The epidemiology of work-related neck pain in diagnostic radiographers working in the eThekwini municipality

By

Akshoy Devnarain

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Durban University of Technology

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

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Akshoy Devnarain Date

Approved for Final Examination

27-11-2022

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Supervisor: Dr Ashura Abdul-Rasheed Date

PhD Health Sciences

MTech: Chiropractic

DEDICATION

I dedicate this dissertation to my mother, Nashi Devnarain. Thank you for everything that you have done for me. I would not have grown up the same and would not have become the person I am today without your sacrifice, guidance, and love. I am truly blessed to have you by my side.

I would also like to dedicate this to my sister, Khayel Devnarain, and my cousin, Sanvir Ramkaran. Thank you for all love and support.

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- Last, but not least, to my mother, who has been supporting and motivating me since the beginning – no words can truly describe all your efforts put into me. I will forever be indebted to you.

ABSTRACT

BACKGROUND

Diagnostic radiography is a branch of radiography that is primarily involved with the diagnosis of disease through diagnostic imaging. Additionally, diagnostic radiographers are predisposed to work-related risk factors due to the work that they perform daily and, as result, they are at risk of developing work-related neck pain (WRNP). Investigating the prevalence and work-related risk factors associated among diagnostic radiographers will create awareness amongst diagnostic radiographers and healthcare providers. Furthermore, in a South African context, this will add updated knowledge to the current literature that exists.

AIM

The aim of the study was to determine the epidemiology of work-related neck pain in diagnostic radiographers working within the eThekwini municipality.

METHODOLOGY

The study used a quantitative approach and a descriptive cross sectional survey design. A total 130 participants were recruited for this study. The population sample included qualified diagnostic radiographers who were employed within the eThekwini municipality in the public and private sectors. The questionnaire was distributed and answered either via Hardcopies or QUESTIOPRO® link. All the data were then imported into SPSS version 26 for analysis.

RESULTS

A total of 61 participants had reported WRNP and hence the prevalence rate was 65.6%. The study also reported that females are more likely to have WRNP. Furthermore, the selected risk factors showed that more than 50% of radiographers with WRNP had worked over-time shifts, 75.4% of radiographers experienced neck pain from wearing lead protective gear, 78.7% of radiographers from the study had neck pain from lifting and positioning heavy equipment and machinery, and 47.5% of the participants who had WRNP had a history of a previously diagnosed neck condition. Additionally, 59% of participants had taken leave from work because of WRNP.

CONCLUSION

This study revealed a high WRNP prevalence rate among diagnostic radiographers working within the eThekwini municipality. The results found in this study shared similar findings from various local and international studies. Due to the high prevalence of WRNP, it is highly recommended that management protocols at work should be investigated to aid diagnostic radiographers.

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CHAPTER ONE: INTRODUCTION

1.1 INTRODUCTION

This chapter provides information on the background and rationale. This chapter will also highlight the aim and objectives, as well as the research problem and structure of the dissertation.

1.2 BACKGROUND

The radiography profession consists of various and different disciplines, including Nuclear Medicine; Radiotherapy; Ultrasound and Diagnostic (Niemi and Paasivaara 2007; Thambura and Swindon 2019). Diagnostic radiography is a branch of radiography and the role of the diagnostic radiographer is a technical one, in which they assist in the diagnosis of disease through diagnostic imaging (Reeves and Decker 2012; Udoh *et al.* 2019). Performing the work of a diagnostic radiographer entails certain specific work-related risk factors, such as lifting or positioning of patients, wearing lead protective gear, carrying or positioning heavy equipment and prolonged standing or sitting, which then predisposes them to different types of musculoskeletal (MSK) pain, of which neck pain is a common area of compliant (Lorusso, Vimercati and L'Abbate 2010; Evans *et al.* 2021).

Neck pain is becoming more prevalent amongst the adult population and, according to the Global Burden of Disease (GBD), it is ranked as one of the leading causes of MSK pain (Jahre *et al.* 2020). The annual prevalence of work-related neck pain (WRNP) amongst workers has been increasing, with neck pain complaints ranging between 27% to 48 % (Darivemula *et al.* 2016; Tsang *et al.* 2018; Oliv *et al.* 2019a).

WRNP has been researched and reported in various occupations including the radiography profession but the profession has changed over the years since these studies were conducted and there are differences amongst the radiographic professions between South African versus international radiographers (Kumar, Moro and Narayan 2004a; Kim and Roh 2014). Hence, the fundamental reasoning for this study on WRNP in diagnostic radiographers is to add updated knowledge to the South African body of literature and explore selected work-related risk factors that may predispose diagnostic radiographers working in both private and public sector to WRNP, as well as its impact on their work performance and overall health.

1.3 AIM OF THE STUDY

The aim of the study is to determine the epidemiology of work-related neck pain in diagnostic radiographers working within the eThekwini municipality.

1.4 STUDY OBJECTIVES

Objective one

To determine the point and period prevalence (12 months) of work-related neck pain in diagnostic radiographers working within the eThekwini municipality.

Objective two

To determine the selected risk factors (working hours, equipment being used, previous injury and number of years working) that are associated with work-related neck pain in diagnostic radiographers.

Objective three

To determine the impact of work-related neck pain on work performance.

1.5 RESEARCH PROBLEM

The daily responsibility and duties of a diagnostic radiographer are physical and mentally demanding due to the specific work-related risk to which they are exposed (Lorusso, Vimercati and L'Abbate 2010; Evans *et al.* 2021). These include carrying or positioning heavy equipment, lifting or positioning of immobile patients, wearing lead protective gear, and prolonged standing or sitting (Lorusso, Vimercati and L'Abbate 2010; Thambura and Swindon 2019) and, as a result, diagnostic radiographers present with complaints of WRNP (Evans *et al.* 2019). Previous studies have reported that the prevalence of neck pain amongst diagnostic radiographers was as high as 50% and 61.9% (Kao *et al.* 2009; YektaKooshali *et al.* 2018).

This study investigated the pre-existing knowledge, to provide a better understanding of WRNP amongst diagnostic radiographers. WRNP complaints in diagnostic radiographers is common and effects their physical and mental well-being (Evans *et al.* 2019). There is also little literature on the epidemiology of work-related ill-health in diagnostic radiographers (Hulls *et al.* 2018). Lorusso *et al*. (2017), reported radiographers to have musculoskeletal issues which were primarily related to physical workload. It was also reported that complaints of

neck pain were the third highest amongst radiographers (Lorusso, Bruno and L'Abbate 2007).

Work-related neck pain is common in diagnostic radiographers; however, the epidemiology surrounding is understudied, especially in the South African context.

1.6 RATIONALE BEHIND THE STUDY

Work-related neck pain is any condition resulting from work-related factors that is thought to cause injuries to the supporting structures within the neck region, such as muscles, tendons, ligaments, and joints (Darivemula *et al.* 2016). There are many studies that have been published on work-related neck pain on various occupations but, in comparison to diagnostic radiographers, there is a paucity in the literature that speaks about WRNP (Brandt *et al.* 2004, Rahmani *et al*. 2013, Temesgen *et al.* 2019).

The role of a diagnostic radiographer is focused on helping to identify and diagnose diseases through the use of various imaging machines (Reeves and Decker 2012). The occupational requirements for a diagnostic radiographer can be very physical and demanding and can predispose them to work-related neck pain (WRNP) (Kumar, Moro and Narayan 2004b; Evans *et al.* 2021). Radiographers are required to repetitively perform load-bearing tasks. These include positioning of immobile patients, moving heavy machinery, lifting and carrying patients, as well as wearing heavy lead aprons (Kumar, Moro and Narayan 2004b; Lorusso, Vimercati and L'Abbate 2010; Evans *et al.* 2019). Therefore, all of these risk factors can lead to excessive strain and stress on the supporting structures, such as the muscles, joints

and ligaments, which can result in WRNP (Kumar, Moro and Narayan 2004b; Lorusso, Vimercati and L'Abbate 2010; Evans *et al.* 2019).

According to Safiri *et al.* (2020), neck pain is a significant public health issue on a global, regional and national level and, therefore, they encourage an increase in awareness on the risk factors, as well as preventive strategies for neck pain, which is warranted in order to help reduce the future burden of this public health issue. Similarly, this study on neck pain in diagnostic radiographers is needed to identify and draw more attention to these diagnostic radiographic healthcare workers, on the possible WRNP to which they are predisposed.

As a result of the attention and awareness around these work-related risk factors, diagnostic radiographers will be more cognisant of their own physical and mental well-being and, therefore, reduce the amounts of MSK complaints, absenteeism, sick leave, disability, and improve overall work productivity and efficiency.

In South Africa, the healthcare system is divided into the public and private healthcare sectors and qualified diagnostic radiographers can be employed at either healthcare systems. These two sectors vary in many aspects thereby allowing for risk factors to differ (Thambura and Swindon 2019).

WRNP in diagnostic radiographers could also be attributed to equipment quality and type when comparing the amount and accessibility to technology and equipment available in South Africa versus international countries (Kabongo, Nel and Pitcher 2015b). A study by Kabongo *et al.* (2015), on the analysis of licensed South African diagnostic imaging equipment, revealed that only three of South Africa’s eleven provinces (Gauteng, Western Cape and KwaZulu-Natal) have the full spectrum of diagnostic imaging

modalities in both the public and private sectors, which places more burden on the healthcare system and on radiographers. As a result, they have to work long hours and cover more shifts. This can eventually lead to development of WRNP (Kabongo, Nel and Pitcher 2015a).

Due to the paucity in the literature on the epidemiology of WRNP in diagnostic radiographers, this study will aid in the contribution to the body-of-knowledge to South African diagnostic radiographers. The information from this study may also be used by other healthcare professionals to help devise treatment, management and, educational protocols when treating patients with work-related MSK complaints.

According to an article on reducing the global burden of MSK conditions by Briggs *et al.* (2018), the Sustainable Development Goals (SDGs) for the period of 2020 to 2030 focus on increasing national and global action and attention on MSK health. It was also stated that the World Health Organization (WHO) can help decrease the global disability burden via focusing on MSK health and through various awareness campaigns and programmes (Briggs *et al.* 2018). Likewise, this study is aligned with the intentions and aims of the SDGs of MSK health by adding to the knowledge and drawing attention to MSK health.

1.7 CONCLUSION

1.7.1 Structure of Dissertation

The subsequent chapters will be structured as follows:

Chapter two will discuss the literature review on WRNP and the prevalence across various occupations. Thereafter, the role of diagnostic radiographers will be examined and followed by certain specific risk factors that predispose them to WRNP.

Chapter three will analyse in detail the methodology used for this study in accordance with the aims and objectives. The study design, data collection tool and study procedure will be expounded.

Chapter four will focus on the results of this study.

Chapter five will discuss the results with respect to the literature.

Finally, chapter six which will provide the conclusion, as well as any limitations and recommendations for this study.

CHAPTER TWO: LITERATURE REVIEW

2.1 INTRODUCTION

This chapter provides an understanding to the diagnostic profession, as well as the work that diagnostic radiographers perform daily. It also gives insight to the background anatomy of the neck, the prevalence of neck pain, WRNP, and the risk factors to which they are predisposed. Lastly, the chapter concludes with the impacts of WRNP.

2.2 WHAT IS DIAGNOSTIC RADIOGRAPHY

The radiographic profession consists of various different disciplines, including nuclear medicine, radiotherapy, and ultrasound and diagnostic (Niemi and Paasivaara 2007; Thambura and Swindon 2019). Each of these disciplines have their own specialisation fields, and, in the case of diagnostic radiography, it includes magnetic resonance imaging (MRI), computerised tomography (CT), vascular interventional angiography and mammography (Du Plessis, Friedrich-Nel and Van Tonder 2010; Thambura and Swindon 2019). Within these various disciplines, diagnostic radiography is one of largest groups (Cowling 2008; Holmström, Haavisto and Talman 2022).

According to the South African Qualifications Authority (SAQA), the newly created qualification for a diagnostic radiographer is a four year bachelor's degree (not the previous three year national diploma qualification) (Pieterse, Lawrence and Friedrich-Nel 2016). The idea behind this newly changed qualification is to equip and train students to cope with complex situations in a real-world environment, using

evidence-based solutions (Pieterse, Lawrence and Friedrich-Nel 2016).

2.3 UNDERSTANDING THE ROLE OF A DIAGNOSTIC RADIOGRAPHER

A diagnostic radiographer is a health care professional whose primary role is assisting in the diagnosis of diseases through diagnostic imaging and procedures (Reeves and Decker 2012; Thambura and Swindon 2019). Diagnostic radiographers, also known as X-ray technologist or radiology technicians, have a specific role when it comes to a scope of practice.

The role of a diagnostic radiographer entails, on a daily basis but, not limited to, performing diagnostic imaging, such as MRI, CT, vascular interventional angiography and mammography (Lorusso, Vimercati and L'Abbate 2010). During the procedure of diagnostic imaging, certain tasks are required, and these include, but are not limited to, positioning and immobilizing patients on the examination table, adequately positioning the radiographic equipment (i.e., overhead tubes, erect bucky) over the relevant body structure, working on desktops or on computers, carrying and processing imaging cassettes and wearing lead protective gear (Bos *et al.* 2007; Lorusso, Vimercati and L'Abbate 2010; Henderson *et al.* 2016).

2.4 BACKGROUND OF THE ANATOMY OF THE NECK

The neck region, also known as the cervical region, is located between the areas of the mandible and clavicle (Kohan and Wirth 2014). The background of the anatomy of the cervical region covers the structures of the joints and disc, the basic structure and function

of the cervical vertebral bodies (VB), the vertebral canal and ligaments, the cervical spinal nerve roots and, lastly the cervical region muscles.

2.4.1 The Joints and Disc

The cervical region is made up of seven cervical vertebral bodies (VB), of which C1 and C2, named atlas and axis respectively, have no intervertebral (IV) disc between them. The remaining cervical vertebrae, i.e., C3 to C7, have an intervertebral disc between them.

The cervical vertebral bodies of C3 to C7 articulate superiorly and inferiorly by the intervertebral discs and articulate with the adjacent vertebrae via the uncovertebral joints (also known as joints of Luschka) and zygapophyseal joints or facet joints (also known as Z-joints) (Evans 2014). The intervertebral disc consists of a gelatinous nucleus pulposus (NP) which is surrounded by an annulus fibrosis (AF) and protected in the midline from herniating into the spinal cord by the posterior longitudinal ligament (Evans 2014).

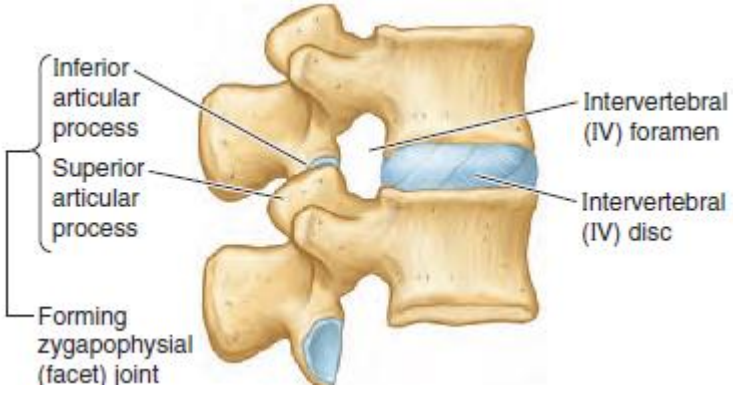

Figure 2.1: The intervertebral disc and the zygapophyseal joints

Source: Keith (2014)

2.4.2 The Basic Structures and Functions Which Make up the Cervical Vertebral Body

The C1 vertebral body (atlas) is the only vertebra that does not have a vertebral body and is divided into the anterior and posterior arches, as well as the lateral mass. The anterior arch consists of facets of the dens (found on C2 vertebral body) and anterior tubercle. The posterior arch consists of posterior tubercle and the groove for the vertebral artery to pass through. The lateral mass consists of the tubercle for the transverse ligament, superior articular surface (process), foramen transversarium and the transverse process (Keith 2014).

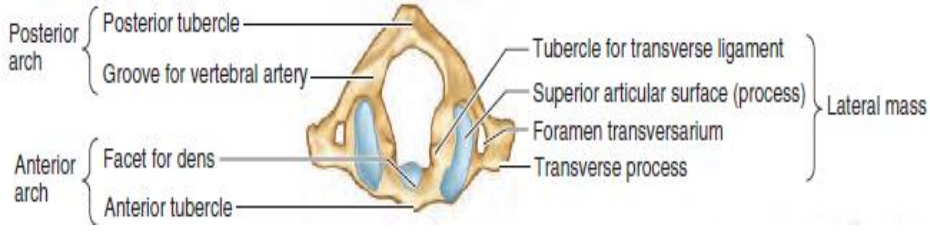

Figure 2.2: The structures of atlas vertebral body

Source: Keith (2014)

The C2 vertebral body (axis), consists of the dens, superior articular facet (which articulates with atlas), inferior articular process, transverse process and the pars interarticularlis.

