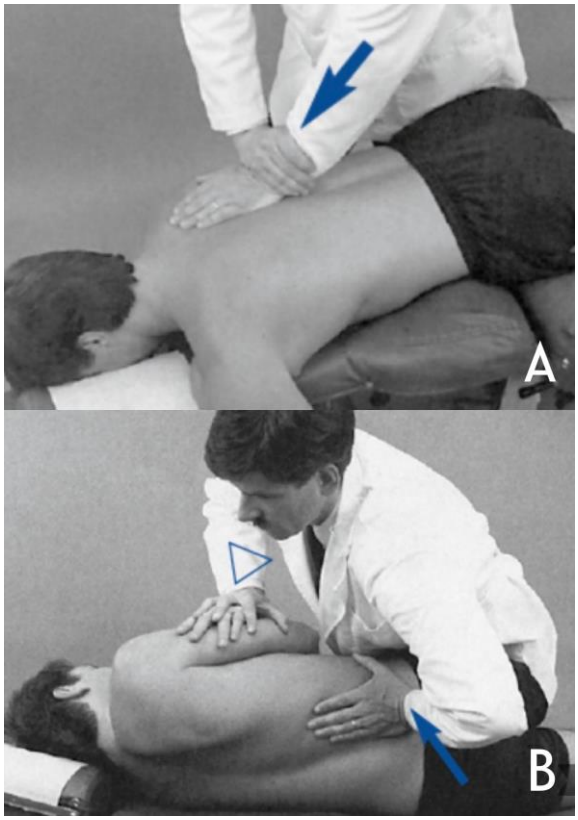
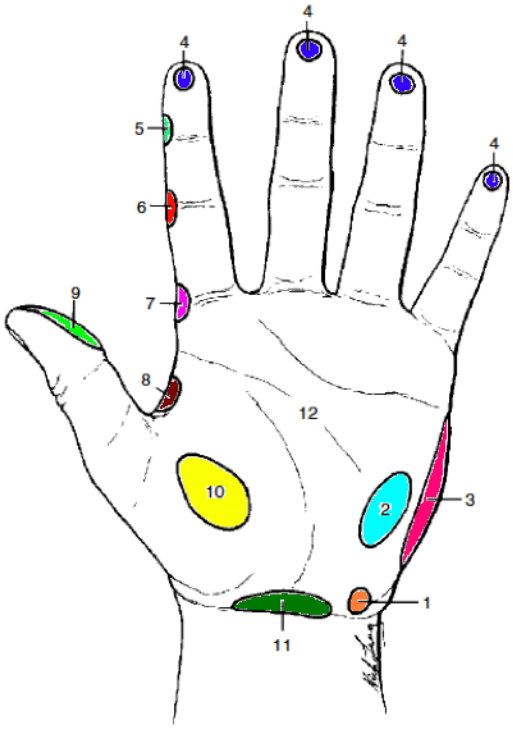


Figure 2.2: A – prone thoracic flexion, B – side lying lumbar roll (Adapted from Bergmann and Peterson 2011: 201,249).

In both instances, the hand is an important short lever between the practitioner and the patient. Although the hand does not contribute to the applied force, it and its structures act as a conduit for force transfer. The strength and flexibility of the hand allows it to twist and assume awkward positions when adjusting, depending on the clinical situation (Byfield 2012:63; Bergmann and Peterson 2011:326; Gatterman 2005:144).

For example, a pisiform contact (Figure 2.3) often requires the wrist to radially deviate to assume proficient contact when adjusting the spine, whereas a thumb contact (Figure 2.3) requires a relatively rigid hand position (Byfield 2012:63; Bergmann and Peterson 2011). Several authors have agreed there are roughly twelve areas on the hand that can be used as contact or transfer points during manipulation (Byfield 2012:59; Bergmann and Peterson 2011:63; Gatterman 2005:144; Byfield 1996). These range from a precise focal contact, such as the pisiform and digital contact, to a broad generalized contact such as the hypothenar or thenar contact (Figure 2.3).



1. Pisiform
2. Hypothenar
3. Metacarpal (Knife-edge)
4. Digit
5. Distal interphalangeal (Index)
6. Proximal interphalangeal
7. Metacarpophalangeal (Index)
8. Web
9. Thumb
10. Thenar
11. Calcaneal
12. Palmar

Figure 2.3: Contact points of the hand for adjustments
(Adapted from Bergmann and Peterson 2011:135)

The use of a precise contact point ensures the adjustment is directed to its intended target, however, this does allow for the smaller structures of the hand to be vulnerable to injury from the large forces generated by HVLA adjustive procedures.

There have been studies done on chiropractors investigating the loads created at the doctor-patient interface during SMT. For example, previous studies reported peak contact force magnitudes at the doctor–patient interface, ranging from about 200N to 60N in similar thoracic manipulations performed at the level T4 (Herzog et al. 1993; Gál et al. (1997) investigated vertebral movements in un-embalmed cadavers and reported mean peak forces of 509N (at T10), whereas Kirstukas and Backman (1999) report mean peak contact forces of as high as 863N - 1315N (around T8).

A similar study by van Zoest and Gosselin (2003) measured three-dimensional (3D) manual contact forces at the doctor-patient interface during cervical, thoracic, and sacroiliac adjustments.

The various force outputs for the relevant spinal levels showed similar readings to that of previous studies and are listed below:

- Cervical 116 newtons (41N to 193N)
- Thoracic 732 newtons (238N to 1315N)
- Lumbar 305 newtons (187N to 496N)
- Sacroiliac 378N (220N to 550N)

Chiropractors perform rotation, forward and lateral flexion movements during SMT, coupled with thrusting forces of 100-1000N magnitudes imparted through focal areas of the hand (Byfield 2012; van Zoest and Gosselin 2003). This acts collectively to increase the load and strain on the various structures of the upper extremity, especially through the hand and wrist, leaving it susceptible to WRMSI (Byfield 2012; Darragh, Campo and King 2012; Bergmann and Peterson 2011; Herzog 2010; Ndetan et al. 2009).

2.7 Chiropractic and WRMSI

Chiropractors are exposed to repeated lifting, bending, twisting, and reaching when performing various therapeutic procedures on their patients (Anderson and Oakman 2016; Byfield 2012; Gyer, Michael and Davis 2017; Holm and Rose 2006; Triano, Descarreaux and Dugas 2012). This creates continual demands on the musculoskeletal system of the practitioner, risking pain and/ or injury to the low back, as well as the shoulders, wrists, and thumbs (Gyer, Michael and Davis 2017; Anderson and Oakman 2016; Byfield 2012; Triano, Descarreaux and Dugas 2012; Holm and Rose 2006).

Studies done on chiropractors propose a possible relationship between the profession and injury. For example, a study published in 1987, on Canadian chiropractors (n=320), found 87% reported back pain, of which 74% were cases of low back pain (Mior and Diakow 1987). Mior and Diakow (1987) found low back pain was more frequently reported by male practitioners (59%), as compared to female practitioners – who reported a higher prevalence of thoracic spine pain (79%).

Holm and Rose (2006) found (n=397) 40% of American chiropractors had experienced at least one WRMSI during their career, with 37% occurring within the first five years of practice. Most injuries reported were of soft tissue structures with the most commonly affected body parts being the wrist, hand, finger (42.9%), shoulder (25.8%) and low back (24.6%). Most of the soft tissue injuries occurred while performing adjustive procedures (67%) on the patient.

Similarly, a study in the United Kingdom found 51.7% of chiropractors reported having at least one WRMSI during their career, with the most frequent complaints being the shoulder (28%) and low back (23%) (Acott-Smith 2018). The results showed that two out of three chiropractors reported the injury having occurred within the first five years following graduation (Acott-Smith 2018).

This is further supported by the work of Hansen et al. (2018), who found 61% of Danish chiropractors (n=376) experienced WRMSIs, most commonly in low back, wrist thumb and shoulder. Overuse complaints were more frequent in females and among practitioners with less than five years in practice.

Lastly, a recent study conducted by Lamprecht and Padayachy (2019) determined the prevalence of WRMSI of chiropractors in the eThekwini Municipality (SA). The results showed 69% lifetime prevalence among practitioners, with majority of injuries affecting the soft tissues of the upper extremity (50%), more specifically the hand/ wrist (31.5%) (Lamprecht and Padayachy 2019). Furthermore, 38.2% of injuries occurred during adjustive procedures and 41.6% of injuries occurred within the first five years of practice (Lamprecht and Padayachy 2019).

2.8 Chiropractic education in SA

The study of chiropractic is currently offered in two educational institutions in the continent of Africa – Durban University of Technology and University of Johannesburg (World Federation of Chiropractic 2020). Both these institutions for higher learning run chiropractic programmes that are internationally accredited by the Council on Chiropractic Education International (CCEI),

through the European Council on Chiropractic Education (ECCE). For a student to qualify as a doctor of chiropractic, they need to complete a Masters degree, as well as an internship programme instituted by the Allied Health Professions Council of South Africa (AHPCSA) (AHP Act 63 of 1982).

The World Federation of Chiropractic (WFC) recognizes chiropractic education and training programmes if they adopt the CCE standards and require a minimum of four years of full-time university education. The DUT Chiropractic programme currently offers three qualification levels:

1. National Diploma of Technology (N. Dip.) Chiropractic (first to third year year)
2. Bachelor of Technology (B. Tech.) Chiropractic (fourth year)
3. Master of Technology (M. Tech.) Chiropractic (fifth year and above)

Though, for full qualification, the exit level is a Masters degree (ECCE 2020; Department of Chiropractic and Somatology 2019).

It is in the third year of study that students undergo training in chiropractic adjustive techniques, as well as various other manual therapies and rehabilitation procedures. Students also undergo training in the use of auxiliary therapeutics, including modality use, massage and temperature therapy.

During the fourth year of study, students experience their preclinical training – which includes diagnostic rounds in a hospital, observational programmes in clinic and the performance of a mock-patient assessment at the end of the year. During this year, students undergo a continuation of adjustive techniques and manual therapies training, with more emphasis on psychomotor skill development.

The fifth year of study brings with it a challenge of balancing an academic year of study with the responsibility of clinical and research tasks. The students begin treating patients at the day clinic, according to an alternating shift allocation throughout the year, and are required to see a certain number of cases in order to qualify. If these cases are not completed, then students continue clinical residency in the following year. Masters students are also

required to treat at satellite community clinics. The adjustment technique training is ongoing in the fifth year and includes techniques of treating the extremities and temporomandibular joint.

Chiropractic students are encouraged to treat at sporting events as early as the end of their fourth year. These events are mandatory for Masters students and offer many advantages. For example, these events have large participation numbers, allowing students to be able to treat a greater quantity of patients at the event than at the day clinic, aiding the development of doctor-patient rapport and clinical competence. However, due to the high volume of patients being treated per student and the limited rest times between patients, students often report symptoms of work-related musculoskeletal injury of the low back and upper extremity.

Chiropractors must demonstrate foundational knowledge acquired through formal education that will prepare them for chiropractic practice upon graduation. This training positions chiropractors as part of the health care team through which they make a unique contribution to improving the health of patients and their communities. A chiropractor is able to apply appropriate clinical skills in the treatment of a patient and to provide information and advice for a healthy lifestyle and continued health. A chiropractor, therefore, must establish and maintain clinical knowledge, skills and attitudes appropriate to chiropractic practice.

2.9 Previous Studies on WRMSI of Chiropractic students

In the existing literature, there are studies that have been done on chiropractic students with regards to injury during their training, reporting similar findings to those done on chiropractic practitioners. For example, the earliest study was conducted by Macanuel et al. (2005), who surveyed Canadian chiropractic students and found 43% of respondents (n=292) reported one or more injuries during their undergrad training. These injuries ranged from low back (35%), neck (28%) and upper back (12%), with 60% occurring during their second year of adjustment training (Macanuel et al. 2005).

A similar study conducted by Bisiacchi and Huber (2006) in Georgia USA, comparing male and female chiropractic students, found 32% of the 125 respondents reported one or more musculoskeletal injury. Female students were found to have a higher susceptibility to injury than male students, especially with wrist (17%) and shoulder injuries (13%) (Bisiacchi and Huber 2006). The results gathered by the researchers support the findings by Macanuel et al. (2005) and called for further research to be done (Bisiacchi and Huber 2006).

Similarly, Ndetan et al. (2009) identified female students being more likely to have a hand and wrist injury, whereas male students were more prone to neck and shoulder injuries. Some 46% of injuries sustained were as a result of administering adjustments and concerned the hand/ wrist (Ndetan et al. 2009). The reported prevalence of injury was 32% (n=572), with 44% being due to exacerbations of prior injuries (Ndetan et al. 2009).

Furthermore, Kuehnel, Beatty and Gleberzon (2008) conducted a collaborative survey of five international chiropractic colleges, investigating the prevalence of injuries among students during technique class. The names of the colleges were not included in the report to ensure anonymity and avoid any negative publicity that may result from the published data, and could only be identified by their country of origin. College A (Africa) reported a significantly lower prevalence of 7% (n=67) when compared to the other colleges: College B (USA) with a prevalence of 53% (n=81); College C (Europe) with 18% (n=143) and finally College D (Australia-New Zealand) with 22% (n=114). A major criticism of Kuehnel, Beatty and Gleberzon's (2008) study is the very limited reasoning for the difference in prevalence between colleges, attributing it only to "cultural factors", such as "expression of pain, what constitutes an injury and willingness of a student to report an injury", with no further clarification.

A more recent study conducted by Kizhakkeveettil et al. (2014), reported a significant relationship between role of adjustor and wrist/hand injury among the students at the Southern California University of Health Sciences. Kizhakkeveettil et al. (2014) noted a significantly higher prevalence of 71%

(n=126) among students, as compared to previous studies. The authors propose that undergraduate technique training often leads to injury that gets overlooked and calls for further research to be conducted with larger sample sizes (Kizhakkeveettil et al. 2014).

2.10 Conclusion

Against this background of studies, students performing their undergraduate chiropractic training possess novice skills with regards to adjustive techniques. The adjustive procedures they practice on each other are often delivered in the absence of clinical necessity, that leads to injury to both the adjustor and the recipient (Kizhakkeveettil et al. 2014; Kuehnel, Beatty and Gleberzon 2008; Mathews 2006; Macanuel et al. 2005).

Chiropractic students have been shown to experience similar injuries to those of their professional counterparts (Lamprecht and Padayachy 2019; Kizhakkeveettil et al. 2014; Holm and Rose 2006).

It is therefore important to determine work-related musculoskeletal injuries of the upper extremity, the prevalence of these injuries and the associated risk factors. This will help future efforts in designing a comprehensive and systematic protocol to prevent injury to training chiropractors.

CHAPTER THREE

MATERIALS AND METHODS

3.1 Study design:

The study was a quantitative, population-based survey utilising a descriptive questionnaire design which documented the upper extremity injuries of chiropractic students. The questionnaire was adapted from a study by Lamprecht and Padayachy (2019), which looked into profiling the work-related musculoskeletal injuries among chiropractors in the eThekwini Municipality.

The questionnaire was required to be efficient and effective in recording the student's injuries and data, thus a pilot study was utilised in the development process as to ensure the study was of good quality. Questionnaires are generally considered to be an appropriate method of research, providing accurate ways of ascertaining quantitative data (Patten 2016; Hicks 2004). Based on the above study design, this research was approved by the Faculty Research Committee (FRC) and Institutional Research and Ethics Committee (IREC) (Ethical clearance number: IREC 054/19) (Appendix A), which details that this research complies with the Declaration of Helsinki, 1975.

3.2 Study population

The study population consisted of chiropractic students registered at the Durban University of Technology. Students registered for fourth year, fifth year, and students completing their Masters dissertation were selected as the population.

3.3 Study recruitment

This study used the total available population made up of chiropractic students who were required to have completed the module Chiropractic Practice and Principles III (CHPP301) (Department of Chiropractic and Somatology Handbook 2019). This included students who also completed any/all of the following adjustment modules:

3.3.1 Chiropractic Principles and Practice IV (CHPP401)

3.3.2 Chiropractic Principles and Practice V (CHPP501)

3.3.3 Clinical Chiropractic V (CLCH501)

(Department of Chiropractic and Somatology Handbook 2019)

Students repeating modules CHPP401 and upward were allowed to participate, as long as CHPP301 had been completed (students repeating CHPP301 were not included in the study population).

3.4 Population size:

Eighty-six chiropractic students (n=86) were registered at DUT for fourth year and above, at the time that the research was conducted (Table 3.1). This study required the total available number of students in the population, rather than sampling, to be implemented, as determined by a biostatistician (Esterhuizen 2018).

Table 3.1: Population size and distribution

Fourth year	Fifth year	Senior years	**TOTAL**
30 students	27 students	29 students	**86 students**

3.5 Population characteristics:

3.5.1 Inclusion criteria:

- All participants must be registered for the chiropractic programme at DUT
- All participants must have completed Chiropractic Principles and Practice III - CHPP301
- Participants must read the Information letter (Appendix C) and sign the Informed consent form (Appendix D).

3.5.2 Exclusion criteria

- Participants who do not sign the informed consent form
- Students participating in the pilot study are to be excluded from the study
- Questionnaires that have incomplete data greater than 50% from Section B of the questionnaire

3.6 Study Procedure

Prior to commencement, full ethical clearance from IREC (Appendix A) and Gatekeeper's permission (Appendix B) was obtained. The lecturer of the fourth year and fifth year class was approached for permission to inform the students about the study and for collection of data at the end of the lecture period. Administering surveys in class, and to the entire student population, minimised the possibilities of errors due to bias in coverage and sample size, or low response rate (Patten 2016). The students were addressed briefly about the study and were offered the chance to participate. Any recipient who chose not to participate in the study, as well as those who did not meet the criteria for the study (3.4), were allowed to leave – with the remaining students becoming part of the study.

The students meeting the criteria were provided with the following: The Letter of Information (Appendix C), Informed Consent form (Appendix D) and the Study Questionnaire (Appendix E). Participants were allowed to complete the documents upon receiving them at the venue and were not allowed to remove the documents from the venue. Any participants who were unable to complete the document in the allocated time were given the chance to complete the questionnaire at the day clinic, with the researcher present, and the documents being kept by the researcher at all times prior to completion.

The completed questionnaires, as well as the informed consent form were attached to each other and placed in a box, and sealed, until full data collection had been completed. The letter of information and confidentiality statement were stored in a separate box and sealed.

