THE PREVALENCE AND RISK OF MUSCULOSKELETAL DISORDERS AMONG DENTAL TECHNICIANS IN SOUTH AFRICA.

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Date: April 2017

DECLARATION

I, hereby declare that the entire work is my own work in both conception and execution, except where explicitly otherwise stated via references and that I have not previously, in its entirety or in part, submitted it for obtaining any qualification in any other university.

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Signature of student Date

Approved for final submission

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Dr Penelope Orton Date

_____ _____

Mrs B.T.E. Kumalo Date

DEDICATION

I dedicate this dissertation to God Almighty, my devoted and beloved husband Dr E. Adetiba, my daughter Oluwatofunmi Adetiba, my family, my supervisors and the dental technicians who agreed to participate in the study.

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ABSTRACT

Introduction

Musculoskeletal disorders (MSDs) are classified as occupational disease. They are described as disorders that affect the musculoskeletal system, and affect the health, productivity and careers of the working population. Dental technicians are at risk of MSDs as much as other members of the dental professionals as a result of their daily activities which involves manual work or they could be labour intensive. The risk factors for MSDs among dental professionals are multifactorial.

Problem statement

There are currently no established statistics on the prevalence and risk of musculoskeletal disorders among dental technicians in South Africa.

Purpose

The purpose of the study was to determine the prevalence and risk of MSDs among dental technicians in South Africa.

Research method

A quantitative research approach using a cross sectional correlational survey design was adopted for this study. Using a purposive sampling, the data base of all the dental technicians was obtained from the South African Dental Technician Council (SADTC) and those with valid e-mail addresses and telephone numbers were invited to participate in the study. A modified Nordic musculoskeletal questionnaire was used to collect data, 79 technicians responded with only 72 valid questionnaires available for analysis.

Results

The twelve month prevalence rate of MSDs among dental technicians in South Africa is 90%. MSDs was reported in all body parts and across all ages and genders. The

prevalence for neck, hand/wrist, upper back and low back pain were the highest, having the same prevalence rate of 68.1%. The risk factors for MSDs in at least one body part that were identified in this study are age, prolonged standing and vibration. There was no significant relationship between gender, alcohol intake, smoking, having children and MSDs in any body part. However, a relationship exists between age and MSDs in the wrist/hand, standing and elbow pain, vibration and lower back symptoms.

Conclusion

The study showed that the prevalence of musculoskeletal disorder is high (90%) among dental technicians in South Africa. The prevalence of MSD is not age or gender related. However, some affected body parts were directly linked to age, standing and vibration. More research needs to be done on the ergonomics and workplace in order to address the high incidence of MSDs.

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LIST OF ACRONYMS

BLS	Bureau of Labour Statistics
BMI	Body Mass Index
LBP	Low Back Pain
MSDs	Musculoskeletal Disorders
NIOSH	National Institute for Occupational Safety and Health
SADTC	South African Dental Technician Council
WHO	World Health Organization
SNQ	Standardized Nordic Questionnaire

DEFINITION OF TERMS

Dental laboratory:	A dental laboratory is a place where variety of products that assist in the provision of oral health care are manufactured or customized.
Dental laboratory technician:	A member of the dental team whose job is to create/construct restorative and dental appliances according to the specification of the dentist.
Musculoskeletal disorder:	An injury and disorder that affects the human body's movement or musculoskeletal system.
Musculoskeletal system:	It provides form, support, stability, and movement to the body.
Prevalence:	Prevalence is a measurement of all individuals affected by a disease or disorder at a particular time.
Risk:	A probability or threat of damage, injury, liability, loss, or any other negative occurrence that is caused by external or internal vulnerabilities, and that may be avoided through preemptive action.

APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Background

Musculoskeletal disorders (MSDs) are common and on the increase among the general and working population. (Widanarko *et al*. 2011; Morse, Bruneau and Dussetschleger 2010; Abduljabbar 2008). MSDs are a cluster of conditions that affect the musculoskeletal system, such as the muscles, joints, tendons as well as other tissues (Simu *et al*. 2014), which often arise out of the work tasks and the awkward postures employees assume. MSDs result in fatigue, pain and sometimes deformity of a joint, and constitutes the main cause of activity limitation, loss of function and long-term disability among the working population (Rabiei *et al.* 2015; Perreault *et al.* 2008; Abduljabbar 2008). MSDs can range from being mild and infrequent, to being severe, chronic and incapacitating (Rambabu and Suneetha 2014). Both work-related and non-work related exposures have been linked to the increased incidence of MSDs (Barbe and Barr 2006).

In 1985, the World Health Organization (WHO) documented that MSDs are work-related when the work conditions and activities significantly contributes to their growth and development, but are not necessarily the sole determinant of causation. Work conditions that could contribute to the exacerbation of MSDs include applying excessive force, vibration, awkward posture and repetition (Chiasson *et al*. 2012; Aghilinejad *et al.* 2011). In the same vein, Aghilinejad *et al.* (2011) described non-work (worker) related factors as being age, gender and psychological characteristics.

During the 1970's, epidemiologic methods were used to investigate the occupational etiology of MSDs and have since appeared regularly in scientific literature. Despite this long standing awareness, MSDs remain a major cause of work-related illness in many countries (Sakzewski and Naser-ud-Din 2013). In 2004, MSDs accounted for 38% of work-related problems compensated for by the Quebec workers' compensation board in Canada (Perreault *et al*. 2008). They continue to be a major health problem, both in the private and government sectors, causing occupational disorders and disabilities that are associated with working days lost and socioeconomic burden to the individual, the

organization and society at large (Aghilinejad *et al.* 2012). Similarly, Jay *et al*. (2014) highlighted that MSDs constitute a major socioeconomic burden on public health systems in North America and Europe.

In the literature, a high incidence of MSDs has been reported in postal workers, sewing machinist, farmers and office workers, to mention a few (Warnakulasuriya *et al.* 2012; Choobineh *et al.* 2011; Osborne *et al.* 2010; Zungu 2009;). Over the years, the advent of modern technologies in the health sector notwithstanding, MSDs are still highly prevalent among healthcare workers, such as nurses, physical therapists, laboratory technicians and dental professionals due to the nature of their work (Wang *et al.* 2015; Rabiei *et al*. 2015; Kumalo 2014; Occhionero, Korpinen and Gobba 2014; Mohammed and Shaik 2013; Kumar, Kumar and Baliga 2012).

Musculoskeletal Disorders create major concerns for dental professionals, as their daily activities involve, for example, adopting a fixed posture and repetitive hand movements that often puts them at risk of musculoskeletal disorders (Hayes, Smith and Taylor 2013; Perreault *et al*. 2008). Dental professionals include dentists, dental hygienists, dental nurses, dental assistants, dental laboratory workers, dental office workers, dental students and dental technicians/technologist (Kumar, Kumar and Baliga 2012; Rolander and Bellner 2001). Dental technicians maintain and improve clients' oral health, appearance, speech and ability to chew by fabricating fixed and removable prostheses according to the dentist's prescription. (Jeong, Bang and Lee 2013; Morse, Bruneau and Dussetchleger 2010; Coşkun Akar *et al.* 2009).

Some epidemiological studies carried out among dental professionals in developed countries suggest that MSDs are prevalent and affect 20-40% of the working dental professional population (Booyens, Van Wyk and Postma 2009; Rolander and Bellner 2001). In a survey of work-related health complaints among Swedish dental laboratory technologists, there was a 79% prevalence rate of health problems, of which MSDs accounted for 68% (Jacobsen, Derand and Hensten-Pettersen 1996). Booyens *et al.* (2009) confirmed a prevalence of MSDs among dental professionals in excess of 50%, which was due to their practice that exposes their muscles to constant contraction with the potential to cause MSDs.

Kumar, Kumar and Baliga (2012) reported that the risk factor highly predictive of developing musculoskeletal pain among dental professionals was biopsychosocial. They documented that there is an association between the biological (physical), psychological (mental) and social risk factors, and the reporting of musculoskeletal symptoms among dental professionals. Similarly, Moodley and Naidoo (2015) classified the possible risk factors of MSDs as ergonomic, work factors (psychosocial risk factors due to job stress) and biomechanical (repetition, awkward postures).

A recent study of MSDs and symptom severity among Australian dental hygienists reported a high correlation between MSDs in the neck, shoulder, lower back region and the nature of the job, such as repetitive scaling task performed daily (Hayes *et al*. 2013). Despite the high number of studies on MSDs in developed countries, data in this regard are limited in developing nations such as South Africa, none of which are specific to dental technicians, which is of particular concern, given that it is a rapidly growing field in the country (Booyens *at al*. 2009; Ellapen *et al*. 2010). Botha *et al.* (2014) reported a prevalence rate of 77.9% of musculoskeletal pain for the neck, associating it with a decrease in height among dentists in South Africa (Both *et al*. 2014). In Kwa-Zulu Natal (KZN) province, a prevalence rate of 54.26% for MSDs was recorded among dentists (Ellapen *et al*. 2010).

1.2 Problem Statement

In South Africa, studies on MSDs have been conducted among office workers (Zungu 2009), nurses (Kumalo 2014; Madiba, Hoque, and Rakgase 2013; Naude 2008) and dentists (Botha *et al*. 2014; Ellapen *et al*. 2010), but an extensive review of the literature did not reveal any studies on the prevalence and risk of MSDs among dental technicians in the country. Dental technicians need to perform detailed tasks that require them to assume prolonged and static working postures, use delicate chairs, perform fine muscular work in unnatural postures, and use high frequency vibration tools, which has been reported to result in their being affected by MSDs. Dental technology is a growing profession in the country, with people being employed in both private and public sector laboratories throughout the country. However, no studies have been done to establish the prevalence and risk factors for MSDs among dental

technicians in South Africa. The information is important as it will help in ergonomics regulation in the field of dental technology. The non-availability of this information will deprive policy makers of an accurate estimation that will assist in making well informed decisions related to resource allocations and subsequent management of those with MSDs. This is also depriving the dental technologist of the South African workers' compensation package.

1.3 Purpose of the Study

The purpose of this study was to describe the prevalence and risk of MSDs among dental technicians in South Africa, to identify the risk factors responsible for these conditions as well as the body parts that are mostly affected.

1.4 Objectives of this study are:

1. To determine the prevalence of MSDs among dental technicians in South Africa.
2. To identify the parts of the body that are most affected by MSDs.
3. To identify possible risk factors for MSDs among dental technicians in South Africa.
4. To determine any correlation between the identified risk factors and the parts of the body most affected by MSDs.

1.5 Research Questions

1. What is the level of prevalence of MSDs among dental technicians in South Africa?
2. Which part/s of the body is/are most affected by the disorder?
3. What are the possible risk factors associated with the disorder?
4. Is there any correlation between each of the identified risk factors and the parts of the body mostly affected by MSDs?

1.6 Significance

This study investigated the prevalence, body parts affected and risk factors for MSDs specific to dental technicians. Currently, nothing is known about the prevalence of this disorder among dental technicians in South Africa hence, prevention strategies are not implemented and nothing is known about the extent of the problem. The findings of this study will add to the body of knowledge on the prevalence of MSDs. Prevention and management strategies for MSDs among dental technologist can be formulated based on the outcomes of this study. These strategies could lead to increased working hours, reduced social and economic consequences and retention of dental technicians in the South African health sector.

1.7 Delimitation

The study will be limited to dental technicians that are registered with the South African Dental Technician Council (SADTC), having valid contact details, residing in South Africa and who are currently working as dental technicians.

1.8 Structure of Dissertation

Chapter 2: Literature review. This chapter provides a review of relevant literatures relating to international and local studies about MSDs in dental health professionals and the theoretical framework for the study.

Chapter 3: Research methodology. This chapter provides a detailed discussion on the study methodology, specifically the study design, study setting and study population. In addition, the sampling method, pilot study, data collection tools and method as well as the data analysis are described. The basic ethical principles considered when conducting research was also included.

Chapter 4: Results. The data collected during the study is presented following analysis, and is summarized and presented in forms of tables and graph.

Chapter 5: Discussion and conclusion. This chapter contains the discussion of the results and compares the findings with similar studies both locally and internationally, and it indicates the extent to which the aim was achieved.

1.9 Conclusion

MSDs are a health effect that often results from occupational exposure to poor ergonomics. Most of the MSDs in dental professionals have been investigated in developing countries, with limited reporting from developing countries, including South Africa. The profession has not established the prevalence and risk factors for MSDs in dental technicians, who perform detailed work on daily basis.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter reviews the literature relating to the prevalence, extent and risk factors of musculoskeletal disorders (MSDs). The coverage of the review includes; current studies in the literature that were sourced from Science Direct, PubMed, Medline, Google Scholar and EBSCO host databases, the risk factors for the disorders and a conceptual framework guiding the study. As the reviewed literature on MSDs found limited reports on dental technicians, the literature includes other dental professionals, for example, dentistry as well as nursing, teaching and computer operators. The keywords used for the literature search were; musculoskeletal disorders, risk factors, dental practitioners, dental technicians, conceptual framework. The chapter starts with an overview of musculoskeletal disorders, then details the prevalence and cost of musculoskeletal disorders, musculoskeletal disorders among different professions, risk factors for MSDs and finally the theoretical framework used in this study.

2.2 Overview of Musculoskeletal Disorders

There are different categories of health problems in modern society that are associated with jobs that people engage in. Musculoskeletal disorders (MSDs) are among the most common job related health problems (Agrawal *et al.* 2014; Ellapen *et al.* 2010; Abduljabbar 2008). MSDs, also known as musculoskeletal conditions, have been reported to be of high occurrence among different groups of occupations over the years. They have also been identified as one of the leading work-related health effects among frontline health care workers, these conditions affecting the musculoskeletal system (MSS) (Munabi *et al*. 2014; Verhagen, Cardoso and Bierma-Zeinstra 2012). According to Triggs and Rogers (2014), the MSS is a multifaceted unit in the human body that comprises of the muscles, bones, tendons, joints, bursa, ligaments, blood vessels and nerves. The primary functions of the MSS are: provide support for the body, enable movement, ensure stability, and protect the vital organs (Triggs and Rogers 2014).

The MSS is interrelated with other body systems, such as the integumentary, nervous and vascular systems, with any dysfunction of one or more of these systems having the potential to affect the MSS. The MSS can be considered to have two constituent sub-systems, these being the muscular system and the skeletal system (Ren, Qian and Ren 2014; Adams 2014). Although physical activities are of great importance to -the MSS, the burden of physically vigorous tasks may pose a threat to it. Repetitive work, awkward postures, or handling of heavy materials may also impair the MSS, which can lead to MSDs, pain or fatigue, and consequently affect other areas of the body (Côté *et al*. 2013).

MSDs include a range of conditions, such as: muscle/tendon strains, tendonitis, ligament sprain, tension neck syndrome, thoracic outlet compression, epicondylitis, radial tunnel syndrome, digital neurosis, trigger finger (thumb), mechanical back syndrome, degenerative vertebral disc, carpal tunnel syndrome, hernias, connective tissue injuries and de quervain's disease. MSDs could be caused or aggravated either by workplace or non-workplace factors (Barbe and Barr 2006; Buckle and Devereux 2002). They can occur from a particular event or as a result of cumulative trauma, and the symptoms can include ache, pain, stiffness, fatigue, tingling and/or numbness, discomfort/dysfunction in the joints, muscles or bones of the neck, shoulder, arm, wrist, hand, upper back, lower back, hips, knees and feet (Wu *et al*. 2012; Hayes, Smith, and Taylor 2010; da Costa and Vieira, 2009). These symptoms may be focal, diffuse, acute or chronic (Verhagen, Cardoso and Bierma-Zeinstra 2012).

