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Carpal tunnel syndrome in physiotherapists in Bloemfontein

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Carpal tunnel syndrome in physiotherapists in Bloemfontein

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Submitted in fulfilment of the requirements in respect of the M.Sc. Physiotherapy degree in the Department of Physiotherapy, in the Faculty of Health Sciences, at the University of the Free State.

Declaration

(i) I, ……………………….declare that the master's research mini-dissertation that I herewith submit at the University of the Free State, is my independent work and that I have not previously submitted it for a qualification at another institution of higher education.

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Nadia Human

29 January 2016

Dedication

To God be the glory, for His amazing presence, grace and love to complete this report.

To my husband, Bukkie, children, Hendie and Hannes and parents, Johan and Ina for their loving support during my study period.

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The planning of this study and writing of this report would not have been possible without Roline Barnes, my study leader of note. Thank you for the incomparable expert guidance and support.

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Abstract

Introduction: Carpal tunnel syndrome (CTS) is the most common compression neuropathy of the upper limb with a 3-5% prevalence among the worldwide general adult population. It is associated with specific personal factors, certain medical conditions, repetitive and forceful hand and wrist movements and occupation. This study aimed at investigating the prevalence of CTS among physiotherapists.

Method: The cross-sectional study included 64 participants, chosen by means of convenience sampling from a population of 158 physiotherapists. Demographic data, details of occupational activities; possible personal, medical and occupational causative factors and arm and hand symptoms were gathered by a structured interview. A participant-completed Katz hand diagram was used to clarify information on upper limb symptoms. Typical CTS signs, height and weight were determined by a physical examination.

Results: According to the case definition the prevalence of definitive CTS was 7.8% and of probable CTS was 7.8%. Age over 40 years and rheumatoid arthritis as personal or medical history causative factors was statistically significant among the definitive diagnosis group. Overweight showed a tendency towards a definitive CTS diagnosis. Years in practice, hours working overtime and working in the neurosurgery field was occupational causative factors in the definitive CTS diagnosed group. No occupational activities or treatment techniques could be found to be associated with the CTS diagnosis. Longer resting periods between patients was the only statistically significant management strategy among the definitive CTS diagnosed group.

Conclusion: Physiotherapy is an at risk occupation for the development of CTS with a prevalence of 15.6% when combining the definitive and probable diagnosis groups, but with no clear occupational activities or treatment techniques as possible risk factors identified.

Summary of the study

Carpal tunnel syndrome (CTS) is the most common compression neuropathy of the upper limb with a 3-5% prevalence among the worldwide general adult population (Celik and Guven, 2008:83 and Giersiepen and Spallek, 2011:239). A CTS diagnosis is based on a variety of specific neurological upper limb sensory and motor symptoms and typical signs determined by medical-history recording, standard special tests and observation as well as electrodiagnostic testing (Palmer, 2011:19; Shannon and Rizzolo, 2012:22 and Bland et al., 2014:6). CTS is associated with specific personal factors, certain medical conditions, repetitive and forceful hand and wrist movements and occupation (Mennen and Van Velze, 2008:200 and LeBlanc and Cestia, 2011:952). This study aimed at investigating the prevalence of CTS among physiotherapists, in Bloemfontein.

Before commencement of the study, ethical clearance was obtained from the Faculty of Health Sciences, University of the Free State (ECUFS NR 54/2015). This was followed by a pilot study following the same procedure as for the main study. No changes were made and the main study commenced.

The cross-sectional study included 64 participants, chosen by means of convenience sampling from a population of 158 physiotherapists. Demographic data, details of occupational activities, possible personal; medical and occupational causative factors and arm and hand symptoms were gathered by a structured interview based on a self-developed questionnaire. A participant-completed Katz hand diagram was used to clarify information on upper limb symptoms. A physical examination was performed by the researcher which included special tests and observations to determine typical CTS signs as well as height and weight measurement to calculate the body mass index of participants. Electrodiagnostic testing was not available due to funding and resource limitations. Data analysis was done by the Department of Biostatistics, University of the Free State.

According to the case definition the prevalence of definitive CTS was 7.8% and of probable CTS was 7.8% for physiotherapists in Bloemfontein. The typical CTS signs and symptoms in both diagnosed groups are indicative of primary CTS with very little or no motor involvement. Age over 40 years (CI, -47.5; -5.7) and rheumatoid arthritis (CI, -84.3; -2.0) as personal or medical history causative factors was statistically significant among the definitive diagnosis group, with overweight (CI, -16.2; 37.9) showing a tendency towards the CTS diagnosed group. Years in practice (p=0.003), hours working overtime (CI, -80.2; -8.9) and working in the neurosurgery field (CI, -66.0; -8.6) was occupational causative factors in the definitive CTS diagnosed group. No occupational activities or treatment techniques, which included forceful and repetitive wrist movements could be found to be associated with the CTS diagnosis. Longer resting periods between patients was the only statistically significant management strategy among the definitive CTS diagnosed group. Other strategies implemented by the CTS diagnosed group included regular change of hand position and correction of poor posture as well as adjustment of techniques, correlated with the conservative treatment options suggested in literature (LeBlanc and Cestia, 2011:955).

The conclusion was made that physiotherapy is an at risk occupation for the development of CTS with a prevalence of 15.6% when combining the definitive (7.8%) and probable (7.8%) diagnosis groups, but with no clear occupational activities or treatment techniques as possible risk factors identified.

This baseline study could inspire further research on the topic of CTS in physiotherapists, especially among a larger population and with more focus on occupational activities and factors as causative factors. Awareness of CTS as occupational hazard in physiotherapy should be raised at undergraduate and postgraduate level.

Key terms: carpal tunnel syndrome; wrist movements; prevalence; physiotherapists; causative factors; upper limb symptoms; typical signs; diagnosis; occupational hazard; management strategies

Opsomming van die studie

Karpale tonnelsindroom (KTS) is die algemeenste kompressie neuropatie van die boonste ledemaat met 'n 3-5% prevalensie in die wêreldwye, algemene, volwasse bevolking (Celik en Guven, 2008:83 en Giersiepen en Spallek, 2011:239). 'n KTS diagnose is gebaseer op 'n verskeidenheid, spesifieke neurologiese boonste ledemaat sensoriese en motoriese simptome en tipiese tekens, wat vasgestel word deur middel van meidese geskiedenisneming, standaard spesiale toetse en observasie, asook elektrodiagnostiese toetsing (Palmer, 2011:19; Shannon en Rizzolo, 2012:22 en Bland et al., 2014:6). KTS word geassosieer met spesifieke persoonlike faktore, sekere mediese toestande, kragtige en herhaaldelike hand- en polsbewegings en beroep (Mennen en Van Velze, 2008:200 en LeBlanc en Cestia, 2011:952). Hierdie studie se doel was om die prevalensie van KTS in fisioterapeute in Bloemfontein te ondersoek.

Voor die aanvang van die studie is etiese goedkeuring verkry van die Fakulteit Gesondheidswetenskappe, Universiteit van die Vrystaat (ECUFS NR 54/2015). 'n Loodsstudie het gevolg wat dieselfde prosedure as vir die hoofstudie gevolg het. Geen verandering is aangebring nie en die hoofstudie het 'n aanvang geneem.

Die dwarssnitstudie het 64 deelnemers ingesluit wat geselekteer is deur gerieflikheidsteekproeftrekking uit 'n populasie van 158 fisioterapeute. Demografiese data; detail van beroepsaktiwiteite, moontlike persoonlike; mediese en beroepsveroorsakende faktore en arm- en handsimptome is ingesamel, deur die voer van 'n gestruktureerde onderhoud, gebaseer op 'n selfontwikkelde vraelys. 'n Katz handdiagram is deur deelnemers voltooi om inligting aangaande boonste ledemaat simptome uit te klaar. 'n Fisiese ondersoek is uitgevoer deur die navorser wat spesiale toetse en observasies ingesluit het om tipiese KTS tekens te bepaal asook lengte- en gewigmetings om die liggaamsmassa-indeks van deelnemers te bepaal. Elektrodiagnostiese toetsing was nie beskikbaar nie, weens 'n tekort aan befondsing en

hulpbronne. Data-analise is uitgevoer deur die Departement Biostatisitek, Universiteit van die Vrystaat.

Volgens die gevalsdefinisie is die prevalensie van ‘n definitewe KTS diagnose 7.8% en van ‘n waarskynlike KTS diagnose 7.8%, vir fisioterapeute in Bloemfontein. Die tipiese KTS simptome in beide gediagnoseerde groepe is beduidend van primêre KTS met min of geen motoriese betrokkenheid. Ouderdom bo 40 jaar (VI, -47.5; -5.7) en rhumatoïede artritis (VI, -84.3; -2.0) as persoonlike of mediese geskiedenis veroorsakende faktore was statisties beduidend in die definitiewe diagnose groep. Oorgewig (VI, -16.2; 37.9) het ‘n neiging tot die KTS gediagnoseerde groep getoon. Jare in praktyk (p=0.003), oortyd werksure (VI, -80.2; -8.9) en werksaam in die neuro-chirurgiese veld (VI, -66.0; -8.6) was veroorsakende beroepsfaktore in die definitiewe diagnose groep. Geen beroepsaktiwiteite of behandelingstegnieke, wat herhaaldelike en kragtige polsbewegings insluit, het ‘n statisties beduidende assosiasie met die KTS diagnose opgelewer nie. Langer rusperiodes tussen pasiënte was die enigste statisties beduidende hanteringsstrategie in die definitiewe KTS gediagnoseerde groep. Ander strategieë wat deur die KTS gediagnoseerde groep geïmplementeer is, het ingesluit: gereelde verandering van handposisie en korrigering van swak postuur, asook aanpassing van tegnieke en dit stem ooreen met die konserwatiewe behandelingsopsies vir KTS, soos voorgestel in literatuur (LeBlanc en Cestia, 2011:955).

Die gevolgtrekking is gemaak dat fisioterapie ‘n risiko beroep is vir die ontwikkeling van KTS, met ‘n prevalensie van 15.6% wanneer die definitef (7.8%) en waarskynlik (7.8%) gediagnoseerde groepe gekombineer word. Geen duidelike beroepsaktiwiteite of behandelingstegnieke kon egter as moontlike risiko faktore geïdentifiseer word nie.

Hierdie basislynstudie kan toekomstige navorsing inspireer met die onderwerp van KTS in fisioterapeute, veral onder groter populasies en met meer fokus op beroepsaktiwiteite as veroorsakende faktore. Bewustheid van KTS as beroepsgevaar in fisioterapie moet geskep word op voorgraadse en nagraadse vlak.

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Glossary

Body mass index (BMI): indicator of body fatness, calculated by using measured height and weight values as follows: weight (kilograms)/height (meters^2) (WHO, 2000:Online).

Carpal tunnel: A tunnel formed by the flexor retinaculum (tight band of connective tissue) spanning the carpal bones (Hansen, 2014:13).

Carpal tunnel release: a surgical procedure to relieve the compression of the median nerve (Dictionary of Medical Terms, 2005:62).

Compression neuropathy: A condition characterized by reduced blood flow and narrowing of the tunnel through which the nerve must pass, leading to acute or chronic ischemia of the nerve (Mennen and Van Velze, 2008:199).

Electrodiagnostic tests: Studies performed by a neurophysiologist including electromyography (EMG)/nerve conduction studies (NCS); plain film radiography; Magnetic Resonance Imaging (MRI); and ultrasonography used to confirm the diagnosis of CTS (Shannon and Rizzolo, 2012:24).

False negative: A diseased individual who is incorrectly identified by a negative test result (Faught, 2001:xi).

False positive: A disease-free individual who is incorrectly identified by a positive test result (Faught: 2001:xii).

Gold standard: An accepted reference test (Faught, 2001:xii).

Nerve conduction tests: An electrophysiological test designed to measure distal and/or sensory motor latency of the median nerve (Faught, 2001:xii).

Occupational hazard: a dangerous situation related to the working environment (Dictionary of Medical Terms, 2005:273).

Occupational health: A multidisciplinary act aimed at protection, promotion, development and enhancement of workers and the work environment as well as enabling workers to conduct socially and economically productive lives (WHO, 2001:Online).

Overuse injuries: Injuries sustained from repeated action as opposed to acute injuries, which occur in an instant (PhysioWorks, 2015:Online).

Sensitivity: The rate of positive responses in a test from persons with a specific disease. A high rate of sensitivity means a low rate of people being incorrectly classed as negative (Dictionary of Medical Terms, 2005:371).

Specificity: The rate of negative responses in a test from persons free from a disease. A high specificity means low rate of false positives (Dictionary of Medical Terms, 2005:385).

Work-related musculoskeletal disorders (WRMD's): All musculoskeletal disorders that are induced or aggravated by work and the circumstances of its performance (European Agency for Safety and Health at Work, 2010:13).

Abbreviations

APB: abductor pollicis brevis

BLS: Bureau of Labor Statistics

BMI: body mass index

CI: confidence interval

CTS: carpal tunnel syndrome

DM: Diabetes Mellitus

ECUFS: Ethics Committee of the Faculty of Health Sciences, University of the Free State

EU: European Union

HPCSA: Health Professions Council of South Arica

ICF: International Classification of Functioning, Disability and Health

MSD's: musculoskeletal disorders

NIOSH: National Institute for Occupational Safety and Health

RA: rheumatoid arthritis

RTD: repetitive trauma disorder

SASP: South African Society of Physiotherapy

UFS: University of the Free State

USA: United States of America

WHO: World Health Organization

WRMD's: work-related musculoskeletal disorders

WRULD's: work-related upper limb disorders

Chapter one

1 Introduction

1.1 Background

Carpal tunnel syndrome (CTS) is the most common compression neuropathy of the upper limb in the world and is a result of chronic compression of the median nerve in the carpal tunnel (Celik and Guven, 2008:83). The prevalence for CTS in the general adult population is 3-5% worldwide (Nora, Becker, Ehlers and Gomes, 2005:275; Giersiepen and Spallek, 2011:239). CTS is associated with the words "over-use injury", "repeated movement syndrome", or "repetitive stress injury" (LeBlanc and Cestia, 2011:952 and McKean, 2014:Online). The diagnosis is based on a variety of irritating neurological symptoms, positive results on standard provocation and special tests, and electrodiagnostic investigations (Giersiepen and Spallek, 2011:238; Palmer, 2011:19 and Bland, Rudolfer and Weller, 2014:6).

1.2 The extent and nature of the problem

The prevalence of CTS in the workplace is rising (Palmer, Harris and Coggon, 2007:57) and the six cases of work-related CTS due to repetitive work in the United States of America (USA) which were first discovered in 1947 by Brian and Wright (Jagga, Lehri and Verma, 2011:68) is far less than the report in 1994 by the USA Bureau of Labor Statistics (BLS) that reported that CTS contributed to 40.8% of all upper limb repetitive movement syndromes in the USA (Jagga et al., 2011:68). For the period from 1997 to 2000 CTS was the number one reported medical problem accounting for 50% of all work-related injuries in the USA (BLS and the NIOSH, 1997-2000). During 2000 in the USA, the median lost-working-days due to work-related CTS was 27 days, the second longest period of lost-working-days of all work-related injuries and syndromes (Dale, Harris-Adamson, Rempel, Gerr, Hegmann, Silverstein and Burt et al., 2013:595). CTS has been listed as sixth amongst recognised occupational diseases in the European Union (EU) since 2001 and in 2009 it had also been recognised as an occupational disease in Germany. In South Africa, CTS is listed as a work-related upper limb disorder (WRULD) of the hand in the Compensations Commissioner's guidelines for health practitioners and employers in managing WRULD's (Department of Labour, 2004:Online). Investigation in tool-manufacturing companies in Bologna, Italy employing manual labourers has shown prevalence rates of 24%-43% for CTS (Giersiepen and Spallek, 2011:240). Following an extensive literature review, no studies regarding CTS in the workplace in South Africa could be found.

The dental profession is the only medical related profession ever investigated for possible CTS. In 1994, Canadian dental assistants and hygienists were investigated for CTS and the results indicated that dental hygienists were 5.2 times more likely to have been diagnosed with CTS and 3.7 times more likely to meet a CTS case definition than the dental assistants (Liss, Jesin, Krusiak and White, 1995:538). Dental hygienists were further investigated in 2001 by Lalumandier and McPhee who analysed 177 USA army dental hygienists' hand problems. Probable or classic symptoms of CTS were exhibited by 56% of these dental hygienists, while Anton, Rosecrance, Merlino and Cook (2002) reported a CTS prevalence of 8.4% amongst 109 dental hygienists attending a continuing education conference in the USA during 2002.

The prevalence or even risk of neurological conditions, especially CTS, in the physiotherapy profession has never been investigated and studies in general on the topic of CTS prevalence in South Africa are very scarce. Intergroup carpal tunnel dimensions have been compared amongst black and white South Africans by Widgegrow, Sacks, Greenberg and Becker (1996) and the incidence of CTS amongst black South Africans has been investigated by Goga (1990:96) who found that 26 black South Africans were diagnosed with CTS over the five year period before publication of the study at the King Edward VIII hospital in Natal, South Africa.

1.3 Management

The management of CTS can be either conservative or surgical and is based on the severity of the symptoms (LeBlanc and Cestia, 2011:954). Conservative treatment includes oral corticosteroids for short-term symptom relief, 24-hour or night splints as well as activity and lifestyle modifications, for example, alternating job functions and using ergonomic equipment (e.g. mouse pads) (LeBlanc and Cestia, 2011:955). A second line of conservative treatment included local steroid injections with 22% of patients being symptom-free for at least one year (McKean, 2014:Online). Only thereafter, surgical treatment will be considered in the case of failure of conservative treatment and entails a carpal tunnel release (either open or endoscopic) (McKean, 2014:Online). It has been found however, that surgical treatment does not necessarily relieve CTS symptoms more than a local steroid injection (LeBlanc and Cestia, 2011:957).

1.4 Aim

The aim of the study was to describe the prevalence of CTS amongst physiotherapists in Bloemfontein, South Africa.
The specific objectives of the study were within physiotherapists practicing in Bloemfontein, to:

- describe the demographic information, work background and occupational activities of the population by utilising a structured interview;
- identify the clinical signs and symptoms related to CTS as determined by a structured interview and physical examination using standardised tests.
- provide a possible clinical diagnosis of CTS as determined by a structured interview and physical examination using standardised tests.
- determine any association between body mass index (BMI) and other possible causes of CTS to establish if physiotherapy is a high-risk occupation for developing CTS by using a structured interview and physical examination.
- describe the strategies that physiotherapists implement to relieve symptoms related to CTS.

The long term purpose of the study is to create awareness amongst the physiotherapy community regarding CTS as an occupational hazard if the results of the study indicate CTS as being an occupational hazard.

1.5 Significance and justification of the study

Often physiotherapists are affected by many of the conditions they treat, which ultimately limit their professional abilities. The main area of research thus far in the physiotherapy population in South Africa concerns upper extremity disorders focused on work-related musculoskeletal disorders (WRMD's) (Barnes, Moolman, Roux, Schabort, Yzel, Raubenheimer, 2011 and Jenkins, 2013).

The lack of research on CTS prevalence as well as the possible relationship between CTS and the occupational demands placed on physiotherapists' hands serves as motivation for this study. Physiotherapists have been identified as an at-risk group regarding WRMD's of the thumb and hands in previous studies (Cromie Robertson and Best, 2000; Barnes et al., 2011 and Jenkins, 2013). According to Cromie et al. (2000) physiotherapists leave the occupation due to WRMD's (Cromie et al., 2000:340-350) and the same could be said for other unidentified occupational hazards, of which CTS may be one. The occupational risk factors contributing to WRMD's are very similar to those identified by the professions where the focus is on forceful and repetitive movements of the hand or wrist (Moraska et al., 2008:260 and Shiri, Miranda, Heliövaara and Viikari-Juntura, 2008:368) and a CTS diagnosis was made. Many of these movements are performed daily by physiotherapists when treating patients.

The results of the study can therefore be used to enhance the physiotherapy community's knowledge and awareness regarding occupational health within the profession and the prevention of CTS. Valuable base-line information on CTS as a possible occupational hazard in the physiotherapy profession can lead to further investigations into identifying strategies that can be implemented by physiotherapists in the prevention of developing CTS.

1.6 Organisation of the research report

The research report is organised as follows:

Chapter two presents the complete literature review and is followed by chapter three, outlining the methodology of the study. In chapter four the results of the study are presented, followed by the discussion in chapter five. Conclusions and limitations of the study are described in chapter six and recommendations are made for future research.

Chapter two

2 Literature review

2.1 Search strategy

The search engines used for this review were The Cochrane Library, Kovsiecat (Academic Search Complete, CINAHL and MEDLINE), KovsieScolar, Google Scholar, PubMed and Science Direct. All articles post 2000 was reviewed. In addition, important relevant articles prior to this were included. The literature search period was from January 2014 to January 2016. The key words/phrases used to obtain the relevant articles were "occupation" and "carpal tunnel syndrome", "over-use injuries in physiotherapists", "diagnosis of carpal tunnel syndrome", "carpal tunnel syndrome background and theory", "treatment of carpal tunnel syndrome". A specialist, Head of the Department of Neurology, University of the Free State (UFS) was contacted to clarify possible "grey areas" in the literature and find all possible sources of relevant literature.

2.2 Background

Compression neuropathies (also known as nerve compression syndromes or entrapment neuropathies) of the upper limb are common with one out of five people in the USA suffering from an upper limb compression neuropathy (Canale and Beaty, 2008:4285). A compression neuropathy is regarded as a severely debilitating clinical condition with regard to physical, psychological and financial impact for the injured (Toussaint and Zager, 2008:573). CTS results from the chronic compression of the median nerve in the carpal tunnel (Celik and Guven, 2008:83) and is the most common compression neuropathy of the upper limb, attributing to 90% of all compression neuropathies worldwide (Aroori and Spence, 2008:6). The second most common treated compression neuropathy of the upper limb is cubital tunnel syndrome also known as ulnar nerve compression (Canale and Beaty, 2008:4298), which is 75% less common than CTS (Mennen and Van Velze, 2008:199). Other upper limb compression neuropathies which are less common and often wrongly diagnosed as other conditions are: radial nerve compression mistaken for De Quervain's disease, and pronator syndrome mistaken for writer's cramp (Mennen and Van Velze, 2008:199-206). CTS is associated with the words "over-use injury", "repeated movement syndrome", or "repetitive stress injury" (LeBlanc and Cestia, 2011:952 and McKean, 2014:Online).