With regards to the senior students, the researcher was stationed in a room at the day clinic and approached the students on duty personally. The students were informed briefly about the study and were offered the chance to participate. Student's that accepted were asked to complete the Letter of Information (Appendix C), Informed Consent form (Appendix D) and the Study Questionnaire (Appendix E). The researcher maintained the same document

storage procedure.

Any participants that were unable to be present at the time of data collection were allocated an alternative date for completion, at the discretion of the researcher, following the same procedure for data collection as previously stated.

3.7 Questionnaire development and background

The questionnaire was adapted from the questionnaire used by Lamprecht and Padayachy (2019), in a study investigating the epidemiology of work-related musculoskeletal injuries among chiropractors in the eThekweni Municipality. The participants were required to answer questions pertaining to the following: participant demographics, practice demographics and work-related musculoskeletal injuries. The questionnaire was modified in order to suit the student participants and, in particular, the research objectives (Appendix E). Permission for use of the questionnaire was granted by the author (Appendix K).

By using this validated questionnaire, it allowed for the maintenance of content validity that had been established by previous authors, ensuring bias is kept to a minimum and decreased chance of misinterpretation of results (Patten 2016; Hicks 2004). The questionnaire design employed a simple answering system using lickert scales, images that defined anatomical areas easily and limited open-ended questions. The questionnaire was divided into the following sections:

- Section A: Demographic data
- Section B: Single most severe upper extremity work-related musculoskeletal injury

This formed the pre-pilot study questionnaire.

3.8 Pilot study/ expert group

A pilot study (PS) is a small-scale version of the planned study conducted with smaller groups, similar to those included in the main study (Doody and Doody

2015). The PS is conducted to practice run and assess for any problems in effectiveness of data collection, and allow for changes to be made before the main study. After obtaining ethical clearance for the study, an expert group was convened to critically assess the questionnaire in terms of face validity and content validity, as well as to determine whether or not the research participants would be able to relate to the questionnaire and reveal any additional errors. It served as a trial run for the study. The PS consisted of the following members:

- The researcher (chairperson of the PS)
- The research supervisor who will act as a facilitator to the researcher
- Two fourth and/or fifth year chiropractic students
- Two/three senior Masters chiropractic students
- Three staff members who have conducted similar research/ supervised research students with similar studies

Each participant was required to read the Letter of information (Appendix F), read and sign the Confidentiality statement (Appendix I), Informed consent form (Appendix G) and Code of conduct (Appendix H). The participants then had the opportunity to raise any questions and verify that they comprehend what was required of them. All participants were then given the pre-pilot study questionnaire (Appendix J). The changes put forth by the PS were implemented to form the post-pilot study questionnaire which, upon approval by the IREC, had become the main study questionnaire (Appendix E).

3.8.1 Changes made to the pre-pilot study questionnaire

- Question 1: No changes
- Question 2:
    - 2.1 Reworded and simplified
    - 2.2 Options changed from “year of study” to “academic qualification”
    - 2.3 Additional module added
- 2.4 Changed to combine 2.3 and 2.4 from previous questionnaire into a single question
- 2.5 No changes

- 2.6 Additional options added
- 2.7 and 2.8 separated to avoid confusion with an additional section added for question 2.8 (Section C)

- Question 3: Section B
    - 3.1 Image added to avoid confusion
    - 3.2 No change
    - 3.3 No change
    - 3.4 Reworded and options grouped
    - 3.5 No change
    - 3.6 Options given to avoid open-ended replies
    - 3.7 – 3.9 No changes
    - 3.10
        - 3.10.1 Options given to avoid open-ended replies
        - 3.10.2 Options given to avoid open-ended replies
        - 3.10.3 Options given to avoid open-ended replies and image added
        - 3.10.4 – 3.10.10 No changes

- Question 4: Added under new Section C
    - 4.1 Adapted from question 3.1
    - 4.2 Adapted from question 3.2
    - 4.3 Adapted from question 3.10
        - 4.3.1 – 4.3.8 adapted from question 3.10.1 – 3.10.8

3.8.2 Face validity:

Face validity is a subjective, superficial assessment by those involved in the research, that indicates the degree to which a measurement procedure appears to be a valid measure of a given variable of construct (Salkind 2010:471) i.e. does the questionnaire answer the research question?

It examines whether the questionnaire seems clear cut, valid and easily interpreted by the participants of the PS (Doody and Doody 2015; Hicks 2004). This was established with the inclusion of chiropractic students who represent

the population in the pilot study, allowing them to evaluate the questionnaire and give feedback. These students were not allowed to participate in the main study.

3.8.3 Content Validity

Content validity refers to the extent to which the instrument must show that it fairly and comprehensively covers the domain or items that it purports to cover (Salkind 2010:238; Whisker 2001). This was achieved by rational analysis of the questionnaire, by the three expert staff members with experience in questionnaire research.

3.9 Data analysis

A statistician was consulted with regards to statistical analysis. IBM SPSS version 26.0 (Released October 2019) was used to analyse the data. Descriptive statistics, such as mean and standard deviation, were used to summarise continuous variables, while frequency tables reporting counts and percentages were used to describe categorical variables. Prevalence was estimated using 95% confidence intervals. Factors associated with injury were assessed at univariate level, using Pearson's chi square tests and t-tests, and factors associated at the <0.1 level were selected as independent variables in a multiple logistic regression model to predict risk of injury. A stepwise backward selection method, based on likelihood ratios, was used to arrive at a final model consisting only of statistically significant risk factors ($p<0.05$). Odds ratios and 95% confidence intervals were reported.

CHAPTER FOUR

RESULTS

4.1 Introduction

This chapter presents the results and the relevant findings of the study.

4.2 Response rate:

Eighty-six chiropractic students (n=86) were eligible at the time of ethical approval and data collection. From the 86, four students (one from fourth, one from fifth year and two from the seniors) participated in the pilot study and were excluded from the main study, resulting in a total available population of 82 (n=82).

Five students declined to participate and/ or did not respond to the invitation to the study. The total number of completed questionnaires was 77. The response rate was calculated as 93.9%.

4.3 Demographics

4.3.1 Age

The mean age of participants was 25 years (SD 3 years), with a range of 21-32 years.

Table 4.1: Age of respondents

Maximum	32
Minimum	21
Mean	25
Standard deviation	3

4.3.2 Gender

Gender distributions of participants are reflected in Figure 4.1 with majority being female (59.7%).

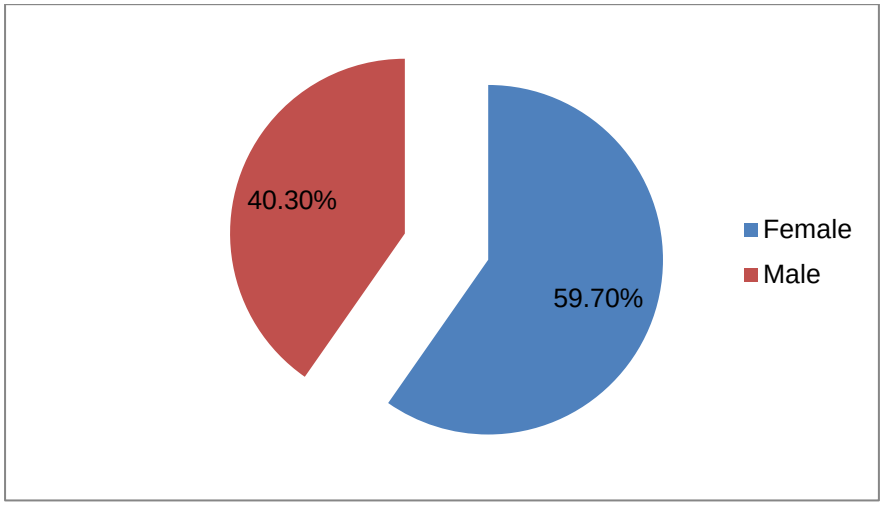


Figure 4.1: Gender of participants

4.3.3 Ethnicity

Table 4.2 reflects the majority of respondents were white (49.4%), Indian (23.4%) and African (18.2%).

Table 4.2: Ethnicity of participants

Race	Percentage
African	18.1%
Asian	2.6%
Coloured	6.5%
Indian	23.4%
White	49.4%

4.3.4 Current year of study

Figure 4.2 reflects the distribution of participants according to their year of study in the chiropractic program. The majority of students were from fourth year (37.7%), fifth year (28.6%) and sixth year (16.9%).

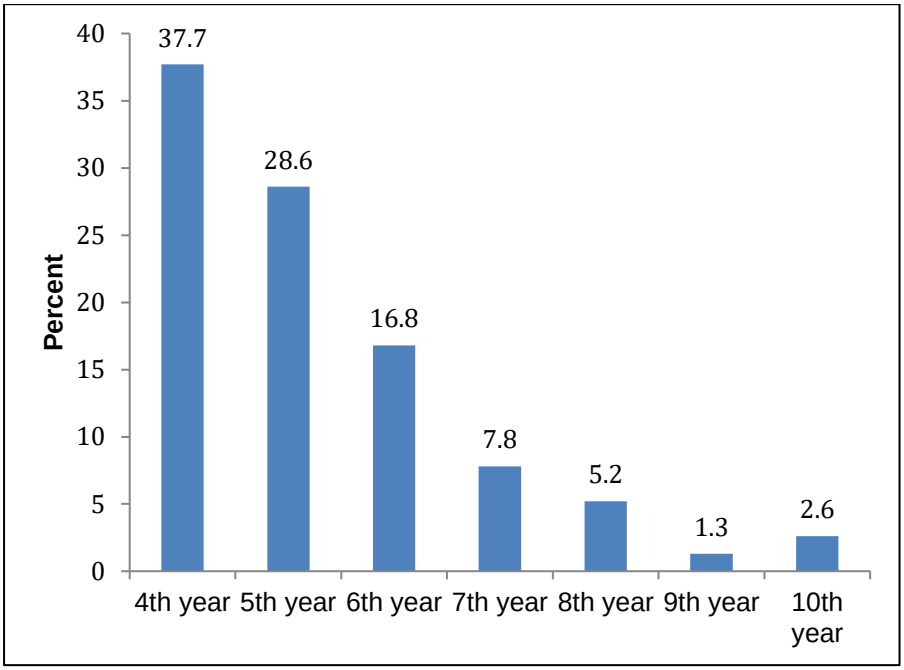


Figure 4.2: Current year of study in chiropractic program

4.3.5 Modules repeated

Figure 4.3 reflects the participants who have repeated modules during their academic progress. Chiropractic Practice and Principles III (CHPP301) was the module reported the most (13%), with the majority of participants having repeated none of the modules (74%).

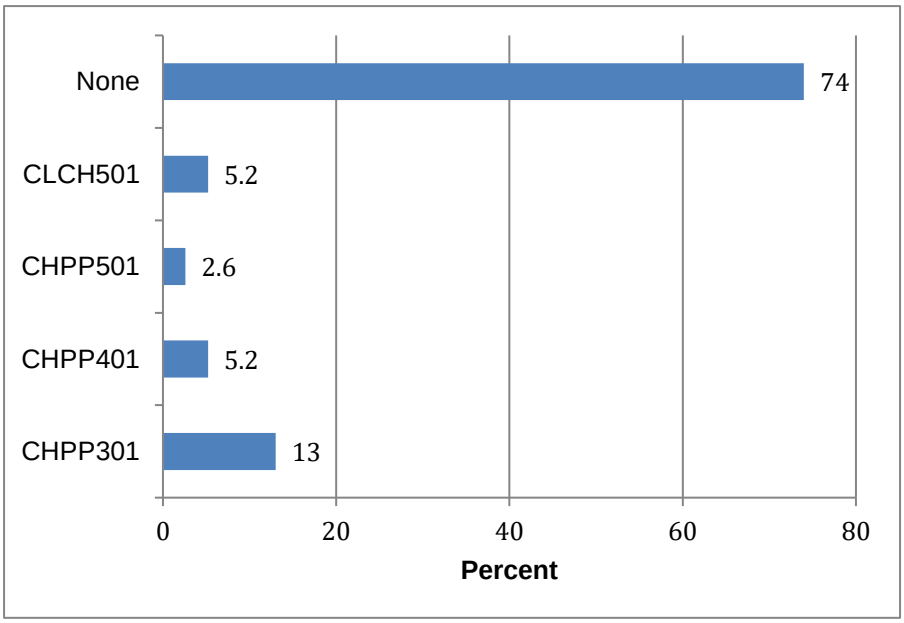


Figure 4.3: Modules repeated

4.4 Prevalence of upper extremity work-related musculoskeletal injury

The period prevalence of upper extremity work-related musculoskeletal injuries was 59.7% (95% CI 47.93 to 70.57%). This was a composite of both new injuries and old-aggravated injuries.

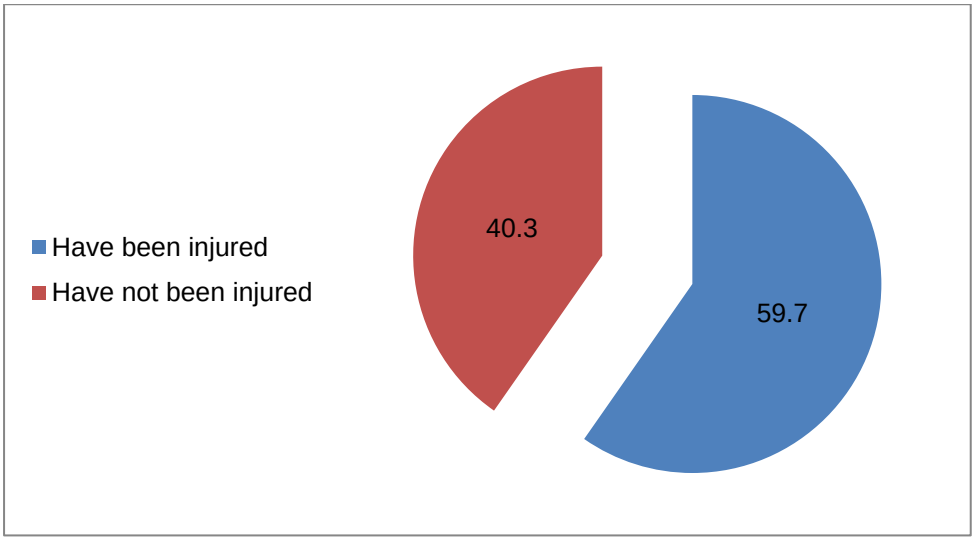


Figure 4.4: Prevalence of upper extremity work-related musculoskeletal injury

4.4.1 Prevalence of new injuries and old aggravated injuries

Figure 4.5 shows 46.8% of participants reported having a new UE-WRMSI and 26% reported having old-aggravated injuries. The two outcomes were combined into one composite outcome for overall prevalence.

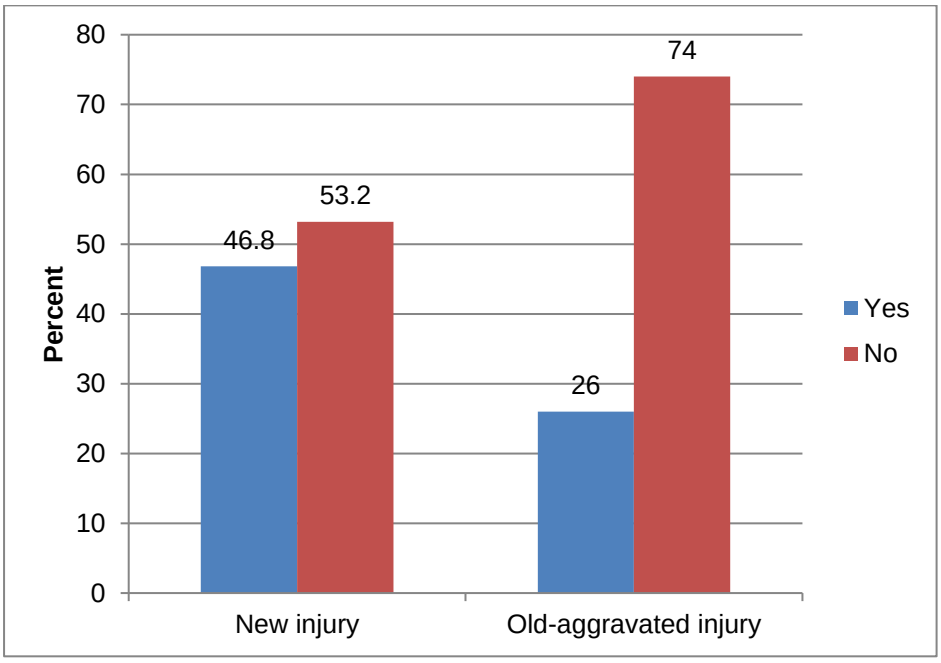


Figure 4.5: Prevalence of new injuries and old-aggravated injuries

4.5 Characteristics of new injury

4.5.1 Part of upper extremity injured

The wrist was the most commonly injured area, with 52.8% of injuries, followed by the shoulder with 19.3%, and the hand with 16.7% (Figure 4.6)

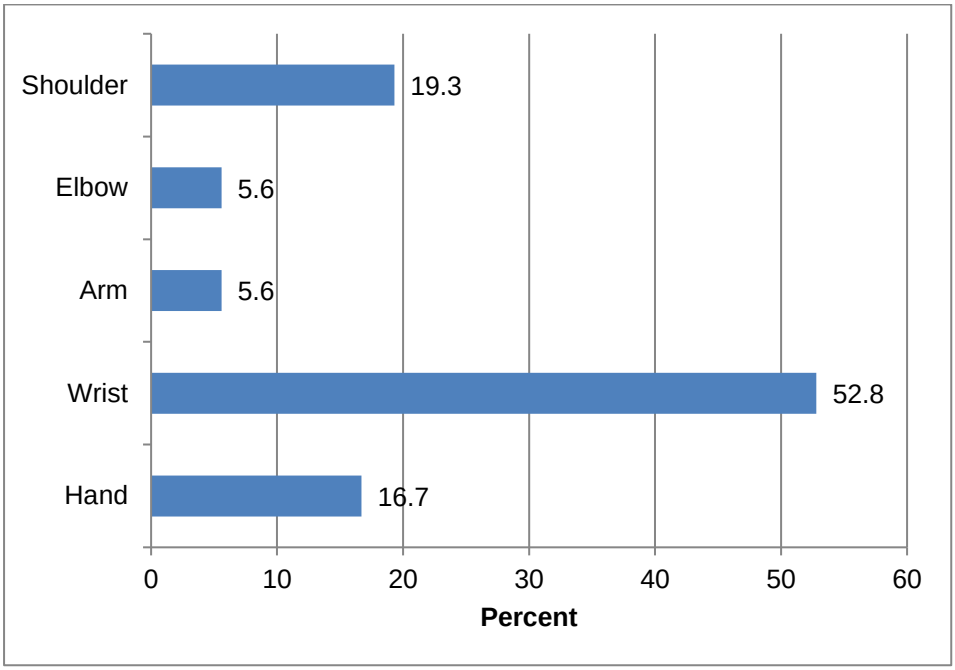


Figure 4.6: Part of upper extremity injured

4.5.2 Type of injury

Figure 4.7 shows the most commonly reported type of new injury (self-diagnosed). Muscle/ tendon strain (41.7%) and joint sprain (22.2%) accounting for the majority, whereas ligament sprain and tendinitis equally reported at 16.7%.