Various terms have been used to refer to MSDs as a result of diverse occupations, work groups, the different tissue involved and the body locations affected. They are also called cumulative trauma disorders, repetitive strain injuries, repetitive trauma disorders, or overuse syndrome (Silverstein *et al.* 1997; Armstrong *et al*. 1993). Booyens, Wyk and Postma (2009) noted that most of the studies from developed countries reported a prevalence of MSDs in excess of 50%, one of the major areas of complaint being the hands, which are often affected by carpal tunnel syndrome. They also reported the symptoms of musculoskeletal problems of the hand to include numbness, tingling sensations in the fingers and night pain. Booyens, Wyk and Postma (2009) further

documented the factors that may have an influence on the severity of musculoskeletal symptoms in the hand as: the use of hand piece and vibratory instruments; the number of working days per week; the number of patient treated of heavy calculus per day; the number of years engaged in dental practice, past or present history of trauma to the wrist and/ hand, medical conditions such as osteoarthritis, rheumatoid arthritis, anti-inflammatory and/ hormonal medication as well as recent pregnancy. There is evidence to support the causal relationship between repetitive work and the development of MSDs of the neck and shoulder (Sakzewski and Naser-ud-Din 2013; Morse, Bruneau and Dussetschleger 2010).

Some common work-related musculoskeletal injuries include non-specific low back pain, neck/shoulder pain and upper extremity conditions (Collins, Janse van Rensburg and Patricious 2011), which are detailed further.

a. **Non-specific low back pain (LBP):** this is one of the most expensive and common disorders that affect people in industrialized countries. It is caused by the deviation from the upright posture, thereby generating increased force on the lumbar spine and heavily loading the disc fibre layer. Over 10% of the people suffering from LBP experience symptoms that persist for more than one year (Collins, Janse van Rensburg and Patricious 2011). Another type of LBP is occupational LBP, which may arise as a result of repetitive use, frequent bending, twisting, static postures and whole-body vibration, some of which the dental technicians are exposed to (Coşkun Akar *et al.* 2009; Torbica and Krstev 2006). Other documented factors that contribute to the development of LBP include a combination of individual factors, such as high body mass index (BMI), fragile back strength and irregular exercise, biomechanical factors (frequent bending and twisting, whole body vibration, non-neutral static posture), and psychosocial factors (low job satisfaction, low social support in the workplace) (Collins, Janse van Rensburg and Patricious 2011).
b. **Neck and shoulder pain:** this occurs when workers are predisposed to performing repetitive or forceful precision tasks, which leads to sustaining static, awkward and constrained posture, such as flexing the thoracic and cervical spine, as well as shoulder elevation and abduction. Conditions that are

associated with neck and shoulder pain include cervical syndrome, cervicobrachial fibromyalgia, tension neck syndrome and rotator cuff muscle. Rotator cuff syndromes in the workplace include rupture of the tendons and impingement tendinosis, which are associated with repetitive or high static loads, especially in combination with rotation, flexion and abduction (Collins, Janse van Rensburg and Patricious 2011).

c. **Upper extremity conditions:** Table 2.1 presents a description of the disorder, and the symptoms and causes of common work-related musculoskeletal disorders that affects the upper limbs.

Table 2.1: Common work-related musculoskeletal disorders that affect the upper limbs (Collins, Janse Van Rensburg and Patricios 2011).

Disorders	**Symptoms**	**Causes**
Carpal tunnel syndrome	Numbness of the middle finger especially at night	Repetitive wrist flexion
Myofascial pain of the neck	Heaviness and aching in the shoulders, upper back and neck	Overhead work and work with extended arms, computer posture, stress reaction
Shoulder bursitis	Shoulder pain and stiffness	Repetitive shoulder movements
Rotator cuff tendinosis	Shoulder pain and stiffness	Repetitive shoulder movements with twisting and overhead activities
Lateral epicondylitis	Lateral elbow pain	Extended wrist
Trigger finger	Locking of fingers in flexion	Repetitive hand grip

2.3 Prevalence and Cost of Musculoskeletal Disorders

MSDs are among the most prevalent and costly occupational health problems in both developed and developing countries. They affect millions of people around the world, and are the predominant cause of severe long-term pain, physical disabilities and loss of time from work (Shuai *et al.* 2014; Sakzewski and Naser-ud-Din 2013; Osborne *et al*. 2012). These disorders also cause an increase in the health care expenditure, loss of work, decrease in the quality of life of the employees affected with that of their families,

as well as economic loss, which affects the employee, the organization and society at large (Yasobant and Rajkumar 2014; Choobineh *et al*. 2011).

Globally, the prevalence of MSDs is exceptionally high (March *et al*. 2014). Since the late 1980s, MSDs have accounted for a substantial percentage of work injuries, with workers compensation claims in developed nations and epidemiological studies suggesting that MSDs are the most prevalent occupational health problems as they affect 20-40% of the adult population (Barbe and Barr 2006). In the United States of America (USA), MSDs affect approximately 500,000 individuals annually. This is more than half of all the combined occupational related illnesses and injuries within a year in the country (Dunning *et al.* 2010). The Bureau of Labor Statistics (BLS) of the USA Department of Labor reported that from 1992 to 2010, MSDs accounted for 29-35% of all occupational injuries involving days off work in the private sector (Davis *et al.* 2014; Bhattacharya 2014). Likewise, in 2013, MSDs accounted for 33% of all injuries and illnesses reported in the USA workplace (Davis *et al*. 2014). Still in the USA, MSDs have adversely affected the private sector, with approximately 320,000 work days lost annually, this representing 29% of days lost due to injuries and claims related to illness (Davis *et al*. 2014). Furthermore, the annual economic burden of MSDs was estimated to be between 45 and 54 billion US dollars.

The United Kingdom (UK) Health and Safety Executive describes MSDs as the most common occupational health problem facing the country. It was estimated that MSDs were the most prevalent job related illnesses in 2009-2010, in which 37% of working days were lost due to MSDs (Health and Safety Executive 2011). The Health and Safety Executive (HSE)(2011) reported that in the UK in 2007/2008, on average, a person suffering from an upper-limb disorder took an estimated 13.3 days off work in 12 months due to a self-reported work-related illness or workplace injury. In 2011/2012, the HSE reported that each person had about 17 days off work as a result of MSDs that was inflicted or aggravated by work. This highlights the fact that MSDs are on the increase, are costly and cannot be ignored. According to the National Institute for Occupational Safety and Health (2013), estimated figures show that in the UK, approximately 439,000 workers in 2011/2012 experienced MSD, which was caused by their present or past jobs, among which 176,000 experienced backaches, 177,000 had issues related to upper limbs and neck, and 86,000 experienced problems with their lower limbs.

In Australia, MSDs are an expensive health problem, with an estimated 4.6 billion dollars being spent on these conditions annually (Hayes, Smith and Taylor 2013). In Saudi Arabia, nearly 2 million workers suffer from MSDs each year (Abduljabbar 2008). In South Africa, as in many other developing countries, no statistics on MSDs were found.

2.4 Musculoskeletal Disorders among Different Professions

Research has shown that MSDs are linked to perceived physical and psychological job demands in the work environment (Choobineh *et al*. 2011). Studies on the prevalence of MSDs in different professions have been widely reported in the literature (e.g. office workers, teachers, computer operators etc.). Among office workers, the use of visual display terminals to display electronic data has affected both the workers and the workplace (Akrouf *et al.* 2010). Workers stay in front of these terminals for long hours adopting a poor body position. This results in health effects such as MSDs that affect the shoulders, elbows, arms, hands, wrist, back, feet and legs (Ghanbary and Habib 2015; Akrouf *et al*. 2010). In a study carried out by Akrouf *et al.* (2010) on MSDs among office workers in Kuwait using the Nordic musculoskeletal questionnaire (NMQ) and 12-item general health questionnaire (GHQ12), it was reported that of the 750 employees that participated in the study, 80% suffered at least an episode of MSD, the most affected body parts being the neck (53.5%), shoulders (49.2%), lower back (51.1%) and upper back (38.4%). The result is comparable to a study carried out among computer users in Isfahan using the NMQ, the results of which showed neck (54.9%), back (53.1%) and shoulders (62.1%) to be the most problematic (Ghanbary and Habibi 2015). Similar results were recorded among Chinese office workers using the NMQ, where the neck accounted for (55.5%) of complaints, the shoulder (50.7%), and the upper back (26.2%) (Wu *et al.* 2012).

According to Chaiklieng and Suggaravetsiri (2012) and Yue, Liu and Li (2012), MSD is one of the prominent causes of ill health retirement among school teachers with prevalence rates of between 40%-95% having been reported among school teachers (Erick and Smith 2011). The prevalence of MSDs among school teachers can be attributed to their job related activities such as frequent head down movement,

repetitively writing overhead on the board, repetitive hand use when marking and using the computer, standing for prolonged hours. These working conditions are unsafe and are the major cause of repetitive strain injury which is another name for MSDs that directly affect the neck, shoulder, upper limb and back (Yue, Liu and Li 2012; Chaiklieng and Suggaravetsiri 2012; Erick and Smith 2011).

Chaiklieng and Suggaravetsiri (2012) conducted a study on risk factors for MSDs among school teachers in Thailand and reported a prevalence rates of 54.5% for low back, 41.6% for shoulder, 36.1% for the upper back, 34.5% for neck and 27.9% for the arm. The report further shows that there was no significant difference in the prevalence rate between genders and across age groups (Chaiklieng and Suggaravetsiri 2012). The risk factors that were identified in this study indicated that teachers with chronic diseases (asthma, diabetes, high blood pressure and peptic ulcer) were at significantly higher risk (1.6 times) for developing MSDs compared to those without. Obesity was also identified as a health risk condition for MSDs among school teachers (Chaiklieng and Suggaravetsiri 2012). Teaching postures (standing, sitting, stretching to write on the board) and the use of computers were linked with neck, upper limb and back pains. Insufficient lightening in the classroom and teacher's office, which leads them to assuming awkward postures in order to see the work better, was also reported as one of the factors responsible for MSDs (Chaiklieng and Suggaravetsiri 2012).

Health care workers are regarded as a group of people at high risk of MSDs, particularly those involved in handling patients (Chung *et al*. 2013; Coluci and Alexandrea 2012). The annual prevalence of MSDs at any body part among the Asian and Western health care working population has been reported to be between 40%-85%, with female workers being more susceptible than their male counterparts (Amin *et al.* 2014). Nursing has been ranked among the occupations with the highest prevalence of MSDs by the United States Bureau of Labour Statistics (BLS 2013). Coluci and Alexandrea (2012) reported that the risk factors that are related to nursing work include psychosocial factors (time pressure, competitiveness and low autonomy), environmental factors (workplace), biomechanical factors (risk movements and postures) and organizational factors (lack of colleagues and inadequate equipment). Nursing personnel are exposed to various tasks that may put them at risk of MSDs, such as lifting heavy weights, and

turning and bending, which usually make them assume awkward and static postures (Coluci and Alexandrea 2012; Tinubu *et al.* 2010).

A study by Amin *et al.* (2014) showed that the body parts that were most affected included the neck, with a prevalence rate of 34%-54%, the shoulder (35%-60%) and the lower back (29%-64%). Amin *et al.* (2014) explored the relationship between psychosocial risk factors and work-related musculoskeletal disorders among public hospital nurses in Malaysia, and reported that over two thirds of 376 nurses had experienced pain or discomfort in at least one site of the musculoskeletal system within the last year. The prevalence rate for the different body parts were the neck (48.9%), followed by the feet (47.2%), the upper back (40.69%) and the lower back (35.28%). Similarly, Arsalani *et al*. (2014) investigated the prevalence of MSDs and associations with organizational, physical and psychosocial working conditions among 520 nursing personnel in Tehran, Iran, and reported that 88% of the participants experienced MSDs in at least one body region in the past 12 months, with the lower back having the highest prevalence rate at (65.3%) followed by the knee (56.2%) and the neck (49.8%).

Dentistry is a branch of medicine that deals with prevention, diagnosis, and treatment of disorders and diseases of the oral cavity, as well as associated structures, specifically in the maxillofacial (face and jaw) area (American Dental Association 2014). It is a profession of paramount importance to the oral health and wellbeing of people (Ellapen *et al*. 2010). Dentistry involves handling vibrating and small instruments, and performing repetitive actions (Vuletic *et al.* 2013). Dentists engage in long surgical procedures, forceful clinical tasks, such as scaling, repetitive task for long periods and endodontic procedures. These procedures are visually demanding and require static and awkward postures,as well as the use of high frequency vibrating tools (Alghadir, Zafar and Iqbal 2015; Gupta, Ankola and Hebbal 2013). Dental professionals are exposed to poor ergonomic practices, which pose a serious hazard and put them at risk of occupational health effects on a constant basis (Gupta, Ankola and Hebbal 2013). According to Morse, Bruneau and Dussetchleger (2010), dentists report 26-73% period prevalence of neck symptoms over a period of one year, and 20-65% with shoulder symptoms. Higher rates were reported among dental hygienists, 54-83% for neck and 35-76% for

shoulder, and dental assistants from 38-62% for neck and 27-62% for shoulder, but the study does not show any report on dental technicians.

A dental laboratory technician is a member of the dental team whose job is to create/construct restorative and dental appliances according to the specification of the dentist (Torbica and Krstev 2006). An ideal work environment of the technician should be clean and well lighted, and they usually have their personal work bench furnished with Bunsen burners, hand instruments, grinding and polishing equipment, which are used to create crown, bridge, prosthesis and mouth models (Torbica and Krstev 2006). Individual characteristics that they must possess are: artistic skill for details and precise work, good vision, the ability to recognize colour shadings and a high degree of manual dexterity (Torbica and Krstev 2006). Figure 2.1 shows a dental technician at work. Coşkun Akar *et al*. (2009) carried out a study assessing the awareness of and self-report of occupation-related health problems among dental laboratory technicians in Turkey, and reported that the prevalence of the health complaints, according to body systems were: ear (6.5%), eye (8.6%), respiratory (10.3%), dermal (11.9%) and musculoskeletal (23.8%). A high prevalence of pain in the shoulders (30.8%), neck (30.1%) and back (36.3%) were reported to have been caused by strenuous and repetitive shoulder/hand movements, strained posture, pronged standing and working with vibrating tools.

Figure 2.1: Dental technicians at work (Portland Community College, 2015)

Despite the development of a great deal of ergonomics and new technology in dentistry, it has been shown that some of these dental professionals spend 86% of their working time with a neck and trunk flexion of at least 30 degrees. The static forces resulting from these postures have caused pain, as evident by a reported point prevalence and 12-month prevalence rate of 64%-93% (Botha *et al.* 2014; Rabiei *et al*. 2015). Lai *et al*. (2013) conducted a study on the prevalence of musculoskeletal disorders in the dental profession in Brunei Darussalam, and reported that the most commonly reported body regions for musculoskeletal disorders experienced in the past one year were neck (53.3%), wrist/hand (53.4%), shoulders (61.7%), upper back (55.7%) and lower back (59.3%). Females were reported to have a higher risk of self-reported MSDs complaints than the males. In South Africa, Botha *et al*. (2014) carried out a 12-month prevalence study on self-reported musculoskeletal pain among dentists in South Africa, and reported that the body part that was mostly affected were the neck (77.9%), lower back (69.8%) and shoulders (72.4%)

2.5 Risk factors for Musculoskeletal Disorders

Identifying the risk factors that are responsible for MSDs is a complex and multifaceted problem (Sakzewski and Naser-ud-Din 2013). Health regulatory bodies,such as the World Health Organization (WHO) (2010) and National Institute for Occupational Safety and Health (NIOSH) (2013), have noted that the risk factors for MSDs are multifactorial in nature and exist across the spectrum of the work environments (Sakzewski and Naser-ud-Din 2013; Morse, Bruneau and Dussetchleger 2010). In order to examine the full extent of the problem, a review of the psychosocial, biomechanical, and individual risk factors for MSDs in dental profession will be briefly looked into.

