THE PREVALENCE AND PROFILE OF SPINAL CORD INJURY IN PUBLIC REHABILITATION HOSPITALS IN GAUTENG, SOUTH AFRICA: A RETROSPECTIVE, POPULATION-BASED STUDY

Michael Alexandre Alves

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DECLARATION

I, Michael Alexandre Alves, declare that this Dissertation is my own, unaided work. It is being submitted for the Degree of Master in Science in Physiotherapy at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at this or any other University.

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(Signature of candidate)

_10_ day of _January_ 2022 in _Johannesburg, South Africa_

ABSTRACT

Introduction: Spinal cord injury (SCI) is devastating, with morbidity affecting physical, emotional, social and vocational life areas. The effects of SCI are multifactorial and have been shown to negatively impact well-being and health-related quality of life. Rehabilitation plays an important role in the prevention of secondary health complications and attainment of functional independence. The Rehabilitation 2030 Call for Action by the World Health Organization has highlighted the need for ongoing surveillance and collection of rehabilitation data to inform planning and optimize service delivery for persons with spinal cord injury (PWSCI).

Aim: The aim of this study was to determine the prevalence and profile of SCI in public healthcare rehabilitation units in Gauteng.

Methodology: A retrospective, medical record review was performed at each of the five public healthcare rehabilitation units in Gauteng. Participants included PWSCI aged 18 years and above who were admitted for rehabilitation between 01 January 2018 and 31 December 2019 with a confirmed, first-time SCI irrespective of cause. A specifically designed data collection form was generated and used, and included all components of the International Spinal Cord Injury Core Data Set.

Results: Overall, 998 patients were admitted for rehabilitation in Gauteng's public healthcare rehabilitation units during the study period. Of these, 386 were PWSCI that fitted the inclusion criteria and their medical records were thus included in the study. This gave the province a SCI prevalence of 38.67% in public healthcare rehabilitation units. Items that were not documented in the medical records are specified as missing in this dissertation. An overall mean age of 36.90 years (SD = 12.12) was noted in the study with those sustaining a traumatic spinal cord injury (TSCI) significantly younger than those sustaining a non-traumatic spinal cord injury (NTSCI) ($p \leq 0.001$). The mean age of participants who sustained a TSCI was 33.56 years (SD = 10.08) whereas the mean age of those sustaining a NTSCI was 43.20 years (SD = 13.14). With regards to sex, males accounted for 69.95% (n = 270) of study participants and females 30.05% (n = 116). Sex was also found to be significantly associated with aetiology, with males more likely to sustain a TSCI (n = 212, 84.46%) and females more vulnerable to NTSCI (n = 76, 58.02%) ($p \leq 0.001$). A positive HIV status (n = 65, 16.84%) and presence of comorbidities (n = 89, 23.06%) were found to be significant risk factors for developing a NTSCI ($p \leq 0.001$). Traumatic SCI (n = 251, 65.70%) was found to be more common than NTSCI (n = 131, 34.29%) with the leading cause of injury assault (n = 136, 35.6%) followed by transportation-related injuries (n = 87, 22.77%) and infectious causes (n = 66, 17.28%). Classification of injury according to the American Spinal Injury Association (ASIA) Impairment Scale (AIS) found complete AIS A injuries to be most common (n = 170, 44.04%) with this finding significantly associated with TSCI ($p \leq 0.001$). Most participants in this study were classified as paraplegic (n = 210, 54.40%) with the lower thoracic spine the area most commonly injured (n = 105, 27.20%). The majority of participants were admitted from tertiary-level healthcare institutions (n = 224, 58.03%) with a mean time between injury and rehabilitation admission of 64.48 days (SD = 59.78). The mean length of stay in rehabilitation was 85.59 days (SD = 63.2) with 342 PWSCI (88.60%) completing rehabilitation and being discharged, most commonly to a private residence (n = 330, 96.49%). The majority of these participants made use of a manually-operated wheelchair at discharge (n = 185, 54.09%). Of those that did not complete rehabilitation (n = 44, 11.40%), 6.48% demised (n = 25), 2.07% refused continuation of rehabilitative treatment (n = 8), 1.81% absconded (n = 7) and 1.04% became medically unstable and were deemed unfit to continue rehabilitation (n = 4).

Conclusion: The findings of this study vary greatly between each of the five public healthcare rehabilitation units but were overall found to be similar to those previously published in Gauteng. A finding unique to South Africa that was confirmed by this study is that more females were affected by NTSCI. This study serves as a strong foundation from which to conduct further epidemiological research into PWSCI not only in Gauteng, but in all other provinces of South Africa too. Furthermore, it is recommended that the epidemiological profile be extended to include privately-funded rehabilitation units in Gauteng and/or South Africa such that there is a comprehensive understanding of SCI on a national scale.

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I would like to extend my gratitude, thoughts and strength to each and every person who has sustained a spinal cord injury. To those that I have had the privilege to meet and share a small part of your journey, I hope that I have done you justice. To those that I am still yet to meet, I hope that I will continue to learn and be able to one day do you justice. *Sisonke!*

Last but certainly not least. To my family. I will never be able to truly explain the role and shining light you have all provided in my life. You have always believed in me and taught me to never give up. I hope that I have made you proud in the past, continue to do so today and always will going forward.

DISCLAIMER

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LIST OF ABBREVIATIONS

AIS	American Spinal Injury Association Impairment Scale
ASIA	American Spinal Injury Association
CNS	Central Nervous System
DGMAH	Dr. George Mukhari Academic Hospital
EH	Edenvale Hospital
HIV	Human Immunodeficiency Virus
ISCICDS	International Spinal Cord Injury Core Data Set
ISNCSCI	International Standards for Neurological Classification of Spinal Cord Injury
LOS	Length of Stay
MDT	Multidisciplinary Team
NHI	National Health Insurance
NQF	National Qualifications Framework
NTSCI	Non-traumatic spinal cord injury
PWSCI	Persons with Spinal Cord Injury
RAF	Road Accident Fund
SCI	Spinal cord injury
SDI	Socio-demographic Index
SHCs	Secondary Health Conditions
SRH	South Rand Hospital
TMRH	Thelle Mogoerane Regional Hospital
TRH	Tshwane Rehabilitation Hospital
TSCI	Traumatic spinal cord injury
TTA	Time to Admission

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CHAPTER 1 BACKGROUND AND NEED

1.1 INTRODUCTION

Injury to the spinal cord is devastating, with morbidity not limited solely to physical aspects but also to emotional, social and vocational life areas. The autonomic functioning of the body and its organ systems is also disrupted (Nógrádi and Vrbová, 2006; Drake, Vogl and Mitchell, 2015) and, combined with a loss of functional independence, leads to an overall negative impact on well-being and health-related quality of life (Craig, Tran and Middleton, 2009). Findings by Njoki, Frantz and Mpofu (2007) noted a negative impact on social and community reintegration after spinal cord injury (SCI) which often results in a significant burden not only on the individual and their families, but also on societal economies (McDaid et al., 2019; Malekzadeh et al., 2021).

Individuals who sustain a SCI require intensive rehabilitation to improve their independence in functional tasks and empower themselves and their families with the necessary education and skills to avoid secondary health conditions (SHCs) (Van Wyk, 2018). Secondary health conditions are a range of health complications that occur as a direct consequence of living with a disability (Rimmer, Chen and Hsieh, 2011). Common SHCs in persons with spinal cord injury (PWSCI) include pain, pressure sores, spasticity, sexual dysfunction as well as bladder and bowel dysfunction (Jensen et al., 2013; Pilusa, Myezwa and Potterton, 2021). Specialized medical care in conjunction with early admission to a specialist multidisciplinary rehabilitation unit has been shown to improve functional outcomes, limit SHCs and lower mortality rates (Parent et al., 2011; Conradsson et al., 2018). The ultimate goal for PWSCI during acute inpatient rehabilitation is to prevent SHCs and prepare for and attain independent bed and wheelchair mobilization where appropriate (Nas et al., 2015).

The World Health Organization (2017) has recognized an increasing need for rehabilitation worldwide and highlighted that this need remains unmet, especially in low- and middle-income countries. Rehabilitation refers to the multidisciplinary- and patient-centered undertaking to enable PWSCI to return to a productive and satisfying life (Harvey, 2016). The demand for rehabilitation services is expected to increase in line with an ageing global population as well as with improving healthcare trends (New, Cripps and Bonne Lee, 2014; World Health Organization, 2017). A call to action through the "Rehabilitation 2030" project has been undertaken and includes collecting of rehabilitation data to enhance health information systems (World Health Organization, 2017).

Literature recommends that a minimum amount of information of PWSCI is kept as per the International Spinal Cord Injury Core Data Set (ISCICDS) (DeVivo et al., 2006; Biering-Sorensen et al., 2017). Collection of information on PWSCI per the ISCICDS ensures standardization when collecting and reporting on data such that studies may be compared and analysed on a global scale. The latest ISCICDS version recommends that collected data must include information on sex, age at injury, SCI cause, neurological status, length of acute hospital and/or rehabilitation stay, whether a vertebral injury was present, whether spinal surgery was performed and whether associated injuries were present (Biering-Sorensen et al., 2017). In addition, information on whether the patient was ventilator-dependent, the place to where patients are discharged and the date of death should be included where applicable (Biering-Sorensen et al., 2017).

The global incidence of SCI in 2016 was 110-160 injuries per million people with this number slightly lower in Sub-Saharan Africa at 70-100 per million (GBD 2016 Traumatic Brain Injury and Spinal Cord Injury Contributors, 2018). Authors in South Africa have offered significant variation regarding the incidence rate of SCI in South Africa with a range from 9.2 per million (Godlwana et al., 2008) to 123 per million (Pefile, Mothabeng and Naidoo, 2018). These variations could be due to a lack of surveillance on disability and its variable reporting the world over. Differences can also be attributed to study methodologies, with certain studies limiting injury profiles to traumatic spinal cord injury (TSCI) and others non-traumatic spinal cord injury (NTSCI). Furthermore, study settings varied across provincial borders and fluctuated between both acute hospital settings and specialized rehabilitation units. A global estimate for the prevalence of SCI was reported as 3400-4090 per million with estimates for the Sub-Saharan Africa region reported as 1940-3190 per million (GBD 2016 Traumatic Brain Injury and Spinal Cord Injury Contributors, 2018). South Africa was found to have a similar SCI prevalence to that of Sub-Saharan Africa with estimates of 1910-2280 per million (GBD 2016 Traumatic Brain Injury and Spinal Cord Injury Contributors, 2018). This owes largely to the lack of reporting in other countries in this region (GBD 2016 Traumatic Brain Injury and Spinal Cord Injury Contributors, 2018).

Motor vehicle accidents remain the leading cause of TSCI worldwide (Lee et al., 2014; Kang et al., 2018). Injuries as a result of falls tend to be increasing in high-income regions largely due to ageing populations, while they remain proportionally low in low- and middle-income regions (Kang et al., 2018). Violence-related causes of TSCI are reported to be highest in Sub-Saharan Africa (Draulans et al., 2011, Lee et al., 2014) with high levels also noted in South America and both the Middle and North East (Lee et al., 2014). Regarding NTSCI, high-income countries had higher incidences of degenerative disease and tumours whilst in low- and middle-income countries a higher incidence of infectious disease (often tuberculosis- and HIV-related) was noted (Lee et al., 2014).

In South Africa, limited information exists regarding the cause of SCI for Gauteng. Traumatic SCI continues to be the leading cause of injury at rehabilitation units in the province (Mashola and Mothabeng, 2019; Mashola, Olorunju and Mothabeng, 2019). Violence-related trauma was found to be the most common cause of TSCI in the province as presented in two outdated studies (Hart and Williams, 1994; Hart, 2000). In the Western Cape, transport-related injuries were common (Sothmann et al., 2015; Phillips, Braaf and Joseph, 2018). Kwazulu-Natal was found to have a high incidence of NTSCI with infectious spondylitis the leading cause of injury in a comprehensive epidemiological study by Pefile, Mothabeng and Naidoo (2018).

Males tend to be more commonly injured than females, with higher male to female ratios seen in developing regions (Kang et al., 2018). This is true for both TSCI and NTSCI populations although a smaller male-to-female ratio is noted in those with NTSCI (van den Berg et al., 2010), a feature seen in both developing and developed countries

(Gupta et al., 2009). These findings were consistent in South African literature with males injured more commonly than females in all published epidemiological data on TSCI. Of significance, however, was the fact that females were more commonly affected by NTSCI (Godlwana et al., 2008; Pefile, Mothabeng and Naidoo, 2018).

Regarding age, there tends to be a “bi-modal distribution” in global literature for TSCI with peaks in the 15-29 and 50+ age groups (van den Berg et al., 2010). For NTSCI, incidence tends to increase with age with a typical median age of 60-65 years (Gupta et al., 2009; Draulans et al., 2011). This finding was mirrored in published research in South Africa with a peak TSCI incidence in the 15-29 age group while a higher, but not globally-reflective mean age of 39.67 years was noted in the NTSCI population (Pefile, Mothabeng and Naidoo, 2018).

International literature shows that paraplegia is most common in developing countries with TSCI causing more severe (complete) injuries as per the American Spinal Injury Association (ASIA) Impairment Scale (AIS) (Draulans et al., 2011; Clark and Marshall, 2017). In South African literature, quadriplegia was most common in all Western Cape epidemiological studies (Joseph et al., 2015; Sothmann et al., 2015; Phillips, Braaf and Joseph, 2018) while paraplegia was most common in Gauteng (Mashola and Mothabeng, 2019; Mashola, Olorunju and Mothabeng, 2019) and Kwazulu-Natal (Godlwana et al., 2008; Pefile, Mothabeng and Naidoo, 2018). Regarding injury completeness, incomplete injuries dominated in the Western Cape (Joseph et al., 2015; Sothmann et al., 2015; Phillips, Braaf and Joseph, 2018) and Kwazulu-Natal (Godlwana et al., 2008; Pefile, Mothabeng and Naidoo, 2018). The opposite was found in Gauteng where complete injuries were most common (Mashola and Mothabeng, 2019; Mashola, Olorunju and Mothabeng, 2019). More incomplete injuries were seen in cases of NTSCI (Pefile, Mothabeng and Naidoo, 2018).

Variances have been identified between the epidemiological literature published locally and that published abroad. This study thus aims to update the outdated epidemiological profile of SCI in Gauteng and identify the prevalence of SCI in public healthcare rehabilitation units in the province. This will assist the province in ensuring that an optimal healthcare provision is provided for PWSCI.

1.2 PROBLEM STATEMENT

The United Nations Convention on the Rights of People with Disability (United Nations, 2006) and the World Health Organization's Rehabilitation 2030 call to action (World Health Organization, 2017) projects advocate for the ongoing surveillance and research on disabilities to inform planning and optimization of service delivery. The current epidemiological profile of SCI in Gauteng remains unknown, with the last epidemiological-specific research conducted in the province more than 20 years ago (Hart and Williams, 1994; Hart, 2000). This highlights the fact that the findings are outdated and in need of revision. Despite Gauteng being South Africa's most populous province, the Western Cape and Kwazulu-Natal were found to have published the majority of SCI-related epidemiological research in South Africa. Of the seven identified studies that have researched either the incidence, prevalence and/or profile of SCI in South Africa, only one included both TSCI and NTSCI (Pefile, Mothabeng and Naidoo, 2018) while one other solely investigated the profile of patients with spinal tuberculosis (Godlwana et al., 2008). As is the case in South Africa, the profile of NTSCI remains largely unstudied worldwide (Clark and Marshall, 2017) – an alarming observation considering the anticipation of a move towards a future with increased numbers of NTSCI in line with an aging population. Noted discrepancies exist between the epidemiological profile of SCI published internationally and those previously published in South Africa. These findings are thus not equitable and may not be used to predict or deduce the profile but rather highlight the need for further research and revision of this topic.

1.3 RESEARCH QUESTION

What is the prevalence and profile of PWSCI who have received rehabilitation in public healthcare rehabilitation units in Gauteng, South Africa?

1.4 AIM OF THE STUDY

To determine the prevalence and profile of PWSCI who have received rehabilitation in public healthcare rehabilitation units in Gauteng, South Africa.

1.5 OBJECTIVES OF THE STUDY

1. Establish the prevalence of PWSCI who have received rehabilitation in the public healthcare setting in Gauteng, South Africa
2. Establish the sociodemographic and injury profiles of PWSCI who have received rehabilitation in the public healthcare setting in Gauteng, South Africa
3. Compare the prevalence and profiles of PWSCI between each of Gauteng's five public healthcare rehabilitation units
4. To determine the associations between sociodemographic and injury profiles of PWSCI who have received rehabilitation in the public healthcare setting in Gauteng, South Africa

1.6 SIGNIFICANCE OF THE STUDY

Gauteng, South Africa's most populous province, falls short in understanding the recent profile of PWSCI receiving rehabilitation in the public healthcare sector. By understanding the epidemiological profile of SCI in Gauteng, preventative programs may further be strengthened. Preventative programs such as the BokSmart programme have been found to reduce the incidence of rugby-related SCI in South Africa (Brown et al., 2016). Not only will this study provide updated epidemiological SCI information, the insight gained from this study may further be used to advocate for the building/formation of a specialized acute SCI facility and more rehabilitation hospitals in Gauteng. This study will also play a role in bridging epidemiological gaps in low- and middle-income countries as recommended by the World Health Organization (2017) and may also be used to inform national policies related to people with disabilities.

With a move towards a model of universal healthcare for all South Africans through the National Health Insurance (NHI) (South African Government, 2021), it is vital that a better understanding of Gauteng rehabilitation is garnered. This study and potential future studies may contribute to the ongoing investigation into the allocation of Gauteng's rehabilitation services to ensure that service delivery is optimized. This will potentially assist key stakeholders in ensuring that Gauteng rehabilitation services for PWSCI are running according to international guidelines and best-recommended practice, especially with an imminent move towards the NHI, which may potentially further burden access to healthcare in the public sector in Gauteng.

1.7 GENERAL OUTLINE OF THIS DISSERTATION

The general outline of this dissertation is provided below:

Figure 1.1: Outline of the Dissertation

CHAPTER 2 LITERATURE REVIEW

This chapter is divided into four sections. Section one seeks to discuss and familiarize the reader with the anatomy of the human spine and spinal cord. In section two, spinal cord injury is explored, while the management and subsequent need for rehabilitation thereafter is explored in section three. Section four seeks to identify and explore the profile of persons with spinal cord injury both internationally and locally whilst investigating associations between sociodemographic and injury profiles.

A variety of online databases including PubMed, the Pedro database, Cochrane reviews and Google Scholar were used. Keywords used included 'spinal cord injury', 'incidence', 'prevalence', 'epidemiology', 'etiology' and 'profile'. Titles were screened and suitable articles accessed. Individual review of journals and textbooks was also done. In addition, websites such as Google, the World Health Organization, the International Spinal Cord Injury Society and Statistics South Africa were accessed for additional information.

2.1 ANATOMY OF THE HUMAN SPINE AND SPINAL CORD

The human spine, also known as the vertebral column, is formed by 33 vertebrae – seven in the cervical, twelve in the thoracic, five in the lumbar, five in the sacral and four in the coccygeal regions (Drake, Vogl and Mitchell, 2015). The typical vertebra consists of an anteriorly located vertebral body, a left and right pedicle, lamina and transverse process, as well as a posteriorly projecting spinous process. Superior and inferior articular processes are found on either side of each lamina and are responsible for the articulation of adjacent vertebrae. A foramen known as the vertebral canal is formed between the anteriorly located vertebral body and posteriorly located vertebral arch (a combination of the left and right pedicles and laminae) (Cramer, 2014). The primary purpose of the vertebral column is to house and protect the spinal cord in addition to providing support for the weight of the body and allowing an axis upon which bodily movement can occur (Cramer, 2014; Drake, Vogl and Mitchell, 2015). For the vertebral column to be damaged, there needs to be extensive external force applied to it (Alizadeh, Dyck and Karimi-Abdolrezaee, 2019) which may jeopardize the integrity of the spinal cord.

The spinal cord is the delicate extension of the central nervous system (CNS) located outside of the cranium and is responsible for connecting the brain with the rest of the body (Darby, 2014). The spinal cord originates from the medulla oblongata of the brainstem and exits the foramen magnum through which it runs caudally within the vertebral canal. Its primary function is to receive, relay and transmit sensory and motor information between the body and the brain through afferent and efferent neuronal fibres respectively (Crossman and Neary, 2010). In addition, the spinal cord also provides autonomic innervation for the internal viscera (Crossman and Neary, 2010). It is for this reason that there is partial or full loss of sensation and/or motor control following SCI, depending on the site of the injury (Nógrádi and Vrbová, 2006).

2.1.1 EXTERNAL FEATURES OF THE SPINAL CORD

There are 31 pairs of spinal nerves which are divided into segmental regions – eight cervical, twelve thoracic, five lumbar, five sacral and one coccygeal (Drake, Vogl and Mitchell, 2015). Each nerve root is numbered consecutively and prefixed according to its relative vertebral region (C1 for the first cervical nerve root, C2 for the second cervical nerve root etc.). Each cervical nerve root exits the vertebral canal through the intervertebral foramen above the vertebra after which it is named (Crossman and Neary, 2010). Thus, the C7 nerve root exits above the C7 vertebra. Since there are eight cervical nerve roots but only seven cervical vertebrae, the eighth cervical nerve root exits between the C7 and T1 vertebrae. As a result, all thoracic and lumbar nerve roots then exit below the vertebral level after which they are named. There are two marked enlargements in the spinal cord (Drake, Vogl and Mitchell, 2015). The first, in the cervical region, is known as the brachial plexus and provides innervation for the upper limbs. The lumbosacral plexus, the second of the enlargements, is found in the lumbar region and is responsible for the innervation of the lower limbs (Crossman and Neary, 2010).