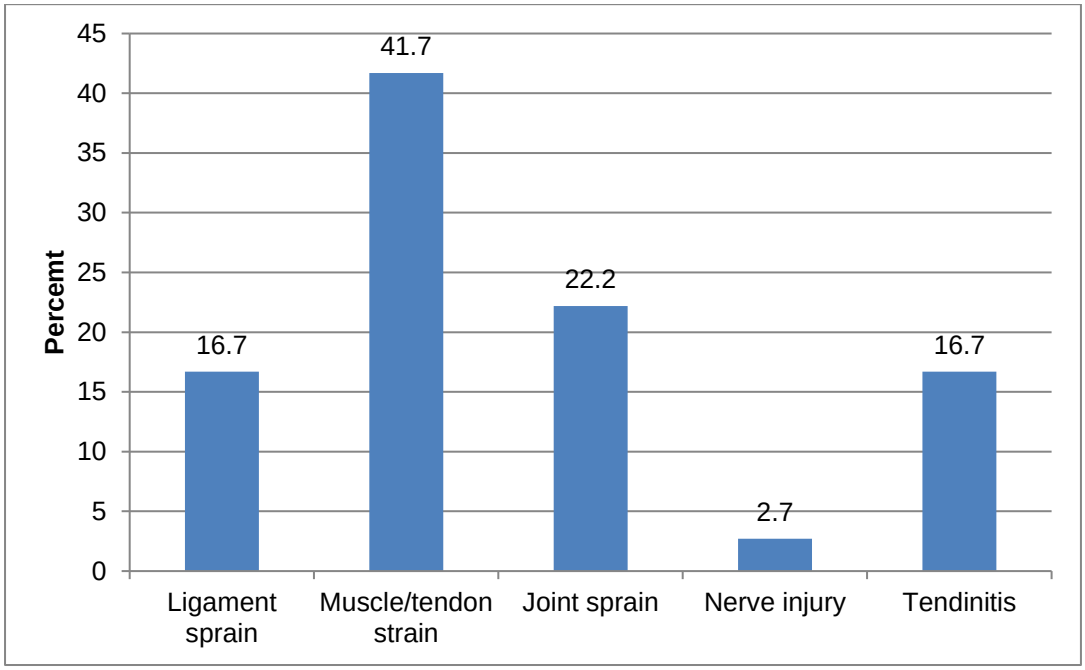


Figure 4.7: Type of new injury (self-diagnosed)

4.5.3 Symptoms of injury

Local pain (66.7%) and tenderness (25%) were the most commonly reported symptoms for new injury (Figure 4.8).

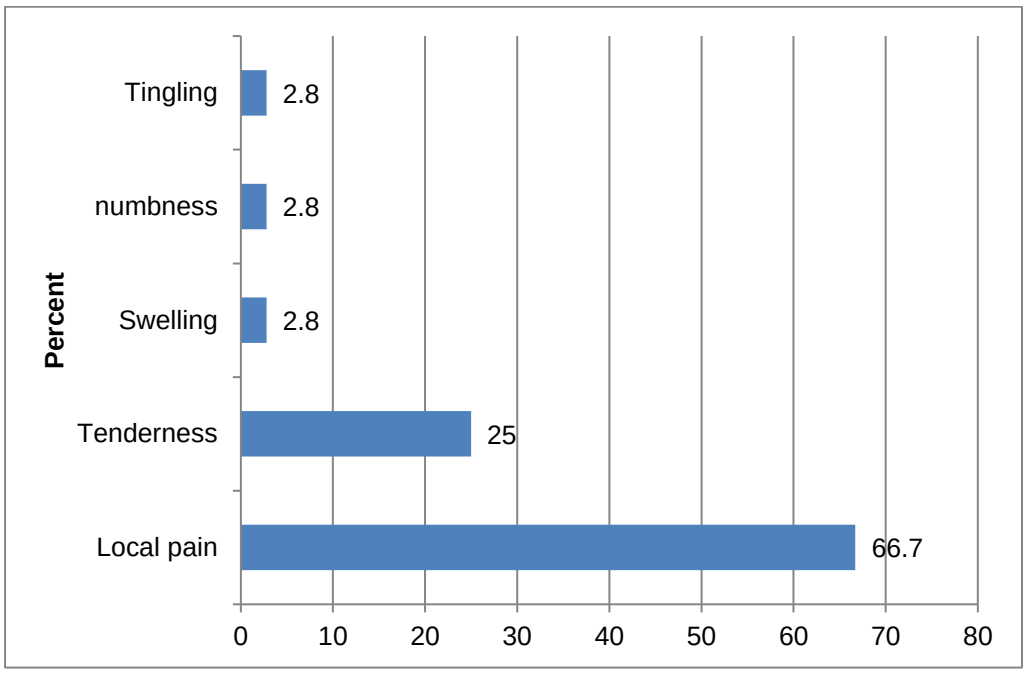


Figure 4.8: Symptoms of new injury

4.5.4 Length of new injury

Figure 4.9 shows the most common duration for new injuries reported to be chronic duration (61.1%), with 33.3% reporting acute duration.

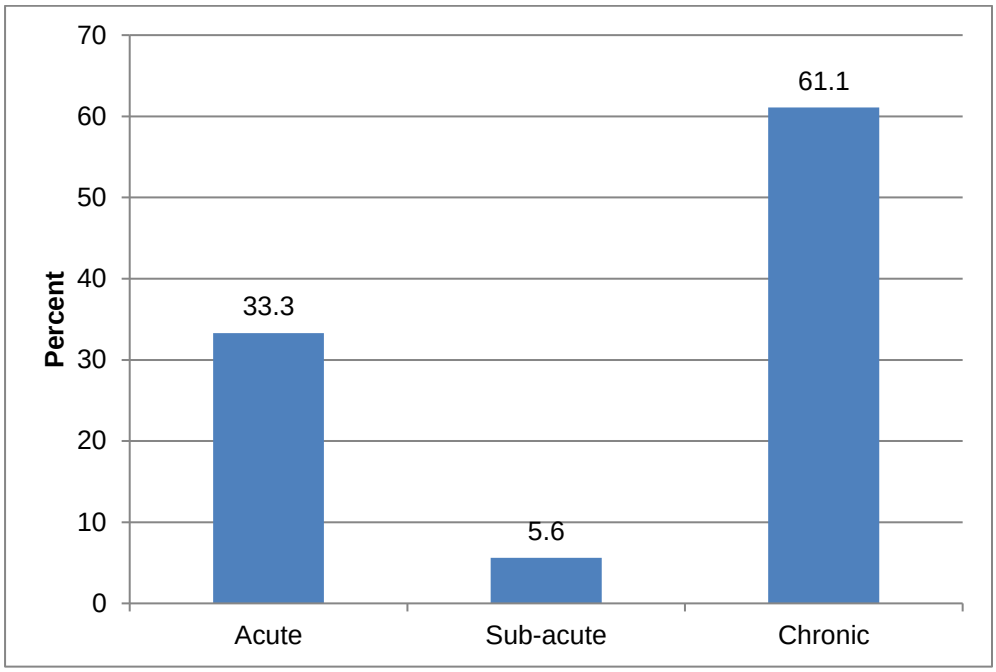


Figure 4.9: Length of new injury

4.5.5 Rating of extent of injury

Majority of the new injuries were rated as either moderate (67%) or mild (30%). 3% of new injuries were rated as severe in extent.

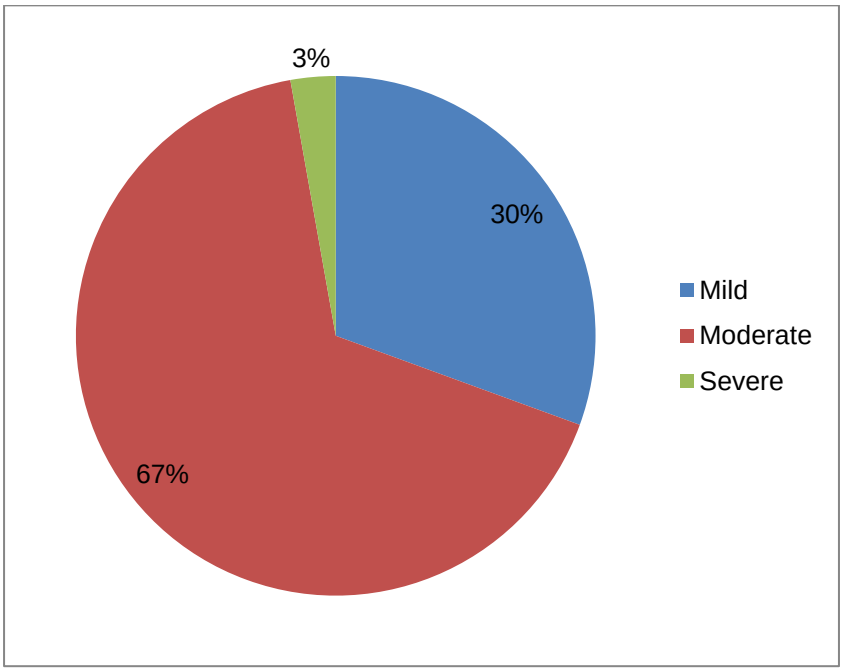


Figure 4.10: Extent of new injury

4.5.6 Activities of daily living

Figure 4.11 shows the activities of daily living affected by new injury. Exercise was far more interrupted by injury than any other activity, whereas bathing was unaffected.

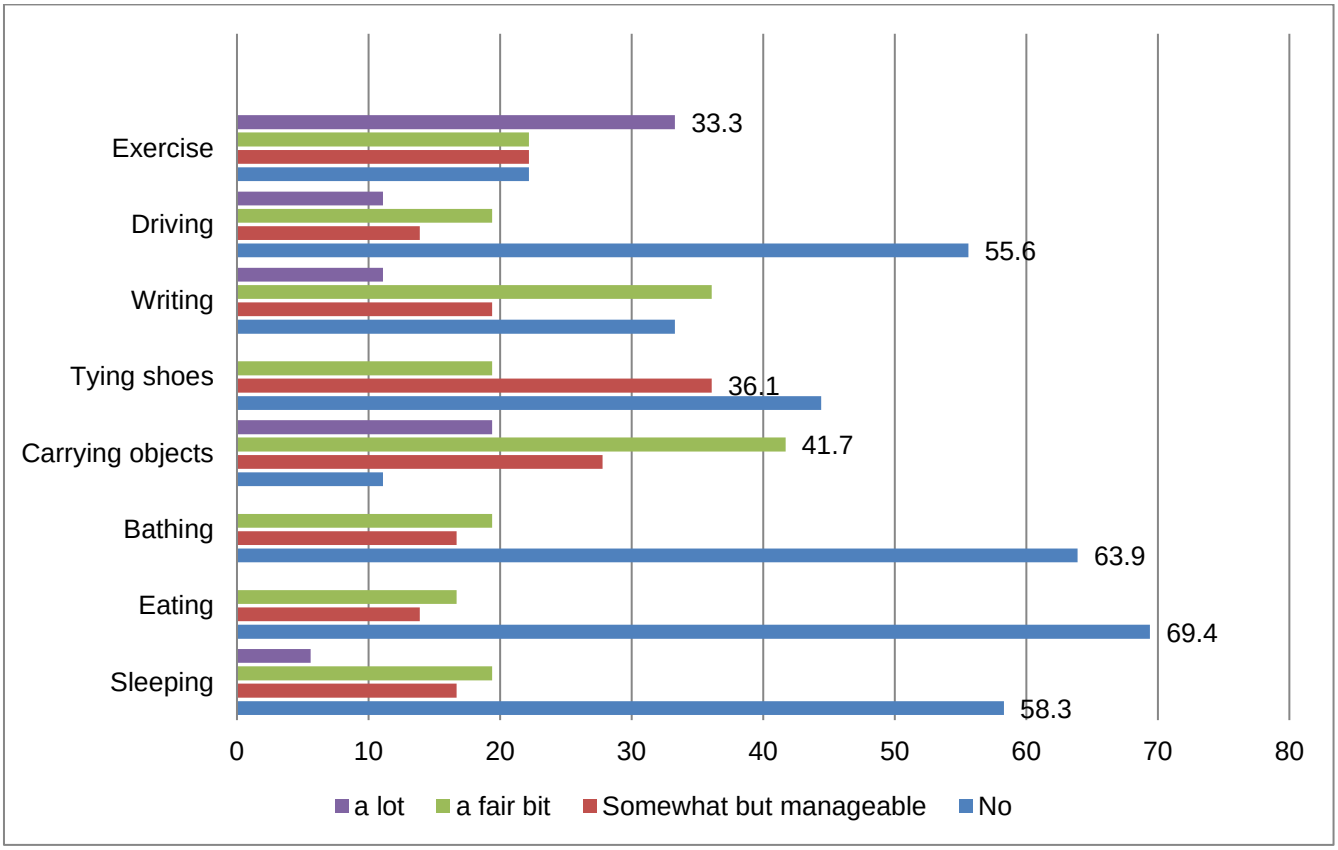


Figure 4.11: Activities of daily living disrupted by new injury

4.5.7 Activity causing new injury

Most new injuries reported were from performing adjustments (72%) and ischemic compression (22%) (Figure 4.12).

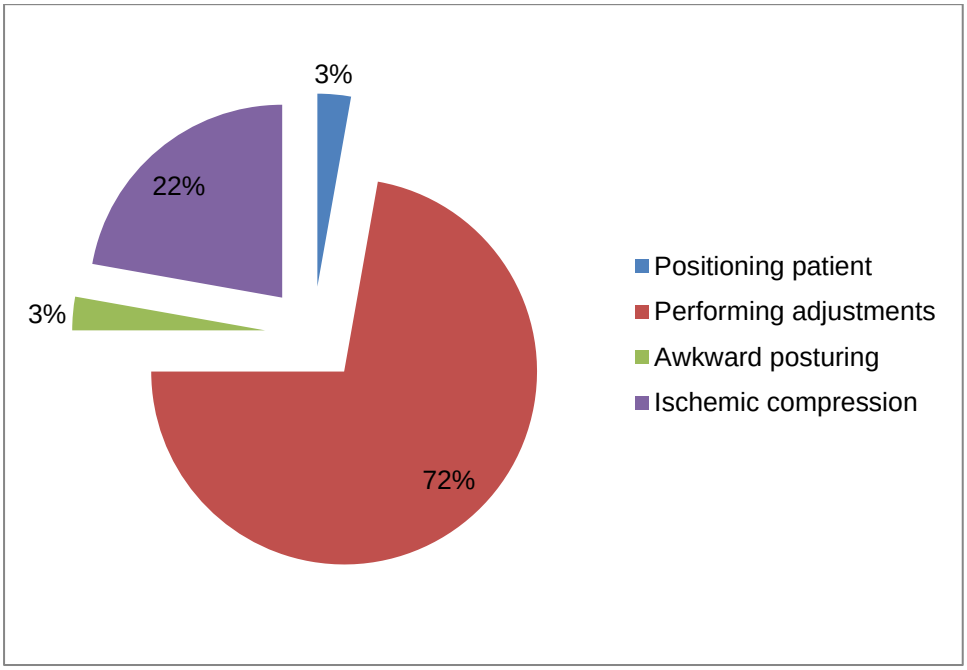


Figure 4.12: Activity causing new injury

4.5.8 Injury due to cramming for test

Most students (67%) were not injured during cramming for a test or exam (Figure 4.13)

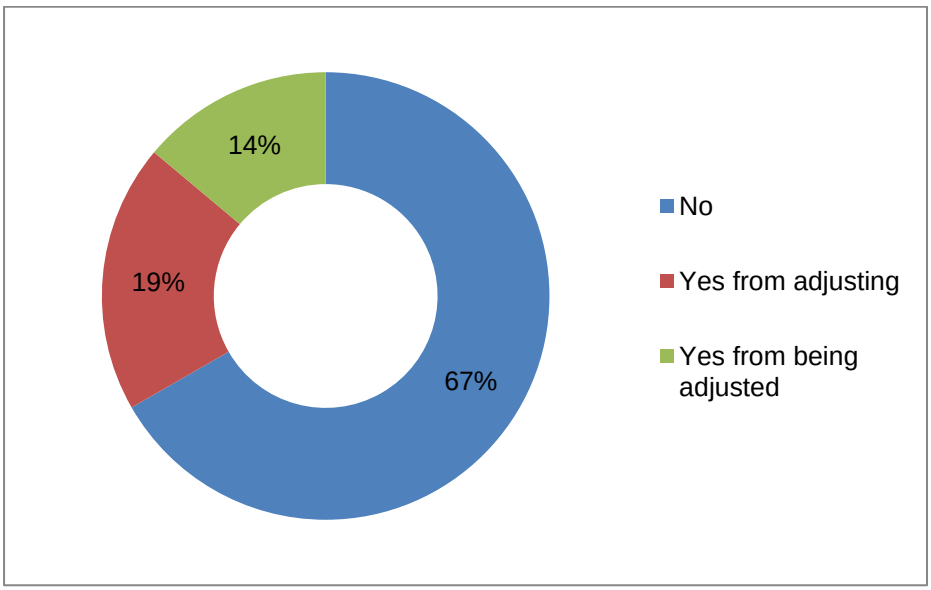


Figure 4.13: Test cramming for new injury

4.5.9 Area adjusting that caused injury

The lumbar (47%), thoracic (30%) and lower extremity (14%) were the areas most commonly manipulated when the new injury occurred (Figure 4.14)

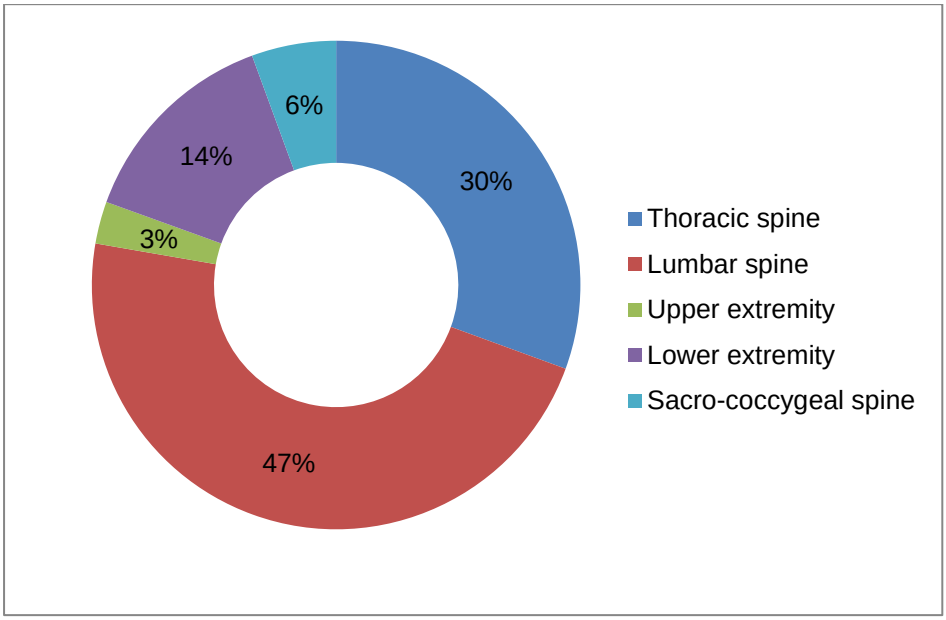


Figure 4.14: Area adjusted for new injury

4.5.10 Contact used during injury

The pisiform contact (63%) was most commonly reported in Figure 4.15, showing the contact points used for new injury, with thumb contact (17%) being the second most reported.