2.5.1 Psychosocial Risk Factors

Many psychosocial factors are associated with MSDs and include a wide variety of conditions that can be grouped into three categories. Category one are factors associated with the internal work environment, which are also referred to as work organizational factors. These relate to certain aspects of the job content, such as the workload, job control, mental demand and job clarity. These also involve organizational characteristic, such as interpersonal relationships, work/rest cycle, financial aspect and community support (Sakzewski and Naser-ud-Din 2013; Nunes and Bush 2012; Freivalds 2011). Category two are factors associated with the external work environment, which include the role of the individual outside work, specifically with respect to their duties and responsibilities relating to families, friends and the community. Females are at high risk as they have more caregiver demands (Sakzewski and Naser-ud-Din 2013; Hayes, smith, Taylor 2013; Freivalds 2011; Morse, Bruneau and Dussetchleger 2010). For example, in many African societies, women do the majority of household tasks, hence, the difference in exposure to risk factors between women and men at work and at home may explain the higher prevalence of MSDs in women in comparison to men (Munabi *et al.* 2014). Category three are the Individual characteristics of the worker, which includes gender, intelligence, culture, educational status, social class, life/work attitude, job satisfaction, personal traits and character. These can influence a person’s capacity to handle potential stressors in the workplace (Sakzewski and Naser-ud-Din 2013; Freivalds 2011).

2.5.2 Biomechanical Risk Factors

Yamalik (2007 cited in Morse, Bruneau and Dussetschleger 2010) in his extensive review of risk factors affecting dental workers, noted some specific dental tasks as risks. He documented that endodontic procedures require direct visualization that could be intricate and difficult, thereby causing awkward and static postures. Most of these procedures require limited range of motion (constrained postures), forceful clinical task, high precision and flexion for instruments, which results in isometric muscle contractions. These factors occasionally act distinctly and sometimes in combination with different forces (Hayes, Smith and Taylor 2013). Evidence has been found in reviews to support a causal relationship between MSDs of the neck, upper extremities and lower back of dental professionals to i. repetitive movements, ii. poor or uncomfortable working postures (Sakzewski and Naser-ud-Din 2013), which are detailed further.

i. **Repetitive movements**: MSDs among dental professionals are mostly attributed to repetitive movements, specifically in the hand and wrist (Sakzewski and Naser-ud-Din 2013). These occur when the same muscle groups and joints are involved over and over again, and whenever a particular movement is done repeatedly over a prolonged period of time. As the tendon at the site involved compresses and stretches, blood flow is reduced, thereby resulting in wear and tear (Sakzewski and Naser-ud-Din 2013).

ii. **Poor or uncomfortable working posture:** prolonged, static and awkward postures have been causally linked to MSDs (Morse, Bruneau and Dussetchleger 2010). Ellapen *et al.* (2010) stated that the mechanism of musculoskeletal pain was attributed to the poor ergonomic work posture and work position adopted by dentist in relation to their patients. Likewise, Abduljabbar (2008) conducted a study to find out the prevalence and distribution of musculoskeletal symptoms among dentist in Saudi Arabia, and investigated the following aspects: the clock-related working posture, the use of dental mirror and the sitting work posture. He reported that 83 of the responding 140 dentists had pain or discomfort from the head, neck, shoulders

or low back. Rotating and bending the neck for better visibility aids the movement of joints from the natural position, and this is likely to strengthen the muscles on one side and weaken the opposing one. These awkward and static postures generate continuous muscle activities that increase intramuscular pressure, thereby blocking the flow of blood and consequently, the flow of oxygen to the affected body part, which in turn degenerate into MSDs (Nunes and Bush, 2012; Morse, Bruneau and Dussetchleger 2010). As indicated by Valachi and Valachi (2003 cited in Botha *et al.* 2014), the following were described as the most common conditions resulting from prolonged static postures in dentistry, and with the long-term effect of developing a musculoskeletal disorder:

- Tension neck syndrome: it can be preceded by a consistent forward head posture, triggering muscle imbalance that could cause ischemia and cervical or disc herniation, or degeneration leading to stiffness, pain, occasional numbness or tingling sensation in one hand, and muscle spasms in the cervical musculature.
- Rotator cuff impingement may be caused by the worker assuming rounded shoulder posture, sustaining an elevated arm, and incorrect body mechanics leading to pain in the shoulder.
- Trapezius myalgia might occur as a result of working with the arm elevated, which causes muscle spasms, tenderness and pain in the upper trapezius muscle.
- Chronic low back pain may be caused by the degeneration or herniation of spinal disks, hypomobile spinal facet joints, muscle strains, and weak postural muscles.

Botha *et al.* (2014) outlined the path of musculoskeletal disorder, as indicated in Figure 2.2, which indicates the the progression from prolonged static posture to the development of musculoskeletal disorder.

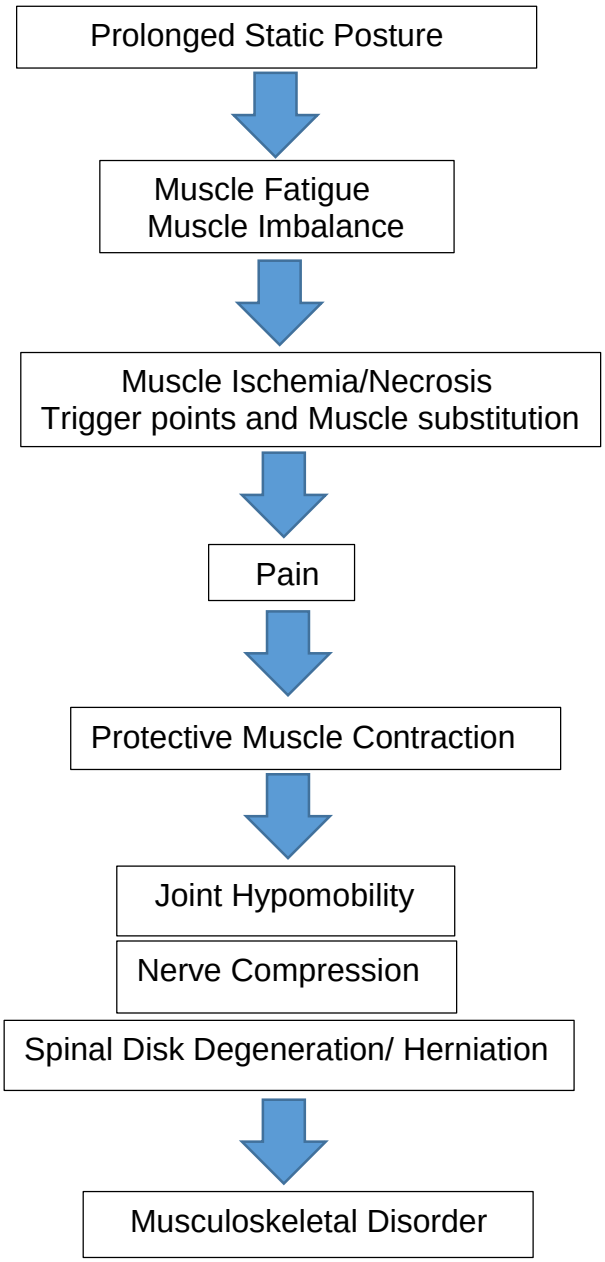

Figure 2.2: Musculoskeletal disorder

2.5.3 Individual Factors

Individual factors, such as demography (age, gender, body mass index) and lifestyle (smoking, alcohol, exercise) have been reported to have an effect on the risk factors for MSDs (Sakzewski and Naser-ud-Din 2013). As one ages, a number of physiological changes occur: the wrist tissues, shoulder and back become more vulnerable to the damaging effects of awkward postures. There is a decrease in the tissue elasticity; joints may become less flexible, less mobile and inflamed; the structural changes occur in the spine and load-bearing joints, which are due to the decrease in the fluids of the joints and the wear and tear on the cartilage. There is a decline in the cognitive process (attention, memory and primary processing) and sensory-motor response. Generally, many components of the human body deteriorate with ageing, possibly causing an adverse response, leading to MSDs and weakening the tissue as a result of cumulative exposure (Davis *et al.* 2014; Collins 2013). However, Tinubu *et al.* (2010) refutes the above, and reported that the incidence of MSDs is sometimes not a function of age and experience. Tinubu *et al.* (2010) detected that the prevalence of MSDs decreased in workers above 50 years of age who had over 20 years working experience. This might be due to a better level of knowledge about injury prevention and the development of coping strategies for musculoskeletal problems (Tinubu *et al.* 2010). Similarly, Abduljabbar (2008) reported that the occurrence of pain and discomfort had the tendency to decline with age and the number of years in practice, describing it as a “healthy workers effect”.

Gender is a contributing risk factor for MSDs and could be associated with the strength, hormones and lower muscle volume of women (Rafie *et al*. 2015). Females also reported more frequent MSDs symptoms, especially headaches and pains in the upper limb, and rate these symptoms worse than males (Widanarko *et al.* 2011; Chowanadisai *et al.* 2000). Rafie *et al*. (2015) reported that the prevalence of MSDs among dental practitioners was higher in women than men. In a study on MSDs carried out among computer users, it was reported that males had the highest prevalence of MSDs in the neck, while women reported the highest prevalence in the shoulder region (Cho, Hwang and Cherng 2012). For low back pain (LBP), Munabi *et al.* 2014 reported that female nurses were 2.26 times more likely to report this than their male colleagues. This may be due to the higher physical constraints and demands that women face.

Cigarette smoking is a lifestyle that impairs and damages the nutrition and structure of the musculoskeletal system through hypoxia and vasoconstriction. It may favour the onset or aggravate the progression of MSDs (Abate *et al.* 2013). In a study of MSDs carried out among bank workers in Kuwait, smoking was shown to be a significant predictor for the occurrence of MSDs in the previous 12 months to that study (Akrouf *et al.* 2010).

Alcohol consumption could serve as an immunosuppressant and when abused, it becomes detrimental to the musculoskeletal system, not only affecting the bones, but also the body mass. This results in a decrease in body mass, suppression of skeletal growth, progressive bone loss, as well as reducing peak bone mass, especially during early adulthood (Bergman *et al.* 2013; Maddalozzo *et al.* 2009). It is estimated that 40–60% of all adult alcohol addicts show skeletal muscle myopathy. This myopathy and muscle wasting associated with chronic alcohol abuse is caused by an imbalance in protein metabolism (Bergman *et al.* 2013; Maddalozzo *et al.* 2009). However, Munabi *et al.* (2014) in their study discussed that intake of alcohol was found to have a protective effect on reported MSDs, and persons who consumed either moderate or excess alcohol reported having consulted a practitioner less often than those who did not drink at all.

Body Mass Index (BMI) is the most common means to quantify weight across a range of body sizes in adults (Hergenroeder *et al.* 2011). It is used to classify an adult into underweight, overweight and obesity by dividing the weight in kilogram by square of height in meters (kg/m^2) (WHO 2010).

Table 2.2: The international classification of adult into underweight, overweight and obesity according to BMI (WHO 2010).

Classification	BMI (kg/m^2)	
	Principal cut-off points	Additional cut-off points
Underweight	<18.50	<18.50
Severe thinness	<16.00	<16.00
Moderate thinness	16.00 - 16.99	16.00 - 16.99
Mild thinness	17.00 - 18.49	17.00 - 18.49
Normal range	18.50-24.99	18.50 - 22.99
		23.00 - 24.99
Overweight	≥25.00	≥25.00
Pre-obese	25.00-29.99	25.00 - 27.49
		27.50 - 29.99
Obese	≥30.00	≥30.00
Obese class I	30.00 - 34.99	30.00 - 32.49
		32.50 - 34.99
Obese class II	35.00 - 39.99	35.00 - 37.49
		37.50 - 39.99
Obese class III	≥40.00	≥40.00

These categories of BMI were developed by the World Health Organization and are based on associated health risks (Hergenroeder 2011). With elevations in fat mass, there is a relative decline in muscle mass and strength. Obesity may create a perfect atmosphere for skeletal muscle catabolism and cause a reduction in physical function (Vincent, Raiser, Vincent 2012). Heuch *et al.* (2013) reported an association between MSDs on the lower back and elevated BMI, but factors relating to the development of the disorder were not identified. Similarly, Viester *et al.* 2013 documented that high (BMI) (overweight and obesity) might be an independent risk factor for MSDs. In their study on the relationship between body mass index and musculoskeletal symptoms in the working population, it was reported that high BMI (overweight and obesity) was moderately associated with a high prevalence of musculoskeletal symptoms in the past 12 months. The prevalence of musculoskeletal symptom was particularly high in the lower extremities.

2.6 Theoretical Framework

A theoretical framework serves as a template when conducting research and has been described as the structure, scaffolding, or frame of your study (Merriam 2009). A theoretical framework can be elaborate or basic, commonsensical or theory driven, descriptive or causal, but describes the main factors to be studied and the relationship among them. With the theoretical framework not having a definite and clear definition, Maxwell (2012) looked at the theoretical framework as one of the five components (concepts, assumptions, expectations, beliefs and the theories) of the research design that links and acts together in a non-cyclical and non-linear way. These components support and inform the research. Different theoretical frameworks on MSDs have been documented in the literature, two that were not used in this study being:

i. "Pyramid of disability". This is a theoretical framework that provides a framework for designing research studies and testing hypothesis using mathematical models. The model describes the progression from no symptoms of MSDs to chronic MSDs and long term disability. It also considers some factors that can facilitate changes between the levels of the pyramid (Evanoff, Dale and Descatha 2014). This framework is considered inappropriate because the objectives of this study are to determine the prevalence and risk factors for the development of MSDs, while this framework looks at the progression of MSDs.
ii. "Linking onset, course, and care". This theoretical framework has its focus on the onset, course and care of just neck pain (Guzman *et al.* 2009). This framework was also considered inappropriate as the study focuses on prevalence of MSDs on various body sites, not only the neck.

2.6.1 The "Dose-Response Model"

The theoretical framework selected for this study was the dose-response model because it accounts for the factors and process that result in musculoskeletal disorders. This model was developed to highlight the multifactorial nature, accounts for the factors and process that results in work-related neck and upper-limb disorder considering that personal characteristics, environmental and sociocultural factors have a role to play as

risk factors for the disorders. The aim of this model is to account for the factors and process that results in musculoskeletal disorders (Salvendy 2012). The model discloses that the more a job is physically demanding, the more the risk for MSDs and pain (Armstrong *et al.*1993; Rolander and Bellner 2001). The model has been proposed to address the etiological mechanisms linking exposure, dose, and capacity to the risk factors for MSDs. These risks arise from some simultaneously contributing factors, namely: physiological, mechanical, individual and psychosocial (Marras *et al.* 2010).The dose-response model is adopted for this study based on its relevance to the study objectives, and that the model can be characterized as having the following four sets of cascading and interacting variables namely: Exposure, Dose, Capacity and Response. Figure 2.3 presents the dose response model. Each of these interacting variables will be discussed briefly in relation to the study in view.