The three meninges of the brain (the dura mater, arachnoid mater and pia mater) are continuous with the spinal cord which is bathed in cerebrospinal fluid. A layer known as the epidural space – approximately 4-6mm in width – exists between these three meninges, the vertebral column and its associated ligamentous/cartilaginous structures. Within this epidural space, a combination of connective tissue, adipose tissue and an internal vertebral venous plexus can be found (Darby, 2014).

The spinal cord is a highly-vascularized structure and receives arterial blood supply from the anterior and posterior spinal arteries (Crossman and Neary, 2010). The anterior spinal artery is formed through the joining of the left and right vertebral arteries. It runs anteriorly on the ventral median fissure of the spinal cord beneath the pia mater. Branches from the vertebral artery also give rise to the posterior spinal artery which is responsible for blood supply to the dorsal aspect of the spinal cord (Crossman and Neary, 2010). Due to its vascularized and delicate structure, the spinal cord is still prone to injury without external force including neoplasms, tumours and infectious diseases (Grassner et al., 2015).

2.1.2 INTERNAL FEATURES OF THE SPINAL CORD

Unlike in the brain, the spinal cord comprises an inner zone of grey matter with an area of white matter constituting the outer margins (Saab, 2006). The grey matter comprises of two anteriorly placed ventral horns and two posterior dorsal horns giving it a "butterfly-like" appearance. A spinal nerve root is formed where the afferent sensory nerves of the ventral horn and efferent motor nerves of the dorsal horn merge (Cramer, 2014; Darby, 2014) and there is one spinal nerve root on both the left and right side of each neural level conveying both motor and sensory information. This is why in certain instances, depending on the nature of the injury (whether through external force or internal damage), the spinal cord can be injured on one side.

The grey matter of the spinal cord is primarily comprised of the cell bodies of sensory fibres, unmyelinated axons and glial cells such as astrocytes and oligodendrocytes (Nógrádi and Vrbová, 2006). The outer margins of white matter are predominantly comprised of myelinated axons that form organized ascending and descending tracts. The ascending tracts relay sensory information from the body to the brain through the dorsal columns and spinothalamic tracts. The dorsal columns are responsible for carrying information about proprioception, discriminative touch and vibration while the spinothalamic tracts carry information about pain, temperature, non-discriminative touch and pressure (Crossman and Neary, 2010). Descending tracts relay information from the brain and brainstem to the rest of the body. The corticospinal tracts originate in the brain's cerebral cortex and are responsible for skilled movements particularly in the distal limbs. The rubrospinal, tectospinal and vestibulospinal tracts originate in the brainstem and are responsible for maintaining muscle tone, spinal reflexes, spinal autonomic functions and control of sensory feedback to higher centres (Crossman and Neary, 2010). It is therefore not surprising that a SCI can result in multiple and varying neurological impairments or dysfunction (Furlan et al., 2011). This dysfunction will be based on the location and extent of damage with catastrophic consequences possible. The following sections will be used to further explore injury to the spinal cord and how these injuries are holistically managed.

2.2 SPINAL CORD INJURY

2.2.1 DEFINITION OF SPINAL CORD INJURY

Spinal cord injury (SCI) is a term used to refer to any injury and/or disease process that affects the neural components within the spinal canal and/or neighbouring nerve roots (Weidner, 2017). Disruption to this delicate part of the CNS results in impaired motor, sensory and autonomic functioning of the body and its organ systems. Typically, persons with spinal cord injury (PWSCI) present with an upper motor neuron syndrome that is clinically characterized by a positive clonus sign, hyperreflexia, an increase in spasticity and motor weakness (Emos and Agarwal, 2020). However, certain exceptions do exist. In the cervical and lumbosacral regions – and depending on the location and extent of the damage – the ventral horns which supply innervation to proximal and distal upper and lower limb muscles may also be affected (Weidner, 2017). This will cause a "lower motor neuron syndrome" with a clinical picture of muscular atrophy, hyporeflexia, flaccid tone and muscle fasciculations (Weidner, 2017). It is important that all PWSCI are classified universally by the same standards.

2.2.2 CLASSIFICATION OF SPINAL CORD INJURY

Accurate and coordinated reporting of SCI is essential for both clinicians and researchers alike to ensure standardization on the diagnosis, treatment and reporting of spinal cord injury (Roberts, Leonard and Cepela, 2017). A subjective, non-specific attempt to fulfil this need was developed from which the Frankel scale was developed and first published in 1969 (Frankel et al., 1969). However, limitations with regards to accuracy and objectivity lead to the American Spinal Injury Association (ASIA) developing and publishing the “International Standards for Neurological Classification of Spinal Cord Injury” (ISNCSCI) in 1982 (American Spinal Injury Association, 1982). The ASIA Impairment Scale (AIS) wholly replaced the Frankel scale in 1992 and to date is the most widely used tool for classifying SCI (Kirshblum and Waring III, 2014) and is being continuously updated (The American Spinal Injury Association, 2021).

The AIS examination involves testing of anorectal function, sensory function across 28 dermatomes and motor function of five upper and five lower limb key muscle groups. The tool allows for the investigator to determine a neurological level of injury as well as whether the injury is complete or incomplete – both important prognostic factors in the functional recovery of PWSCI (Roberts, Leonard and Cepela, 2017). To determine the neurological level of injury, the lowest neurological segment with intact sensation and motor function (muscle strength of grade three or above on the Medical Research Council muscle strength scale) is determined. For example, if a patient has intact sensation in all dermatomes up to T6 on both the left and right sides, their neurological level of injury would be classified as T6. As this injury would have occurred in the thoracic segment of the spinal cord, the injury would be termed paraplegia. Paraplegia refers to motor or sensory impairment secondary to neural damage in the thoracic, lumbar or sacral regions of the spinal cord and the motor and sensory fallout is limited to the trunk and lower limbs with sparing of the upper limbs (Ko, 2019). Sensory or motor impairment as a result of damage to the neural elements of the cervical region of the spinal cord is referred to as quadriplegia or tetraplegia (Ko, 2019). The affected body parts include the upper limbs as well as the trunk and lower limbs.

With regards to completeness of injury, a complete (AIS A) injury refers to there being no motor or sensory functioning below the neurological level of injury including in the sacral segments (S4-S5). Where some degree of sensory or motor functioning is spared below the neurological level of injury (including in the S4-S5 sacral segments), the injury is deemed incomplete (graded AIS B, C or D depending on the retained sensory/motor function). In addition to the ISNCSCI classification system, five "syndromes" of incomplete SCI have been defined and are currently recognized (Hayes et al., 2000), namely central cord syndrome, posterior cord syndrome, Brown-Séquard syndrome, cauda equina syndrome and conus medullaris syndrome. These syndromes are distinguished according to the spinal cord area that is damaged as ascending and descending tracts vary in position and function (Swain and Grundy, 2002; Ko, 2019).

Central cord syndrome results in a greater degree of motor impairment in the upper limbs than in the lower limbs while sensory impairment is varied. In anterior cord syndrome, flaccid paralysis at the neurological level of injury is seen with spastic motor paralysis and impaired pin prick sensation below the level of neurological damage. Posterior cord syndrome refers to damage in the dorsal column of the spinal cord. It results in a loss of proprioceptive sense with deep touch, position and vibratory changes (Ko, 2019). Brown-Séquard syndrome – also referred to as unilateral cord syndrome – results in motor impairment on the side of cord hemi-section while a loss of pain and temperature is experienced on the opposite side. The final two syndromes – cauda equina and conus medullaris syndrome, often grouped together as clinically they can be indistinguishable – arise as a result of injury to the L1 to L5 nerve roots located distal to the termination of the spinal cord (Rider and Marrar, 2019). Although conus medullaris syndrome may present as an upper motor neuron lesion conditional on the extent of the injury, these syndromes typically present as lower motor neuron lesions. Bladder and bowel dysfunction and varying degrees of lower limb weakness and sensory disruption is common, notwithstanding a usually favourable outcome

(McKinley et al., 2007). The appropriate management of SCI is imperative, irrespective of whether the SCI resulted in paraplegia, tetraplegia, complete or incomplete paralysis.

2.3 THE MANAGEMENT OF SPINAL CORD INJURY IN GAUTENG PROVINCE

Although Gauteng is South Africa's smallest province by land area, it is the most populous province with a 2019 mid-year population estimate of 15 176 115 people (total South African population 58 775 022) (Statistics South Africa, 2019). The province is divided into 3 metropolitan municipalities (Johannesburg, Ekurhuleni and Tshwane) and 2 district municipalities which are further divided into 6 local municipalities (Sedibeng district comprising of Emfuleni, Lesedi and Midvaal local municipalities; West Rand district comprising of Merafong, Mogale City and Rand West City local municipalities).

South African citizens have access to two different healthcare models – a government-funded public healthcare system as well as a private insurance/out-of-pocket healthcare system (Delobelle, 2013). As per a 2018 general household survey, public healthcare is accessed by approximately 83.6% of South Africans (an estimated 48.03 million people) (Statistics South Africa, 2018). In Gauteng, this proportion is slightly lower at 76.1% (an estimated 11.16 million people) but still represents a three-quarter majority of provincial citizens (Statistics South Africa, 2018). The following sections seek to outline the medical and rehabilitative management of SCI in the public healthcare setting in Gauteng.

2.3.1 THE MEDICAL MANAGEMENT OF SPINAL CORD INJURY

Medical management of SCI is guided by causes of the injury. In cases where a traumatic spinal cord injury (TSCI) is suspected, it is recommended that the patient be transported to the closest hospital able to provide care for trauma cases (Ahn et al., 2011). Once at the hospital, the Advanced Trauma Life Support guidelines are implemented by conducting a primary survey and ensuring the stability of the individual's airway, breathing and circulation (Fehlings et al., 2017). Further, an assessment of disability (by looking at consciousness using the Glasgow Coma Scale), as well as exposure (bleeding, hypothermia and burns) is done (Fehlings et al., 2017). A full-body investigation is done with diagnostic imaging such as x-rays, CT and MRI scans ordered for further investigation of suspected spinal cord injury (Fehlings et al., 2017). In the case of a confirmed SCI, prompt and comprehensive medical and / or surgical management is needed to minimize further neurological damage to the spinal cord and surrounding structures (Harvey, 2016).

It has been advised that a neurosurgical team assess the patient to decide if decompression or fixation is indicated in cases where the neural elements are being compressed or are unstable respectively (Fehlings et al., 2017). If not, conservative options such as orthoses and bed rest may be prescribed. Ongoing care of all bodily systems is then indicated with special care taken to avoid preventable complications such as pressure ulcers, venous thromboembolism, autonomic dysreflexia and bladder and/or bowel dysfunction (Fehlings et al., 2017). A full rehabilitation program consisting of varying health professionals is recommended for PWSCI with the aim to return them to a productive and satisfying life (Harvey, 2016).

2.3.2 THE REHABILITATIVE MANAGEMENT OF SPINAL CORD INJURY

Rehabilitation of PWSCI is a multidimensional and complex undertaking that spans the survivors' lifetime. The World Health Organization (2019) described rehabilitation as "a set of interventions designed to optimize functioning and reduce disability in individuals with health conditions in interaction with their environment". Using the World Health Organization's International Classification of Functioning, Disability and Health (ICF) as a framework upon which to base the rehabilitation approach for PWSCI, a biopsychosocial approach from a multidisciplinary team (MDT) is needed (World Health Organization, 2013). It is recommended that the team be led by a Physical Medicine and Rehabilitation physician and must include a physiotherapist, occupational therapist, speech therapist, dietician, social worker as well as the patient's family (Nas, 2015). The rehabilitative team needs to focus not only on the SCI and its related bodily impairments, but on the effect these impairments have on activities of daily living and social participation. The rehabilitation of PWSCI may be separated into acute, subacute and chronic stages although exact demarcation of each stage remains debatable (Burns et al., 2017).

2.3.2.1 ACUTE REHABILITATION

The rehabilitation of PWSCI begins as soon as medical stability is established (Harvey, 2016). Treatment goals during the acute stage will ultimately be focused on the prevention of secondary health conditions (Nas et al., 2015). Complications can occur in a multitude of organ systems and are common in the cardiovascular, respiratory, musculoskeletal and urogenital systems (Hagen, 2015). A secondary goal during the acute stage is preparing the individual for functional tasks such as moving in bed and achieving a sitting position in both the bed and on the wheelchair (Nas et al., 2015).

To prevent respiratory complications, breathing exercises and early mobilization is encouraged with rigorous chest physiotherapy indicated where necessary (Nas et al., 2015). Musculoskeletal complications during the acute stage are common, with contractures and joint stiffness having a profound effect on functional ability and contributing to disabling pain and spasticity (Harvey et al., 2011). Daily passive range of motion exercises and stretching should be done at this stage with positioning of joints crucial to maintain muscle length for future function (Nas et al., 2015).

Orthostatic hypotension is another common complication in the acute stage and refers to a reduction in blood pressure associated with a postural change from supine to upright positions and often occurs due to prolonged bed rest (Claydon, Steeves and Krassioukov, 2006). Symptoms range from mild dizziness to a total loss of consciousness and in rare instances, death (Shen et al., 2014). Low-level evidence for the management of orthostatic hypotension includes pharmacological agents and the application of functional electrical stimulation to the lower limbs while better success has been exhibited with the use of gradual head-up positional changes as achieved with the use of a tilt-table (Krassioukov et al., 2009; Shen et al., 2014).

International literature has shown that direct admission or early transfer of PWSCI into a specialized acute care unit is related to a shortened length of stay, fewer complications and a lower mortality rate (Parent et al., 2011; Maharaj et al., 2017). In Gauteng, there is no dedicated acute SCI unit as there is in the Western Cape (Groote Schuur Hospital Acute Spinal Cord Injury Unit) (Sothmann et al., 2015) and Kwazulu-Natal (King Dinizulu Hospital Spinal Unit) (Pefile, Mothabeng and Naidoo, 2018). The medical management is thus carried out at various hospitals across Gauteng with patients who require neurosurgical/orthopaedic management to decompress/stabilize their injuries often transferred to facilities that can provide this type of specialized care.

2.3.2.2 SUB-ACUTE REHABILITATION

Once medically stable and all initial medical and/or surgical management has been completed, PWSCI are transferred to specialized rehabilitation facilities. A full neurological assessment needs have been conducted to determine the extent of injury and resultant functional ability. A shift in focus from a predominantly bed-based setting to one more conducive to working on functional movement and activities of daily living is made. To assist the MDT, a toolkit of 33 outcome measures validated for use in PWSCI has been designed by Chan et al. (2017) and spans a multitude of clinical areas to include all aspects of the ICF. Clinicians are encouraged to use these outcome measures on a regular basis to assess and monitor rehabilitation progress (Wade, 2004).

It is imperative that the PWSCI becomes an active member of their rehabilitation and this begins with the setting of realistic goals taking into account therapist and patient views (Harvey, 2016). The treating MDT will have a better understanding of key bodily impairments and the limitations these will pose on functional ability and ultimately participatory community roles in the future. Functional goals during this stage include attaining good mobility in bed and transitions from a lying to sitting position (Harvey, 2016). The ability to maintain a sitting position on the side of the bed as well as in a wheelchair allows for the PWSCI to move towards achieving independent transfers to and from a wheelchair (Nas et al., 2015). It must be noted that patient expectations differ and goals within the sub-acute phase are not uniform. For example, Harvey (2016) noted that some patients would prioritize independence in functional activities while others may prioritize walking.

Upper limb strength is one of the key components needed for independence with particular reference to bed mobility and transfers to and from a wheelchair. Where there is weakness of neurologically-intact muscles, progressive resistance strength training has been shown to not only improve muscle strength but also quality of life (Harvey, 2016). However, in partially-paralyzed muscles as a direct result of a SCI, discrepancies still exist regarding the optimal strength training paradigm (Harvey, 2016). Improving sitting balance is an essential aspect to achieving independent transfers to and from the wheelchair and to aid in wheelchair use and general activities of daily living (Nas et al., 2015).

2.3.2.3 CHRONIC REHABILITATION

By the time PWSCI reach the chronic stage of rehabilitation, they will have completed their acute and sub-acute rehabilitation stays and been discharged home (Nas et al., 2015). During the chronic stage of rehabilitation, it is vital that PWSCI attain societal reintegration. This will assist psychological and emotional well-being as depression and post-traumatic stress disorder is common post SCI (Nas et al., 2015). All members of the MDT play an important role in helping PWSCI realize their role in society and to assist them return to meaningful work (Holmlund et al., 2020). In Gauteng, the follow-up care of PWSCI is disjointed with a lack of standardization regarding follow-up protocols of PWSCI post discharge. For example, some rehabilitation centres would book the patient for a follow-up appointment at their own facility while others may alternatively provide the individual with a referral to their nearest facility that provides rehabilitative care. It is of importance that the MDT responsible for the rehabilitation of PWSCI understand the global and local epidemiological profile of SCI such that targeted healthcare provision may be achieved.

2.4 THE GLOBAL PROFILE OF SPINAL CORD INJURY

Epidemiology refers to the study of disease distribution (frequency and pattern) as well as determinants (causes, risk factors) in a specific population (Last, 2001). Incidence is the term used to describe the number of new occurrences of a specific health condition while prevalence is used to describe the proportion of a population living with a specific health condition at a given time or over a specified time period (Spronk et al., 2019).

2.4.1 THE INCIDENCE OF SPINAL CORD INJURY

Global estimates from the 2016 Global Burden of Disease Study (GBD 2016 Traumatic Brain Injury and Spinal Cord Injury Collaborators, 2018) suggest an estimated worldwide age-standardized incidence of 130 spinal cord injuries per million persons (range 110 to 160). Miao et al. (2020) report the use of a socio-demographic index (SDI) as a measure by which to assess a countries' development and health outcomes. Rated on a scale from zero to one, countries with a higher SDI are thought to have better development and health scores and a score closer to one. Contradictory to this, countries with a lower SDI have a score closer to zero and poorer development and overall health scores.

Regions with a higher SDI have been shown to have higher age-standardized SCI incidence rates with North America (260 per million persons) and Western Europe (260 per million persons) topping the global charts (GBD 2016 Traumatic Brain Injury and Spinal Cord Injury Collaborators, 2018). Countries with a middle SDI – under which South Africa has been classified – had the lowest age-standardized SCI incidence rates (80 per million persons). A study by Furlan et al. (2013) assessed the age-standardized incidence of TSCI by continent. Spinal cord injury incidence rates of between 20.7 and 83.0 per million persons were given for high-income North America with a much larger gap noted in Europe with estimates between 8.0 and 130.6 per million (Furlan et al., 2013). In Asia and the Middle East, an SCI incidence of between 14.6 and 246.0 per million persons was reported while Oceania reported an incidence rate between 10.0 and 77.0 per million persons (Furlan et al., 2013). A review by Singh et al. (2014) provided crude incidence rates compared to the age-standardized rates provided by the GBD 2016 Traumatic Brain Injury and Spinal Cord Collaborators (2018) and Furlan et al.

(2013). In North America, the SCI incidence ranged from 25.6 to 83.0 per million persons. A combined assessment of Europe and the Middle East showed an SCI incidence of between 6.2 and 58.0 per million persons (Singh et al., 2014). In Asia and Oceania, a crude SCI incidence rate of between 10.0 and 56.1 per million persons was given (Singh et al., 2014).

Very little data has been provided regarding the incidence rates of SCI in Africa. No estimates were provided in a study by Furlan et al. (2013) nor in a study by Singh et al. (2014). Kang et al. (2018) later reported an SCI incidence rate of 13.0 per million for Botswana while a study by Fitzharris, Cripps and Lee (2014) reported an SCI incidence rate of 13.9 and 11.7 per million for South Africa and Zimbabwe respectively. In the Western Cape, Joseph et al. (2015) reported a crude SCI incidence rate of 75.6 per million persons in a public setting study while Phillips, Braaf and Joseph (2018) reported a crude incidence of 20.0 per million persons in their private healthcare setting. By sex, a male and female SCI incidence of 130.3 and 21.2 per million persons was given for males and females respectively (Joseph et al., 2015). In Kwazulu-Natal, Pefile, Mothabeng and Naidoo (2018) provided a crude SCI incidence rate of 123 per million persons while Godlwana et al. (2008) reported an incidence of 20.9 per million in their study based solely on spinal tuberculosis.

When one considers this data, important inferences must be considered. Caution needs to be taken when comparing incidence rates as numerous discrepancies exist including differences in methodology, data collection and assessment thereof. A lack of global research into SCI may contribute to this. Contextualization needs to be noted too. As shown in two studies from the Western Cape over the same time period, a notable difference in incidence was noted between public and private healthcare settings (Joseph et al., 2015; Phillips, Braaf and Joseph, 2018). Additionally, it is not plausible to compare reported incidence rates from older studies as not only are people living longer presently and thus suffering from more age-related causes, technological advancements in transportation have resulted in a sharp increase in transportation-related SCI (Kang et al., 2018). Improved standards of medical care and survival bias may mean that more people are reaching acute hospitals with a diagnosis of SCI in regions with a higher SDI. In addition, reporting on these diagnoses is not only more standardized, but more precise in higher SDI regions as well. This can account for the higher incidence rates in North America and Western Europe while similarly explaining the lack of incidence reporting in lower SDI regions – particularly in Africa. In South Africa, the lack of a national SCI registry or database as well as a lack of epidemiological studies have been noted as concerning by the researcher.