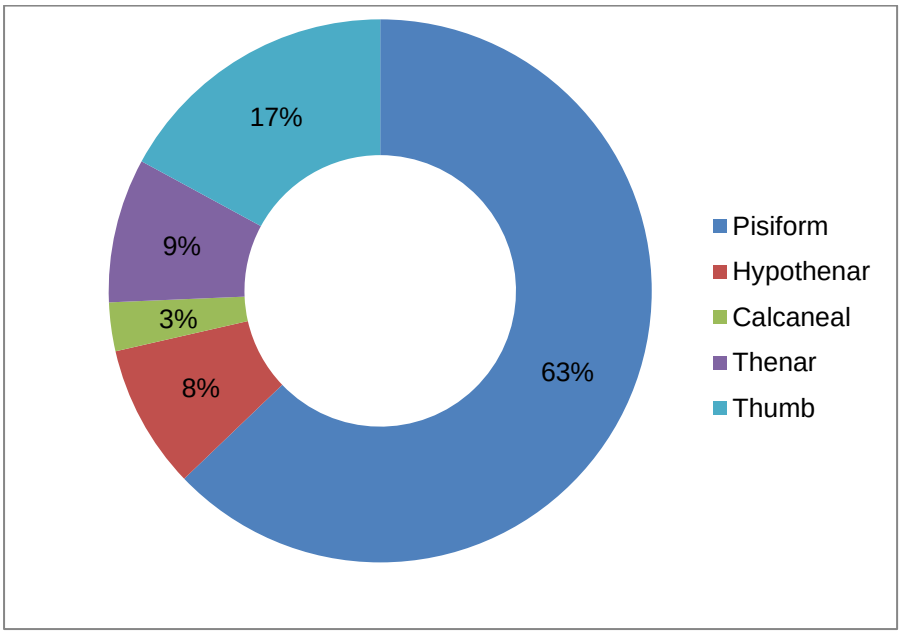


Figure 4.15: Contact used for new injury

4.5.11 Bed height during injury

Figure 4.16 shows the bed heights for new injury, with knee height (69%) and below knee (17%) accounting for the majority of new injuries.

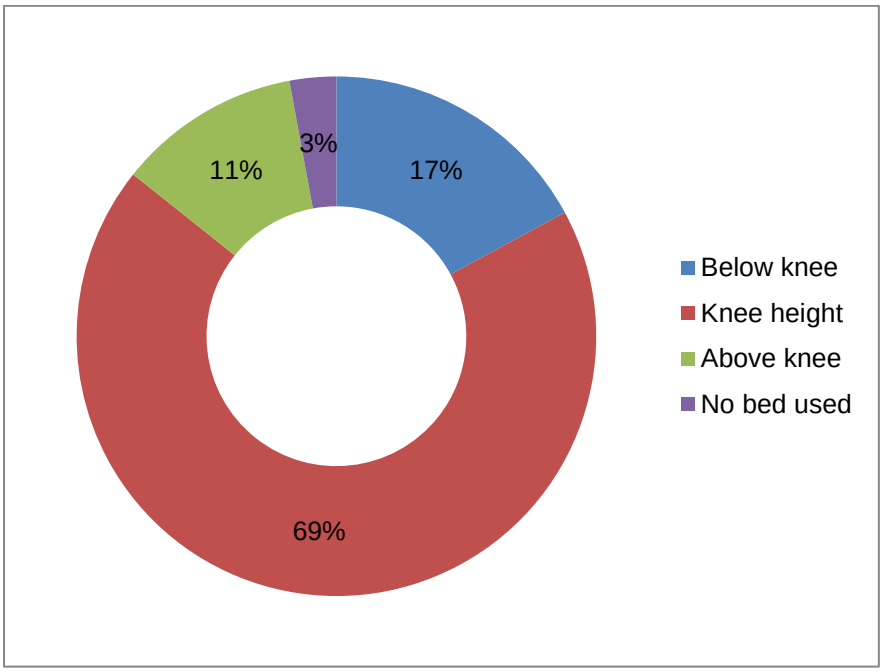


Figure 4.16: Bed height for new injury

4.5.12 Doctor position during injury

The doctor position reported most commonly for new injury was fencer stance (57.1%), square stance (20%) and bent over (17.1%) (Figure 4.17).

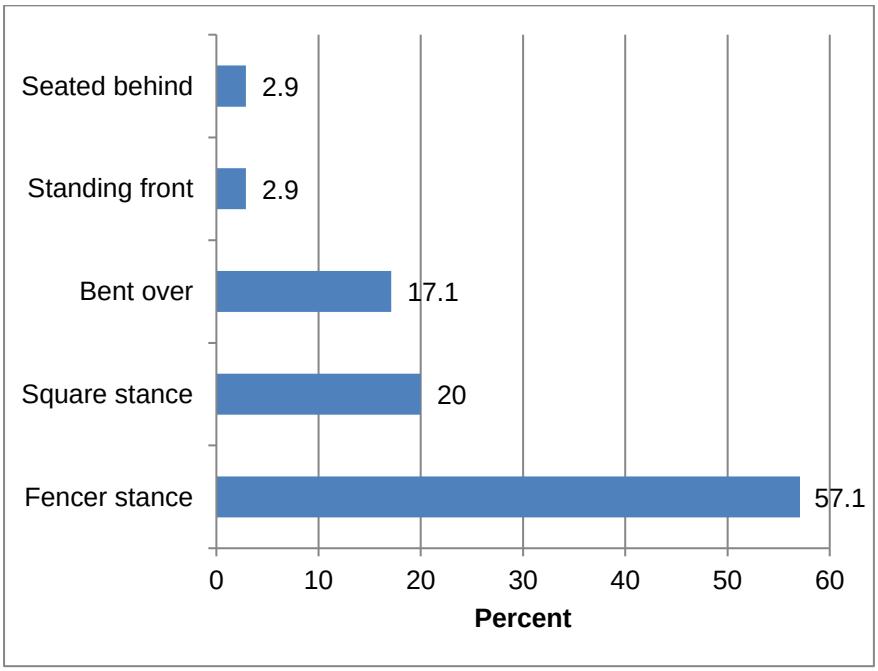


Figure 4.17: Doctor position for new injury

4.5.13 Response to new injury

The most common responses to new injury was 28.6% requiring treatment and 25.7% resolving to avoid the injuring technique and improving positioning respectively (Figure 4.18).

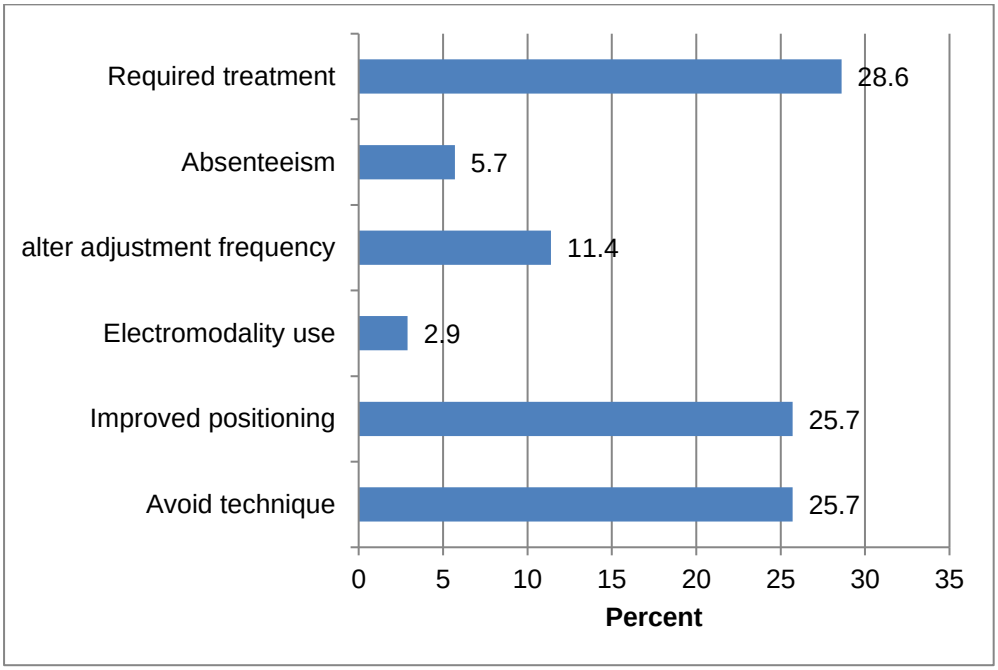


Figure 4.18: Response to new injury

4.5.14 Setting for new injury

Figure 4.19 shows the clinic setting (35.3%) and sport event setting (29.4%) as being the most common setting for injuries.

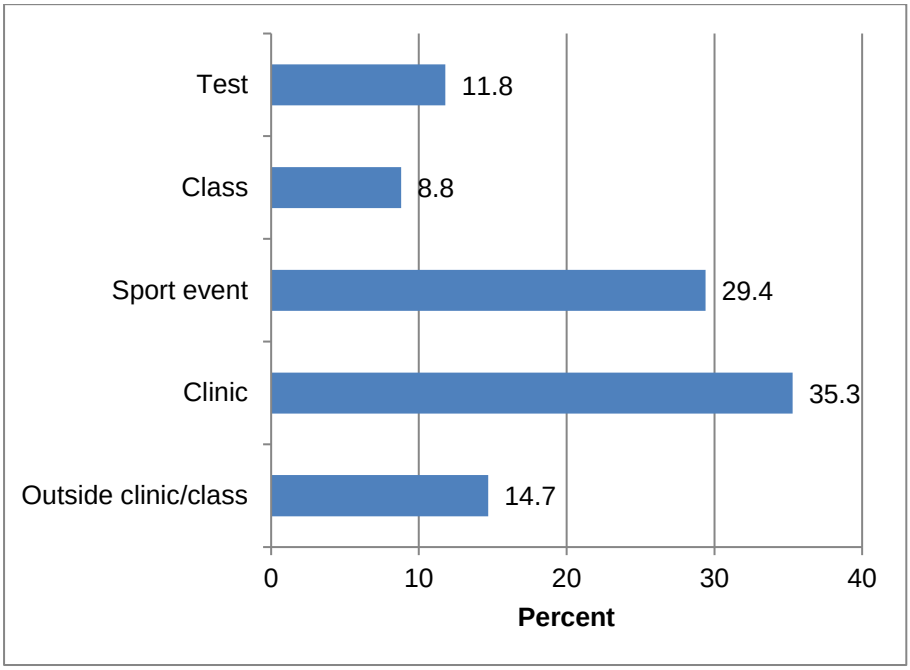


Figure 4.19: Setting for new injury

4.6 Old aggravated injury

4.6.1 Part of upper extremity injured

The wrist was the most commonly aggravated injury with 65%, followed by the shoulder with 20% (Figure 4.20).

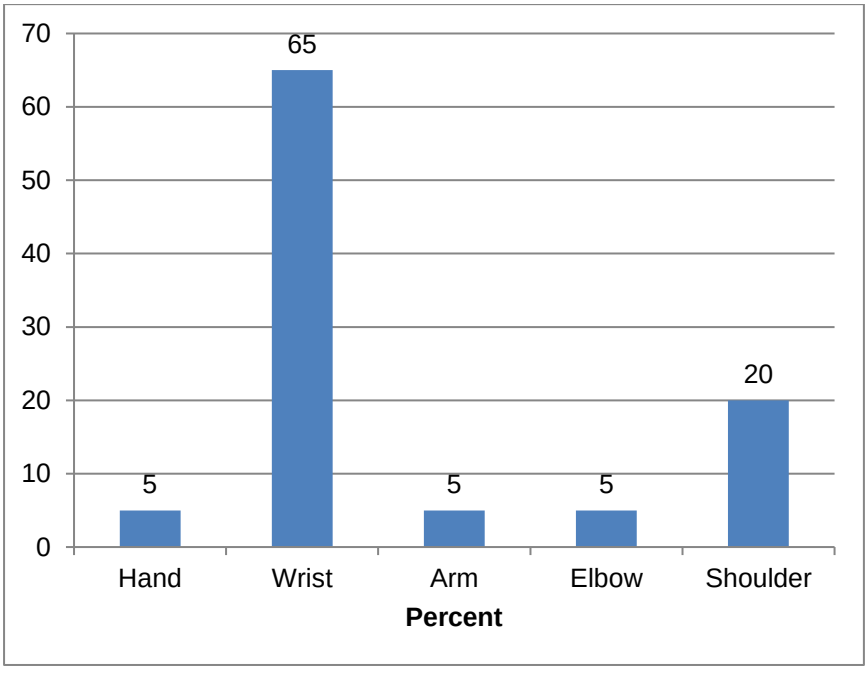


Figure 4.20: Part of upper extremity with aggravated injury

4.6.2 Activity causing the aggravated injury

Figure 4.21 shows more than two-thirds of aggravated injuries occurred while performing adjustments (75%).

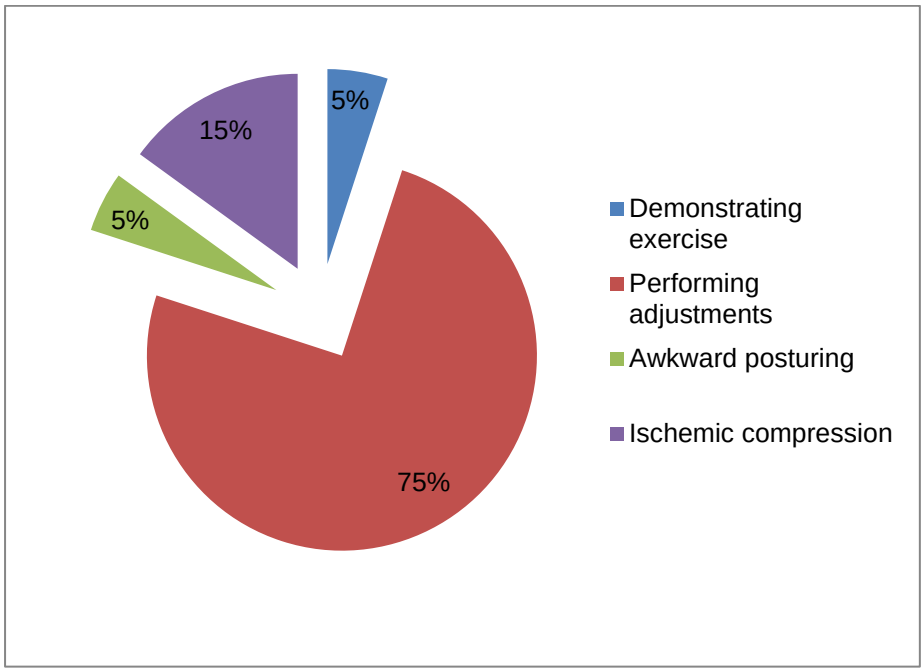


Figure 4.21: Activity for the aggravated injury

4.6.3 Area adjusting for aggravated injury

The thoracic (37%), lumbar (26%) and cervical (21%) spines were the area most commonly manipulated when the aggravated injury occurred (Figure 4.22)

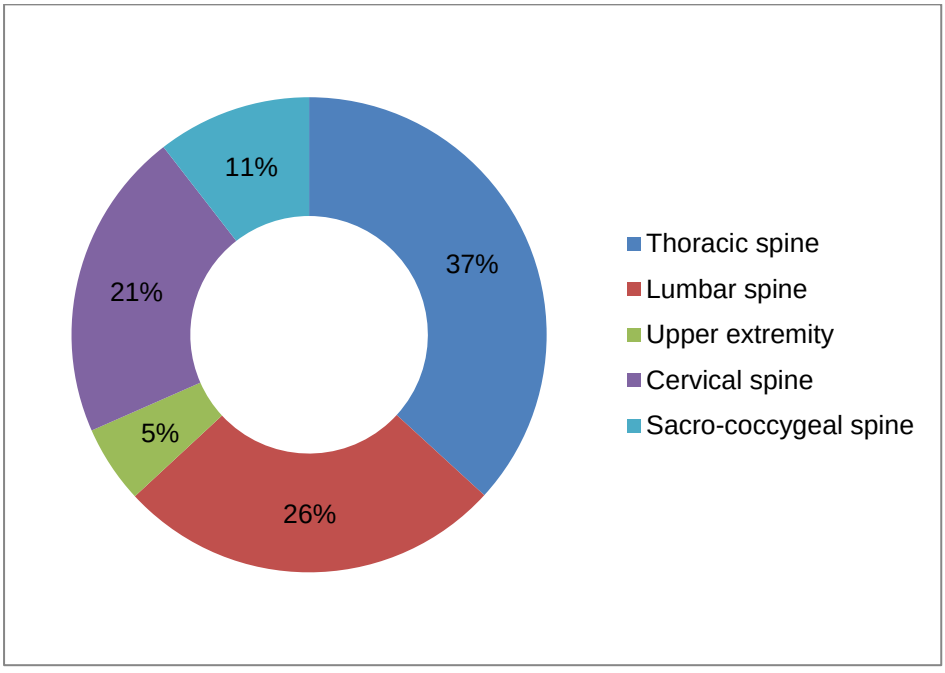


Figure 4.22: Area adjusting for aggravated injury

4.6.4 Contact point for aggravated injury

Figure 4.23 shows the contact points used for aggravated injury, with pisiform contact (53%) accounting for more than half the injuries. Some 16% reported fingertip contact when injured.