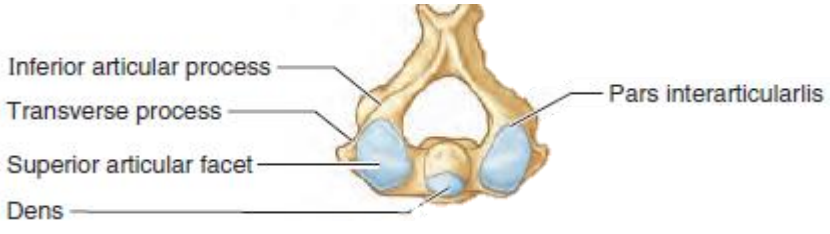

Figure 2.3: The structures of axis vertebral body

Source: Keith (2014)

The vertebral bodies from C3 to C6 are known as typical cervical vertebra, whereas C1, C2 and C7 vertebra are known as atypical cervical vertebra due to the distinguishing features they have, compared to the vertebral bodies of C3 to C6.

The characteristics of vertebral bodies C3 to C6 are as follows. The vertebral foramen at C3 is slightly more rounded and less triangular in shape in comparison to the succeeding vertebra, i.e., C4 to C6 vertebral foramen become more triangular in shape as the lower down the cervical region gets to C7 level. The function of the vertebral foramen is to protect and allow for the passage of the spinal cord and meninges. The C2 to C6 vertebral bodies have bifid spinous process that are short and become longer as the lower down the cervical region gets to C7 (which has the longest spinous process in the cervical region).

In comparison, C7 spinous process does not have a bifid end tip. The function of a spinous process is to serve as an attachment site for muscles to attach on to. The foramen transversarium of C3 to C6 are larger in comparison to C7 for foramen transversarium. The function of foramen transversarium is to allow for the passage of the vertebral artery and vein (Keith 2014).

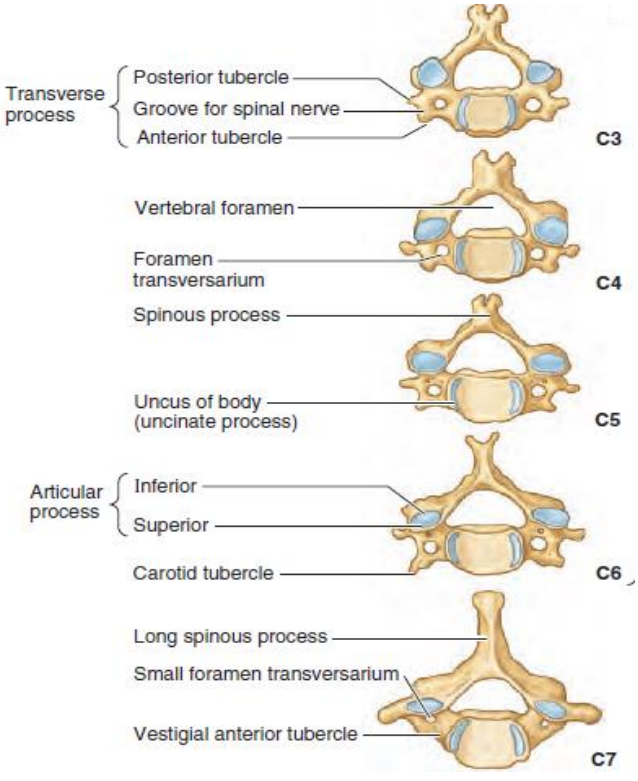

Figure 2.4: The structures of vertebrae C3 to C7

Source: Keith (2014)

2.4.3 The Boundaries of the Vertebral Canal and the Ligamentous Structures of the Cervical Vertebra

Figure 2.5 shows the boundaries of the vertebral canal, which are formed by the anterior, lateral and posterior walls. The anterior wall is made up of posterior longitudinal ligament (PLL). The lateral and posterior walls are made up of the vertebral arches, namely the pedicles and laminae alternating with the intervertebral foramina and ligamenta flava (LF) (Keith 2014).

The cervical vertebrae consist of a few ligamentous structures, namely, the anterior longitudinal ligament (ALL), the posterior longitudinal ligament (PLL), the ligament flava (LF), interspinous

ligament (IL), the supraspinous ligament (SL) and the intertransverse ligament.

The ALL is a strong, fibrous band which connects and covers the anterolateral aspect of VB and IV disc. This ligament extends from the pelvic surface of the sacrum to the anterior tubercle of C1 vertebra and occipital bone anterior to the foramen magnum. The function of the ALL is to prevent hyperextension of the vertebral column and maintain stability of the VB and the joints between them. The ALL is the only ligament to limit extension, the rest of the IV ligaments some degree and forms of flexion.

The PLL is slightly weaker and narrower than the ALL. The PLL extends within the vertebral canal along the posterior aspect of the VB and attaches to IV discs and lesser to the posterior aspect of the VB from C2 to the sacrum. The function of the PLL is to help prevent posterior herniation from the NP, as well as to weakly resist some degree of hyperflexion of the vertebral column.

The LF is a strong, long and thin elastic yellow ligament. The LF extends vertically from the lamina above to the lamina below. The function of the LF is to resist the separation of the lamina by limiting flexion movements of the vertebral column, hence preventing injury to the IV disc.

The IL are thin and weak ligaments that connects adjoining spinous processes, by attaching from the root to the apex of each spinous process. The SL is a cord-like, strong, broad nuchal ligament, that attaches the tips of the spinous process from C7 to the sacrum. The intertransverse ligaments, attaches and connects adjacent transverse processes (Keith 2014).

Figure 2.5 illustrates the boundaries of vertebral canal, as well as the cervical ligaments on a lateral view.

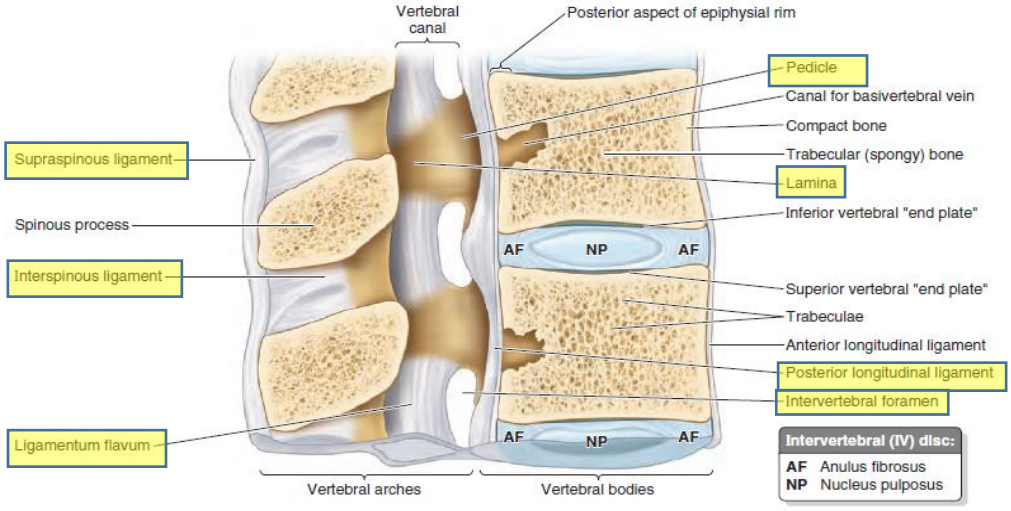

Figure 2.5: The boundaries of vertebral canal, as well as the cervical ligaments on a lateral view

Source: Keith (2014)

2.4.4 Cervical Spinal Nerve Roots

As discussed about the boundaries of the vertebral canal, the intervertebral foramina is the opening in which the spinal/segmental nerves exit through from the vertebral column. The spinal nerves branch off in bilateral pairs from a specific segment of the spinal cord. The name or the identity of the spinal nerves are allocated to a letter and number, example C4 spinal nerve. The letter C indicates the region of the spine and the number indicates the order of spinal emergence from superior to inferior. Hence C4 is the 4th cervical spinal nerve root (Keith 2014). There are a total of eight cervical spinal nerves: C1 to C7 spinal nerve roots exists superiorly to their named vertebra and C8 which exists between C7 and T1 vertebral levels (Evans 2014).

Figure 2.6 illustrates the cervical spinal nerve roots and their corresponding levels.

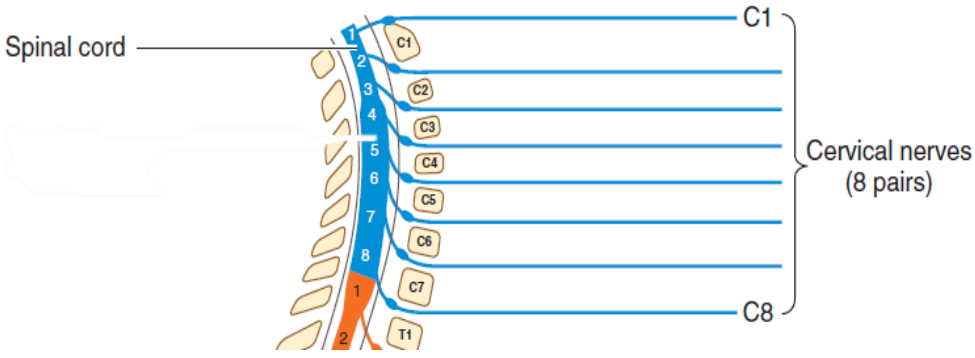

Figure 2.6: Cervical spinal nerve roots and their corresponding levels

Source: Keith (2014)

2.4.5 Cervical Muscles that are Commonly Associated with Neck Pain

Tables 2.1a and 2.1b describes each muscle along with the attachments, innervations and main actions.

Table 2.1a: Muscle attachments, innervations, and main actions

Muscle	Superior Attachment	Inferior Attachment	Innervation	Main Actions
Platysma	Inferior border of mandible, skin, and subcutaneous tissues of lower face.	Fascia covering superior parts of pectoralis major and deltoid muscles.	Cervical branch of facial nerve.	Draws corners of mouth inferiorly and widens. Draws skin of neck superiorly when teeth are clenched.
Sternocleidomastoid (SCM)	Lateral surface of mastoid process of temporal bone and lateral half of superior nuchal line.	*Sternal head:* anterior surface of manubrium of sternum. *Clavicular head:* superior surface of medial third of clavicle.	Spinal accessory nerve; C2 and C3 nerves.	*Unilateral contraction:* tilts head to same side (i.e., laterally flexes neck) and rotates it so face is turned superiorly toward opposite side. *Bilateral contraction:* (1) extends neck, (2) flexes cervical vertebrae so that chin approaches manubrium, or (3) extends superior cervical vertebrae while flexing inferior vertebrae so chin is thrust forward with head kept level. With cervical vertebrae fixed, may elevate manubrium and medial ends of clavicles, assisting pump-handle action of deep respiration.
Trapezius	Medial third of superior nuchal line, external occipital protuberance, nuchal ligament, spinous processes of C7–T12 vertebrae.	Lateral third of clavicle, spine of scapula and acromion.	Spinal accessory nerve; C2 and C3.	Elevates, retracts and rotates scapulae superiorly. When shoulders fixed, bilateral contraction extends neck; unilateral contraction produces lateral flexion to same side.
Rectus capitis lateralis	Jugular process of occipital bone	Transverse process of atlas (C1 vertebra).	Branches from C1 and C2 spinal nerves.	Helps to stabilize and flex head.
Splenius capitis	Bottom half of nuchal ligament and spinous processes of superior six thoracic vertebrae.	Lateral aspect of mastoid process and lateral 1/3 of superior nuchal line.	Posterior rami of middle cervical spinal nerves.	Bilaterally extends head and neck. Laterally flexes and rotates head and neck to same side.
Levator scapulae	Transverse processes C2–C6 vertebrae.	Superior part of medial border of scapula.	cervical spinal nerves C3 and C4. Dorsal scapular nerve C5.	Downward rotation of scapula, as well as tilts its glenoid cavity.

Source: Keith (2014)

Table 2.1b: Muscle attachments, innervations, and main actions

Muscle	Superior Attachment	Inferior Attachment	Innervation	Main Actions
Middle scalene	Transverse processes of C5–C7 vertebrae.	Superior surface of 1st rib.	Anterior rami of cervical spinal nerves.	Elevates 1st rib during forced inspiration and flexes the neck laterally.
Posterior Scalene	Transverse processes of C5–C7 vertebrae.	External border of 2nd rib.	Anterior rami of cervical spinal nerves C7 and C8.	Elevates 2nd rib during forced inspiration and flexes neck laterally.
Anterior scalene	Transverse processes of C3–C6 vertebrae.	1st rib.	Cervical spinal nerves C4–C6.	Flex head.
Rectus capitis anterior	Base of cranium and near the occipital condyle,	Anterior to the lateral mass of C1 (atlas).	Branches from C1 and C2 spinal nerves	Flex head.
Longus capitis	Occipital bone.	Transverse process of C3 to C6.	Anterior rami of C1–C3 spinal nerves.	Flex head.
Longus colli	C1 vertebra; bodies of C1–C3 and transverse processes of C3–C6 vertebrae.	C5–T3 vertebrae. transverse processes of C3–C5 vertebrae.	Anterior rami of C2–C6 spinal nerves.	When working unilaterally, helps flexes and rotation to opposite side.

Source: Keith (2014)

2.5 UNDERSTANDING NECK PAIN

According to Bier *et al.* (2018), neck pain can be described as an uncomfortable sensory and emotional experience that could be related to potential or actual tissue damage or injury to the neck region. The parameters of the neck region start at the superior nuchal line and extend down to the level of the scapular spine (Bier *et al.* 2018). Neck pain can be categorized according to the duration or period in which the pain could last (Cohen 2015; Cohen and Hooten 2017).

There are three main categories for the durations: acute neck pain, subacute neck pain and chronic neck pain. Acute neck pain is pain lasting less than six weeks; subacute neck pain lasts less than or

equal to three months and chronic neck pain is pain longer than three months (Cohen 2015; Cohen and Hooten 2017).

2.5.1 The Prevalence of Neck Pain

According to Jahre *et al.* (2020), the Global Burden of Disease (GBD) study found that, amongst the leading cause of MSK disorders, neck pain was ranked the second highest amongst young adults aged 20 to 24 years old. It was also mentioned that the GBD data from this study found neck pain to be of concern, as there was a 21% increase within the population prevalence of neck pain that lasted longer than three months between the years 2006 and 2016 (Jahre *et al.* 2020). Furthermore, Jahre *et al.* (2020) reported that a 12 month prevalence on neck pain had ranged between 42% to 67% in young adults.

In France, Vincent *et al.* (2013) investigated the annual prevalence of nonspecific neck pain in patients who had a previous history of neck pain. The results revealed that 48% of the patients experienced nonspecific neck pain, classifying their neck pain as chronic or recurrent pain (Vincent *et al.* 2013).

A study in USA by Cohen (2015) on epidemiology, diagnosis and treatment of neck pain, reported that most epidemiologically studies reported an annual prevalence increase of neck pain that ranged between 15% to 50%. It was further reported that neck pain prevalence is higher and peaks in middle aged females (Cohen 2015). Similarly, a USA study by Bier *et al.* (2018) found that an estimate of 50% of the population that reported having neck pain, had a neck pain prevalence of six and 12 months.

In Ethiopia, El-Sayed *et al.* (2010) investigated the prevalence of neck pain from the rural southwest of Ethiopia and the results showed that 5% of this population reported neck pain (El-Sayed *et al.* 2010).

According to Rushton, Basson and Olivier (2019), in a study on neck pain in South Africa, the prevalence of neck pain over a 12 month period was recorded between 30%-50%. Similarly, a 2020 South African study by Kamerman *et al.* (2020) reported that at least 1 in 5 South African adults suffers with chronic pain, of which 17.7% suffer with chronic neck pain.

2.6 WORK-RELATED NECK PAIN

2.6.1 Aetiology

WRNP is defined as neck pain that is experienced from occupational related risk factors which cause strains or injuries to the musculoskeletal structures that make-up the neck region (Darivemula *et al.* 2016). According to Cagnie *et al.* (2007) WRNP is multidimensional and is influenced by a range of physical and psychosocial factors that occur within the workplace.

It was also further reported that physical work-related factors included holding awkward neck postures or increasing head tilt and neck flexion posture for prolonged periods, working in the same position for prolonged periods, and performing repetitive movements (Cagnie *et al.* 2007; Kocur *et al.* 2019). Psychosocial factors such as mental tiredness, fatigue and stress were all associated with WRNP (Cagnie *et al.* 2007; Candan, Sahin and Akoğlu 2019).

2.6.2 Pathophysiology

According to Kocur *et al.* (2019) patients with neck pain from physical work-related factors have been linked with abnormalities in cervical spine curvatures, muscle length and increased loading of the IVD within the cervical region. Kocur *et al.* (2019) further discussed that a collection of muscle metabolites in both homo and heteronymous

muscles during prolong static postural contractions within the neck muscles increases the activity of group 3 and 4 muscle afferents, which results in an activation of gamma loop and leads increased activity within the primary muscle spindle afferents. Lastly, this results in an increased muscle tone and stiffness (Kocur *et al.* 2019).