2.4.2 THE PREVALENCE OF SPINAL CORD INJURY

Actual prevalence rates of SCI are grossly underreported (Singh et al., 2014; Kang et al., 2018). The lowest prevalence of SCI globally was reported as 440 per million in Iran while prevalence rates of 490 and 526 per million were provided for Australia and Iceland respectively. A global estimate of SCI prevalence has been reported as 3680 per million persons – an overall estimate of 27 million people living with a SCI worldwide (GBD 2016 Traumatic Brain Injury and Spinal Cord Injury Collaborators, 2018). The researcher notes that higher prevalence rates tend to be noted in regions with a higher SDI. Western Europe and high-income Asia Pacific were reported to have the highest global SCI prevalence rates at 8540 and 8210 per million persons respectively. Middle SDI regions were found to have an estimated SCI prevalence rate of 2310 per million persons (GBD 2016 Traumatic Brain Injury and Spinal Cord Injury Collaborators, 2018).

By continent, Furlan et al. (2013) report that the Americas showed an estimated annual SCI prevalence of 50-1298 per million persons while in Europe, an estimate of 227-526 per million persons was made. In Asia and the Middle East, a prevalence estimate of 236-849.8 per million was made while Oceania presented estimates of 681 per million persons. No actual SCI prevalence data has been offered for Africa. Estimates for Sub-Saharan Africa have been made at 1910 SCIs per million persons while for South Africa an estimate of 2060 SCIs per million persons has been made (GBD 2016 Traumatic Brain Injury and Spinal Cord Injury Collaborators, 2018). The researcher has observed a dearth of literature that reports on SCI prevalence as compared to incidence rates of SCI.

The limited prevalence reporting is worrying due to an expected increase in the number of persons living with SCI in the future. This is owing largely to medical advances and an aging population, factors likely to result in better survival rates post injury as well as a greater incidence and prevalence of NTSCI which has been found to increase with an increase in age (van den Berg et al., 2010). Health and disability policies may thus be inaccurately drafted and/or incorrectly implemented effectively as it is difficult to offer service provision to an unknown number of PWSCI – from a primary to tertiary healthcare level. As previously stated, a lack of a national database and a lack of standardized reporting may be responsible for the lack of prevalence reporting in South Africa. Based on estimates (GBD 2016 Traumatic Brain Injury and Spinal Cord Injury Collaborators, 2018), South Africa has a SCI prevalence a fourth of that reported in regions such as Western Europe despite South Africa's high incidence rates. Further research is warranted to investigate this conflicting phenomenon. This may be attributed to potentially inadequate follow up post-rehabilitation discharge leading to a higher mortality rate as a result of secondary health conditions. By identifying the prevalence of PWSCI who received rehabilitation in a public healthcare setting, healthcare stakeholders can be engaged to ensure adequate facilities and staffing are available to follow up these patients.

2.4.3 THE EPIDEMIOLOGICAL PROFILE OF SPINAL CORD INJURY

By investigating and understanding the epidemiological profile of SCI, patterns, causes and risk factors may be highlighted. This will allow for preventative strategies to be designed – or the effectiveness of existing ones reviewed – to ultimately lower incidence and prevalence rates. Additionally, this information can assist in ensuring that the offered healthcare services match the epidemiological profile to ensure optimum service delivery.

2.4.3.1 AETIOLOGY

There is more literature published both internationally and locally on TSCI as compared to NTSCI. In high-income regions, falls tend to be the leading cause of SCI having recently replaced motor vehicle accidents as the latter's incidence stabilizes and/or decreases in many regions (Lee et al., 2014; Kang et al., 2018). Rahimi-Movaghar et al. (2013) assessed the epidemiology in developing regions and found motor vehicle accidents (41.4%) to be the leading cause of injury ahead of falls (34.9%). Similarly, Lee et al. (2014) found that SCI secondary to motor vehicle accidents are on the rise. A study by New et al. (2014) reported that high-income countries had higher levels of tumours and degeneration-related causes. Developing countries had high levels of infection-related causes with tuberculosis and HIV-related conditions common (Draulans et al., 2011). It can thus be concluded that aetiological patterns vary globally with income classification holding significance.

The picture of TSCI and NTSCI in Africa differs from the high-income regions described above. Draulans et al. (2011) included both TSCI and NTSCI when they assessed aetiology across Sub-Saharan Africa. Motor vehicle accidents were the leading cause of injury in Nigeria (49%), Sierra Leone (50%) and Zimbabwe (56%) with falls dominating in Senegal (49%). Falls and violence were the next most common causes of TSCI in Nigeria, Sierra Leone and Zimbabwe. The authors have proposed that the high numbers of motor vehicle accidents may be due to a rise in the accessibility and use of motor vehicles in low-income regions with the infrastructure often lacking. Falls may be attributed to workplace incidents and a lack of safety equipment and/or supervision. Regarding NTSCI, tuberculosis of the spine was responsible for the most cases of NTSCI in Ethiopia (27%) followed by HIV myelopathy (17%) and spinal metastatic disease (15%). This was similar in Ghana, with spinal tuberculosis responsible for 30% of NTSCI followed by neoplastic conditions (14%) and cervical spine spondylosis with myelopathy (13%). Niger reported spondylotic myelopathy (29.8%) and tuberculosis myelopathy (25%) to be the leading cause followed by neoplastic disease (15%) and transverse myelitis (12%). Lastly, in Zimbabwe, neoplasms were most common (28%) with spinal tuberculosis (27%) next most common. Routine screening for HIV was not common practice in the majority of these studies and thus the association between HIV and tuberculosis remains relatively unstudied with suggestions that a positive correlation exists between the two (Draulans et al., 2011).

2.4.3.1.1 **SOUTH AFRICAN AETIOLOGY**

In Gauteng, two retrospective studies found violence to be the most common cause of SCI with gunshot wounds responsible for 36% of injuries in a study by Hart and Williams (1994) and 44% of injuries in a study by Hart (2000). Motor vehicle accidents were the second most common cause of injury at 25% for both studies with stab wounds third and responsible for 20% and 15% of injuries respectively (Hart and Williams, 1994; Hart 2000). Little information was provided regarding NTSCI with only 11% and 10% of each study population being diagnosed with NTSCI. While no clear categorization was provided, the study by Hart and Williams (1994) reported that "most" cases were as a result of spinal tuberculosis.

Contextualization is of utmost importance when analysing these results. Firstly, both studies were conducted in the same public rehabilitation unit – one of five in Gauteng. These results thus cannot be generalized across all public rehabilitation units in Gauteng. Secondly, the study periods of each study were 1988 to 1993 and 1988 to 1998 respectively. This suggests that there may be an overlap of collected data which may skew findings. These study periods were based during a tumultuous time period in South African history with pre-democratic political and other violence rife (Stevens, 2008). Lastly, compensation from the South African Government's Road Accident Fund means that many PWSCI as a result of motor vehicle accidents receive their rehabilitation in private rehabilitation units (Road Accident Fund, 2021). This lowers the incidence of motor vehicle accident-related TSCI in public rehabilitation units and thus may explain the low number of injuries as compared with global findings.

In the Western Cape, a one-year prospective study of all acute public healthcare hospitals found assault to be the leading cause of SCI at 59.3% (gunshot wounds most prevalent at 52% of all assault injuries then stab wounds at 33% and blunt trauma at 15%) followed by transportation injuries (26.3%) and falls (11.7%) (Joseph et al., 2015). A retrospective study by Phillips, Braaf and Joseph (2018) was done over the same single-year period as the prospective study by Joseph et al. (2015). It was conducted in a private healthcare acute setting to compare private and government funded healthcare settings. The authors reported that transport-related injuries were the leading cause of injury at 38.5% followed by falls at 30.8% and assault at 15.4%. A retrospective study over an 11-year period at an acute SCI unit by Sothmann et al. (2015) found the most common cause of injury to be transport-related at 44.6% followed by assault at 27.2% (gunshots 14.4%, stabs 8.6% and blunt trauma 4.3%) and falls at 15.5%. No observation was made with regards to NTSCI in any of these three studies. High levels of gang-related violence may be the reason for the high numbers of SCI as a result of assault in the study by Joseph et al. (2015). These prominent levels of assault mirror older studies by Hart (2000) as well as Hart and Williams (1994), however, it must be noted that political turmoil and violence were suggested to be contributors to high numbers of SCI secondary to assault.

Studies by Joseph et al. (2015) and Phillips, Braaf and Joseph (2018) were conducted to compare public and private healthcare settings. In the public healthcare setting, much higher incidences of assault were noted with high levels of transport-related injuries and falls noted in the private healthcare setting. The high levels of assault reflected the findings in Gauteng with the results from the private healthcare setting mirroring those published internationally (Kang et al., 2018). A retrospective review over an 11-year period at a specialized acute SCI unit by Sothmann et al. (2015) found that almost half of their study population had transport-related injuries. These findings differed from the Gauteng study by Hart (2000) who also looked at an 11-year period and found assault to be the leading cause of injury. These results may differ as a result of the different era and study settings. In the Western Cape, the study was undertaken at the Groote Schuur Hospital Acute Spinal Cord Injury Unit – a specialized acute SCI unit – whereas in Gauteng it was a specialized SCI rehabilitation unit. Compensation from the Road Accident Fund has resulted in several PWSCI as a result of motor vehicle accidents receiving compensation to complete their rehabilitation in a private healthcare setting. This may account for the high numbers of patients with transport-related injuries in the acute SCI unit in the Western Cape compared to the lower numbers in Gauteng's rehabilitation unit. Potentially, many patients from the acute SCI unit may have been transferred to private healthcare settings to complete their rehabilitation.

In Kwazulu-Natal, a retrospective study over a 6-year period was conducted at an acute public healthcare SCI unit by Pefile, Mothabeng and Naidoo (2018). The authors assessed both TSCI and NTSCI and found that NTSCI was more common than TSCI. In the NTSCI group, infective spondylitis – commonly spinal tuberculosis – was responsible for 79% of injuries followed by neoplasms at 16%. In the TSCI group, motor vehicle accidents were the most common cause of injury at 64% followed by falls and violence at 20% and 9% respectively. A second study by Godlwana et al. (2008) – based at the same acute setting that Pefile, Mothabeng and Naidoo (2018) – reported solely on spinal tuberculosis and thus no comment can be made with regards to aetiology from this study. South Africa is home to the fourth highest HIV prevalence in the world after eSwatini, Lesotho and Botswana (Satoh and Boyer, 2019; Kaiser Family Foundation, 2021). Kwazulu-Natal has high rates of HIV and, as of 2015, had the highest prevalence of tuberculosis in the country (Satoh and Boyer, 2019). Research has shown that people with HIV are more likely to develop tuberculosis as a result of weakened immune systems (Shankar et al., 2014). Regional factors and the burden of co-infection may explain the high levels of NTSCI – especially as a result of tuberculosis – in the province.

Overall, South Africa had the highest levels of violence-related SCI in the world with Gauteng responsible for the majority of these cases. The Western Cape tended to mirror international trends although no research has been reported on specialized rehabilitation units. Kwazulu-Natal led the country in terms of NTSCI with spinal tuberculosis responsible for the majority of cases. Research on SCI incidence and/or epidemiology has only been published for 3 of South Africa's 9 provinces. Further assessment is not only encouraged but greatly needed.

2.4.3.2 SEX

Globally, males tend to be more affected than females when it comes to SCI. A major review by Kang et al. (2018) found males to be more commonly affected in every study they reviewed with male to female ratios ranging between 1.10:1 to 6.69:1 in high-income countries and 1:1 to 7.59:1 in low-income countries. The authors propose this to be a consequence of males being the ones more often responsible for leading family and societal roles. Further, males more frequently partake in communal and dangerous activities. Rahimi-Movaghar et al. (2013) found a similar trend in their systematic review of low-income countries showing that males were responsible for a minimum of 66% of cases in each country with a male to female ratio ranging from 2:1 to 12.4:1. International literature reports that while males are more commonly affected by NTSCI, the male to female ratio tends to be smaller than for the TSCI population (van den Berg et al., 2010).

In South Africa, no sex disparity exists for TSCI with males always more commonly injured than females. In Gauteng, males accounted for 80% of patients in a study by Hart and Williams (1994) and 79% in a study by Hart (2000) giving a male to female ratio of 4:1 in both studies. In the Western Cape, males accounted for 85.5% and 84% of study participants respectively with male to female ratios of 5.9:1 and 5.25:1 (Joseph et al., 2015; Sothmann et al., 2015). The high numbers of males suffering from TSCI reflected a study by Nicol et al. (2014) who reported that males accounted for 71.3% of all trauma cases at a tertiary trauma unit in the Western Cape. Higher incidence rates of trauma in males leaves this population group at a higher risk of suffering from a SCI. A smaller study by Phillips, Braaf and Joseph (2018) reported that 77% of their study participants were males with a male to female ratio of 3.3:1. In Kwazulu-Natal, Pefile, Mothabeng and Naidoo (2018) reported that 62% of study participants were males with a male to female ratio of 1.5:1. It must however be noted that the NTSCI population of that study were found to have more females than males (n = 54, 53%). A study by Godlwana et al. (2008) which focused on spinal tuberculosis was the only study in South Africa where females were more commonly injured than males. Females accounted for 58% of the studies' participants with a male to female ratio of 0.72:1. From this, it seems that NTSCI (including spinal tuberculosis) more commonly affects females. This may be a direct result of the high numbers of women living with HIV and tuberculosis in the province (Karim et al., 2009). Additionally, it is common for co-infection to exist between the two conditions and this may play a role in the high prevalence of spinal tuberculosis (Satoh and Boyer, 2019).

2.4.3.3 AGE

Differing findings have been presented in populations with TSCI and NTSCI. In the TSCI population in high-income countries, two peaks have been identified with those between 15 and 29 years and those above the age of 65 years at risk (van den Berg et al., 2010). A review by Kang et al. (2018) found a mean age range of 14.6 to 67.6 years in high-income countries. These findings were somewhat consistent in low-income countries, where Rahimi-Movaghar et al. (2013) reported an overall mean age of 32.4 years (range 20.6 to 46.0 years) and Kang et al. (2018) reported a mean age range of 29.5 to 46.0 years. In Sub-Saharan Africa, a mean age range of 28-37 years was noted in the TSCI population and 40-45 years in the NTSCI population. No second peak was identified in low-income countries as there was in high-income countries, possibly a consequence of a lower life expectancy. While no mean age was offered in a study of high-income countries by Kang et al. (2018), a larger age range was noted at 14.6 to 67.6 years old. For those sustaining NTSCI, the incidence tended to increase with age (van den Burgh et al., 2010). This relative increase in age in the NTSCI population can possibly be attributed to the increased age in conditions such as tumours and degenerative changes (van den Berg et al., 2010). The older ages reported in developed regions may attest to longer life expectancies in these regions (Statista Research Department, 2020) and the relative increase in risk of NTSCI associated with this.

In South Africa, similar findings to those in low-income countries were identified. In Gauteng, no mean age was identified although 46% of participants were between the age of 20 and 29 years in an outdated study by Hart and Williams (1994) and 60% were between the ages of 16 and 30 in another by Hart (2000). In the Western Cape, a slightly older age trend was noted in the public healthcare sector compared to that internationally with a mean age of 33.5 years (54% between 18 and 30 years) and 34.0 years (33.5% between the age of 21 and 30 years) in studies by Joseph et al. (2015) and Sothmann et al. (2015) respectively. An older mean age of 47.0 years (range 24-88 years) was reported by Phillips, Braaf and Joseph (2018) in their study based in the private healthcare sector. The younger peaks of TSCI, particularly in the public healthcare sector, may be a reflection of higher levels of interpersonal violence and motor vehicle accidents with trauma shown to be most common in the 18 to 40-year age group in the Western Cape (Nicol et al., 2014). In Kwazulu-Natal, the age of those sustaining TSCI was similar to that in the Western Cape with a mean age of 33.1 years (40% between the age of 31-45) reported by Pefile, Mothabeng and Naidoo (2018). The NTSCI profile in Kwazulu-Natal did not match that published internationally with relatively young populations of 39.7 and 28.0 years reported by Pefile, Mothabeng and Naidoo (2018) and Godlwana et al. (2008) respectively. The younger population reported by Godlwana et al. (2008) attests largely to a study population that was 32% children (between 0-17).

2.4.3.4 INJURY SEVERITY

The cervical spine was the most common site of injury in both high- and low-income countries which ultimately results in varying degrees of quadriplegia Kang et al. (2018). This is due to the cervical spine being comparatively mobile and thus more susceptible to injury than other regions (Torlincasi and Waseem, 2021). This is especially true during high-velocity and complex injury mechanisms such as those experienced during motor vehicle accidents. Contradictory to this, however, Rahimi-Movaghar et al. (2013) and Draulans et al. (2011) both reported that paraplegia was the most common type of injury in low-income countries. The authors propose that the lower numbers of complete quadriplegia may be a direct result of high mortality levels related to complete cervical cord transection and the poor prognosis thereof. Worldwide, more PWSCI were found to have sustained incomplete injuries in high-income regions (Kang et al., 2018). Contradictory, in low-income regions, complete injuries were found to be more common as reported by Rahimi-Movaghar et al. (2013) and Draulans et al. (2011). TSCI tends to cause a higher number of complete injuries while NTSCI tends to cause more incomplete injuries (Kang et al., 2018). This may be a direct result of the higher energy mechanisms involved with trauma as compared to the usually slower and progressive onset associated with NTSCI.

In South Africa, injury profiles differed between provinces. In Gauteng, high numbers of complete injuries were reported by Mashola, Olorunju and Mothabeng (2019) as well as in an older study by Hart and Williams (1994) with 58% and 66% of participants presenting in this manner respectively. This differed to findings in the Western Cape where more participants were found to have sustained incomplete injuries in studies by Joseph et al. (2015), Sothmann et al. (2015) and Phillips, Braaf and Joseph (2018) with a proportion of 60.7%, 68.3% and 76.9% respectively. In Kwazulu-Natal findings mirrored those of Gauteng with complete injuries responsible for 66% and 68% in studies by Pefile, Mothabeng and Naidoo (2018) and Godlwana et al. (2008) respectively.

Regarding injury levels, outdated studies by Hart and Williams (1994) and Hart (2000) in Gauteng reported high levels of paraplegia with incidences of 75% and 76% respectively while a recent study by Mashola, Olorunju and Mothabeng (2019) recently reported a paraplegia proportion of 61%. The opposite findings were reported in the Western Cape with studies by Joseph et al. (2015), Sothmann et al. (2015) and Phillips, Braaf and Joseph (2018) all reporting higher incidences of quadriplegia (53.1%, 59.3% and 53.8% respectively). Similar to the findings reported in Gauteng, high levels of paraplegia were noted with incidences of 81% and 74% as reported by Pefile, Mothabeng and Naidoo (2018) and Godlwana et al. (2008) respectively. Patients with incomplete injuries may be discharged from acute hospitals without receiving specialized in-patient rehabilitation due to the better functional ability noted in this population (Wilson, Cadotte and Fehlings, 2012). Furthermore, due to the lack of bed availability and waiting times for rehabilitation, those with complete injuries may have more chance of receiving rehabilitation than those with incomplete injury. This may offer reasons for the higher numbers of participants with complete injuries in Gauteng and Kwazulu-Natal as these settings were specialized rehabilitation units.

2.4.3.5 LENGTH OF STAY

The rehabilitation length of stay (LOS) refers to the difference between the day of admission into and the date of discharge from a rehabilitation unit. Rehabilitation LOS varies greatly between countries. In the United States, an overall reduction in LOS has been noted with an average rehabilitation length of stay of 98 days between 1972 and

1979 to 34 days between 2015 and 2019 (National Spinal Cord Injury Statistical Centre, 2019). All time statistics based in America show that patients with complete quadriplegia have the longest length of rehabilitation stay at 94 days followed by incomplete quadriplegia (53 days), complete paraplegia (52 days) and incomplete paraplegia (39 days) (National Spinal Cord Injury Statistical Centre, 2019). A review by Burns et al. (2017) reported an overall rehabilitation LOS of 93.34 days in India, 58.8 days in Saudi Arabia and 37.8 days in Thailand. More developed regions had a longer rehabilitation LOS as reflected in Canada (99.2), the Netherlands and Belgium (227.6), Serbia (169) and Turkey (73.6). The Saudi Arabian study reflected on the rehabilitation LOS in both TSCI and NTSCI reporting a mean of 58.8 days and 46.2 days for each respective study population.

Only one study has investigated LOS for PWSCI receiving rehabilitation in Gauteng. It was reported that PWSCI were admitted for a mean of 89.56 days (SD = 25.84 days) in a mixed privately-funded and government-funded sample of patients in specialized rehabilitation units in Gauteng (Hastings, Ntsiea and Olorunju, 2015). This finding was similar to that published previously for India and Canada. This finding was notably longer than that reported in the United States of America as well as in low-income countries such as Saudi Arabia and Thailand, but notably shorter than high-income countries such as the Netherlands, Belgium and Serbia. Investigating this topic showed that PWSCI spend more time in rehabilitation than they do in the acute setting.

2.4.3.6 TIME TO ADMISSION

Parent et al. (2011) performed a review of the literature and reported that very little data has been recorded regarding time to admission (TTA) worldwide (the difference between day of injury and day of admission into a rehabilitation unit). The authors reported that patients waited a mean of 33.4 days and 19 days in two American studies while waiting a mean of 54.6 days in Italy. To the authors knowledge, TTA has only been reported in a single South African study on SCI rehabilitation. A mean TTA of 168.03 days (SD = 10.00) was reported by Hastings, Ntsiea and Olorunju (2015) in their public- and privately-funded study of SCI rehabilitation in Gauteng. While investigations have been made into the LOS in the acute setting in the Western Cape (Joseph et al., 2015; Sothmann et al., 2015; Phillips, Braaf and Joseph, 2018) and Kwazulu-Natal (Godlwana et al., 2008; Pefile, Mothabeng and Naidoo, 2018), no clarity was provided with regards to where these PWSCI were discharged to after their acute stays. From this, it would be inaccurate to report these findings under this subheading as it was not reported if they were eventually admitted to rehabilitation or discharged home.