A CTS diagnosis is based on a triad, depending on a variety of irritating neurological sensory and motor symptoms including tingling, numbness, decreased sensation and night-time pain in the palm of the hand and the radial three and a half fingers, as well as weakness of the hand and/or hand grip (Aroori and Spence, 2008:6 and Shannon and Rizzolo, 2012:22), positive results on standard provocation and special tests (see 2.6.1, p13), and electrodiagnostic investigations (Giersiepen and Spallek, 2011:238; Palmer, 2011:19 and Bland et al., 2014:6).

The causative and risk factors for CTS include personal factors namely: age (older than 40 years), female gender, obesity, pregnancy and medical history namely: local tumour or deformity, rheumatoid arthritis (RA), diabetes mellitus (DM) (type not specified), hypothyroidism, amyloidosis; sarcoidosis; leukaemia, tuberculosis, and a history of upper limb trauma (LeBlanc and Cestia, 2011:952). Epidemiological studies have clearly shown the association of CTS with forceful repetitive work and use of vibratory equipment (Rosecrance, Cook, Anton and Merlino, 2002:108; Shiri et al., 2008:368 and Dale et al., 2013:496).

CTS is more often seen in the workplace (Palmer et al., 2007:57) with occupational factors and activities increasingly associated with the development of CTS (Shannon and Rizzolo, 2012:22). Its incidence has contributed to 40.8% of all upper limb repetitive motion disorders in 1994, as reported by the USA BLS (Jagga et al., 2011:68), it accounted for 50% of all work-related injuries in the USA in the year 2000 (BLS and the NIOSH, 1997-2000), and half of all workers with occupational CTS, missed 27 working days or more in 2002 (Rosecrance et al., 2002:108 and

Dale et al., 2013:595). The number of days of missed work when viewed on a per-case basis was greater than that for amputations, fractures and back disorders (Rosecrance et al., 2002:108). According to the USA BLS report of 2002, CTS accounted for 27 700 occupational illness cases in the USA during 2002 (Rosecrance et al., 2002:108). CTS has been listed as the sixth most common recognised occupational disease in the EU since 2001, and listed as occupational disease number 506 in the EU's register of occupational diseases since 2003 (Giersiepen and Spallek, 2011:240). In 2009 the recognition of CTS as an occupational disease in Germany, became a reality when a scientific research paper was published by the medical expert advisory panel to the German Federal Ministry of Labour and Social Affairs, which supported the listing of CTS as an occupational disease (Giersiepen and Spallek, 2011:240). In the South African Compensations Commissioner's guidelines for health practitioners and employers to manage WRULD's, CTS is listed and described as a WRULD of the hand (Department of Labour, 2004:Online). The conditions listed in these guidelines associated with CTS include: assembly work, typing, scrubbing, computer work, grinding, hammering, and packing. CTS prevalence rates of 24%-43% have been shown in studies conducted in tool manufacturing companies in Bologna, Italy employing manual labourers working on conveyor belts (Giersiepen and Spallek, 2011:240). After an extensive literature review, no studies regarding CTS in the workplace in South Africa could be found.

2.3 Overview: anatomy, physiology and histology of peripheral nerves

The peripheral nerve (e.g. median nerve) consists of nerve fibres (axons) that differ in size and conduct nerve impulses to and from the central nervous system. These axons may be surrounded by a myelin sheath (Martini and Bartholomew, 2007:240). The most common peripheral nerve is classified as a mixed nerve (for example, the median nerve); because it contains both sensory and motor nerve fibres (Afifi and Bergman, 2005:9). When a cross-section of a single peripheral nerve is examined, three different connective tissue sheaths are observed (see Figure 2.1).

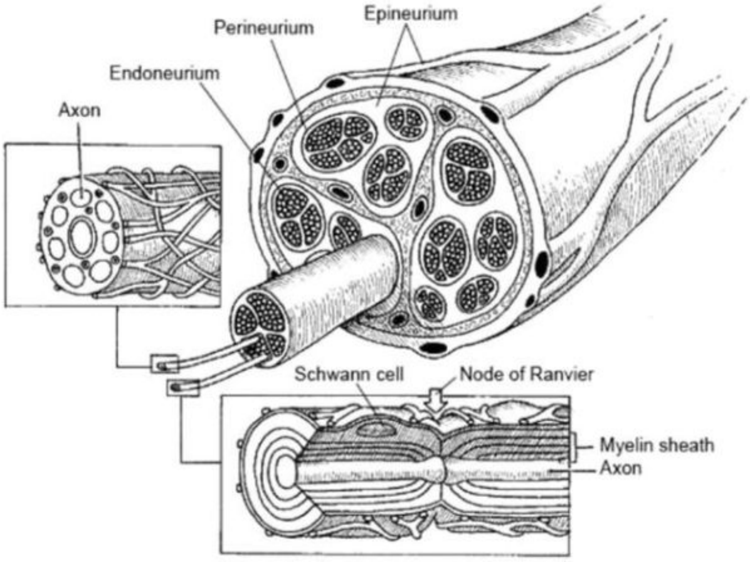

Figure 2.1 Cross-section of a peripheral nerve

The outer sheath is known as the epineurium (Afifi and Bergman, 2005:10-11) and contains blood and lymph vessels and acts as a shock absorber when the nerve is exposed to pressure or trauma. The epineural fibres are closely linked with the central sheath, the perineurium. The perineurium surrounds and divides groups of axons into fascicles of different sizes and gives strength and elasticity to the nerve (Afifi and Bergman, 2005:10-11). The inner sheath of connective tissue, called the endoneurium, surrounds a single axon with a myelin sheath or small groups of axons with no myelin sheath, and is connected to both the peri- and epineurium (Campbell, 2008:1952). This sheath acts as a strong, protective shield for the delicate axon.

2.4 Overview: anatomy of the carpal tunnel

The osseofibrous carpal tunnel (see Figure 2.2, p10), is formed by the flexor retinaculum (also called the transverse carpal ligament) on the palmar aspect of the wrist attaching to the corner of the hamate and pisiform on the ulnar aspect of the wrist, to the scaphoid and trapezium on the radial aspect of the wrist and the proximal row of carpal bones on the dorsal aspect (Trumble, Gilbert and McCallister, 2001:255-256). The carpal tunnel is a rigid structure containing the median nerve, the long flexor tendons of the fingers (four flexor digitorum profundus tendons and four flexor digitorum superficialis tendons) as well as the flexor tendon of the thumb (flexor pollicis longus).

The eight flexor tendons of the fingers are arranged in two rows on the ulnar aspect of the tunnel, partially surrounded by one common flexor tendon sheath. The tendon of flexor pollicis longus are on the radial aspect, surrounded by its own tendon sheath. The median nerve passes deep to the flexor retinaculum, between the flexor digitorum superficialis tendons and the flexor carpi radialis tendon which runs in a sub-compartment on the radial aspect of the carpal tunnel. It is important to note that the palmar cutaneous branch of the median nerve runs anterior to the flexor retinaculum ("outside of the carpal tunnel") (Sinnatamby, 2006:84-85). Therefore the sensation of the skin over the area of the thenar eminence, supplied by this branch, is not affected by CTS. Only the skin on the palm of the hand, and the radial three and a half fingers, is affected by CTS (Shannon and Rizzolo, 2012:22). Any condition (e.g. rheumatoid synovitis, hypothyroidism, amyloidosis or pregnancy) that might promote swelling and/or thickening of either the flexor retinaculum or the tendon sheaths that surround the flexor tendons within the tunnel, will reduce the space, and compress on the median nerve (Trumble et al., 2001:255-256; Faught, 2001:10 and Mennen and Van Velze, 2008:199). The space may also be reduced by a wrist dislocation, Colles fracture, osteophytes or local tumours (Mennen and Van Velze, 2008:199).

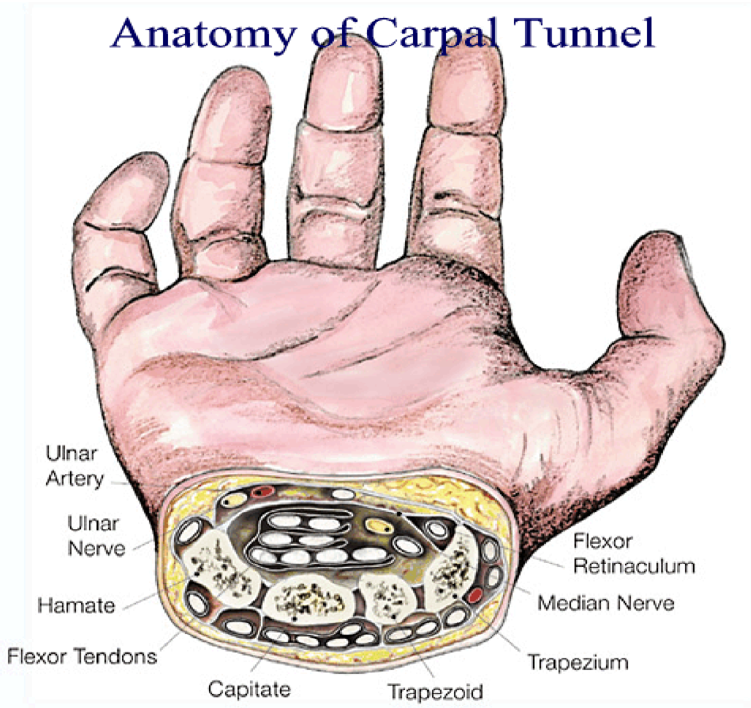

Figure 2.2 Carpal tunnel of the right hand

2.5 Peripheral nerve injuries

As previously discussed, the peripheral nerve is well surrounded by connective tissue sheaths and therefore protected. The most common causes and mechanisms of traumatic nerve injuries include: penetrating injuries, compression, traction and ischemia (Campbell, 2008:1951).

A compression neuropathy causes increased pressure in an anatomical tunnel which is a rigid structure. The increased pressure leads to reduced micro-circulation in the nerve, leading to venous obstruction or reduced arterial blood supply. These pathophysiological changes presenting in the carpal tunnel, are similar to that of compartment syndrome (Mennen and Van Velze, 2008:200). As normal capillary pressure ranges from 30-35 mmHg, external pressures as low as 30 mmHg may cause weakened venous blood flow in the epineurium (Mennen and Van Velze, 2008:17), which leads to the formation of endoneurial oedema. Complete cessation of the nerve's micro-circulation occurs at pressures of 80 mmHg and disrupts the intracellular axonal transport. Prolonged compression of a nerve will lead to permanent axonal damage and intraneural fibrosis (Mennen and Van Velze, 2008:199-200).

The signs and symptoms of an ischemic nerve varies in intensity and character, as it depends on factors including the duration and seriousness of the compression, as well as the type of nerve affected (motor and/or sensory) (Mennen and Van Velze, 2008:199). CTS is an example of a nerve injury classified as a neuropraxia by Seddon and Sutherland (see Table 2.1 Seddon and Sunderland peripheral nerve injury classification below), where full recovery may take up to four months (Mennen and Van Velze, 2008: 128).

Table 2.1 Seddon and Sunderland peripheral nerve injury classification

Sunderland	Seddon	Injury	Neurosensory impairment	Recovery Potential
I	Neuropraxia	Intrafascicular oedema, conduction block	Neuritis, paresthesia	Full (1day to 1 week)
		Possible segmental demyelination	Neuritis, paresthesia	Full (1 to 2 months)
II	Axonotmesis	Axon severed, endoneurial tube intact	Paresthesia, episodic dysesthesia	Full (2 to 4 months)
III		Endoneurial tube torn	Paresthesia, dysesthesia	Slow, incomplete (12 months)
IV		Only epineurium intact	Hypoesthesia, dysesthesia, neuroma formation	Neuroma-in-continuity
V	Neurotmesis	Loss of Continuity	Anaesthetic, intractable pain, neuroma formation	None
VI		Combination of above	Combination of above	Unpredictable

2.6 Pathophysiology of CTS

CTS can be seen as the classic example of a chronic compression neuropathy. The weakening of the median nerve in terms of conduction is the result of compression of the median nerve in the carpal tunnel leading to local ischemia (Werner and Andary, 2002:1373).

In a chronic compression neuropathy the venous return is blocked, first, during external compression, leading to hyperemia and oedema of the nerve; this leads to a further increase in pressure due to the accumulation of blood and results in ischemia of the nerve (similar to the vicious cycle of compartment syndrome – see Figure 2.3) (Werner and Andary, 2002:1374).

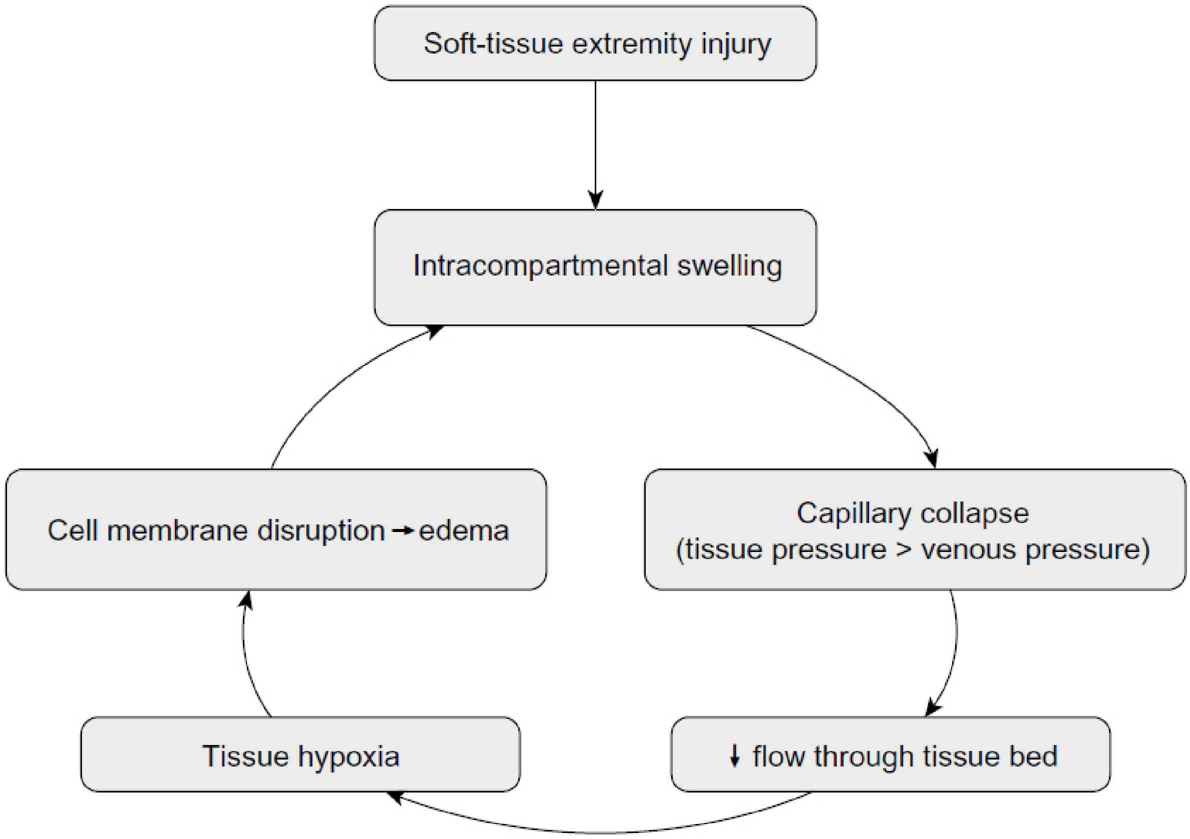

Figure 2.3 Vicious cycle of compartment syndrome

An observation noted during surgery of patients with chronic compression neuropathy was a thin nerve in the area of compression with swelling of the nerve at the proximal area of the compression (Werner and Andary, 2002:1374).

The exact pathophysiology of the pressure increase in the carpal tunnel over time, as well as the response to a change in wrist joint position, is unclear. Two types of pressure can occur: interstitial fluid pressure inside the carpal tunnel and direct contact pressure on the median nerve from surrounding tissue. Increased fluid pressure over time, is viewed similarly to tendon sheath thickening (e.g. in rheumatoid synovitis) in a limited space (Werner and Andary, 2002:1375). Dramatic changes in fluid pressure are also observed with different positions of the wrist joint: extension increases the pressure tenfold while flexion increases the pressure eightfold (Werner and Andary, 2002:1375).

2.7 Clinical features and diagnosis of CTS

The clinical diagnosis of CTS is based on a comprehensive patient evaluation by the practitioner, which includes a thorough history of the patient's symptoms, a physical examination utilising standardised special tests (e.g. Phalen's manoeuver and Tinel's sign), observational components and lastly, electrodiagnostic tests (Shannon and Rizzolo, 2012:23).

2.7.1 Signs and symptoms

A wide spectrum of signs and symptoms is mentioned in the available literature (Mennen and Van Velze, 2008; D'Arcy and McGee, 2009; LeBlanc and Cestia, 2011 and Shannon and Rizzolo, 2012) and these signs and symptoms vary in severity according to the progression of the condition (Aroori and Spence, 2008:9). According to LeBlanc and Cestia (2011:952-954), and Shannon and Rizzolo (2012:23), the symptoms of CTS start gradually with tingling, numbness or decreased sensation, nocturnal pain experienced in the palm of the hand, and the radial three and a half fingers. Bilateral involvement is also predominantly noted in CTS (Gonzalez-Roig, Cubero-Rego and Santos-Anzorandia, 2008:357). With progression of the condition, weakness of the hand and grip occurs, specifically due to muscle weakness of abductor pollicis brevis (APB). Thenar eminence wasting occurs last, and only in cases of severe, chronic or neglected CTS (Mennen and Van Velze, 2008:200; D'Arcy and McGee, 2009:3114 and LeBlanc and Cestia, 2011:953).

Several special tests are utilised during the diagnosis of CTS, but it should be noted that none of these tests should be used in isolation and are complementary to each other to accurately diagnose CTS (Aroori and Spence, 2008:9). Special tests supported by most authors include: Durkan's test; Tinel's sign, reverse Phalen's manoeuver; Phalen’s manoeuver and the use of the Katz hand diagram. The tests will be described in detail below:

Durkan's test is performed by the patient’s hand being supported in 20° wrist flexion and supination by the practitioner and pressure being applied with the practitioner’s opposite thumb or finger over the distal flexion crease of the wrist; the point where the median nerve enters the carpal tunnel. Pressure is maintained for 60 seconds. Onset of pain, paresthesia or numbness in the median nerve distribution within 60 seconds is a positive result. This test has a sensitivity of 87% and specificity of 90% (Durkan, 1991:536) and is viewed by many surgeons and neurologists as the most sensitive special test to diagnose carpal tunnel syndrome relying on it exclusively for diagnostic purposes (Reider, 2005:147 and McKean, 2014:Online).

Figure 2.4 Durkan’s test

With Tinel’s sign, pain and tingling is provoked in the distribution of the median nerve from the wrist to the hand, by the practitioner percussing over the median nerve at the wrist area (Gonzalez-Roig et al., 2008:357). The percentage of asymptomatic patients with a positive Tinel’s sign ranges from 0%-45% (D’Arcy and McGee, 2009:3113). The sign has a sensitivity of 60% and specificity of 75% (Gonzalez-Roig et al., 2008:357 and LeBlanc and Cestia, 2011:955), and is recommended to be used in combination with one or more special tests as well as comprehensive patient medical-history recording (Hobby, 2008:1).

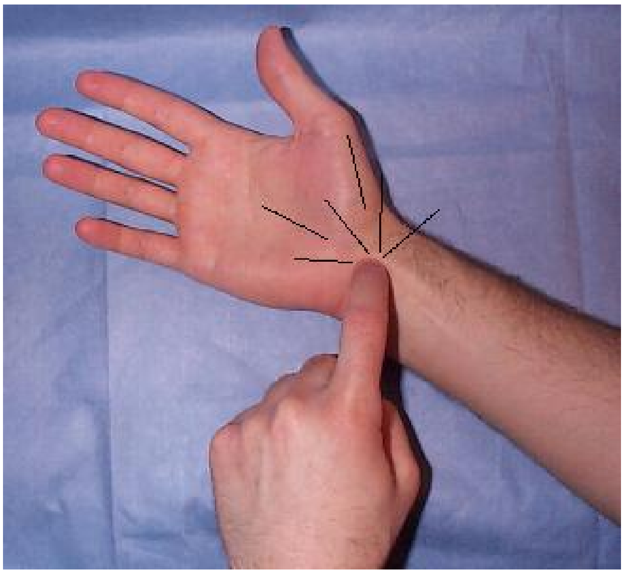

Figure 2.5 Tinel’s sign

The reverse Phalen manoeuver is performed by resting both elbows of the patient on a table with the patient pressing both palms against each other with 90° wrist extension for 60 seconds (indirectly compressing the median nerve at the wrist). This test is deemed positive if producing paresthesia and pain in the distribution of the median nerve within 60 seconds (Reider, 2005:147). It has a sensitivity of 46% and specificity of 81% (Gomes, Becker, Ehlers and Nora, 2006:967).

Figure 2.6 Reverse Phalen’s manoeuver

The Phalen manoeuver is performed by resting both elbows of the patient on a table and placing the wrists in 90° flexion for at least 60 seconds, once again indirectly compressing the median nerve at the wrist. Producing the symptoms as for the reverse Phalen's manoeuver within 60 seconds indicates a positive result. Phalen's manoeuver is deemed the most sensitive of the three tests (Tinel's, Phalen's and reverse Phalen's) with a sensitivity of 73% and specificity of 73% (Reider, 2005:147; Gomes et al. 2006:967; Gonzalez-Roig et al., 2008:357; D'Arcy and McGee, 2009:3112; and Shannon and Rizzolo, 2012:23-24). A study conducted by Faught (2001), demonstrated efficacy of Tinel's sign combined with Phalen's manoeuver in the diagnosis of CTS.

Figure 2.7 Phalen's manoeuver

The Katz hand diagram is utilised by surgeons, neurologists and hand therapists to enable these professionals to make a CTS diagnosis (LeBlanc and Cestia, 2011:954). A provided hand and arm diagram for left and right (anterior and posterior view) is completed by the patient indicating by means of four different shapes or coloured pens where they typically experience numbness, pain, tingling, and decreased sensation. The hand diagram is interpreted by the medical specialist or hand therapist according to the scoring system by Katz:
A) classic; B) probable; and C) unlikely (LeBlanc & Cestia, 2011:957).
(See Figure 3.2, p38)

The self-administered hand diagram is viewed as one of the most specific tests to diagnose CTS (McKean, 2014:Online). According to Nora, Becker, Ehlers and Gomes (2004:69) and Aroori and Spence (2008:10), the hand diagram was found to have a sensitivity of 80% and specificity of 90%.