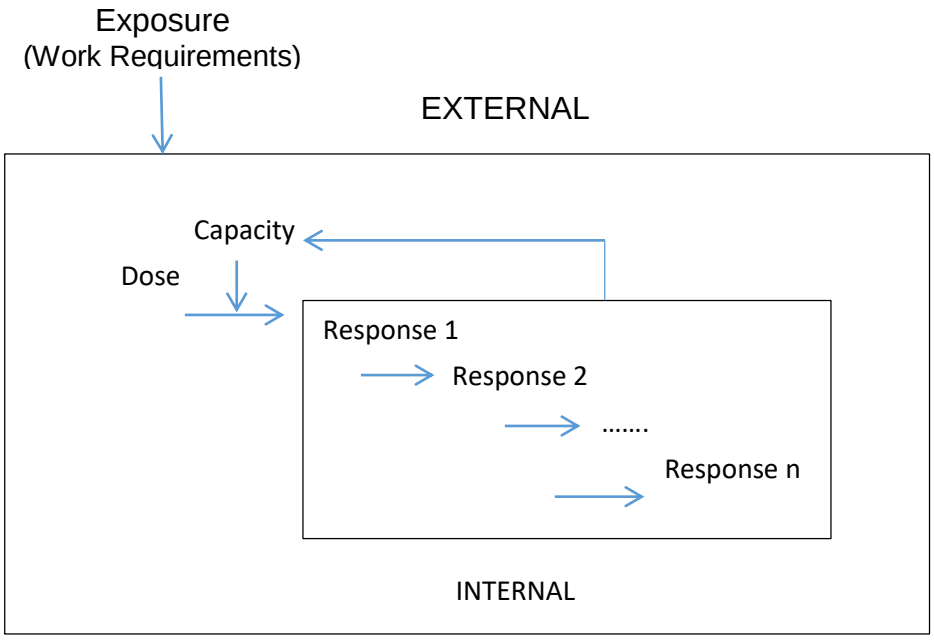

Figure 2.3: Dose response model (Armstrong *et al.* 1993)

i. Exposure: This refers to the work environmental factors and requirements (external factors) that involve the use of vibrating hand tools, different sizes, shapes, weight and work objects (Salvendy, 2012). All these are exposures that require forces, have associated repetition rates, magnitudes and duration, and are important determinants of work postures, tissue loads, frequency and velocity of muscle contraction. Other exposures can also be the work organizational factors that can result in psychological strain such as: psychological workload, job control or role ambiguity (Karsh 2006; Abduljabbar 2008; Armstrong *et al.* 1993). Coşkun Akar *et al.* (2009) reported that strain posture, strenuous and repetitive shoulder/hand movements, prolonged standing and working with vibrating tools were the most reported work related exposures among dental professionals (Coşkun Akar *et al.* 2009) . Booyens *et al.* (2009) showed that only workload had a significant association with hand symptoms, and confirmed that constant muscle contractions have the potential to cause MSDs. The nature of work and the work environment of the dental technologists indicates that they are exposed to some of these factors. Exposures such as bending, over stretching, scaling, vibration, standing, sitting, repetitive hand movement, same posture for long periods and awkward posture were captured in this study.

ii. Dose: This is defined by a set of factors that affects the internal state of the individual (Salvendy 2012). Doses can be physiological, psychological or mechanical disturbances:

a. Physiological disturbances: this involves the intake of metabolic substrates that produces metabolites, displaces ion and causes tissue damage (Salvendy 2012). Smoking can be linked to the onset of back pain or may intensify its progression. (Abate *et al.* 2013). In this study, cigarette smoking and alcohol were considered.

b. Psychological disturbances: this could be anxiety about the work load (Salvendy, 2012), stress and lack of support from the employer and/or family (Karsh, 2006; Armstrong *et al.* 1993). In a review of an article by Morse, Bruneau and Dussetchleger (2010), it was revealed that there is a

relationship between work-home conflicts and musculoskeletal pain. They identified dental hygienist and dental assistants to be more affected by work-family conflicts and demands, as they are primarily female and have more caregiver demands than men. In this study, psychosocial factors were not considered.

c. Mechanical disturbances: they are tissue forces and deformation that are produced as a result of overexertion or repetitive body movement. (Salvendy 2012; Karsh 2006; Armstrong *et al.* 1993). In the studies carried out by Ellapen *et al.* (2010) and Abduljabbar (2008), the participants (dental practitioners) suffered from shoulder pain and discomfort that could be related to the repeated unnatural working postures for prolonged period.In this study, mechanical disturbances were captured.

iii. Response: A response is an outcome of the dose caused by exposure (Salvendy 2012), and is a change that occurs to the internal state as a result of the dose. The response at one level can act as a dose to the next level (Salvendy 2012). There are different levels of responses, namely: primary (referred to as response 1 in figure 3) and secondary (referred to as response 2 in figure 3) (Rolander and Bellner 2001). For instance, exposures (constant force, vibrations, repeated and prolonged exertions day after day) can cause a change in the shape and composition of the tissue and metabolite level (primary response), which in turn leads to pain or discomfort (secondary response). The effect of the dose can be an immediate response or can require a long period of time (Salvendy 2012; Karsh 2006; Armstrong *et al.* 1993). Most studies noted a high prevalence of secondary responses, as primary responses cannot be captured by questionnaires (Botha *et al.* 2014; Simu *et al.* 2014; Kumar, Kumar and Baliga 2012). The model entails that the effect of the response (system changes) can either be increased dose tolerance (adaptation) or reduced dose tolerance, thereby lowering the system capacity (Salvendy 2012). In this study, secondary response refers to pain or discomfort in any of the nine body regions, which was captured using the Nordic Musculoskeletal Questionnaire (NMQ).

iv. Capacity: According to this model, the ability of the individual to resist the effect or destabilization of the dose can lead to either reduction or enhanced capacity (Salvendy 2012). For enhanced capacity, muscles may develop the ability to adapt (become stronger) to certain loads, similarly, they can develop increased aerobic or anaerobic metabolic capacity (Karsh, 2006; Armstrong *et al.* 1993). This corroborates the report by Abduljabbar (2008), which showed that the frequency of pain and discomfort have a tendency to decrease with age and the number of years in the practice of dentistry. Abduljabbar (2008) furthermore documented that the lower levels of pain and discomfort felt among older dentist may be due to the “healthy workers effect”. Enhancement of capacity is when muscles are able to adapt to loads. However, not all tissues adapt at the same rate, some muscle might not be able to adapt to loads, thereby leading to reduced capacity, which was shown in studies that attributed premature ill-heath retirement among dentist to MSDs. They reported that older workers are more susceptible to work-related MSDs than younger workers because of decreased functional capacity (Hayes *et al.* 2013; Morse, Bruneau and Dussetchleger 2010). In this study, age and number of years in practice were captured.

2.7 Conclusion

The literature review has shown an overview of the musculoskeletal system that is interrelated with other body systems, what MSDs are and some common work-related musculoskeletal injuries, especially those that affect the upper limbs. The prevalence and cost of MSDs across countries was documented and it was noted that MSDs are the most prevalent and costly occupational health problem. Included in this review were the possible risk factors for developing MSDs, which are psychosocial, biomechanical and individual factors. The dose-response model was the appropriate theoretical framework chosen for the study, as it reflected the exposure, dose, response and capacity that are accounted for the factors and process that results in MSDs. The next chapter will discuss the research methodology, data collection process and the analysis of the findings.

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CHAPTER 3

RESEARCH METHODOLOGY

3.1 Introduction

Research methodology is the method used to carry out research, and is a planned and scientific procedure that includes numerical schemes and statistical approaches for the purpose of finding solution to a problem through data collection (Rajasekar, Philominathan & Chinnathambi, 2006). This chapter describes the techniques used to collect data and analyze the resulting data. The chapter presents the research design, study population, study sampling and sampling techniques, tools for data collection, the data collection process and statistical analysis to be used in the study.

3.2 Research Design

Research design is the conceptual structure within which research is conducted. It constitutes the blueprint for the collection, measurement and analysis of data. As such, the design includes an outline of what the researcher did from writing the objectives and its operational implications to the final analysis of data (Grove, Gray, Burns 2014). This study adopted a quantitative (non-experimental) research approach, which involves the use of a cross sectional correlational survey design. Quantitative research is a type of research in which the researcher decides what to study, then asks specific and narrow questions, collects numerical data and analyses the data using statistics in an unbiased and objective manner (Polit and Beck 2012). A cross sectional survey is used to study a phenomenon at a given time or to gather data from multiple groups at the same time (Parahoo 2014). This study design is selected as it has been used in previous studies on musculoskeletal disorders (MSDs) among dentists, steelworkers, nurses and office workers (Botha *et al.* 2014; Aghilinejad *et al.* 2012; Tinubu *et al.* 2010; Zungu 2009) and based on their results, the method was considered appropriate for actualizing the following objectives, all of which were addressed through a questionnaire survey, as indicated in Figure 3.1

Table 3.1: The objectives and associated methods

	Objective	Method
1	To determine the prevalence of MSDs among dental technicians in South Africa.	SNQ questionnaire
2	To identify the parts of the body mostly affected by MSDs.	
3	To identify possible risk factors for MSDs among dental technicians in South Africa	
4	To determine any correlation between each of the identified risk factors and the parts of the body mostly affected by MSDs.	Statistical analysis

3.3 Study Setting

The study was conducted among all dental technicians that were registered with the South African Dental Technician Council (SADTC) and practicing as dental technicians, most of which work in privately owned dental laboratories in South Africa. They usually have their own workbenches, which is usually clean and well lit, and is equipped with a Bunsen burner, grinding equipment, polishing equipment and handheld instruments, such as wax spatulas, scalers, periotomes and dental handpiece. A high degree of manual dexterity, ability to recognize fine colour shadings, good vision, an artistic aptitude for detail and precise work makes their job extremely delicate.

3.4 Study Population

A population is a group of experimental data, persons, animals, businesses etc. that is made up of elementary units, which cannot be further decomposed. It is a well-defined set that has specific properties and is also a collection of all elements being described or measured by a sample (LoBiondo-Wood and Haber 2014). In quantitative research, the population refers to the entire aggregate of those that meet a set of specifications (Polit and Beck 2012). The population criteria establish the target population; that is, the entire set of cases (entire set of individuals or elements) who meet the sampling criteria and whom the researcher would like to make generalization from (Grove, Gray and Burns 2014; LoBiondo-Wood and Haber 2014; Polit and Beck 2012). The target population for this study comprises all registered dental technicians on the database of

SADTC with functional e-mail addresses and telephone numbers. The SADTC has 652 registered active members who consist of both males and females working as dental technicians at different dental laboratories in South Africa.

3.5 Study Sample

Sampling is the act, process or technique of selecting a representative part of a population, called a sample, for the purpose of determining parameters or characteristics of the whole population (Polit and Beck 2012). The goal of sampling is to determine a population's characteristics by directly observing only a portion of the population. Therefore, it is important to have a good representation of the population, as conclusion made from the groups' findings could be used to generalize findings in the target population (Shields and Twycross 2008; Polit and Beck 2012). Purposive sampling was used in this study, the names and details of the entire registered dental technicians (652) and laboratories being sourced from SADTC, all of whem were invited to participate in the study via e-mails and telephone calls. Dental laboratories in Durban were approached and handed the questionnaire.

Size is an important factor depending on what the researcher is investigating and the population involved. The researcher used the largest sample possible because the larger the sample, the more representative of the population, it is likely to be and a sufficient statistical power can be achieved (Polit and Beck 2012). To achieve 5% margin of error at 95% confidence level, a minimum of 242 respondents was needed. In order to attain this for analysis, 20% was added to this figure and so the sample size required was 291. Respondents in the study were sampled based on full compliance with the inclusion criteria.

In order to participate in this study, the following criteria were complied with:

- be registered on the database of the SADTC as a dental technician.
- have a functional email addresses and/or telephone numbers.
- reside and be practicing in South Africa.
- be English literate

Participants were excluded from this study if they did not meet the above inclusion criteria.

3.6 Data Collection Tool

The tool used for data collection is a well-used and validated questionnaire that has been used nationally and internationally in similar studies. A questionnaire is a method of gathering self-report responses to a written set of questions from participants through written, verbal or electronic means (Grove, Gray, Burns 2014; Parahoo 2014). It is a predetermined, standardized and structured tool that has been solely designed for the purpose of collecting data from a large number of people over a geographical area as part of a research study (Parahoo 2014) and so an appropriate data collection tool in this study.

The validated Standardized Nordic Questionnaire (SNQ) for musculoskeletal symptoms was used to collect data. This tool was developed by a team of Nordic Council of Ministers who were tasked with creating a simple, standardized questionnaire that could be used for screening MSDs in ergonomic settings, and for epidemiological studies of MSDs in occupational health services (Kuorinka *et al.* 1987). The SNQ is an open access, reliable and valid tool that has been repeatedly used among health professionals to investigate MSDs both in South Africa and internationally (Botha *et al.* 2014; Hayes *et al.* 2013; Rabiei *et al.* 2015). In order to capture the demographic variables of the respondents, the demographic section of the questionnaire in Kumalo (2015) was appropriately modified to suit dental technicians. The tool is in English and was not translated into any local other language. The questionnaire was sent via e-mail in an editable format, this made it easy for respondents to complete and return.

The questionnaire (Appendix F) is made up of three sections. Section A contains questions on personal and lifestyle information. Section B collects data on occupational history, and section C gathers data on symptoms of any musculoskeletal disorder experienced by the respondent within the last seven days to twelve months, which are classified into nine musculoskeletal regions of the body.

3.7 Validity and Reliability

The two most important aspects of precision are validity and reliability, which are tools of an essentially positivist epistemology (Golafshani 2003). Joppe (2000 cited in Golafshani 2003), provides an explanation of what validity is in quantitative research by positing that it determines whether the research truly measures that which it was intended to measure, or how truthful the research results are. In other words, does the research instrument enable the the research to achieve their aim. Researchers generally determine validity by asking a series of questions, and will often look for the answers in the research of others. Similarly, Parahoo (2014) referred to validity as the extent to which a questionnaire or other method of data collection measures the phenomenon under investigation. The validity of an instrument is a determination of how well the instrument reflects the abstract concept being examined. It is measured in a continuum. According to Grove, Gray and Burns (2014), no instrument is completely valid, which requires researchers to determine the degree of validity of an instrument rather than whether validity exists.

Joppe (2000 cited in Golafshani 2003) defines reliability as the extent to which results are consistent over time and an accurate representation of the total population under study is referred to as reliability. If the results of a study can be reproduced under a similar methodology, then the research instrument is considered to be reliable. Furthermore, reliability could also refer to the consistency of the tool in measuring the same phenomena. A reliability coefficient of 0.70 or higher was considered ‘acceptable’ for this study. The validity and reliability of the SNQ for musculoskeletal symptoms has been investigated and approved in different studies (Aghilinejad *et al.* 2012; Crawford 2007). The reliability coefficient of the collected data using the SNQ was computed.

After the data gathering questionnaire was designed, a pilot study was carried out using the instrument, which was subjected to expert opinions in order to ensure its validity. Experts in the field of dental technology and occupational health were consulted and given the tool to establish content and construct validity. Pretesting was done for relevance and clarity of wording among five dental technicians. Their response was an indication that the questionnaire was clear, well understood and applicable to their profession. There was therefore no need to rephrase or change any question.

Table 3.2: Reported validity and reliability of the Standardized Nordic Questionnaire

Study	Author	Validity	Reliability
The relationship between work-related musculoskeletal disorders, absenteeism and visits to the staff clinic by nurses in an eThekwini District hospital.	Kumalo 2015	The author reported that the standardized Nordic Musculoskeletal questionnaire is a valid tool	0.719 (96%)
Prevalence of Musculoskeletal Disorders among Iranian Steel Workers.	Aghilinejad, Choobineh, Sadeghi, Nouri, Ahmadi 2012	The author reported that the standardized Nordic Musculoskeletal questionnaire is a valid tool	Unavailable
Development and Test-Retest Reliability of an Extended version of the Nordic Musculoskeletal Questionnaire (NMQ-E): A screening instrument for musculoskeletal pain.	Dawson, Steele, Hodges and Stewart 2009	The author reported that the standardized Nordic Musculoskeletal questionnaire is a valid tool	Kappa values ranging from 0.88 to 1

3.8 Data Collection Process

Data collection is a precise and systematic gathering of information relevant to the research purpose or the specific objectives, questions, or hypotheses of a study (Grove, Gray, Burns 2014). Before data collection for the research was done, the researcher sought permission to conduct the study and obtained ethical clearance from the Durban University of Technology Ethics Committees. Permission was also obtained from SADTC to have access to the e-mail addresses and phone numbers of the registered dental technicians (Appendix B). E-mails containing the information letter (Appendix D) and informed consent (Appendix E) explaining the purpose of the study, ensuring anonymity and confidentiality of their responses, and soliciting their feedback together with the questionnaire (Appendix F) was sent to all the potential participants. The questionnaire was in an editable format to enable the participant complete it and send it back without the need for printing and scanning. After two weeks the researcher phoned and sent e-mails to all the participants who had not responded to remind them. In sixteen weeks, three e-mails were sent and telephone calls were made at different

times. After four months following the distribution of the questionnaires the data was analysed.