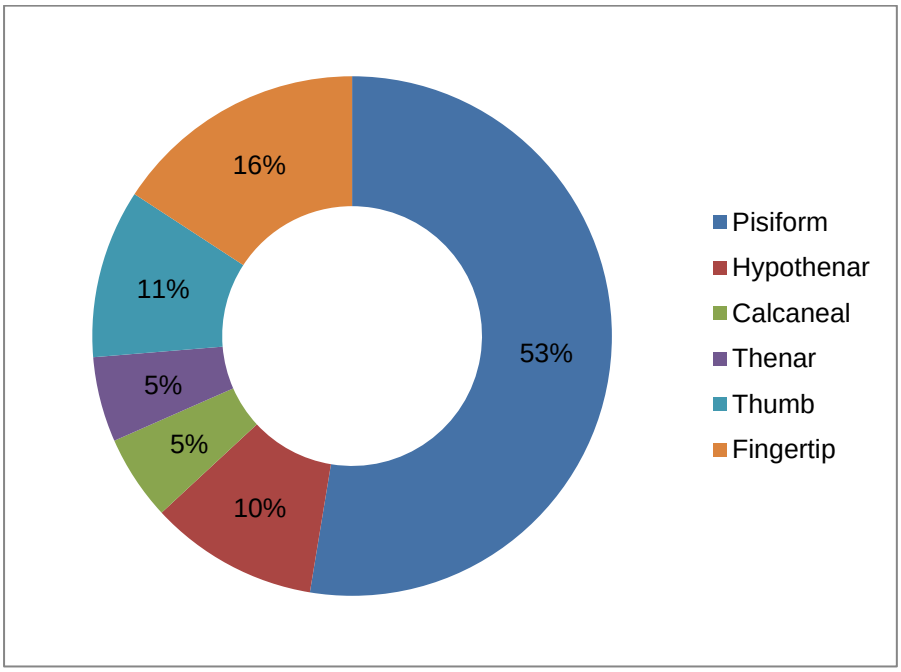


Figure 4.23: Contact point for aggravated injury

4.6.5 Bed height for aggravated injury

Figure 4.24 shows the bed heights for aggravated injury with knee height (58%) and below knee (26%) accounting for the majority of aggravated injuries.

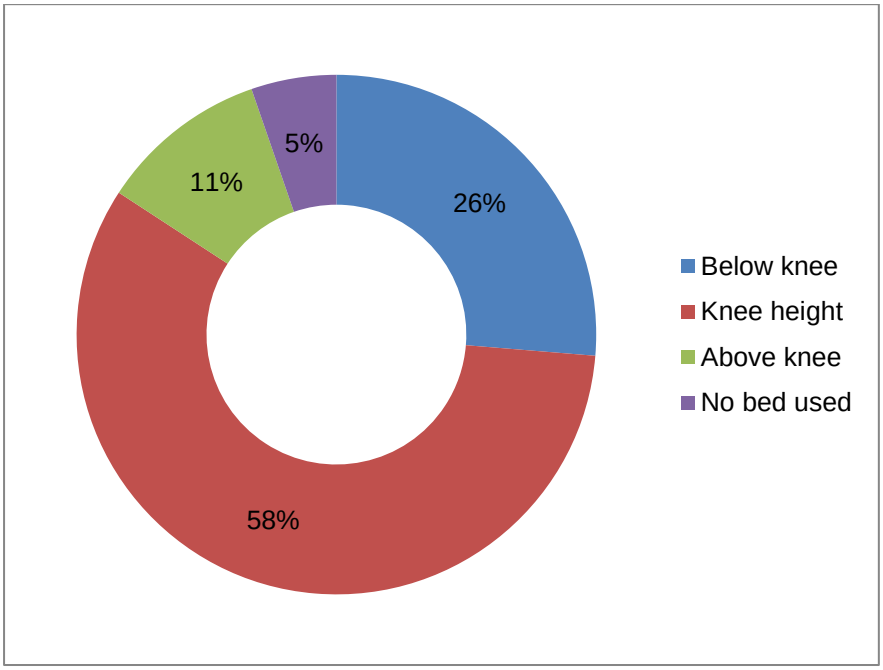


Figure 4.24: Bed height for aggravated injury

4.6.6 Doctor position for aggravated injury

The position reported the most for aggravated injury was Fencer stance (68.3%) and Bent over (15.8%) (Figure 4.25).

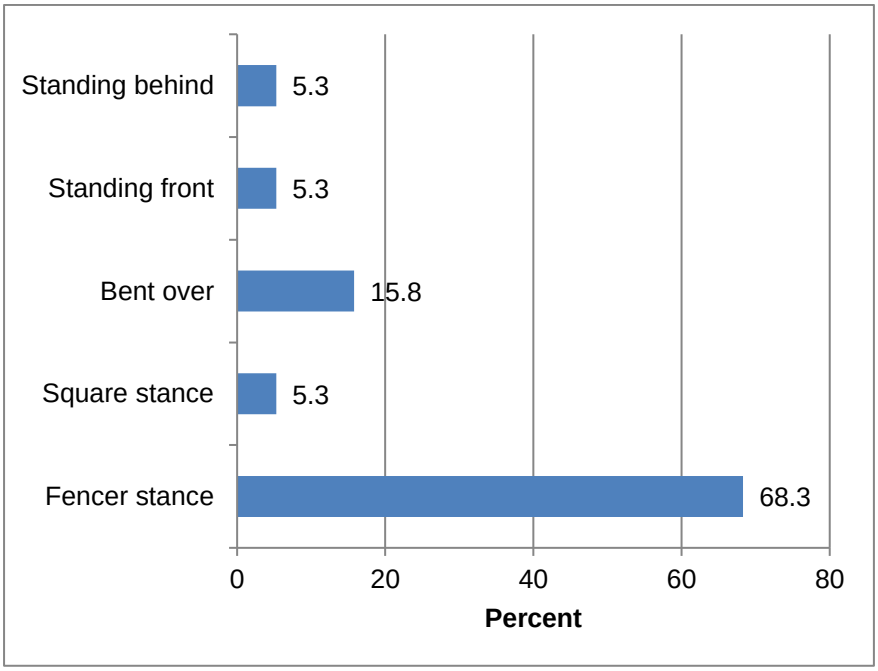


Figure 4.25: Doctor position for aggravated injury

4.6.7 Response to aggravated injury

Figure 4.26 shows 42.1% of old-aggravated injuries to have required treatment and 15.8% resolving to avoid the injuring technique.

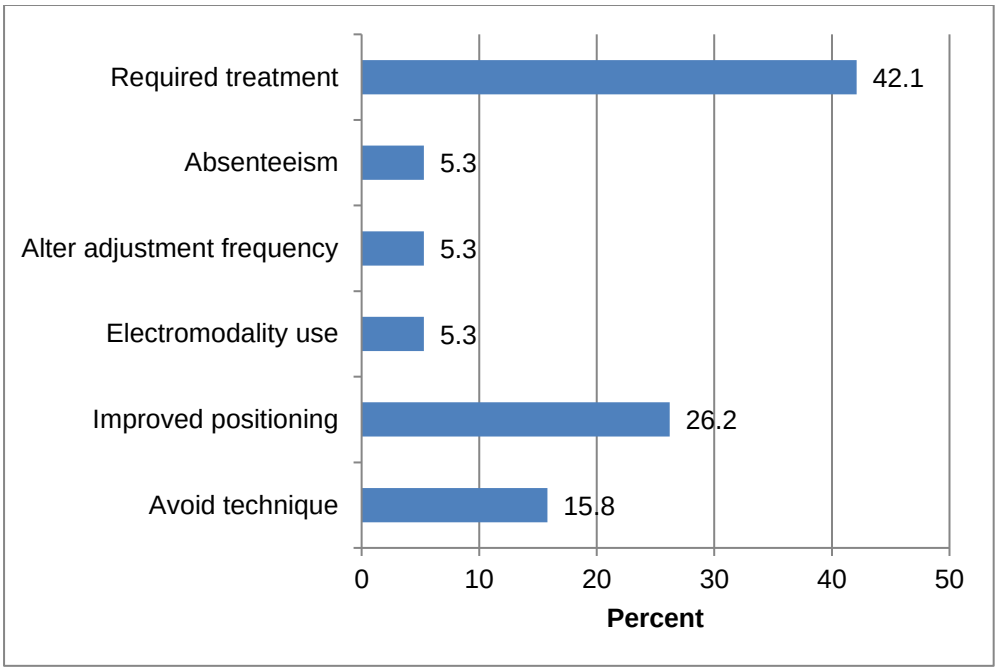


Figure 4.26: Response to aggravated injury

4.7 Association between selected risk factors and upper extremity work-related musculoskeletal injury

4.7.1 Demographics and upper extremity work-related musculoskeletal injury

None of the demographic variables showed a significant association with prevalence of injury, apart from a moderately non-significant association with year of study (p=0.080).

Table 4.3: Demographics and upper extremity WRMSI

		Have you experienced an UE-WRMSI				Univariate p value
		No		Yes		
		Count	%	Count	%	
Gender	Male	14	45.2%	17	54.8%	0.472
	Female	17	37.0%	29	63.0%	
Race	African	7	50.0%	7	50.0%	0.247
	Asian	0	0.0%	2	100.0%	
	Coloured	3	60.0%	2	40.0%	
	Indian	4	22.2%	14	77.8%	

	White	17	44.7%	21	55.3%	
Current year of study in chiropractic programme	4th	15	53.6%	13	46.4%	0.080
	5th	6	27.3%	16	72.7%	
	6th	5	38.5%	8	61.5%	
	7th	4	66.7%	2	33.3%	
	8th	0	0.0%	4	100.0%	
	9th	1	100.0%	0	0.0%	
	10th	0	0.0%	2	100.0%	
Highest qualification achieved	N.Diploma	12	50.0%	12	50.0%	0.517
	B.Technology	18	36.7%	31	63.3%	
	M.Technology	1	25.0%	3	75.0%	
Modules repeated	None	22	38.6%	35	61.4%	1.000
	CHPP301	4	40.0%	6	60.0%	
	CHPP401	2	50.0%	2	50.0%	
	CHPP501	1	50.0%	1	50.0%	
	CLCH501	2	50.0%	2	50.0%	

Table 4.4: Age and upper extremity WRMSI

	Have you experienced a UE-WRMSI	N	Mean	Std. Deviation	Std. Error Mean	T statistic, p value
Age in years	No	31	25.48	2.965	.533	1.25, 0.216
	Yes	46	24.70	2.546	.375	

4.7.2 Occupational related factors and upper extremity work-related musculoskeletal injury

Frequency of dry needling was associated with injury (p=0.003). Electro-modalities (p=0.073) and temperature therapy (p=0.077) use were also suggestive of possible associations, however not statistically significant.

Table 4.5: Occupational related factors and UE-WRMSI

		Have you experienced an UE-WRMSI				Univariate p value (Fisher's exact)
		No		Yes		
		Count	Row %	Count	Row %	
Time range spent on practical work	Less than 5hrs	15	50.0%	15	50.0%	0.315
	Between 5-10hrs	8	40.0%	12	60.0%	
	More than 10hrs	8	29.6%	19	70.4%	
Frequency using	Rarely	2	100.0%	0	0.0%	0.176

dominant hand when adjusting	Sometimes	1	33.3%	2	66.7%	
	Often	18	46.2%	21	53.8%	
	Always	10	30.3%	23	69.7%	
Frequency using non-dominant hand when adjusting	Never	0	0.0%	1	100.0%	0.117
	Rarely	7	77.8%	2	22.2%	
	Sometimes	10	34.5%	19	65.5%	
	Often	11	34.4%	21	65.6%	
	Always	3	50.0%	3	50.0%	
Frequency using activator	Never	15	44.1%	19	55.9%	0.713
	Rarely	13	41.9%	18	58.1%	
	Sometimes	2	22.2%	7	77.8%	
	Often	1	33.3%	2	66.7%	
Frequency using dry needling	Never	0	0.0%	1	100.0%	0.003
	Rarely	2	50.0%	2	50.0%	
	Sometimes	9	81.8%	2	18.2%	
	Often	19	38.8%	30	61.2%	
	Always	1	8.3%	11	91.7%	
Frequency using electromodalities	Never	4	80.0%	1	20.0%	0.073
	Rarely	8	47.1%	9	52.9%	
	Sometimes	7	36.8%	12	63.2%	
	Often	12	41.4%	17	58.6%	
	Always	0	0.0%	7	100.0%	
Frequency using ischemic compression	Rarely	1	100.0%	0	0.0%	0.378
	Sometimes	8	53.3%	7	46.7%	
	Often	19	35.8%	34	64.2%	
	Always	3	37.5%	5	62.5%	
Frequency using mobilizations	Never	1	100.0%	0	0.0%	0.384
	Rarely	2	28.6%	5	71.4%	
	Sometimes	13	44.8%	16	55.2%	
	Often	14	42.4%	19	57.6%	
	Always	1	14.3%	6	85.7%	
Frequency using temperature therapy	Never	2	40.0%	3	60.0%	0.077
	Rarely	15	57.7%	11	42.3%	
	Sometimes	10	40.0%	15	60.0%	
	Often	3	15.8%	16	84.2%	
	Always	1	50.0%	1	50.0%	
Frequency using strapping	Never	1	100.0%	0	0.0%	0.647
	Rarely	12	41.4%	17	58.6%	
	Sometimes	14	41.2%	20	58.8%	
	Often	4	36.4%	7	63.6%	
	Always	0	0.0%	2	100.0%	
Frequency using	Never	1	50.0%	1	50.0%	0.781

massage	Rarely	13	50.0%	13	50.0%	
	Sometimes	9	37.5%	15	62.5%	
	Often	8	33.3%	16	66.7%	
	Always	0	0.0%	1	100.0%	
Frequency using blocking	Never	5	35.7%	9	64.3%	0.810
	Rarely	23	43.4%	30	56.6%	
	Sometimes	2	25.0%	6	75.0%	
	Often	1	50.0%	1	50.0%	
Frequency using stretching	Rarely	2	50.0%	2	50.0%	0.637
	Sometimes	8	53.3%	7	46.7%	
	Often	17	37.8%	28	62.2%	
	Always	4	30.8%	9	69.2%	
Frequency using traction	Never	2	40.0%	3	60.0%	0.793
	Rarely	10	40.0%	15	60.0%	
	Sometimes	13	43.3%	17	56.7%	
	Often	5	31.3%	11	68.8%	
	Always	1	100.0%	0	0.0%	

"Years of study", use of "Dry needling", "Electro-modalities" and "Temperature therapy" were entered into a multiple logistic regression model. Backward selection was used to eliminate non-significant predictors, after adjusting for the other variables in the model. In the final model, after 4 steps only, dry needling remained as a predictor of injury. Those who used dry needling, "Often" compared to "Never" to "Sometimes", were 3.5 times more likely to be injured (p=0.043) while those who used it "Always", compared to "Never" to "Sometimes" were 24 times more likely to be injured (p=0.007).

Table 4.6: Multiple logistic regression model for dry needling

		Sig.	OR	95% C.I.for OR	
				Lower	Upper
Step 4[a]	Dry needling use	.015			
	Often	.043	3.474	1.043	11.570
	Always	.007	24.200	2.417	242.331
	Constant	.144	.455		

4.7.3 Use of dominant hand and upper extremity work-related musculoskeletal injury

Chi-Square testing (Table 4.8) and cross-tabulations (Table 4.7) were performed on dominant hand use and injury. No significant differences were noted, although a trend showing more likely to be injured if using dominant hand frequently (often/always) compared to less frequently (sometimes/rarely).

Table 4.7: Cross-tabulation for dominant hand use and injury

Crosstabulation: Dominant hand use * Injury					
			Injury		Total
			No	Yes	
Dominant hand use	Rarely/sometimes	Count	3	2	5
		% within dominant	60.0%	40.0%	100.0%
	Often/always	Count	28	44	72
		% within dominant	38.9%	61.1%	100.0%
Total		Count	31	46	77
		% within dominant	40.3%	59.7%	100.0%

Table 4.8: Chi-Squared test for dominant hand use and injury

Chi-Square Tests					
	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.866a	1	.352		
Continuity Correction	.211	1	.646		
Likelihood Ratio	.846	1	.358		
Fisher's Exact Test				.387	.317
Linear-by-Linear Association	.855	1	.355		
N of Valid Cases	77				
a. 2 cells (50.0%) have expected count less than 5. The minimum expected count is 2.01.					
b. Computed only for a 2x2 table					

CHAPTER FIVE

DISCUSSION

5.1 Introduction

This chapter will discuss the results of the study with specific detail on findings and objectives.

5.2 OBJECTIVE ONE: To determine the period prevalence of upper extremity work-related musculoskeletal injuries among chiropractic students

The period prevalence of upper extremity work-related musculoskeletal injuries was 59.7% (95% CI 47.93 to 70.57%). A composite of both new and old-aggravated injuries was used to determine the period prevalence. When compared with studies done on chiropractic students abroad, certain dissimilarities are observed.