2.6.3 Clinical Presentation

According to Candan, Sahin and Akoğlu (2019) and Larsson, Søgaard and Rosendal (2007), patients who suffer from WRNP usually present with pain or stiffness on the affected side, with or without decreased range of motion of the neck; on palpation, there may be pain and tightness or increase muscle bulk with sensitivity over the tender points. Headaches may or may not be present with the neck pain and the onset of symptoms usually occur after engaging in prolonged or repetitive tasks (Larsson, Søgaard and Rosendal 2007; Candan, Sahin and Akoğlu 2019).

2.6.4 Prevalence of Work-Related Neck Pain

Research and literature across many professions and occupations have shown an increase in prevalence of WRNP over the past serval years (Darivemula *et al.* 2016; Tsang *et al.* 2018)

A Danish study by Brandt *et al.* (2004) on office workers, revealed work-related neck pain to be a common problem, especially among those who had worked long hours on their computers. Similarly, Rahmani *et al.* (2013), investigated dentists working in Iran and the results revealed that an average of 47% of dentists experienced WRNP.

In 2016, a study conducted by Darivemula *et al*. reported a 43.3% annual prevalence of WRNP in desk job workers at a tertiary care hospital in New Delhi (Darivemula *et al.* 2016). A Swedish study

showed that the annual prevalence of WRNP amongst workers had ranged between 27% to 48%, of which 23% of these workers had reportedly suffered with this pain for three months (Oliv *et al.* 2019a). This study also highlighted that of the total participants who responded to having WRNP, 63% were females (Oliv *et al.* 2019a).

A study of school teachers in Ethiopia revealed neck pain as the most common occupational related health problem and cause of morbidity due to the variety of daily tasks for which those teachers were responsible (Temesgen *et al.* 2019).

A South African study on the common work-related musculoskeletal strains and injury indicates that neck pain occurs between 15-44% of the general community and amongst office workers it was as high as between 50-60% (Collins, Janse Van Rensburg and Patricios 2011). Similarly a South African study by Rushton, Basson and Olivier (2019) mentioned that the incidence and prevalence of musculoskeletal disorders amongst office workers who were employed in the private sector were that 76% suffered from MSK complaints, with WRNP being the second most common compliant.

Another South African study on ophthalmologists, revealed that 62.9% reported having work-related MSK disorders, of which neck pain was one of the most common complaints(Anderson *et al.* 2021).

2.6.5 Prevalence of Work-Related Neck Pain Among Diagnostic Radiographers

According to previous studies conducted across various countries on MSK complaints among diagnostic radiographers, the results showed that work-related neck pain was commonly highlighted amongst this profession (Kao *et al.* 2009; Lorusso, Vimercati and L'Abbate 2010).

In Canada, study by Kumar, Moro and Narayan (2004a), on Morbidity among X-ray technologist had showed that WRNP was ranked the second highest at 28% amongst these staff members. Similarly, A study in Taipei, on work-related MSK disorders amongst staff in the radiology department (Kao *et al.* 2009) revealed that neck pain was the highest compliant among these staff members at 61.9% (Kao *et al.* 2009).

An Italian study on MSK complaints among X-ray technologists showed that the prevalence rates of MSK complaints was increasing, and WRNP was ranked as the second highest MSK compliant (Lorusso, Vimercati and L'Abbate 2010).

In Southern Nigeria, Udoh *et al.* (2019) investigated MSK symptoms and severity among radiographers and sonographers; the results showed 76.3% had at least one MSK symptom of which 40.4% had complaints of neck pain.

A South African study by Thambura and Swindon (2019) on occupational risk factors and their impact on migration of radiographers from KwaZulu-Natal revealed that 20.8% of radiographers suffered with WRNP.

2.7 RISK FACTORS ASSOCIATED WITH NECK PAIN

Neck pain seems to be increasing in prevalence and has not only led to pain or disability but has caused a huge financial and personal burdens on individuals, families and the healthcare system (Safiri *et al.* 2020). According to the systematic analysis of the Global Burden of Disease study, neck pain is multifactorial and can be organized into different categories. such as previous neck injuries or conditions,

sleep patterns, exercise/physical activities and stress related risk factors (Safiri *et al*. 2020).

2.7.1 History of Previous Neck Injuries or Conditions

According to Kim *et al.* (2018), in a study in China on risk factors of non-specific neck pain in computer-using office workers, there is a strong association with previous neck injuries and current neck pain of participants, which is identified as an important risk factor for neck pain (Kim *et al.* 2018).

A study by Green *et al*. (2018) discussed different factors that could lead to neck pain, including prior neck pain and injury. It was also highlighted the most common spinal pathologies and traumatic injuries that could be a risk factor for neck pain. Examples of spinal pathologies include cervical radiculopathy, cervical disc herniation, scoliosis in the neck region and osteoarthritis in the neck. Examples of traumatic injuries include motor vehicle accident, falls and contact sport injuries in the neck region (Green *et al.* 2018).

A study by Bier *et al.* (2018) on the clinical practice guideline for physical therapy assessment and treatment in patients with nonspecific neck pain mentioned that 50% to 85% of the general population with neck pain report that they experience neck pain one to five years later. Additionally, neck pain in the working class appears to be more prominent and recurrent, with about 60% to 80% of the working class population reported having neck pain one year later, after having previous history of neck pain. Also, 50% of the population who reported previous neck injury or trauma-related neck pain would experience to some degree of neck pain at six to 12 months post-accident or post-trauma (Bier *et al.* 2018).

Guez *et al.* (2002) reported a positive association between a previous history of neck injuries and neck pain. Over 25% of all cases with neck pain had a history of neck pain, with whiplash injury being the most common initial injury (Guez *et al.* 2002).

2.7.2 Sleep Patterns

Reduced sleep duration, quality, or disruption in normal sleep patterns is referred to as insomnia (Kim *et al.* 2015). There has been an association between neck pain and insomnia. According to Kim *et al.* (2015), 41 % of patients who had been suffering with neck pain had also been suffering with symptoms of insomnia and that insomnia is linked to aggravating the neck pain. Insomnia is frequently perceived as a secondary symptom in chronic neck pain suffers, as the relationship between sleep and pain was described as a bidirectional relationship, as both can lead to the other (Kim *et al.* 2015).

Similarly, a study done on neck pain and risk factors on office workers showed that 81% of office workers who had experienced low to high levels of sleep disturbances, also experienced neck pain (Ehsani, Mosallanezhad and Vahedi 2017). Part of the reasons why neck pain was linked to sleep disturbances was due to the abnormal long night-day shifts that the office workers had to frequently work (Ehsani, Mosallanezhad and Vahedi 2017).

Kazeminasab *et al.* (2022) stated that the overall factor of low sleep quality or disrupted sleep could play a role in changing the way central pain processing within the spine, brainstem and cortical levels, which ultimately can manifest as hyperalgesia. Further, the measurement tools used to assess sleep quality provide evidence of the association between neck pain and poor sleep quality and quantity. Hence, it is important to promote sleep management intervention in the hopes of

decreasing pain sensitivity and increasing pain modulatory capacity (Kazeminasab *et al.* 2022).

2.7.3 Exercise/Physical Activities

According to the study by Soysal, Bilge and Arda (2013), a decrease in the level of physical activity in daily life, which was referred as “disuse” in the article, presented as an aggravating factor for developing chronicity of pain. It was found that patients who had performed less physical activity had more neck pain and presented with high levels of depression and sleep disruption. Similarly, regular engagement in physical activity is more likely to improve quality of life, depression and sleep disruption (Soysal, Bilge and Arda 2013). This statement was supported by Kim *et al.* (2018), who investigated in the identifying risk factors for first-episode neck pain. The results showed that physical activity was identified as a protective factor for the development of neck pain.

Palmlöf *et al*. (2016) found that work-related physical activity and leisure physical activity could affect neck pain differently. If physical activity is self-chosen by the person during leisure time, it could lead to a stress relieving and a positive attitude and decrease the level of neck pain the person felt. In contrast, if there is physical activity at the workplace (work-related physical activity) and is not a self-chosen activity, then it may not produce the same stress relieving and positive attitude.

The results of this study showed that leisure physical activity prevents long-duration and severe neck pain if the person is free from neck pain but, if not, and they have already experienced some mild neck pain, then leisure physical activity may not relieve the neck pain (Palmlöf *et al.* 2016).

An article on the comparative effectiveness of physical exercise interventions for chronic non-specific neck pain by De Zoete *et al.* (2021) examined different types of physical activities and exercise and its effect on chronic neck pain. Two groups were used in this study. The first group was the control group that had neck pain and did not perform any physical activity or exercise, compared to the second group that did perform physical activity and exercise. The results showed that three different types of exercise interventions were found to be most effective in decreasing pain intensity and disability. The three types of exercises included motor control, Pilates/yoga/tai chi and strengthening exercises (De Zoete *et al.* 2021).

2.7.4 Stress Related Risk Factors

According to Kazeminasab *et al.* (2022), stress has been associated with pain and even disability. It has also been identified as a risk factor for neck pain. Just like disrupted sleep, stress can also contribute to changing the way central pain processing within the spine, brainstem and cortical levels, which ultimately can manifest as hyperalgesia. It was also found that adolescents with neck pain had remarkably more symptoms of stress when compared to those who did not have neck pain (Kazeminasab *et al.* 2022).

Amin *et al.* (2018) mentioned that emotional stress was becoming more frequently reported in both developed and developing countries. It was also reported that the annual prevalence was on average 20%. The results from this study were that the most commonly reported body region to be affected by musculoskeletal pain was the neck (48.9%). Also, emotional stress and work-related stress are associated with MSK pain (Amin *et al.* 2018).

This was also supported by a similar study by Ehsani, Mosallanezhad and Vahedi (2017), whose study focused on risk factors of neck pain in office employees. The results showed that individual/ personal factors such as emotional stress and work-related stress (i.e., working long hours or prolonged standing) can be associated to neck pain (Ehsani, Mosallanezhad and Vahedi 2017).

Other types of stress, such as financial stress, have also been associated with neck pain. A study by Yang and Haldeman (2020), showed that financial worries/stress was highly associated with neck pain. Some of these financial stresses included paying monthly bills, rent or mortgage and medical healthcare costs (Yang and Haldeman 2020).

Similarly, an article on stress-related MSK pain by Mcfarlane (2007) discussed that when the role of certain psychosocial factors in patients who had complained of MSK pain were looked at, these factors included being female, divorced and experiencing financial stress/strain. There were reported higher amounts of work-related stress/strain and overall depression when compared to individuals who did not experience any psychosocial factors.

2.8 WORK-RELATED NECK PAIN RISK FACTORS SPECIFIC TO DIAGNOSTIC RADIOGRAPHERS

The role of a diagnostic radiographer is complex and is physically demanding. There are certain specific work-related risk factors that could predispose them to WRNP, including work shift hours, aged equipment and machinery, use of lead protection, operating heavy equipment or machinery, lifting/positioning patients, prolonged hours

standing or sitting at a desk (Bos *et al.* 2007; Lorusso, Vimercati and L'Abbate 2010; Henderson *et al.* 2016).

2.8.1 Work Shift Hours

Healthcare workers usually have to work overtime shifts in addition to their normal daily/weekly shifts (Hamid *et al.* 2018). A study on ergonomics hazards and MSK disorders among healthcare facilities by Hamid *et al.* showed that 43.5% of healthcare workers, such as X-ray technicians, worked overtime hours of more than eight hours in addition to their weekly shift. Working multiple shifts are associated with MSK pain and are susceptible to ergonomic hazards (Hamid *et al.* 2018).

In addition to MSK pain complaints, working overtime can lead to fatigue and exhaustion. A study by Anderson, Martins and Gelbcke (2019) showed that 92% of the radiographic staff members had to work overtime, of which all of them experienced exhaustion mentally and physically. Some of the staff members also experienced MSK complaints as a result of the overtime. Most common areas reported were the neck and shoulders. Anderson, Martins and Gelbcke (2019) also discussed that some of reasons leading the staff to working overtime included large numbers of patients, working with broken equipment and exposure to ergonomic risks related to manoeuvring weights (equipment or patient),

From a South African context, according to Thambura and Swindon (2019), a great number of radiographers working in KwaZulu-Natal had worked over 60 hours per week, which is much more than the average hours per week (45 hours per week). It was found that the main reason for the staff members working overtime was due to the critical staff shortage in the KwaZulu-Natal province. And as a result,

this caused extreme fatigue, exhaustion and MSK complaints. The most common MSK complaints included headaches (43%), low back pain (36%) and neck pain (21%) (Thambura and Swindon 2019).

2.8.2 Number of Years Working

A study by Kumar, Moro and Narayan (2004) on perceived physical stress at work and musculoskeletal discomfort in X-ray technologists, found a high prevalence of MSK pain in the young population of X-ray technologist. It was reported that one third of participants were under the age of 30-years and had a work experience for only 5-years and less, while the reminding two thirds of the participants were under the age of 40-years and had work experience of 10-years or less (Kumar, Moro and Narayan 2004).

In contrast, a study on ergonomics hazards and musculoskeletal disorders among workers of health care facilities by Hamid *et al.* (2018) found that out of the total participants who had complaints of MSK pain, 55% had less than 5-years of work experience, while the other 45% had more than five years of experience.

2.8.3 Aged Equipment and Machinery

A study by Memon *et al.* (2016) on occupational health related concerns among surgeons discussed the importance of the maintenance of equipment and machinery. It is important to keep the equipment and machinery updated and optimally calibrated so that they are reliable, less strenuous when being operated and less likely to cause injury to the patient and doctor (Memon *et al.* 2016). This is supported by the article on occupational risk factors and their impact on migration of radiographers from South Africa that a lack of regular maintenance of valuable equipment and machinery, especially in the public healthcare sector, can lead to occupational-risk factors, such

as work-related stress, fatigue, job burnout and MSK complaints (Thambura and Swindon 2019).

The lack of maintenance and servicing of older radiographic equipment and accessories not only cause or lead to MSK pain and complaints to the radiographers but also results in regular malfunction and break-downs of valuable equipment. It was also reported that the older malfunctioning machinery leads to decreased work productivity, job satisfaction and more importantly diagnostic accuracy. Additionally, it can lead to backflow of patients during peak hours (Ofori-Manteaw, Antwi and Arthur 2015).

2.8.4 Use of Lead Protection

The use of lead protection is one of the most important personal protective equipment (PPE) for healthcare workers who are exposed to radiation (Monaco *et al.* 2020). The standard average size/thickness is usually 0.5 mm but there are many variations to the materials and thickness of the protective garments used other than lead. For example, other types of materials used include antimony, barium and bismuth. There are also different types of protective garments used to shield various aspects of the body from radiation, including closed vs open back shields, one-piece vs two-piece (example vest and skirt) or belted vs unbelted one-piece (Monaco *et al.* 2020).

The average weekly prevalence of MSK pain, such as neck and back pain, ranges between 50% to 60% in healthcare workers who wear lead aprons frequently (Cornelis *et al.* 2021). It was also mentioned that besides work-related MSK pain and discomfort, prolonged use of lead aprons can cause work-related stress syndrome, which is also known as burnout (Cornelis *et al.* 2021). Similarly, an article by

Knuttinen *et al.* (2021) discussed that wearing lead aprons during operations and radiation exposures can cause work-related MSK disorders. They had also classified the use of lead aprons as risk equipment (Knuttinen *et al.* 2021).

According to the article on MSK complaints among Italian X-ray technologists, radiographers are exposed to physically challenging and demanding tasks on a daily basis, and this profession shows a high prevalence in MSK complaints. There were also certain risk factors, such as wearing lead aprons, that were identified as contributing factors to the MSK pain (Lorusso, Vimercati and L'Abbate 2010).

Another study on radiographers in Gaza by Alagha and Aljeesh (2013) on MSK disorders among radiology technologists at government hospitals reported that 55% of radiographers working in government hospitals had MSK disorders due to wearing lead protective aprons. Some of their MSK disorders included back pain (32%), neck pain (19%) and shoulders (17%) (Alagha and Aljeesh 2013).

2.8.5 Operating Heavy Equipment or Machinery

Much time during an X-ray procedure is operating heavy equipment and machinery in order to adequately position radiographic equipment over the appropriate region of a patient’s body. Examples include carrying image cassettes and transferring and positioning portable X-ray machines, also known as bedside units (BSU) (Lorusso, Vimercati and L'Abbate 2010; Thambura and Swindon 2019).

An article by Telaprolu and Anne (2014) on physical and psychological work demands as potential risk factors for musculoskeletal disorders among workers in weaving operations, showed that the highest risk factor associated with MSK pain included risk factors related to,

pushing, moving, lifting, and lowering heavy objects. The most common areas affected included the lower back, knees and upper back (Telaprolu and Anne 2014).