3.9 Data Analysis

Data analysis is the organization and processing of the data that has been collected, which is further structured and made meaningful for appropriate interpretation (Polit and Beck 2012). The data were analyzed using IBM SPSS version 23, the resulting information being presented in this study. The methods of analysis are presented in Table 3.3.

Table 3.3: Methods of analysis used for each of the study objectives

Objective		Method of analysis
1	To determine the prevalence of MSDs among dental technicians in South Africa.	Percentage frequency measure.
2	To identify the parts of the body mostly affected by MSDs.	Percentage frequency measure.
3	To identify possible risk factors for MSDs among dental technicians in South Africa	Inferential statistics including chi-square test of independence
4	To determine any correlation between each of the identified risk factors and the parts of the body mostly affected by MSDs.	Chi-square test of independence, independent samples t-test and Pearson's correlation.

Chi-square test of independence is used on cross-tabulations to see whether a significant relationship exists between two variables. Pearson's correlation measures how variables or rank orders are related. Independent samples t-test compares two groups of cases in one variable.

Percentage frequency measure was used to analyze Section A and B of the questionnaire so as to determine the prevalence and the parts of the body most affected by MSDs (Objective 1 and 2). Inferential statistics including chi-square test of independence was used to analyse the demographic and lifestyle characteristics that formed part of the possible risk factors (objective 3). Inferential statistics, namely chi

square and Pearson's Product-Moment correlation was used to determine any correlation between each of the identified risk factors and the body part mostly affected by MSDs (Objective 4). A confidence level of 0.05 was used in this study. Results were presented in the form of graphs, tables and figures.

3.10 Ethical Consideration

Approval to conduct the study was granted by the Research Higher Degrees Commission (RHDC) Committee of the Faculty of Health Sciences and ethical clearance from the Institutional Research Ethics Committee (IREC), both from the Durban University of Technology before the study commenced. Permission was sought from the SADTC to access their database, and information about the research as well as consent forms were sent to potential respondents. They were assured of anonymity; however, the consent forms included their names, which were kept electronically in a coded file separate from the completed questionnaires, and were not linked to any questionnaires. A code number instead of a name was used for the questionnaires and the principles of ethics were integrated into the study namely;

Autonomy (respect for persons): the participants were treated as autonomous agents, with the right to self-determination and to the full disclosure. Participants were duly informed of the nature of the study and of their right to either participate or not, and that they could withdraw at any time without prejudice. All the explanations and disclosure were included in the information letter and consent form that were sent to the potential participants.

Beneficence: it is the responsibility of the researcher to maximize the benefits and minimize any form of harm to the participants (Polit and Beck 2012). The participants were informed of the benefits of participating through the information letter and they experienced no risk or harm during the study.

Justice: participants were assured of their right to privacy, which was maintained throughout the study. The selection of participants was done fairly and with no discrimination, as all the registered dental technicians were sent the questionnaires. The researcher did not show any prejudice to those who refused to participate. Participants were given free access to the researcher regarding any

clarification, which was duly maximized. There was no breach in confidentiality, as all the questionnaires were handled by the researcher, the information provided was not linked to the participant's identity and only the summary of the findings was made available to the general public (Parahoo 2014; Polit and Beck 2012).

Informed consent: potential participants were given adequate information about the research, the process and the benefit involved. Written informed consent was obtained from participants who understood the information and acknowledged voluntary participation.

3.11 Conclusion

This cross sectional study of MSDs included participants from across South Africa, with data being obtained using the validated Nordic Musculoskeletal Questionnaire, which was electronically distributed. Data was analyzed using Statistical Package for Social Science and the resulting information will be presented in the next chapter.

CHAPTER 4

RESULTS

4.1 Introduction

This chapter presents the findings obtained from the study, the purpose being to determine the prevalence and risk of musculoskeletal disorders among dental technicians in South Africa. This was done by addressing four objectives:

1. to determine the prevalence of MSDs among dental technologist in South Africa
2. to identify the risk factors responsible for these conditions as well as the body parts that are most affected and
3. to determine any correlation between each of the identified risk factors and the parts of the body most affected by MSDs.

4.2 Sample Realization

Out of the entire population of dental technicians in South Africa (652), the aim was to have a sample size of 291, which included an extra 20% that would have catered for non-response or incomplete questionnaires. All the dental technicians in South Africa were invited to participate via emails and telephone calls. Questionnaires, consent forms and letters of information were sent to all the email addresses that were made available by the South African Dental Technician Council and telephone calls were made to them. A friendly reminder was sent via e mail to all the dental technicians two weeks later because only 15 had earlier responded. The researchers' supervisor and co supervisor sent personal e-mails to the dental technicians but this yielded a poor response. As a follow up on the e-mails and in an effort to improve the response rate of the dental technicians, all the dental laboratories in Durban were visited to hand out the questionnaires as the researcher resides in Durban. Despite several appointments and phone calls that were made before the visit, most declined when they saw the questionnaire and only few consented to participate. At the end of the visit to these laboratories in Durban, only 12 responses were gathered.

Over 16 weeks, telephone calls were made at different times, 3 e-mails were sent, some declined participating, some said they had relocated, and only 79 dental

technicians responded with 72 valid questionnaires available for computing (n= 72). Seven questionnaires were incomplete, in all of which the majority of the questions were left unanswered hence, those questionnaires were excluded from the analysis. This amounted to a response rate of 11% which is similar to the response rate of 10.9% reported by Botha et al. (2014) in a study of self-reported musculoskeletal pain among dentists in South Africa.

4.3 Demographic Characteristics Of The Respondents

The respondents were asked to indicate their gender. The information in Table 4.1 shows that of the total sample size (N= 72), the majority of the participants in this study were males, n=62 (86.1%), with only n=10 (13.9%) females, the standard deviation is 12.8.

Table 4.1: Gender and age of respondents

Variable		**Number**	**Percent**
Gender	Male	62	86.1
	Female	10	13.9
	Total	72	100
Age	20-29	13	18.1
	30-39	26	36.1
	40-49	15	20.8
	50-59	6	8.3
	60-69	11	15.3
	70-79	1	1.4
	Total	72	100.0

The respondents were requested to indicate their ages in years, Table 4.1 shows the age frequency. The participants (N=72) were between the ages of 25 and 76 years. The mean age was 41 years (SD 12.8). The majority of the respondents n= 41 (57%) were between the ages of 30 and 49 years. The percentage of participants between ages 20 and 29 was n=13 (18%), those between 60 and 69 years were n=11 (15.3%). A smaller percentage of the respondents n= 6 (8.3%) were between the ages of 50 and 59 years

and only n=1 (1.4%) of the respondents was between ages 70-79. The minimum BMI of the respondents was 13.9 and the maximum was 40.3 with a mean of 25.7 and standard deviation of 5.6.

Table 4.2: BMI of the respondents in age categories

BMI	**Age**						**Total**
	20-29	30-39	40-49	50-59	60-69	70-79	
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
Underweight	1 (1.4)	2 (2.8)	2 (2.8)	0 (0)	0 (0)	0 (0)	5 (7)
Normal	8 (11)	11(15)	7 (8)	2 (2.8)	0 (0)	0 (0)	28 (39)
Overweight	2 (2.8)	5 (7)	4 (5)	3 (4)	10 (14)	0 (0)	24 (33)
Obese	2 (2.8)	8 (11)	2 (3)	1 (1.4)	1 (1.4)	1(1.4)	15 (21)
Total	13 (18)	26 (36)	15 (21)	6 (8.3)	11 (15.3)	1 (1.4)	72 (100)

4.4 Occupational History

This section reports on the occupational history and the work characteristics/occupational exposure in relation to MSDs. The respondents have been working as registered dental technicians for a minimum of 2 years and a maximum of 52 years and 2 months with a mean of 17 years and SD =12.78. These respondents reported that on average, the minimum and maximum number of hours worked per week are 5 hours and 72 hours respectively.

Table 4.3: Does your job involve any of the following ergonomic risk factors?

Job	Never	Rarely	Sometimes	Often	Always
	n (%)	n (%)	n (%)	n (%)	n (%)
Bending	2 (3)	8 (11)	32(44)	29(40)	1(1.4)
Overstretching	16(22)	27(38)	13(18)	16(22)	0 (0)
Scaling	30 (42)	30 (42)	5 (7)	7 (10)	12 (17)
Vibration	11(15)	12(17)	17(24)	29(40)	3(4)
Standing	0 (0)	6(8)	28(39)	33(46)	5(7)
Siting	0(0)	0(0)	3(4)	22(31)	47(65)
Repetitive hand movement	0(0)	0(0)	1(1)	20(28)	51(71)
Same posture for long periods	0(0)	2(3)	6(8)	21(29)	43(60)
Awkward posture	7(10)	17(24)	21(29)	14(19)	13(18)

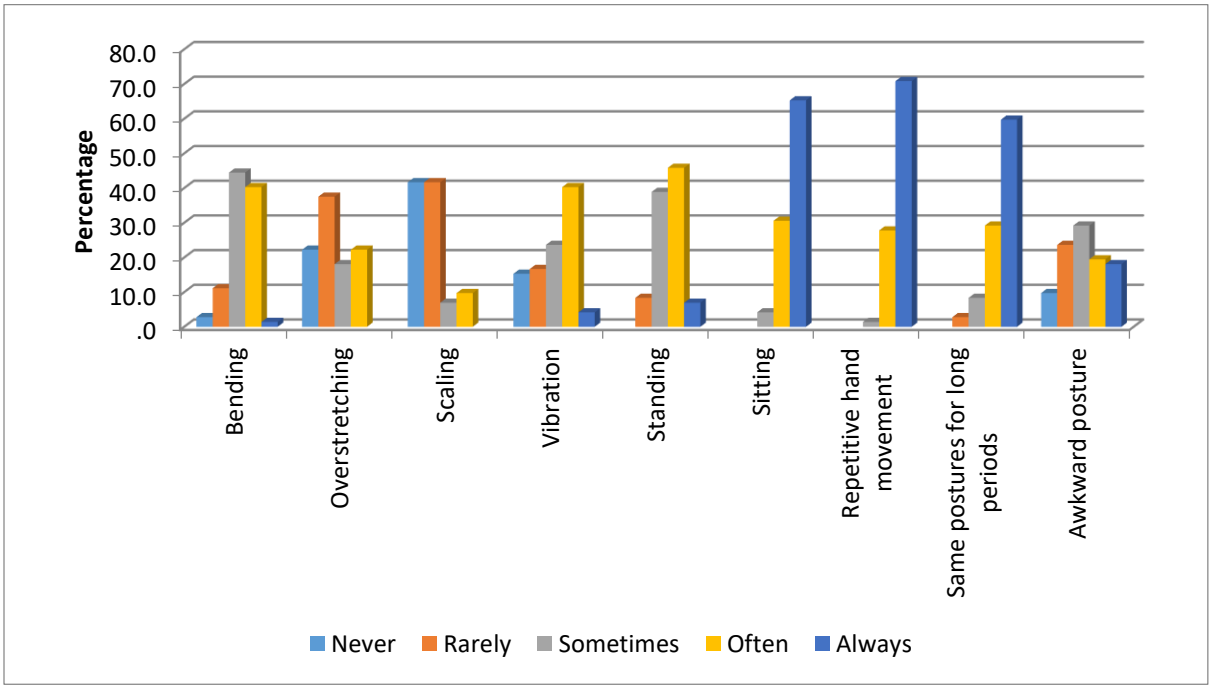

Figure 4.1: Frequency of occupational exposure to ergonomic risk factors

Table 4.4: Occupational exposure to ergonomic risk factors

	Chi-Square	Df	P
Bending	62.306	4	.000
Overstretching	25.917	4	.000
Scaling	58.139	4	.000
Vibration	25.500	4	.000
Standing	62.306	4	.000
Sitting	115.639	4	.000
Repetitive hand movement	136.472	4	.000
Same postures for long periods	89.806	4	.000
Awkward posture	7.444	4	.114

df= degrees of freedom significance p=<0.005

4.5 The association between ergonomic hazards and frequency of occurrence.

From the analysis in table 4.3, figure 4.1 and table 4.4, a significant number of respondents n=62 (86%) indicated that their job 'sometimes', 'often' or 'always' involved bending ($\chi 2$ (4, N=72) = 62.306, p<.0005). Significantly, more than expected respondents (n= 27) indicated that they 'never', 'rarely' or often overstretched while working ($\chi 2$ (4, N=72) = 25.917, p<.0005). For scaling which is part of the dental technician's job description, a significant number of respondents had 'never' n=30 (42%) or 'rarely' n=30 (43%) scaled ($\chi 2$ (4, N=72) = 58.139, p<.0005). Majority of the respondents n=46 (64%) reported that they 'sometimes' and 'often' use vibrating instrument ($\chi 2$ (4, N=72) = 25.500, p<.0005). A significantly more than expected percentage of respondents indicated that they sometimes n=28 (39%) and often n=33 (46%) stand. Respondents reported that standing was sometimes and often part of the job ($\chi 2$ (4, N=72) = 62.306, p<.0005. Sitting was reported to be significant as respondents' indicated to 'often' (n=22) and 'always' (47) sitting ($\chi 2$ (4, N=72) = 115.639, p<.0005). Analysis shows a significant number of respondent's reported repetitive hand movement n=71 (99%) ($\chi 2$ (4, N=72) = 136.472, p<.0005). A majority of

the respondents reported that they ‘often’ n=21 (29%) and ‘always’ n=43 (60%) assume the same posture for long periods while working ($\chi 2$ (4, N=72) = 89,806, p<.0005). A significant percentage rarely n=17 (24%) or sometimes n=21 (29%) assume an awkward posture while working.

4.6 Lifestyle Characteristics

The lifestyle characteristics that were investigated in this study were cigarette smoking and alcohol consumption. These were reflective of the physiological disturbance factors of dose in the dose-response model. Few of the respondents n=10 (13.9%) smoked and those that smoked reported that they smoked for between 1 and 34 years (SD= 8.3). Of those who reported smoking, 60% smoked 10-15 cigarettes a day. All the participants that smoked reported having MSDs which represented 15.4% of the total respondents that had MSDs. Analysis showed that n=38 (58.2%) of the respondents consumed alcohol with 58.2%, reporting to consuming between 1 and 3 alcohol drinks a day, the mean was 0.74 and SD=0.805. The majority of respondents n=35 (92%) who drank alcohol experienced MSDs which constituted 53.8% of the total respondents that suffered MSDs.

4.7 MSDs Distribution Of Respondents

The majority of the respondents (75%) were below the age of 50 (n=54) and 87% of these participants had experienced MSDs. Of the total respondents, those in the age category 30-39 years had the highest frequency of MSDs, n=26 (36.1%), of which n=23 (88.5%) had MSDs in at least one body part in the last 12 months which makes a total of 35.4% of the respondents with MSDs (table 4.3.1). There was no significant relationship between age and MSDs as MSDs cut across all ages and genders among these respondents.

Table 4.5: Distribution of Respondents and those with MSDs by age and gender

MSDs	Age						Total
	20-29	30-39	40-49	50-59	60-69	70-79	
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
Male	9 (13.8)	19 (27.7)	10 (16.9)	6 (9.2)	11 (16.9)	1 (1.5)	56 (86.1)
Female	3 (4.6)	4 (6.2)	2 (3.1)	0 (0)	0 (0)	0 (0)	9 (13.9)
Total	12 (18.5)	23 (35.4)	12 (18.5)	6 (9.2)	11 (16.9)	1 (1.5)	65 (100)

The majority of the respondents n=65 (N=72) had experienced MSDs in at least one body part in the last 12 months. The analysis in table 4.3 shows that MSDs cut across all ages and BMI among these respondents.