In keeping with these results, Kizhakkeveettil et al. (2014), Macanuel et al. (2005) and Kuehnel, Beatty and Gleberzon (2008) reported a prevalence of 71% (n=126), 55% (n=292) and 53% (n=81) respectively. These results are comparatively high and in line with the findings of this study.

However, the African (7% [n=67]), European (18% [n=143]) and Australia/New Zealand (22% [n=110]) colleges report lower prevalence of injury (Kuehnel, Beatty and Gleberzon 2008). This is comparable with the lower prevalence of 31.5% reported by Ndetan et al. (2009), 44% of which was due to old-aggravated injuries.

With regards to SA research, the higher prevalence among students is in line with the findings by Lamprecht and Padayachy (2019), who reported a prevalence of 69.85% amongst chiropractors in the eThekwini municipality.

The wrist (60%) was found to be most vulnerable to WRMSI, followed by the shoulder (20%) and the hand (17%). Many of the injuries were of soft tissue structures, such as muscle/ tendon strain (42%), ligament sprain (17%) and tendinitis (17%). The injuries to both the wrist and hand can be ascribed to the adjustive procedures (74%) performed by the students, while shoulder injuries are attributed to adjustments, awkward posturing (8%) and the transfer or movement of patients (3%). A rationale for this may be, unlike the shoulder joint, the wrist and hand is made up of multiple smaller joints, supported by various ligaments between the bones and tendon sheaths, that run across the carpal bones (Drake, Vogl and Mitchell 2020:783). This allows for the necessary flexibility and manoeuvrabilty required by the hand when administering HVLA adjustments, at the trade off of strength and durability (Drake, Vogl and Mitchell 2020:785; Triano, Descarreaux and Dugas 2012; Bergmann and Peterson 2011; Triano et al. 2001).

This is validated by the results of studies showing higher prevalences of wrist and hand injuries during adjustive procedures. For example, Ndetan et al. (2009) found hand and wrist injuries to be most common when performing adjustments (45.6%), a finding similarly noted by Bisiacchi and Huber (2006), reporting wrist injuries to be the second most commonly injured area in their study. Naturally, Kizhakkeveettil et al. (2014) found a statistical significance between performing adjustive procedures and wrist/ hand injuries ($p<0.5$) suggesting a causal relationship between the two.

In accordance to these conclusions, this study found most injuries occurred during adjustive procedures (74%) and ischemic compression (19%). There is strong evidence in the literature that suggests WRMSIs are a consequence of HVLA adjustive procedures (Byfield 2012; Triano, Descarreaux and Dugas 2012; da Costa and Vieira 2010; Holm and Rose 2006; Rupert and Ebete 2004; Triano 2001). A consensus by Hodgetts and Walker (2018), Thomsen et al. (2007) and Stock (1991) ascribe hand and wrist injuries to highly repetitive forceful movements, i.e. adjustments (Llopis et al. 2019). This is in line with studies done on chiropractors and students, both locally and abroad (Lamprecht

and Padayachy 2019; Hodgetts and Walker 2018; Kizhakkeveettil et al. 2014; Ndetan et al. 2009; Holm and Rose 2006).

When compared to the results on physical therapy students, chiropractic students experience a greater amount of hand and wrist pain. A study by Verma, Kailas and Krishnan (2020), describing the work-related musculoskeletal pain among physiotherapy students, found greater levels of back pain (46% LBP; 15% upper back), neck (16%), knee (8%) and foot pain (4%). However, the students reported no cases of wrist and hand pain. This is not surprising as chiropractic students are trained to deliver HVLA adjustive techniques which have been shown to predispose the hand and wrist to WRMSI (Hodgetts and Walker 2018; Byfield 2012; Triano, Descarreaux and Dugas 2012; Triano 2001).

5.3 OBJECTIVE TWO: To determine selected risk factors (demographic and occupational related) associated with chiropractic students and upper extremity work-related musculoskeletal injuries

5.3.1 Demographic related factors

5.3.1.1 Age

The average age of participants was 25 years (standard deviation of three years) and ranged from 21 to 32 years. This is comparable with previous studies conducted at DUT, where the students were most commonly aged 22 to 25 years (Basdav, Haffejee and Puckree 2016; Prangley 2010; Fyfe 2006).

The results show no correlation between age of the student and injury of the upper extremity ($p=0.216$). Nevertheless, 46 participants of the total 77 did experience a UE-WRMSI, with the average age of injured participants being 24.7 years (mean age for non-injured participants was 25.4 years).

Similarly, studies on American chiropractic students found the age to range between 21 – 30 years (Hodgetts and Walker 2018; Kizhakkeveettil et al. 2014;

Ndetan et al. 2009; Kuehnel, Beatty and Gleberzon 2008; Bisiacchi and Huber 2006; Macanuel 2005). Kizhakkeveettil et al. (2014), Kuehnel, Beatty and Gleberzon (2008), Macanuel et al. (2005) and Ndetan et al. (2009), previously reported no correlation between age and injury.

5.3.1.2 Gender

The gender split between participants was 59.7% female and 40.3% male, similar to the distribution of qualified chiropractors in the eThekwini Municipality noted by Lamprecht and Padayachy (2019). The majority of injured students were also female (63%), and correlate with the findings of Bisiacchi and Huber (2006) and Kizhakkeveettil et al. (2014).

The results of this study showed no statistically significant association between gender of the participant and injury of the upper extremity. However, the results indicate a trend towards females being more likely to experience a UE-WRMSI than males, especially with regards to the hand and wrist. This trend was also observed by previous studies done on chiropractors and physical therapists (Lamprecht and Padayachy 2019; Naidoo 2018; Holm and Rose 2006; Mathews 2006; Glover et al. 2005; Cromie, Robertson and Best 2000; Bork et al. 1996)

5.3.1.3 Ethnicity

Ethnicity was found to have no statistical correlation to injury. The student population involved in the study had a large proportion of white participants (49.4%) with 23.4% Indian and 18.1% African. These findings compare to those by Fyfe (2006), where the ethnic distribution of chiropractic students was more skewed, with white accounting for 66%, Indian 27% and African 5%.

Ralekwa (2010) argues that this disparity is due to the chiropractic profession being relatively unpopular and unfamiliar among the African population. An explanation for this may be socio-economic differences, consumer preferences and accessibility as some of the challenges the chiropractic profession is currently facing in SA. Ralekwa (2010) concludes the overall knowledge,

perception and utilisation of chiropractic amongst DUT students to be poor. Nevertheless, chiropractic is currently offered in two educational institutions in the continent of Africa, Durban University of Technology and University of Johannesburg (World Federation of Chiropractic 2020).

5.3.1.4 Year of study

The fifth and sixth year students reported majority of injuries with 72.7% and 61.5% respectively. However, more than half of students in their fourth year (53.6%) reported not being previously injured during their training so far. At the end of fourth year, students have undergone adjustments training for the previous two years, along with practical training of other manual techniques – such as mobilisations. These sessions are class-based and in smaller groups of students, with very little variation between adjustor and mock patient, leading to familiarity between body types.

In the fifth and sixth years, students work in the clinical setting, both on campus as well as at external satellite clinics. Students see a variety of cases and exposed to treating many different types of patients, not seen in the classroom setting. Fifth year students are also required to complete a specific number of sporting patients, which they are able to treat at various sporting events throughout the year. Therefore, an argument can be made for students in the latter years, who adjust more frequently and adjust a wider variety of patients, are more likely to be injured than students in the earlier years.

However, similar studies contrast these findings. Macanuel et al. (2005) noted nearly 60% of reported injuries occurred during the second year of college, when the majority of diversified adjustive techniques are being taught to students for the first time. Although an even greater amount of adjustive techniques are taught in third and fourth year of study, Macanuel et al. (2005) reports they accounted for 17.41% of injuries. The researcher argues that students may not be competent within their first year of training and may be more likely to experience injuries, but subsequently acquire adequate psychomotor skills as they progress through the years of study.

Bisiacchi and Huber (2006) and Kizhakkeveettil et al. (2014) support this argument, and have found a preponderance of injuries in the preclinical educational setting. Kizhakkeveettil et al. (2014) reports modules demonstrating thoracic and cervical adjustments having 73% of reported injuries (n=126), and determined a statistically significant correlation between shoulder, wrist and hand injuries among students.

The results of this study were not in conformity with studies done abroad, the majority of injuries reported occurred in the clinical setting (35%) rather than in class. This was further supported by the higher prevalence in years performing clinical activity, with the year performing both academic and clinical work (fifth year) having the highest. None of the demographic variables showed a significant association with prevalence of injury, apart from a moderately non-significant association with year of study (p=0.080).

5.3.2 Occupational related factors

5.3.2.1 Time spent on practical work

The distribution of time spent on practical work, per week, among participants was almost even. Thirty-nine percent spent less than 5 hours, 35% spent more than 5 hours and 26% spent between 5 and 10 hours on performing practical work per week. The majority of injured participants performed, on average, more than 10 hours of practical work a week (41%), however, this was not found to be statistically significant.

This correlates with other studies done on chiropractors, as well as manual therapists, identifying the risk of increased hands-on time spent performing manual therapy and WRMSI (Lamprecht and Padayachy 2019; Anderson and Oakman 2016; Barnes et al. 2011; Pereira 2009; Mathews 2006).

Many of the reviewed international studies done on chiropractic students have not addressed the risk of time spent on practical work and its association with injury, a limitation highlighted by Kizhakkeveettil et al. 2014 and Macanuel et al. (2005).

5.3.2.2 Adjustments and injury

Questions pertaining to the frequency of adjustments performed were divided into the use of dominant hand versus non-dominant hand. Ninety-six percent of students who experienced injuries frequently adjust with their dominant hand, as compared to 52% of injured students, who frequently adjust with their non-dominant hand. These results showed no significant differences between frequency of adjustments and injury, although a trend showed those are more likely to be injured when adjusting with their dominant hand. It is difficult to make comparisons to previous studies, as these studies have not differentiated injuries from adjusting, in terms of hand dominance.

However, studies have shown greater proficiency with technique decreases the chance of injury to the practitioner (Pasquier et al. 2019; Hodgetts and Walker 2018; Kizhakkeveettil et al. 2014; Byfield 2012:113; Bisiacchi and Huber 2006; Triano 2001). The hand and wrist were found to be susceptible to soft tissue injury when incorrectly applied during an adjustive procedure (Triano, Descarreaux and Dugas 2012; Triano 2001). This results in an altered biomechanical relay of the adjusting force, with unnecessary strain put on the components of the hand and wrist (Gyer, Michael and Davis 2017:26; Studin and Owens 2017; Byfield 2012:113; Kizhakkeveettil et al. 2014; Bergmann and Peterson 2011:327; Herzog 2010).

The existing literature has extensively demonstrated the reduced dexterity of the non-dominant hand when compared to the dominant hand, a consequence of the asymmetric use between hands for various activities (Pasquier et al. 2019; Sivagnanasunderam et al. 2015; Bowden and McNulty 2013; Brown et al. 2006). For example, Brown et al. (2006) and Sivagnanasunderam et al. (2015) found approximately 90% of the adult population prefer the use of their dominant hand when performing activities of daily living. The asymmetric dexterity can be attributed to the reduced use and training of the hand, as well as the decreased cortical excitability in the non-dominant motor cortex of the brain (Sivagnanasunderam et al. 2015).

Practitioners unfamiliar with the application of the non-dominant hand when adjusting have an increased likelihood of incorrect hand placement and are subsequently more likely to sustain an injury to that hand (Lamprecht and Padayachy 2019). However, with review of the results of this study, this may not be the case with chiropractic students, as they adjust more frequently with both hands, owing to the testing procedure in the various practical modules as compared to their professional counterparts (ECCE 2020; Department of Chiropractic and Somatology 2019; Pasquier et al. 2019; Lamprecht and Padayachy 2019).

Nevertheless, recurrent cumulative microtrauma and repetitive strain, compounded by the increased frequency of adjustments performed with the dominant hand, accounts for the higher prevalence of dominant hand and wrist injury among students.

5.3.2.3 Dry needling, electro-modalities and temperature therapy

The use of dry needling frequently was found to be associated with injury (p=0.003). Ninety-three percent of students who experienced injuries reported using dry needling regularly. This finding is consistent with those found by De Lamprecht and Padayachy (2019), Keyter (2010) and Gouveia (2009), that dry needling remains a popular modality – often used by chiropractors within their treatment protocols.

Dry needling is a popular adjunctive therapy that has been shown to have many clinical applications. These range from the treatment of myofascial trigger points, short-term treatment of fibromyalgia, muscle-tendon strains and the treatment of migraine headaches (Dommerholt and de las Penas 2018; Casanueva et al. 2014; Dunning et al. 2014). Dry needling, in itself, does not require the practitioner to perform any actions that would put them at risk of WRMSI, such as prolonged awkward postures, heavy lifting and repetitive movements (Dunning et al. 2014). Injuries to the practitioner from dry needling

are usually a result of needle stick injury and do not place the practitioner at risk of developing WRMSI (Dommerholt and de las Penas 2018; Dunning et al. 2014).

This study found the frequent use of electro-modalities (p=0.073) and temperature therapy (p=0.077) were suggestive of possible associations, however, were not statistically significant. Keyter (2010) found that electro-modalities fell in the minority of modalities often used by SA chiropractors, with 36% Ultrasound (US), 30% Interferential Current (IFC), and 25% Trans-electrical nerve stimulation (TENS). Similarly, 27% of chiropractors in the eThekwini municipality employed the use of electro-modalites and 21% used temperature therapy (Lamprecht and Padayachy 2019).

As per their clinical training, students treating in the day clinic are encouraged to make use of the various modalities on offer at the clinic, under the supervision of the attending clinician (ECCE 2020; DUT Chiropractic Day Clinic Handbook 2019). This allows the student to apply theoretical knowledge of electro-modality treatment gained in class, as well as familiarise themselves with the setup and application of the equipment. The various electro-modalities, including the IFC, TENS and US, have been shown to be highly effective in the treatment of musculoskeletal conditions (Corrêa et al. 2016; Gladwell et al. 2015; Patil and Dasgupta 2012) and effective adjuncts to manipulative therapy (Morgan 2016; Downing 2015; Tao, Du and Zhou 2012). This may account for the increased use among students, when compared to their professional counterparts.

5.4 Hypothesis

The results of the study allow for the hypothesis to be fully accepted and the null hypothesis to be rejected. The accepted hypothesis states: Chiropractic students at the Durban University of Technology will have a high prevalence of upper-extremity work-related musculoskeletal injury.

CHAPTER SIX

CONCLUSION

6.1 Introduction

This chapter presents the conclusions of the study, the limitations experienced during the study and the recommendations for further research.

6.2 Conclusion

This study determined the prevalence of WRMSIs to the upper extremity of chiropractic students at DUT was in accordance, yet marginally higher (at 59.7%) compared to studies done abroad (Hodgetts and Walker 2018; Kizhakkeveettil et al. 2014; Ndetan et al. 2009; Kuehnel, Beatty and Gleberzon 2008; Bisiacchi and Huber 2006; Macanuel et al. 2005).

The areas most affected were the wrist (60%), shoulder (20%) and hand (17%), with majority of the injuries involving the soft tissue structures: muscle/ tendon strain (42%), ligament sprain (17%) and tendinitis (17%). Most injuries occurred during adjustive procedures (74%) and ischemic compression (19%).

The demographic variables showed no significant association with prevalence of injury, apart from a moderately non-significant association with year of study (p=0.080). The frequent use of electro-modalities (p=0.073) and temperature therapy (p=0.077) were suggestive of possible associations, however, were not statistically significant. The results showed no significant differences between frequency of adjustments and injury, although suggesting a greater likelihood of injury to the upper extremity when adjusting with the dominant hand.

These results support the findings on practicing chiropractors in the eThekwini Municipality (Lamprecht and Padayachy 2019), while contrasting the findings on chiropractic students abroad (Kizhakkeveettil et al. 2014; Ndetan et al. 2009; Kuehnel, Beatty and Gleberzon 2008; Bisiacchi and Huber 2006; Macanuel et al. 2005). This highlights the need for further investigation to bridge the gap between the two.

Research into the injuries facing the chiropractic profession is necessary, as it helps to create awareness, improve overall safety and wellbeing, as well as ensure the longevity of the profession. The injuries that affect students during their training, and/ or early on in the careers, may significantly impact the quality of treatment; result in time away from work, loss of income and possibly affect the practitioner's quality of life and psychological well-being (Hodgetts and Walker 2018).

6.3 Limitations

The study relied on the total available population, as determined by a biostatistician. This number would decrease during the initial stages of the study, as senior chiropractic students who were in the process of completing their Masters dissertation and internship requirements would qualify at different times during the year and not be available to participate in the study.

Data collection took place at the end of the year, leading up to examinations, which may have influenced a rushed approach in the completion of the questionnaire by participants.

The questionnaire required participants to recall injuries from their past and the results may be limited to recall bias, i.e. poor memory recollection. The questionnaire was self-administered and relied on the honesty of the participants.

6.4 Recommendations

Based on the results of this study, there is a need for injury prevention programmes and intervention studies, aimed at reducing the amount of injuries among chiropractic students.

Future studies should include a larger population size, with the possible inclusion of chiropractic students from the University of Johannesburg.

Complimentary studies investigating the WRMSIs of the other health science professions at the DUT, i.e. Biomedical and Clinical technology, Dental Science, Emergency Medical care and rescue, Medical Orthotics and Prosthetics, Nursing, Radiography and Somatology.

Further research on WRMSIs should be conducted on the student population of other manual therapy professions, i.e. occupational therapists and physical therapists, to allow for the comparison with chiropractic students.

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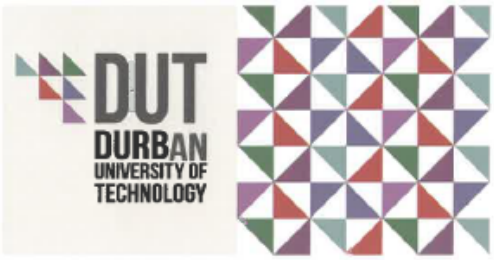
Appendices

Appendix A: IREC Approval Letter



Institutional Research Ethics Committee
Research and Postgraduate Support Directorate
2nd Floor, Berwyn Court
Gate 1, Steve Biko Campus
Durban University of Technology

P O Box 1334, Durban, South Africa, 4001

Tel: 031 373 2375
Email: lavishad@dut.ac.za
http://www.dut.ac.za/research/institutional_research_ethics

www.dut.ac.za

11 October 2019

Mr K A Singh
P O Box 863
Umhlanga Rocks
Durban
4320

Dear Mr Singh

Upper extremity work-related musculoskeletal injuries among chiropractic students at the Durban University of Technology
Ethical Clearance number IREC 054/19

The Institutional Research Ethics Committee acknowledges receipt of your final data collection tool for review.