In the early stages of the disease the patient's symptoms are attributed to the involvement of the sensory component of the median nerve and symptoms from the motor fibres are only later reported (Aroori and Spence, 2008:9). The following discussion of several studies on the topic of CTS diagnosis will highlight this fact.

In a cross-sectional study performed by Nora et al. (2005:275-283) on patients older than 12 years, visiting five different hospitals in Brazil for electrodiagnostic tests over a period of 18 months, 2582 patients with 3982 upper limb involvement presented with symptoms, signs, and distribution of symptoms associated with CTS. According to the study, symptoms statistically indicative of CTS were paraesthesia, pain, hand weakness and cramps, classically noted in the thumb, index and middle finger, and radial half of the ring finger. Nocturnal worsening of symptoms and worsening of symptoms with effort was also a frequent complaint amongst the CTS group. The clinical sign statistically significant associated with CTS in the study was thenar eminence wasting ($p<0.001$). The reverse Phalen manoeuver was found to be more accurate in diagnosing CTS than the classical Phalen manoeuver and according to the authors this could be due to Phalen's manoeuver having a higher sensitivity (see 2.6.1, p16). It was also noted that 46% of the participant's not being diagnosed with CTS, had a positive reverse Phalen's manoeuver result, opposed to 18.7% in the CTS group, indicating a false positive.

A prospective, cross-sectional descriptive study by Gonzalez-Roig et al. (2008:357) in Havana, Cuba, was performed on 100 patients already referred for electrodiagnostic tests due to clinical suspicion of CTS. Thirty healthy individuals with no history of neurological or general diseases were also included to verify test sensitivity and specificity as well as diagnostic precision. All participants underwent a neurophysiological evaluation which included: confirmation of clinical signs and symptoms (pain; numbness; nocturnal or continuous worsening of paraesthesia;

weak thumb abductors, and thenar eminence wasting); completion of a hand diagram, Tinel's sign, and Phalen's manoeuver. This was followed by electrodiagnostic tests to determine the sensitivity and specificity of the clinical features and risk factors for CTS. The following results were found in the study. CTS is predominantly bilateral but with unequal severity in both hands. The triad of numbness-pain-nocturnal paraesthesia localised in the nerve supply area of the median nerve of the participants were found to be crucial in the diagnosis of CTS since, according to the authors, these symptoms are diffusely spread over the whole of the upper limb in musculoskeletal disorders (MSD's). Muscle testing by manual resistance given against thumb abduction, and carried out by the same appointed researcher, indicated APB weakness and showed a diagnostic precision of 73.2%. No specific muscle testing scale was used. Lastly, Phalen's manoeuver performed in this study had sensitivity and specificity values of 73% and 75.5% respectively. The results of the study also indicated that Tinel's sign had sensitivity and specificity values of 60.3% and 85.1%.

Gonzalez-Roig et al. (2008:357) concluded the use of the specific signs and symptoms as described above, to diagnose CTS to be significant as it had a diagnostic precision of 75.8%. The researchers further indicated both Phalen's manoeuver, and Tinel's sign were found to be useful in the diagnosis of CTS.

During a cross-sectional retrospective study of 163 patients in Catania, Italy, who visited the university's electromyography laboratory during 12 months, Caliandroa, La Torrec, Aprilea, Pazzagliaa, Commodarid, Tonalia and Paduaa (2006:231), established that a glove like distribution of paraesthesia of the whole hand is more telling of CTS than paraesthesia only in the area innervated by the median nerve. During the study a clinical and electrophysiological CTS diagnosis was made in 233 hands of participants of which 70 were bilateral. A glove like distribution of paraesthesia was found in 70.4% of patients, and median nerve distribution of paraesthesia in 29.6%. These findings are in contrast with the findings from Nora et al. (2005) and Gonzalez-Roig et al. (2008) which indicated a localised median nerve distribution of paresthesia to be sufficient for a CTS diagnosis. Gonzalez-Roig et al. (2008) and Nora et al. (2005) used a standard testing protocol comprising of an interview, physical evaluation and electrodiagnostic tests to make the CTS diagnosis but also included a Katz hand diagram as an added diagnostic instrument, which was not included by Caliandro et al. (2006). A prospective cross-sectional study design was used by Gonzalez-Roig et al. (2008) as well as Nora et al. (2005) whilst Caliandro et al. (2006) made use of a retrospective cross-sectional study design. The contradictory results could therefore be attributed to the difference in data gathering instruments and study designs. Caliandro et al. (2006:231) concluded after the completion of their study the usefulness of the Katz hand diagram as used by Gonzalez-Roig et al. (2008) and Nora et al. (2005) to be included as part of the diagnosis process and not just a patient interview to determine the paraesthesia distribution.

According to Werner and Andary (2002:1376), the signs and symptoms of CTS are divided into two groups: primary and secondary symptoms. The primary symptoms include numbness, pins and needles, and nocturnal worsening where Werner and Andary (2002:1376) found a strong correlation ($p<0.001$) between these primary symptoms and electrodiagnostic testing (see 2.6.2, p21). Secondary symptoms included pain, weakness of handgrip and clumsiness of the hand. During the study a weaker correlation ($p<0.01$) between the above mentioned symptoms and electrodiagnostic testing was found. The authors suggested that these secondary symptoms may not be directly related to median nerve impingement per se but could be related to other conditions such as tenosynovitis causing increased pressure in the carpal tunnel.

Miedany, Ashour, Youssef, Mehanna and Meky (2008:456) examined the relationship between clinical manifestations of CTS with the outcome of special tests and electrodiagnostic tests. In Cairo, Egypt, 232 patients with CTS manifestations were investigated and a CTS diagnosis was made using a questionnaire and clinical evaluation which included special tests for CTS and electrodiagnostic testing of the median nerve. The authors supported the distribution of symptoms as described by Werner and Andary (2002). According to Miedany et al. (2008), the primary CTS symptoms of numbness, pins and needles, and nocturnal worsening are typical of median nerve damage and this could be attributed to the "good" electrodiagnostic correlation found in the study by Werner and Andary (2002). The secondary symptoms could be typical of other involved tissue, such as damaged tendons, muscles or nerves and therefore, the “weaker” electrodiagnostic correlation as described by Werner and Andary (2002).

Miedany et al. (2008:456) stated that although Phalen’s manoeuver, reverse Phalen’s manoeuver and the carpal tunnel compression test (Durkan’s test) are tests with high sensitivity to be used in the diagnosis of CTS, it does not exclude the possibility of the clinician still making the differential diagnosis of tenosynovitis of the flexor muscles of the hand. It is emphasized by the authors that cervical radiculopathy, tenosynovitis and tendinitis (e.g. De Quervain’s disease) should always be considered as possible differential diagnoses before a definitive diagnosis of CTS can be made, as these conditions are very similar in their manifestations.

During a cervical radiculopathy the patient is likely to suffer from symptoms localised to one side of the neck which radiates to the scapular area, occipital area, arm and hand, with paraesthesia occurring in a radicular distribution. Pain and other sensory symptoms may be elicited by neck movements, and motor symptoms may include muscle atrophy corresponding to the affected nerve root, and may also include absence of the deep tendon reflexes (Jebson and Kasdan, 2006:28).

Tenosynovitis presents with crepitations, evident swelling of the affected area, loss of active range of wrist flexion and extension, and tendon ruptures (Jebson and Kasdan, 2006:60). The main symptoms of tendinitis include localised swelling and pain against resistance of the involved tendons (Jebson and Kasdan, 2006:75).

When considering a CTS diagnosis, the possibility of the above mentioned differential diagnoses with their specific symptoms should always be explored (Miedany et al., 2008:456). If these specific symptoms, as described above, are not present, the symptoms of APB weakness and thenar eminence wasting are likely to be indicative of CTS in its progressed stage (Mennen and Van Velze, 2008:200).

2.7.2 Electrodiagnostic testing

Electrodiagnostic testing (nerve conduction tests) is viewed by many authors as the gold standard and most reliable in the absolute diagnosis of CTS (Nora et al. 2005:276; Palmer, 2011:16 and Shannon and Rizzolo, 2012:24). The sensitivity of these tests ranges from 80-92 % and specificity range from 80 to 99 % (Werner and Andary, 2002:1379). Contrary to this, electrodiagnostic tests have been described by many authors as having significant false-positive and false-negative rates in CTS, and therefore provocative tests remain important in the diagnosis of CTS (Tetro, Evanoff, Hollstein and Gelbermann, 1998:493; Aroori and Spence, 2008:11 and Hobby, 2008:1). It is clear from literature that the classical triad of diagnostic tools should therefore be utilised during the diagnosis of CTS and that patient history-taking, and physical examination of the patient, forms the basis of diagnosis, where patients with only some signs may already benefit from treatment (Palmer, 2011:19).

2.8 Extent and nature of the problem

The number of individuals diagnosed with CTS has increased by 25% over the last few decades and a dramatic increase in CTS surgery since the 1990's has been reported amongst males and females older than 50 years, in France, Germany, Italy, the USA, Canada, and the Scandinavian countries (Tuppin, Blotière, Weill, Ricordeau and Allemand, 2011:905 and Giersiepen and Spallek, 2011:239). Carpal tunnel release surgery is amongst the most frequently performed surgical procedures in Germany with 300 000 cases per year (Giersiepen and Spallek, 2011:238). In the USA 35 new cases of CTS per 10 000 healthy individuals are reported per year (Giersiepen and Spallek, 2011:240). No statistics of the surgical procedures or new cases per year in South Africa could be found.

According to literature the prevalence of CTS in the worldwide general adult population is estimated to be 3-5% (Nora et al., 2005:275; Giersiepen and Spallek, 2011:239), and even as high as 9.2% in females (Giersiepen and Spallek, 2011:240). Except for the study by Goga (1990), indicating the incidence of CTS in black South Africans, as in the 26 cases over a five year period at King Edward VIII hospital, no other literature is available on the prevalence of CTS in South Africa.

2.8.1 CTS Etiology

In the table below a summary is provided of all the etiologies of CTS as agreed upon by authors. The etiologies are listed in order of most to least common, and include personal factors and medical history (Mennen and Van Velze, 2008:200; LeBlanc and Cestia, 2011:952 and Shannon and Rizzolo, 2012:24).

Table 2.2 Etiology of CTS

Etiology	**Authors**	**Date: page number**
Idiopathic	Mennen and Van Velze LeBlanc and Cestia Shannon and Rizzolo	2008:199 2011:952 2012:24
Obesity	Lam and Thurston Hobby Hlebs, Majhenic and Vidmar	1998:192 2008:1 2014:220
Pregnancy	Jebson and Kasdan Mennen and Van Velze Shannon and Rizzolo	2006:261 2008:200 2012:24
RA	Jebson and Kasdan Hobby Mennen and Van Velze	2006:261 2008:1 2008:200
Hypothyroidism	Shannon and Rizzolo McKean	2012:24 2014:Online
DM (type not specified)	Aroori and Spence Mennen and Van Velze Jagga et al.	2007:7 2008:200 2011:69
History of upper limb trauma e.g. Colles fracture	Mennen and Van Velze Jagga et al.	2008:200 2011:69

	LeBlanc and Cestia	2011:952
Local e.g. benign tumor, mass lesion	Mennen and Van Velze LeBlanc and Cestia	2008:200 2011:952
Amyloidosis	Aroori and Spence	2007:7
Sarcoidosis	Aroori and Spence LeBlanc and Cestia	2007:7 2011:952
Multiple myeloma	Aroori and Spence LeBlanc and Cestia	2007:7 2011:952
Leukemia	Aroori and Spence LeBlanc and Cestia	2007:7 2011:952
Infection (e.g. Tuberculosis or septic arthritis)	Mennen and Van Velze Shannon and Rizzolo	2008:200 2012:24

Idiopathic CTS occurs in an otherwise normal and healthy upper limb (Lozano–Calderon, Anthony and Ring, 2008:525), and Shannon and Rizzolo (2012:22) stated that as many as 50 % of CTS cases are idiopathic. Idiopathic CTS has a higher prevalence amongst females, and the age of diagnosed individuals is predominantly over 40 years of age (Gonzalez-Roig et al., 2008:356 and Mennen and Van Velze, 2008:199). The highest incidence of CTS occurs in middle-aged and elderly women over the age of 40 years (Becker, Nora, Gomes, Stringari, Seitensus, Panosso and Ehlers, 2002:1430; Geoghegan, Clark, Bainbridge, Smith and Hubbard, 2004:315; Nora et al., 2005:276). This increased risk of CTS with age corresponds with the fact that in both males and females between the ages of 30-70 years, an estimated 15-30% of neurons die (Hlebs et al., 2011:219).

Women are more susceptible to CTS than men, with a female: male ratio of 3:1 (Hobby, 2008:1). According to the literature there is no clear explanation as to why women are more likely to develop CTS, but it is postulated that it may be due to the smaller size of the carpal tunnel in women (BLS and the NIOSH, 1997-2000). In the neutral wrist position the mean cross-sectional area of the carpal tunnel for men is 182.5mm^2 and for women is 151.2mm^2 (Kim, Joo, Han and Kim, 2012:29).

There is a statistical relationship between obesity and CTS, with the general CTS population twice as likely to be overweight (BMI≥25), and the female CTS population twice as likely to be obese (BMI≥30) (Lam and Thurston, 1998:192; Becker et al., 2002:1433 and Hobby, 2008:1). Hlebs et al. (2014:220) stated that an increase of BMI by one kg/m² (corresponding to a weight increase of about three kilograms in a person of average height) increases the likelihood of developing CTS by eight percent.

2.8.2 CTS and occupational factors and activities

In 1947 CTS was first discovered to be related to occupations by Brian and Wright who reported six cases of work-related CTS during repetitive work in the USA (the occupations were not specified) (Jagga et al., 2011:68). The BLS (USA) reported in 1994 that 40.8% of all upper extremity repetitive motion disorders in the workplace to be CTS (Jagga et al., 2011:69), and Aroori and Spence (2008:7) described CTS as the most common form of Repetitive Trauma Disorder (RTD).

CTS still largely affects the working population, especially where the focus is on forceful manual tasks and repetitive movements of the hand or wrist (e.g. manual labourers or meat packers) (Moraska, Chandler, Edmiston-Schaetzel, Franklin, Calenda and Enebo, 2008:260 and Shiri et al. 2008:368). This leads to a significant number of lost-working-days, where the median lost work-time for work-related CTS was 27 days in the USA in 2013, as estimated by Dale et al. (2013:495). Time away from work has costly medical and financial implications not only for the individual but also for society. Dale et al. (2013:495) reported CTS to be the most expensive upper extremity disorder in the USA at an estimated medical cost of more than $2 billion per year only taking the cost of surgery into account. Further financial and psychological implications due to time away from work for the employee are loss of income, fear of not being promoted or hired again, and “being labelled a complainer” contributing to lost productivity (Rosecrance et al., 2002:115).

The latter might even cause workers to not seek medical treatment which will lead to functional limitations disrupting activities of daily living, resulting in resignation from work or permanent worker disability (Rosecrance et al., 2002:115 and Shiri et al., 2008:368). With 18% of workers developing CTS, they leave their job for which they are qualified, within 18 months (Dale et al., 2013:496), which places a financial strain on the worker and his/her family. Due to the disorder, it is not always possible to seek other employment immediately and it is very difficult to provide evidence proving the association between their occupation, and development of the disorder, thus minimising chances of worker's compensation (Palmer et al., 2007:58).

It is interesting to note that the "problem list" of functional limitations and worker disability for employees developing CTS is two of the important aspects recognised in the International Classification of Functioning, Disability and Health (ICF) (WHO:2002:Online). The ICF is a framework used by the World Health Organization (WHO) to describe health, and health related states of individuals. Physiotherapists worldwide use the ICF to plan, communicate, and make important decisions regarding a patient's rehabilitation and how to improve his/her quality of life (WHO:2002:Online). The "problem list" of these employees has been identified, but the impact on quality of life has never been investigated.

Lozano-Calderon et al. (2008:528 - 533) conducted a meta-analytic study of 107 English articles (publication dates from 1950 to 2007) to determine the direct relationship between CTS, biological and/or occupational factors as causative risk factors. Biological factors included personal factors and medical history. The Bradford Hill criteria (Lucas and McMichael, 2005:792-795) were used to evaluate the quality and strength of the scientific evidence that demonstrated an etiological relationship between CTS and a proposed risk factor. Ninety seven percent of the studies investigating biological factors as risk factors found a link to CTS, and 82% of the studies that investigated career, found a relationship between occupation and CTS. Lozano-Calderon et al. (2008) found the following occupational factors (in order of high to low) to be strongly supported risk factors: activities that require repetitive hand use; substantial exposure to vibratory equipment; type of occupation; activities that require repeated or persistent wrist flexion; stressful manual work that requires repeated or persistent hand use in non-ergonomic positions, and activities that require repeated or persistent wrist extension.

Jarvik and Yuen (2001:241 - 244), found that patients already diagnosed with CTS complained of worsening of symptoms during activities which included continued wrist flexion and extension; repetitive wrist movements; typing on a keyboard and driving. A systematic review by Palmer et al. (2007:57-65) was conducted to expand existing knowledge regarding the relationship between CTS and certain professions. It was found that the belief of an important association between keyboard and computer work was not substantially supported by the body of evidence. Palmer (2007:57-65) did find the most common occurrence of CTS was amongst professions that included the use of vibratory tools, production-line work and the food packing industry. Some production-line workers described their work as including activities of recurrent or persistent wrist flexion and extension or ulnar and radial deviation of the wrist, as well as utilising precision grip with repetition. Repeated flexion and extension of the wrist, specifically, increased the chances of developing CTS with more than 50% (Palmer et al., 2007:64). In 2008 Shiri et al. concluded after their investigation that work tasks demanding handgrip with powerful forces or the use of vibratory tools are associated with CTS and that the association is stronger if these work tasks are accompanied by repetitive movements of the hand or wrist. These findings were confirmed by Aroori and Spence (2008:7), and again, in 2011, in a paper published by Palmer.

Several occupations have been studied and identified as being high risk in the development of CTS, due to the repetitive and persistent wrist movements required. Palmer (2011:20-21) listed these occupations as occupations involving exposure to vibration (e.g. foresters; rock drillers and stone masons); assembly work (e.g. in the auto-mobile industry), and food processing and packaging (e.g. poultry workers and frozen food packers).

Other occupations identified as being high risk for the developing of CTS included full-time and part-time supermarket cashiers (prevalence of 31% and 19.3% respectively) (Bonfiglioli, Mattioli, Fiorentini; Graziosi, Curti and Violante, 2007:248-253 and Aroori and Spence, 2008:7); gardeners; musicians; farmers; construction workers; masseurs, and upholsterers (Giersiepen and Spallek, 2011:241), as well as grinders; workers sewing car seats, and aircraft engineers (Aroori and Spence, 2008:7).

The only medical profession ever investigated for possible CTS is the dental profession. In 1994, Canadian dental assistants and hygienists were investigated by completing the Standardised Nordic Questionnaire (Kuorinka, Jonsson, Kilbom, Vinterberg, Biering-Sørensen, Andersson and Jørgensen, 1987:233-237) about musculoskeletal symptoms. The results indicated that dental hygienists were 5.2 times more likely to have been diagnosed with CTS and 3.7 times more likely to meet a CTS case definition than dental assistants (Liss et al., 1995:538). As part of a study on hand problems amongst 5000 USA army dental personnel in 2001 by Lalumandier and McPhee, 177 dental hygienists were analysed in detail. Probable or classic symptoms of CTS were exhibited by 56% of these dental hygienists, but no definitive diagnosis was made to provide the prevalence of CTS. Anton et al. (2002) reported a CTS prevalence of 8.4% amongst 109 dental hygienists attending a continuing education conference in the USA during 2002 and also reported that, according to a report by the USA BLS (1998) dental hygienists were ranked first of all occupations in the proportion of CTS cases per 1000 employees. Hayes, Cockrell and Smith (2009) included the CTS study by Anton et al. (2002) in a systematic review on the topic of MSD’s amongst dental professionals highlighting that CTS symptoms may already begin during training.

2.9 Biomechanics of manual physiotherapy modalities

Pressure in the carpal tunnel increases over time in response to wrist positions (Werner and Andary, 2002:1375). Pressure can firstly be caused by changes in interstitial fluid pressure within the carpal tunnel, with extension increasing the pressure tenfold, and flexion eightfold (Werner and Andary, 2002:1375). Secondly, direct contact pressure by adjacent structures on the median nerve can be exerted (Werner and Andary, 2002:1375) when the carpal tunnel area decreases with wrist flexion or extension.

The carpal tunnel has a U-shape which is formed by the carpal bones and the flexor retinaculum forming the roof of the tunnel. In addition, there is an annular group of ligaments on the dorsal side of the wrist and the volar carpal ligament on the palmar side. These ligaments around the wrist can be viewed as a series of elastic arm bands connected to one another by a series of elastic longitudinal elements (see Figure 2.8, p29). Extension of the wrist causes the arm bands to spread apart and stretch the longitudinal elements on the palmar side of the wrist, moving closer together, and compress the elements on the dorsal side of the wrist. Wrist extension therefore causes the volar ligament on the palmar side of the wrist to press down on the contents of the carpal tunnel squeezing the contents between the volar carpal ligament and the palmar aspects of the carpal bones, and reduces the available space (Werner and Andary, 2002:1375). Furthermore, wrist extension causes the thick proximal part of the finger flexor tendons to be drawn into the area of the carpal tunnel reducing the already limited available space even further (Werner and Andary, 2002:1375).

Flexion of the wrist causes the proximal edge of the flexor retinaculum to press against the palmar aspect of the joint capsule (Werner and Andary, 2002:1375). This presses the finger flexor tendons against the head of the radius creating compression of the median nerve (Skie, Zeiss, Ebraheim and Jackson, 1990:937).

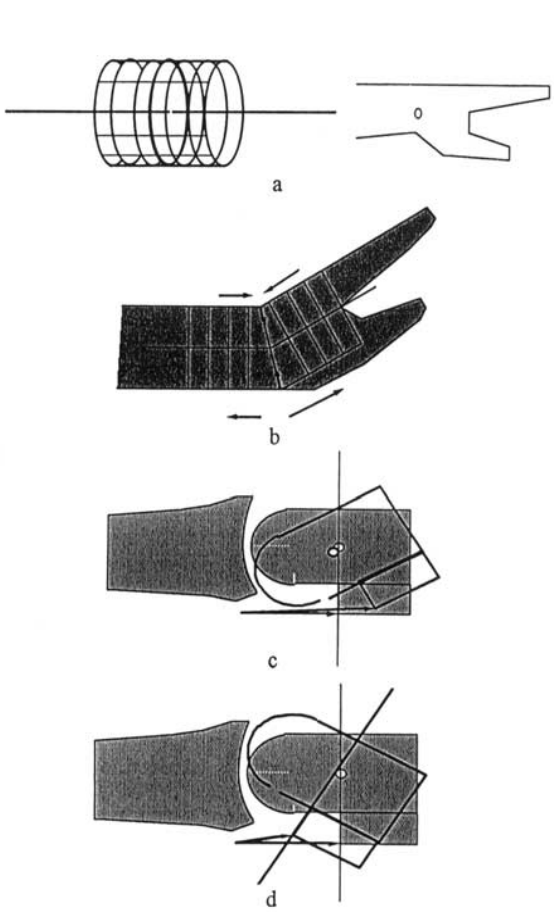

Figure 2.8 Pressure increase in the carpal tunnel during wrist extension and flexion

The movements described in literature (forceful/powerful hand movements/grips, and repetitive wrist movements, especially flexion and extension movements) as increasing the risk for CTS, are typical movements performed by physiotherapists on a daily basis during the treatment of patients by means of manual therapy and respiratory techniques.