A Nigerian study by Udoh *et al.* (2019) on MSK symptoms and severity among radiographers and sonographers revealed that the most common MSK pain compliant was low back pain (52%) and neck/shoulder pain (40%). The study had also revealed that 67% of the radiographers and sonographers that experienced MSK pain had difficulties in performing their duty as result of the MSK pain symptoms. One of the most common major risk factors experienced by these radiographers included lifting and moving heavy equipment (Udoh *et al.* 2019).

A study by Evans *et al.* (2021) on self-reported work-related MSK disorders among radiographers revealed that radiographers often felt low back pain, neck pain and ankle and foot pain symptoms more frequently. They had also noticed that some of these MSK symptoms interfered with their typical daily activities and, in most cases, about 70% to 90% had reported that their work had exacerbated the symptoms. The radiographers also found that when carrying the image cassettes and positioning them behind the patients often caused strain on the lower back and upper extremities, as well as lifting and moving heavy equipment and machinery lead to lower back and neck strain (Evans *et al.* 2021).

2.8.6 Lifting/Positioning Patients

As previously mentioned, the role of radiographers includes adequately positioning the patient and X-ray machine in order to obtain the most accurate X-ray image and, as a result, lifting and positioning the patient is an important step in this process (Lorusso,

Vimercati and L'Abbate 2010; Thambura and Swindon 2019). This action of repeatedly lifting patients off or on the examination table is associated with adding stress on weight-bearing joints, such as the knees and lower back (Thambura and Swindon 2019).

Radiographers have also reported that repeated tasks done on a daily basis were most stressful to their bodies. These tasks included lifting and manoeuvring patients from a wheelchair, as well as repositioning a patient from supine to side, and vice versa (Evans *et al.* 2021). Radiographers who performed daily tasks of transferring patients to the cart/table or lifting/assisting patients experienced the highest pain and discomfort. It was also mentioned that 50% of injuries on radiographers were a result of lifting/assisting patients to bed and other types of assistance (Evans *et al.* 2021).

The lifting/positioning of patients is also seen as a risk factor in other healthcare professions. A study by Krishnan, Raju and Shawkataly (2021) on the prevalence of work-related MSK disorders among nursing staff members revealed that the highest prevalence of work-related MSK pain complaints were noted in the most frequently performed tasks, such as lifting and pushing and transferring of dependent/comatose patients (Krishnan, Raju and Shawkataly 2021).

Similarly, another study done on MSK disorders in physiotherapists by Anyfantis and Biska (2018) found a correlation of MSK injuries in physiotherapists while lifting and moving patients during certain weight stabilizing techniques. The most commonly affected regions include the neck, lower back and shoulders (Anyfantis and Biska 2018).

2.8.7 Prolonged Hours Standing or Sitting at a Desk

A study done in Kuwait by Alrowayeh *et al.* (2021) on the prevalence and risk factors of work-related lower back pain among radiographers showed that during certain work activities, such as prolonged periods of sitting or standing, there was an increase in the prevalence of work-related lower back pain and that standing or sitting for long periods were significantly associated with MSK pain (Alrowayeh *et al.* 2021).

Another study on practicing radiographers and their copying mechanisms with regards to MSK pain by Okeji *et al.* (2019) revealed that one of the largest contributing factors or causes of lower back pain among radiographers was standing and walking throughout the entire X-ray procedure. Some of the coping strategies employed included sitting and resting after a few hours of working on their feet (83.6%) and standing after a few hours of sitting down (61.8%) (Okeji *et al.* 2019).

The average prevalence of MSK disorders among people who routinely spend between three to five hours at the computers and performing desk work is 40% to 70% (Mohammadipour *et al.* 2018). Similarly, the study on the short term musculoskeletal and cognitive effects of prolonged sitting during office computer work by Baker *et al.* (2018) found that symptoms of muscle fatigue and discomfort were felt over two hours of prolonged sitting. It was also noticed that the level of discomfort was felt throughout the areas of body with the low back region experiencing the highest concentration of discomfort (Baker *et al.* 2018).

Evans *et al.* (2021) reported that about 40% of radiographers experienced pain and discomfort during long hours of standing. It was also discussed that a combination of other specific work-related activities would be a further contributing factor and increasingly aggravate the pain and discomfort. An example of this is that radiographers reported more pain when wearing lead protective aprons while standing for long X-ray procedures (Evans *et al.* 2021).

2.9 THE IMPACT OF WORK-RELATED NECK PAIN

Work-related MSK pain has been linked to various outcomes, the severity of which depends on the amount of risk factors to which one is exposed (Fan and Straube 2016; Monaco *et al.* 2020). The various outcomes of work-related MSK pain include occupational/work injuries, chronic diseases, work-related disability and absenteeism from work (Fan and Straube 2016; Monaco *et al.* 2020).

In some cases, the occupational risk factors are so overwhelming that they cause negative physical and psychosocial effects, which have resulted in radiographers changing their workplace, emigrating to another country or changing to another profession entirely (Thambura and Swindon 2019).

2.9.1 Health and Quality of Life

A Hungarian study on the possible predictors of burnout among radiographers by Sipos *et al.* (2020) revealed that because of work-related stress factors, such as increased overtime shift due to the department being understaffed, the radiographers are more likely to experience high levels of emotional exhaustion and burnouts, which negatively impacts health and well-being, as well as leads to job dissatisfaction (Sipos *et al.* 2020).

Other studies on radiographers have also reported on various consequences of work-related stress, such as fatigue, absenteeism, exhaustion, depression, tension headaches and a combination of mental and biological burdens, that results in a decrease in immunity, which contributes to becoming more susceptible to common colds and flus (Anderson, Martins and Gelbcke 2019; Alrowayeh *et al.* 2021; Cornelis *et al.* 2021).

2.9.2 Work Performance

Oranye and Bennett (2018) investigated the prevalence of work-related MSK and non-MSK injuries in healthcare workers and found that work-related MSK disorders were the most prevailing type of injuries found among healthcare workers, particularly among nurses, employees of support services and clinical staff members. It was also reported that the implications and costs related to such work-related injuries include work absence, decreased work productivity and, in some cases, claims of work disability from the healthcare sector (Oranye and Bennett 2018).

Workers who experienced work-related pain showed a decreased work ability and work performance and resulted in a decrease in total work productivity when compared with workers who did not experience any pain (Oliv *et al.* 2019a).

Amongst other healthcare professions, such as dentistry, there are also implications of work-related stress on the work performance of these professionals (Marklund *et al.* 2020). It has been reported that an accumulation of high stress levels, pain and discomfort can result in a decrease in quality, quantity and overall work productivity (Marklund *et al.* 2020).

2.10 SUMMARY OF LITERATURE

This chapter has provided insight to the role of diagnostic radiographers as relating to neck pain. The definitions of WRNP have also been discussed to provide an understanding of the type and location of MSK pain of the study population.

The prevalence of neck pain and WRNP had also been discussed in various professions and among the diagnostic radiographers. Most of these studies represent data from international countries and focused on healthcare and office workers. Risk factors discussed in this study were divided into categories, namely risk factors for neck pain and WRNP risk factors specific to diagnostic radiographers.

While diagnostic radiographers and the association of various MSK pain and risk factors have been studied, the literature around WRNP and their risk factors from a South African context is limited and, hence, this study will provide and add to the body of literature.

This study explores the risk involved with the work a South African diagnostic radiographer must perform daily and to determine the prevalence of work-related neck pain. In addition to adding to the body of literature, this study will create awareness around risk factors and WRNP associated with diagnostic radiographers. The information from this study can also help healthcare practitioners understand the risks factors associated with WRNP and aid in the decision-making process of management and preventive strategies.

2.11 CONCLUSION

In this chapter, the role and function or diagnostic radiographers was unpacked, as well as the anatomy of the neck region. A further discussion on the prevalence among other healthcare workers and

neck pain and WRNP was explored. Risk factors related to the profession and its impact on the radiographers was also reported in the literature.

The next chapter will explore and highlight the methodological processes that were used in this study.

CHAPTER THREE: METHODOLOGY

3.1 INTRODUCTION

This chapter will present and discus the data collection process of the study, as well as engage and unpack the methodological processes that underpin the study.

3.2 STUDY DESIGN

The study design was quantitative, using a descriptive cross sectional survey (Kothari 2004; Apuke 2017). A descriptive study makes use of questionnaires to collect data. According to Kothari (2004), the key importance of a descriptive design is to describe a state of affairs, as it currently exists. Using a quantitative research approach allows the researcher to get objective answers that are specific to the research questions (Apuke, 2017). Hence, this design was the most appropriate for this study.

3.3 STUDY LOCATION

The research study was conducted in both public and private hospitals located within the eThekwini municipality district. For the study to be conducted, a support letter to the eThekwini municipality (Appendix 3) requesting permission to data collect within the eThekwini district had to be obtained prior to attaining gatekeeper permission from the South African government's Department of Health (Appendix 4) and private hospital managers (Appendix 5).

Table 3.1 Private and public hospitals within the eThekwini municipality district.

Table 3.1: Private and public hospitals

PRIVATE HOSPITAL	PUBLIC HOSPITAL
• The Crompton Hospital • Entabeni Hospital • Parklands Hospital • St. Augustines • Westville Hospital • Ahmed Al-Kadi Private Hospital • City Hospital Ltd • Durdoc Hospital • Ethekwini Hospital & Heart Centre • Hillcrest Private Hospital • Lenmed Shifa Private Hospital • Mount Edgecombe Hospital • Victoria Hospital	• Addington Hospital - Regional hospital • Clairwood Hospital - Specialised chronic hospital • Inkosi Albert Luthuli Central Hospital – National central hospital • King Dinuzulu Hospital (King George V)- Specialised TB Hospital • King Edward VIII Hospital – Tertiary hospital • Mahatma Ghandi Hospital – Regional hospital • Osindisweni Hospital – District hospital • Prince Mshiyeni Hospital – Regional hospital • R.K Khan Hospital – Regional hospital • Wentworth Hospital – District Hospital • St Aidan's Hospital – State-aided, regional hospital

3.4 STUDY POPULATION

The target population included qualified diagnostic radiographers who were registered with the Health Professionals Council of South Africa (HPCSA) and who were employed within the eThekwini municipality in the public and private sectors. In order to observe and determine the true representation of data for this population group, diagnostic radiographers from both private and public were utilised in this study.

3.5 PARTICIPANT RECRUITMENT

The participant recruitment process involved the use of a research advertisement (Appendix 6) which was dropped off by the researcher at the data collection sites. In addition, the advertisement was posted

on the researcher's social media platforms. The research was also advertised through word of mouth and communicated to the diagnostic radiographic departments via email. Interested participants either completed the questionnaire through the QUESTIOPRO® link or if the researcher visited the data collection site, they had completed the questionnaire on a printed hardcopy.

3.6 SAMPLING

3.6.1 Sampling Size

The total number of diagnostic radiographers in the eThekwini municipality was attained through the online active HPCSA iRegister, which is accessible to the public. The total number of diagnostic radiographers with active HPCSA registrations was 236. A sample size of 144 diagnostic radiographers were utilised in this study as the sample was calculated at a 95% confidence interval and a 5% margin error (Esterhuizen, 2020).

3.6.2 Sampling Strategy

The sampling strategy employed in this study was convenience sampling, selecting participants who are readily and easily available, overcoming many of the limitations associated with research (Taherdoost 2016). Due to the large variety of public and private hospitals present within the eThekwini district, the quickest, easiest and most inexpensive option available for sampling in this study was the convenience sampling strategy.

3.6.2.1 Inclusion Criteria

- Diagnostic radiographers registered with HPCSA.
- Diagnostic radiographers who were employed at the public or private sectors within the eThekwini municipality.
- Participants who provided and signed informed consent.

3.6.2.2 Exclusion criteria

- Nuclear medicine radiographers, ultra-sonographers, and radiotherapists.
- All student radiographers (interns or community service).
- Those who partook in the focus group and pilot study were excluded from the main study.

3.6.3 Data Collection Tool

The questionnaire (Appendix 12) for this study was conceptualised and adapted from various articles. Table 3.2 indicates the articles that were used in the different sections of the questionnaires.

Table 3.2: Questionnaire reference list

Article references	Section from questionnaire
Misailidou *et al.* (2010)	Section A – Demographics.
Punnett and Wegman (2004); Green (2008)	Section B – Neck pain prevalence.
Punnett and Wegman (2004); Green (2008)	Section C – General risk factors.
Green (2008); Oliv *et al.* (2019b)	Section D – Work- related risk factors.
Green (2008); Oliv *et al.* (2019b)	Section E – Impact of work-related neck pain on job performance.

The questionnaire consisted of a total of five sections (namely Section A to Section E). In section A, there was a total of six questions based on demographic data. In section B, a total of four questions based on

neck pain prevalence data. In section C there were eight questions which were based on general risk factors. In section D, a total of 20 questions were based on work-related risk factors. In section E, a total of three questions were based on the impact of work-related neck pain on job performance.

3.7 RESEARCH PROCEDURE

Once provisional ethical clearance and gatekeeper permissions were attained, the research procedure was followed.

3.7.1 Focus Group

A focus group is a technique whereby the researcher assembles a group of individuals to discuss a specific topic, aiming to draw from the complex personal experiences, beliefs, perceptions, and attitudes of the participants through a moderated interaction (Nyumba *et al.* 2018). The purpose of a focus group was to assess the strength and weaknesses of the topic, as well as to critically analyse the relevant literature and discuss both the potential merits and issues (Nyumba *et al.* 2018).

3.7.1.1 Inclusion Criterion for the Focus Group

- Participants were required to sign a letter of informed consent (Appendix 9)
- Participants were required to sign a confidentiality agreement (Appendix 8) before participation.

3.7.1.2 Exclusion Criterion for the Focus Group

- Nuclear medicine radiographers, ultra-sonographers, and radiotherapists.
- Student radiographers.

- Internship/ community service students.

3.7.1.3 Focus Group Procedure

In this study, the focus group was conducted in the following manner:

- The meeting took place on a virtual platform using Microsoft Teams; this method was chosen as it limited face-to-face contact during COVID-19. A date and time that was convenient to all members of the focus group was then selected.
- The focus group consisted of the researcher, a researcher supervisor, two chiropractic staff members/clinicians, a master's research student who had previously conducted survey research study, and two diagnostic radiographers from both the public and private sectors, who met the inclusion criterion.
- Each member of the focus group was emailed a letter of information (Appendix 7), as well as a confidentiality form (Appendix 8) and an informed consent form (Appendix 9) that were required to be signed and emailed back to the researcher.
- The diagnostic radiographers who partook in the focus group were excluded from the main study.
- The focus group meeting began with the researcher reading out each question from the questionnaire aloud, and discussions per question took place amongst the members of the group, with regards to of the relevance of the questions in accordance with the aims and objectives of the study.
- This assisted the researcher in terms of identifying important areas that needed addressing regarding the questionnaire.
- After discussing each question, the members of the focus group were thanked, and the meeting was ended.

- The meeting was recorded for future reference and was only accessible by the researcher and supervisor.
- After completing the corrections discussed during the focus group meeting, the post-focus group questionnaire was developed.

3.7.2 Pilot Study

The pilot study allowed for the questionnaire to be tested for feasibility and to identify if any flaws that could have been present before the main study commenced. The pilot study also helped to check that the questionnaire was well-organized and ran smoothly. The purpose was to receive feedback from the participants who partook in the pilot study to help improve the questionnaire (Leon, Davis and Kraemer 2011).

3.7.2.1 Inclusion Criteria for the Pilot Study

- Diagnostic radiographer who was registered with HPCSA.
- Diagnostic radiographers who were currently employed at the public or private sectors within the eThekwini municipality.

3.7.2.2 Exclusion Criteria for the Pilot Study

- Nuclear medicine radiographers, ultra-sonographers, and radiotherapists.
- Student radiographers.

3.7.2.3 Pilot Study Procedure

The pilot was conducted in the following manner:

- Two diagnostic radiographers, one from the public and one from the private sector, who met the inclusion criteria for the main study, were contacted and approached via word of mouth with help from the radiographers who partook in the focus group.

- The first diagnostic radiographer was emailed the link to the DUT QUESTIOPRO® link and completed the questionnaire via the online platform. The second diagnostic radiographer was handed the hardcopy of the questionnaire to complete.
- This assisted in determining any logistical problems and feasibility issues from either method of completing the questionnaire. The diagnostic radiographers who partook in the pilot study were not included in the main study.
- The letter of information (Appendix 10) and an informed consent form (Appendix 11) were given to the participants to read and sign prior to the questionnaire being completed.
- Comment boxes were available at the end of both the hardcopy and digital copy of the questionnaires for the participants to make any suggestions
- Once the questionnaires were answered, all comments and feedback were used to produce the finalized questionnaire (Appendix 12) for the main study.