2.4.3.7 OTHER INJURY CHARACTERISTICS

Contention exists around the timing of neurosurgical intervention with mixed results reported in the literature. A recent review of the literature by Nakashima, Nagoshi and Fehlings (2015) has shown that surgical decompression within 24 hours following acute SCI facilitates neurological improvement, reduces the overall hospital LOS and results in fewer post-operative complications. A study by Joseph et al. (2015) reported that 73.1% of study participants in the Western Cape presented with a vertebral fracture, with 51.7% of the study population being managed with spinal surgery. A study by Sothmann et al (2015) reported that 64.6% of study participants underwent spinal surgery although no comment was made on the number of participants with vertebral fractures or associated injuries. Phillips, Braaf and Joseph (2018) reported that 76.9% of their study population had vertebral fractures while the same amount underwent spinal surgery. In Kwazulu-Natal, 77% of the study population in a study by Pefile, Mothabeng and Naidoo (2018) received surgical spine intervention. No information in this regard was offered in studies from Gauteng and Kwazulu-Natal. Further investigation into the incidence rates of both vertebral fractures and spinal surgery in PWSCI is thus warranted as a basis upon which studies investigating the outcomes and associations may be conducted.

Associated injuries have been typically found to negatively affect hospital LOS and treatment outcomes (Fine, Stover and DeVivo, 1987) although little recent data has been published to support this. DeVivo et al. (2006) recommended that information on the following associated injuries be kept: moderate to severe traumatic brain injury, non-vertebral fractures requiring surgery, severe facial injuries affecting sense organs, major chest injury requiring a chest tube or mechanical ventilation, traumatic amputation of a limb, severe haemorrhaging as well as damage to any internal organ requiring surgery. In the Western Cape, a study by Joseph et al. (2015) found that associated injuries were present in 57.9% of their study population while Phillips, Braaf and Joseph (2018) reported a lower incidence at 30.8%. In Kwazulu-Natal, Pefile, Mothabeng and Naidoo (2018) reported that 13% of their study population had an associated injury. No comment was made in any of the Gauteng studies despite the province's relatively high levels of traumatic injuries which may lead to higher numbers of associated injuries.

Comorbidities, the presence of other diseases or health conditions – pre-existing or acquired – may lead to disruption in the rehabilitation process stopping PWSCI from reaching their expected goals as per neurological status (DeVivo et al., 2011). A study by (Horn et al., 2013) investigated the effect of comorbidities on various rehabilitation outcomes and reported that patients with a higher comorbidity burden – through either incidence or severity – are likely to have a longer LOS owing to medical interruptions during the rehabilitation process. Pre-existing comorbidities (especially in populations of older age and complete injury) were found to be a major risk factor for death in an acute setting, during rehabilitation as well as post-discharge from rehabilitation (Furlan, Kattail and Fehlings, 2009; Osterthun et al., 2014).

2.5 CONCLUSION

Although Gauteng is South Africa's most populous province, it falls desperately short with regards to understanding the epidemiological profile of SCI in both the public and private healthcare sector. While attempts have been made to shed light on this topic, the published literature is outdated and in need of revision. Furthermore, these attempts were based at a single rehabilitation unit and thus the results cannot be generalized for the province. The Western Cape and Kwazulu-Natal have both recently published epidemiological studies for PWSCI further highlighting the importance of an updated profile for Gauteng.

CHAPTER 3 METHODOLOGY

3.1 STUDY DESIGN

This study employed a non-experimental, retrospective medical record review design. This type of study design allows the researcher to review pre-existing, patient-cantered data to help answer research questions. The selected design is inexpensive, time-efficient and does not require expensive equipment or settings (Panacek, 2007). Valuable information may be gathered to help guide future prospective or experimental studies (Vasser and Holzmann, 2013).

3.2 STUDY SETTING

This study focused on specialized rehabilitation units for persons with spinal cord injury (PWSCI) in the public healthcare setting in Gauteng, South Africa. In Gauteng province, there are five spinal cord injury (SCI) rehabilitation units based at the following five hospitals: Thelle Mogoerane Regional Hospital (TMRH), South Rand Hospital (SRH), Edenvale Hospital (EH), Dr. George Mukhari Academic Hospital (DGMAH) and Tshwane Rehabilitation Hospital (TRH) (Table 3.1). These rehabilitation units are responsible for the rehabilitation of PWSCI in Gauteng although PWSCI from other provinces such as Limpopo, North West and Mpumalanga make use of these facilities as there are no specialized SCI rehabilitation units in these provinces. Each rehabilitation unit works on a referral system where patients who require rehabilitation are referred for assessment and subsequent admission into the rehabilitation unit depending on suitability, medical stability and bed availability. Should no beds be available for immediate admission, patients are placed on a waiting list with rehabilitation continuing at the referring hospital until a bed is available. Of note, Dr. George Mukhari Academic Hospital only provides specialized in-patient rehabilitation services for PWSCI who require neurosurgical intervention.

Table 3.1: An Outline of Rehabilitation Services Offered in the Public Healthcare Setting in Gauteng

	Municipality	**Rehabilitation Services Offered**	**Rehabilitation Bed Capacity at Each Unit**
TMRH	Ekurhuleni	SCI Rehabilitation Neurological Rehabilitation	22
SRH	City of Johannesburg	SCI Rehabilitation Neurological Rehabilitation	15
EH	City of Johannesburg	SCI Rehabilitation Neurological Rehabilitation	6
DGMAH	City of Tshwane	SCI Rehabilitation	24
TRH	City of Tshwane	SCI Rehabilitation Neurological Rehabilitation Amputee Rehabilitation Paediatric Rehabilitation General Rehabilitation	61
			Total: 128

3.3. STUDY PARTICIPANTS

Convenience sampling was used to select medical records for this study (Etikan, Musa and Alkassim, 2016). It is a type of non-probability sampling where practical criteria such as geographical location – in this case, Gauteng public healthcare rehabilitation units – are included in the study. All medical records of PWSCI admitted to any of the above-mentioned rehabilitation units between 01 January 2018 and 31 December 2019 were considered eligible for inclusion into the study. A two-year period was selected to allow for possible seasonal variations or other changes that may affect data (Wu and Ashton, 1997; Worster and Haines, 2004).

3.3.1 INCLUSION CRITERIA

All medical records of adult patients (aged 18 years and above) admitted with a confirmed, first-time SCI (irrespective of cause of injury) to any of Gauteng's specialized public healthcare spinal cord injury rehabilitation units between 01 January 2018 and 31 December 2019 were included.

3.3.2 EXCLUSION CRITERIA

Medical records that showed patients presenting with no neurological fallout (classified as an AIS E according to the American Spinal Injury Association) were excluded. Medical records with neurological fallout due to brain pathology (e.g. stroke, traumatic brain injury, space-occupying lesions) or peripheral nervous system pathology (e.g. Guillain-Barre Syndrome, peripheral neuropathy) were excluded.

3.3.3 SAMPLE SIZE

No sample size was calculated for this study as all medical records that met the inclusion criteria were included in the study. Based on historical data, it was calculated that approximately 270 PWSCI are admitted to Gauteng's public healthcare rehabilitation units for rehabilitation each year and thus an estimated sample of 540 medical records may be expected across the two-year study period. Table 3.2 shows how the estimated sample size was obtained.

Table 3.2: Estimated Sample Size for the Study

Rehabilitation Unit	Estimated Number of PWSCI Admitted for Rehabilitation Per Year	Total Estimate of PWSCI Admitted Over the Two-Year Study Period
TMRH	45	90
SRH	20	40
EH	10	20
DGMAH	45	90
TRH	150	300
TOTAL	**270**	**540**

3.4 DATA COLLECTION TOOLS

Participant data was collected using a specifically designed data collection form (Appendix A). This form was developed to collect information on both sociodemographic and injury profiles with its development being guided by the International Spinal Cord Injury Core Data Set (ISCICDS) as well as epidemiological literature both in South Africa and abroad. The ISCICDS aims to standardize a minimum amount of data collected during studies involving PWSCI (DeVivo et al., 2006; Biering-Sorensen et al., 2017). While no testing of validity or reliability has been undertaken to date, the ISCICDS was developed through consensus using the best available evidence to field-leading experts (Biering-Sorensen and Noonan, 2016). The tool allows for SCI research to have a certain aspect of comparable data globally and will allow for associations to be inferred between sociodemographic and injury profiles. Once drafted, the data collection form was reviewed independently by two researchers in the field of SCI. No omissions from the original ISCICDS tool were made. However, the following categories were added: HIV status, presence and type of comorbidities, occupation, marital status, highest level of education, hospital type from which the patient was admitted, whether the patient survived their rehabilitation stay as well as the type of assistive device used at discharge from rehabilitation. **Table 3.3 and Table 3.4** summarizes the data collected in this study.

Table 3.3: Sociodemographic Data Collected During the Study

Sociodemographic Profile	
Age	Sex
Ethnicity	Municipality/District in Which the Patient Resides
Occupation	Marital Status
Highest level of Education	

Table 3.4: Injury Profile Data Collected During the Study

Injury Profile	
Data Set	**Description**
HIV Status	Presence or absence of the Human Immunodeficiency Virus
Comorbidities	Presence or absence of health comorbidities
Aetiology	Cause of Injury
Neurological Status	Severity of the injury according to the ASIA Impairment Scale (AIS) (grade A, B, C or D).
	Neurological level of injury as determined by the most caudal segment of the spinal cord with intact motor and sensory function.
Vertebral Injury	Presence of a spinal fracture and/or dislocation.
Spinal Surgery	Present history of a laminectomy, neural canal restoration, reduction, spinal fusion and/or internal fixation being performed.
Associated Injury	Moderate/severe traumatic brain injury, non-vertebral fracture requiring surgery, severe facial trauma affecting sense organs, major chest injury requiring a chest tube or mechanical ventilation, limb amputation, severe haemorrhaging or damage to any internal organ requiring surgery.
Time to Admission	Length between the date of injury and admission to the rehabilitation unit.
Length of Stay	Length between date of admission to and discharge from the rehabilitation unit.
Source of Referral	Type of hospital from which the patient was admitted – tertiary, regional or district. Admissions from home or other settings accepted.
Rehabilitation Survivor	Whether the patient was alive at discharge from rehabilitation.
Ventilatory Support at Discharge from Rehabilitation	Presence of ventilatory assistance to sustain respiration (24 hours a day, less than 24 hours a day or continuous positive airway pressure for sleep apnoea.
Use of Assistive Device at Discharge from Rehabilitation	Type of assistive device used most commonly for daily mobility.

3.5 PROCEDURE

Once ethical clearance was received, a pilot study and the subsequent main study data collection was done. These events are described below.

3.5.1 PILOT STUDY

To ensure and improve the practicality, familiarity, efficiency and quality of the data collection form and overall study procedure (Thabane et al., 2010), a pilot study was conducted at Thelle Mogoerane Regional Hospital during the week of 26 October 2020 due to the logistical convenience to the researcher. Ten medical records from 2017 – chosen to ensure that the medical records fell outside of the inclusion criteria of 01 January 2018 to 31 December 2019 – were randomly selected once ethical approval was received to conduct the study. The researcher used the data collection form to collect data from these records. Where information was not available, it was recorded as missing. No amendments needed to be made to the data collection form or to the study in its entirety.

3.5.2 MAIN STUDY

As each rehabilitation unit provided written consent to perform the study, suitable arrangements were made for the researcher to travel to each unit and extract data. This occurred between the months of November 2020 and March 2021. On the agreed upon date and time, the researcher travelled to the rehabilitation unit where a space to conduct the data extraction was identified and agreed upon between the relevant parties. Rehabilitation ward records (such as admission books and ward handover-books) were used to identify patients admitted to the unit for SCI rehabilitation between 01 January 2018 and 31 December 2019. The medical records of these patients were then perused with those fitting the inclusion criteria being enrolled into the study. Using a combination of hospital, physiotherapy and/or occupational therapy records, the data collection form was used to anonymously collect data from each enrolled medical record. All records were then returned appropriately and the researcher left the study site. The information from the data collection forms were then coded and inputted onto a Microsoft Excel spreadsheet for further analysis.

3.6 STATISTICAL ANALYSIS

The collected data was then analysed according to the study objectives (Table 3.5).

Table 3.5: Study Objectives and the Associated Type of Statistical Analysis Performed

Study Objectives	Type of Data	Statistical Test
1. Establish the prevalence of PWSCI who received rehabilitation in the public healthcare setting in Gauteng, South Africa	a. Continuous data	a. Frequency and Percentage
2. Establish the profile of PWSCI who received rehabilitation in the public healthcare setting in Gauteng, South Africa: 2.1. Sex, aetiology, neurological status, presence of vertebral fractures, spinal surgery done, presence of associated injuries, ventilator dependency, date of death 2.2. Age at time of injury, rehabilitation length of stay	a. Categorical data b. Continuous data	a. Frequency and percentage b. Mean with standard deviation and median with range
3. Compare the profiles of PWSCI between each of Gauteng's specialized rehabilitation units	a. Categorical data b. Continuous data	a. Frequency and percentage b. Mean with standard deviation and median with range
4. To determine the associations between the sociodemographic and injury profiles of	a. Categorical data	a. Chi-squared, Fischer's exact test,

PWSCI who received rehabilitation in Gauteng, South Africa	b. Continuous data	Spearmen and logistic regression b. ANOVA, independent t-test, Pearson's correlation, Mann-Whitney U test

Data was summarized using descriptive statistics and inferential statistics to investigate relationships between independent and dependent variables. Continuous variables were analysed using mean with standard deviation as well as median and interquartile ranges while categorical variables were analysed using frequencies and percentages. The Mann-Whitney U test was used to determine whether significant differences existed between continuous variables of age, time to admission, length of stay and cause of injury. The Chi-squared measure of association and the Fischer's exact test were used to determine associations between independent and dependent categorical variables. The Spearman correlation coefficient was used to determine the relationship between age, time to admission and length of stay. Univariate and multivariate binary logistic regression was used to determine the predictors of cause of injury. Significance was set at p ″ 0.05.

3.7 ETHICAL CONSIDERATIONS

Ethical clearance was granted by the University of the Witwatersrand's Human Research Ethics Committee (clearance certificate number: M200852; 22 October 2020 (Appendix B). This research study is registered with the National Health Research

Database (GP_202008_083). Permission to conduct the study at each respective rehabilitation unit was granted (Appendix C).

To ensure patient confidentiality, data was collected with each medical record being assigned a unique case number. No identifiable data was included on the data collection form. The Microsoft Excel spreadsheet used to code information from the data collection form was password protected with access limited to the researcher and the direct study supervisors.

In light of the global COVID-19 pandemic, precautions were undertaken to ensure the safety of the researcher and hospital staff. This included the washing of hands and sanitization of all stationery before and after use. In addition, the researcher wore full personal protective equipment at all times during data collection and contact with hospital staff.

CHAPTER 4 RESULTS

This chapter sets out to present the findings from this study as per the study objectives. Overall, 386 medical records from the public healthcare rehabilitation units in Gauteng met the inclusion criteria and were enrolled into this study (Figure 4.1).

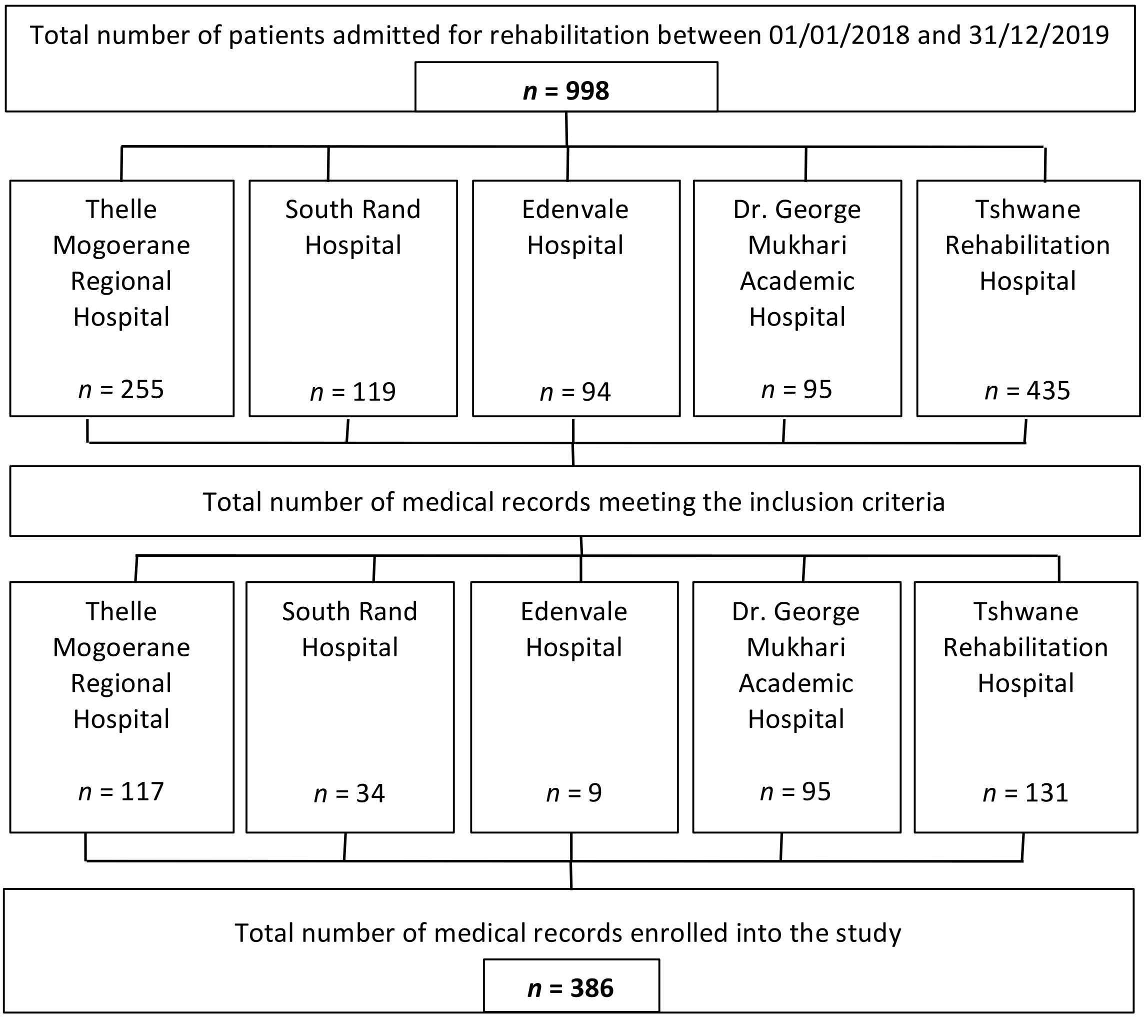

Figure 4.1: Flow Chart Showing Inclusion of Medical Records Enrolled into the Study

4.1 PREVALENCE OF SPINAL CORD INJURY IN REHABILITATION UNITS

The prevalence of SCI at each of Gauteng's public healthcare rehabilitation units was calculated as to fulfil the study's first objective. The total number of patients admitted for rehabilitation at Thelle Mogoerane Regional Hospital (TMRH), South Rand Hospital (SRH), Edenvale Hospital (EH), Dr. George Mukhari Academic Hospital (DGMAH) and

Tshwane Rehabilitation Hospital (TRH) during the study period was recorded and amounted to 998 patients. The number of PWSCI admitted for rehabilitation as compared to the overall number of admissions was then used to calculate the prevalence (Table 4.1). Overall, Gauteng had a SCI rehabilitation unit prevalence of 38.67% for this study. Two rehabilitation units were shown to have noticeable outliers. Only 9.57% of participants admitted at EH across the two-year study period had a SCI. Conversely, 100% of participants admitted to DGMAH for rehabilitation had a SCI as the unit only provides specialized in-patient rehabilitation services to PWSCI.

Table 4.1: Prevalence of SCI as Calculated for the Study

Number of Patients (n)	TMRH	SRH	EH	DGMAH	TRH	OVERALL
Non-SCI Patients	138	85	85	0	304	612
SCI Patients	117	34	9	95	131	386
Total Patients	255	119	94	95	435	998
SCI Prevalence (%)	**45.88**	**28.57**	**9.57**	**100**	**30.11**	**38.67**

4.2 SOCIODEMOGRAPHIC PROFILE

Table 4.2 below portrays the age of PWSCI admitted for rehabilitation and gives results for each individual rehabilitation unit and for the province as a whole. The oldest mean age was found at DGMAH (49.63, SD = 13.37) with the lowest mean age noted in participants at TMRH (33.38, SD = 10.31). The median age of participants who sustained a traumatic spinal cord injury (TSCI) was notably younger (31 years) than those who sustained a non-traumatic spinal cord injury (NTSCI) (44 years).

Table 4.2: Demographic Information Depicting the Age of Study Participants

DEMOGRAPHIC	TMRH	SRH	EH	DGMAH	TRH	OVERALL
AGE						
Mean (SD)	33.38 (10.31)	34.97 (9.40)	37.44 (11.14)	49.63 (13.37)	37.14 (12.39)	36.90 (12.12)
Median (range)	30 (19-70)	33 (19-55)	35 (24-60)	42 (19-75)	35.5 (18-71)	34 (18-75)

In this study, an almost exact same proportion of study participants were in the 31-45 age category (n = 148, 38.85%) and in the 18-30 age category (n = 147, 38.58%). Table 4.3 below shows the breakdown of age by category for each rehabilitation unit while Figure 4.2 depicts the breakdown of age category for Gauteng as a whole.