Manual therapy consists of a broad group of treatment techniques in which the physiotherapist applies forces directly to the patient's musculoskeletal system (Brukner and Khan, 2001:143). These treatment techniques include Maitland mobilisations, manipulations, soft tissue therapy/massage, and percussions all requiring significant input from the physiotherapist's hands (Jenkins, 2013:21). Longitudinal stroking is an example of soft tissue therapy and is described as stroking in the direction of venous flow, done for five minutes per lesion (Brukner and Khan, 2001:149). The wrists are repetitively taken into full extension for the full five minutes per lesion (see Figure G.1, Appendix G).

Other massage techniques include digital ischaemic pressure (direct pressure applied with a 90° angle to the skin, three minutes per lesion); sustained myofascial tension (sustained longitudinal pressure, eight-12 minutes per lesion) and transverse friction (oscillating pressure applied transversely with no movement between the physiotherapist's fingers and the patient's skin, three-10 minutes per lesion) (Brukner and Khan, 2001:149). The wrists are repetitively taken into full extension or flexion for the time per lesion, for each of the techniques (see Figure G.2 – G.3, Appendix G).

Percussion is performed to vibrate the thorax via clapping on the chest and/or back to help loosen thick secretions, a manual therapy technique used during respiratory physiotherapy (Clinkscale, Spihlman, Watts, Rosenbluth and Kollef, 2012:221) (see Figure G.4, Appendix G).

Maitland mobilisations are passive oscillatory movements of a joint in any range of movement or a sustained stretch with or without tiny amplitude oscillations at the limit of the range of movement (Maitland, 2001:4). One example of such a mobilisation is the longitudinal caudad movement of the elbow joint, where the physiotherapist's one hand is gripping the forearm distally, and the other hand is applying the passive oscillatory movement at the anterior aspect of the forearm proximally, with the physiotherapist's wrist in full extension (Maitland, 1998:181). These movements are repeated for at least 90 seconds per joint (Maitland, 2001:218).

An increased oscillation frequency applied during a technique as well as an increased length of time a technique is applied during manual therapy, may also result in stress or strain on the joints (Jenkins, 2013:21).

Barnes et al. (2011) reported most musculoskeletal injuries in physiotherapists to be within the first five years of practice and suggested this could be due to increased work load post-graduate, resulting in increased repetitive forces through the thumb. The same could be suggested for the wrist and forceful movements used during massage.

2.10 The research focus within the physiotherapy profession to date

The main area of research on disorders within the physiotherapy profession thus far focused on WRMD's.

Cromie et al. (2000:340-350) made use of a self-developed questionnaire survey and reported a life-time prevalence of WRMD's of the thumbs to be 33.6% and of the wrist and hands to be 21.8%, where one out of six physiotherapists in Victoria, Australia indicated that they left their occupation as a result of WRMD's. Activities listed by physiotherapists as occupation-related risk factors, included performing manual therapy techniques, carrying, lifting or moving heavy materials or equipment, working in awkward, cramped, or in the same positions for long periods of time, and not taking enough breaks during the day (Cromie et al., 2000:340-350). Risk factors identified by physiotherapists and occupational therapists in Queensland, Australia, suffering from WRMD's, which most likely limited their capacity to work at full-strength were poor work postures, awkward body movements, and repetitive tasks (Passier and McPhail, 2011:30-32). Another study on WRMD'S in physiotherapists was conducted in 2012 by Buddhadev and Kotecha on physiotherapists in the Saurashtra region in India. The results of the study found that 15% of physiotherapists in the Saurashtra region complained of shoulder WRMD's. This study did not focus on hand disorders, and will not be discussed further.

To date, only two studies investigated the topic of work-related musculoskeletal hand disorders in South Africa. In 2011, Barnes et al. reported on the lifetime prevalence of work-related thumb and wrist pain amongst physiotherapists in the small geographical region, Bloemfontein, in the Free State, South Africa. This study reported a 62.5% prevalence of thumb and wrist disorders. In an unpublished study by Jenkins (2013) the life-time prevalence of work-related thumb problems of 65.3% - 67.5% amongst physiotherapists using manual therapy techniques in South Africa were reported, but wrist problems were not investigated. Both studies utilised self-developed questionnaires based on previous literature.

2.11 Significance, justification of the study and conclusion

All over the world, the logos for physiotherapy include hands. Many of the conditions, especially MSD's treated by physiotherapists often affect themselves, and limit their professional ability at the end of the day as described in 2.8, p28.

Physiotherapists have been identified as an at-risk group regarding WRMD's of the thumb and hands in previous studies (Cromie et al., 2000; Barnes et al., 2011 and Jenkins, 2013). The occupational risk factors contributing to this are very similar to those identified by the professions which have been investigated for CTS. Still, the prevalence or even risk of neurological conditions, especially CTS, in the physiotherapy profession, has never been investigated, and studies in general on the topic of CTS in South Africa, are very scarce, as described in 1.1, p1 and 2.7, p21.

Physiotherapists tend to leave the occupation due to WRMD's (Cromie et al., 2000) and the same can be said for other possibly unidentified occupational hazards, of which CTS may be one. A physiotherapist diagnosed with CTS will have to seek medical management (McKean, 2014:Online) which has financial implications for the physiotherapist added to an uncertain number of days away from work, causing emotional stress to the physiotherapist and his/her team as well as a greater work load on the rest of the team. Physiotherapists use their hands during their daily work and seeing that no type of management is full-proof, symptoms may return within one year (LeBlanc and Cestia, 2011:957 and McKean, 2014:Online). The physiotherapist might be limited to administrative work, to seek medical management, and with all the added burdens more than once, they may leave the profession pre-maturely.

CTS largely affect the working population, where the focus is on forceful and repetitive movements of the hand or wrist (Moraska et al., 2008:260 and Shiri et al. 2008:368). Many of these movements are performed daily by physiotherapists when treating patients. Investigating if CTS affects the Bloemfontein physiotherapy population served as motivation for this study as well as the lack of research on CTS in South Africa, and CTS being a possible prevalent work-related disorder amongst physiotherapists world-wide.

The methodology used in this study to investigate CTS in physiotherapists in Bloemfontein, South Africa is outlined in chapter three.

Chapter three

3 Methodology

3.1 Introduction

This chapter outlines the methodology used in the study. Research design, study population, measurement instruments, and ethical clearance are explained. The pilot study, procedure followed during the data collection, as well as the statistical analysis, is described.

3.2 Research design

A quantitative, cross-sectional study was conducted, during the period from June 2015 to August 2015.

3.3 Study population

The study population consisted of all Health Professions Council of South Africa (HPCSA) registered, practicing physiotherapists, and community service physiotherapists in Bloemfontein during 2015. A total of 158 physiotherapists were practicing in Bloemfontein, at the time of the study according to a list compiled by the South African Society of Physiotherapy (SASP), Free State Branch, and the Department of Physiotherapy, UFS. The area of Bloemfontein (which is part of the Mangaung Metropolitan municipality) included all the neighbourhoods within a 25km radius of the University of the Free State, thus excluding the neighbourhoods in the entire Mangaung Metropolitan municipality.

3.4 Study sample

Convenience sampling and snow-ball sampling was done from the master list of the study population. Convenience sampling was chosen in an attempt to achieve the required sample size, and minimising travel costs as all the physiotherapists employed in one practice or institution could be included per visit. Participants were sourced from all four corners of, and central Bloemfontein. According to the master list of the study population there was a definite tendency towards the private practice. Sampling was, however, not done according to the vicinity of participants to the researcher or the participant's sector of employment.

According to Mennen and Van Velze (2008:199) 96% of all diagnosed cases of CTS are female patients, and according to Giersiepen and Spallek (2011:240) the prevalence of CTS is 9.2% in the female population. A study conducted by Human, Chingwaru, Du Plessis, Gildenhuys, Kruger, Le Grange and Liebenberg et al. (2014) investigated the current physiotherapy conservative treatment protocols for CTS used by physiotherapists in Bloemfontein, Free State. Since 82% of the participants in the study by Human et al. (2014) were female, this CTS prevalence in females of 9.2% (Giersiepen and Spallek, 2011:240) was used to calculate the study sample of 64 participants. According to the power calculation with a predicted CTS prevalence of 6% (see Figure 3.1, p36) the study sample size for this study was calculated as 64, with 99.9% power. The study sample calculation for this study was generated using SAS/STAT software, Version 9.4 of the SAS System for Windows 6.1.7601. Copyright © 2013 SAS Institute Inc. SAS and all other SAS Institute Inc. product or service names are registered trademarks or trademarks of SAS Institute Inc., Cary, NC, USA.

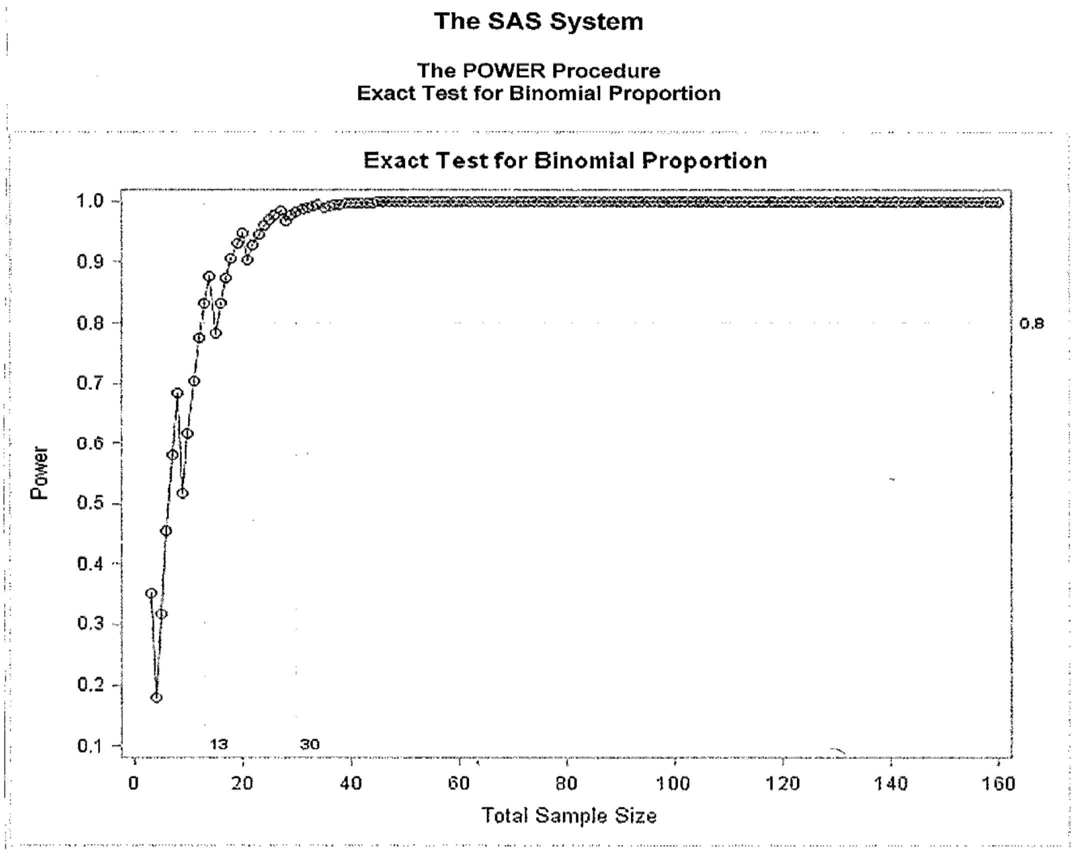

Figure 3.1 Exact test for Binomial Proportion

3.5 Measurement instruments

3.5.1.1 Self-developed questionnaire

A self-developed questionnaire (Appendix A) was utilised for the structured interview. This questionnaire included questions from previous research as well as available literature (Kamath and Stothard, 2003:458-459; Barnes et al., 2011; Shannon and Rizzolo, 2012:23; McKean, 2014:Online; Bland et al., 2014:1-6), and conversations with colleagues in the health professions, including physiotherapists, occupational therapists, orthopaedic surgeons, neurosurgeons, and neurologists.

The questionnaire included questions regarding demographic information including age, gender, work sector, years in practice, employment status; medical history; history of causative factors of CTS, as well as previous diagnosis of and/or treatment for CTS; symptoms experienced by the participants which included questions pertaining to pain, pins and needles, numbness, weakness, poor thumb endurance, unilateral or bilateral symptoms, worsening factors, start of symptoms, as well as time periods that participants experienced symptoms. Detailed information regarding occupational activities and factors, emphasising main area of work, working hours, overtime, treatment techniques mainly used, as well as rest periods were explored, and lastly, symptom relief information including strategies implemented by the participants to relieve their symptoms was covered in the developed questionnaire.

The questionnaire was developed in English and translated into Afrikaans by the researcher and an independent English speaking physiotherapist, fluent in Afrikaans, and familiar with medical terminology. Linguistic validity was enhanced by using the forward backward translation process as described by Wild, Grove, Martin, Eremenco, McElroy, Verjee-Lorenz and Erikson (2005:94-100). The Afrikaans questionnaire was then translated back into English by another independent English speaking physiotherapist, fluent in Afrikaans and familiar with medical terminology. Grammar and spelling discrepancies were corrected. The questionnaire was available in English and Afrikaans as these are the two languages in which the researcher is proficient.

3.5.1.2 Katz hand diagram

The self-administered Katz hand diagram is viewed as one of the most specific tests (76%) to diagnosing CTS (McKean, 2014:Online). According to Nora et al. (2004:69), and Aroori and Spence (2008:10), the hand diagram is found to have a sensitivity of 80%, and specificity of 90%. A hand and arm diagram for left and right (anterior and posterior view) with four different shapes or coloured pens indicating where the participants typically experience numbness; pain; tingling, and decreased sensation was to be completed by the participants. Descriptors used by the participants were: numbness (in red ink); pain (in green ink); tingling (in blue ink) and decreased sensation (in purple ink). The hand diagram was then interpreted by the researcher according to the scoring system as stipulated by Katz. Please refer to section 2.6.1, p17.

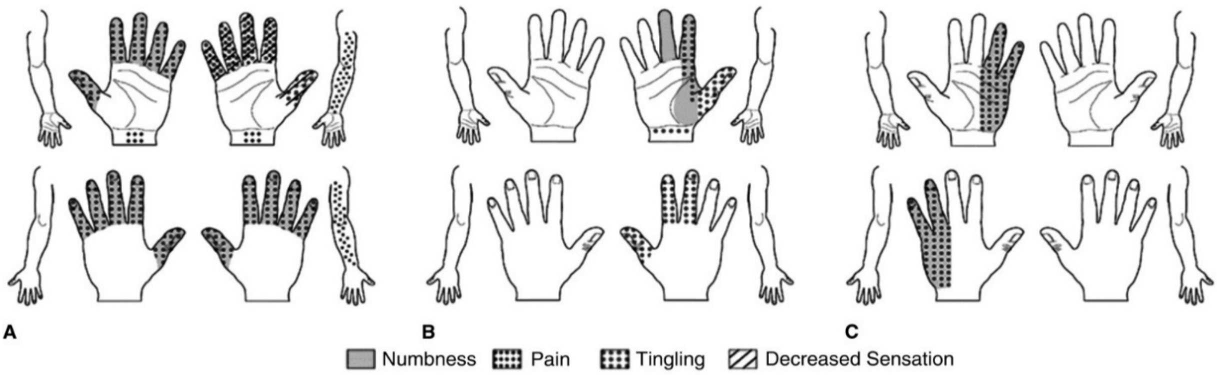

Figure 3.2 Katz hand diagram

(See Appendix B)

3.5.1.3 Physical examination

The physical hand examination performed by the researcher consisted of performing special tests, muscle testing, as well as observing the hands of the participants bilaterally. The tests and observations performed included the Durkan's carpal compression test; Tinel's sign; the reverse Phalen manoeuver; the Phalen manoeuver; muscle strength testing of APB (only classified as weakened or normal, no standardised scale was used), and finally observation for wasting of the thenar eminence which consists of the muscle bellies of APB, flexor pollicis brevis and opponens pollicis.

The special tests supported by most authors (Faught, 2001; Reider, 2005; Gonzalez-Roig et al., 2008; D'Arcy and McGee, 2009; Shannon and Rizzolo, 2012 and McKean, 2014:Online) included in the study was: Durkan's test, Tinel's sign, reverse Phalen's manoeuver and Phalen's manoeuver.

Durkan's test was performed by the patient's hand being supported in 20° wrist flexion and supination by the researcher, and pressure being applied with the researcher's opposite thumb or finger over the distal flexion crease of the wrist; the point where the median nerve enters the carpal tunnel. Pressure was maintained for 60 seconds. Onset of pain, paraesthesia or numbness in the median nerve distribution within 60 seconds was a positive result. This test has a sensitivity of 87%, and specificity of 90% (Durkan, 1999:536). It is viewed by many surgeons and neurologists as the most sensitive special test to diagnose carpal tunnel syndrome relying on it exclusively for diagnostic purposes (Reider, 2005:147 and McKean, 2014:Online).

With Tinel's sign, pain and tingling was provoked in the distribution of the median nerve from the wrist to the hand by percussing on the median nerve at the wrist (Gonzalez-Roig et al., 2008:357). The percentage of asymptomatic participants with a positive Tinel's sign ranges from 0%-45% (D'Arcy and McGee, 2009:3113). The sign has a sensitivity of 60%, and specificity of 75% (Gonzalez-Roig et al., 2008:357 and LeBlanc and Cestia, 2011:955), and is recommended to be used in combination with one or more special tests, as well as comprehensive patient medical-history recording (Hobby, 2008:1).

The reverse Phalen manoeuver was performed by resting both elbows of the participant on a table with the participant pressing both palms against each other into 90° wrist extension for 60 seconds (indirectly compressing the median nerve at the wrist). This test was deemed positive if it produced paraesthesia and pain in the distribution of the median nerve within 60 seconds (Reider, 2005:147). The test has a sensitivity of 46%, and specificity of 81% (Gomes et al., 2006:967).

The Phalen manoeuver was performed by resting both elbows of the participant on a table, and placing the wrists in 90° flexion for at least 60 seconds, once again indirectly compressing the median nerve at the wrist. Producing the symptoms as for the reverse Phalen manoeuver within 60 seconds indicated a positive result. The Phalen manoeuver is deemed the most sensitive of the three tests performed (Tinel's, Phalen's and reverse Phalen's) with a sensitivity of 73%, and specificity of 73% (Reider, 2005:147; Gomes et al. 2006:967; Gonzalez-Roig et al., 2008:357; D'Arcy and McGee, 2009:3112; and Shannon and Rizzolo, 2012:23-24). A study conducted by Faught (2001), demonstrated efficacy of Tinel's sign combined with Phalen's manoeuver in the diagnosis of CTS.

Muscle strength testing of APB (only classified as weakened or normal, no standardised scale was used), and observation of the thenar eminence for wasting, concluded the physical hand examination. Muscle testing strength of APB was assessed with the arm in supination (palm facing the ceiling), making sure the hand was stabilised, except for the thumb, which was in relaxed full extension. The participant was asked to abduct the thumb, through full range of movement, against resistance from the researcher (Shannon and Rizzolo, 2012:23-24). If the participant could perform this movement with no effort, the result was documented as normal. In the case of effort the muscle strength was documented as weakened (Shannon and Rizzolo, 2012:23-24; Reider, 2005:147).

Inspection of the hand for thenar eminence wasting was conducted by firstly checking thumb opposition, which, in a non-affected individual, would tighten the thenar muscle group (Shannon and Rizzolo, 2012:23-24). The thenar eminence was also observed from the side and concavity was noted in the case of wasting/atrophy (D'Arcy and McGee, 2009:3112). The result was documented as normal or weakened.

The possibility of electrodiagnostic testing for this study was explored by the researcher during meetings with the Department of Neurology, UFS, but limited funds and resources excluded this as a viable option to include in the study. Palmer (2011:19) stated that the classical triad of diagnostic tools for CTS consisting of electrodiagnosis; medical-history recording, and physical hand examination, should all be utilised during the diagnosis of CTS. Although electrodiagnostic testing has been described by many authors as the gold standard in CTS diagnosis (Shannon and Rizzolo, 2012:24), other authors disagreed by stating that electrodiagnosis have significant false-positive and false-negative rates in CTS (Aroori and Spence, 2008:11 and Hobby, 2008:1). Therefore medical-history recording and physical examination of the hand remain important in forming the basis of CTS diagnosis (Tetro et al., 1998:493 and Hobby, 2008:1).

A qualified orthopaedic hand surgeon trained and tested the researcher on the correct procedure performing the tests which were included in the study. This surgeon completed post-graduate international training. No further details are provided, due to the limited number of orthopaedic surgeons in Bloemfontein, thereby protecting the identity of the specialist. The pre-testing was performed on two individuals who were not participating in the study, and the researcher's findings were compared to those of the orthopaedic surgeon to verify accuracy. The orthopaedic surgeon corrected the researcher's technique for Tinel's sign to increase the force of percussion, and in Durkan's test, to increase the pressure being applied with the thumb on the wrist.

Table 3.1 Criteria for making a diagnosis of CTS

Diagnosis made	Katz pattern	Provocative tests	Hand inspection
Definitive diagnosis	Classic	Positive in 3-4 tests	Weakened in 1-2 tests
Definitive diagnosis	Classic	Positive in 3-4 tests	-
Definitive diagnosis	Probable	Positive in 3-4 tests	Weakened in 1-2 tests
Probable diagnosis	Probable	Positive in 3-4 tests	-

Obesity is listed as a personal causative factor for CTS (Jebson and Kasdan 2006:261; Hobby, 2008:1; LeBlanc and Cestia, 2011:952 and McKean, 2014:Online), and therefore the participant's body weight was determined by using a digital calibrated scale (Tanita Digital Lithium Scale – HD-327). A digital scale was utilised due to better precision of the measurements and ease of reading the digital measurement on the liquid crystal display (LCD) therefore limiting possible errors. Participants' height was determined by using a portable stadiometer (Seca 213 from Lifemax). This specific stadiometer was recommended by the Department of Dietetics, UFS as their preferred choice, since it is easy to transport; set-up is quick; the measuring rod is very stable, and the scale is printed on the side of the measuring rod making the reading of the measurement easy and precise.