Table 4.6: Distribution of respondents with MSDs by age and Body Mass Index (BMI)

BMI		Age						Total
		20-29	30-39	40-49	50-59	60-69	70-79	
		n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
With MSDs	Underweight	1 (1.5)	1 (1.5)	2 (3)	0 (0)	0 (0)	0 (0)	4 (6)
	Normal	7 (11)	10 (15)	6 (9)	2 (3)	0 (0)	0 (0)	25 (38.5)
	Overweight	2 (3)	5 (8)	4 (6)	3 (5)	10 (15)	0 (0)	24 (37)
	Obese	2 (3)	7 (11)	0 (0)	1 (1.5)	1 (1.5)	1 (1.5)	12 (18.5)
Total		12 (19)	23 (35)	12 (19)	6 (9)	11 (17)	1 (1)	65 (100)

4.8 MSDs In Different Body Parts

The Nordic Musculoskeletal Questionnaire was used to determine in which part of the body are the MSDs localized. Table 4.7 and Figure 4.2 shows that the body parts most affected during the last 12 months are the neck n=49 (68%), the upper back n=49 (68%) and the lower back n=49 (68%). The wrist/hand also had a high frequency for MSDs on the right n=27 (38%), left n=5 (7%) and n=17 (24%) for both wrists/hands. More of the respondents n=32 (44%) were affected in both shoulders than the right shoulder n=9

(13%) or the left shoulder n=2 (3%) and n=12 (17%) suffered with pain in the elbows. Few of the respondents n=23 (32%) suffered pain and discomfort in one or both knees, n=14 (19%) suffered pain in one or both ankles/feet, and n=11 (15%) suffered pain in one or both hips/thighs. A higher frequency rate was reported for the last 12 months than for the last 7 days. Pain and discomfort were not reported by the respondents as often in the last seven days as they were in the last 12 months.

Table 4.7: Musculoskeletal symptoms in different body parts

Body part		**Pain and discomfort during the last 12 months**		**Pain and discomfort during the last 7 days.**	
		Yes n (%)	No n (%)	Yes n (%)	No n (%)
Neck		49 (68%)	23 (32%)	15 (21%)	34 (47%)
Shoulders	Right	9 (13%)	29 (40%)	15 (21%)	28 (39%)
	Left	2 (3%)			
	Both	32 (44%)			
Elbows	Right	7 (10%)	60 (83%)	6 (8%)	6 (8%)
	Left	0 (0)			
	Both	5 (7%)			
Wrist/hand	Right	27 (38%)	23 (32%)	15 (21%)	34 (47%)
	Left	5 (7%)			
	Both	17 (24%)			
Upper back		49 (68%)	23 (32%)	11 (15%)	38 (53%)
Lower back (small of the back)		49 (68%)	23 (32%)	12 (17%)	37 (51%)
One or both hips/thighs		11 (15%)	61 (85%)	6 (8%)	5 (7%)
One or both knees		23 (32%)	49 (68%)	11 (15%)	12 (17%)
One or both ankles/feet		14 (19%)	58 (80%)	7 (10%)	7 (10%)

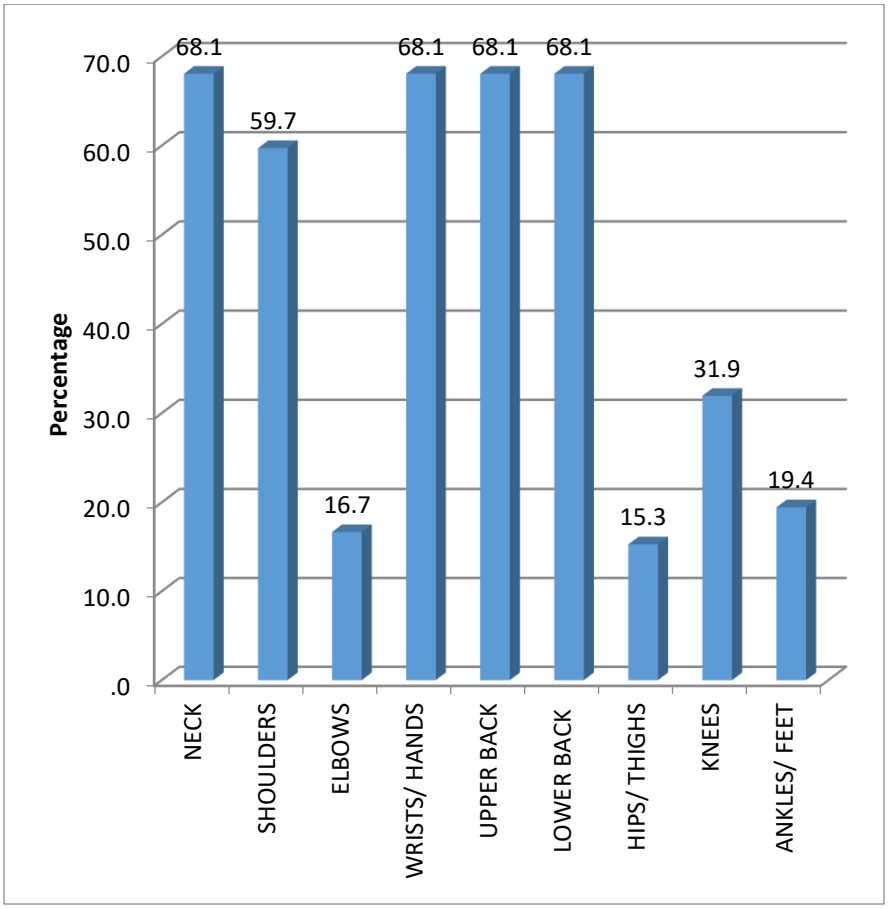

Figure 4.2: 12 months' prevalence of pain and discomfort by body part

For each of the body parts, a binomial test was done to see whether a significant proportion of those who do suffer from symptoms had been prevented from working because of these symptoms. A significant proportion (68%) of those who suffered from neck symptoms were prevented from doing normal work (p=.003). Eighty six percent of those who suffered from shoulder symptoms were not prevented from doing normal work (p<.0005). Few of the respondents (17%) who suffered from elbow discomfort were prevented from working (p=0.039) but the majority of the respondents (84%) who suffered discomfort in the wrist/hands were not prevented from doing normal work (p<.0005). Of those who had discomfort (82%) in the upper back were able to do normal work (p<.0005). For those respondents with discomfort in the lower back, 18% were prevented from doing normal work (p<.0005). Of the respondents that suffered discomfort in one or both hips/thighs (n=11), none was prevented from doing normal work (p=0.001).

Figure 4.3 shows that the majority n=44 (61.1%) (p=0.006) of the participants had been seen by a doctor, physiotherapist, chiropractor, or other health professional because of MSDs but only 25% of these had ever been hospitalized. Just under 10% (9.7%) reported to have ever changed jobs due to MSDs.

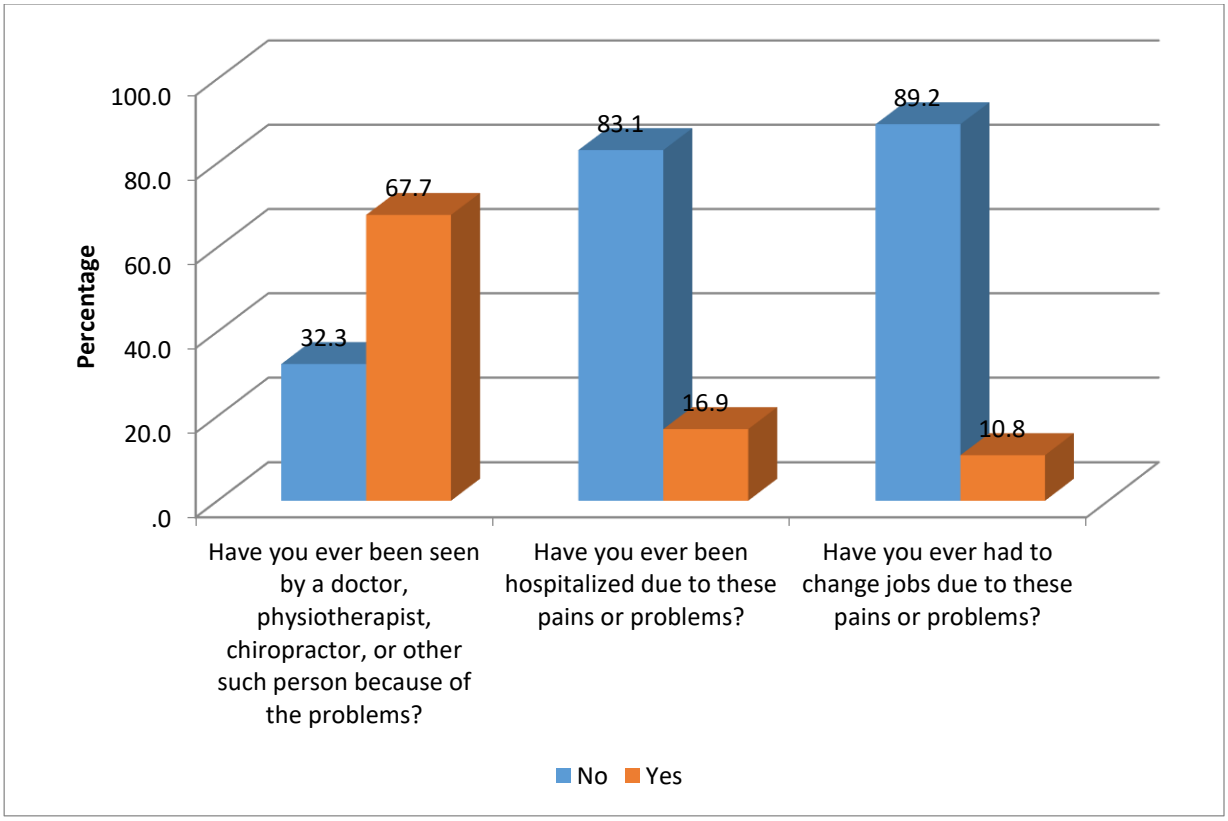

Figure 4.3: The distribution of visits to health professionals, hospitalization and change of jobs as a result of MSDs

Table 4.8 and figure 4.4 indicates that 20 respondents experienced problems in the past 12 months for 1-7 days while 18 participants experienced problems for more than 30 days. 39 participants were not prevented from doing normal work in the last year but 18 were prevented for 1-7 days.

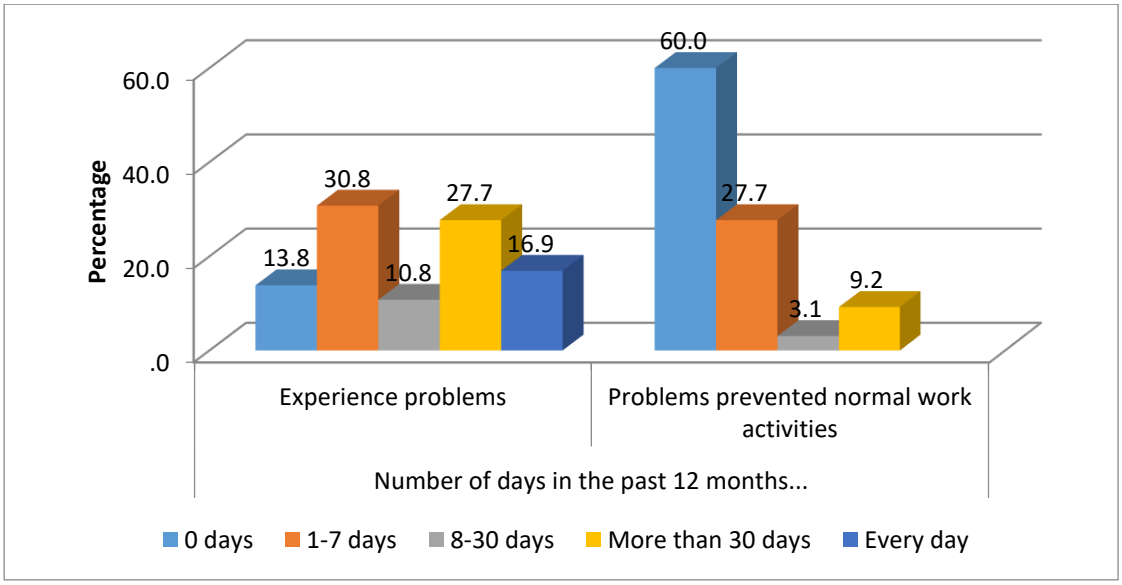

Figure 4.4: The distribution of days with problems and the effects on normal work

Table 4.8: Frequency for days with symptoms of MSDs

	For how many days did you have the problems in the past 12 months?		**For how many days in the last year did the problems prevent you from doing your normal work?**	
	Category	N	Category	N
1	0 days	9	0 days	39
2	1-7 days	20	1-7 days	18
3	8-30 days	7	8-30 days	2
4	More than 30 days	18	More than 30 days	6
5	Every day	11	Every day	0
Total		65		65

The analysis in figure 4.5 showed that 52.8% of the respondents reduced their activity at work as a result of MSDs and majority of participants 63.9% had reduced leisure activity in the last 12 months due to MSDs ($p<0.005$)

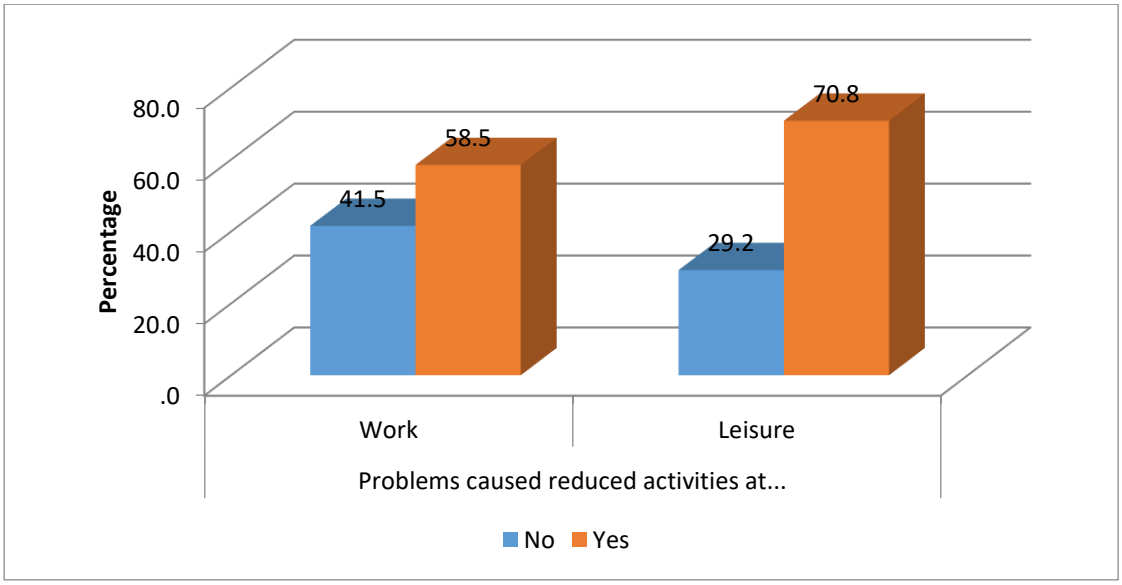

Figure 4.5: Reduced work and leisure due to MSDs

4.9 Correlation Between Risk Factors and Prevalence of MSDs in Each Body Part.

The risk factors identified were age, long years of practice as a dental technician and the different job exposures, such as standing and vibration. The independent sample t-test was applied to test whether there were any significant differences in these measures for those who did and did not experience symptoms.

For the parts of the body most affected;

NECK- there were no significant differences in these measures for those who experienced neck symptoms compared to those who did not experience neck symptoms.

SHOULDERS- there were no significant differences in these measure for those who experienced shoulder symptoms compared to those who did not experience shoulder symptoms

ELBOWS- there were no significant differences in these measures for those who did experience elbow symptoms compared to those who did not experience elbow symptoms. However, chi-square analysis (Table 4.7.1) showed that there was a significant relationship between standing and elbow symptoms (Fisher's = 7.436, p=0.4). Specifically, significantly more of those who experienced elbow symptoms stand often or always.