Table 4.3: Representation of Age by Category for Each Rehabilitation Unit

AGE n (%)	TMRH	SRH	EH	DGMAH	TRH	OVERALL
18-30	60 (51.28)	13 (38.24)	2 (22.22)	24 (26.37)	48 (36.92)	147 (38.58)
31-45	42 (35.90)	16 (47.06)	5 (55.56)	36 (29.56)	49 (37.69)	**148 (38.85)**
46-60	11 (9.40)	5 (14.71)	2 (22.22)	21 (23.08)	27 (20.77)	66 (17.32)
61+	4 (3.42)	0	0	10 (10.99)	6 (4.61)	20 (5.25)

** Values in Bold Indicate Highest Value in This Category*

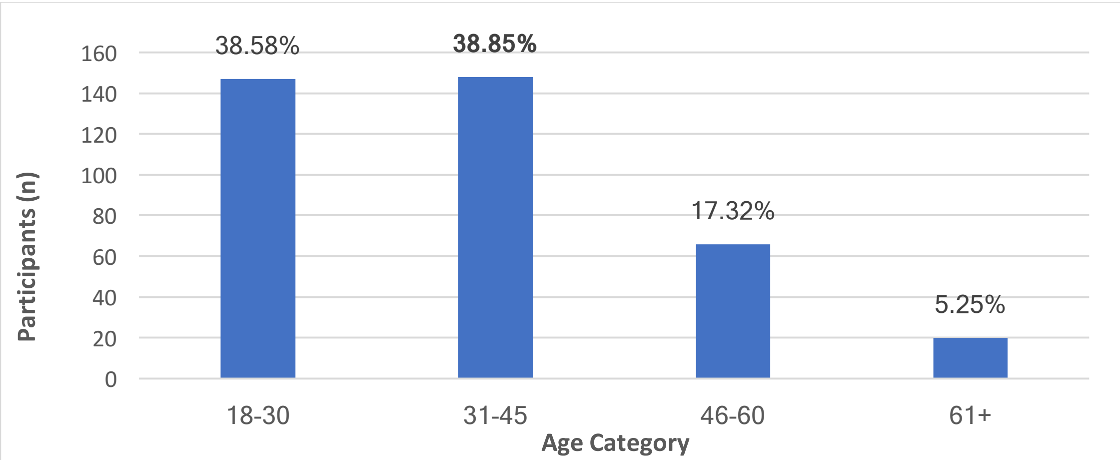

Figure 4.2: Representation of Age by Category for Gauteng Province

Table 4.4 below provides the results of sex and ethnicity for PWSCI admitted for rehabilitation and gives results both for each individual rehabilitation unit and for the province as a whole. Figure 4.3 depicts the sex and ethnicity findings for both the TSCI and NTSCI groups.

Males were more commonly injured than females at all rehabilitation units. In the TSCI group, males were responsible for 84.46% of the population (n = 212) with 41.98% of the NTSCI group (n = 55) being male. Females were more commonly affected by NTSCI than their male counterparts. A male-to-female ratio of 5.44:1 and 0.72:1 can be concluded for the TSCI and NTSCI populations respectively.

Regarding ethnicity, a substantial majority of participants at all rehabilitation units were Black across both the TSCI and NTSCI groups (n = 236, 94.02% and n = 121, 89.63% respectively). Of note, no Indian participants sustained a TSCI.

Table 4.4: Demographic Information Depicting Sex and Ethnicity of Study Participants

	TMRH	SRH	EH	DGMAH	TRH	OVERALL
SEX n (%)						
Male	84 (71.79)	25 (73.53)	5 (55.56)	58 (61.05)	98 (74.81)	**270 (69.95)**
Female	33 (28.21)	9 (26.47)	4 (44.44)	37 (38.95)	33 (25.19)	116 (30.05)
ETHNICITY n (%)						
Black	105 (89.74)	31 (91.18)	9 (100)	93 (97.89)	119 (90.84)	**357 (92.49)**
White	2 (1.71)	1 (2.94)	0	2 (2.11)	8 (6.11)	13 (3.37)
Coloured	9 (7.69)	1 (2.94)	0	0	4 (3.05)	14 (3.63)
Indian	1 (0.85)	1 (2.94)	0	0	0	2 (0.52)

** Values in Bold Indicate Highest Value in This Category*

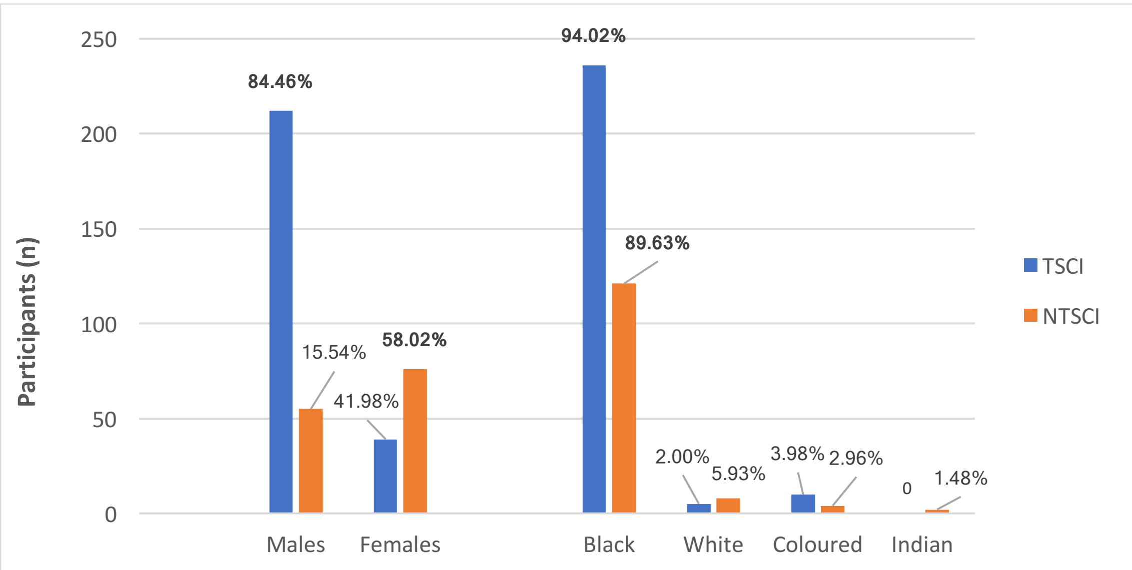

Figure 4.3: Representation of Sex and Ethnicity for the TSCI and NTSCI Groups

Table 4.5 below provides information on the area of residence, occupation, marital status and highest level of education of PWSCI admitted for rehabilitation in public healthcare rehabilitation units in Gauteng and gives results for each individual rehabilitation unit and for the province as a whole.

The majority of participants sustaining a SCI in Gauteng were residing in the province's metropolitans (n = 255, 66.06%). At the time of injury, most of the study participants were in the formal employment sector (n = 161, 41.71%). A substantial number of study participants had never been married when they sustained their injury (n = 226, 58.55%). Approximately a third of the study participants in this study had an unknown level of education (n = 136, 35.23%). Where this information was known, just under a quarter had a Grade 12 (NQF level 4) qualification (n = 89, 23.06%).

Table 4.5: Demographic Information Depicting Area of Residence, Occupation, Marital Status and Highest Level of Education

DEMOGRAPHIC	TMRH	SRH	EH	DGMAH	TRH	OVERALL
AREA OF RESIDENCE n (%)						
City of Tshwane	0	0	0	36 (37.89)	55 (41.98)	**91 (23.58)**
City of Johannesburg	46 (39.31)	16 (47.06)	5 (55.56)	0	21 (16.03)	88 (22.80)
City of Ekurhuleni	50 (42.74)	5 (14.71)	4 (44.44)	4 (4.21)	13 (9.94)	76 (19.69)
West Rand	4 (3.42)	7 (20.59)	0	0	4 (3.05)	15 (3.89)
Sedibeng	5 (4.27)	6 (17.65)	0	0	2 (1.53)	13 (3.37)
Another Province	2 (1.71)	0	0	50 (52.63)	36 (27.48)	88 (22.80)
Unknown	10 (8.55)	0	0	5 (5.26)	0	15 (3.89)
OCCUPATION n (%)						
Unemployed	18 (15.38)	12 (35.29)	5 (55.56)	20 (21.05)	35 (26.72)	90 (23.32)
Self Employed	15 (12.82)	2 (5.88)	2 (22.22)	11 (11.58)	23 (17.56)	53 (13.73)
Formal Employment	47 (40.17)	20 (58.82)	2 (22.22)	33 (34.74)	59 (45.04)	**161 (41.71)**

Student	5 (4.27)	0	0	3 (3.16)	9 (6.87)	17 (4.40)
Pensioner	3 (2.56)	0	0	7 (7.37)	3 (2.29)	13 (3.37)
Unknown	29 (24.79)	0	0	21 (22.11)	2 (1.53)	52 (13.47)
MARITAL STATUS n (%)						
Never Married	65 (55.56)	23 (67.65)	7 (77.78)	50 (52.63)	81 (61.83)	**226 (58.55)**
Married	20 (17.09)	8 (23.53)	2 (22.22)	27 (28.42)	36 (27.48)	93 (24.09)
Divorced	2 (1.71)	3 (8.82)	0	3 (3.16)	3 (2.29)	11 (2.85)
Widowed	2 (1.71)	0	0	1 (1.05)	10 (7.63)	13 (3.37)
Unknown	28 (23.93)	0	0	14 (14.73)	1 (0.76)	43 (11.14)
EDUCATION LEVEL AS PER NQF FRAMEWORK n (%)						
1	14 (11.97)	10 (29.41)	0	12 (12.63)	23 (17.56)	59 (15.28)
2	6 (5.13)	3 (8.82)	0	10 (10.53)	10 (7.63)	29 (7.51)
3	17 (14.53)	7 (20.59)	1 (11.11)	10 (10.53)	20 (15.27)	55 (14.25)
4	17 (14.53)	14 (41.18)	2 (22.22)	15 (15.79)	41 (31.30)	89 (23.06)
5	0	0	0	0	1 (0.76)	1 (0.26)
6	2 (1.71)	0	0	4 (4.21)	8 (6.11)	14 (3.63)
7	1 (0.85)	0	0	1 (1.05)	1 (0.76)	3 (0.78)
8	0	0	0	0	0	0
9	0	0	0	0	0	0
10	0	0	0	0	0	0
Unknown	60 (51.28)	0	6 (66.67)	43 (45.26)	27 (20.61)	**136 (35.23)**

** Values in Bold Indicate Highest Value in This Category*

4.3 INJURY PROFILE

Table 4.6 below provides information on the aetiology, classification of injury and level of injury of PWSCI admitted for rehabilitation in public healthcare rehabilitation units in

Gauteng and gives results both for each individual rehabilitation unit and for the province as a whole.

Traumatic SCI (n = 251, 65.70%) was more common than NTSCI (n = 131, 34.29%) in this study. Assault (gunshot, stab and blunt force injuries) was responsible for 35.23% of all injuries while transport-related injuries accounted for 22.54% (motor vehicle, pedestrian vehicle and motorbike/bicycle accidents). The most common type of NTSCI was due to infectious causes (n = 66, 17.10%). Just under half of the total proportion of study participants (n = 170, 44.04%) were classified as having complete injuries as per the American Spinal Injury Association (ASIA) Impairment Scale (AIS). Regarding incomplete syndromes, Brown-Séquard Syndrome was reported in 5.18% (n = 20), Central Cord Syndrome in 3.11% (n = 12) and Anterior Cord Syndrome in 0.26% (n = 1) of all participants. The most commonly injured spine region was the lower thoracic spine with paraplegia (n= 210, 54.40%) more common than quadriplegia (n = 55, 14.25%).

Table 4.6: Injury Profile Information Depicting Aetiology, Classification of Injury and Level of Injury

INJURY PROFILE	TMRH	SRH	EH	DGMAH	TRH	OVERALL
AETIOLOGY n (%)						
Sporting Injury	0	0	0	1 (1.05)	2 (1.53)	3 (0.77)
Gunshot Wound	41 (35.04)	6 (17.65)	2 (22.22)	8 (8.42)	27 (20.61)	**84 (21.76)**
Stab Wound	15 (12.82)	7 (20.59)	2 (22.22)	3 (3.16)	13 (9.92)	40 (10.36)
Blunt Trauma	0	1 (2.94)	0	4 (4.21)	7 (5.34)	12 (3.11)
MVA	19 (16.24)	4 (11.76)	0	20 (21.05)	26 (19.85)	69 (17.88)
PVA	4 (3.42)	0	1 (11.11)	7 (7.37)	5 (3.82)	17 (4.40)
MBA/Bicycle	0	0	0	0	1 (0.76)	1 (0.26)
Fall	9 (7.69)	1 (2.94)	0	7 (7.37)	7 (5.34)	24 (6.22)
Other Traumatic Cause	0	1 (2.94)	0	0	0	1 (0.26)
Degenerative	2 (1.71)	0	0	10 (10.53)	5 (3.82)	17 (4.40)
Spinal Tumour	6 (5.13)	1 (2.94)	0	2 (2.11)	6 (4.58)	15 (3.89)

Vascular	2 (1.71)	0	0	0	1 (0.76)	3 (0.77)
Infectious	16 (13.68)	8 (23.53)	4 (44.44)	15 (15.79)	23 (17.56)	**66 (17.10)**
Other Non-Traumatic Cause	3 (2.56)	4 (11.76)	0	15 (15.79)	8 (6.11)	30 (7.77)
Unknown	0	1 (2.94)	0	3 (3.16)	0	4 (1.04)
INJURY SEVERITY n (%)						
ASIA A	59 (50.43)	13 (38.24)	6 (66.67)	35 (36.84)	57 (43.51)	**170 (44.04)**
ASIA B	6 (5.13)	0	0	1 (1.05)	2 (1.53)	9 (2.33)
ASIA C	21 (17.95)	5 (14.70)	1 (11.11)	12 (12.63)	26 (19.85)	65 (16.84)
ASIA D	5 (4.27)	0	0	5 (5.26)	6 (4.58)	16 (4.15)
Incomplete SCI Syndrome	9 (7.69)	5 (14.71)	0	5 (5.26)	14 (10.69)	33 (8.55)
Unknown	17 (14.53)	11 (32.35)	2 (22.22)	37 (38.95)	26 (19.85)	93 (24.09)
LEVEL OF INJURY n (%)						
C1-C8	10 (8.55)	2 (5.88)	1 (11.11)	12 (12.63)	30 (22.90)	55 (14.25)
T1-T6	27 (23.08)	9 (26.47)	3 (33.33)	11 (11.58)	20 (15.27)	70 (18.13)
T7-T12	39 (33.33)	5 (14.71)	3 (33.33)	26 (27.37)	32 (24.43)	**105 (27.20)**
L1-L5	15 (12.82)	3 (8.82)	0	6 (6.32)	11 (8.40)	35 (9.07)
Incomplete SCI Syndrome	9 (7.69)	5 (14.71)	0	5 (5.26)	14 (10.69)	33 (8.55)
Unknown	17 (14.53)	10 (29.41)	2 (22.22)	35 (36.84)	24 (18.32)	88 (22.80)

** Values in Bold Indicate Highest Value in This Category*

Table 4.7 below provides information on the source of referral, time to admission (TTA), length of stay (LOS), HIV status, presence of comorbidities, presence of spinal fractures, presence of spinal surgery and presence of associated injuries of PWSCI admitted for rehabilitation in public healthcare rehabilitation units in Gauteng and gives results both for each individual rehabilitation unit and for the province as a whole.

A substantial proportion of the overall number of participants were admitted from tertiary healthcare institutions (n = 224, 58.03%) with TRH having the highest single-unit proportion at 77.10% (n = 101). Of interest, TMRH was the only rehabilitation unit where more patients were admitted from regional hospitals rather than from tertiary hospitals (n = 55, 47.01%). Regarding TTA, the overall mean was 64.48 (SD = 59.78) days with a median of 46 and range of 1-369. This information was missing in a substantial number of participants at DGMAH (n = 58, 61.05%). The overall mean LOS was 85.59 (± SD = 63.21) days. Overall, 16.84% (n = 65) of all participants were HIV positive (39.12% were negative, n = 151; unknown in 44.04%, n =170). Of note, rehabilitation units which had higher proportions of negative HIV statuses also had larger amounts of missing data (range 55.56% to 61.76%). A total proportion of 23.05% of study participants had comorbidities with 3.11% presenting with multiple comorbidities. The most common comorbidity noted in this study was tuberculosis (n = 44, 11.40%) followed by hypertension (n = 26, 6.74%) and diabetes (n = 5, 1.30%). Across all rehabilitation units, 66.84% of participants had a vertebral fracture with 46.12% of those participants being managed with spinal surgery. Associated injuries were noted in 22.02% of participants.

Table 4.7: Injury Profile Information Depicting Source of Referral, Time to Admission, Length of Stay, HIV Status, Comorbidities, Presence of Vertebral Fractures, Presence of Spinal Surgery and Presence of Associated Injuries

INJURY PROFILE	TMRH	SRH	EH	DGMAH	TRH	OVERALL
SOURCE OF REFERRAL n (%)						
Tertiary Hospital	53 (45.30)	21 (61.76)	5 (55.56)	44 (46.32)	101 (77.10)	**224 (58.03)**
Regional Hospital	55 (47.01)	11 (32.35)	1 (11.11)	5 (5.26)	2 (1.53)	74 (19.17)
District Hospital	2 (1.71)	0	1 (11.11)	20 (21.05)	17 (12.98)	40 (10.36)
Home	3 (2.56)	2 (5.88)	0	0	5 (3.82)	10 (2.59)
Other	1 (0.85)	0	0	0	6 (4.58)	7 (1.81)
Unknown	3 (2.56)	0	2 (22.22)	26 (27.37)	0	31 (8.03)
TIME TO ADMISSION						
Mean (SD)	59.87 (49.97)	72.25 (59.44)	23.60 (17.52)	43.76 (72.95)	76.70 (63.97)	64.48 (59.78)
Median (range)	45 (1-369)	56 (16-309)	29 (1-45)	16 (1-365)	55 (4-359)	46 (1-369)

Unknown n (%)	1 (0.85)	6 (17.65)	4 (44.44)	58 (61.05)	27 (20.61)	96 (24.87)
LENGTH OF STAY						
Mean (SD)	60.93 (33.87)	54.75 (40.26)	59.38 (23.59)	99.17 (84.28)	108.86 (64.58)	85.59 (63.21)
Median (range)	56 (5-199)	49 (9-213)	60 (31-103)	85 (9-388)	100.5 (11-311)	72 (5-388)
Not Applicable n (%)	17 (14.53)	1 (2.94)	0	20 (21.05)	6 (4.58)	38 (9.84)
Unknown n (%)	0	0	1 (11.11)	10 (10.53)	5 (3.82)	16 (4.15)
HIV STATUS n (%)						
Positive	18 (15,38)	8 (23.53)	3 (33.33)	19 (20.00)	17 (12.98)	65 (16.84)
Negative	56 (47.86)	5 (14.71)	1 (11.11)	21 (22.11)	68 (51.91)	151 (39.12)
Unknown	43 (36.75)	21 (61.76)	5 (55.56)	55 (57.89)	46 (35.11)	**170 (44.04)**
COMORBIDITIES n (%)						
None	80 (68.38)	23 (67.65)	6 (66.67)	42 (44.21)	92 (70.23)	**243 (62.95)**
Hypertension	3 (2.56)	4 (11.76)	0	6 (6.32)	13 (9.92)	26 (6.74)
Diabetes	0	0	0	3 (3.16)	2 (1.53)	5 (1.30)
Epilepsy	1 (0.85)	0	0	0	0	1 (0.26)
Respiratory Disease	0	0	0	0	1 (0.76)	1 (0.26)
Tuberculosis	17 (14.53)	3 (8.82)	0	9 (9.47)	15 (11.45)	44 (11.40)
Multiple	0	1 (2.94)	1 (11.11)	5 (5.26)	5 (3.82)	12 (3.11)
Unknown	16 (13.68)	3 (8.82)	2 (22.22)	30 (31.58)	3 (2.29)	54 (13.99)
PRESENCE OF VERTEBRAL FRACTURES n (%)						
Yes	88 (75.21)	19 (55.88)	5 (55.56)	61 (64.21)	85 (64.89)	**258 (66.84)**
No	19 (16.24)	8 (23.53)	2 (22.22)	8 (8.42)	40 (30.53)	77 (19.95)
Unknown	10 (8.55)	7 (20.59)	2 (22.22)	26 (27.37)	6 (4.58)	51 (13.21)
PRESENCE OF SPINAL SURGERY						

n (%)						
Yes	35 (29.91)	11 (32.35)	1 (11.11)	40 (42.11)	67 (51.15)	154 (39.90)
No	77 (65.81)	21 (61.76)	8 (88.89)	28 (29.47)	58 (44.27)	**192 (49.74)**
Unknown	5 (4.27)	2 (5.88)	0	27 (28.42)	6 (4.58)	40 (10.36)
PRESENCE OF ASSOCIATED INJURIES n (%)						
Yes	35 (29.91)	7 (20.59)	2 (22.22)	11 (11.58)	30 (22.90)	85 (22.02)
No	74 (63.25)	22 (64.71)	7 (77.78)	50 (52.63)	69 (52.67)	**222 (57.51)**
Unknown	8 (6.8)	5 (14.7)	0	34 (35.8)	32 (24.4)	79 (20.47)

** Values in Bold Indicate Highest Value in This Category*

Table 4.8 below provides information on the reasons for not completing rehabilitation, the discharge destination, mobility aid used at discharge and the ventilator dependency at discharge of PWSCI admitted for rehabilitation in public healthcare rehabilitation units in Gauteng and gives results both for each individual rehabilitation unit and for the province as a whole.

Out of the 386 study participants, 88.60% (n = 342) were discharged with the other 44 participants (11.40%) not completing their rehabilitation stays. Of these 44 participants, 25 participants demised resulting in a rehabilitation mortality rate of 6.48%. Of note, 21.05% of participants at DGMAH did not complete rehabilitation. A substantial proportion of participants that were discharged were done so to a private residence (n = 330, 96.49%). The most common mobility aid used was a manually-operated wheelchair (n = 185, 54.09%). Of the 342 participants that were discharged from rehabilitation, none were reliant on external sources of oxygen or mechanical ventilation.