Privacy of participants during their height and weight measurement was ensured by measurements taking place in a separate room, screened off area or committee room at the venue of data collection and no verbal read-outs were done, measurements were simply documented. Both weight and height measurements were taken according to the guidelines as stipulated by the WHO guidelines (Puoane, Fourie, Shapiro, Rosling, Tshaka and Oelofse, 2005:8).

Height was measured to the nearest 0.1cm. The participants were asked to take off their shoes, standing with their feet shoulder width apart, and upright with their backs, buttocks and heels as close as possible to the stationary back pole of the stadiometer. Body weight was recorded to the nearest 0.5 kg. Participants were barefoot and asked to take off all excess clothing for example heavy jackets or scarves; they had to empty their pockets to ensure that an accurate reading was obtained.

Both height and weight was measured three times and documented. The average height and weight was calculated followed by the BMI calculation for each participant during data analysis, according to the following formula: weight (kg) divided by height^2 (m^2) (WHO, 2000:Online). Each participant's body BMI was then interpreted by the researcher according to the WHO standardised values as being underweight, normal weight, overweight or obese (WHO, 2006:Online). This classification was done in order to determine if obesity was associated with the development of CTS in the physiotherapy population in Bloemfontein (see Table 2.2, p22).

Table 3.2 Classification of body mass index (BMI)

Classification	**BMI (kg/m²)**
Underweight	< 18.5
Normal weight	18.5 - < 25
Overweight	25 - < 30
Obese	30 - ≥ 40

The other causative factors for CTS were investigated as part of demographic and medical history information in the questionnaire (see 3.5, p37).

Data gathered during the physical examination was documented on a self-developed Excel data spread sheet (Appendix C) by the researcher, and verified simultaneously by the participant.

3.5.2 Pilot study

A pilot study was conducted on two practicing physiotherapists (one from each sector) before commencement of the main study. The size of the sample for the pilot study was calculated in conjunction with the biostatistician. The pilot study was conducted using the same procedure as for the main study to assess the feasibility of the study in terms of time commitment by participants, to determine the flow of the structured interview, to obtain clarity and precision for the physical hand examination, and to establish possible changes to be made to the study, if any. The consulting qualified orthopaedic surgeon, who trained the researcher in order to perform the special tests correctly, verified the pilot study results by repeating the tests on the two participants. The main aims of the pilot study was answered with the two participants. No changes were made and the participants of the pilot study were included in the main study sample as participant one and two.

3.5.3 Testing procedure

Ethical clearance was obtained from the Ethics Committee of the Faculty of Health Sciences, UFS - ECUFS NR 54/2015 (see Appendix F) before commencement of the study. Data gathering commenced in June 2015.

Individuals participated in their personal capacity and appointments were scheduled for lunch hours or after hours. Although the gathering of data was done at the place of work for most participants, it did not influence their professional responsibilities at all. It was therefore not necessary to obtain permission to conduct the study on the physiotherapists from The Free State Department of Health, hospital managers or physiotherapy heads of departments.

All HPCSA registered, practicing physiotherapists, and community physiotherapists in Bloemfontein, were included in the study. Participants were sourced from both the public and private sector. Participants had to give informed consent, understand English or Afrikaans in order to participate in the study as the researcher is only proficient in the two languages, to be able to complete the structured interview, and obtain the necessary information for the study.

Convenience sampling was done from the master list of the study population (see 3.4, p34) until 64 participants were identified and tested. The researcher chose a name from the master list and contacted the potential participant telephonically to explain the study, time needed for data collection, and ethical aspects as outlined in the information letter (see Appendix D). The researcher also enquired if any other physiotherapists worked at the practice or institution with the participant, and contacted each of them for possible inclusion in the study. The time needed to collect the data per participant was determined during the pilot study, and clearly stated to the participants during the initial phone call to ensure that participants allocated enough time in their schedule to complete all the tests. In the case of more than one participant per practice or institution agreeing to participate, consecutive appointments were made. As soon as an appointment was scheduled, the researcher delivered the information letter/s (Appendix D) and informed consent form/s (Appendix E) personally to the participant/s at least a day prior to data collection.

The information letter contained information regarding the aim and nature of the study, explained the procedure for data collection, and ensured participants of confidentiality. The informed consent form (Appendix E) complied with the elements as required by the ethics committee, and was signed by participants before participating in the study.

In the case of appointments not taking place the following day after delivery of the information letter and consent form, a reminder phone call was made to the specific participant one day prior to the date and time agreed upon by all parties involved to remind them with regard to the study. Data collection took place at the place of work of each participant, which was indicated by participants as being the most suitable and convenient place for data collection. Upon arrival, the researcher ensured that the informed consent form (Appendix E) was signed by the participant, and also allowed time for clarifying any questions or queries if any, by the participant.

The interview and physical evaluation data collection took place in a separate room, screened off area or committee room at the agreed venue to ensure privacy. The structured interview was performed by the researcher in Afrikaans or English as indicated by the participant. The researcher documented all the answers on the questionnaire, while the participant simultaneously checked the correct documentation of the answers. At the end of each session the participant was given the opportunity by the researcher to check the fully completed questionnaire for verification.

It was then required by the researcher that participants had to complete the provided Katz hand diagram according to the colours indicated in the measurement tool (see Appendix B). The researcher provided the participants with the necessary coloured pens. Only participants indicating to have the symptoms listed on the Katz hand diagram were asked to complete this part of the measurement procedure. Participants indicating no symptoms or symptoms other than listed on the hand diagram were not required to complete the diagram.

A physical hand examination was then conducted by the researcher. This was performed on all participants, irrespective whether they indicated hand symptoms or not. The participants were instructed to sit in a comfortable, supported position at a table and the tests were performed bilaterally by the researcher. Each test was done exactly as described in 3.5, p39-40. This was followed by measurement of the physiotherapist's weight and height as discussed in 3.5, p41-42. Data of the physical hand examination was recorded on the Excel data sheet (Appendix C) developed by the researcher, and correct documentation was simultaneously checked by the participant.

Each day's data was coded and entered into an Excel spreadsheet by the researcher on the very same day to minimise possible errors due to large numbers of data being entered at once. Data was re-entered by the researcher on a separate Excel spreadsheet before submitting it to the Department of Biostatistics, UFS for data verification and defaulting before commencing with the subsequent data analysis.

Each questionnaire, data sheet, and hand diagram was given a unique number allocated to each individual participant, to ensure confidentiality, but still ensuring the researcher would be able to link data to each individual in the case of identity disclosure, if required by law.

3.6 Ethical aspects

3.6.1 Permission from authorities and mandatory approval

Ethical clearance was obtained from the Ethics Committee of the Faculty of Health Sciences, UFS (ECUFS NR 54/2015) (see Appendix F).

Individuals were participating in their personal capacity and therefore it was not necessary to obtain permission from any other authorities. Participants were made aware prior to commencement of the study that participation was voluntary. A copy of the information letter (Appendix E) complying with the requirements of the ethics committee was provided to the participants before commencement of the study. Participants had to complete and sign the consent form before partaking in the study. Demographic and personal information of participants will remain confidential and will purely be used for the purpose of the research study. There were no risks involved for the participants to take part in the study. No remuneration was offered for participation, and no additional costs were incurred by the participants taking part in the study.

Participants identified with a risk for developing CTS were informed and advised by the researcher to consult a specialist medical practitioner and on possible treatment and lifestyle changes.

Data collected by the researcher, and the master list of the physiotherapists who participated in the study, will be stored for fifteen (15) years at the Department of Physiotherapy, UFS. Only the researcher and the chairperson of the Quality Assurance Committee at the department will have access to the master list. Study results may be made available to the participants on request.

Participants were made aware prior to taking part in the study that the results of the study might be published in an accredited journal to create awareness of the prevalence of CTS amongst physiotherapists in Bloemfontein. Data however will be presented for the group, and no individual identification will be possible.

3.7 Data analysis

The data analysis for this study was generated using SAS/STAT software, Version 9.4 of the SAS System for Windows 6.1.7601. Copyright © 2013 SAS Institute Inc.

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Analysis of data was done by the Department of Biostatistics, UFS. Descriptive statistics, namely frequencies and percentages for categorical data, and medians and percentiles for continuous data, were calculated. The prevalence of CTS was calculated and described by means of 95% confidence interval for the prevalence.

Associations were calculated for the variables mentioned in the objectives and described by means of 95% confidence intervals for the median or percentage difference and relative risks.

3.8 Conclusion

A cross-sectional study was done. A self-developed questionnaire, Katz hand diagram, physical examination of the hand, and the recording of height and weight was used to collect data from participants. Data analysis was done using the SAS/STAT software, Version 9.4 of the SAS System for Windows 6.1.7601. The results from this study are outlined in chapter four.

Chapter four

4 Results

4.1 Introduction

Data was gathered from 64 participants by means of a structured interview, a physical examination conducted by the researcher, as well as the completion of a Katz hand diagram. A percentage of 40.5% of the total population of physiotherapists in Bloemfontein participated. Every participant contacted agreed to participate and there were no drop-outs.

Throughout this chapter the median value will be used since the data was not normally distributed.

4.2 Demographic information

The participants had a median age of 32.9 years, with the youngest participant 23.3 years, and the oldest participant 59.5 years of age (25th and 75th percentiles, 27.8 and 39.7). Fifty seven participants were female.

The table below summarises the employment sector, and employment status of the 64 participants:

Table 4.1 Employment sector and status of participants (n=64)

Employment sector				**Employment status**					
Private sector		**Public sector**		**Full time**		**Part time**		**Locum**	
n	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
47	73.4	17	26.6	55	85.9	6	9.4	3	4.7

4.3 Occupational activities and factors

The median years for actively practicing as physiotherapists for the participants was 9.5 years, with a minimum of one year, a maximum of 36 years, and the median age when the participants started practicing as physiotherapist was 22.9 years of age (25^{th} and 75^{th} percentiles, 5 and 16). When asked about working-hours per week, 44 (n=64) participants indicated the median of 40 normal working-hours per week (25^{th} and 75^{th} percentiles, 40 and 40), and 12 (n=64) participants indicated the median of three overtime hours per week (25^{th} and 75^{th} percentiles, 0 and 4). Overtime included after hours and weekends, where 45 (n=64) participants indicated that they did work overtime.

Participants were asked to indicate their main area/s of work, defined as the area/s where they spend more than 50% of their normal work day:

Table 4.2 Main area of work (n=64)

Area	n	%
Musculoskeletal out-patients	41	64.1
Medical/respiratory	25	39.1
Sport rehabilitation	21	32.8
Acute orthopaedics	19	29.7
Neurological rehabilitation	13	20.3
Paediatrics	10	15.6
Neurosurgery	8	12.5
Spinal rehabilitation	8	12.5
General surgery	7	10.9
Other*	7	10.9
Acute neurology	6	9.4
Geriatrics	6	9.4
Cardio thoracic surgery	5	7.8

*Other = Women's health; administrative work load; psychiatry and chronic pain patients

Most of the participants (n=20) indicated that they had two areas as their main working areas. No conclusion could be made regarding any specific combinations of main work areas indicated by the participants.

The treatment techniques which were mainly used during a normal work day were defined as those techniques that participants utilised during more than 50% of their work day:

Table 4.3 Treatment techniques mainly used (n=64)

Treatment technique	**n**	**%**
Soft tissue techniques	44	68.8
Orthopaedic mobilisation techniques	38	59.4
Manual respiratory techniques (percussion/vibration/shaking)	27	42.2
General massage	25	39.1
Other*	25	39.1
Use of vibration machine in respiratory physiotherapy	7	10.9

*Other = Dry needling; strapping; rehabilitation exercises; neuro-developmental therapy techniques; general mobilisation techniques; adult neurology rehabilitation techniques; transferring weak patients; neural mobilisation techniques

Participants were also asked questions regarding rest periods, or breaks of at least 10 minutes, taken between treatment sessions. Thirty-one (n=64) participants did not take regular rest periods, and worked for longer than two hours non-stop on a daily basis. A further eight participants indicated that they worked for two hours before stopping for a break of at least ten minutes between patients.

4.4 Medical history

Questions posed regarding personal health (including pregnancy) and medical history was related to causes and risk factors of CTS or a history of CTS.

Six of the 57 female participants indicated that they were pregnant at the time of the study.

Other risk factors indicated by participants are listed in Table 4.4 below.

Table 4.4 Medical history (n=64)

Condition	n
History of upper limb trauma*	7
RA	2
Hypothyroidism	2
DM	0
Mass lesions	0
Amyloidosis	0
Sarcoidosis	0
Multiple myeloma	0
Leukemia	0

*Included: wrist ganglion (n=2); wrist surgery for cartilage tear (n=1); radius fracture (n=3); scaphoid fracture (n=1) and De Quervain's disease (n=1)

Two of the participants indicated that they had been diagnosed with CTS and had undergone electrodiagnostic tests to confirm the diagnosis. Test results indicated damage to both the sensory and motor components of the median nerve. One participant developed bilateral CTS during her second pregnancy (a year ago) which was treated by wearing night splints. The CTS resolved completely five weeks post-delivery without any recurrence or complications.

4.5 Signs and symptoms

Symptoms experienced by participants during, or at the end of their work week, are indicated in Figure 4.1.

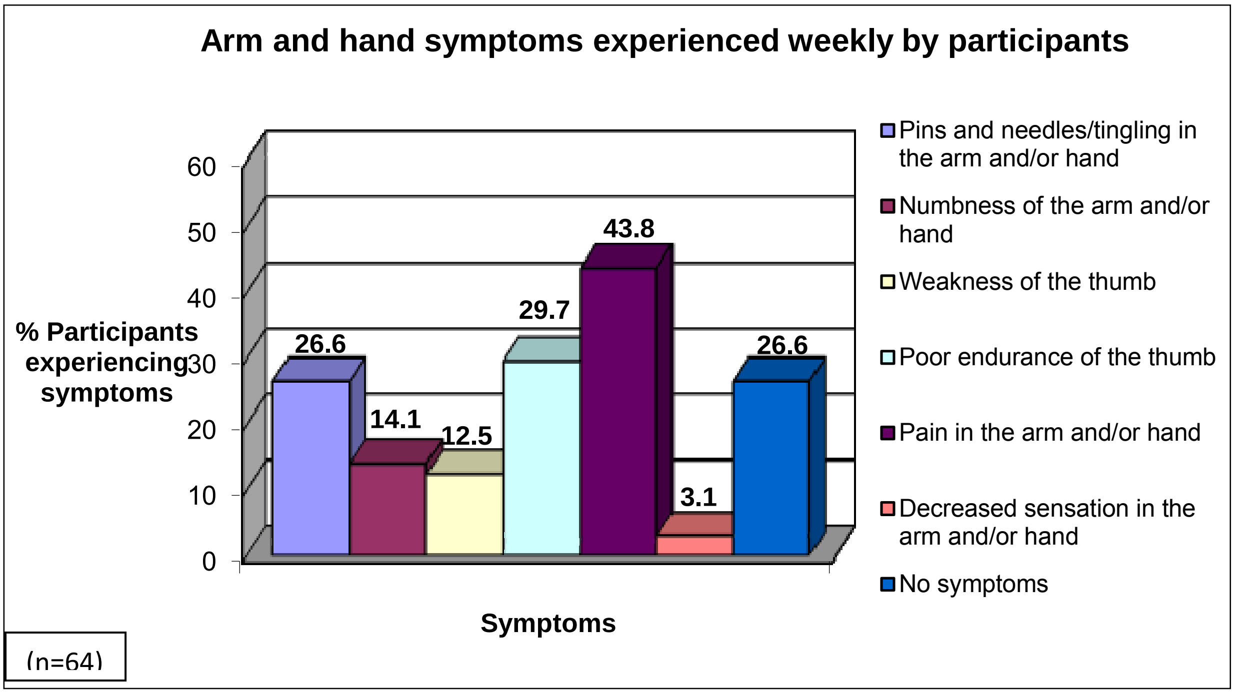

Figure 4.1 Symptoms experienced by participants during or at the end of the work week

The median number of symptoms experienced by 25 participants was one (25^{th} and 75^{th} percentiles, 0 and 2). Interestingly enough one participant indicated as having experienced all six symptoms. Depending on the answers provided by the 47 participants who experienced symptoms, it was then required of only the participants indicating to have the symptoms listed on the Katz hand diagram to continue by completing the Katz hand diagram. The symptoms to be indicated and interpreted on the Katz hand diagram were numbness; pain; pins and needles/tingling, and decreased sensation, all to be noted in the arm and/or hand (see 3.5, p38). Only 39 of the 47 participants indicated that they experienced one or more of the listed symptoms and therefore continued to complete the Katz hand diagram. The results of the Katz hand diagram classification is summarised in Table 4.5:

Table 4.5 Classification of participants' hand diagrams according to Katz (n=39)

Pattern classification of completed Katz hand diagram	n	%
Classic CTS	3	7.7
Probable CTS	7	18
Unlikely CTS	29	74.4

Of the 47 (n=64) participants experiencing upper limb symptoms, 24 (n=47) participants experienced their symptoms on a weekly basis; 21 (n=47) participants on a monthly basis, and only two (n=47) on a yearly basis (see Figure 4.2).

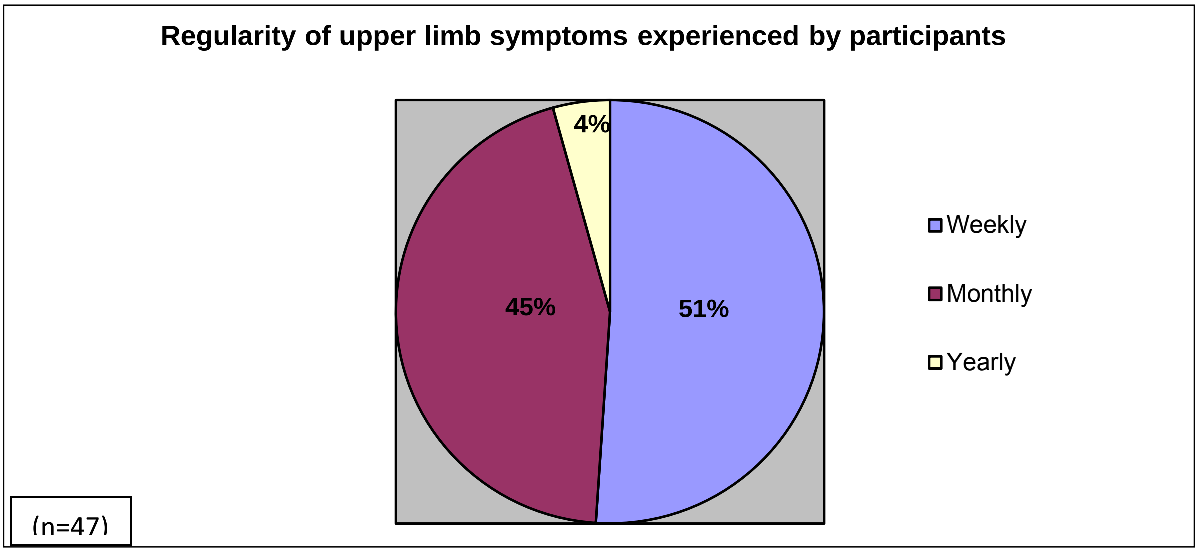

Figure 4.2 Regularity of upper limb symptoms experienced by participants

Of the 47 (n=64) participants experiencing any of the symptoms as listed in Figure 4.1, eight experienced their symptoms in their left hand, 17 in their right hand, and 22 in both hands. In the case of only one hand being affected it is to be noted that it was the dominant hand in 16 (n=25) of the cases.

Symptoms worsened at night for 13 (27.7%) of the participants, and during clinical work for 37 (78.7%) of the participants (n=47).

A number of factors were pointed out by participants that worsen their symptoms during clinical work (see Figure 4.3).

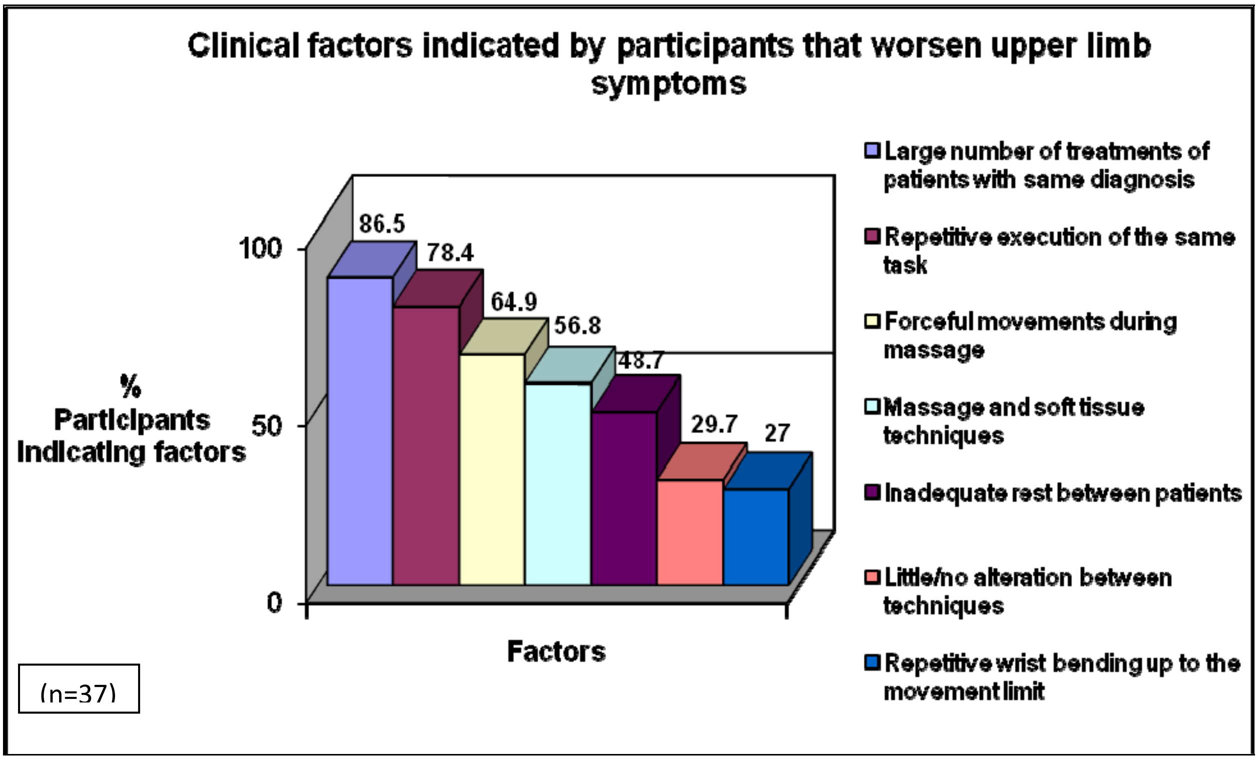

Figure 4.3 Factors in clinical work worsening upper limb symptoms of participants

Other factors in clinical work indicated by participants that worsened their upper limb symptoms, which are not indicated in Figure 4.3 include: working in a poor posture for long periods of time (13.5%); working overtime (10.8%); inadequate information regarding professional risks (2.7%) and poor kinetic planning (2.7%). It is interesting to note that of the 31 (n=64) participants who indicated that they worked for longer than two hours before taking a break of at least 10 minutes, only 13 participants (n=37) with upper limb symptoms indicated that they found that inadequate rest periods worsened their symptoms. Of the eight (n=64) participants indicating working for two hours before resting, only two (n=37) participants indicated inadequate resting periods as a worsening factor. To be noted is that, of the 45 (n=64) participants who indicated working overtime, only three (n=37) participants with upper limb symptoms, felt this to be a worsening factor. Of these three participants, the maximum hours of overtime-work were three hours. A small number of participants (n=11) working for longer than three hours overtime per week (up to 10 hours), and having symptoms, did not indicate overtime to be a factor for worsening of their symptoms (see 4.3, p49).