Table 4.9: Relationship between standing and elbow symptoms of pain and discomfort

Elbow symptoms of pain and discomfort		Standin--g				Total
		Rarely	Sometimes	Often	Always	
elbow pain and discomfort	No frequency	5	27	25	3	60
	%	8.3%	45.0%	41.7%	5.0%	100.0%
	Yes frequency	1	1	8	2	12
	%	8.3%	8.3%	66.7%	16.7%	100.0%
Total	frequency	6	28	33	5	72
	%	8.3%	38.9%	45.8%	6.9%	100.0%

UPPER BACK: There were no significant differences for those who experienced upper backache symptoms compared with those who did not experience upper backache symptoms.

LOWER BACK: There were no significant differences between those who experienced symptoms of lower back pain and/or discomfort compared with those who did not experience symptoms. However, Chi square analysis showed that there was a significant relationship between vibration and low back symptoms (Fishers= 9.234, p= 0.046) (see table 4.7.4). Significantly more of those who experienced low back symptoms reported often being exposed to vibration.

Table 4.10: Relationship between vibration and lower back symptoms

		Vibration					Total
		Never	Rarely	Sometimes	Often	Always	
Lower Back symptoms	No frequency	6	4	8	4	1	23
	%	26.1%	17.4%	34.8%	17.4%	4.3%	100.0%
	Yes frequency	5	8	9	25	2	49
	%	10.2%	16.3%	18.4%	51.0%	4.1%	100.0%
Total	Frequency	11	12	17	29	3	72
	%	15.3%	16.7%	23.6%	40.3%	4.2%	100.0%

P=<0.05

HIP/THIGHS: There is a significant relationship in the expected direction between pain in hips/thighs and standing, respondents who reported standing more often also reported more pain in one or both hips/thighs (Fishers extract test=10.403, p= 0.009).

Table 4.11 Relationship between standing and pain in one or both hips/thighs

		Standing				Total
		Rarely	Sometimes	Often	Always	
Pain in one or both hips/thighs	No frequency	5	28	24	4	61
	%	8.2%	45.9%	39.3%	6.6%	100.0%
	Yes frequency	1	0	9	1	11
	%	9.1%	.0%	81.8%	9.1%	100.0%
Total	frequency	6	28	33	5	72
	%	8.3%	38.9%	45.8%	6.9%	100.0%

P=<0.05

KNEES: There was no significant difference in measures for those who experienced symptoms of knee pain and/or discomfort compared with those who did not experience symptoms.

ANKLES/FEET: There were no significant differences between those who experienced symptoms of pain and/or discomfort in the ankles/feet compared with those who did not experience symptoms.

PHYSICAL FACTORS: For physical factors, Pearson's correlation coefficient was applied and there was no significant relationship between the job exposures (physical factors) and musculoskeletal symptoms.

4.10 Conclusion

The results of this study showed that the 12-month prevalence of MSDs for the surveyed dental technicians in South Africa was high (90%). For the different body regions, the prevalence ranges from 59.7% - 68.1% and the body parts commonly affected are the neck (68.1%), shoulders (59.7%), wrists/hands (68.1%), upper back (68.1%) and lower back (68.1%). Factors that were identified to be strongly associated with MSDs among dental technicians in South Africa are age, years of practice, standing and vibration. These results are comparable with the findings in other similar studies on the prevalence of MSDs among dental professionals in South Africa.

CHAPTER 5

DISCUSSION OF THE FINDINGS, RECOMMENDATIONS AND CONCLUSION

5.1 Introduction

This chapter presents a discussion on the findings of this research study and the conclusion drawn from the findings. It also reviews the study limitations, makes recommendations for future research and initiatives, and notes the significance of the findings. The purpose of the study was to describe the prevalence of MSDs among dental technicians in South Africa, to identify the risk factors responsible for these conditions as well as the body parts that are mostly affected. The dose-response model is used in this chapter to frame the discussion around the research objectives. The dose-response model has four sets of cascading and interacting variables namely: Exposure, Dose, Capacity and Response. The discussion will be presented with respect to the four objectives.

5.2 Objective 1: To determine the prevalence of MSDs among dental technicians in South Africa

In this study, the responses to the Standardised Nordic questionnaire (SNQ) for analysis of musculoskeletal symptoms indicated a 90% prevalence rate of MSDs among dental technicians in South Africa. This is in line with the dose-response model, which describes response as an outcome of the dose caused by exposure. The response could either be primary or secondary, in this study secondary responses refers to pain and the current study recorded a high prevalence of secondary responses which falls within the prevalence range of 64-97% found among dental professionals in other studies (Rabiei *et al.* 2015; Kierklo *et al.* 2011; Dajpratham *et al.* 2010; Hayes, Cockrell and Smith 2009). The result of this study showed that there was no significant difference in the MSDs prevalence between the male and female respondents, and that they cut across all ages. Similar findings were reported in previous studies, where no statistically significant differences existed in the prevalence of MSDs between gender and age groups for all body regions among dentists and other occupational/industrial

groups (Vuletic *et al.* 2013; Lai *et al.* 2013; Widanarko *et al.* 2011). In contrast, Maulik *et al.* (2014) reported a significant association between gender, being higher in the female technicians, with MSDs particularly affecting the neck among medical laboratory technicians. Similarly, Rafie *et al*. (2015) reported that the prevalence of MSDs was generally higher in women than men, and commented that the gender difference may be associated with the female hormones, lower muscle volume and strength of women.

5.3 Objective 2: To identify the parts of the body most affected by MSDs

According to the dose-response model, dose can be physiological, psychological and mechanical disturbances that may affect the internal state of an individual. In the current study, the mechanical disturbances w-ere captured as the response to the effect of the dose were mostly felt in the neck, wrists/hands, upper and lower back. The authors of SNQ had grouped the body into nine regions, with questions on pain or discomfort in the last 12 months or 7 days being asked. Several international and local studies on MSDs reporting the various affected body parts have been published among dental professionals, specifically among dentists, with few reports relating to MSDs in dental technicians (Alghadir, Zafar and Iqbal 2015; Moodley and Naidoo 2015; Botha *et al*. 2014; Vuletic *et al.* 2013; Lia *et al*. 2013; Booyens, Van Wyk and Postma 2009). The unique findings in all these studies is the high prevalence rate of MSDs in the neck and shoulders.

Abduljabbar (2008), in a study on dentists, sought to determine prevalence in the nine body regions, namely: neck, shoulders, elbows, wrists/hands, upper back, lower back, one or both hips/ thighs, one or both knees, one or both ankles/feet. The investigation showed that the frequency of pain and discomfort in the neck, shoulders and lower back was relatively high. Similarly, Vuletic *et al.* (2013) reported prevalence in the same body region, with 76.2% of the dentists having pain in the neck, 71.4% in the upper back and 68.3% in the shoulders, while Simu *et al.* (2014) carried out a similar study but did not include the elbow. They reported that the most commonly affected areas were the lower back, neck and the shoulder regions. Many international studies on dental professionals (Alghadir, Zafar and Iqbal 2015; Vuletic *et al.* 2013; Lia *et al*. 2013; Abduljabbar 2008)

show that MSDs are most prevalent in the neck, shoulder, lower back and upper back, with a 48-83% prevalence rate. Similarly, local studies among dental professionals (Moodley and Naidoo 2015; Botha *et al.* 2014; Booyens, Van Wyk and Postma 2009) showed that neck, hand, shoulder and lower back accounted for the highest prevalence, with rates between 56.6 to 99.1%. These rates were 12 months' prevalence, while in the current study, the body parts with the highest secondary response rate over 12 months were the neck, shoulders, wrists/hands, upper back and lower back, with prevalence rates of 59.7 to 68.1%.

MSDs of the neck, wrists/hands, upper back and lower back have the same prevalence rate of 68.1%, this being slightly higher than that of oral hygienist in South Africa, where the prevalence rate was reported to be 66.5%. The high prevalence rate of MSDs of the neck is supported in results reported by Booyens, Van Wyk and Postma (2009). They reported that more than a quarter of respondents worked on immobile operator chairs, some of which had no back and/or arm support. These factors, which are related to equipment, refers to "exposure" in terms of the dose-response model. They suggested that the immobility of the operator chairs may have played an important role in developing neck pain, which is a secondary response. Lia *et al.* (2013) reported a 52.9% prevalence rate for pain in the neck among dental technicians in Brunei Darussalam. They found that the work posture of the participants, which involved flexion of the cervical spine (exposure), is a probable explanation for neck MSDs (secondary response). These reports correspond to this study, where 96% of the respondents reported often to always sitting and assuming a position of neck and spine flexion with the head and shoulders bent forward (refer figure 2.1). This position is maintained for prolonged periods of time. Similarly, Moodley and Naidoo (2015) reported a higher prevalence rate for neck pain (98.2%) among dentists in KwaZulu-Natal, and attributed it to clinical dental work. They reported that dentists work with their neck in the forward position resulting in neck pain.

In the current study, an increase in age and longer years in practice was significantly linked to wrists/hands symptoms. This result showed a reduction in capacity, which is similar to that of Widanarko *et al*. (2011), who carried out a study on prevalence of musculoskeletal symptoms in relation to gender, age and occupational/industrial group.

They reported that older workers are at higher risk of MSDs due to cumulative trauma and declining capacities. In addition, Ellapen *et al*. (2010) reported that the high incidence of musculoskeletal pain and discomfort in the wrist is as a result of some work load in dentistry that requires precise vision and fine manipulative hand movements. However, this is in contrast to that of Abduljabbar (2008), who reported enhancement of capacity. He documented that the occurrence of pain and discomfort had the tendency to decline with age and the number of years in practice, describing it as a "healthy workers effect". Lai *et al.* (2013) reported a lower prevalence rate of 35.5% for MSDs of the wrists/hands among dental technicians in Brunei Darussalam. Similarly, Botha *et al.* (2014) and Vuletic *et al.* (2013) reported the prevalence rate of 49.7% and 50.5% for the wrist/hands respectively among dentists, but the reasons were not explored.

MSDs of the upper and lower back also had a high prevalence rate of 68.1%, these findings being similar to that of Lia *et al.* (2013), who reported a 58.8% prevalence on the upper back, and a lower prevalence rate of 41.2% for the lower back among dental technicians in Brunei Darussalam. It was reported that work stations with insufficient lighting results in dental professionals assuming an awkward position of the body, which has been reported to be a risk factor for developing MSDs (Lia *et al.* 2013). In the current study, more than half of the participants (67%) reported to sometimes, often or always assuming awkward postures, but there was no significant relationship between this and reported MSDs. Vuletic *et al.* (2013) reported a similar prevalence rate of 71% and 66% for the upper and lower back respectively among dentists in Novi Sad. Ellapen *et al.* (2010), in their study on the incidence of work-related musculoskeletal pain among dentists in Kwa-Zulu Natal, hypothesized that the working postures most dentists prefer requires vertebral flexion, and that they assume such postures for a prolonged period of time, which produces musculoskeletal pain in the back.

The prevalence of MSDs in the shoulder is also in excess of 50% (59.7%), which is keeping with that reported in a study by Lai *et al.* (2013), who reported a prevalence rate of 68.8% of MSDs in the shoulder among dental technicians in Brunei Darussalam. Rafie *et al.* (2015), in their study on the prevalence of upper extremity musculoskeletal disorders in dentists, attributed the prevalence of pain in the shoulder to the nature of dental practice. They further documented that leaning forward 15° or 30° with elevated

shoulders, and maintaining such postures for a long period of time, exerts pressure on the shoulder which in turn cause a secondary response. Similarly, Ellapen *at al.* (2010) reported that the dental cohort in their study on MSDs among dentists in Kwa-Zulu Natal suffered from shoulder pain and discomfort in their dominant shoulder. They related the pain to repeated unnatural working postures involving abduction and elevation of their dominant arms for prolonged period. Most national (Moodley and Naidoo 2015; Booyens, Van Wyk and Postma 2009) and international studies (Alghadir, Zafar and Iqbal 2015; Vuletic *et al.* 2013; Abduljabbar 2008) on MSDs among dental professional reported MSDs in the shoulders in excess of 50%.

5.4 Objective 3: To identify possible risk factors for MSD`s, and determine any correlation between them and the body parts most affected

The aim of the dose-response model is to account for the factors and processes that results in MSDs as a result of exposure. The exposures captured in this study were bending, overstretching, scaling, vibration, standing, sitting, repetitive hand movement, same posture for long periods and awkward posture. Standing and vibration were identified as risk factors for MSDs in the current study, in addition to age and longer years of practice. In the literature, gender, work posture, repetitive hand movement and age has been reported as risk factors for developing MSDs among dental professionals and office workers amongst other professions (Alghadir, Zafar, Iqbal 2015; Cho, Hwang, Cherng 2012).

In the current study, age was identified as a risk factor for MSDs, with older dental technicians reporting more MSDs in the wrists/hands. This is consistent with the findings of White (2013), who reported MSDs among older spay and neuter Veterinarians and Heiden *et al*. (2013) in their study on MSDs in nurses.

There are varying reports regarding the effect of longer years in practice on the prevalence of MSDs. In the current study, those who had worked as dental technicians for longer periods experienced MSDs in at least one body part. This finding is consistent with the results of White (2013), who carried out a study on the prevalence and risk factors associated with musculoskeletal discomfort in spay and neuter Veterinarians,

and identified longer years of practice as a risk factor for MSDs. Inconsistencies with these study findings was identified in the results of Rafie *et al*. (2015), Choobineh *et al.* (2012) and Chamani *et al.* (2012) in their studies on dentists, in which they reported that no statistically significant relationship was found between years of practice and MSDs.

The respondents who experienced wrist/hand symptoms were significantly older on average than those who did not have pain, and had also worked as a dental technician for significantly longer. This could be due to a number of physiological changes that occurs as one ages and the nature of dental technician practice. The wrist tissues become more vulnerable to the damaging effects of repetitive movements, there is a decrease in the tissue elasticity, and the wrist joint may become less flexible, less mobile and more inflamed, which is due to the decrease in the joint's fluids and the wear and tear on the cartilage (Davis *et al.* 2014; Collins 2013). This is consistent with the findings of White (2013), who reported that age and increasing working years was positively related to hand pain severity among spay and neuter Veterinarians. Da Costa and Vieira (2010), in a systematic review of longitudinal studies on the risk factors for work-related musculoskeletal disorders, reported that older age was the main risk factor found to have reasonable evidence supporting a causal relationship with wrist/hand MSDs. However, the findings of the current study are inconsistent with Tinubu *et al*. (2010) and Abduljabbar (2009), who reported that the prevalence of MSDs decreased in older workers and those with longer years in practice.

This study identified standing as a risk factor for MSDs, with a significant relationship being indicated between pain in the hips/thighs and standing, with participants who reported standing more often reporting increased pain in one or both hips/thighs. This is similar to the findings of White (2013), who reported that veterinarian surgeons who stand always or most of the time experienced discomfort in the lower limbs. However, the studies by Arsalani *et al.* (2014) and Choobineh *et al.* (2010) on MSDs among Nursing Personnel showed that low back and knee pain were associated with prolonged standing position. There was a unique finding in the current study, where a significant relationship was found to exist between standing and elbow symptoms, as respondents who reported often to always standing experienced increased elbow pain /discomfort. A Chi square analysis demonstrated that the only risk factor associated with elbow pain

was standing, although a search in the literature did not reveal any such previous findings.

In the current study, vibration was identified as a risk factor for MSDs, being specifically linked to low back symptoms. This is consistent with the findings of Alghadir, Zafar and Iqbal (2015), who reported the use of vibrating tools as a risk factor for MSDs among dental professionals in Saudi Arabia. Significantly, many of those who experienced low back symptoms reported often exposure to vibration. This corresponds with the findings of Kaewboonchoo *et al.* (1998), who carried out a study among workers exposed to hand-arm vibration using SNQ and reported a high prevalence of MSDs in the lower back. Similarly, Keyserling (2000), in his study on workplace risk factors and occupational musculoskeletal disorders, reported a causal relationship between lower back pain and hand-arm vibration among workers. However, the result in this current study differs with that of Nasaruddin, Tamrin and Karrppiah (2014), who reported that there was no significant relationship with MSDs in any body part and hand vibration among Malaysian auto repair mechanics.