Table 4.8: Injury Profile Information Depicting Reasons for Not Completing Rehabilitation, Discharge Destination, Mobility Aid Used at Discharge from Rehabilitation and Ventilator Dependency at Discharge from Rehabilitation

INJURY PROFILE	TMRH	SRH	EH	DGMAH	TRH	OVERALL
REASON FOR NOT COMPLETING REHABILITATION n (%)						
Medically Unstable	4 (3.42)	0	0	0	0	4 (1.04)
Absconded	5 (4.27)	0	0	1 (1.05)	1 (0.76)	7 (1.81)
Refusal of Hospital Treatment	3 (2.56)	0	0	2 (2.11)	3 (2.29)	8 (2.07)
Demised	5 (4.27)	1 (2.94)	0	17 (17.89)	2 (1.53)	**25 (6.48)**
DISCHARGE DESTINATION* n (%)						
Private Residence	100 (100.00)	32 (96.97)	8 (88.89)	66 (88.00)	124 (99.20)	**330 (96.49)**
Another Hospital	0	0	1 (11.11)	5 (6.67)	1 (0.80)	7 (2.05)
Assisted-Living Residence	0	1 (3.03)	0	0	0	1 (0.29)
Unknown	0	0	0	4 (5.33)	0	4 (1.17)
MOBILITY AID USED AT DISCHARGE FROM REHABILITATION * n (%)						
Battery-Operated Wheelchair	13 (13.00)	2 (6.06)	1 (11.11)	4 (5.33)	14 (11.20)	34 (9.94)
Manually-Operated Wheelchair	62 (62.00)	18 (54.55)	8 (88.89)	32 (42.67)	65 (52.00)	**185 (54.09)**
Walking Frame or Rollator	9 (9.00)	4 (12.12)	0	20 (26.67)	17 (13.60)	50 (14.62)
Elbow crutches/stick/cane	5 (5.00)	6 (18.18)	0	1 (1.33)	11 (8.80)	23 (6.73)
None	8 (8.00)	0	0	6 (8.00)	14 (11.20)	28 (8.19)
Unknown	3 (3.00)	3 (9.09)	0	12 (16.00)	4 (3.20)	22 (6.43)
VENTILATOR DEPENDENCY AT DISCHARGE * n (%)						
Yes	0	0	0	0	0	0
No	100 (100.00)	33 (100.00)	9 (100.00)	75 (100.00)	125 (100.00)	**342 (100.00)**

** Includes only those discharged from rehabilitation (n = 342)*

† Values in Bold Indicate Highest Value in This Category

4.4 ASSOCIATIONS BETWEEN SOCIODEMOGRAPHIC AND INJURY PROFILES

The data collected in this study was not normally distributed. Table 4.9 below shows the test for normality using the Shapiro-Wilk test. Significance was set at a p-value of less than 0.05 and all continuous variables of age, TTA and LOS were found to be significant ($p \leq 0.001$).

Table 4.9: Shapiro-Wilk Test for Normality of Data

	Shapiro-Wilk		
Tests for Normality	**Statistic**	**df**	**Sig.**
Age	0.945	257	**0.00***
Time to admission	0.747	257	**0.00***
Length of stay	0.897	257	**0.00***

** Values in Bold Indicate Significant Value*

4.4.1 ASSOCIATION BETWEEN SOCIODEMOGRAPHIC FACTORS AND SCI AETIOLOGY

Inferential statistics was used to investigate associations between SCI aetiology and sociodemographic factors with a significance value set at $p \leq 0.05$ (Table 4.10). Participants with TSCI were found to be significantly younger than participants with NTSCI ($p \leq 0.001$). This was calculated using the Mann-Whitney U Test. A comparison between other sociodemographic factors and SCI aetiology was done using the Chi-Square test of Association and Fischer's Exact Test.

Participants that had a TSCI were significantly younger than those with a NTSCI ($p \leq 0.001$). A significant association was identified between SCI aetiology and sex ($p \leq 0.001$), occupation ($p \leq 0.001$) and marital status ($p \leq 0.001$). No association was identified between SCI aetiology and ethnicity ($p = 0.08$), area of residence ($p = 0.06$) and highest level of education ($p = 0.22$).

Table 4.10: Associations Between Sociodemographic Factors and Aetiology

	TSCI	**NTSCI**	**p-value**
Age			
Median (Q1-Q3)	31 (26-39.75)	44 (32.5-51.5)	**0.00***
Sex			**0.00***

n (%)			
Male	212 (84.46)	55 (41.98)	
Female	39 (15.54)	76 (58.02)	
Ethnicity n (%)			†0.08
Black	236 (94.02)	121 (89.63)	
White	5 (2.00)	8 (5.93)	
Coloured	10 (3.98)	4 (2.96)	
Indian	0	2 (1.48)	
Area of Residence n (%)			†0.06
City of Tshwane	51 (20.82)	40 (31.75)	
City of Johannesburg	62 (25.31)	26 (20.63)	
City of Ekurhuleni	58 (23.67)	18 (14.29)	
West Rand	7 (2.86)	6 (4.76)	
Sedibeng	12 (4.90)	3 (2.38)	
Another Province	55 (22.45)	33 (26.19)	
Occupation n (%)			**0.00***
Unemployed	49 (21.39)	41 (39.05)	
Self-employed	39 (17.03)	14 (13.33)	
Formally employed	124 (54.15)	37 (35.24)	
Student	14 (6.11)	3 (2.86)	
Pensioner	3 (1.31)	10 (9.52)	
Marital Status n (%)			**0.00***
Never Married	171 (75.66)	55 (47.01)	
Married	45 (19.91)	48 (41.03)	
Divorced	6 (2.65)	5 (4.27)	
Widowed	4 (1.77)	9 (7.69)	
Education n (%)			0.22
Grade 9 or lower	47 (26.6)	12 (16.67)	
Grade 10 – 11	61 (34.5)	23 (31.9)	
Grade 12	59 (33.3)	30 (41.7)	
Post-secondary	10 (5.6)	7 (9.72)	
** = significant p value*			

† = Fischer's exact test

** Values in Bold Indicate Significant Value*

4.4.2 ASSOCIATION BETWEEN INJURY PROFILE FACTORS AND SCI AETIOLOGY

Inferential statistics was used to investigate associations between SCI aetiology and injury profile factors with a significance value set at p ≤ 0.05 (Table 4.11). The Chi-Square test of Association, Fischer's Exact Test and the Mann-Whitney U Test were all used to investigate potential associations.

A significant association existed between SCI aetiology and injury classification (p ≤ 0.001), TTA (p ≤ 0.001), HIV status (p ≤ 0.001) and presence of comorbidities (p ≤ 0.001). Additionally, a significant relationship was noted between aetiology and presence of vertebral fractures (p ≤ 0.001), presence of spinal surgery (p ≤ 0.001) and presence of associated injuries (p ≤ 0.001). The completion of rehabilitation (p ≤ 0.001) and the discharge destination (p ≤ 0.001) for PWSCI was also significantly associated to aetiology. There was no significant association between aetiology and level of injury (p = 0.88), source of referral (0.57), LOS (0.06) or mobility aid used at discharge from rehabilitation (p = 0.41).

Table 4.11: Associations Between Injury Profile Factors and Aetiology

	TSCI	NTSCI	p-value
Injury Classification n (%)			**0.00***
ASIA A	143 (61.61)	27 (40.30)	
ASIA B	12 (5.17)	3 (4.48)	
ASIC C	38 (16,38)	27 (40.30)	
ASIA D	10 (4.31)	6 (8.96)	
Incomplete Syndrome	29 (12.50)	4 (5.97)	
Level of Injury n (%)			0.88
C1-C4	15(7.6)	7(10.3)	
C5-C8	26(13.2)	7(10.3)	
T1-T6	51(25.9)	19(27.9)	

T7-T12	80(40.6)	25(36.8)	
L1-L5	25(12.7)	10(14.7)	
Source of Referral n (%)			0.57
Tertiary Hospital	140 (58.82)	83 (71.55)	
Regional Hospital	60 (25.21)	14 (12.07)	
District Hospital	28 (11.76)	12 (10.34)	
Home	6 (2.52)	4 (3.45)	
Other	4 (1.68)	3 (2.59)	
Time to admission			
Mean (SD)	60.39 (53.98)	90.56 (72.02)	
Median (Q1-Q3)	43 (25-76)	79 (44.25-116.5)	**0.00***
Length of Stay			
Mean (SD)	88.96 (63.57)	77.91 (61.73)	
Median (Q1-Q3)	73 (46-113)	66 (29-109)	0.06
HIV Status n (%)			**0.00***
Positive	21 (15.79)	44 (53.01)	
Negative	112 (84.21)	39 (46.99)	
Comorbidities n (%)			**0.00***
Yes	20 (9.13)	69 (61.06)	
No	199 (90.87)	44 (38.94)	
Vertebral fracture n (%)			**0.00***
Yes	211 (93.4)	45 (42.5)	
No	15 (6.6)	61 (57.5)	
Spinal Surgery n (%)			**0.00***
Yes	141 (61.30)	51 (43.97)	
No	89 (38.70)	65 (56.03)	
Associated injuries n (%)			**†0.00***
Yes	85 (43.8)	-	
No	109 (56.2)	111(100)	
Completed Rehabilitation n (%)			**0.00***
Yes	232 (92.43)	110 (82.09)	

No	19 (7.57)	24 (17.91)	
Discharge Destination n (%)			**†0.00***
Private Residence	227 (98.27)	103 (96.26)	
Another Hospital	4 (1.73)	3 (2.80)	
Assisted-Living Residence	0	1 (0.93)	
Mobility Aid Used at Discharge n (%)			0.41
Battery-operated WC	26 (11.76)	8 (8.01)	
Manually-operated WC	132 (59.73)	53 (53.54)	
Walking frame / Rollator	30 (13.57)	20 (20.20)	
Elbow crutches / Cane / Stick	14 (6.33)	9 (9.09)	
No Mobility Aid	19 (8.60)	9 (9.09)	
** = significant p value* *† = Fischer's exact test*			

** Values in Bold Indicate Significant Value*

4.4.3 RELATIONSHIP BETWEEN AGE, TIME TO ADMISSION AND LENGTH OF STAY

The association between age, TTA and LOS was investigated using Spearmann correlation analysis (r) (Table 4.12). No correlation was found to exist between age and TTA (r = 0.06, p = 0.28), age and LOS (r = 0.05, p = 0.35) or TTA and LOS (r = 0.08, p = 0.21).

Table 4.12: Association Between Age, Time to Admission and Length of Stay

	Spearman's rho	Age	Time to admission	Length of stay
Age	Correlation Coefficient	1.00		
	p-value	.		
Time to admission	Correlation Coefficient	0.06	1.00	
	p-value	0.28	.	
Length of stay	Correlation Coefficient	0.05	0.08	1.00
	p-value	0.35	0.21	.

4.4.4 SOCIODEMOGRAPHIC PREDICTORS OF TRAUMATIC SPINAL CORD INJURY

Binary logistic regression was used to determine the sociodemographic predictors of SCI (Table 4.13). Age, sex and being unemployed were all found to be significant predictors of acquiring a TSCI. The probability of acquiring a TSCI were found to increase by 0.94 for every one-unit increase in age ($p \leq 0.001$) and by 0.14 in females as compared with their male counterparts ($p \leq 0.001$). Being unemployed was found to increase the odds of acquiring a TSCI by 0.37 ($p \leq 0.001$).

Table 4.13: Sociodemographic Predictors of Spinal Cord Injury

PREDICTOR	33.2 Univariate		Multivariate	
	43.2 EXP(B) [95%CI]	p-value	EXP(B) [95%CI]	p-value
Age	0.93 [0.91-0.95]	0.00	0.94 [0.92-0.96]	**0.00***
Sex				
Male	Reference	Reference	Reference	Reference
Female	0.13 [0.08-0.22]	0.00	0.14 [0.09-0.24]	**0.00***
Occupation				
Formally employed	Reference	Reference	Reference	Reference
Self-employed	0.83 [0.41-1.70]	0.61	0.75 [0.34-1.65]	0.47
Unemployed	0.37 [0.21-0.64]	0.00	0.37 [0.20-0.72]	**0.00***
Student	1.39 [0.38-5.11]	0.62	1.08 [0.25-4.72]	0.92
Pensioner	0.09 [0.02-0.34]	0.00	0.51 [0.10-2.55]	0.41

** Values in Bold Indicate Significant Value*

4.4.5 INJURY PROFILE PREDICTORS OF INJURY OUTCOMES

Binary logistic regression was used to determine the sociodemographic predictors of injury outcomes (Table 4.14). The probability of sustaining a vertebral fracture was found to increase significantly by 0.37 in females and 0.26 in the unemployed respectively ($p \leq 0.001$). Regarding rehabilitation mortality, a significant correlation exists with regards to age, with the risk of death increasing by 0.92 for every one-unit increase in age ($p \leq 0.001$). There was no significant sociodemographic predictor of undergoing spinal surgery.

Table 4.14: Sociodemographic Predictors of Vertebral Fractures, Spinal Surgery and Rehabilitation Mortality

PREDICTOR		Univariate		Multivariate	
		EXP(B) [95%CI]	p-value	EXP(B) [95%CI]	p-value
Vertebral fracture					
	Age	0.98 [0.96-1.00]	0.06	0.99 [0.96-1.02]	0.54
	Sex				
	Male	Reference	Reference	Reference	Reference
	Female	0.32 [0.19-0.55]	0.00	0.37 [0.20-0.70]	**0.00***
	Occupation				
	Formally employed	Reference	Reference	Reference	Reference
	Self-employed	1.21 [0.46-3.17]	0.70	1.15 [0.43-3.07]	0.78
	Unemployed	0.23 [0.12-0.44]	0.00	0.26 [0.14-0.50]	**0.00***
	Student	2.72 [0.34-21.58]	0.35	3.57 [0.41-30.88]	0.25
	Pensioner	0.27 [0.07-1.04]	0.06	0.44 [0.09-2.07]	0.30
Spinal surgery					
	Age	1.02 [1.00-1.03]	0.10	1.02 [1.00-1.05]	0.06
	Sex				
	Male	Reference	Reference	Reference	Reference
	Female	1.33 [0.84-2.12]	0.23	1.12 [0.65-1.92]	0.68
	Occupation				
	Formally employed	Reference	Reference	Reference	Reference
	Self-employed	0.78 [0.41-1.51]	0.46	0.76 [0.39-1.48]	0.42
	Unemployed	1.02 [0.60-1.74]	0.94	0.99 [0.57-1.73]	0.98
	Student	1.85 [0.63-5.46]	0.26	2.42 [0.76-7.69]	0.13
	Pensioner	0.53 [0.13-2.13]	0.37	0.29 [0.06-1.31]	0.11
Mortality					
	Age	0.92 [0.89-0.95]	0.00	0.92 [0.88-0.97]	**0.00***

	Sex				
	Male	Reference	Reference	Reference	Reference
	Female	0.62 [0.27-1.43]	0.27	1.27 [0.31-5.23]	0.74
	Occupation				
	Formally employed	Reference	Reference	Reference	Reference
	Self-employed	0.97 [0.22-3.41]	0.84	0.94 [0.23-3.79]	0.93
	Unemployed	4.65 [0.57-37.82]	0.15	4.29[0.51-36.41]	0.18
	Student and pensioner excluded				

** Values in Bold Indicate Significant Value*

Multivariate regression analysis, adjusted for age and sex, was conducted to assess the predictors of injury profile factors on aetiology (Table 4.15). Traumatic SCI was found to be a significant predictor for the presence of vertebral fractures (p ≤ 0.001). Additionally, TSCI was found to be a significant predictor of undergoing spinal surgery (p ≤ 0.001). Rehabilitation mortality was not found to be a significant predictor associated with aetiology (p = 0.31) nor was the mobility aid used at discharge from rehabilitation (wheelchair: p = 0.14, walking frame/rollator: p = 0.65 and crutches/cane/walking stick: p = 0.92).

Table 4.15: Association Between Injury Profile Factors and Aetiology

INJURY PROFILE		Univariate		Adjusted for age and sex	
	Aetiology	**EXP(B)[95%CI]**	**p-value**	**EXP(B)[95%CI]**	**p-value**
Vertebral fracture	TSCI	0.05 [0.03-0.10]	0.00	0.04 [0.02-0.08]	**0.00***
	NTSCI	Reference	Reference	Reference	Reference
Mortality	TSCI	0.27[0.12-0.62]	0.00	0.60[0.22-1.61]	0.31
	NTSCI	Reference	Reference	Reference	Reference
Spinal surgery	2.03[1.29-3.20]	0.00	0.51[0.30-0.87]	0.01	**0.01***
	Reference	Reference	1.96[1.15-3.33]	0.01	**0.01***
Mobility Aid Used at Discharge	Aetiology	EXP(B)[95%CI]	p-value	EXP(B)[95%CI]	p-value

Wheelchair	TSCI	0.96[0.41-2.29]	0.93	2.13[0.78-5.83]	0.14
	NTSCI	Reference	Reference	Reference	Reference
Walking frame / Rollator	TSCI	0.60[0.22-1.63]	0.32	1.31[0.41-4.19]	0.65
	NTSCI	Reference	Reference	Reference	Reference
Crutches / Cane / Walking Stick	TSCI	0.70[0.21-2.31]	0.56	1.07[0.27-4.29]	0.92
	NTSCI	Reference	Reference	Reference	Reference
The reference category is: No mobility aid					

** Values in Bold Indicate Significant Value*

Multivariate regression analysis, adjusted for age and sex, was used to investigate associations between injury profile factors and the presence of comorbidities and HIV status (Table 4.16). It was found that comorbidities were not a predictor of vertebral fractures (p = 0.09), rehabilitation mortality (p = 0.62), the undergoing of spinal surgery (p = 0.11) or for the use of a certain mobility aid (wheelchair: p = 0.30, walking frame: p = 0.27 and crutches: p = 0.13). Regarding HIV status, it was not found to be a predictor of vertebral fractures (p = 0.82), rehabilitation mortality (p = 0.26), undergoing spinal surgery (p = 0.27) or for the use of a certain mobility aid (wheelchair: p = 0.24, walking frame: p = 0.37 and crutches: p = 0.71).

Table 4.16: Association Between Injury Profile Factors and HIV Status and Presence of Comorbidities

INJURY PROFILE		**Univariate**		**Adjusted for age and sex**	
		EXP(B) [95%CI]	**p-value**	**EXP(B) [95%CI]**	**p-value**
Vertebral fracture	**Presence of comorbidities**				
	Yes	Reference	Reference	Reference	Reference
	No	0.40 [0.22-0.72]	0.00	0.57 [0.29-1.10]	0.09
	HIV status				
	Positive	Reference	Reference	Reference	Reference
	Negative	1.61 [0.82-3.18]	0.17	1.09 [0.52-2.27]	0.82

Mortality	**Presence of comorbidities**				
	Yes	Reference	Reference	Reference	Reference
	No	0.26 [0.09-0.81]	0.02	0.72 [0.20-2.65]	0.62
	HIV status				
	Positive	Reference	Reference	Reference	Reference
	Negative	1.78 [0.39-8.18]	0.46	2.67 [0.48-15.03]	0.26
Spinal surgery	**Presence of comorbidities**				
	Yes	Reference	Reference	Reference	Reference
	No	1.7 [0.99-2.92]	0.05	1.64 [0.90-3.00]	0.11
	HIV status				
	Positive	Reference	Reference	Reference	Reference
	Negative	1.38 [0.75-2.54]	0.30	1.44 [0.76-2.75]	0.27
Assistive device	**Presence of comorbidities**				
Crutches	Yes	5.14 [0.91-29.03]	0.06	4.11 [0.66-25.69]	0.13
	No	Reference	Reference	Reference	Reference
Walking frame	Yes	3.75 [0.75-18.72]	0.11	2.59 [0.48-13.97]	0.27
	No	Reference	Reference	Reference	Reference
Wheelchair	Yes	3.87 [0.88-16.96]	0.07	2.25 [0.48-10.50]	0.30
	No	Reference	Reference	Reference	Reference
Assistive device	**RVD status**				
Crutches	Positive	0.45 [0.21-34.20]	0.45	1.64 [0.12-22.62]	0.71
	Negative	Reference	Reference	Reference	Reference
Walking frame	Positive	4.80 [0.53-43.26]	0.16	2.79 [0.29-26.90]	0.37
	Negative	Reference	Reference	Reference	Reference
Wheelchair	Positive	5.58 [0.71-44.22]	0.10	3.53 [0.43-29.31]	0.24
	Negative	Reference	Reference	Reference	Reference

** Values in Bold Indicate Significant Value*

4.5 CONCLUSION

This chapter presented the results of data collected for PWSCI admitted for rehabilitation at each of Gauteng's public healthcare rehabilitation units. The following chapter will be used to delve into these results in a detailed manner and compare these findings to those published not only in South Africa, but internationally too.

CHAPTER 5 DISCUSSION

This chapter discusses the results as they appear in the previous chapter while also comparing the findings to previously published literature. The chapter comprises of four sections with the framework based on the study objectives, namely to determine the prevalence and profile of persons with spinal cord injury (PWSCI) receiving rehabilitation in the public healthcare sector in Gauteng, South Africa. The first section of this chapter discusses the prevalence of PWSCI. Section two addresses the sociodemographic profile, section three the injury profile and section four the association between the sociodemographic and injury profiles.