Strategies most often implemented by participants to relieve their symptoms during or at the end of the clinical work week were: change of hand position (68.1%); more regular adjustment of techniques (48.9%); self-massage, or use of soft tissue techniques (22.2%); change of poor posture (19.2%); choosing to utilise electrotherapy modalities to allow hands to rest (17%), and self-strapping of the wrist (16.7%). Symptoms decreased in 38 (80.9%) of the participants when taking a long break from work, or after a holiday.

Participants also had to indicate the start of any symptoms experienced within their career (see Figure 4.4).

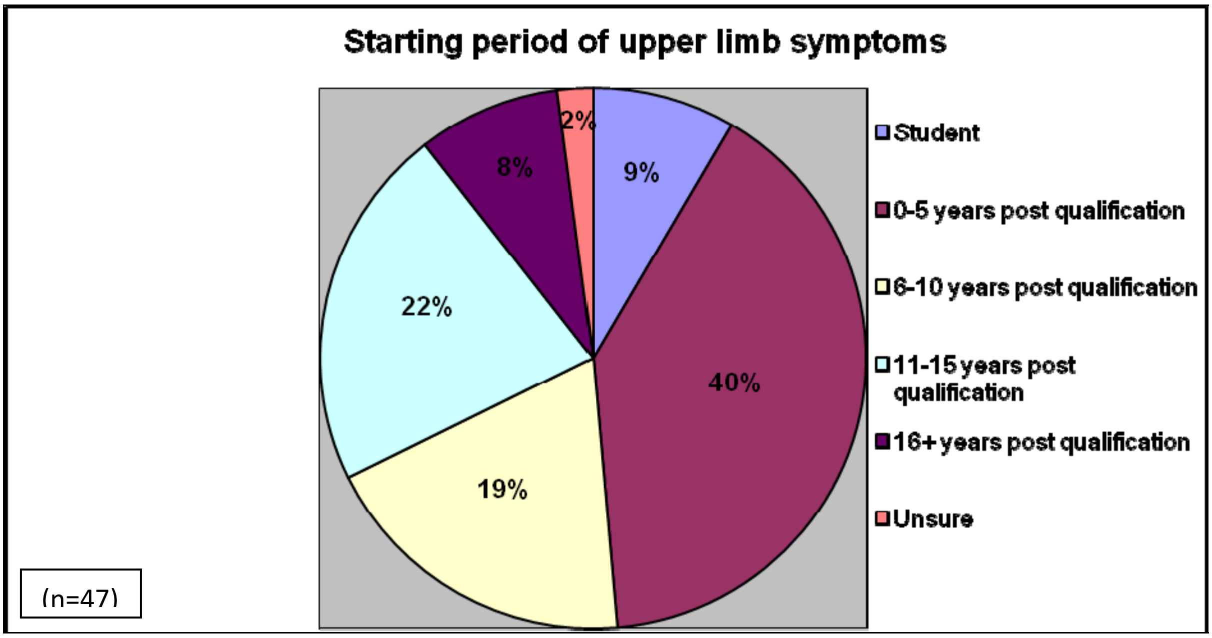

Figure 4.4 Starting period of symptoms in physiotherapy career

The majority (40.0%) of the participants indicated that their symptoms started within the first five years after graduating, and the second largest portion (22.0%) of the participants indicated the start of their symptoms to be 11-15 years post-qualification.

All participants (n=64) underwent the physical hand examination, as well as determining height and weight in order to calculate the participants' BMI.

The physical hand examination consisted of observation of the hand and performing special tests on both hands. The special provocative tests performed, included Durkan's test; Tinel's sign; reverse Phalen manoeuver, and Phalen manoeuver. The findings were documented as positive if the specific symptoms were elicited as described in 3.5, p38-41.

Table 4.6 Findings of special provocative tests for diagnosis of CTS (n=64)

Test	Right hand				Left hand			
	Positive		Negative		Positive		Negative	
	n	%	n	%	n	%	n	%
Durkan	21	32.8	43	67.2	19	29.7	45	70.3
Tinel	7	10.9	57	89.1	10	15.6	54	84.4
Reverse Phalen	11	17.2	53	82.8	10	15.6	54	84.4
Phalen	7	10.9	57	89.1	9	14.1	55	85.9

Observation and further testing of the hand included observing the thenar eminence of the participant for muscle atrophy, as well as testing muscle strength of APB. The findings were documented by the researcher as normal or weakened.

Table 4.7 Findings of observation and muscle testing of the hand for diagnosis of CTS (n=64)

Observation	Right hand (n)		Left hand (n)	
	Normal	Weakened	Normal	Weakened
Thenar eminence atrophy	62	2	64	0
APB Muscle strength	62	2	62	2

When asked about hand symptoms in the questionnaire (see 4.5; Figure 4.1, p52), eight (n=64) participants indicated to suffer from weakness of the thumb. Only one participant (n=8) who indicated weakness of the thumb in the questionnaire, had a weakened APB (unilateral) during the muscle testing component.

Participants' weight and height was measured by the researcher in order to calculate the BMI which was then interpreted by the researcher according to the WHO standardised values (WHO, 2006:Online).

Table 4.8 Body mass index (BMI) results of participants (n=64)

Classification	**BMI (kg/m²)**	**Participants**	
		n	**%**
Underweight	< 18.5	1	1.6
Normal weight	18.5 - < 25	33	51.6
Overweight	25 - < 30	18	28.1
Obese	30 - ≥ 40	12	18.8

4.6 CTS Diagnosis

For the purpose of this study a diagnosis of CTS was made according to the following operational criteria:

Table 4.9 Criteria for making a diagnosis of CTS

Diagnosis made	**Katz pattern**	**Provocative tests**	**Hand inspection**
Definitive diagnosis*	Classic	Positive in 3-4 tests	Weakened in 1-2 tests
Definitive diagnosis*	Classic	Positive in 3-4 tests	-
Definitive diagnosis*	Probable	Positive in 3-4 tests	Weakened in 1-2 tests
Probable diagnosis**	Probable	Positive in 3-4 tests	-

*Group 1; **Group 2

No diagnosis (group 3) was made if a participant did not comply with either of the above mentioned criteria.

According to the criteria summarised in table 4.9, the following diagnoses was made during the study. Five participants (7.8%; n=64) had a definitive CTS diagnosis which falls within the 95% confidence interval (CI) [3.4; 17] for the prevalence of CTS; five participants (7.8%; n=64) had a probable diagnosis, and 54 participants (84.4%; n=64) did not fit the criteria for the diagnosis of CTS.

The breakdown of the findings of the ten participants in group 1 and 2 regarding signs, are outlined in Table 4.10. All ten participants had a positive result for Durkan's test. Only two participants in group 1 had wasting of the thenar eminence, and only one participant in group 1 had weakened muscle strength of APB.

Table 4.10 Findings of participants' results regarding CTS signs of CTS groups 1 and 2 (n=10)

Signs and symptoms	**CTS Group 1 (n=5)**	**CTS Group 2 (n=5)**
Positive finding	**n**	**n**
Durkan	5	5
Tinel	1	4
Reverse Phalen	2	3
Phalen	3	3
Thenar eminence atrophy	2	0
Weakened muscle strength of APB	1	0

The breakdown of the findings of the ten participants in group 1 and 2 regarding symptoms are outlined in Table 4.11. Only one participant in each group complained of weakness of the thumb. One participant in group 1, and two participants in group 2, complained of poor endurance of the thumb muscles.

Table 4.11 Findings of participants' results regarding CTS symptoms of CTS groups 1 and 2 (n=10)

Symptoms indicated by participants	**CTS Group 1 (n=5)**	**CTS Group 2 (n=5)**
	n	**n**
Pins and needles/tingling in the arm and/or hand	3	4
Numb feeling in the arm and/or hand	3	2
Pain in the arm and/or hand	3	3
Decreased sensation in the arm and/or hand	2	0
Poor endurance of the thumb muscles	1	2
Weakness of the thumb	1	1

Unless otherwise specified the findings for group 1 will now be summarised further. The summarised findings for group 2 appears in Appendix H.

4.6.1 CTS Diagnosis and causative risk factors

Table 4.12 and 4.13 summarises the findings of diagnosed group 1 regarding personal factors, and medical history as causes and risk factors related to CTS. Not all causative and risk factors regarding medical history related to CTS appears in the tables, but only the causative and risk factors indicated by participants in this study.

Table 4.12 Body mass index (BMI) in CTS group 1 (n=5)

CTS Diagnosis	BMI							
Group 1: Definitive diagnosis(n=5)	Underweight (n=1)		Normal weight (n=33)		Overweight (n=18)		Obese (n=12)	
	n	%	n	%	n	%	n	%
	0	0	0	0	4	22.2	1	8.3

When interpreting the BMI of participants, the results indicated that the 95% CI [-45.2 ; -5.6] for the percentage difference between the underweight, as well as the normal weight group, and overweight group, showed a statistically significant difference where more overweight participants had CTS than the underweight or normal weight participants. Obese participants showed a tendency to be diagnosed with CTS more than underweight or normal weight participants (CI, -35.4; 3.9), but this was not statistically significant. Overweight participants also showed, statistically, a non-significant tendency to be diagnosed with CTS rather than participants being classified as being obese (CI, -16.2; 37.9).

Table 4.13 Personal and medical history factors in CTS group 1 (n=5)

Factor	Group 1: Definitive diagnosis (n=5)			
	n	%	95% CI	Statistical significance
Age >40	4	25	[-47.5 ; -5.7]	Significant
Female	5	8.8	[-27.0 ; 18.9]	Not significant
Pregnant	0	0	[-21.0 ; 29.6]	Not significant
RA	1	50	[-84.3 ; -2.0]	Significant (wide interval)
Upper limb trauma	0	0	[-27.0 ; 18.9]	Non-significant tendency

The only statistically significant associations with a definitive CTS diagnosis are: age older than 40 years, and having RA. The interpretation on the results on gender was not significant due to the small number of males in the study. A statistically non-significant tendency was shown for participants who do not have upper limb trauma to be diagnosed with CTS.

4.6.2 CTS Diagnosis and occupational factors and activities

Table 4.14 and 4.15 summarises the employment sector and status for the participants with a definitive CTS diagnosis.

Table 4.14 Employment sector of CTS group 1 (n=5)

Employment sector	Group 1: Definitive diagnosis (n=5)			
	n	**%**	**95% CI**	**Statistical significance**
Public sector (n=17)	0	0	[-22.6 ; 8.7]	Not significant
Private sector (n=47)	5	10.6		

Table 4.15 Employment status of CTS group 1 (n=5)

Employment status	Group 1: Definitive diagnosis (n=5)		
	n	**%**	**95% CI**
Full time employment (n=55)	4	7.3	Full time and part time: [-32.0 ; 17.3] Full time and locum: [-72.2 ; 2.9] Part time and locum: [-79.2 ; 14.2]
Part time employment (n=6)	0	0	
Locum (n=3)	1	33.3	

None of the findings regarding employment sector or status in CTS group 1 were statistically significant.

Regarding years practicing, the median number of years practicing for the group with a definitive CTS diagnosis (n=5), was 26 years. Seeing as the three groups of CTS diagnosis were too small for a confidence interval calculation, the Kruskal Wallis test was used with a p-value of less than 0.05 deemed as statistically significant. A p-value of 0.003 showed the median number of years practicing, being statistically significant as a possible occupational risk factor for a CTS diagnosis.

Regarding working hours, it was found that the median number of normal working hours for both the definitive and probable CTS groups (group 1 and 2), was 40 hours per week. The median number of overtime hours for group 1, was three hours per week, and for group 2, four hours per week. The p-values for the normal and overtime working hours for group 1 and 2, calculated according to the Kruskal Wallis test, are indicated in table 4.16 below.

Table 4.16 Working hours for CTS groups

	Normal working hours (p-value)	**Overtime working hours (p-value)**	**Statistical significance**
Group 1 and 2	p = 1.0	p = 0.59	Not significant

Table 4.17 summarises the findings regarding area of work for the participants with a definitive CTS diagnosis.

Table 4.17 Main area of work in CTS group 1 (n=5)

Main area of work	**Group 1: Definitive diagnosis (n=5)**			
	n	**%**	**95% CI**	**Statistical significance**
Cardio thoracic surgery (n=5)	0	0	[-35.2 ; 8.4]	Non-significant tendency
Paediatrics (n=10)	1	10.0	[-33.3 ; 0.5]	Non-significant tendency
Neurological rehabilitation (n=13)	0	0	[-13.7 ; 21.0]	Not significant
Acute neurology (n=6)	1	16.7	[-49.7 ; 6.9]	Non-significant tendency
Acute orthopaedics (n=19)	3	15.8	[-33.4 ; 3.3]	Non-significant tendency
Musculoskeletal out-patients (n=41)	5	12.2	[-25.5 ; 3.7]	Non-significant tendency
Sport rehabilitation (n=21)	2	9.5	[-22.5 ; 11.0]	Not significant
Spinal rehabilitation (n=8)	0	0	[-23.9 ; 19.3]	Not significant
Neurosurgery (n=8)	3	37.5	[-66.0 ; -8.6]	Significant
General surgery (n=7)	1	14.3	[-44.5 ; 7.9]	Non-significant tendency
Geriatrics (n=6)	0	0	[-30.7 ; 18.6]	Non-significant tendency
Medical/respiratory (n=25)	1	4.0	[-10.5 ; 20.0]	Not significant
Other* (n=7)	0	0	[-27.0 ; 18.9]	Not significant

*Other = Women's health; administrative work load; psychiatry and chronic pain patients

A statistically significant tendency was found for participants who worked in the neurosurgery field to suffer from CTS. A statistically non-significant tendency was found for participants who do not work in cardiothoracic surgery to suffer from CTS, and the participants who do work in paediatrics; acute neurology; acute orthopaedics; musculoskeletal out-patients; general surgery or geriatrics, show statistically, a non-significant tendency to suffer from CTS.

Table 4.18 summarises the findings regarding the treatment techniques mainly used (more than 50% of the working day) by CTS group 1.

Table 4.18 Treatment techniques mainly used by CTS group 1 (n=5)

Treatment technique used	**Group 1: Definitive diagnosis (n=5)**			
	n	**%**	**95% CI**	**Statistical significance**
Orthopaedic mobilisation techniques (n=38)	5	13.2	[-27.3 ; 1.7]	Not significant
Soft tissue techniques (n=44)	5	11.4	[-24.0 ; 6.0]	Not significant
General massage techniques (n=25)	2	8.0	[-18.0 ; 13.6]	Not significant
Manual respiratory techniques (n=27)	2	7.4	[-16.1 ; 14.9]	Not significant
Use of vibration machine (n=7)	0	0	-	Not significant
Other (n=25)	1	4.0	[-10.5 ; 20.0]	Not significant

*Other = Dry needling; strapping; rehabilitation exercises; neuro-developmental therapy techniques; general mobilisation techniques; adult neurology rehabilitation techniques; transferring weak patients; neural mobilisation techniques

None of the findings regarding treatment techniques, mainly used by CTS group 1, were statistically significant.

Participants in CTS group 1 indicated the following regarding work periods before taking a break/rest of at least 10 minutes between patients:

Table 4.19 Period of time working without rest in CTS group 1 (n=5)

Period of time without rest	**Group 1: Definitive diagnosis (n=5)**		
	n	**%**	**95% CI**
Half an hour (n=15)	1	6.7	Half an hour and an hour [-21.6 ; 29.8] Half an hour and two hours [-40.9 ; 19.5] Half an hour and more than two hours [-19.2 ; 21.0] An hour and two hours [-47.1 ; 17.1] An hour and more than two hours [-24.9 ; 18.8] Two hours and more than two hours [-15.5 ; 38.0]
An hour (n=10)	0	0	
Two hours (n=8)	1	12.5	
More than two hours (n=31)	3	9.7	

None of the findings regarding the period of time working without rest between patients, mainly used by CTS group 1, were statistically significant.

4.6.3 CTS Diagnosis and upper limb symptoms

The CTS groups with a definitive (group 1), and probable diagnosis (group 2), indicated the following responses regarding experiencing their symptoms in only one hand or bilaterally:

Table 4.20 CTS group 1 and 2, and the symptomatic hand (n=10)

CTS group	**Left hand (n=8)**		**Right hand (n=17)**		**Bilateral (n=22)**		**95% CI**	**Statistical significance**
	n	**%**	**n**	**%**	**n**	**%**		
Group 1 (n=5)	0	0	2	40.0	3	60.0	[-46.5 ; 46.5]	Not significant
Group 2 (n=5)	0	0	2	40.0	3	60.0		

There was no statistical difference in CTS diagnosis with regard to symptoms being bilateral or not for either of the CTS groups.

CTS group 1 indicated the following responses regarding the behaviour of their symptoms experienced:

Table 4.21 Behaviour of symptoms in CTS group 1 (n=5)

Influencing factor on upper limb symptoms		**Group 1: Definitive diagnosis (n=5)**			
		n	**%**	**95% CI**	**Statistical significance**
Nocturnal worsening of symptoms (n=47)	Yes (n=13)	4	30.8	[6.1 ; 54.8]	Significant
	No (n=34)	1	2.9		
Relief of symptoms with long break or holiday (n=47)	Yes (n=38)	3	7.9	[-47.3 ; 6.2]	Not significant
	No (n=9)	2	22.2		
Clinical work worsening symptoms (n=47)	Yes (n=37)	3	8.1	[-43.3 ; 7.6]	Not significant
	No (n=10)	2	20.0		

A statistically significant difference was found regarding nocturnal worsening of symptoms, where participants diagnosed with CTS (group 1), had nocturnal worsening of symptoms.

A summary of the factors indicated by group 1 that mostly worsen their symptoms are given in Table 4.22 below.

Table 4.22 Main factors indicated by CTS group 1 to worsen symptoms (n=5)

Factor worsening upper limb symptoms	**Group 1: Definitive diagnosis (n=5)**			
	n	**%**	**95% CI**	**Statistical significance**
Repetitive execution of the same task (n=29)	3	10.3	[-21.2 ; 9.9]	Not significant
Forceful movements during massage (n=24)	3	12.5	[-26.4 ; 6.6]	Not significant
Large number of treatments of patients with the same diagnosis (n=32)	3	9.4	[-18.6 ; 12.1]	Not significant
Little/no changes between techniques (n=11)	1	9.1	[-30.6 ; 11.2]	Not significant
Overtime work (n=4)	2	50.0	[-80.2 ; -8.9]	Significant
Repetitive wrist bending to the limit of movement (n=10)	2	20.0	[-45.6 ; 2.8]	Not significant
Massage and soft tissue techniques (n=21)	2	9.5	[-22.5 ; 11.0]	Not significant

Overtime work is the only factor with statistical significance noting the very wide interval for the percentage difference of [-80.2; -8.9].

Table 4.23 indicates the strategies implemented by CTS group 1 to prevent possible CTS.

Table 4.23 Strategies mainly implemented by CTS group 1 to prevent possible CTS (n=5)

Strategy implemented	**Group 1: Definitive diagnosis (n=5)**			
	n	**%**	**95% CI**	**Statistical significance**
Changing of hand position (n=32)	2	6.3	[-12.1 ; 18.6]	Not significant
Changing of poor posture (n=9)	1	11.1	[-36.5 ; 9.7]	Not significant
More regular changing of treatment techniques (n=23)	2	8.7	[-20.1 ; 12.3]	Not significant
Longer resting periods between patients (n=2)	1	50.0	[-84.3 ; -2.0]	Significant

Longer resting periods between patients is the only strategy with statistical significance noting the very wide interval for the percentage difference of [-84.3; -2.0].

Four participants from group 1 (n=5) indicated the start of their symptoms to be later in their career at 11+ years post qualification. For group 2 (n=5); three participants indicated the period of 11+ years post qualification, to be the period for the start of their symptoms. In group three (n=54), only 37 participants had any symptoms, and continued to complete this section. From these 37 participants, 25 participants indicated the starting period of their symptoms to be 0-10 years post qualification, and eight indicated it to be 11+ years post qualification.

The regularity of symptoms for the CTS group 1 is indicated in Table 4.24.

Table 4.24 Regularity of symptoms as indicated by CTS group 1 (n=5)

Regularity of experiencing upper limb symptoms	**Group 1: Definitive diagnosis (n=5)**		
	n	**%**	**95% CI**
Weekly (n=24)	5	20.8	Weekly and monthly [1.5% ; 40.5%] Weekly and yearly [-45.9% ; 40.5%] Monthly and yearly [-65.8% ; 15.5%]
Monthly (n=21)	0	0	
Yearly (n=2)	0	0	

A statistically significant difference was found where participants who experienced symptoms weekly were in the group with a definitive CTS diagnosis.