3.8 MAIN STUDY PROCEDURE

Upon full ethical approval, the main study procedure took place as follows:

- Participant recruitment resumed.
- The researcher travelled, if allowed on the hospital premises, to each research site and left the advertisements (Appendix 6), within the radiography departments for circulation and distribution. In the case of the hospitals that did not allow the researcher onsite, due to COVID-19 restrictions, the

researcher was provided with the email addresses for the management staff at the radiography departments. The management staff relayed the advertisement and spread awareness of the research study.

- The researcher also posted the advert on social media platforms to further increase awareness.
- The methods employed for the questionnaire design included a dual method approach. This depended on the COVID-19 restrictions that each hospital had decided.
- Interested participants located at the hospitals that did not allow the researcher access were emailed the DUT QUESTIOPRO® link to complete.
- Interested participants located at the hospitals that did allow the researcher onsite were handed hardcopies of the questionnaire by the researcher to be completed.
- The researcher allocated certain days for each data collection site.
- Prior to completing either the digital or hardcopy questionnaire, the participant had to read and sign the letter of information (Appendix 1) and inform consent form (Appendix 2). The letter of information and informed consent form were also present on the DUT QUESTIOPRO® link prior to completing the questionnaire online.
- Once the questionnaires were completed, the hardcopies questionnaires were placed in separate allocated ballot boxes. The digital copies were submitted and saved on the QUESTIOPRO® account website. This account was only accessible by the researcher.

- Once the data collection was completed, the questionnaire data were captured and exported into an Excel spreadsheet for data analysis.
- All data and completed questionnaires were safely kept in storage.

3.8.1 COVID-19 Safety Protocol

During the data collection process, the following safety protocols were maintained:

- The researcher and participants were all wearing masks.
- All of the participants' hands were sanitised before they were handed any forms.
- Each of the participants were encouraged to utilise their own pens.
- Each participant placed their own answered questionnaire in ballot boxes to limit interaction. In addition, the researcher placed all ballot boxes and questionnaires under the sun for a duration of five days before the data capturing and analysis process begun.
- Social distancing was also maintained throughout the data collection process.
- The online DUT QUESTIOPRO® version of the questionnaire promoted COVID-19 safety.

3.9 DATA MANAGEMENT

The researcher had two ballot boxes, one with the signed informed consent forms and the second one with all answered hardcopy questionnaires. The researcher also had all the responses from the online questionnaire captured on an Excel spreadsheet, as well as the

hardcopy data recorded on the Excel spreadsheet. All the data were then imported into SPSS version 26 for analysis.

Descriptive analysis was used to describe the prevalence, specific risk factors and impact on work performance associated with work-related neck pain. Prevalence was reported as a percentage along with 95% confidence intervals. The factors associated with point prevalence of neck pain were assessed initially using bivariate analysis, such as chi square tests, for categorical predictors, and t-tests for continuous variables. Those factors found to be associated at the $p<0.2$ level was further modelled as in dependant variables in a multiple logistic regression model. Factors meeting the $p<0.05$ level were retained in the final model and odds ratios; 95% confidence intervals and *p* values was reported. A *p* value <0.05 was considered as statistically significant. This information was obtained through a biostatistician.

3.10 ETHICAL CONSIDERATIONS

The following ethical considerations were taken into account.

3.10.1. Autonomy

Autonomy is the capacity of an individual to make a choice without coercion or external influence (Osamor and Grady 2018). This was accounted for as participants were not pressured into partaking in the study and each participant received a letter of information (Appendix 1), in which they could choose whether to be a part of the study or not. Any participants wishing to participate in the study then needed to return a consent form (Appendix 2), which was signed once they had read the information letter (Appendix 1).

3.10.2. Beneficence

Beneficence is defined as an act of kindness with a strong connotation of doing good to others including moral obligation (Martela and Ryan 2020). In this study, it was accounted for as the information provided by participants was be used to determine the epidemiology of work-related neck pain and associated risk factors. This information can then be used to provide treatment and management guidelines for these participants and benefit the profession as a whole.

3.10.3. Justice

Justice was ensured and maintained with all participants in the study in that they were all treated equally and with respect.

3.10.4. Non-Maleficence

Non-maleficence means not harming or inflicting the least harm to reach a beneficial outcome (Motloba 2019). This study was voluntary and therefore participants were allowed to withdraw at any point without fear of harm and consequences, thus maintaining non-maleficence.

3.10.5. Confidentiality

Confidentiality was maintained as participants were not required to provide their identity details on the questionnaires and the completed questionnaires were placed in ballot boxes to ensure anonymity.

3.11 CONCLUSION

This chapter highlighted the various methodological processes used for this study. It unpacked the features of the study design, study population, the sampling, as well as explaining the process of

developing the data collection tool. This chapter also expounded upon all the ethical considerations that were taken into account.

Chapter four will provide the results and chapter five will explain and discuss the results of the study.

CHAPTER FOUR: RESULTS

4.1 INTRODUCTION

This chapter focuses on illustrating the results of the statistical analysis from the data collected. The results are presented in tables and graphs.

4.2 SAMPLE SIZE AND RESPONSE RATE

The sample size calculated for this study was 144 participants. The study received a total of 130 responses. However, a total of 37 responses were excluded due to incompletion of the questionnaire. Hence, only 93 responses from a total of 130 responses were considered valid and complete, which resulted in a study response rate of 72%.

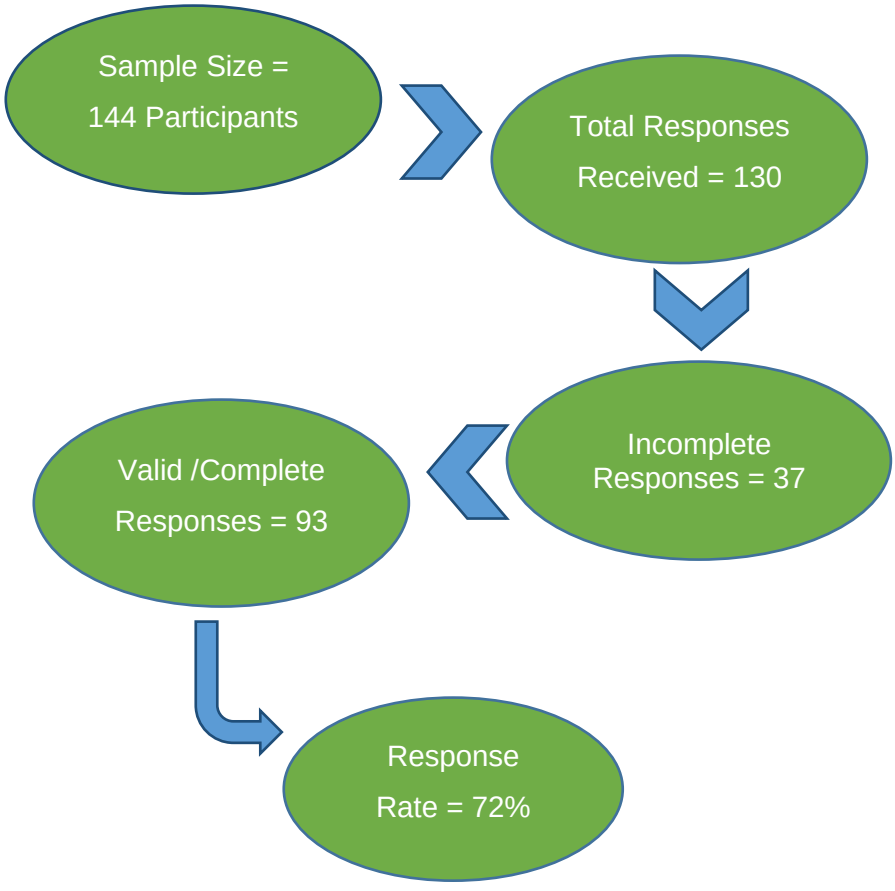

Figure 4.1: Sample size and response rate

4.3 RESULTS

The results were outlined according to the demographics of study participants, prevalence of neck pain, distribution of risk factors in those with work-related neck pain, association between demographic factors and work-related neck pain and the impact of work-related neck pain.

4.3.1 Demographics of Study Participants

The demographic factors included the participants' age, gender, race, weight, height and modality speciality category (general radiography, computed tomography, theatre radiography, MRI, mammography).

4.3.1.1 Age

The mean age of the participants was between 31-40 years of age, which had accounted for 41.9% of the total participants, as depicted in Table 4.1.

Table 4.1: Age category

		Count	Column N %
Age category	20-30 years	30	32.3%
	31-40 years	39	41.9%
	41-50 years	17	18.3%
	>50 years	7	7.5%
	Total	93	100.0%

4.3.1.2 Gender

The mean gender of the study was females, which accounted for 73.1% of the study population, as depicted in Table 4.2.

Table 4.2: Gender category

		Count	Column N %
Gender category	Male	25	26.9%
	Female	68	73.1%
	Total	93	100.0%

4.3.1.3 Race

The study had various race groups respond, the results show that the Indian race category accounted for 53.8% of the total participants response, which is shown in Table 4.3.

Table 4.3: Race category

		Count	Column N %
Race category	African/black	30	32.3%
	Coloured	6	6.5%
	Indian	50	53.8%
	White	5	5.4%
	Other	2	2.2%
	Total	93	100.0%

4.3.1.4 Weight and Height

The weight and height of the participants were also recorded. The results show that mean weight and height were 61–70 kg (34.4%) and 1.6–1.7m (66.7%) respectively, which is depicted in Table 4.4.

Table 4.4 Weight and height category

		Count	Column N %
Weight category (kg)	40–50kg	3	3.2%
	51–60kg	19	20.4%
	61–70kg	32	34.4%
	71–80kg	18	19.4%
	81–90kg	12	12.9%
	>90kg	9	9.7%
	Total	93	100.0%
Height category (meters)	1.4–1.5m	21	22.6%
	1.6–1.7m	62	66.7%
	1.8–1.9m	9	9.7%
	Over 2m	1	1.1%
	Total	93	100.0%

4.3.1.5 Modality Speciality

This study also recorded the participants modality speciality. The results showed general radiography 79 (84.9%), computed tomography 64 (68.8%), theatre radiography 49 (52.7%), MRI 13 (14%), and mammography 24 (25.8%), which is shown in Table 4.5.

Table 4.5: Modality speciality category

		Count	Column N %
Modality speciality category of general radiography	no	14	15.1%
	yes	79	84.9%
	Total	93	100.0%
Modality speciality category of computed tomography	no	29	31.2%
	yes	64	68.8%
	Total	93	100.0%
Modality speciality category of theatre radiography	no	44	47.3%
	yes	49	52.7%
	Total	93	100.0%
Modality speciality category of MRI	no	80	86.0%
	yes	13	14.0%
	Total	93	100.0%
Modality speciality category of mammography	no	69	74.2%
	yes	24	25.8%
	Total	93	100.0%

4.3.2 Prevalence of Work-Related Neck Pain

This study investigated the point and period prevalence of WRNP in diagnostic radiographers. From the overall total of 93 participants, 61 participants (65.6%) reported WRNP. In addition, of these 61 participants, 57 (93.4%) reported WRNP in the last 6 months, while 55 participants (90.2%) reported WRNP in the last year.

Table 4.6 depicts the prevalence of work-related neck pain.

Table 4.6: Prevalence of WRNP

		Count	Column N %
Work-related neck pain	no	32	34.4%
	yes	61	65.6%
	Total	93	100.0%
Neck pain 6 months prevalence	no	4	6.6%
	yes	57	93.4%
	Total	61	100.0%
Neck pain 12 months prevalence	no	6	9.8%
	yes	55	90.2%
	Total	61	100.0%

4.3.3 Distribution of Risk Factors in Those with Work-Related Neck Pain

The distribution of risk factors were represented in participants who reported WRNP. The total number participants represented in this category is 61 out of 93. Descriptive analysis of the distribution of risk factors within the group with WRNP was utilized.

4.3.3.1 Neck-Related Injury, Diagnosis and Treatment

This study looked at previous neck injury (16.4%), diagnosed neck condition (47.5%) and treatment (47.5%) in the participants with WRNP.

Table 4.7 below depicts previous neck injury, diagnosis and treatment.

Table 4.7: Previous neck injury, diagnosis and treatment

		Count	Column N %
Neck injury experienced	no	51	83.6%
	yes	10	16.4%
	Total	61	100.0%
Diagnosed with neck condition	no	32	52.5%
	yes	29	47.5%
	Total	61	100.0%
Neck condition treated	no	32	52.5%
	yes	29	47.5%
	Total	61	100.0%

4.3.3.2 Sleep Patterns, After Work Hours Engagement and Exercise

The study investigated the daily sleeping hours, after work hours engagement, such as prolong sitting (21.3%), heavy lifting and carrying (26.2%), prolong computer use (21.3%). Participants who engaged in exercise activity (44.3%) were more likely to exercise for 1–3 days per week (36.1%).

Table 4.8 shows sleep patterns, after work hours engagement and exercise.

Table 4.8: Sleep patterns, after work hours engagement and exercise

		Count	Column N %
Hours of sleep (per night)	3–5 hours	9	14.8%
	6–8 hours	52	85.2%
	Total	61	100.0%
After work hours exposure to prolong sitting	no	48	78.7%
	yes	13	21.3%
	Total	61	100.0%
After work hours exposure to heavy lifting and carrying	no	45	73.8%
	yes	16	26.2%
	Total	61	100.0%
After work hours exposure to prolong computer work	no	48	78.7%
	yes	13	21.3%
	Total	61	100.0%
Partake in any exercise activity	no	34	55.7%
	yes	27	44.3%
	Total	61	100.0%
Exercise activity per week (days)	1–3 days	22	36.1%
	4–6 days	2	3.3%
	7 days	3	4.9%
	n/a	34	55.7%
	Total	61	100.0%

4.3.3.3 Stress and Work Performance

The results found that 75.4% of participants experienced stress, of which 19.7% experienced financial stress, 36.1% experienced emotional stress, 62.3% experienced work-related stress and 42.6% indicated that stress had an impact of their work performance.

Table 4.9: Depicts stress and work performance

		Count	Column N %
Currently experience any stress	no	15	24.6%
	yes	46	75.4%
	Total	61	100.0%
Financial stress experience	no	49	80.3%
	yes	12	19.7%
	Total	61	100.0%
Emotional stress experience	no	39	63.9%
	yes	22	36.1%
	Total	61	100.0%
Work-related stress experience	no	23	37.7%
	yes	38	62.3%
	Total	61	100.0%
Stress impact on work performance	no	20	32.8%
	yes	26	42.6%
	n/a	15	24.6%
	Total	61	100.0%

4.3.3.4 Work Shift Hours and Total Years in Clinical Setting

The results showed that 100% of participants worked 8-10 hours day shift, 44.3% worked 14 to 16 hours of night shift, and 54.1% worked over-time shift. The mean average total work hours per week was 30-40 hours (44.3%), the mean total years in clinical practice was 6-10 years (24.6%) and the mean total years in current hospital was 1-5 years (34.4%).

Table 4.10: Work shift hours and total years in clinical setting

		Count	Column N %
Average hours per day work shift (8–10 hrs)	yes	61	100.0%
	Total	61	100.0%
Average hours per night work shift (14–16 hrs)	no	34	55.7%
	yes	27	44.3%
	Total	61	100.0%
Work over-time shift	no	28	45.9%
	yes	33	54.1%
	Total	61	100.0%
Average total work hours per week	30–40 hours	27	44.3%
	41–50 hours	26	42.6%
	>51 hours	8	13.1%
	Total	61	100.0%
Total years in clinical practice	1–5 years	12	19.7%
	6–10 years	15	24.6%
	11–15 years	12	19.7%
	16–20 years	11	18.0%
	>21 years	11	18.0%
	Total	61	100.0%
Total years in current hospital	1–5 years	21	34.4%
	6–10 years	18	29.5%
	11–15 years	12	19.7%
	16–20 years	6	9.8%
	>21 years	4	6.6%
	Total	61	100.0%

4.3.3.5 Most Often Used Modality or Workstation

The results showed that 78.7% of the participants worked in general radiography, 42.6% worked in computed tomography, 21.3% in theatre radiography, 11.5% in MRI, 18% in mammography, 6.6% in

admin/computer workstations and 3.3% worked in angiography and dental radiography.

Table 4.11: Most often used modality or workstation

		Count	Column N %
Most often used modality at work (general radiography)	no	13	21.3%
	yes	48	78.7%
	Total	61	100.0%
Most often used modality at work (computed tomography)	no	35	57.4%
	yes	26	42.6%
	Total	61	100.0%
Most often used modality at work (Theatre radiography)	no	48	78.7%
	yes	13	21.3%
	Total	61	100.0%
Most often used modality at work (MRI)	no	54	88.5%
	yes	7	11.5%
	Total	61	100.0%
Most often used modality at work (mammography)	no	50	82.0%
	yes	11	18.0%
	Total	61	100.0%
Other most often used modality (admin and computer work)	no	57	93.4%
	yes	4	6.6%
	Total	61	100.0%
Other most often used modality (dental and angiography and lab work)	no	59	96.7%
	yes	2	3.3%
	Total	61	100.0%

4.3.3.6 X-Ray Machines and Lead Protective Equipment

The study investigated the age of the X-ray machines and the thickness of the lead protective equipment. The results showed that the mean age of X-ray machines was 4–10 years old (45.9%), the most frequently used lead thickness gear was option 1 (0.25 mm–0.35 mm (62.3%), the mean hours per day wearing lead equipment was 0–1 hour (52.5%) and 46 participants (75.4%) reported experiencing neck pain when wearing lead protective equipment.