Gender in the literature has been identified as a risk factor for developing MSDs, with females having been reported to experience more MSDs symptoms than males (Alghadir, Zafar and Iqbal 2015; Collins and O'Sullivan 2015; Cho *et al.* 2012; Kumar, Kumar and Baliga 2012; Abduljabbar 2008). Their biological differences, such as hormonal conditions, body size (higher body weight and smaller height), muscular capacity (lower strength and composition), lower threshold of tolerance and work-life balance, could account for their high prevalence of MSDs (Alghadir, Zafar and Iqbal 2015; Collins and O'Sullivan 2015; Cho *et al.* 2012). However, findings from the current study did not show any significant difference between genders and the MSDs in any body part. This is consistent with the findings of Kumalo (2015) on MSDs among Nurses in South Africa, who reported no significant relationship between gender and MSDs. The finding in the current study could be attributed to the small number of female respondents n=10 (13.9%). For posture, Moodley and Naidoo (2015) reported that an increase in MSDs is associated with poor posture, but no significant relationship was established in the current study for posture and MSDs, while there was no significant relationship with MSDs in the hands regarding repetitive hand movement.

BMI has been shown to be significantly associated with MSDs in similar studies (Ahmad Nasaruddin, Mohd Tamrin, Karrppiah 2014,) while in the current study, it was not identified as a risk factor. Despite the fact that half (50%) of the participants were overweight or obese, there was no correlation between BMI and MSDs in the current study. This is consistent with the findings of Moodley and Naidoo (2015) and Rafie *et al.* (2015), who also found no correlation between BMI and MSDs among dentists.

5.5 Recommendations

The following recommendations are made as a result of the findings from this study:

For a more reliable estimate, future studies should involve a confirmed diagnosis of MSDs through a physical examination and assessment of the research subjects. The severity of pain in the body site can be assessed by using a Visual Analog Scale (VAS) to gauge more accurately how much pain is experienced.

The effects of psychosocial and other factor such as exercise on the prevalence of MSDs among dental technicians needs to be explored.

The effects of exercise in reducing the incidence of MSDs among dental technicians needs to be investigated.

Studies need to be conducted on preventing and managing MSDs.

The current study showed that the only risk factor associated with elbow pain was standing, this should be clarified in future studies.

Dental laboratory technicians should have more education on the effects of laboratory ergonomics.

Ergonomics regulations and technical guidelines should be developed by the government that would help manage cognitive and physical ergonomics in the workplace.

Policies should be put in place to ensure that every dental laboratory has an occupational health service.

5.6 Conclusion

MSDs are a major occupational health problem for dental professionals, studies showing that there is a high prevalence of MSDs among dental professionals all over the world, which is related to their internal and external work environments, the individual characteristics of the worker and the ergonomics of dental practice. In this study, a high prevalence rate of MSDs was recorded among dental technicians in South Africa. The identified risk factors were age, longer years in practice, standing and the use of vibrating tools. Most affected parts of the body in this study were the neck, shoulder, wrist/hands, upper back and lower back. There are many opportunities to assist dental professionals, particularly the dental technicians, to maintain optimal health during the course of their career. This could be done through improved occupational health practice, education on risk factors for MSDs, adjustment of the work environment and wellness maintenance which could be achieved by regular exercise, reduced BMI, smart drinking and no smoking. Theses measures will improve the quality of life, and ensure that older technicians do not leave the profession due to injuries.

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DUT
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Institutional Research Ethics Committee
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9 December 2015

IREC Reference Number: **REC 148/15**

Ms J N Adetiba
Flat 4, Modena Quarters
250 Moore Road
Glenwood
Berea
Durban
4001

Dear Ms Adetiba

The prevalence and risk of musculoskeletal disorders among dental technicians in South Africa

The Institutional Research Ethics Committee acknowledges receipt of your gatekeeper permission letter.

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

Yours Sincerely,

[redacted]

Professor J K Adam
Chairperson: IREC

DUT DURBAN UNIVERSITY OF TECHNOLOGY
2015 -12- 09
INSITUTUTIONAL RESEARCH ETHICS COMMITTEE
P O BOX 1334 DURBAN 4000 SOUTH AFRICA

Appendix B

Department of Nursing, 2nd floor Open House Building, Ritson Campus, Durban. 4001.

Tel: 031 3732606 Fax: 031 3732039

South African Dental Technician Council

954 Cnr Hill & Arcadia Street,

Arcadia, Pretoria

Gauteng.

Dear Sir/Madam

REQUEST FOR PERMISSION TO ACCESS YOUR DATABASE

I am a registered student for Masters in Nursing at the Durban University of Technology. My research topic is: “The prevalence and risk of musculoskeletal disorders among dental technologist in South Africa”.

Musculoskeletal disorders (MSDs) are among the most common and costly occupational health problems that affect millions of people around the world. The disorders often cause severe long-term pain, physical disabilities and loss of time from work. MSDs create major concerns for the dental technologists/technicians as their daily activities often times put them at risk of the disorders.

The aim of this study is to determine the prevalence of musculoskeletal disorders, identify the risk factors responsible for the conditions as well as the body parts that are mostly affected. The study population are dental technologist/technician registered on the database of the South African Dental Technician Council (SADTC) with functional e-mail addresses and telephone numbers.

A validated Standard Nordic Questionnaire will be used to collect data from all the dental technologist/technician. Confidentiality and anonymity of both the participants and the council will be maintained at all times. Feedback and recommendations will be given at the completion of the study.

I hereby request for permission to access the names, email addresses and telephone numbers of the registered dental technologist/technicians on your database. The participants’ information will be kept confidential and the outcomes will be reported to you. Ethical approval will be obtained from the Durban university of Technology Institutional Research Ethics Committee.

Person to contact in the event of any problems or queries:

Researcher: Joy Adetiba Tel: 0623896630 e-mail: joyadetiba@gmail.com

Supervisor: Dr Penny Orton Tel: 0313732537

Co-Supervisor: Ms Thandi Kumalo Tel: 0313732036
Dept. HOD: Prof N Sibiya Tel: 0313732606
Institutional Research Ethics administrator: 0313732900
Complaints can be reported to the DVC: TIP, Prof. F.Otieno: 031 373 2382.
Thank you

……..	…….
Joy Adetiba	Dr Penny Orton (Supervisor)
Date:	Date:

SOUTH AFRICAN DENTAL TECHNICIANS COUNCIL
DIE SUID AFRIKAANSE RAAD VIR TANDTEGNICI

Tax Invoice

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Account	Your Reference	Tax Exempt	Tax Reference	Sales Code	
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Code	Description	Quantity	Unit	Unit Price	Disc%	Tax	Nett Price
20	Registration Printing Fee	1.00		410.00		14.00%	410.00

Sub Total		359.65
Discount @	0.00%	0.00
Amount Excl Tax		359.65
Tax		50.35
Total		410.00

NB PLEASE USE YOUR REGISTRATION NUMBER AS REFERENCE

WHEN MAKING PAYMENT!!!

EXEMPTION

Exemption may be granted by the Council in the following instances:
(a) To persons who have reached the age of 70 years

PENALTIES

Non payment of annual levies can lead to erasure from register. A dental technician who's name has been erased from the register can in terms of Section 24(5) of the Act be restored to the register if such dental technician

(a) within a period of six (6) months after the date his/her name was removed from the register, pays the equivalent of two (2) times the annual fee, including any other oustanding fees;

(b) After a period of six (6) months has expired after the date of removal from the register, pays the equivalent of five (5) times the annual fee, including any other outstanding fees.

Appendix D

LETTER OF INFORMATION

Dear Participant,

Thank you for voluntarily agreeing to participate in this study.

Title of the Research Study: The prevalence and risk of musculoskeletal disorders among dental technicians in South Africa

Principal Investigator/s/researcher: Mrs Joy Adetiba (PGD, Occupational Health Nursing)

Co-Investigator/s/supervisor/s: Dr. Penny Orton (PhD, Nursing),
Mrs Thandi Kumalo (MTech,Nursing)

Brief Introduction and Purpose of the Study: Musculoskeletal disorders (MSDs) are among the most common and costly occupational health problems that affect millions of people around the world and the disorders often cause severe long-term pain, physical disabilities and loss of time from work. MSDs create major concerns for the dental technicians as their daily activities often times put them at risk of the disorders.

The aim of this study is to determine the prevalence of musculoskeletal disorders, identify the risk factors responsible for the conditions as well as the body parts that are mostly affected among dental technologists in South Africa.

Outline of the Procedures: The consent form and questionnaire will be sent via e-mail in an editable format so that there will be no need for printing and scanning. Questionnaires and consent forms are to be filled and sent back via the same e-mail address within two weeks. Within the period, I may call as many times as possible so as to remind the participants. If there are no appreciable responses after two weeks, a reminder mail/ calls will be put through to the participants again.

Risks or Discomforts to the Participant: There are no risks whatsoever involved in this study.

Benefits: Preventive and management strategies for MSDs among dental technicians can be formulated based on the outcome of this study which could lead to increase working hours, reduced social and economic consequences and retention of dental technicians in the South African health sector.

Reason/s why the Participant May Be Withdrawn from the Study: You can choose to withdraw at any time without any consequences.

Remuneration: There will be no remuneration for participating in the study.

Costs of the Study: There is no monetary cost involved for participating.

Confidentiality: Confidentiality will be maintained and anonymity is assured as no name will be required on the questionnaire. However, the consent forms will include the participants name but they will be kept away electronically in a coded file and will be

unlinked with the questionnaires. A code number instead of name will be used for the questionnaires.

Research-related Injury: There will be no research related injury.

Persons to Contact in the Event of Any Problems or Queries:

Researcher: Joy Adetiba Tel: 0623896630

Supervisor: Dr Penny Orton Tel: 0313732537

Co-Supervisor: Ms Thandi Kumalo Tel: 0313732036

Departmental HOD: Prof M N Sibiya Tel: 031 373 2606

Institutional Research Ethics administrator: Tel: 031 373 2900

Complaints can be reported to the DVC: TIP, Prof F.Otieno on 031 373 2382.or dvctip@dut.ac.za.

Appendix E

INSTITUTIONAL RESEARCH ETHICS COMMITTEE (IREC) CONSENT

Statement of Agreement to Participate in the Research Study:

Thank you for accepting the invite to participate in this study which aims to determine the prevalence and risk of musculoskeletal disorders among dental technicians in South Africa.

- I hereby confirm that I have been informed by the researcher, Joy Adetiba, about the nature, conduct, benefits and risk of this study - Research Ethics Clearance Number: 148/15.
- I have also received, read and understood the above written information (Participant Letter of Information) regarding the study.
- I am aware that the results of the study, including personal details regarding my gender and age will be anonymously processed into a study report.
- In view of the requirements of research, I agree that the data collected during this study can be processed in a computerised system by the researcher.
- I may, at any stage, without prejudice, withdraw my consent and participation in the study.
- I understand that significant new findings developed during the course of this research which may relate to my participation will be made available to me.

_____ _____

_____

Full name of participant Date Signature

I, Joy Adetiba (the researcher) herewith confirm that the above participant has been fully informed about the nature, conduct and risks of the above study.

_____		_____
Full Name of Researcher	Date	Signature

_____	_____	_____
Full Name of Witness	Date	Signature

QUESTIONNAIRE

Please answer all questions by indicating with letter (X) on your answer or fill in where appropriate. All information that you give will be kept confidential. Do not write your name in any of the forms.

SECTION A: PERSONAL INFORMATION

1. Gender

Male	
Female	

2. Age _____ years

3. Weight _____ kg

4. Height _____ m

5. Are you right handed or left handed?

Right handed	
Left handed	

6. Do you smoke?

YES	NO

7. How many cigarettes do you smoke per day? [If you don't smoke enter zero] _____

8. For how many years have you smoked? [If never smoked, enter zero] _____

9. Do you consume alcohol?

YES	NO

10. On average, how many alcoholic drinks do you consume per day? [If you don't drink alcohol, enter zero]

_____

	YES	NO
11. Do you have children?		
12. Have you received or are you currently receiving any form of treatment for a musculoskeletal disorder?		

SECTION B: OCCUPATIONAL HISTORY

13. How long have you been working as a dental technician? _____ months _____ years

14. on the average, how many hours per week do you work? _____

15. Does your job involve any of the following?

	Never	Seldom	Sometimes	Often	Always
15.1 Bending					
15.2 Overstretching					
15.3 Scaling					
15.4 Vibration					
15.5 Standing					
15.6 Sitting					
15.7 Repetitive hand movement					
15.8 Same postures for long periods					
15.9 Awkward posture					

	YES	NO	N/A
16. Have you had any form of work related injury in the past 12 months?			
17. Were you off from work as a result of such injury?			

8. If **YES** to question 17, how many days? _____ days

SECTION C: STANDARDIZED NORDIC QUESTIONNAIRE FOR ANALYSIS OF MUSCULOSKELETAL SYMPTOMS (Kuorinka et al. 1987)

HAVE YOU AT ANYTIME DURING THE LAST 12 MONTHS suffered with, for example, aching, pains, discomfort etc in…	**To be answered only by those who have suffered in some way**			
	Have you at anytime during the last 12 months been prevented from doing normal work (at home or away from home) because of the suffering?		**Have you suffered at anytime during the last 7 days**	
	NO	**YES**	**NO**	**YES**
1. NECK NO ☐ ☐ YES				
2. SHOULDERS NO ☐ ☐ Yes, right shoulder ☐ Yes, left shoulder ☐ Yes, both shoulder				
3. ELBOWS NO ☐ ☐ Yes, right elbow ☐ Yes, left elbow ☐ Yes, both elbows				
4. WRISTS/HANDS NO ☐ ☐ Yes, right wrist/hand ☐ Yes, left wrist/hand ☐ Yes, both wrists/hands				
5. UPPER BACK NO ☐ ☐ YES				
6. LOWER BACK (small of the back) NO ☐ ☐ YES				
7. ONE OR BOTH HIPS/THIGHS NO ☐ ☐ YES				
8. ONE OR BOTH KNEES NO ☐ ☐ YES				
9. ONE OR BOTH ANKLES/FEET NO ☐ ☐ YES				

Answer the following questions ONLY IF YOU HAVE SUFFERED IN SOME WAY

	NO	YES
10. Have you ever been seen by a doctor, physiotherapist, chiropractor, or other such person because of the problems?		
11. Have you ever been hospitalized due to these pains or problems?		
12. Have you ever had to change jobs due to these pains or problems?		

13. For how many days did you have the problems in the past 12 months? (Select ONE option only)

0 days	1 – 7 days	8 – 30 days	More than 30 days	Every day

14. Have any of the above troubles caused you to reduce your activity in the following area during the last 12 months?

	NO	YES
a) Work activity (at home or away from home)		
b) Leisure activity		

15. For how many days in the last year did the problems prevent you from doing your normal work? (Select ONE option only)

0 days	1 – 7 days	8 – 30 days	More than 30 days	Every day

Thank you for participating in this study.

Researcher: Mrs Joy Adetiba

Contact no: 0623896630

Appendix G

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

10 April 2017

To whom it may concern

Editing of Thesis

I have edited the following Masters Thesis, with my edits being provided as 'track changes' in Microsoft Word, the final content being at the discretion of the student and her supervisor.

Title: The prevalence and risk of musculoskeletal disorders among dental technicians in South Africa

Student: Joy Adetiba

Regards

[redacted]

Carrin Martin
MSocSci, PGDipPH
Editor
School of Health Science
College of Health Science
University of KwaZulu-Natal
Westville Campus
South Africa