The participants in group 1 (n=5) provided the following additional information:

One participant indicated that working with meat; gardening, or doing needle work worsened her symptoms. The participant further indicated that wrist flexion when writing, or working on the computer, severely worsened her symptoms. This particular participant already had a positive result with electrodiagnostic testing for the sensory component of the median nerve (right), and indicated that she had an appointment with an orthopaedic surgeon. Another participant from group 1 also indicated that she had a positive result with electrodiagnostic testing for the sensory component of the median nerve (left is worse than right), and has an appointment with a neurosurgeon. Another participant indicated that she had a family history of CTS with her mother being diagnosed with the syndrome. This participant also does a lot of mountain biking with constant vibration through fully extended wrists for long periods of time. Furthermore, one participant indicated that her fingers and wrists always feel stiff.

The participants in group 2 (n=5) provided the following additional information:

One participant previously had an inflammatory condition of the right thumb, but it cleared with oral nonsteroidal anti-inflammatory medication. Another participant indicated that she plays a lot of volleyball with many overhead shoulder activities, and one participant indicated to have a medical history of a right scaphoid fracture.

4.7 Conclusion

According to the case definition for this study, 7.8% (n=64) of the participants had a definitive CTS diagnosis, and 7.8% (n=64) a probable CTS diagnosis. Regarding causes and risk factors associated with CTS, being overweight and older than 40 years of age showed statistically significant associative factors with a definitive CTS diagnosis. Regarding occupational activities and CTS diagnosis, it was found that the 26 median years in practice for the CTS diagnosed group was statistically significant, as well as working in the neurosurgery field. Participants experiencing nocturnal worsening of symptoms, and experiencing symptoms on a weekly basis, were statistically significant associated with a definitive CTS diagnosis.

The results of the study will be discussed in further detail in chapter five.

Chapter five

5 Discussion

5.1 Introduction

Carpal tunnel syndrome (CTS) results from the chronic compression of the median nerve in the carpal tunnel (Celik and Guven, 2008:83), and is the most common compression neuropathy of the upper limb seen worldwide, attributing to 90% of all compression neuropathies (Aroori and Spence, 2008:6). The appearance of CTS in the workplace is rising (Palmer et al., 2007:57) but the only medical related profession ever investigated for possible CTS, is the dental profession, specifically dental hygienists and assistants in the USA and Canada (Anton et al., 2002; Lalumandier and McPhee, 2001 and Liss et al, 1995:521-540). The main area of research regarding disorders within the physiotherapy profession thus far focused on WRMD's, and to date, only two studies investigated the topic of work-related musculoskeletal hand disorders in South Africa (Barnes et al., 2011 and Jenkins, 2013). The prevalence or even risk of neurological conditions, especially CTS, in the physiotherapy profession, has never been investigated internationally or in South Africa. It must be noted that literature on this topic might be available or unpublished, but was not found following an extensive literature search.

5.2 Demographic information and occupational activities

Data was gathered from 64 participants by means of a structured interview, and physical examination conducted by the researcher, as well as the completion of a Katz hand diagram by participants. The studies by Barnes at al. (2011) and Human et al. (2014) used the same population, namely physiotherapists in Bloemfontein, Free State, South Africa, but both included the entire population, with no sampling method used. In the study by Barnes et al. (2011) 88 physiotherapists participated, and 98 participated in the study by Human et al. (2014). Due to the nature of this study which entailed special tests to be performed by the researcher, the sample size is smaller than the mentioned studies, but according to the power calculation, it is sufficient to have statistical power as discussed in section 3.4 (see Figure 3.1, p36).

The participants had a median age of 32.9 years, the range being 23.3-59.5 years (n=64). This median age is indicative of experienced participants who have been practicing for more than ten years, if looking at the youngest age of 23.3 years. The age-range of 23.3-59.5 years also reflects the ages ranging between newly qualified to nearly retired physiotherapists. The median age in this study also compares with the median age in Barnes et al. (2011) of 31 years, and the age of less than 40 years by the majority of participants (62.5%) in the study by Jenkins (2013). In this study 89.1% of the participants were female; correlating with the perception that physiotherapy is still a predominantly female occupation, as was stated by Barnes et al. (2011) with 83.0% female participants and Human et al. (2014) with 81.6% female participants.

The median number of years actively practicing as physiotherapist was 9.5 years (n=64) within a range of 1-36 years. This is slightly higher than the stated, experienced median 8 years, by both Barnes et al. (2011) and Human et al. (2014). The participants in this study are therefore slightly more experienced and possibly more prone to CTS since they have been working for a longer period. It could also indicate that not many newly qualified physiotherapists chose Bloemfontein as a working environment since 2014.

The majority (73.4%) of participants (n=64) were employed in the private sector and worked full-time (85.9%). The reason for this could be the poor economic climate currently in South Africa, where full-time employment in the private sector versus full-time employment in the public sector guarantees a better salary where management structures are in place (Rakgokong, 2007), as well as job security since the public sector struggles to retain skilled medical staff (Adäo, 2015:Online). Human et al. (2014) found 58.1% of the participants to be employed in the private sector and Barnes et al. (2011) found that 86.4% worked full-time. The difference in employment sector in this study could further be attributed to the convenience sample selection method in this study versus inclusion of the whole population by Human et al. (2014). Regarding working hours, 68.8% of the participants worked the median 40 normal working hours per week, and 18.8%, the median three hours overtime per week, with the majority (29.7%) not working overtime at all. The majority of participants being employed full-time covering a 40 normal working hour week is in accordance with the law stipulating a maximum of 45 hours per week for full-time employees in South Africa (Department of Labour, 2016:Online).

5.3 CTS Diagnosis

5.3.1 Case definition of CTS

The case definition used in this study included upper limb symptoms and median nerve compression neuropathy abnormalities, as indicated by answers to the questionnaire, special test findings and hand diagrams, are considered to be highly specific for CTS as described by Dale et al. (2013:500). D'Arcy and McGee (2009:3115) and Shannon and Rizollo (2012:23) agree on the use of hand diagrams, a history of upper limb symptoms and a physical hand examination to best support a diagnosis of CTS.

According to the following operational criteria, the diagnosis of CTS was made for the purpose of this study:

Table 5.1 Criteria for making a diagnosis of CTS

Diagnosis made	**Katz pattern**	**Provocative tests**	**Hand inspection**
Definitive diagnosis*	Classic	Positive in 3-4 tests	Weakened in 1-2 tests
Definitive diagnosis*	Classic	Positive in 3-4 tests	-
Definitive diagnosis*	Probable	Positive in 3-4 tests	Weakened in 1-2 tests
Probable diagnosis**	Probable	Positive in 3-4 tests	-

*Group1; **Group 2

5.3.2 Prevalence of CTS

The following results were found during the study: 7.8% of the participants (n=64) had a definitive CTS diagnosis which falls within the 95% confidence interval (CI) of [3.4; 17] for the prevalence of CTS; 7.8% (n=64) had a probable diagnosis and 84.4% (n=64), no diagnosis. This prevalence of 7.8% for a definitive CTS diagnosis is higher than the prevalence for the worldwide general adult population of 3-5% (Nora et al., 2005:275; Giersiepen and Spallek, 2011:239). The prevalence established in this study is lower than the prevalence of CTS among the female population in the world, which is 9.2% (Giersiepen and Spallek, 2011:240) but it should be noted that in this study the population was predominantly, but not exclusively, female (89.1%). When referring to the combined prevalence of 15.6% for definitive and probable CTS, it is much higher than the CTS prevalence for the general adult population or female population.

When comparing the results of the present study with the only other medical profession ever investigated for CTS, the prevalence of a definitive CTS diagnosis of 7.8% in this study is slightly lower than the 8.4% CTS prevalence reported amongst USA dental hygienists in 2002 by Anton et al. The combined prevalence of 15.6% for definitive and probable CTS diagnosis in this study is also much lower than the prevalence of probable or classic symptoms of CTS exhibited by 56% of the dental hygienists studied by Lalumandier and McPhee (2001). The dental hygienist profession demands static neck and trunk positions in a poor sitting posture for up to 86% of the work day, whilst forcefully and repetitively gripping small tools, and using vibratory equipment with the forearms unsupported (Anton et al., 2002:249 and Hayes et al., 2009:163). In the CTS diagnosed group in this study, forceful movements, repetition of the same task, and little or no changes between techniques, was not statistically significantly associated with the CTS diagnosis, and therefore the difference in the movement and forces used in the dental profession could be the attributing factor for the higher prevalence rates found in the studies.

When comparing the CTS prevalence of 7.8% in this study with other occupations prone to developing CTS, the prevalence for this study is much lower than the CTS prevalence of 19.3% for part-time cashiers (all female, mean age of 37.6 years) , and considerably lower than the prevalence rate of 24%-43% as reported for manual labourers in the tool industry in Italy, Bologna (68.9% male, mean age 36.3 years), or the 31% prevalence for full-time cashiers (all female, mean age of 38.7 years) (Bonfiglioli et al., 2007:248-253 and Giersiepen and Spallek, 2011:240). The occupational activities of the supermarket cashiers include all day moving and lifting of heavy items which demands a forceful grip, and repeated wrist flexion and extension with insufficient rest periods throughout the day (Bonfiglioli et al., 2007:251). The demands on the hands of the manual labourers include repetitive manual tasks of the hands while forcefully gripping heavy hand-held power tools or vibratory machinery (Giersiepen and Spallek, 2011:241). The occupational activities of the physiotherapy profession does not entail the static standing and continuous lifting of heavy items done by supermarket cashiers or the heavy duty occupational activities of manual labourers, and could therefore be the explanation for the much higher prevalence rates as described by Bonfiglioli et al. (2007:252) or Giersiepen and Spallek (2011:241).

Another reason for the lower prevalence rate in this study could also be the small sample size.

When looking at the area of focus for work-related hand disorders within the physiotherapy profession in South Africa, a life-time prevalence for thumb and wrist pain among physiotherapists in Bloemfontein, South Africa, was reported by Barnes et al. (2011) to be 62.5%, while Jenkins (2013) reported a life-time prevalence of thumb problems to be 65.3% - 67.5% for physiotherapists in South Africa, using manual therapy techniques. The prevalence rates of the WRMD's in both these studies are considerably higher than the prevalence rate for CTS among physiotherapists in Bloemfontein, in this study. In both the studies by Barnes et al. (2011) and Jenkins (2013), no diagnosis was made by the researcher and the participants "diagnosed" themselves by indicating if they suffered from the problem which was being investigated, with pain in the thumb and wrist being the only "diagnostic" symptom. In the present study, a diagnosis of CTS was made according to the operational criteria outlined by the researcher, and the accuracy of the diagnostic instruments, rather than perceptions of the participants themselves, could be the reason for the lower prevalence rates. Secondly, the use of manual therapy, especially orthopaedic manipulative therapy techniques, was indicated by 70.9% of the participants in the study by Barnes et al. (2011) to contribute to their symptoms, as well as treating "many patients on a daily basis", while Jenkins (2013) reported that contributing to symptoms were treating more than six patients per day with orthopaedic manipulative therapy techniques which forces the thumb into hyperextension. The use of orthopaedic manipulative techniques causing these abnormal thumb movements on a regular basis, is however not indicative of causing CTS, but rather WRMD'S.

5.4 Signs and symptoms of the CTS groups

A wide spectrum of telling signs and irritating upper limb symptoms are indicative of a CTS diagnosis, and are usually identified by means of a physical hand examination including provocative tests, hand observation, and patient medical-history recording (Mennen and Van Velze, 2008; D'Arcy and McGee, 2009; LeBlanc and Cestia, 2011 and Shannon and Rizzolo, 2012), as was used by the researcher during this study.

The symptoms reported by the participants in CTS group 1 and 2 are considered to be evident of the stage of pathology (LeBlanc and Cestia, 2011:952-954), and the more commonly reported symptoms included tingling, numbness, and pain experienced in the palm of the hand, and radial three and a half fingers, as well as nocturnal worsening of symptoms. The localised median nerve distribution area of the symptoms indicated by these participants was confirmed by their Katz hand diagrams (Gonzalez-Roig et al, 2007). In both groups, the reporting on motor symptoms such as weakness, and poor endurance of the thumb muscles, are less common, suggesting little or no progression of the disease as these symptoms are viewed to be indicative of CTS in a progressed stage (Mennen and Van Velze, 2008:200; Aroori and Spence, 2008:9 and D'Arcy and McGee, 2009:3114). Further information regarding the behaviour of the symptoms was reported where nocturnal worsening of symptoms were more frequently detected in group 1, and participants in group 1 experienced their symptoms on a weekly basis. This compares with the statement that regular nocturnal worsening is described as a primary symptom of CTS by Werner and Andary (2002:1376). No statistical difference in CTS diagnosis regarding symptoms being bilateral or not was found in this study, with bilateral involvement reported to be predominant in CTS (Gonzalez-Roig et al., 2007:357).

Positive finding of Durkan's test in all ten of the participant's in group 1 and 2 is testament to the specificity of 90%, and sensitivity of 87% of this test, as well as the view of many surgeons and neurologists that Durkan's test is the test relied upon exclusively to diagnose CTS (Durkan, 1999:536).

The high rate of positive findings with Tinel's sign in group 2, and not group 1, could be attributed to the test's false positive rate of 0-45% (D'Arcy and McGee, 2009:3113). From the Phalen manoeuver, reverse Phalen manoeuver and Tinel's sign, the Phalen manoeuver, with the highest rate of sensitivity (73%), and specificity (73%) of the three tests, had the most consistent result for group 1 and 2. The combination of Tinel's sign and Phalen's manoeuver was stated by Faught (2001) to have high efficacy in the diagnosis of CTS. This is the case in the present study, and when comparing the only slightly higher positive results in group 2 to group 1 regarding the combination of these two tests, it can be postulated that Phalen's manoeuver equalised the false positive results of Tinel's sign.

The findings of the observation components which focused on the motor aspects of CTS resulted in findings of a low rate of weakness only in group 1. Evidence once more, that the CTS is not in a progressed, severe or chronic stage, for either group 1 or 2 (Mennen and Van Velze, 2008:200; D'Arcy and McGee, 2009:3114 and LeBlanc and Cestia. 2011:953). The results of the electrodiagnostic tests of the two participants in group 1 (supplied by the participants themselves) also confirmed that the damage has only been to the sensory component of the affected median nerve. These elctrodiagnostic results were only reported by the participants and not substantiated by a neurologist report.

5.5 Causes and risk factors of CTS

5.5.1 CTS Etiology

A large number of causative and risk factors for CTS have been studied and documented (see 2.7.1, p22). (McKean, 2014:Online; LeBlanc & Cestia, 2011:952-954; Mennen and Van Velze, 2008:200; Lozano-Calderon et al., 2008:525 and Jebson and Kasdan 2006:261). In this study associations between CTS diagnosis, and a number of causative and risk factors, were established.

Idiopathic CTS is more prevalent among females with a female: male ratio of 3:1, where the age of diagnosed individuals are predominantly between 40 and 60 years (Gonzalez-Roig et al., 2008:356; Mennen and Van Velze, 2008:199 and Hobby, 2008:1). In this study the 95% CI between women and men was [-27.0; 18.9], and showed no statistical significant difference between any of the CTS groups. The predominant age of CTS diagnosis was confirmed in this study where four out of the five physiotherapists from group 1, was older than 40 years, and the 95% CI [-47.5 ; -5.7] showing a statistical significant difference with an association between CTS diagnosis, and an age of 40 years or older. The fact that there was no gender association in this study, but only an association with age, indicated that the CTS in this study might not be idiopathic, with other causative factors also playing a role in the development of the condition.

Obesity as a high risk factor for the development of CTS has been confirmed by several studies (Lam and Thurston, 1998:192; Becker et al., 2002:1433; Hobby, 2008:1 and Hlebs et al., 2014:220). Being obese (BMI ≥30) can increase a person's chances of developing CTS by 2.5-times. In this study, being overweight (BMI 25 - < 30) rather than obese, had a higher statistical non-significant tendency with having a definitive CTS diagnosis (CI, -16.2; 37.9), and overweight participants showed a significant statistical association with a probable CTS diagnosis (CI, -45.2; -5.6). Literature states that the female CTS population are twice as likely to be obese (BMI ≥30), rather than overweight (Lam and Thurston, 1998:192; Becker et al., 2002:1433 and Hobby, 2008:1). But in the case of this study, the CTS population (group 1) tended to be overweight rather than obese and they were all female. This could be attributed to the fact that although these participants are not obese, they are showing signs and symptoms of CTS because they are using repetitive wrist movements during work, leisure activities, and activities of daily living.

Participants in this study who had RA were more likely to have CTS with a 95% CI of [-84.3; -2.0] showing a statistically significant difference. RA is listed as one of the more common etiologies associated with CTS (Jebson and Kasdan, 2006:261; Hobby, 2008:1 and Mennen and Van Velze, 2008:200). The association in this study is, however, within a very wide interval where only two participants (n=64) had RA, with one of them in group 1.

Participants in this study with no upper limb trauma history showed a tendency towards having CTS but this association was statistically non-significant, CI= [-27.0; 18.9]. This finding is interesting as upper limb trauma is known to be associated with CTS (Mennen and Van Velze, 2008:200 and Aroori and Spence, 2008:7). A history of upper limb trauma is listed as one of the least common causes of CTS (see Table 2.2, p22), and it could therefore be the reason for not being a cause in this study.

Lozano-Calderon et al. (2008:528 - 533) conducted a meta-analytic study of 107 English articles (publication dates from 1950 to 2007) to determine the direct relationship between CTS, and biological and/or occupational factors as causative risk factors. Biological factors included personal factors and medical history. Lozano-Calderon et al. (2008) reported that 78% of the studies investigating both biological and occupational factors, as combined risk factors, found a link to CTS. In this study only three biological factors were associated with CTS, namely overweight (rather than obese) (Hobby, 2008:1), age > 40 years (Gonzalez-Roig et al., 2008:356), and RA (Mennen and Van Velze, 2008:199), which could indicate that physiotherapy is one of the professions where not only biological factors, but also occupational factors are the risk factors for the development of CTS, and that the CTS is not idiopathic.

5.5.2 CTS and occupational factors and activities

Only two occupational factors were statistically significant regarding the diagnosis of CTS. The biggest factor playing a role, was the years-in-practice (p=0.003), where the participants in group 1 practiced for a median number of 26 years, and group 3 for 8 years; thus indicating, the longer in practice, the more likely a CTS diagnosis. In CTS group 1, four of the five participants indicated the starting period of their symptoms to be 11+ years post qualification. This late onset of symptoms is in contrast to the finding by Barnes et al. (2011) where 55.6% of the participants indicated the start of their thumb and wrist pain symptoms to be within five years post qualification. The deduction can be made that strain caused by manual therapy, and the increased workload post qualification must have a more severe and intense effect on the thumb and wrist joints than the carpal tunnel to cause wrist and thumb work-related injuries much earlier in the physiotherapist's career than CTS. Changes in technique execution with increasing years in the physiotherapy profession could also lead to biomechanical changes and tissue length adaptations which might delay the onset of symptoms.

The long careers of participants in group 1, despite having their symptoms for a number of years, did not cause any of them to leave the profession or scale down. This is in contrast to the 18% of manual workers leaving their job within 18 months of developing the disorder (Dale et al., 2013:496) or the one in six physiotherapists in Victoria, Australia leaving their job due to WRMD's (Cromie et al., 2000:340-350). The manual workers in the study by Dale et al. (2013:496) who left their profession indicated that the symptoms of CTS had become too severe and thus the condition had become chronic, not only limiting their ability to work but also to perform activities of daily living. The majority of the physiotherapists in the study by Cromie et al. (2000:340) indicated that their lower back pain had become moderate to severe and prevented them from working, doing their usual activities of daily living, and daily leisure activities. The study by Cromie et al. (2000:340) therefore, did not give exclusive information on physiotherapists leaving the profession due to WRMD's involving hand/wrist conditions. In this study, however, all but one of the participants still practiced full-time, and three participants indicated to work for more than two hours before taking a break of at least ten minutes, on a daily basis. The participants in group 2 all work full-time, and three out of the five also indicated to work daily for more than two hours before taking a rest. As discussed in 5.4, p77, the symptoms of group 1 and 2 are considered to be evident of the stage of pathology (LeBlanc and Cestia, 2011:952-954).

Although the option of leaving the profession was not explored in this structured interview, three participants in group 1 who realised that they suffered from the condition, volunteered the information, of not ever having considered leaving the physiotherapy profession. They mentioned that they did not feel the symptoms to be severe enough, and did not know what they would do otherwise if leaving the profession.

The second occupational factor of statistical significance indicated to worsen symptoms by group 1, was overtime work, but with a very wide interval of [-80.2; -8.9]. This factor is not mentioned by any other studies to be an occupational risk factor for the development of CTS. It could be argued that none of the other occupations perform overtime work as the job is of “high intensity” (e.g. manual labourers, rock drillers, stone masons, food processors) (Palmer, 2011:20-21), or working hours are strictly monitored (e.g. supermarket cashiers) (Bonfiglioli et al., 2007:250). In full-time private practice physiotherapy overtime is a reality of every work week, as no time limit can be put on a treatment, especially when considering in-hospital treatments. Many physiotherapists may voluntarily take on extra work, especially over weekends to supplement their income.

CTS largely does affect the working population where the focus is on forceful manual tasks and repetitive movements of the hand or wrist (Moraska et al., 2008:260 and Shiri et al. 2008:368). These tasks, grips and movements are typically performed daily by physiotherapists when treating patients by means of manual therapy (Brukner and Khan, 2001:143). In this study no occupational activity, movement or treatment technique indicated by the participants in group 1 or 2 had any statistical significance relating to the CTS diagnosis. It could be that the movements and forces used in the physiotherapy profession are not as repetitive, persistent, or forceful as that used in the manual labour, or packing industry (Palmer, 2011:20-21).

Regarding specific fields within the physiotherapy profession, a statistically significant tendency was found for participants working in the neurosurgery field to have CTS (CI, -66.0; -8.6). The term neurosurgery is, however, very broad and the type of therapy techniques performed in this field, rather than the field itself, could be the risk factors. Physiotherapy treatment of neurosurgical patients may include in-hospital sessions in the acute phase, and out-patient treatments. Treatment in the acute phase will include manual respiratory physiotherapy techniques (percussion), and mobilisation of weak patients (Bhat, Chakravarthy and Rao, 2014:367), whilst out-patient treatments will include exercises, manual therapy techniques, and massage (Reiman, Harris and Cleland, 2009:18). The forceful hand movements/grips and repetitive wrist movements described in literature to increase the risk for CTS are typical movements performed by physiotherapists during the treatment of patients by means of manual therapy, massage and percussion (Brukner and Khan, 2001:143), and could be the reason for this field to have an association with CTS development.

Physiotherapists are at an increased risk for developing CTS with personal factors (age > 40 and overweight), medical history (RA), and occupational factors (years in practice; overtime, and working in the neurosurgery field) which are identified to be associated with the development of CTS.