We are pleased to inform you that the data collection tool has been approved. Kindly ensure that participants used for the pilot study are not part of the main study.

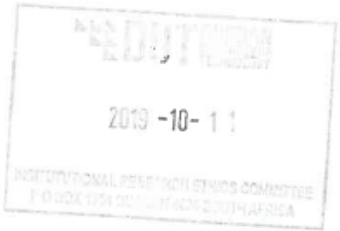
In addition, the IREC acknowledges receipt of your gatekeeper permission letters.

Please note that FULL APPROVAL is granted to your research proposal. You may proceed with data collection.

Any adverse events [serious or minor] which occur in connection with this study and/or which may alter its ethical consideration must be reported to the IREC according to the IREC Standard Operating Procedures (SOP's).

Please note that any deviations from the approved proposal require the approval of the IREC as outlined in the IREC SOP's.

Yours Sincerely,



Professor J K Adam
Chairperson: IREC

Appendix B: Gatekeeper Approval

Gatekeeper's permission letter

Research Title:
Upper extremity work-related musculoskeletal injuries among chiropractic students at the Durban University of Technology

Supervisor: Dr. K. Padayachy, M.Tech: Chiropractic; PhD: Anatomy
Research student: Kyle Andrew Singh, B.Tech: Chiropractic

To the Head of department Chiropractic,

I hereby request permission to conduct research at the Durban University of Technology Chiropractic Department and Chiropractic Day Clinic. The study will involve addressing the students at the end of a subject period and include requesting permission from their lecturer prior to this. Once permission is granted the students will be given the opportunity to participate in the study by completing a simple questionnaire. The study will also involve meeting with any eligible participants one on one at the chiropractic day clinic, where they will be offered the opportunity to participate in the study.

Please find attached a copy of the research proposal and design as well as the Institutional Research Ethics Committee provisional approval letter. Should you require any further information about the study or have any queries please do not hesitate to contact me.

Kind regards,

Kyle Singh (Chiropractic)
Student number: 21217966
Cell: 0769013894
Email: kxle750@hotmail.com

Appendix C: Letter of information (Main study)

LETTER OF INFORMATION
MAIN STUDY

Dear Participant,
I would like to thank you for participating in my study.

Research Title:
Upper extremity work-related musculoskeletal injuries among chiropractic students at the Durban University of Technology

Supervisor: Dr. K. Padayachy, M.Tech: Chiropractic; PhD: Anatomy
Research student: Kyle Andrew Singh, B.Tech: Chiropractic

Background to the study:

Work-related musculoskeletal injuries (WRMSI) are very common among the healthcare profession especially amongst nursing and physiotherapy where there's great need to use the upper limb and lower back to perform daily tasks. It has been found that manual therapy as performed by physical therapists was related to wrist, hand and elbow injury. The chiropractic profession has been identified as at risk for work-related musculoskeletal injuries due to the high physical demand on the practioner and the application of manual therapies including adjustment/manipulation.

There have been a few studies done on practicing chiropractors that identify most WRMSI's occurring within the first few years of practice (Homack 2005; Holm and Rose 2006; Lamprecht 2018; Mathews 2006; Pereira 2009). There have been similar findings in studies that look at chiropractic students in North America, during their under-graduation technique training showing an increase in prevalence in wrist and hand injuries (Bisiacchi and Huber 2006; Kuehnel et al. 2008; Macanuel et al. 2005; Ndetan et al. 2009). . A study done by Bisiacchi and Huber (2006) at a North American chiropractic college found a significant relationship between female students and prevalence of hand and wrist WRMSI's, a result similarly noted by Ndetan (2009).

However the existing literature reveals a gap attributed to lack of cultural differences of students as well as non-uniformity among university course duration and training (Kuehnel et al. 2008). For instance, South African students

are required to complete a Masters thesis to obtain their qualification, which takes on average 7 years (5 years course work and 2 years for Masters completion) (Allied Health Professions Council of South Africa); exposing them to vastly more time in training when compared to their North American counterparts who are required to complete a Doctor of Chiropractic degree (DC) which runs for 3 years and 4 months (Council of Chiropractic Education: Parker University). Furthermore the South African chiropractic programme instructs the use of the diversified technique, a technique shown to have the highest prevalence amongst any other techniques for WRMSI's (Ndetan 2009). The previously mentioned studies call for additional research to be done on students elsewhere, identifying any new risk factors for WRMSI's. It is therefore important to determine a profile of upper extremity work-related musculoskeletal injuries among the chiropractic students at DUT. This will help future efforts in designing a comprehensive protocol to prevent injury among training chiropractors.

Participation in this study is entirely voluntary and refusal to participate will not result in any adverse consequences. All information gathered from the study will be kept private and confidential. The results of the study will only be used for research purposes and will be made available to you when the study has been completed.

Aim: To determine a profile of upper extremity injuries among chiropractic students at the Durban University of Technology

Study objectives:

1. To determine the period prevalence of upper extremity work-related musculoskeletal injuries among chiropractic students.
2. To determine selected risk factors (demographic related and occupational related) associated with chiropractic students and upper extremity work-related musculoskeletal injuries.

Procedure:

You are required to **read** and **sign** the Informed Consent form, after which you may proceed in completing the study questionnaire. Any queries may be directed to the researcher for further clarification, if necessary. Once both documents are completed you may alert the researcher and the documents will be collected and stored accordingly. You may keep the letter of information if you want otherwise it will also be collected.

Contact details in the event of any Problems or Queries:

Research supervisor: Dr K. Padayachy (keserip@hotmail.com)
Institutional Research Ethics Administrator: 031 373 2900
Complaints can be reported to the Director of Research and Postgraduate Support: 031 373 2577

Thank you for your participation and cooperation.
Your time and assistance is greatly appreciated.

Kyle Andrew Singh
Research student
Dr K. Padayachy
Supervisor

Appendix D: Informed Consent form (Main study)

INFORMED CONSENT FORM
MAIN STUDY

Statement of Agreement to Participate in the Research Study:

I hereby confirm that I have been informed by the researcher, **Kyle Andrew Singh**, about the nature, conduct, benefits and risks of this study - Research Ethics Clearance Number: **IREC 054/19**

I have also received, read and understood the Participant Letter of Information regarding the study.

I am aware that the results of the study, including personal details regarding my sex, age, race and diagnosis will be anonymously processed into a study report.

In view of the requirements of research, I agree that the data collected during this study can be processed in a computerised system by the researcher.

I may, at any stage, without prejudice, withdraw my consent and participation in the study.

I have had sufficient opportunity to ask questions and (of my own free will) declare myself prepared to participate in the study.

I understand that significant new findings developed during the course of this research that may relate to my participation will be made available to me.

Full name of participant	**Date**	**Signature**

I, **Kyle Singh** herewith confirm that the above participant has been fully informed about the nature, conduct and risks of the above study.

Signature:

Appendix E: Main Study Questionnaire

MAIN STUDY QUESTIONNAIRE

SECTION A

1. Demographic detail (Tick appropriate box)

1.1 Gender ☐ Male ☐ Female

1.2 Age in years _____ years

1.3 Race (for statistical purposes only)

- ☐ African
- ☐ Asian
- ☐ Coloured
- ☐ Indian
- ☐ White
- ☐ Other

(If other, please specify) _____

2 Demographics

2.1 What is your current year of enrolement in the Chiropractic program?

☐ 3rd year ☐ 4th year ☐ 5th year ☐ 6th year ☐ 7th year

☐ Other (please specify):

2.2 What is the highest academic qualification that you have **SUCCESSFULLY COMPLETED**?

☐ N. Diploma ☐ B.Technology ☐ M. Technology

2.3 From the list below, please select which modules you have **REPEATED**, if any: (if you have not repeated any modules then select "Not applicable")

☐ Chiropractic Practice and Principles III ☐ Chiropractic Practice and Principles IV ☐ Chiropractic Practice and Principles V

☐ Clinical Chiropractic IV ☐ Clinical Chiropractic V ☐ Not applicable

2.4 What is the average number of hours spent performing **PRACTICAL** work-related activities **PER WEEK**? (this includes activities such as performing adjustments and manipulations, performing mobilizations, performing orthopaedic testing and/or performing auxillary therapy)

Note: these hours will also include class, clinic and/or sporting event settings

☐ Less than 5 hours ☐ Between 5 and 10 hours ☐ More than 10 hours

2.5 How often do you adjust using the following **(tick appropriate box)**?

Dominant hand	☐ Always	☐ Often	☐ Sometimes	☐ Rarely	☐ Not applicable
Non-dominant hand	☐ Always	☐ Often	☐ Sometimes	☐ Rarely	☐ Not applicable
Activator/ impulse adjustor	☐ Always	☐ Often	☐ Sometimes	☐ Rarely	☐ Not applicable

2.6 How often do you use **NON-MANIPULATIVE TECHNIQUES (tick appropriate box):**

Dry needling	☐ Always	☐ Often	☐ Sometimes	☐ Rarely	☐ Not applicable
Electromodalities (IFC, TENS, EMS)	☐ Always	☐ Often	☐ Sometimes	☐ Rarely	☐ Not applicable
Ischemic Compression	☐ Always	☐ Often	☐ Sometimes	☐ Rarely	☐ Not applicable
Mobilizations	☐ Always	☐ Often	☐ Sometimes	☐ Rarely	☐ Not applicable
Cryotherapy/ thermotherapy	☐ Always	☐ Often	☐ Sometimes	☐ Rarely	☐ Not applicable
Strapping/ Taping	☐ Always	☐ Often	☐ Sometimes	☐ Rarely	☐ Not applicable

Massage	☐ Always	☐ Often	☐ Sometimes	☐ Rarely	☐ Not applicable
Blocking	☐ Always	☐ Often	☐ Sometimes	☐ Rarely	☐ Not applicable
Stretching	☐ Always	☐ Often	☐ Sometimes	☐ Rarely	☐ Not applicable
Manual traction	☐ Always	☐ Often	☐ Sometimes	☐ Rarely	☐ Not applicable

Other (please specify):

2.7 Have you ever injured your **wrist/hand/arm/shoulder** whilst performing any of the previously mentioned activities? (i.e. whilst performing the role of an adjustor/chiropractor)

☐ Yes (You may procede to **SECTION B** of the questionnaire)
☐ No

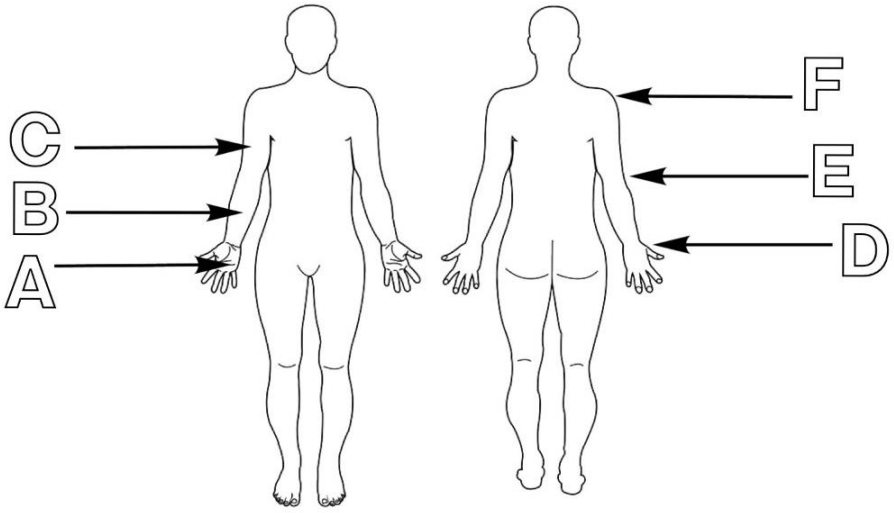
2.8 Have you had a prior **wrist/hand/arm/shoulder** injury aggravated by the previously mentioned activities (i.e. whilst performing the role of an adjustor/chiropractor)?

☐ Yes (you may procede to **SECTION C** of the questionnaire)
☐ No (You are done with this questionnaire – ***thank you kindly for your time***)

SECTION B

3 **Upper Extremity Work-Related Musculoskeletal Injury: SINGLE MOST SEVERE**

3.1 Which part/s of the upper extremity was affected? **(Tick appropriate box)**



- ☐ A: Hand (part between fingertips and wrist joint)
- ☐ B: Arm (part between the wrist and elbow joint)
- ☐ C: Upper arm (part between the elbow and shoulder joint)
- ☐ D: Wrist
- ☐ E: Elbow
- ☐ F: Shoulder

3.2 What type of injury would you say it was? **(Tick all that apply)**

- ☐ Ligament sprain
- ☐ Muscle/ tendon strain
- ☐ Tendinitis
- ☐ Joint subluxation
- ☐ Fracture
- ☐ Ligament/ tendon tear
- ☐ Synovitis
- ☐ Nerve injury
- ☐ Joint sprain
- ☐ Other

If other please specify _____

3.3 Did you experience any of the following symptoms?

- ☐ Local stiffness
- ☐ Local pain
- ☐ Tenderness
- ☐ Heat
- ☐ Tingling
- ☐ Diffuse stiffness
- ☐ Cramps
- ☐ Swelling
- ☐ Numbness
- ☐ None

3.4 How long did the injury last for?

Acute
- ☐ less than a day
- ☐ 1 day to 1 week

Subacute
- ☐ more than a weeks to 1 month
- ☐ 1 month to 2 months

Chronic
- ☐ more than 2 months

3.5 What would you rate the pain or extent of the injury?

☐ Severe ☐ Moderate ☐ Mild ☐ Very mild

3.6 Did the injury disrupt your activities of daily living? **(Tick all that apply)**

Activity	A lot	A fair bit	Somewhat but manageable	Not at all
Sleeping				
Eating				
Bathing				
Carrying objects				
Tying shoes				
Writing				

Driving
Exercising

3.7 What activity would you say caused the injury?

- ☐ Orthopaedic testing
- ☐ Positioning patient
- ☐ Applying a modality
- ☐ Manual traction
- ☐ Other (please specify):
- ☐ Demonstrating exercise
- ☐ Performing adjustment/ manipulation
- ☐ Maintaining awkward position
- ☐ Ischemic compression

3.8 Have you had an injury as a result of cramming in adjustments before a practical test/ exam?

- ☐ Yes – from adjusting
- ☐ Yes – from being adjusted
- ☐ No

3.9 With regards to the question above, what would you say this injury was a result of**:**

- ☐ A one-time episode
- ☐ Initial episode with subsequent flare-ups
- ☐ Performing a technique you aren't used to
- ☐ Cumulative trauma
- ☐ Poor technique
- ☐ Other

If other please specify _____

3.10 If the injury occurred as a result of **PERFORMING A MANIPULATION**:

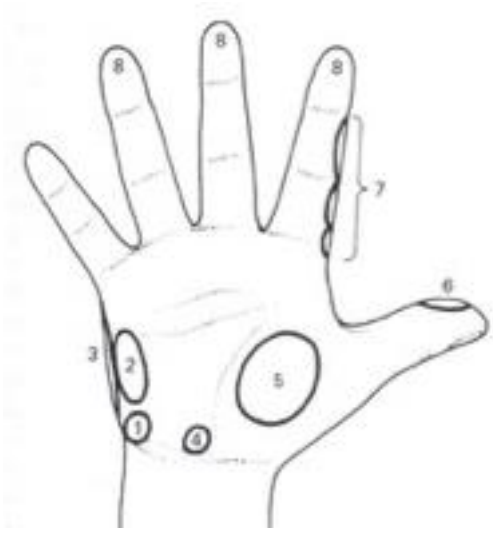
3.10.1 What anatomical area were you adjusting?