Table 4.12: Age of X-ray machines and thickness of lead protective equipment

		Count	Column N %
Average age of X-ray unit used (years)	1–5 years	10	16.4%
	6–10 years	28	45.9%
	11-15 years	15	24.6%
	16–20 years	5	8.2%
	>21 years	3	4.9%
	Total	61	100.0%
Average thickness of lead protection used option 1 (0.25 – 0.35mm)	no	23	37.7%
	yes	38	62.3%
	Total	61	100.0%
Average thickness of lead protection used option 2 (0.36 – 0.50mm)	no	46	75.4%
	yes	15	24.6%
	Total	61	100.0%
Average thickness of lead protection used option 3 (0.50 – 1.0mm)	no	53	86.9%
	yes	8	13.1%
	Total	61	100.0%
Average thickness of lead protection used option 4 (1.1 – 1.25mm)	no	54	88.5%
	yes	7	11.5%
	Total	61	100.0%
Average thickness of lead protection used option 5 (more than 1.26mm)	no	60	98.4%
	yes	1	1.6%
	Total	61	100.0%
Average hours per day wearing lead protection	0–1 hours	32	52.5%
	1–3 hours	20	32.8%
	3–5 hours	7	11.5%
	5–7 hours	1	1.6%
	>7 hours	1	1.6%
	Total	61	100.0%
Experience neck pain from wearing lead protection gear	no	15	24.6%
	yes	46	75.4%
	Total	61	100.0%

4.3.3.7 The Daily Tasks Involved as a Radiographer

The study examined the various tasks that are common in radiography. The results indicated that 83.6% of the participants push and pull X-ray units, 95.1% lift and position patients, 93.4% transfer patients on or off beds, 86.9% position overhead X-ray tubes, 80.3% push hospital bed-patients, 41% are involved in prolonged desk work, 82% stand for prolonged periods, 72% carry image cassettes and 85.2% wear lead aprons daily. Table 4.13 depicts the daily tasks involved as a diagnostic radiographer.

Table 4.13: Daily tasks involved as a diagnostic radiographer

		Count	Column N %
Job requires daily activity of option 1 (push and pull X-ray units)	no	10	16.4%
	yes	51	83.6%
	Total	61	100.0%
Job requires daily activity of option 2 (lift and position patients)	no	3	4.9%
	yes	58	95.1%
	Total	61	100.0%
Job requires daily activity of option 3 (transfer patients on or off beds)	no	4	6.6%
	yes	57	93.4%
	Total	61	100.0%
Job requires daily activity of option 4 (position overhead X-ray tube)	no	8	13.1%
	yes	53	86.9%
	Total	61	100.0%
Job requires daily activity of option 5 (push hospital bed-patients)	no	12	19.7%
	yes	49	80.3%
	Total	61	100.0%
Job requires daily activity of option 6 (desk work for prolong periods)	no	36	59.0%
	yes	25	41.0%
	Total	61	100.0%
Job requires daily activity of option 7 (standing for prolong periods)	no	11	18.0%
	yes	50	82.0%
	Total	61	100.0%
Job requires daily activity of option 8 (carry image cassettes)	no	17	27.9%
	yes	44	72.1%
	Total	61	100.0%
Job requires daily activity of option 9 (wear lead aprons)	no	9	14.8%
	yes	52	85.2%
	Total	61	100.0%

4.3.3.8 Neck Pain Associated with Daily Tasks as a Radiographer

The results revealed 41% of participants experience neck pain from pushing and pulling X-ray units, 63.9% reported neck pain from lifting and positioning patients, 52.5% reported neck pain from transferring patients on or off beds, 27.9% reported neck pain from positioning overhead tubes. A further 16.4% reported neck pain with pushing hospital bed-patients, 27.9% reported neck pain from prolonged desk work, 11.5% reported neck pain from standing for prolonged periods, 16.4% reported neck pain from carrying image cassettes and 60.7% reported neck pain from wearing lead protective gear. Table 4.14 depicts neck pain involved with daily tasks as a diagnostic radiographer.

Table 4.14: Neck pain involved with daily tasks as a diagnostic radiographer

		Count	Column N %
Neck pain from daily activity of option 1 (push and pull X-ray units)	no	36	59.0%
	yes	25	41.0%
	Total	61	100.0%
Neck pain from daily activity of option 2 (lift and position patients)	no	22	36.1%
	yes	39	63.9%
	Total	61	100.0%
Neck pain from daily activity of option 3 (transfer patients on or off beds)	no	29	47.5%
	yes	32	52.5%
	Total	61	100.0%
Neck pain from daily activity of option 4 (position overhead X-ray tube)	no	44	72.1%
	yes	17	27.9%
	Total	61	100.0%
Neck pain from daily activity of option 5 (push hospital bed-patients)	no	51	83.6%
	yes	10	16.4%
	Total	61	100.0%
Neck pain from daily activity of option 6 (desk work for prolong periods)	no	44	72.1%
	yes	17	27.9%
	Total	61	100.0%
Neck pain from daily activity of option 7 (standing for prolong periods)	no	54	88.5%
	yes	7	11.5%
	Total	61	100.0%
Neck pain from daily activity of option 8 (carry image cassettes)	no	51	83.6%
	yes	10	16.4%
	Total	61	100.0%
Neck pain from daily activity of option 9 (wear lead aprons)	no	24	39.3%
	yes	37	60.7%
	Total	61	100.0%

4.3.3.9 Neck Pain Associated Specifically with Heavy Lifting or Positioning of Patients or Equipment

The results show that 91.8% of the participants are required to lift or position heavy patients, 82% lift or position heavy equipment, of which 86.9% report neck pain when lifting or positioning heavy patients, and 78.7% reported neck pain when lifting or positioning heavy equipment.

Table 4.15: Neck pain associated specifically with heavy lifting or positioning of patients or equipment

		Count	Column N %
Job requires heavy lifting or positioning of patients	no	4	6.6%
	yes	56	91.8%
	n/a	1	1.6%
	Total	61	100.0%
Job requires heavy lifting or positioning of equipment	no	11	18.0%
	yes	50	82.0%
	Total	61	100.0%
Neck pain from heavy lifting or positioning of patients	no	6	9.8%
	yes	53	86.9%
	n/a	2	3.3%
	Total	61	100.0%
Neck pain from heavy lifting or positioning of equipment	no	11	18.0%
	yes	48	78.7%
	n/a	2	3.3%
	Total	61	100.0%

4.3.4 Treatment for Neck Condition

A total of 47.5% (n=29) of the participants who reported having a neck condition had it treated. The practitioner who treated the neck condition is shown below; most were treated by multiple practitioners but the most common practitioner was a physiotherapist.

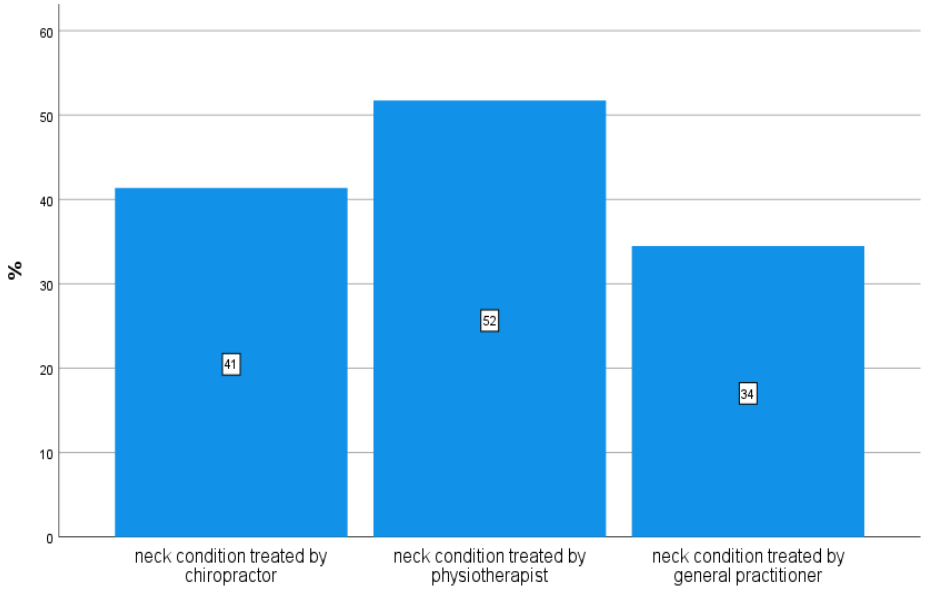

Figure 4.2: Percentage of those who had their neck condition treated by type of practitioner (n=29)

4.3.5 After Hours Shift

A total of 33 participants reported working after hour shifts, of which, the greatest number, option 1 (45%), worked 6–8 hours over time, followed by option 3 (36%), who worked greater than 10 hours and, last was option 2 (18%), who worked 8–10 hours.

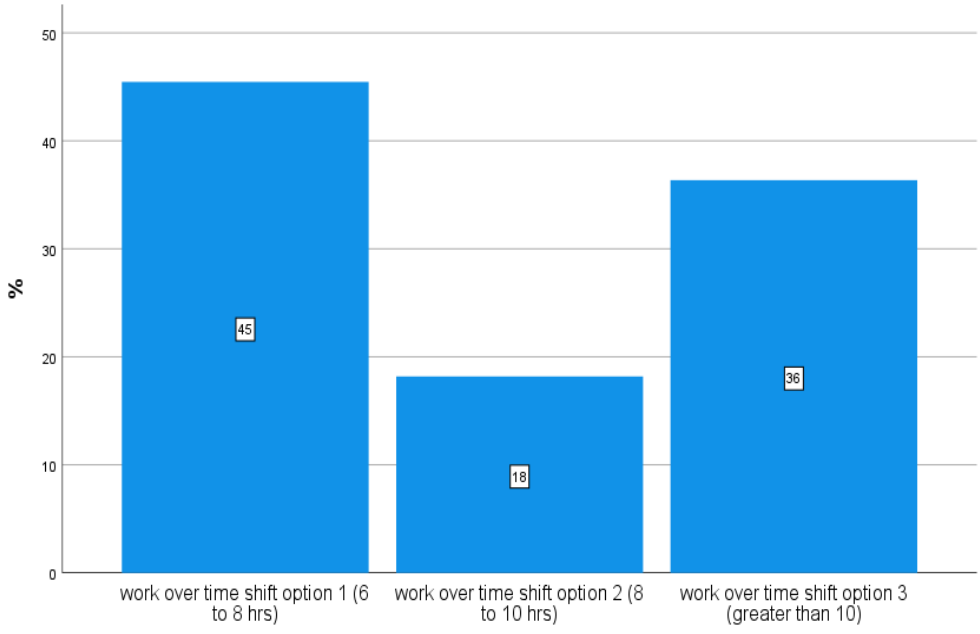

Figure 4.3: Percentage of those who worked after hours by shift option (n=33)

4.3.6 Association Between Demographic Factors and Work-Related Neck Pain

The demographic factors associated with WRNP shown in Table 4.16 explain that only gender was associated with neck pain ($p<0.001$). Females were more likely to have neck pain than males. The other factors were not linked to neck pain.

Table 4.16: Association between demographic factors and work-related neck pain

		Work-related neck pain				*p*-value
		no		yes		
		Count	Row N %	Count	Row N %	
Age category	20–30	10	33.3%	20	66.7%	0.622
	31–40	16	41.0%	23	59.0%	
	41–50	4	23.5%	13	76.5%	
	>50	2	28.6%	5	71.4%	
Gender category	Male	17	68.0%	8	32.0%	<0.001
	Female	15	22.1%	53	77.9%	
	Other	0	0.0%	0	0.0%	
Race category	African/ black	15	50.0%	15	50.0%	0.227
	Coloured	1	16.7%	5	83.3%	
	Indian	14	28.0%	36	72.0%	
	White	1	20.0%	4	80.0%	
	Other	1	50.0%	1	50.0%	
Weight category (kg)	40–50kg	2	66.7%	1	33.3%	0.820
	51–60kg	6	31.6%	13	68.4%	
	61–70kg	11	34.4%	21	65.6%	
	71–80kg	5	27.8%	13	72.2%	
	81–90kg	4	33.3%	8	66.7%	
	>90kg	4	44.4%	5	55.6%	
Height category (meters)	1.4-1.5m	4	19.0%	17	81.0%	0.116
	1.6-1.7m	22	35.5%	40	64.5%	
	1.8-1.9m	5	55.6%	4	44.4%	
	over 2m	1	100.0%	0	0.0%	
Modality speciality category of general radiography	no	4	28.6%	10	71.4%	0.618
	yes	28	35.4%	51	64.6%	
Modality speciality category of computed tomography	no	11	37.9%	18	62.1%	0.630
	yes	21	32.8%	43	67.2%	
Modality speciality category of theatre radiography	no	17	38.6%	27	61.4%	0.416
	yes	15	30.6%	34	69.4%	
Modality speciality category of MRI	no	28	35.0%	52	65.0%	0.766
	yes	4	30.8%	9	69.2%	
Modality speciality category of mammography	no	23	33.3%	46	66.7%	0.711
	yes	9	37.5%	15	62.5%	

4.3.7 Impact of Work-Related Neck Pain

From the total responses, 44.3% of participants reported that pain affected their ability to perform tasks at work and 59% reported that they had to take leave.

Table 4.17: Impact of work-related neck pain

		Count	Column N %
Neck pain affected ability to perform certain task at work	no	34	55.7%
	yes	27	44.3%
	Total	61	100.0%
Neck pain resulted in having to take leave from work	no	25	41.0%
	yes	36	59.0%
	Total	61	100.0%

Furthermore, of those who took leave from work (n=36), most participants took 1-6 days leave (81%), followed by 13.9%, who took 6-21 days and 5.6% of the participants took more than 21 days.

Table 4.18: Average days taken leave from work

		Count	Column N %
Average days taken leave from work	1–6 days	29	80.6%
	6–21 days	5	13.9%
	>21 days	2	5.6%
	Total	36	100.0%

4.4 CONCLUSION

This study had investigated the prevalence, selected risk factors and impact of WRNP in diagnostic radiographers working in the eThekwini municipality. The results depicted that only gender was associated with neck pain (p<0.001); females were more likely to have pain than males. The results had also demonstrated that certain work-related

risk factors are more likely to result in WRNP amongst diagnostic radiographers and negatively impact their work performance.

Chapter 5 will present the discussion of the study's results.

CHAPTER FIVE: DISCUSSION

5.1 INTRODUCTION

This chapter will pound upon the results found in the study in association with the objectives of the study and the literature in chapter two. The objectives included the point and period prevalence of WRNP, selected risk factors (working hours, equipment used, previous injury and number of years working) and the impact of WRNP on work performance.

5.2 DEMOGRAPHICS

5.2.1 Age

In this study, 30 (32.3%) participants were in the 20–30 year old age group. The second age group of 31–40 year olds had the most response of 39 (41.9%). The third age group of 41–50 year olds had 17 (18.3%) participants. The last age group of over 50 year olds had the least number of responses at 7 (7.5%) participants.

5.2.2 Gender

Table 4.2 shows that the majority of the responses were female, accounting for 68 (73.1%), while the number of responses from males was only 25 (26.9%).

5.2.3 Race

The Indian ethnic group accounted for the majority of the responses at 50 (53.8%), the African/black ethnic group followed at 30 (32.3%) responses. The Coloured and White ethnic groups accounted for 6

(6.5%) and 5 (5.4%) respectively and only 2 (2.2%) participants selected the “other” race category.

5.2.4 Weight

This study found that the mean average weight was between 61-70kg (34.4%), whereas only 3 (3.2%) participants selected 40–50kg. Further, 19 (20.4%) participants were between 51–60kg, 18 (19.4%) were 71–80kg, 12 (12.9%) were between 81–90kg and lastly, 9 (9.7%) were greater than 90kg.

5.2.5 Height

Most participants were between 1.6–1.7m and this accounted for 62 (66.7%) of the responses. Further, 21 (22.6%) participants were between 1.4–1.5m, 9 (9.7%) were between 1.8–1.9m and only 1 participant was over 2m.

5.2.6 Modality Speciality

As shown in Table 4.5 participants were given the choice to select the modality speciality in which they operate and work with daily. The results showed that majority of 79 (84.9%) participants work with general radiography, 64 (68.8%) participants work with computed tomography, 49 (52.7%) participants are involved with theatre radiography, 24 (25.8%) work with mammography and lastly the least accounted for 13 (14%) participants who worked with MRI machines.