5.1 THE PREVALENCE OF SCI IN GAUTENG'S PUBLIC HEALTHCARE REHABILITATION UNITS

This study found that 38.67% of patients in public healthcare rehabilitation units in Gauteng were admitted for SCI rehabilitation. This study was the first to the authors' knowledge to provide a prevalence estimate of spinal cord injury (SCI) in South African rehabilitation units. A systematic review by Singh et al. (2014) reported on the prevalence of SCI from nine separate studies. Of these nine studies, four reported on national prevalence rates of SCI while the other five reported on city centres and/or counties. It may be suggested then that this is the first study globally to assess the prevalence rate of SCI in a rehabilitation unit. In this study, a notable variance was noted in the SCI prevalence rate between each rehabilitation unit. This is likely owing to the varying policy at each unit with a lack of standardization in the public healthcare rehabilitation setting in Gauteng. By understanding the SCI prevalence in Gauteng rehabilitation units, targeted healthcare provision may be advocated for which will ultimately, together with policy development and/or strengthening, ensure the best possible care for PWSCI in the province. It is thus recommended that the rehabilitation prevalence rate of SCI continues to be investigated to achieve these goals.

5.2 THE SOCIODEMOGRAPHIC PROFILE OF PWSCI IN GAUTENG REHABILITATION UNITS

5.2.1 AGE

The findings of this study showed that young individuals are significantly more susceptible to sustaining a traumatic spinal cord injury (TSCI) while older individuals are significantly more likely to sustain a non-traumatic spinal cord injury (NTSCI). The mean age in the current study was comparable at four of the five rehabilitation units, with DGMAH having a notably higher mean and median age. This is likely to be a reflection of the unit admitting the highest proportion of participants with NTSCI, a factor that has previously been found to be associated with an increase in age (van den Berg et al., 2010).

The age of PWSCI in specialized public healthcare settings in South Africa tends to follow a closely comparable trend by province and for the county as a whole. The mean age of participants in this study was found to be similar to previous literature published in Gauteng, Kwazulu-Natal as well as in the acute public healthcare setting in the Western Cape (Hart and Williams, 1994; Hart, 2000; Sothmann et al., 2015; Joseph et al., 2017; Pefile, Mothabeng and Naidoo, 2018; Mashola, Olorunju and Mothabeng, 2019). It must be noted, however, that a much younger cohort was found in the current study than was reported in the acute private healthcare setting in the Western Province (Phillips, Braaf and Joseph, 2018). The age discrepancy between the public and private healthcare setting in South Africa may be a reflection of fewer injuries being as a result of assault in the private healthcare setting with interpersonal violence continuing to affect younger and poorer populations.

When comparing the findings of this study to those published internationally, some differences can be noted. The mean age reported in this study is slightly older than that previously reported for developing countries (Rahimi-Movaghar et al., 2013, Kang et al., 2018). Compared to the global systematic review published by van den Berg et al. (2018), an absence of a “second peak” in PWSCI above the age of 65 can be noted. South Africa has a life expectancy of 62.5 for males and 68.5 for females (Statistics South Africa, 2019) while in developed countries the life expectancy is 79 for males and 82 for females (Szmigiera, 2021). The lower life expectancy in South Africa, together with the higher proportion of TSCI as compared to NTSCI, may explain the lack of a "second peak".

It was found that almost 80% of participants in this study were under the age of 45 with similar proportions in the 18-30 and 31-45-year age groups. This finding represents a large proportion of the working age population. Preventative programs for TSCI should thus be aimed at curbing injuries in the younger population, often as a result of assault and motor vehicle accidents. Not only will this save medical and social support costs for PWSCI, more young individuals will be part of the general work force limiting the impact on the South African economy. Preventative programs for NTSCI should be aimed at older population groups. This will help limit the burden of morbidity and mortality in older populations and allow these individuals to life longer, more meaningful lives.

5.2.2 SEX

Males have been found to be more susceptible to SCI than females. This statement was confirmed by the results of this study which showed that more males than females were found to have an SCI in public healthcare rehabilitation units in Gauteng. This was true for each of the five rehabilitation units, with a proportion of males ranging from 55.56% to 74.81%. Overall, a male-to-female ratio of 2.33:1 was found with 69.95% of participants being male. Males were found to be significantly more likely to sustain a TSCI than females with the latter significantly more likely to sustain a NTSCI.

Differences in sex can be noted between this study and in the previously published literature from South Africa. The overall proportion of males in this study was lower than that reported previously in Gauteng and in the Western Cape (Hart and Williams, 1994; Hart, 2000; Joseph et al., 2015; Sothmann et al., 2015; Phillips, Braaf and Joseph, 2018). This may be attributed to the detailed inclusion and investigation of NTSCI in this study, with this cohort found to have a higher proportion of females. This explains the fact that a similar proportion of males were reported in this study and that by Pefile, Mothabeng and Naidoo (2018) who also included an analysis of NTSCI. This was confirmed by the fact that similar proportions of males were found between this and all South African studies that focussed on TSCI when isolating the TSCI population of this study. Furthermore, the high proportion of males in the Western Cape may potentially be compounded by the gang violence that is rife not only in males, but in the younger population too.

The male-to-female ratio noted in this study is one of the lowest reported in developing regions. One distinguished discrepancy exists between the current study and those published internationally. A systematic review of NTSCI in Sub-Saharan African countries by Musubire et al. (2017) reported that 18 out of 19 published articles for this region reported a male predominance (although the male-to-female ratio was less than that for TSCI). Contradictory to this, all three studies (including the current study) that included accurate reporting of NTSCI in South Africa were found to have a female predominance (Godlwana et al., 2008; Pefile, Mothabeng and Naidoo, 2018). Of note, the single study in the systematic review by Musubire et al. (2017) that reported a female predominance was also published in South Africa (Bhigjee et al., 2001). This may be a reflection of a high prevalence of HIV and tuberculosis, particularly amongst women, in both Kwazulu-Natal and Gauteng where these findings were reported (Human Sciences Research Council, 2017).

As a province, Gauteng will do well to direct preventive programmes for TSCI towards males while for NTSCI efforts should be aimed at females. Regular and widespread screening as well as educational interventions aimed at HIV and tuberculosis. The common co-infection between the two illnesses may result in more cases of NTSCI with females having been shown to be more at risk in South Africa (Satoh and Boyer, 2019). These efforts will surely assist the province – and the country as a whole – in lowering the burden of both TSCI and NTSCI.

5.2.3 ETHNICITY

The ethnicity of PWSCI in this study was substantial and unrivalled at each rehabilitation unit. Overall, a distinct majority of participants were Black with Indians accounting for the least proportion of study participants. This is likely a testament to the high prevalence of Black individuals in South Africa (80.66%) (Statistics South Africa, 2016), with 89.2% of this population accessing public healthcare services (Statistics South Africa, 2019). A point of interest from this study was that White participants were three times as likely to sustain a NTSCI than a TSCI. This may attest to findings by Silber and Geffen (2009) who reported that violent crimes in South Africa disproportionately affect Black and Coloured people. Additionally, the average age of White South Africans is higher than that of other ethnic groups, with a peak noted between the age of 45 and 60 (Statistics South Africa, 2016). With the incidence of NTSCI having been shown to increase with age (van den Berg et al., 2010), this is likely a factor adding to the higher numbers of NTSCI in this population group.

This study is the first to comment on ethnicity in Gauteng rehabilitation units. This demographic factor was also not reported on in any of the three epidemiological studies of SCI in the Western Cape (Joseph et al., 2015; Sothmann et al., 2015; Phillips, Braaf and Joseph, 2018). Ethnicity tended to be equivalent when comparing the findings of this study to those reported by Pefile, Mothabeng and Naidoo (2018) in Kwazulu-Natal. However, more Indian participants were noted in the Kwazulu-Natal-based study than in Gauteng. This is a direct reflection of ethnic differences between the two provinces with Kwazulu-Natal having a higher proportion of Indians (7.9%) than in Gauteng (2.7%) (Statistics South Africa, 2016). By continuing to collect and investigate this data set, possible trends may be found to exist between ethnicity and other aspects of the sociodemographic and injury profiles of PWSCI. This will help guide future prevention approaches and management strategies to optimize outcomes for PWSCI.

5.2.4 AREA OF RESIDENCE

The provision of rehabilitation services for PWSCI in the public healthcare setting in Gauteng has been found to be disjointed. In this study, it was established that a quarter of participants were residing in the City of Tshwane when they sustained their injury. The bed capacity for patients requiring rehabilitation is four times more in the City of Tshwane than it is in the City of Johannesburg and in the City of Ekurhuleni. This is likely a direct reflection of the dedicated rehabilitation hospital that is Tshwane Rehabilitation

Hospital, the only of its kind in the public healthcare setting in the province. Of note, just under a quarter of all participants in this study were admitted from other provinces. No association was found to exist between the area of residence for study participants and SCI aetiology.

A lack of rehabilitation services undermines the principle of universal access to healthcare for all people. This study has helped achieve a better understanding about which areas Gauteng's public healthcare rehabilitation units are servicing most commonly. This has helped identify and localize the need for further public healthcare rehabilitation units in Gauteng and the surrounding provinces as to meet the goals set out by the "Rehabilitation 2030" initiative (World Health Organization, 2017). Ultimately, this will also contribute to achieving the realization of the third Sustainable Development Goal as set out by the United Nations', namely good health and well-being.

5.2.5 OCCUPATION

The majority of participants in this study were formally employed at the time of injury. This was especially true for those in the TSCI group, where more than half of that cohort were working formally at the time of injury. It may be proposed that there is a potential yet unstudied relationship between increasing income and partaking in potentially risky health behaviours that may place individuals at risk of sustaining traumatic injuries. Of interest, this study showed that unemployed individuals are twice as likely to sustain a NTSCI. This may be a reflection of the higher rates of unemployment in HIV-positive individuals, with HIV a significant contributor to conditions such as HIV-related myelopathies and spinal tuberculosis (Levin and Lyons, 2018). Further, a more complex and often less abrupt onset in those with NTSCI may lead to a potential loss of employment as signs and symptoms worsen over time (New and Marshall, 2014; Gedde et al., 2019). Students were three times as likely to suffer from a TSCI as compared to NTSCI. This is likely due to the younger age associated with TSCI contrary to the older age with which NTSCI is associated (van den Berg et al., 2010). Further, it has been shown that young people tend to engage in risky behaviours predisposing them to accidental, if not substantial injury (Steinberg, 2008). In keeping with this explanation, pensioners were nine times more likely to suffer a NTSCI, once again a consequence of an increased incidence of NTSCI associated with an increase in age.

Comparison between the results of this study and those previously published in South Africa need to be made with care. While no information has been previously published for Gauteng, some investigations in the Western Cape and Kwazulu-Natal are noted. In a study by Braaf, Phillips and Joseph (2018) in the Western Cape, no comment on employment status was made. The authors did, however, comment on employment type, dividing participants by “white collar workers” (60%) and “blue collar workers” (40%). No comparison to our study can be drawn from their results. This study showed a similar rate of unemployment but a greater proportion of employment than was found by Pefile, Mothabeng and Naidoo (2018) in Kwazulu-Natal. Although a greater proportion of data was missing in our study, and thus interpretations may be inaccurate, it may reflect better employment opportunities in Gauteng as compared with Kwazulu-Natal (de Villiers, 2019a). Godlwana et al. (2008) reported 80% of their study population with spinal tuberculosis in Kwazulu-Natal were unemployed.

Understanding the type of employment that preceded each study participant’s injury is important. Achieving societal integration includes the return to work for PWSCI post injury. With the high rate of unemployment in South Africa (Statistics South Africa, 2021), return to work should form a significant part of rehabilitation for PWSCI not only in Gauteng but in South Africa as a whole.

5.2.6 MARITAL STATUS

A majority of participants in this study were classified as “never married” while a quarter were classified as “married”. Although the current study reports a higher proportion, the results are similar to those provided by Statistics South Africa (2016) for the South African population at large. The average age at which South Africans marry has been reported as 37 years old (Statistics South Africa, 2016) which is the mean age in this study. A large proportion of participants in the TSCI group were classified as never married, possibly a reflection of the mean age of this group being approximately five years younger than the average age at which people marry in South Africa. In the NTSCI group, participants were twice as likely to be married as compared to their TSCI counterparts. This may be a reflection of the global trend showing an increased likelihood of marriage with an increase in age (Goodwin, McGill and Chandra, 2009). Furthermore, those in the NTSCI group were twice as likely to be divorced and approximately seven times as likely to be widowed than their TSCI counterparts. This is, once again, likely testament to the increasing incidence of NTSCI with an increase in age as reported by van den Berg et al. (2010).

No comment was made with regards to marital status in any of the published epidemiological literature in Gauteng (Hart, 1994; Hart and Williams, 2000) nor the Western Cape (Joseph et al., 2015; Sothmann et al., 2015; Phillips, Braaf and Joseph, 2018). Comparisons to this study could thus only be made against a single, Kwazulu-Natal-based study by Pefile, Mothabeng and Naidoo (2018). The authors of that study reported that 71% of their population were never married, whilst 25% were married at the time of injury. While an exactly comparable proportion of participants were married in our study and that by Pefile, Mothabeng and Naidoo (2018), the Kwazulu-Natal-based study was found to have a greater proportion of participants who had never married. This may be a result of the higher proportion of an unknown marital status in the current study, as similar findings of being divorced and widowed were noted across the two studies. Comparisons by aetiology differed between the two studies. These findings by Pefile, Mothabeng and Naidoo (2018) closely align with those for the province as a whole, where it was reported that 68.3% of the population had never been married (Statistics South Africa, 2016).

Sustaining a SCI can be devastating and can have a negative effect on all aspects of life including social aspects. Family support, be it from a spouse or immediate family member is needed to ensure continuity of care and prevention of secondary health conditions (Pilusa et al., 2021). This study may form a basis upon which to conduct further research into the relationship between SCI and marital/family support.

5.2.7 HIGHEST LEVEL OF EDUCATION

The highest level of education attained by PWSCI at the time of their injury was recorded and classified according to the National Qualifications Framework (NQF). The NQF was formed to standardize learning achievements for South African citizens (South African Qualifications Authority, 2020). No comment on educational level was previously made in the published epidemiological literature in Gauteng (Hart, 1994; Hart and Williams, 2000) nor the Western Cape (Joseph et al., 2015; Sothmann et al., 2015; Phillips, Braaf and Joseph, 2018). Whilst a large proportion of this data was missing in a study published by Pefile, Mothabeng and Naidoo (2018), attempts were made to report on their participant's highest level of education. When adjusting for the unknown proportion of participants in the current study (as was done in theirs), almost five times the proportion of participants were found to have a primary qualification (Grade 9 or lower) as compared to in the Kwazulu-Natal-based study. Slightly more participants in this study achieved a Grade 10 or Grade 11 qualification than did in the aforementioned study from Kwazulu-Natal. Almost twice as many participants in Kwazulu-Natal had completed a Grade 12 when compared to the findings of our study. Overall, neither study reported a significant association between highest level of education and SCI aetiology. Extreme caution is needed when interpreting these results as a large proportion of missing data was noted in both study settings. When comparing Grade 12 pass rates over the last 10 years, Gauteng has consistently had a higher pass rate than Kwazulu-Natal (de Villiers, 2019b), and thus the Grade 12 comparisons between the two studies remains not only incongruous, but wholly unexplained. Further research into this data set remains warranted with no clear associations being found to exist in this study nor in those previously published.

5.3 INJURY PROFILE OF PWSCI IN GAUTENG REHABILITATION UNITS

5.3.1 AETIOLOGY

Traumatic SCI was found to be twice as common as NTSCI in this study. Injuries as a result of assault were responsible for a third of overall injuries while transportation-related injuries were responsible for a fifth of the overall injuries. When isolating the TSCI cohort, assault accounted for just over half of traumatic injuries, transportation just over a third, falls approximately a tenth and sporting injuries a solitary percentage. With regards to NTSCI, infectious causes were responsible for just under a fifth of overall injuries in this study, two and a half times more common than "other" causes (most commonly neoplasms). Degenerative changes, spinal tumours and vascular causes together accounted for less than 10% of all injuries. When isolating the NTSCI cohort, infectious causes were responsible for half of all non-traumatic injuries while 22.90% of non-traumatic injuries were a result of other causes. Other causes (predominantly neoplasms) were found to be twice as common as degenerative changes and spinal tumours which in turn were four times as common as vascular causes.

Notable differences are noted between the findings relating to TSCI in this study and to those previously published in the country. Gauteng continues to be have the highest proportion of assault-related injuries when compared to other provinces. While the proportion of violence-related injuries was lower in this study than in previously published but outdated literature in the province, this feature has remained unchanged across many years (Hart and Williams, 1994; Hart, 2000). The high proportion of assault in these outdated studies are likely a reflection of an increasingly violent study period associated with a turbulent and transitional political landscape at that point in South African history (Stevens, 2008). Although Joseph et al. (2015) reported a similar proportion of violence-related injury in the Western Cape to that of the current study, that province and Kwazulu-Natal were both found to have a higher proportion of transport-related injuries (Sothmann et al., 2015; Phillips, Braaf and Joseph, 2018; Pefile, Mothabeng and Naidoo, 2018). These differences as compared to the rehabilitation-based studies of Gauteng may be a reflection of the acute study setting in both the Western Cape and Kwazulu-Natal. As a result of compensation from the Road Accident Fund, many of the participants with injuries related to transportation may go on to receive rehabilitation in the private healthcare setting. This may explain the lower proportion of injuries as a result of motor vehicle accidents in the public healthcare rehabilitation setting in Gauteng. The Western Cape also reported South Africa's highest proportion of injuries as a result of falls, a proportion five times greater than that found in this study (Phillips, Braaf and Joseph, 2018). This may be explained by the older age of participants in that study as well as the private healthcare setting. Findings by Doolan, Ehrlich and Myer (2007) reported that those with a higher socioeconomic profile (and thus those more likely to access private healthcare) are less likely to be exposed to violent crimes.

The epidemiological profile of NTSCI remains poorly researched not only in South Africa but the world over. By including those who received public rehabilitation for an SCI due to non-traumatic causes in this study, the understanding of this cohort in Gauteng was strengthened. Kwazulu-Natal was found to be the only province in which authors presented findings to show that NTSCI was more common than TSCI (Pefile, Mothabeng and Naidoo, 2018). The 54% prevalence of NTSCI reported by Pefile, Mothabeng and Naidoo (2018) was notably higher than the 33.94% reported in this study. Similar to the current study, infective spondylitis was found to be the most common cause of NTSCI (79%) followed by neoplasms (16%). A significant association exists between a positive HIV status and NTSCI, which is unsurprising as Kwazulu-Natal has the highest prevalence of HIV and second highest prevalence of tuberculosis in South Africa (Kanabas, 2020).

International literature of TSCI does not mirror the epidemiological findings of TSCI in Gauteng. Findings by Lee et al. (2014) and Kang et al. (2018) report that motor vehicle accidents and falls are the leading cause of SCI worldwide. Motor vehicle accidents were shown to be the most common cause of SCI in developing regions and in Sub-Saharan Africa by Rahimi-Movaghar et al. (2013) and Draulans et al. (2011) respectively. Gauteng continues to produce the highest proportion of SCI as a result of assault not only in the country, but worldwide. Further investigation into this phenomenon is necessary with prevention strategies needing to be reassessed and better implemented. The province has been shown to have the highest level of crime in South Africa followed by the Western Cape and Kwazulu-Natal (Crime Stats SA, 2017). Regarding NTSCI, the findings of this study better match those published in developing countries. It is interesting to note that infectious causes - particularly spinal tuberculosis - remains the leading cause of NTSCI in South Africa. These findings are similar to those reported in other developing countries such as Ethiopia and Ghana (Draulans et al., 2011). While developed countries tend to have a higher proportion of NTSCI as a result of degenerative conditions and tumours, developing countries tend to have a higher proportion of infections, particularly a result of tuberculosis and HIV (New et al., 2014).

On reflection, it appears evident that the province has become less violent over time and, combined with an improving life expectancy and aging population, the proportion of age-related injuries (falls and other NTSCI causes) in the province has grown steadily. While traditionally plagued by infectious disease, the incidence and prevalence of non-communicable injury and disease is however rising in South Africa, with estimates showing levels two to three times higher than in developed regions (Mayosi et al., 2009). As components of the quadruple burden of disease, trauma and injury remain a large contributor to the incidence of TSCI while infectious disease will continue to contribute to the incidence of NTSCI. It is of utmost importance, then, that prevention strategies for TSCI are aimed at curbing the high levels of interpersonal violence and assault in the province. The high proportions of infectious disease and the subsequent development of NTSCI shows that there is a gap in the screening, diagnosis and management of conditions such as HIV and tuberculosis which remain rife in low income countries. It is necessary that these issues are addressed promptly with ongoing epidemiological surveillance in the province necessary as an increased need for rehabilitation services in the province is likely to develop.

5.3.2 INJURY CLASSIFICATION

Complete injuries accounted for just under half of all injuries in this study with incomplete lesions responsible for a third of overall injuries. As per the AIS classification system, an AIS C injury was the most common type of incomplete injury followed by incomplete SCI syndromes. Complete injuries were more common in the TSCI group compared to the NTSCI group. An AIS C and AIS D injury classification were both more than twice as common in the NTSCI group than in the TSCI group. In this study, incomplete SCI syndromes were more likely to be caused by a traumatic than non-traumatic cause. These findings are in line with those proposed by McKinley et al. (2007).

The findings off this study don't align completely with those previously published in Gauteng. A study by Mashola, Olorunju and Mothabeng (2019) report that 58% of their study participants had an AIS A injury. An outdated study by Hart and Williams (1994) reported that 66% of their study population had an AIS A injury – notably higher than the 44.04% reported in this. The higher proportion of complete injuries in the former studies may thus be a result of the high proportion of missing information in this study (24.09%). While caution is needed in postulating results, TSCI has constantly been shown to cause more cases of AIS A SCI. Thus, if the high proportion of TSCI in Gauteng is used to hypothesize injury classification of the missing data, a large proportion may be classified as a complete injury and thus the two studies' findings would align better.