- ☐ Cervical spine
- ☐ Thoracic spine
- ☐ Lumbar spine
- ☐ Other (please specify):
- ☐ Upper extremity
- ☐ Lower extremity
- ☐ Sacral/coccygeal spine

3.10.2 What technique did you use?

- ☐ Diversified
- ☐ Other:

3.10.3 What primary contact point did you use? (please tick)



☐ 1: Pisiform
☐ 2: Hypothenar
☐ 3: Metacarpal
☐ 4: Calcaneal
☐ 5: Thenar
☐ 6: Thumb
☐ 7: Interphalange
☐ 8: Fingertip

3.10.4 Which bed height did you use? (please tick)

☐ Below knee height ☐ Knee height ☐ Above knee height ☐ No bed used (Standing or seated chair adjustment

3.10.5 What was the patient position in which you performed the adjustment? (please tick)

☐ Seated ☐ Supine ☐ Side lying ☐ Prone ☐ Standing

3.10.6 What was the doctor position in which you performed the adjustment?

☐ Fencer stance ☐ Square stance ☐ Bent over ☐ Standing behind ☐ Standing in front
☐ Seated behind ☐ Seated in front ☐ Other:

3.10.7 How many times did you perform the adjustment on the patient?

☐ One time ☐ Two times ☐ Three times ☐ More than three times

3.10.8 Did the injury result in you changing your technique?

☐ Yes ☐ No

3.10.9 What was your response to the injury?

☐ Avoided the technique
☐ Improved body posture and positioning
☐ Increased use of electromodalities as alternative
☐ Alter frequency of manipulations
☐ Absenteeism from class/clinic
☐ Required treatment for injury
☐ Other: (please specify)

3.10.10 What was the setting of the injury occurence?

☐ Practicing out of clinic/technique class
☐ During treatment of patient at clinic
☐ During treatment of patient at a
☐ During technique classes

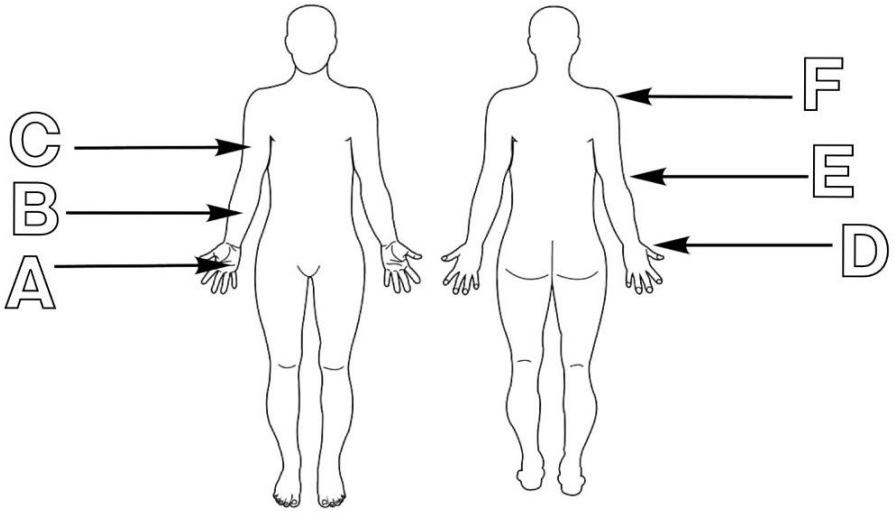
sporting event
☐ During practical exam/test ☐ Other
If other please specify _____

End of Section B: THANK YOU FOR PARTICIPATING

SECTION C

4. Prior injury aggravated by performing role of chiropractor

4.1 What was the site of your prior upper extremity injury?



☐ A: Hand (part between fingertips and wrist joint)
☐ B: Arm (part between the wrist and elbow joint)
☐ C: Upper arm (part between the elbow and shoulder joint)
☐ D: Wrist
☐ E: Elbow
☐ F: Shoulder

4.2 What activity would you say aggravated the injury?
☐ Orthopaedic testing
☐ Positioning patient
☐ Applying a modality
☐ Manual traction
☐ Other (please specify):
☐ Demonstrating exercise
☐ Performing adjustment/ manipulation
☐ Maintaining awkward position
☐ Ischemic compression

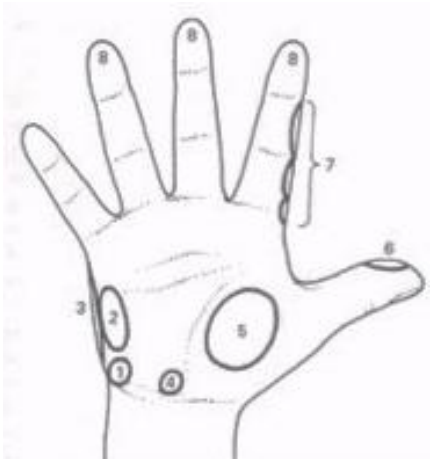
4.3 If the injury was aggravated as a result of **PERFORMING A MANIPULATION:**
4.3.1 What anatomical area were you adjusting?

☐ Cervical spine
☐ Thoracic spine
☐ Lumbar spine
☐ Other (please specify):
☐ Upper extremity
☐ Lower extremity
☐ Sacral/coccygeal spine

4.3.2 What technique did you use?

☐ Diversified ☐ Other:

4.3.3 What primary contact point did you use? (please tick)



☐ 1: Pisiform
☐ 2: Hypothenar
☐ 3: Metacarpal
☐ 4: Calcaneal
☐ 5: Thenar
☐ 6: Thumb
☐ 7: Interphalange
☐ 8: Fingertip

4.3.4 Which bed height did you use? (please tick)

☐ Below knee height ☐ Knee height ☐ Above knee height ☐ No bed used (Standing or seated chair adjustment

4.3.5 What was the patient position in which you performed the adjustment? (please tick)

☐ Seated ☐ Supine ☐ Side lying ☐ Prone ☐ Standing

4.3.6 What was the doctor position in which you performed the adjustment? (please tick)

☐ Fencer stance ☐ Square stance ☐ Bent over ☐ Standing behind ☐ Standing in front
☐ Seated behind ☐ Seated in front ☐ Other:

4.3.7 How many times did you perform the adjustment on the patient?

☐ One time ☐ Two times ☐ Three times ☐ More than three times

4.3.8 What was your response to the injury?

☐ Avoided the technique
☐ Improved body posture and positioning
☐ Increased use of electromodalities as alternative
☐ Alter frequency of manipulations
☐ Absenteeism from class/clinic
☐ Required treatment for injury
☐ Other: (please specify)

END OF SURVEY
Thank you for participating

Appendix F: Letter of information (Pilot study)

LETTER OF INFORMATION
PILOT STUDY

Dear Participant,
I would like to welcome you into the pilot study for my research.

Research Title:
Upper extremity work-related musculoskeletal injuries among chiropractic students at the Durban University of Technology

Supervisor: Dr. K. Padayachy, M.Tech: Chiropractic; PhD: Anatomy
Research student: Kyle Andrew Singh, B.Tech: Chiropractic

Background to the study:

Work-related musculoskeletal injuries (WRMSI) are very common among the healthcare profession especially amongst nursing and physiotherapy where there's great need to use the upper limb and lower back to perform daily tasks. It has been found that manual therapy as performed by physical therapists was related to wrist, hand and elbow injury. The chiropractic profession has been identified as at risk for work-related musculoskeletal injuries due to the high physical demand on the practioner and the application of manual therapies including adjustment/manipulation.

There have been a few studies done on practicing chiropractors that identify most WRMSI's occurring within the first few years of practice (Homack 2005; Holm and Rose 2006; Lamprecht 2018; Mathews 2006; Pereira 2009). There have been similar findings in studies that look at chiropractic students in North America, during their under-graduation technique training showing an increase in prevalence in wrist and hand injuries (Bisiacchi and Huber 2006; Kuehnel et al. 2008; Macanuel et al. 2005; Ndetan et al. 2009). . A study done by Bisiacchi and Huber (2006) at a North American chiropractic college found a significant relationship between female students and prevalence of hand and wrist WRMSI's, a result similarly noted by Ndetan (2009).

However the existing literature reveals a gap attributed to lack of cultural differences of students as well as non-uniformity among university course duration and training (Kuehnel et al. 2008). For instance, South African students are required to complete a Masters thesis to obtain their qualification, which takes on average 7 years (5 years course work and 2 years for Masters completion) (Allied Health Professions Council of South Africa); exposing them to vastly more time in training when compared to their North American counterparts who are required to complete a Doctor of Chiropractic degree (DC) which runs for 3 years and 4 months (Council of Chiropractic Education: Parker University). Furthermore the South African chiropractic programme instructs the use of the diversified technique, a technique shown to have the highest prevalence amongst any other techniques for WRMSI's (Ndetan 2009). The previously mentioned studies call for additional research to be done on students elsewhere, identifying any new risk factors for WRMSI's. It is therefore important to determine a profile of upper extremity work-related musculoskeletal injuries among the chiropractic students at DUT. This will help future efforts in designing a comprehensive protocol to prevent injury among training chiropractors.

Participation in this study is entirely voluntary and refusal to participate will not result in any adverse consequences. All information gathered from the pilot study will be kept private and confidential. The results of the discussion will only be used for research purposes.

Aim: To determine a profile of upper extremity injuries among chiropractic students at the Durban University of Technology

Study objectives:

1. To determine the period prevalence of upper extremity work-related musculoskeletal injuries among chiropractic students.
2. To determine selected risk factors (demographic related and occupational related) associated with chiropractic students and upper extremity work-related musculoskeletal injuries.

Procedure:

You are required to read and sign the Informed consent form, Confidentiality statement and Code of Conduct forms. After which you will receive a copy of the proposed questionnaire. Each question will then be discussed noting any suggestions recommended to limit the misinterpretation by the respondents. Any suggestions or comments to modify the questionnaire for easier understanding will also be noted. If inconsistencies are found or changes proposed, a unanimous vote is required to institute change to the questionnaire.

All comments and contributions to the discussion will be kept confidential.

Contact details in the event of any Problems or Queries:
Research supervisor: Dr K. Padayachy (keserip@hotmail.com)
Institutional Research Ethics Administrator: 031 373 2900
Complaints can be reported to the Director of Research and Postgraduate Support: 031 373 2577

Thank you for your participation and cooperation.
Your time and assistance is greatly appreciated.

Kyle Andrew Singh
Research student

Dr K. Padayachy
Supervisor

Appendix G: Informed consent form (Pilot study)

INFORMED CONSENT FORM
PILOT STUDY

Statement of Agreement to Participate in the Research Study:

I hereby confirm that I have been informed by the researcher, _____ (name of researcher), about the nature, conduct, benefits and risks of this study - Research Ethics Clearance Number: _____,
I have also received, read and understood the above written information (Participant Letter of Information) regarding the study.
I am aware that the results of the study, including personal details regarding my sex, age, race and diagnosis will be anonymously processed into a study report.
In view of the requirements of research, I agree that the data collected during this study can be processed in a computerised system by the researcher.
I may, at any stage, without prejudice, withdraw my consent and participation in the study.
I have had sufficient opportunity to ask questions and (of my own free will) declare myself prepared to participate in the study.
I understand that significant new findings developed during the course of this research that may relate to my participation will be made available to me.

_____ _____ _____ _____

Full Name of Participant Date Time Signature

_____ _____ _____

Full Name of Witness (If applicable) Date Signature

_____ _____ _____

Full Name of Legal Guardian (If applicable) Date Signature

I, Kyle Singh herewith confirm that the above participant has been fully informed about the nature, conduct and risks of the above study.

_____ _____ _____

Full Name of Researcher Date Signature

Appendix H: Code of conduct (Pilot study)

CODE OF CONDUCT: PILOT STUDY

This form needs to be completed by every member of the Pilot study prior to the commencement of the meeting.

As a member of this committee I agree to abide by the following conditions:

1. All information contained in the research documents and any information discussed during the meeting will be kept private and confidential. This is especially binding to any information that may identify any of the participants in the research process.

2. None of the information shall be communicated to any other individual or organisation outside of this specific pilot study as to the decisions of this meeting.

3. The information from this pilot study will be made public in terms of a journal publication, which will in no way identify any participants of this research.

Member represents	Name	Signature	Contact details

Appendix I: Confidentiality statement (Pilot study)

CONFIDENTIALITY STATEMENT – PILOT STUDY

DECLARATION
IMPORTANT NOTICE:

THIS FORM IS TO BE READ AND FILLED IN BY EVERY MEMBER PARTICIPATING IN THE PILOT STUDY, BEFORE THE MEETING CONVENES.

1. All information contained in the research documents and any information discussed during the pilot study meeting will be kept private and confidential. This is especially binding to any information that may identify any of the participants in the research process.
2. The returned questionnaires will be coded and kept anonymous in the research process.
3. None of the information shall be communicated to any other individual or organization outside of this specific meeting as to the decisions of this pilot study.
4. The information from this pilot study will be made public in terms of a journal publication, which will in no way identify any participants of this research.
5. Once this form has been read and agreed to, please fill in the appropriate information below and sign to acknowledge agreement.

Member name Contact number Sign

Appendix J: Pre-pilot study questionnaire

PROPOSED QUESTIONNAIRE

SECTION A

2. Demographic detail (Tick appropriate box)

3.11 Gender ☐ Male ☐ Female

3.12 Age in years _____ years

3.13 Race (for statistical purposes only)

- ☐ African
- ☐ Asian
- ☐ Coloured
- ☐ Indian
- ☐ White
- ☐ Other

(If other, please specify) _____

4 Demographics

4.1 What is the highest year of academic study that you have **SUCCESSFULLY COMPLETED**? (i.e. if you are currently in 4th year then 3rd year will be the highest completed year)

☐ 3rd year ☐ 4th year ☐ 5th year ☐ 6th year ☐ 7th year

☐ Other (please specify):

4.2 From the list below, please select which modules you have **REPEATED**, if any: (if you havent repeated any modules then select "Not applicable")

☐ Chiropractic Practice and Principles III	☐ Chiropractic Practice and Principles IV	☐ Chiropractic Practice and Principles V	☐ Clinical Chiropracti c V	☐ Not applicabl e

4.3 What is the average number of hours spent on hands-on practice **IN CLASS** per week? (this includes all the hours practicing adjustments, auxillary therapeutics, orthopaedic testing)

☐ Less than 5 hours ☐ Between 5 and 10 hours ☐ More than 10 hours ☐ Not applicable

4.4 What is the average number of hours spent on hands-on practice **IN CLINIC** per week (this includes all treatment and testing hours)

☐ Less than 5 hours ☐ Between 5 and 10 hours ☐ More than 10 hours ☐ Not applicable

4.5 How often do you adjust using the following **(tick appropriate box)**?

Dominant hand	☐ Always	☐ Often	☐ Sometimes	☐ Rarely	☐ Not applicable
Indifferent hand	☐ Always	☐ Often	☐ Sometimes	☐ Rarely	☐ Not applicable
Activator/ impulse adjustor	☐ Always	☐ Often	☐ Sometimes	☐ Rarely	☐ Not applicable
Diversified technique	☐ Always	☐ Often	☐ Sometimes	☐ Rarely	☐ Not applicable

4.6 How often do you use **NON-MANIPULATIVE TECHNIQUES (tick appropriate box):**

Dry needling	☐ Always	☐ Often	☐ Sometimes	☐ Rarely	☐ Not applicable
Electromodalities	☐ Always	☐ Often	☐ Sometimes	☐ Rarely	☐ Not applicable
Cryotherapy/ thermotherapy	☐ Always	☐ Often	☐ Sometimes	☐ Rarely	☐ Not applicable
Strapping	☐ Always	☐ Often	☐ Sometimes	☐ Rarely	☐ Not applicable
Massage	☐ Always	☐ Often	☐ Sometimes	☐ Rarely	☐ Not applicable
Stretching	☐ Always	☐ Often	☐ Sometimes	☐ Rarely	☐ Not applicable

Other (please specify)

_____

4.7 Have you ever injured your wrist/hand/arm/shoulder whilst performing any of the previously mentioned activities (i.e. whilst performing the role of an adjustor/chiropractor) or any prior injury aggravated by the previously mentioned techniques?

- ☐ Yes (You may procede to the next section of the questionnaire)
- ☐ No (You are done with this questionnaire – thank you kindly for your time)

SECTION B

5 Work related musculoskeletal injuries: SINGLE MOST SEVERE work related musculoskeletal injury

5.1 Which part/s of the upper extremity was affected? **(Tick appropriate box)**

- ☐ Hand (part between fingertips and wrist joint)
- ☐ Arm (part between the wrist and elbow joint)
- ☐ Upper arm (part between the elbow and shoulder joint)
- ☐ Wrist
- ☐ Elbow
- ☐ Shoulder

5.2 What type of injury was it (Tick all that apply)

- ☐ Ligament sprain
- ☐ Muscle strain
- ☐ Tendinitis
- ☐ Fracture
- ☐ Ligament/ tendon tear
- ☐ Synovitis
- ☐ Dislocation
- ☐ Other

If other please specify _____

5.3 Did you experience any of these symptoms?

- ☐ Local stiffness
- ☐ Local pain
- ☐ Tenderness
- ☐ Heat
- ☐ Diffuse stiffness
- ☐ Cramps
- ☐ Swelling
- ☐ None

5.4 How long did the injury last for?

- ☐ 1 day or less
- ☐ 3 days or less
- ☐ 1 week to 1 month
- ☐ More than a month
- ☐ 2 days or less
- ☐ 3 days to 7 days
- ☐ 1 month or less
- ☐ More than 3 months (ongoing)

5.5 What was the pain/extent of the injury?

☐ Severe ☐ Moderate ☐ Mild ☐ Very mild ☐ None

5.6 Did the injury disrupt your activities of daily living?

- ☐ Not at all
- ☐ Somewhat
- ☐ A fair bit
- ☐ A lot
- ☐ Cant recall/remember

5.7 What activity caused the injury/ aggravated the existing injury? (includes performing these activities during practical classes and/ or at sporting events)

- ☐ Orthopaedic testing
- ☐ Positioning patient
- ☐ Applying modality
- ☐ Manual traction
- ☐ Other (please specify):
- ☐ Demonstrating exercise
- ☐ Perfroming manipulation
- ☐ Maintaining awkward position
- ☐ Ischemic compression

5.8 Have you had an injury as a result of cramming in adjustments before a practical test/ exam?

☐ Yes – from adjusting ☐ Yes – from being adjusted ☐ No

5.9 What would you say this injury was a result of**:**

- ☐ A one-time episode
- ☐ Initial episode with subsequent flare-ups
- ☐ Cumulative trauma
- ☐ Other

If other please specify _____

5.10 If the injury occurred as a result of **PERFORMING A MANIPULATION**:

5.10.1 What anatomical area were you adjusting?

_____

5.10.2 What technique did you use?

_____

5.10.3 What contact did you use? (e.g. Pisiform contact)

_____

5.10.4 Which bed height did you use? (select from the following)

☐ Too low ☐ Knee-height ☐ Too high ☐ No bed used (Standing or seated chair adjustment

5.10.5 What was the patient position in which you performed the adjustment? (select from the following)

☐ Seated ☐ Supine ☐ Side lying ☐ Prone ☐ Standing

5.10.6 What was the doctor position in which you performed the adjustment?

☐ Fencer stance ☐ Square stance ☐ Bent over ☐ Standing behind ☐ Standing in front
☐ Seated behind ☐ Seated in front ☐ Other:

5.10.7 How many times did you perform the adjustment on the patient?

☐ Once ☐ Twice ☐ Thrice ☐ More than three times

5.10.8 Did the injury result in you changing your technique?

☐ Yes ☐ No

5.10.9 What was your response to the injury?

☐ Avoided the technique
☐ Improved body posture and positioning
☐ Increased use of electromodalities
☐ Alter frequency of manipulations
☐ Missed class/clinic
☐ Required treatment
☐ Other: (please specify)

5.10.10 What was the setting of the injury occurence?

☐ Practicing out of clinic/technique class
☐ During treatment of patient at clinic
☐ During treatment of patient at a sporting event
☐ During technique classes
☐ During practical exam/test
☐ Other

If other please specify _____

END OF SURVEY

Thank you for your time
Kind regards
Kyle Singh

Appendix K: Permission from author of questionnaire

Re: Dissertation questionnaire

AL Almay Lamprecht <14mayq@gmail.com>
Sun 07/29, 6:03 PM
You

Reply

Good evening Mr Singh,

Thank you very much for your inquire with regards to my research.

You are more than welcome to utilize my questionnaire and adapt it to suit your study population.

All the best with your research.

Kind regards
Almay Lamprecht