Similarly, the study by Kao *et al.* (2009) found that majority of diagnostic radiographers were involved with general radiography followed by CT and MRI. However, some studies done on radiographers were not specific and included all disciplines within the radiography, such as ultra-sonographers, nuclear medicine and

radiotherapy staff members (Udoh *et al.* 2019; Thambura and Swindon 2019).

5.3 PREVALENCE OF WORK-RELATED NECK PAIN

As depicted in Table 4.6, the results from the study reported that 65.6% of diagnostic radiographers had WRNP. These results are consistent with the results from Kao *et al.* (2009), as the prevalnece rate was reported at 61.9%.

However, the results from this study showed a higher prevalence rate when compared to the results found in more recent studies including Thambura and Swindon (2019), Udoh *et al*. (2019), Kumar, Moro and Narayan (2004a) and Lorusso, Vimercati and L'Abbate (2010). All these studies had reported WRNP prevalence to be 40% or lower.

5.4 SPECIFIC WORK-RELATED RISK FACTORS

5.4.1 Working Hours

Healthcare workers typically work overtime shifts in addition to their normal daily or weekly shift (Hamid *et al.* 2018). A study on the ergonomics hazards and MSK disorders among healthcare facilities by Hamid *et al*. (2018) showed that 43.5% of healthcare workers, such as X-ray technicians, worked overtime hours of more than eight hours in addition to their weekly shift. The results from this study are consistent as shown in Table 4.10, that 100% of participants worked eight to 10 hours day shift, in addition to 44.3% of radiographers who worked 14 to 16 hours of night shift and more than 50% worked over-time shifts.

According to Thambura *et al.* (2019), a large number of radiographers working in KwaZulu-Natal worked overtime hours that went over the average 45 hour per week and, as a result, this caused extreme fatigue, exhaustion and MSK complaints. Similarly, this study showed that 43% of participants had worked between 41 and 50 hours per week, while, in some cases (13.1%), diagnostic radiographers were required to work more than 51 hours per week. Hence, these results are consistent in showing that working hours are a prominent risk factor in the development of WRNP.

5.4.2 Protective Equipment

The use of lead protection is one of the most important personal protective equipment (PPE) for healthcare workers who are exposed to radiation (Monaco *et al.* 2020). According to Monaco *et al.* (2020), the standard average size/thickness of the lead apron is usually 0.50 mm. The results from this study were inconsistent with that study, as the majority (62.3%) of diagnostic radiographers had reported wearing lead apron gear, with thickness of 0.25 mm to 0.35 mm. The results had also show that only 24.6% of radiographers wore lead aprons with a thickness of 0.36 mm to 0.50 mm and 13.1% of radiographers wore lead aprons with a thickness of 0.50 mm to 1.0 mm.

Cornelis *et al.* (2021), described that the average weekly prevalence of MSK pain, including neck pain and back pain was between 50% to 60% in healthcare workers who wear lead aprons frequently. The results from this study are synonymous, as 75.4% of radiographers experienced neck pain from wearing lead protective gear, of which 60.7% had neck pain from the daily use of lead aprons.

Whilst this study reported high rates of neck pain as a result of wearing lead aprons, some studies in the literature do not support this high

prevalent rate, such as the study by Alagha and Aljeesh (2013) on MSK disorders among radiology technologist at government hospitals. It reported that 55% of radiographers working in government hospitals had MSK disorders due to wearing lead protective aprons, of which only 19% accounted for neck pain complaints.

5.4.3 Operating Heavy Machinery

Studies by Telaprolu and Anne (2014) and Udoh *et al.* (2019) highlighted that the highest risk factors associated with MSK pain included pulling, pushing, moving, lifting and lowering heavy objects and machines. Additionally, Udoh *et al.* (2019) reported that 67% of radiographers experienced MSK complaints, of which 40% related to neck/shoulder pain, due to the most common major risk factor experienced by these radiographers of lifting and moving of heavy equipment.

The results from this study are congruent and show a higher prevalence of neck pain as 78.7% of the radiographers from the study had neck pain from lifting and positioning heavy equipment and machinery. The literature explored in this study further supports the results, as the study by Evans *et al.* (2021) reported that in most cases about 70% to 90% of radiographers when carrying the image cassettes or lifting and moving heavy equipment and machinery, which leads to neck pain and exacerbates their other MSK symptoms.

5.4.4 Previous Injury or Diagnosis

The results revealed that only 16.4% of participants who had WRNP reported a history of previous neck injury experienced, However, the results also showed that almost half (47.5%) of the participants who had WRNP had reported a history of previous diagnosed neck

condition. Although the results did not show a high rate history of previous neck injury, these previous neck injuries can contribute to the risk of developing neck pain (Kim *et al.* 2018).

The literature supports the results obtained from this study on history of previous diagnosis of neck condition as a risk factor for neck pain (Green *et al.* 2018 and Bier *et al.* 2018). According to Guez *et al.* (2018), there are positive associations between a previous history of neck injuries and neck pain. Over one fourth of all cases with neck pain had a history of neck pain, with whiplash injury being the most common initial injury (Guez *et al.* 2002).

5.4.5 Number of Years Working/ Experience

In Table 4.10, the results for total work years' experience were evenly scattered: almost one quarter (24.6%) of participants who had WRNP had worked or had clinical experience in the profession for 6-10 years. This is supported in the literature by Kumar, Moro and Narayan (2004), that two thirds of the participants who had experienced MSK pain had work experience between 5-10 years. Whilst the study by Hamid *et al.* (2018) reported that 55% of healthcare workers with MSK disorders had five years and less work experience, the remainder of 45% of the healthcare workers, which is still a considerable size of the participants had worked more than five years.

5.5 THE IMPACT OF WORK-RELATED NECK PAIN ON WORK PERFORMANCE

5.5.1 Health and Quality of Life

Studies by Anderson, Martins and Gelbckle (2019); Alrowayeh *et al.* (2021); Cornelis *et al.* (2021) and Sipos *et al.* (2020) revealed that, due to work-related stress factors, radiographers are more likely to

experience high levels of emotional exhaustion, burnouts, fatigue and a decrease in immunity. These can negatively impact health and well-being, as well as lead to job dissatisfaction and affect the ability to perform certain tasks at work.

The results from the study revealed major similarities with the literature, as it recorded 75.4% of participants currently experienced stress, of which 62.3% had experienced work-related stress, and 42.6% of the participants' stress had an impact on their work performance. These are likely to result in increased fatigue, burnouts and exhaustion (Sipos *et al.* 2020).

5.5.2 Work Performance

The results from this study revealed that 59% of participants had taken leave from work as a result of WRNP, of which 80.6% had taken an average of 1-6 days off work, followed by 13.9% had taken 6-21 days off work and lastly 5.6%, who had taken more than 21 days off (Table 4.18).

The results of the study are aligned with the exploration of literature. Oranye and Bennett (2018) reported that the implications and costs on radiographers related to such work-related MSK complaints included work absence, decreased work productivity and some cases claims of work disability from the healthcare sector. Similarly, Oliv *et al.* (2019) and Marklund *et al.* (2020) reported that healthcare workers who experienced work-related pain and work-related risk factors had shown a decrease in overall work performance and were more likely to take leave from work when compared to workers who did not experience any pain.

5.6 CONCLUSION

In chapter 5, the results have been compared and discussed according to the studies that are pertinent to the aims and objective of the study. The study concluded that WRNP is a highly prevalent complaint, as well as that female diagnostic radiographers are more like to experience WRNP and the selected work-related risk factors associated with WRNP. Furthermore, decreased work performance and absenteeism are associated with diagnostic radiographers with WRNP.

Chapter 6 will present the conclusion, limitations and recommendations for this study.

CHAPTER SIX: LIMITATIONS, RECOMMENDATIONS AND CONCLUSION

6.1 INTRODUCTION

This chapter will present and discuss the limitations uncovered in this study, make recommendations for future research studies and conclude this study.

6.2 LIMITATIONS

There was a lack of uniformity amongst the different types of diagnostic radiographers from the participants, i.e., of the different types of diagnostic radiographers (general radiographers, computed tomography radiographers, mammographers etc), there was an unequal representation amongst the different types of diagnostic radiographers who had participated in the study.

The COVID-19 safety protocol restrictions placed by certain public and private hospitals meant that the researcher was prohibited from entering the radiology departments and interacting with the participants directly. As a result of this, the response time and rate were impacted as these participants were only made aware of the research through the research advertisement (Appendix 6), word-of-mouth and social media post and not directly from the researcher.

6.3 RECOMMENDATIONS

Future research studies should focus on investigating diagnostic radiographers in other parts of KwaZulu-Natal and other provinces in South Africa. Those finding could be compared to this study and may help add new and updated literature on WRNP in diagnostic radiographers from a South African context.

Additional studies from a comparative context should be done to provide more knowledge and understanding on the work-related risk factors faced by diagnostic radiographers in different hospital settings. Such studies include comparing diagnostic radiographers working in public sector in comparison to working in private sectors.

Further studies should explore and consider investigating work-related risk factors among nuclear medicine radiographers, ultra-sonographers and radiotherapists.

6.4 CONCLUSION

The results and findings of the study were discussed in accordance with the aim and objectives of the study. The study reported a high prevalence rate (65.6%) of WRNP among diagnostic radiographer working within the eThekwini municipality. Furthermore, the study reported a high prevalence in the following selected work-related risk factors of overtime working hours, equipment being used (utilization of lead protective aprons and operating heavy machinery) and previous history of neck injury and diagnosis. The study also revealed the association that females are more likely to experience WRNP. WRNP amongst diagnostic radiographers are likely to decrease their overall health and quality of life and work performance.

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APPENDICES

Appendix 1: Letter of Information

LETTER OF INFORMATION

Title of study: The epidemiology of work related neck pain in diagnostic radiographer working within the eThekwini municipality.

Research student: Akshoy Devnarain

Supervisor: Dr A Abdul-Rasheed (MTech: Chiropractic)

Purpose of the study

The aim of the study is to determine the epidemiology of work-related neck pain in diagnostic radiographers working within the eThekwini municipality and to explore the specific risk factors that are associated with work related neck pain as well as the impact it has on work performance.

Procedures

You will receive the questionnaire to be filled out, within the eThekwini municipality, in and around the hospital you employed at. You will be expected to complete and sign Informed Consent (Appendix C) prior to receiving the questionnaire (Appendix A).

Inclusion criteria:

- The diagnostic radiographers had to be registered and qualified with HPCSA
- These diagnostic radiographers must currently be employed at the public or private sectors within the eThekwini municipality.

Exclusion criteria:

- Nuclear medicine radiographers, ultrasonographers and radiotherapists, all must be excluded from the study.
- All student radiographers.

Risks or discomfort to the participant

There are no risks or risk of discomfort to you during this study.

Benefits

Your contribution to this study by volunteering to partake will help us Chiropractors to build on our knowledge. This will benefit you as a patient, as we will be able to provide you with more effective health care in the future as a suffer from work related neck pain. This study will give you a better understanding of specific risk factors and the influence that it has on your work performance.

Reason why you may be withdrawn from the study

If you are non-compliant and have not completed at least 80% of the questionnaire, you will be withdrawn from the study

AS A VOLUNTARY PARTICIPANT IN THIS RESEARCH STUDY, YOU ARE FREE TO WITHDRAW FROM THE STUDY AT ANY GIVEN TIME, WITHOUT GIVING A REASON FOR WITHDRAWING AND WITHOUT CONSEQUENCE

Remuneration

You will not be receiving any monetary or other type of remuneration for participation in this study

Cost of the study

You will not be expected to cover any costs towards the study

Confidentiality

All patient information is confidential. The results of this study will be used for research purposes only. Only individuals that are directly involved in this study (Dr A Abdul-Rasheed (MTech: Chiropractic) and myself) will be allowed to access these records.

Persons to contact should you have any problems or questions

Should you have any questions that you would prefer being answered by an independent individual, feel free to contact my supervisor on the following numbers Dr A. Abdul-Rasheed (Tel: (031) 3732102). If you are not satisfied with a particular area of this study, please feel free to forward any concerns to the Durban University of Technology Research and Ethics Administrator on (031) 3732375. Complaints can be reported to the Acting Manager of Research and Postgraduate Support, Ms V Govender on (031) 373 2558 or vanesh@dut.ac.za.

Thank you for participating in my research study.

Akshoy Devnarain
(Research student)

Appendix 2: Consent Form

CONSENT

Statement of Agreement to Participate in the Research Study:

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

Full Name of Participant	**Date**	**Time**	**Signature**

I, Akshoy Devnarain here with 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 (If applicable)	**Date**	**Signature**
Full Name of Legal Guardian (If applicable)	**Date**	**Signature**

Appendix 3: A Support Letter to the eThekwini Municipality

KWAZULU-NATAL PROVINCE
HEALTH
REPUBLIC OF SOUTH AFRICA

DIRECTORATE: Monitoring and Evaluation
Physical address: 83 King Cetshwayo Highway; Highway House; Mayville 4091
Postal Address: private Bag X 54318, Durban 4000 eThekwini District Office
Tel: 031 240 5308 Fax: 031 240 5555 Email: Ntombenhle.Ngcobo@kznhealth.gov.za
www.kznhealth.gov.za

Enquiries: Mrs. N.P Ngcobo
Date: 05/07/2021

Mr. A. Devnarain
Durban University of Technology
School of Science

RE: SUPPORT FOR RESEARCH STUDY "THE EPIDEMIOLOGY OF WORK RELATED NECK PAIN IN DIAGNOSTIC RADIOGRAPHERS WORKING IN THE ETHEKWINI MUNICIPALITY"

I have pleasure in informing you that the District is granting you support to conduct the research study titled **"The Epidemiology of Work Related Neck Pain in Diagnostic Radiographers Working in the EThekwini Municipality"** in EThekwini Health District

Please note the following:

1. Please ensure you adhere to all the policies, procedures, protocols and guidelines of the department of health with regards to this research.
2. This research will only commence once this office has received confirmation from the provincial health research committee in the KZN department of health.
3. Please ensure this office is informed before you commence your research.
4. The District office/facility will not provide any resources for this research.
5. You will be expected to provide feedback on your findings to the district office/facility.

Thank you.

Sincerely,

Mrs. N.P. Ngcobo
(P, Monitoring and Evaluation Manager)
EThekwini Health District

GROWING KWAZULU-NATAL TOGETHER

Appendix 4: Gatekeeper Permission from Department of Health

health
Department:
Health
PROVINCE OF KWAZULU-NATAL

Physical Address: 330 Langalibalele Street, Pietermaritzburg
Postal Address: Private Bag X9051
Tel: 033 395 2805/ 3189/ 3123 Fax: 033 394 3782
Email:
www.kznhealth.gov.za

DIRECTORATE:
Health Research & Knowledge Management

NHRD Ref: KZ_202104_014

Dear Mr A. Devnarain
(DUT)

Approval of research

1. The research proposal titled **'The epidemiology of work related neck pain in diagnostic radiographers working in the eThekwini municipality. Full Partial X D'** was reviewed by the KwaZulu-Natal Department of Health (KZN-DoH).

   The proposal is hereby **approved** for research to be undertaken at Addington, Clairwood, Inkosi Albert Luthuli Central, King Dinuzulu Hospital Complex, King Edward VIII, Mahatma Gandhi Memorial, Osindisweni, Prince Mshiyeni Memorial, RK Khan, St Aidan's and Wentworth Hospital.

2. You are requested to take note of the following:
   a. *All research conducted in KwaZulu-Natal must comply with government regulations relating to Covid-19. These include but are not limited to: regulations concerning social distancing, the wearing of personal protective equipment, and limitations on meetings and social gatherings.*
   b. *Kindly liaise with the facility manager BEFORE your research begins in order to ensure that conditions in the facility are conducive to the conduct of your research. These include, but are not limited to, an assurance that the numbers of patients attending the facility are sufficient to support your sample size requirements, and that the space and physical infrastructure of the facility can accommodate the research team and any additional equipment required for the research.*
   c. *Please ensure that you provide your letter of ethics re-certification to this unit, when the current approval expires.*
   d. *Provide an interim progress report and final report (electronic and hard copies) when your research is complete to **HEALTH RESEARCH AND KNOWLEDGE MANAGEMENT, 10-102, PRIVATE BAG X9051, PIETERMARITZBURG, 3200** and e-mail an electronic copy to hrkm@kznhealth.gov.za*
   e. *Please note that the Department of Health shall not be held liable for any injury that occurs as a result of this study.*

For any additional information please contact Mr X. Xaba on 033-395 2805.

Yours Sincerely

04/06/2021

Dr E Lutge

Fighting Disease, Fighting Poverty, Giving Hope

Appendix 5: Gatekeeper Permission from Private Hospital Managers

JACKPERSAD
& PARTNERS INC.
SPECIALIST DIAGNOSTIC RADIOLOGISTS

3rd Floor Maxwell Centre
71/73 Ismail C Meer St (Lorne St), Durban
Tel : 031-365 2100
Fax : 086 272 1976
E-mail: info@jrp.co.za
www.jackpersad.co.za

28 July 2021

To Mr A Devnarain

Thank you for your email enquiry regarding conducting your research study with the diagnostic radiographers at our JPI practice.