5.6 CTS and strategies implemented for relief of symptoms

The only strategy of statistical significance implemented by group 1 to relieve symptoms was longer resting periods between patients, but with a very wide interval of [-84.3; -2.0]. This is a good strategy to implement as a lack of sufficient rest periods during work can contribute to the development of CTS (Department of Labour, 2004:Online and Bonfiglioli et al., 2007:251). The other strategies implemented by the participants in group 1 for symptom relief included: changing of hand position (n=2); changing of poor posture (n=1), and more regular changing of treatment techniques (n=2). The symptom relief methods for these participants are all still conservative and in line with those listed by LeBlanc and Cestia (2011:955), which included alternating job functions (regular change of hand position, adjustment of techniques, as well as longer resting periods), and focussing on ergonomics (change of poor posture). Not one of the two participants in group 1 who underwent electrodiagnostic testing indicated to be taking oral corticosteroids (LeBlanc and Cestia, 2011:955), or have received a local steroid injection (McKean, 2014:Online), but are both due to consult a specialist surgeon.

5.7 Conclusion

Data analysis and interpretation of the data as discussed in detail in chapter four and five lead the researcher to concluding that CTS is an occupation hazard for physiotherapists but not as significant as WRMD's. The full discussion following in chapter six was added to the conclusion paragraph.

Chapter six

6 Conclusion

6.1 Conclusion

The following conclusions can be made from the results and discussion of this study:

The definitive CTS prevalence is 7.8%, and a further probable CTS prevalence is 7.8% among practicing physiotherapists in Bloemfontein, South Africa. A CTS prevalence rate of 15.6% can be calculated when combining the definitive and probable diagnosis groups, making physiotherapy one of the professions with a risk of developing CTS.

The signs and symptoms reported by both the definitive CTS group, and probable CTS group are indicative of primary CTS, not progressive or severe, and with very little or no motor involvement of the median nerve.

The age of 40 years and older (CI, -47.5; -5.7), and a medical history of RA (CI, -84.3; -2.0) were causative factors associated with CTS and of statistical significance in this study. Overweight (BMI 25 - < 30) rather than obesity (BMI ≥30) (CI, -16.2; 37.9) showed a tendency towards the diagnosis of CTS for participants in this study. The number of years practicing (p=0.003) was statistically significant associated with a CTS diagnosis, and overtime work hours per day (CI, -80.2; -8.9) was considered the only statistically significant worsening factor of symptoms. No occupational activities or treatment techniques in physiotherapy could be identified to be associated with a CTS diagnosis, and neurosurgery was the only specific field within physiotherapy having a statistical significant tendency (CI, -66.0; -8.6) towards an association with a CTS diagnosis. The movements used by physiotherapists during treatments, such as forceful and repetitive wrist movements, commonly associated with CTS, were not found to be associated with CTS.

Strategies implemented, mainly by participants with a definitive (n=5) CTS diagnosis to decrease symptoms, included: change of hand position (6.3%), more regular changes of treatment techniques (8.7%), change of poor posture (11.1%), and longer resting periods between patients (50%). The longer resting period between patients was the only strategy of statistical significance utilised by CTS diagnosed physiotherapists (CI, -84.3; -2.0). All of these strategies mentioned previously correlated with the suggested conservative treatment options mentioned in the available literature.

6.2 Limitations

The following limitations of this study are recognised:

The cross-sectional design provided a measure of CTS prevalence at a single point in time for each participant. Participants who had short-lived symptoms may not have reported the symptoms, and therefore did not meet the CTS case definition for this study.

Answers regarding worsening, as well as decrease or relief of symptoms, relied on participant's recall, and could have been reported incorrectly.

The questionnaire did not include an elaboration of the number of days per week or specific days on which symptoms worsened. This could have provided useful information regarding fatigue over-use.

No provision was made in the questionnaire regarding hobbies, leisure activities or possible family history which could have contributed to the development of CTS. This was also not detected during the pilot study as it was not a specific question and not mentioned under the comments section at the end of the questionnaire. When participant number four volunteered this information in the comment section at the end of the questionnaire, the researcher started to include it as a question in the comment section and went back to the three participants already seen to include their responses.

No cross-checks of data coding or the interpretation of the Katz hand diagrams were done by a research assistant or independent trained person. This could have contributed to the researcher to be biased towards the findings of this study.

The inclusion of electrodiagnostic testing in this study could have been very useful in at least all of the participants with a definitive or probable CTS diagnosis, to clarify if the motor component of the median nerve was involved. Due to the lack of funding and available resources, electrodiagnostic testing was not available to the researcher.

6.3 Recommendations

This study could serve as a baseline study for further research on the topic of physiotherapists being at risk for the development of CTS among a bigger physiotherapy population in South Africa and contribute to the limited available literature on the topic of CTS prevalence in South Africa. Future studies should also include electrodiagnostic tests if resources are available to better substantiate possible diagnoses made.

A longitudinal study making use of daily journals could be performed which follows the physiotherapists identified in this study with a definitive and probable CTS diagnosis to investigate occupational factors and activities (including very specific detail on wrist movements and forces used daily), factors worsening symptoms, as well as management and possible preventative strategies over a longer period of time. An advantage of journal-keeping as a research tool is the reliance upon short-term memory. Keeping a daily journal is, however, a very time-consuming task and participants should rather not be asked to write for months on end but at specific intervals within a period of time, accompanied by very clear instructions from the researcher (Woll, H. 2013:3).

Important research that has so far been neglected not only in physiotherapy, but in all health care professions, is the impact on quality of life of individuals suffering from either a disease or a disorder. Therefore research regarding the impact of CTS on the quality of life of all individuals suffering from this debilitating condition would contribute to decision-making within the health care profession regarding the rehabilitation of the disorder.

Raising awareness of CTS as an occupational hazard within the physiotherapy profession, and teaching preventative strategies on an undergraduate and postgraduate level can be achieved with the assistance of the SASP by giving short lectures at accredited courses. The results of this study can be published in an accredited journal, and presented at accredited physiotherapy congresses. Physiotherapists need to take better care of their health and wellness, already at a young age. Awareness of CTS added to the list of occupational hazards in the profession might encourage all to do so.

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Appendices

Appendix A

Questionnaire

English

Afrikaans

Appendix B

Data sheet – Katz hand diagram

English

Afrikaans

Appendix C

Data sheet – physical examination

Appendix D

Participant information letter

English

Afrikaans

Appendix E

Participant consent form

English

Afrikaans

Appendix F

Letter of ethical clearance

Appendix G

Figures of manual therapy techniques

Appendix H

Tables of results for CTS group 2

Department of Physiotherapy
University of the Free State
Bloemfontein
9301
03 June 2015

INFORMATION LETTER

Dear Participant

CARPAL TUNNEL SYNDROME IN PHYSIOTHERAPISTS IN BLOEMFONTEIN

You have been selected to participate in a research study which forms part of the requirements in attaining my M.Sc.Physiotherapy degree at the Department of Physiotherapy, University of the Free State. Your participation is of utmost importance to contribute to the success of this study and is therefore much appreciated.

The aim of this study is to describe the prevalence of carpal tunnel syndrome (CTS) (percentage) among physiotherapists in Bloemfontein. The need for knowledge exists and this would therefore be the first study conducted regarding carpal tunnel syndrome in physiotherapists. The information gained from the study may create awareness amongst the physiotherapy community regarding new occupational hazards and eventually lead to the implementation of strategies to better protect ourselves.

The study is conducted by means of a structured interview, where a questionnaire is completed by the researcher. This is done to determine what type of work you mainly do and if you experience any hand and/or upper limb symptoms. This is followed by the completion of a hand diagram by yourself to gain further knowledge on any symptoms you might be experiencing, a very short physical hand examination done on both hands by the researcher with the purpose to determine the presence of any signs typical of CTS and lastly, measuring of your height and weight in order to calculate your body mass index (BMI) as this is also related to CTS. Participation is voluntary and refusal to partake will not have any consequences. You may withdraw or discontinue at any point during the study and it will not involve any penalties. There are no risks involved in partaking in the study. You will not receive any remuneration for taking part and no cost will be incurred by you. The process of data gathering and the management of the data-sheets thereafter will be handled with strict confidentiality and personal information will be kept confidential. If results are published, this may lead to cohort identification. Organisations that may inspect and/or copy my research records for quality assurance and data analysis include groups such as the Ethics Committee, Faculty of Health Sciences, UFS.

Information obtained in this research study will be used in presentations to deliver study findings and in the form of an article published in peer reviewed journals. Feedback on results of this study will be available on request by contacting the researcher through the contact details supplied.

The study will be reviewed by the Ethics Committee of the Faculty of Health Sciences, UFS. If you have any questions pertaining to ethical aspects of the study, you may contact the researcher or the secretariat of the Ethics Committee of the Faculty of Health Sciences office of secretarial (051) 4017795, EthichsFHS@ufs.ac.za.

A returned, signed copy of the attached consent letter will serve as informed consent to participate in the study. You will also receive a copy of the information sheet.

If you have any further queries, contact details are as follows:

Researcher:	**Study leader:**
Nadia Human	**Roline Barnes**
082 928 4712	**051 201 3295**
humann@ufs.ac.za	**barnesry@ufs.ac.za**

Department Fisioterapie
Universiteit van die Vrystaat
Bloemfontein
9301
03 Junie 2015

INLIGTINGSBRIEF

Geagte deelnemer

KARPALE TONNELSINDROOM IN FISIOTERAPEUTE IN BLOEMFONTEIN

U is gekies om deel te neem aan ‘n navorsingstudie wat deel vorm van die vereistes vir die verkryging van my M.Sc.Fisioterapie graad aan die Departement Fisioterapie, Universiteit van die Vrystaat. U deelname is van uiterste belang om by te dra tot die sukses van hierdie studie en word opreg waardeer.

Die doel van die studie is om die prevalensie te beskryf van karpale tonnelsindroom (KTS) (persentasie) onder praktiserende fisioterapeute in Bloemfontein. Daar bestaan ‘n leemte vir kennis rondom hierdie onderwerp en dus sal hierdie die eerste studie wees wat uitgevoer word rakende karpale tonnelsindroom in fisioterapeute. Die inligting verkry vanuit hierdie studie kan bewustheid skep onder die fisioterapie gemeenskap rakende nuwe beroepsgevare en eindelik lei tot die implementering van strategieë om onsself beter te beskerm.

Die studie word uitgevoer deur middel van ‘n gestruktureerde onderhoud, waar die navorser ‘n vraelys sal invul. Dit word gedoen om vas te stel watter tipe werk u hoofsaaklik doen en of u enige simptome van die hand en/of boonste ledemaat ervaar. Daarna volg die voltooiing van ‘n handdiagram deur uself om verdere kennis te verkry oor die simptome wat u mag ervaar, ‘n baie kort fisiese hand ondersoek uitgevoer deur die navorser op beide hande om die teenwoordigheid van enige tekens, tipies van KTS, vas te stel en laastens, sal die navorser u gewig en lengte meet, sodat u liggaamsmassa-indeks (“BMI”) bereken kan word, aangesien dit ook ‘n verband kan hê met KTS. Deelname is vrywillig, en weiering om deel te neem sal geen gevolge inhou nie. U mag enige tyd deelname aan die studie staak of onttrek en dit sal geen boetes of verliese inhou nie. Daar is geen risiko's verbonde aan deelname nie. U sal geen vergoeding ontvang vir deelname nie en u sal ook geen koste dra nie. Die proses van data-insameling en die hantering van data-lyste daarna sal met streng vertroulikheid hanteer word en persoonlike inligting sal vertroulik gehou word. Indien resultate gepubliseer word, kan dit lei tot groepsidentifikasie. Organisasies wat my navorsingsrekords mag nagaan en/of kopieer vir gehalteversekering en data-analise sluit in groepe soos die Etiekkomitee, Fakulteit Gesondheidswetenskappe, UV.

Die inligting in die navorsingstudie gaan gebruik word in voordragte om studie bevindinge oor te dra en in die vorm van 'n artikel, gepubliseer in resensie joernale. Terugvoer van die resultate van die studie sal beskikbaar wees op aanvraag deur die navorser te kontak by kontakbesonderhede aangeheg.

Die studie word deur die Etiekkomitee van die Fakulteit van Gesondheidswetenskappe, UV, hersien. Indien u enige navrae het rakende etiese aspekte van die studie, kan u gerus die navorser of die sekretariaat van die Etiekkomitee van die Fakulteit van Gesondheidswetenskappe kantoor kontak (051) 4017795, EthicsFHS@ufs.ac.za.

'n Getekende, teruggekeerde kopie van die aangehegte toestemmingsbrief, sal dien as ingeligte toestemming tot deelname aan die studie. U sal ook 'n afskrif van die inligtingsbrief ontvang.

Indien u enige vrae het, kontakbesonderhede is as volg:

Navorser:
Nadia Human
082 928 4712
humann@ufs.ac.za

Studie-leier:
Roline Barnes
051 401 3295
barnesry@ufs.ac.za

CONSENT TO PARTICIPATE IN RESEARCH

CARPAL TUNNEL SYNDROME IN PHYSIOTHERAPISTS IN BLOEMFONTEIN

I have been asked to participate in a research study with the title: Carpal tunnel syndrome in physiotherapists in Bloemfontein. I have been informed about the study by the researcher and read the attached information. I agree to participate in the:

- Structured interview.
- Completion of a hand diagram.
- Physical examination of both hands.
- Measuring of my height and weight.

I shall receive a copy of the participant information sheet.

I may contact the researcher or the study leader at any time if I have questions about the research. I may contact the secretariat of the Ethics Committee of the Faculty of Health Sciences, UFS telephonically (051) 4017795, or via email EthicsFHS@ufs.ac.za if I have questions regarding the ethical aspects of the study.

Any questions I had, has been answered to my satisfaction by the researcher.

I understand what my involvement in the study entails and I give voluntarily consent to participation.

____________________	____________________
Signature of Participant	Date
____________________	____________________
Name in print	Place
____________________	____________________
Signature of Witness	Date
____________________	____________________
Signature of Researcher	Date

Researcher:	Study leader:
Nadia Human	Roline Barnes
082 928 4712	051 401 3295
humann@ufs.ac.za	barnesry@ufs.ac.za

TOESTEMMING TOT DEELNAME AAN NAVORSING

KARPALE TONNELSINDROOM IN FISIOTERAPEUTE IN BLOEMFONTEIN

Ek is versoek om aan 'n navorsingstudie deel te neem met die titel: Karpale tonnelsindroom in fisioterapeute in Bloemfontein. Ek is oor die studie ingelig deur die navorser en het die inligtingsdokument gelees. Ek stem in om deel te neem aan die:

- Gestruktureerde onderhoud.
- Voltooing van 'n handdiagram.
- Fisiese ondersoek van beide hande.
- Meting van my lengte en gewig.

Ek sal 'n kopie van die inligtingsdokument ontvang.

Ek mag die navorser of studieleier enige tyd kontak indien ek enige vrae rakende die navorsing het. Ek kan die sekretariaat van die Etiekkomitee van die Fakulteit Gesondheidsweteskappe, UV by telefoonnommer (051) 4017795, of per e-pos EthicsFHS@ufs.ac.za kontak, indien ek enige vrae het rakende die etiese aspekte van die studie.

Enige vrae wat ek gehad het, is voldoende beantwoord deur die navorser.

Ek verstaan wat my betrokkenheid by die studie behels en gee vrywilliglik toestemming tot deelname.

______________________	______________
Handtekening van Deelnemer	Datum
______________________	______________
Naam in drukskrif	Plek
______________________	______________
Handtekening van Getuie	Datum
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Figure G.1 Longitudinal stroking

Figure G.2 Transverse friction

Figure G.3 Sustained myofascial tension

Figure G.4 Percussion

Table H.1 Body mass index (BMI) in CTS group 2 (n=5)

CTS Diagnosis	**BMI**							
Group 2: Probable diagnosis(n=5)	**Underweight (n=1)**		**Normal weight (n=33)**		**Overweight (n=18)**		**Obese (n=12)**	
	n	**%**	**n**	**%**	**n**	**%**	**n**	**%**
	0	0	4	12.1	1	5.6	0	0

Table H.2 Personal and medical history factors in CTS group 2 (n=5)

Factor	**Group 2: Probable diagnosis (n=5)**		
	n	**%**	**95% CI**
Age >40	2	12.5	[-47.5 ; -5.7]
Female	5	8.8	[-27.0 ; 18.9]
Pregnant	0	0	[-21.0 ; 29.6]
RA	0	0	[-84.3 ; -2.0]
Upper limb trauma	1	14.3	[-27.0 ; 18.9]

Table H.3 Employment sector of CTS group 2 (n=5)

Employment sector	**Group 2: Probable diagnosis (n=5)**		
	n	**%**	**95% CI**
Public sector (n=17)	1	5.9	[-22.6 ; 8.7]
Private sector (n=47)	4	8.5	

Table H.4 Employment status of CTS group 2 (n=5)

Employment status	**Group 2: Probable diagnosis (n=5)**		
	n	**%**	**95% CI**
Full time employment (n=55)	5	9.1	Full time and part time: [-32.0 ; 17.3] Full time and locum: [-72.2 ; 2.9] Part time and locum: [-79.2 ; 14.2]
Part time employment (n=6)	0	0	
Locum (n=3)	0	0	

Table H.5 Main area of work in CTS group 2 (n=5)

Main area of work	Group 2: Probable diagnosis (n=5)		
	n	**%**	**95% CI**
Cardio thoracic surgery (n=5)	0	0	[-35.2 ; 8.4]
Paediatrics (n=10)	1	10.0	[-33.3 ; 0.5]
Neurological rehabilitation (n=13)	1	7.7	[-13.7 ; 21.0]
Acute neurology (n=6)	0	0	[-49.7 ; 6.9]
Acute orthopaedics (n=19)	2	10.5	[-33.4 ; 3.3]
Musculoskeletal out-patients (n=41)	3	7.3	[-25.5 ; 3.7]
Sport rehabilitation (n=21)	3	14.2	[-22.5 ; 11.0]
Spinal rehabilitation (n=8)	1	12.5	[-23.9 ; 19.3]
Neurosurgery (n=8)	0	0	[-66.0 ; -8.6]
General surgery (n=7)	1	14.3	[-44.5 ; 7.9]
Geriatrics (n=6)	0	0	[-30.7 ; 18.6]
Medical/respiratory (n=25)	2	8.0	[-10.5 ; 20.0]
Other* (n=7)	0	0	[-27.0 ; 18.9]

*Other = Women's health; administrative work load; psychiatry and chronic pain patients

Table H.6 Treatment techniques mainly used by CTS group 2 (n=5)

Treatment technique used	**Group 2: Probable diagnosis (n=5)**		
	n	**%**	**95% CI**
Orthopaedic mobilisation techniques (n=38)	3	7.9	[-27.3 ; 1.7]
Soft tissue techniques (n=44)	3	6.8	[-24.0 ; 6.0]
General massage techniques (n=25)	2	8.0	[-18.0 ; 13.6]
Manual respiratory techniques (n=27)	1	3.7	[-16.1 ; 14.9]
Use of vibration machine (n=7)	0	0	-
Other (n=25)	4	16.0	[-10.5 ; 20.0]

*Other = Dry needling; strapping; rehabilitation exercises; neuro-developmental therapy techniques; general mobilisation techniques; adult neurology rehabilitation techniques; transferring weak patients; neural mobilisation techniques

Table H.7 Period of time working without rest in CTS group 2 (n=5)

Period of time without rest	**Group 2: Probable diagnosis (n=5)**		
	n	**%**	**95% CI**
Half an hour (n=15)	1	6.7	Half an hour and an hour [-21.6 ; 29.8] Half an hour and two hours [-40.9 ; 19.5] Half an hour and more than two hours [-19.2 ; 21.0] An hour and two hours [-47.1 ; 17.1] An hour and more than two hours [-24.9 ; 18.8] Two hours and more than two hours [-15.5 ; 38.0]
An hour (n=10)	1	10.0	
Two hours (n=8)	0	0	
More than two hours (n=31)	3	9.7	

Table H.8 Behaviour of symptoms in CTS group 2 (n=5)

Influencing factor on upper limb symptoms		**Group 2: Probable diagnosis (n=5)**		
		n	**%**	**95% CI**
Nocturnal worsening of symptoms (n=47)	Yes (n=13)	1	7.7	[6.1 ; 54.8]
	No (n=34)	4	11.8	
Relief of symptoms with long break or holiday (n=47)	Yes (n=38)	3	7.9	[-47.3 ; 6.2]
	No (n=9)	2	22.2	
Clinical work worsening symptoms (n=47)	Yes (n=37)	4	10.8	[-43.3 ; 7.6]
	No (n=10)	1	10.0	

Table H.9 Main factors indicated by CTS group 2 to worsen symptoms (n=5)

Factor worsening upper limb symptoms	**Group 2: Probable diagnosis (n=5)**		
	n	**%**	**95% CI**
Repetitive execution of the same task (n=29)	4	13.8	[-21.2 ; 9.9]
Forceful movements during massage (n=24)	3	12.5	[-26.4 ; 6.6]
Large number of treatments of patients with the same diagnosis (n=32)	4	12.5	[-18.6 ; 12.1]
Little/no changes between techniques (n=11)	2	18.2	[-30.6 ; 11.2]
Overtime work (n=4)	0	0	[-80.2 ; -8.9]
Repetitive wrist bending to the limit of movement (n=10)	2	20.0	[-45.6 ; 2.8]
Massage and soft tissue techniques (n=21)	3	14.3	[-22.5 ; 11.0]

Table H.10 Strategies mainly implemented by CTS group 2 to prevent possible CTS (n=5)

Strategy implemented	**Group 2: Probable diagnosis (n=5)**		
	n	**%**	**95% CI**
Changing of hand position (n=32)	1	3.1	[-12.1 ; 18.6]
Changing of poor posture (n=9)	0	0	[-36.5 ; 9.7]
More regular changing of treatment techniques (n=23)	1	4.4	[-20.1 ; 12.3]
Longer resting periods between patients (n=2)	0	0	[-84.3 ; -2.0]

Table H.11 Regularity of symptoms as indicated by CTS group 2 (n=5)

Regularity of experiencing upper limb symptoms	**Group 2: Probable diagnosis (n=5)**		
	n	**%**	**95% CI**
Weekly (n=24)	2	8.3	Weekly and monthly [1.5% ; 40.5%] Weekly and yearly [-45.9% ; 40.5%] Monthly and yearly [-65.8% ; 15.5%]
Monthly (n=21)	3	14.3	
Yearly (n=2)	0	0	