Please be informed, consent has been granted for your research study. As indicated in your mail to us, the research study will be conducted via email utilising the research tool of a questionnaire. This is in keeping with our Covid protocol and policies and thus no site visits will be allowed. The venue managers will distribute the questionnaires to the diagnostic radiographers for the selected venues in your research study. Our venue and deputy managers have been informed regarding this matter and you can communicate with them via email. I will provide you with the relative email addresses.

I trust you will inform me of any impediments you may encounter and you will ensure the POPIA legislature is followed. Please ensure I am copied in all correspondence to the staff of the JPI practice.

We wish you well in your research study.

Kind Regards,
Fathima Farouk
Projects/Academic Team

JACKPERSAD
& PARTNERS INC.

Cell: 0833067439

JACKPERSAD & PARTNERS INC.
REG.NO: 2007/027164/21
VAT REG NO: 4480241142
BOX 48900
BERT 4078

LAKE, SMIT PARTNERS Inc.
www.lakesmit.co.za
SPECIALISTS IN DIAGNOSTIC RADIOLOGY
PR. No. 3805948 Reg. No. 2003/031449/21 VAT No. 4100209818

Dear Mr A Devnarain

Thank you for your email regarding conducting your research at Lake, Smit & Partners Inc.

We will gladly assist you by informing the radiographers of your research. Please be aware that due to COVID restrictions, you will not be able to personally visit the venues namely, Crompton, Entabeni, Parklands, St Augustine and Westville hospital on site.

As the clinical tutor I will assist in sending any information to the Practice managers of the above-mentioned venues who will distribute the information to the radiographers. Please ensure your contact details are available on this document to allow the radiographers to contact you personally.

Should require any further information please don't hesitate to contact me.

Kind regards

Amy Nothling

Appendix 6: Research Advertisement

ARE YOU A DIAGNOSTIC RADIOGRAPHER?

WHO IS EXPERIENCING NECK PAIN?

WOULD YOU LIKE TO BE APART OF A STUDY?

For More Information

Contact:

AKSHOY DEVNARAIN

0724989726

akshoydevnarain47@gmail.com

Appendix 7: Letter of Information – Focus Group

LETTER OF INFORMATION – FOCUS GROUP

Title of study: The epidemiology of work-related neck pain in diagnostic radiographers working in the eThekwini municipality.

Research student: Akshoy Devnarain

Supervisor: Dr A Abdul-Rasheed (MTech: Chiropractic)

Purpose of the study

The aim of the study is to determine the epidemiology of work-related neck pain in diagnostic radiographers working within the eThekwini municipality and to explore the specific risk factors that are associated with work related neck pain as well as the impact it has on work performance.

Procedures

You will be asked to read the Letter of Information (Appendix F), the Confidentiality agreement (Appendix G) and Informed Consent (Appendix H). You will then be given an opportunity to ask any questions regarding the focus group procedure and have time to sign the Letter of Information (Appendix F) and Informed Consent (Appendix H) as well as (Appendix G) which states that you will keep confidential any discussion within and regarding the focus group. The focus group will then proceed with the discussion of the questionnaire. The researcher as the chair of the meeting will sequentially read the questions out aloud before the group is asked to discuss the relevance of the question to the aims and objectives of the study as well as then deciding whether the questions are understandable by the general trail running population. Therefore, the focus group may agree to, disagree with or be undecided about the inclusion of questions in the questionnaire. For the questions to be included or excluded, the group is required to be unanimous in their agreement to include or exclude questions. For those questions were there is indecision about the relevance or inclusion of the question, it may either need to reside to a simple vote with a majority or the question can be deferred for purposes of being reviewed by the researcher in the context of the literature available in the domain of running.

Inclusion criteria:

- The diagnostic radiographers had to be registered and qualified with HPCSA
- These diagnostic radiographers have to currently be employed at the public or private sectors within the eThekwini municipality.

Exclusion criteria:

- Nuclear medicine radiographers, ultrasonographers and radiotherapists, all have to be excluded from the study.
- All student radiographers.

Risks or discomfort to the participant

There are no risks or risk of discomfort to you in this study

Benefits

Your contribution to this study by volunteering to partake will help us Chiropractors to build on our knowledge. This will benefit you as a patient, as we will be able to provide you with more effective health care in the future as a suffer from work related neck pain. This study will give you a better understanding of specific risk factors and the influence that it has on your work performance.

Reason why the participant may be withdrawn from the study

If you are non compliant and have not completed at least 80% of the questionnaire, you will be withdrawn from the study

AS A VOLUNTARY PARTICIPANT IN THIS RESEARCH STUDY, YOU ARE FREE TO WITHDRAW FROM THE STUDY AT ANY GIVEN TIME, WITHOUT GIVING A REASON FOR WITHDRAWING AND WITHOUT CONSEQUENCE

Remuneration

You will not be receiving any monetary or other type of remuneration for participation in this study

Cost of the study

You will not be expected to cover any costs towards the study

Confidentiality

All patient information is confidential. The results of this study will be used for research purposes only. Only individuals that are directly involved in this study (Dr A Abdul-Rasheed (MTech: Chiropractic) and myself) will be allowed to access these records.

Persons to contact should you have any problems or questions

Should you have any questions that you would prefer being answered by an independent individual, feel free to contact my supervisor on the following numbers Dr A. Abdul-Rasheed (Tel: (031) 3732102). If you are not satisfied with a particular area of this study, please feel free to forward any concerns to the Durban University of Technology Research and Ethics Administrator on (031) 3732375. Complaints can be reported to the Acting Manager of Research and Postgraduate Support, Ms V Govender on (031) 373 2558 or vanesh@dut.ac.za.

Thank you for participating in my research study.

Akshoy Devnarain
(Research student)

Appendix 8: Confidentiality Form – Focus Group

IMPORTANT NOTICE: This form is to be read and filled in by every member participating in the expert group, before the focus group meeting convenes.

CONFIDENTIALITY STATEMENT AND CODE OF CONDUCT: Focus group

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

2. None of the information shall be communicated to any other individual or organisation outside of this specific focus group as to the decisions of this expert group.

3. The information from this focus group will be made public in terms of a dissertation/thesis and/or journal publication, which will in no way identify any of the participants involved in this expert group.

4. The returned questionnaires will be coded and kept anonymous in the research process.

5. The expert group may be either voice or video recorded, as a transcript of the proceedings will need to be made. The data will be stored securely under password protection.

6. All data generated from this expert group (including the recording) will be kept for five years in a secure location at Durban University of Technology and thereafter will be destroyed.

Once this form has been read and agreed to, please fill in the appropriate information below and sign to acknowledge agreement.

Please print in block letters:

Focus Group Member: _____ Signature: _____

Witness Name: _____ Signature: _____

Researcher's Name: _____ Signature: _____

Supervisor's Name: _____ Signature: _____

Appendix 9: Informed Consent Form – Focus Group

CONSENT

Statement of Agreement to Participate in the Focus Group Study:

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

_____	_____	_____	_____
Full Name of Participant	**Date**	**Time**	**Signature** /

I, Akshoy Devnarain, 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 (If applicable)	**Date**	**Signature**
_____	_____	_____
Full Name of Legal Guardian (If applicable)	**Date**	**Signature**

Appendix 10: Letter of Information – Pilot Study

LETTER OF INFORMATION – PILOT STUDY

Title of study: The epidemiology of work-related neck pain in diagnostic radiographer working within the eThekwini municipality.

Supervisor: Dr A Abdul-Rasheed (MTech: Chiropractic)

Research student: Akshoy Devnarain.

Institution: Durban University of Technology

Purpose of the study

The aim of the study is to determine the epidemiology of work-related neck pain in diagnostic radiographers working within the eThekwini municipality and to explore the specific risk factors that are associated with work related neck pain as well as the impact it has on work performance.

Procedures

The participants will be required to read and complete the Letter of Information (Appendix I) and Informed Consent (Appendix J). Thereafter the participant will be required to complete the questionnaire (post-focus group) (Appendix K). The participant will then be required to complete a questionnaire evaluation form in order to identify any problems with the questionnaire (Appendix L).

Inclusion criteria:

- The diagnostic radiographers had to be registered and qualified with HPCSA
- These diagnostic radiographers must currently be employed at the public or private sectors within the eThekwini municipality.

Exclusion criteria:

- Nuclear medicine radiographers, ultrasonographers and radiotherapists, all must be excluded from the study.
- All student radiographers.

Risks or discomfort to the participant

There are no risks or risk of discomfort to the participants of this study

Benefits

Your contribution to this study by volunteering to partake will help us Chiropractors to build on our knowledge. This will benefit you as a patient, as we will be able to provide you with more effective health care in the future as a suffer from work related neck pain. This study will give you a better understanding of specific risk factors and the influence that it has on your work performance.

Reason why the participant may be withdrawn from the study

Participants who are non compliant and who have not completed at least 80% of the questionnaire, will be withdrawn from the study

AS A VOLUNTARY PARTICIPANT IN THIS RESEARCH STUDY, YOU ARE FREE TO WITHDRAW FROM THE STUDY AT ANY GIVEN TIME, WITHOUT GIVING A REASON FOR WITHDRAWING AND WITHOUT CONSEQUENCE

Remuneration

The participant will not be receiving any monetary or other type of remuneration for participation in this study

Cost of the study

The participant will not be expected to cover any costs towards the study

Confidentiality

All patient information is confidential. The results of this study will be used for research purposes only. Only individuals that are directly involved in this study (Dr A Abdul-Rasheed (MTech: Chiropractic) and myself) will be allowed to access these records.

Persons to contact should you have any problems or questions

Should you have any questions that you would prefer being answered by an independent individual, feel free to contact my supervisor on the following numbers Dr A. Abdul-Rasheed (Tel: (031) 3732102). If you are not satisfied with a particular area of this study, please feel free to forward any concerns to the Durban University of Technology Research and Ethics Administrator on (031) 3732375. Complaints can be reported to the Acting Manager of Research and Postgraduate Support, Ms V Govender on (031) 373 2558 or vanesh@dut.ac.za.

Thank you for participating in my research study.

Akshoy Devnarain
(Research student)

Appendix 11: Informed Consent – Pilot study

CONSENT

Statement of Agreement to Participate in the Pilot Group Study:

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

_____	_____	_____	_____
Full Name of Participant	**Date**	**Time**	**Signature** /

I, Akshoy Devnarain, 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 (If applicable)	**Date**	**Signature**
_____	_____	_____
Full Name of Legal Guardian (If applicable)	**Date**	**Signature**

Appendix 12: Final Questionnaire

Section A:

Demographics:

Please answer the following. Please Select which options are applicable to you:

1. Age
A. 20 to 30
B. 31 to 40
C. 41 to 50
D. Over 50

2. Gender
A. Male
B. Female
C. Other

3. Race
A. African
B. Coloured
C. Indian
D. White
E. Other

4. Weight (kg)
A. 40 kg to 50 kg
B. 51 kg to 60 kg
C. 61 kg to 70 kg
D. 71 kg to 80 kg
E. 81 kg to 90 kg
F. Over 91 kg

5. Height (meter)
A. 1.4 m to 1.5 m
B. 1.6 m to 1.7 m
C. 1.8 m to 1.9 m
D. Over 2.0 m

6. Are you specializing in any of the following modalities? (Please select more than one if applicable to you)

A. General radiography (inclusive of mobile radiography)
B. Computed tomography (CT)
C. Theatre radiography
D. Magnetic Resonance Imaging (MRI)
E. Mammography

Section B:

Neck pain Prevalence:

Please answer the following. Circle if options are available or fill in where blocks are applicable:

1. Do you currently suffer with neck pain?
A. Yes
B. No

2. Have you ever had Work Related Neck pain? (i.e., Neck pain that is caused due to the work that you do?)
If you answer NO, You DO NOT have to continue with the Questionnaire, if you answer YES, you can continue with the Questionnaire.
A. Yes
B. No

3. Have you ever had Neck pain over the past 6 months?
A. Yes
B. No

4. Have you ever suffered Neck pain over the past 12 months?
A. Yes
B. No

Section C:
General Risk Factors

Please answer the following. Circle if options are available or fill in where blocks are applicable:

1. Have you ever experienced Neck injury?
A. Yes
B. No

2. Have you ever been diagnosed with any Neck condition? (Example, Whiplash, Osteoarthritis, Spondylosis or Rheumatoid arthritis)
A. Yes
B. No

3. Have you ever had your Neck condition treated? If you answer YES, please specify by whom you have received treatment from (Example, Chiropractic, Physiotherapy or General practitioner)
A. Yes

B. No

4. On average, how many hours of sleep do you take per night?
A. 3 to 5 hours
B. 6 to 8 hours
C. 9 to 11 hours
D. 12 or more hours

5. Outside of work hours, are you exposed to any of the following?
(Circle more than one if applicable).

A. Sitting for long periods at a time
B. Lifting/ carrying heavy items
C. Working on laptops or computers for long periods
D. None of the above

6. Do you Exercise?
If you answered YES, please specify How many days a week you exercise for?

A. Yes

B. No

7. Do you currently experience any type of stress? If YES, please specify by selecting what type of stress you have (you may select more than one if applicable).

A. No
B. Yes
   i. Financial stress
   ii. Emotional stress
   iii. Work-related stress

8. Would you say that your stress has impacted on your work performance?

A. Yes
B.No

Section D:

Work related risk factors:

Please answer the following. Circle if options are available or fill in blocks if applicable:

1. On average, how many hours per work shift do you cover? (If you work an Overtime shift, please select how many hours do you work for).

A. Day shift - 8 to 10 hours
B. Night shift – 14 to 16 hours
C. Over time shift
   i. 6 to 8 hours
   ii. 8 to 10 hours
   iii. More than 10 hours

2. On average, how many hours per week in total do you work? (This must include overtime hours, if applicable)

A. 30 to 40 hours
B. 41 to 50 hours
C. More than 51 hours

3. How many years in total have you been in clinical practice?

A. 2 to 5 years
B. 6 to 10 years
C. 11 to 15 years
D. 16 to 20 years
E. More than 21 years

4. How many years in total have you been working in this current practice/hospital?

A. 1 to 5 years
B. 6 to 10 years
C. 11 to 15 years
D. 16 to 20 years
E. More than 21 years

5. Which modalities would you classify yourself working amongst with most of the time? (Circle more than one if applicable).

A. General radiography (inclusive of mobile radiography)
B. Computed tomography (CT)
C. Theatre radiography
D. Magnetic Resonance Imaging (MRI)
E. Mammography
F. Other, please specify

6. On average, how old would you say is the x-ray unit that you operate?

A. 1 to 5 years
B. 6 to 10 years
C. 11 to 15 years
D. 16 to 20 years
E. More than 21 years

7. On average, how thick is the lead apron/Jacket you currently use? (Select more than one if applicable)

A. 0.25 mm to 0.35 mm
B. 0.36 mm to 0.50 mm
C. 0.50 mm to 1.0 mm
D. 1.1 mm to 1.25 mm

8. On average, how many hours per day do you wear a lead protective gear?
A. 0 to 1 hour
B. 1 to 3 hours
C. 3 to 5 hours
D. 5 to 7 hours
E. More than 7 hours

9. Have you ever experienced neck pain from wearing the lead protective gear?
A. Yes
B. No

10. Does your job require you to do any of the following daily? (If applicable, circle more than one options related to you).
A. Push/pull mobile x-ray units
B. Lift/position patients
C. Transfer patients off/on the chair/bed
D. Position the overhead x-ray tube
E. Push hospital bed-patients
F. Sit at a desk for long periods of time
G. Stand for long periods of time
H. Carry image cassettes
I. Wear lead aprons

11. Did you ever experience neck pain due to any of the activities mentioned in question 10? If YES, please indicate which activities?
A. No
B. Yes, please specify

12. Does your job require lifting/positioning patients or heavy equipment? If yes, please state what are you lifting /positioning?
A. Yes
B. N/A

13. If you answered yes to question 12, do you ever experience neck pain from lifting/positioning patients or equipment?
    A. Yes
    B. No
    C. N/A

Section E:

Impact of Work related neck pain on job performance:

Please answer the following. Circle if options are available or fill in blocks if applicable:

1. Has your neck pain affected your ability to do certain tasks at work?
A. Yes
B. No

2. Has your neck pain resulted in you having to take days off work (absent leave)?
A. Yes
B. No

3. Can you approximate on average, how many days off you have taken?
A. 1 to 6 days
B. 6 to 21 days
C. More than 21
D. N/A (Have not taken any days off)

Appendix 13: Proofreader Certificate

Helen Bond

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15 July 2022

CERTIFICATE

Akshoy Devnarain

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Dear Akshoy

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I wish you the very best in your submission and your career.

Kind regards

Helen Bond (Bachelor of Arts, HDE)

Appendix 14: Plagiarism Report

Draft 1- Akshoy Devnarain Thesis

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