In the Western Cape, Joseph et al. (2015) reported a similar proportion of complete injuries to that noted in this study. Injuries that were classified as an AIS D were nine times more common in the Western Cape study than in the current study. This may be a result of grouping, as that study separated incomplete SCI syndromes with which an AIS D classification has been shown to be commonly associated (McKinley et al., 2007). Phillips, Braaf and Joseph (2018) reported a lower proportion of complete injuries in their study although this may be attributed to a smaller sampling. The authors used the umbrella term "incomplete injuries" to present AIS B, C and D injuries and thus comparisons against this study cannot be drawn.

In Kwazulu-Natal, similar findings to this study were reported by Pefile, Braaf and Joseph (2018). Slightly fewer instances of complete injuries were noted in the overall study population. Twice as many incomplete injuries were noted in the TSCI group in Kwazulu-Natal than in Gauteng. Of the NTSCI population, an AIS D classification was most common followed by an AIS C classification. Once again, grouping may be responsible for the higher proportion of PWSCI presenting with an AIS D classification as the current study separated incomplete SCI syndromes. In their study on spinal tuberculosis, Godlwana et al. (2008) reported an AIS A classification in a quarter of their study population while a third had an incomplete injury.

The results of this study were in alignment with those published internationally. Findings by Rahimi-Movaghar et al. (2013) and Draulans et al. (2011) found that complete injuries were most common in developing countries and in Sub-Saharan Africa respectively. Further, agreement was found in the fact that TSCI causes more complete injuries. This is likely a result of high-velocity injuries (as was found with the high proportion of assault and transport-related injuries in this study) being more likely to cause complete SCI (Wilson, Cadotte and Fehlings, 2012).

5.3.3 LEVEL OF INJURY

Paraplegia was significantly more common than quadriplegia in this study. This finding was similar to published literature in Gauteng by Mashola, Olorunju and Mothabeng (2019) as well as in outdated studies by Hart and Williams (1994) and Hart (2000). This finding was also true in Kwazulu-Natal, where 66% and 68% of participants were paraplegic in studies by Pefile, Mothabeng and Naidoo (2018) and Godlwana et al. (2008) respectively. Paraplegia was found to be the most common type of injury in both developing regions and Sub-Saharan Africa (Draulans et al. 2011; Rahimi-Movaghar et al., 2013). In the Western Cape, however, quadriplegia was found to be more common than paraplegia with 59.3% and 53.1% of study participants as reported by Sothmann et al. (2015) and Joseph et al. (2015) respectively. The authors propose that this may be a reflection of the priority scale for admission that is used by the Groote Schuur Hospital Acute Spinal Cord Injury Unit. Participants with cervical injuries often have a greater need for surgical intervention to stabilize the spine and potentially preserve/promote neurological recovery. Additionally, the higher proportion of cervical injuries may be related to the higher incidence of transport-related injuries with the cervical spine the most common site of injury in motor vehicle accidents, especially in those wearing seatbelts (Andalib et al., 2018). This is due to the fact that the cervical spine is highly mobile and thus more susceptible to injury (Torlincasi and Waseem, 2021). The relatively lower proportion of transportation-related injuries in this study may thus explain the higher proportion of thoracic spine injuries and resulting paraplegia.

The lower thoracic spine was the most common site of injury in this study as it was in published literature in Kwazulu-Natal (Godlwana et al., 2008; Pefile, Mothabeng and Naidoo, 2018). Injury levels tended to be fairly similar in the current study when comparing the TSCI and NTSCI groups. However, in the Kwazulu-Natal-based study by Pefile, Mothabeng and Naidoo (2018), a significant association was found to exist between cervical and upper thoracic injuries and TSCI as well as between lumbar injury and NTSCI. Findings by Godlwana et al. (2008) on spinal tuberculosis also found the lumbar spine to be commonly injured.

5.3.4 SOURCE OF REFERRAL

In this study, it was found that most participants were admitted from tertiary-level healthcare institutions with more than half of admissions done so from these hospitals. When combined with regional-level healthcare institutions, this proportion climbs to 77.2%. It is not surprising that we did not find any association between source of referral and SCI aetiology as literature does not report this as a sociodemographic or injury profile factor. One plausible reason for the high levels of admissions from tertiary hospitals may be because these institutions are able to offer better care for PWSCI as they have the necessary medical specialists available to treat these individuals. Further, these institutions are likely to be better resourced than their district-level counterparts. In the face of a lack of a specialized acute SCI unit in the province – such units being shown to have better outcomes on overall length of hospital stay, complications and mortality (Parent et al., 2011) – these results may help guide and implement MDT training to better improve the acute care for PWSCI in Gauteng.

5.3.5 TIME TO ADMISSION

The average time to admission (TTA) reported in this study was markedly shorter than those published previously in Gauteng (Hastings, Ntsiea and Olorunju, 2015). Participants from this study who were diagnosed with TSCI and NTSCI waited approximately 110 and 80 days less than those participants reported in the study by Hastings, Ntsiea and Olorunju (2015) respectively. The latter study included both private- and government-funded participants without discrimination noted between the two. Without this knowledge, it is difficult to confer differences between the two studies. However, the faster admissions to rehabilitation seen in this study may be a result of intra-hospital transfers from the general hospital setting into the rehabilitation units which tend to be on the same premises, thus lowering the mean TTA. Participants in the NTSCI group had a significantly higher mean TTA of 90.56 days compared to the shorter 60.39 days for their TSCI counterparts. It may be proposed that the discrepancy between TSCI and NTSCI participants in this study may be a result of the less abrupt onset of injury in the non-traumatic population compared to those with traumatic injuries, with the seeking of medical care often delayed. Waiting times at each rehabilitation unit varied greatly with no clear trend found to exist. Comparisons of the average TTA presented by authors in the Western Cape and in Kwazulu-Natal cannot be made as these findings referred to the waiting period for admission into acute settings and not a specialized rehabilitation unit. TTA has not been well reported globally with only two known results presented on patients requiring rehabilitation (Parent et al., 2011). The TTA reported in this study was longer than in the United States of America (33.4 days in one study and 19 in another) and in Italy (54.6 days) (Parent et al., 2011). With the findings of this study closer reflecting those published internationally, the large inconsistency as compared to those previously published in Gauteng warrant further research into this injury outcome.

5.3.6 LENGTH OF STAY

The mean rehabilitation length of stay (LOS) for PWSCI admitted to Gauteng's public healthcare rehabilitation units was found to be 85.59 days. The shortest LOS was five days whilst the longest was 388 days. The results did not show any significance between LOS for TSCI and NTSCI. Neither age or TTA was found to be associated with LOS in this study. Interestingly, PWSCI in the City of Johannesburg and City of Ekurhuleni tended to have a shorter LOS than their City of Tshwane counterparts. This may be a consequence of a fewer rehabilitation beds in the former two municipalities, which cater for two large tertiary-level healthcare institutions (each with a capacity of over 1000 beds) feeding into the 43 available rehabilitation beds. By location, these 43 rehabilitation beds at

TMRH, SRH and EH are expected to cater for the City of Johannesburg, City of Ekurhuleni, Sedibeng District and West Rand District, a total of 10.12 million people and 75.56% of Gauteng's overall population (Statistics South Africa, 2016).

As with TTA, no data regarding LOS was provided by Mashola, Olorunju and Mothabeng (2018), Hart and Williams (1994) nor Hart (2000) in their previous investigations into rehabilitation units in Gauteng. The mean length of stay reported in this study was closely comparable to that reported by Hastings, Ntsiea and Olorunju (2015) although it must be noted that the study population in the latter was a combination of two public- and privately-funded rehabilitation units in Gauteng and direct comparisons can thus not be made. No comparison can be made to the findings provided in the Western Cape or Kwazulu-Natal as the literature published in these provinces is based on acute-care units and not specialized rehabilitation units. This study is thus the first in South Africa to investigate the LOS for PWSCI solely in specialized government-funded rehabilitation units.

Internationally, a sharp decline in rehabilitation LOS has been noted in the United States of America with LOS between the years 2015 and 2019 a third of that reported in this study (Burns et al., 2017). Developing regions such as India, Saudi Arabia and Thailand reported a rehabilitation LOS of 93.34, 58.8 and 37.8 days respectively (Burns et al., 2017). While great variation can be noted in these findings, the LOS reported in our study tends to be on the longer side. It may be of note, however, that a shorter LOS internationally may reflect healthcare insurance limits with regards to paying for in-patient rehabilitation. Nonetheless, the lack of consistent global findings warrants further research into rehabilitation LOS and potential associations.

5.3.7 HIV STATUS

In this study, it was reported that 16.84% of the overall study population were HIV positive, with a significant proportion of these participants sustaining a NTSCI. The proportion of HIV in PWSCI receiving rehabilitation in Gauteng has previously not been studied. The two studies based in Kwazulu-Natal reported a significant association between HIV positivity and NTSCI (Godlwana et al., 2018; Pefile, Mothabeng and Naidoo, 2018) in acute healthcare settings. Realizing the “90-90-90” strategy set by the Joint United Nations Programme on HIV/AIDS (UNAIDS) is of utmost importance as a direct consequence of the association between HIV positivity and NTSCI (Joint United Nations Programme on HIV/AIDS, 2014). This strategy aims to successfully diagnose 90% of people living with HIV, have 90% of people living with HIV on antiretroviral therapy and achieve viral load suppression in 90% of those on antiretroviral treatment (Joint United Nations Programme on HIV/AIDS, 2014). These goals were ultimately not met. The Joint United Nations Programme on HIV/AIDS (2020) reports an attainment of 81%, 67% and 59% of each respective outcome. By continuously working towards and ultimately achieving these targets through focused primary healthcare screening, it is proposed that Gauteng’s rehabilitation units will see a decline in HIV-related NTSCI.

5.3.8 COMORBIDITIES

This study is the first to the authors knowledge to explore comorbidities in PWSCI receiving rehabilitation at any of the public healthcare rehabilitation units in South Africa. In this study, it was found that a majority of PWSCI did not have any comorbidities. In those that did, tuberculosis was found to be most common and twice as common as hypertension. The presence of comorbidities was significantly associated with NTSCI, with just under two thirds of the NTSCI group presenting with one or more comorbidities as compared with the approximate 10% of those in the TSCI group. It may be argued that those sustaining a NTSCI are likely to have a worse overall health profile compared to their TSCI counterparts. While TSCI is usually linked to an abrupt, unexpected onset, NTSCI tends to onset over a longer period and in an older population with these factors potentially resulting in worse overall health.

5.3.9 PRESENCE OF VERTEBRAL FRACTURES, SPINAL SURGERY AND ASSOCIATED INJURIES

In our study, TSCI was found to be significantly associated with the presence of a vertebral fracture, undergoing of spinal surgery and sustaining an associated injury when adjusted for sex and age. Two thirds of the study participants sustained a fracture to the vertebral column, with a substantial proportion being as a result of TSCI rather than NTSCI. The risk of sustaining a vertebral fracture was found to increase by 0.26 in the unemployed. This is likely owing to the greater proportion of complete (and thus more severe) injuries in this proportion of participants. It can thus be assumed that an association exists between the presence of a vertebral fracture and injury severity as per the AIS classification.

This study is the first known Gauteng study to comment on these components of the International Spinal Cord Injury Core Data Set. In the Western Cape, a slightly higher proportion of vertebral fractures was noted compared to that found in this study. Undergoing spinal surgery was approximately twice as common in both the Western Cape and Kwazulu-Natal as it was in this Gauteng-based study. This is likely due to a difference of study setting with these studies being conducted in acute settings. It can be assumed that not all patients with a vertebral fracture or those that undergo spinal surgery will be transferred into a specialized rehabilitation unit. Neurological sparing and/or an improvement post-surgery may leave them no longer in need of intense, in-patient rehabilitation. Regarding associated injuries, Joseph at al. (2015) reported almost twice as many associated injuries in the Western Cape acute setting but little difference was reported by Phillips, Braaf and Joseph (2018) or Pefile, Mothabeng and Naidoo (2018) to the proportion found in this study.

Surgical decompression remains a contentious topic in the world of SCI with outcomes variable (Wilson et al., 2017). By understanding the proportion of PWSCI that have vertebral fractures and those that receive spinal surgery, potential neurological gains can be further investigated. Surgical decompression within 24-hours of injury has the potential to facilitate neurological improvement, reduce hospital LOS and prevent post-operative complications (Nakashima, Nagoshi and Fehlings, 2015). This topic requires further investigation, particularly in the public healthcare setting in South Africa where access to neurosurgical intervention is often delayed due to a lack of resources and high patient load requiring these services.

5.3.10 MORTALITY

A mortality rate of 6.48% was noted in this study. These findings are the same as those reported by Mashola, Olorunju and Mothabeng (2019) and similar to those proposed by Hart and Williams (1994). Further, this study found that mortality rates were twice as high in the NTSCI group, with a much older mean age of 49.92 being identified in those that demised. A significant correlation exists with regards to age with the risk of death increasing by 0.92 for every one-unit increase in age. Of significance, mortality was four times as common in the quadriplegic population (9.09%) of this study as compared to those that were paraplegic (2.86%).

No further rehabilitation data for mortality has been published in South Africa. In the Western Cape, mortality was investigated at an acute SCI unit by Sothmann et al. (2015) where it was found that 2.2% of patients demised. This was a third of that noted in this study and may be a reflection of specialized and closely-monitored medical care while PWSCI await rehabilitation. The higher rates of mortality in persons with quadriplegia is in line with findings by Chamberlain et al. (2015). The authors gave an overall mortality range of 10.8% and 34.6% in African countries for PWSCI. In-hospital mortality rates were three times higher in low-middle income countries, with mortality being an indicator of quality of hospital care (Chamberlain et al., 2015). The findings of this study are both below that offered for African countries. This may be a reflection of more specialized care for PWSCI in the acute and sub-acute settings, with further research needed to assess the mortality rate post-discharge from South African rehabilitation units.

5.3.11 DISCHARGE DESTINATION

Of the PWSCI that completed rehabilitation (n = 338), almost all were discharged to a private residence (97.63%). This is likely owing to the fact that PWSCI would have completed their acute and sub-acute stays and thus be deemed fit and ready for discharge and reintegration into their home and community environments. In Kwazulu-Natal, Pefile, Mothabeng and Naidoo (2018) assessed the discharge destination of

PWSCI from the acute setting and found that 66% of study participants were discharged to their referring hospital for further medical/rehabilitative management while 23% were discharged to a private residence. This information was not known in 9% of participants while 1% of participants were homeless, 1% were discharged into a nursing home and 1% into correctional facility care. The results of this study are in line with those by Dionne et al. (2020), who reported that 89% of PWSCI were discharged home with the remaining 11% being discharged to nursing homes and long term care facilities (Dionne et al., 2020). The findings of the current study may reflect a lack of specialized long-term care facility beds or assisted-living residences in the public healthcare setting in Gauteng. Further research into this topic will allow for an accurate provision of referral and/or follow-up services whether at specialized stepdown units or at a community level to cater for PWSCI and further reintegrate these individuals into society in Gauteng.

5.3.12 MOBILITY AID USE AT DISCHARGE FROM REHABILITATION

While this study is the first to investigate the type of mobility aid at discharge from public healthcare rehabilitation units in South Africa, Mashola, Olorunju and Mothabeng (2019) did investigate this factor at a single, privately-funded rehabilitation unit in Gauteng. Slightly more participants were found to be wheelchair bound in the current study as compared to that of Mashola, Olorunju and Mothabeng (2019) while a similar proportion of participants were able to walk with or without assistive devices. This finding was unknown in twice the proportion of participants in the study by Mashola, Olorunju and Mothabeng (2019) which may have affected the accuracy of these conclusions.

In the current study, the use of manually-operated wheelchairs was four times as common as walking frames/rollators and six times as common as motorized wheelchairs as well as no mobility aid at all. Elbow crutches/sticks/canes were the least common mobility aid used. No association was noted between mobility aid used and aetiology of SCI. Further investigation into this outcome may help guide rehabilitation units and stakeholders to ensure that the procurement and provision of mobility aids is in line with rehabilitation needs. It can be noted then that PWSCI are most commonly discharged from the rehabilitation unit using a manually-operated wheelchair.

5.3.13 VENTILATOR DEPENDENCY

No PWSCI were dependent on external ventilation at discharge from rehabilitation. This was the first rehabilitation-based study in South Africa to report on this outcome although Sothmann et al. (2015) reported a ventilator dependency rate of 0.9% in their acute study setting in the Western Cape. A prevalence of 6-8% of PWSCI are ventilator dependent with the prevalence increasing in higher injury levels (Sharma et al., 2020). The lack of ventilator dependent participants in this study is likely due to a very small proportion of participants presented with high quadriplegia. It is unknown what proportion of PWSCI are ventilator dependent at discharge from rehabilitation with research focused on long-term outcomes for those dependent on ventilation.

5.4 CONCLUSION

This chapter has been used to systematically discuss the results found in chapter four as per the study objectives. The results of this study are commonly aligned with those previously published in South African literature, although differences between local and international literature have been shown to exist. This leaves South Africa with a somewhat unique sociodemographic and injury profile of SCI, further highlighting the necessity of this study.

CHAPTER 6 CONCLUSION

The sociodemographic and injury profiles of persons with spinal cord injury (PWSCI) receiving public rehabilitation in South Africa is a topic not well researched. While South African epidemiological studies are historically concentrated in the Western Cape and Kwazulu-Natal, the research from Gauteng remains outdated and somewhat in need of revision. The aim of this study was therefore to determine the prevalence and profile of PWSCI who have received rehabilitation in the public healthcare sector in Gauteng, South Africa. In this chapter, the findings will be summarized with study limitations and recommendations brought to light.

By investigating the number and type of condition of patients admitted for rehabilitation in Gauteng between 01 January 2018 and 31 December 2019, the author was able to successfully calculate the prevalence of spinal cord injury (SCI) in Gauteng's public rehabilitation units. Overall, 386 patients fitted the inclusion criteria and their medical records were enrolled into the study. Specific sociodemographic and injury profile information was extracted from each medical record and used to determine an epidemiological profile. Descriptive and inferential analysis was then used to compare the prevalence and profile as well as sociodemographic and injury profile associations across Gauteng’s five public healthcare rehabilitation units.

This study found that young males are disproportionately affected by traumatic spinal cord injury (TSCI) in public healthcare rehabilitation units in Gauteng. Assault continues to be the leading cause of injury, with numbers unrivalled the world over. These injuries tend to be severe, most commonly causing complete paraplegia to the lower thoracic spine. Furthermore, a significant association was found to exist between TSCI and vertebral fractures, associated injuries and spinal surgery. While preventive strategies the world over continue to focus on transport- and fall-related SCI, South Africa would do well to address the high levels of violence and crime in the fight against TSCI. In those with non-traumatic spinal cord injury (NTSCI), females and the elderly are significantly more affected with associations found to exist between a positive HIV status, the presence of comorbidities as well as unemployment. Those with NTSCI were found to wait significantly longer to be admitted for rehabilitation while no significant difference was noted in the rehabilitation length of stay between the two groups. Most persons with spinal cord injury (PWSCI) are discharged from rehabilitation dependent on a wheelchair for mobility, placing them at risk for secondary health conditions which remain prominent in this cohort. In the continued absence of an acute SCI unit in Gauteng, acute healthcare provision for PWSCI will continue to remain disjointed. It is imperative, then, that continued preventative education and professional development of both the general population at large and medical personnel working with PWSCI (particularly at tertiary- and regional-level healthcare facilities – the place from where PWSCI are most commonly admitted to rehabilitation from) is undertaken respectively.

6.1 LIMITATIONS

This study made use of a retrospective data collection procedure. Missing information was found to be an undeniable problem throughout with variable amounts of missing data at each of the study sites (in particular, Dr. George Mukhari Academic Hospital) and in differing categories. Where information was available, human error may disturb the accuracy and completeness of recording. Further, not all new cases of SCI in Gauteng received rehabilitation as a consequence of limited bed availability and potentially inadequate lines of referral to the rehabilitation units. This study also did not investigate the profile of SCI in those under the age of 18.

6.2 RECOMMENDATIONS

Practice:

In the continued lack of a national SCI database, detailed record keeping and data collection for PWSCI will remain an undertaking up to the individual. The author thus continues to advocate for the implementation of a mandatory, standardized, prospectively-kept SCI database in-line with global recommendations as outlined by the International Spinal Cord Injury Core Data Set. Further, it is recommended that a targeted, preventative approach towards limiting SCI as a result of assault is undertaken with regular and thorough reassessment of these strategies crucial. This does not exclude transport-related injuries, however, which were still found to be common. Policy makers are urged to take note of the high proportion of injuries in this regard to implement and review current preventative measures.

Research:

It is recommended that this same study be conducted at Gauteng's private healthcare rehabilitation units over the same study period. This will provide grounds for direct comparisons to be made between the two cohorts and give Gauteng a complete picture of SCI rehabilitation. Similar research to that presented here should be conducted in other provinces to provide a more complete picture of SCI in South Africa and help guide policy change by ensuring the best possible care and opportunity for these individual's post-injury. More research regarding the profile and outcomes of NTSCI is required both locally and abroad.

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APPENDIX A

The data collection form used in this study:

DATA COLLECTION SHEET

REHAB UNIT: _______________ PARTICIPANT NUMBER: _____________

Table 1 – Demographic Profile:

Age at Injury Gender	RVD status Co-morbidities		Occupation Marital Status	
Ethnicity	Municipality in which the patient resides		Highest level of education	

Table 2 – Injury-related Characteristics:

Aetiology:		**Vertebral Fracture?**	Y/N: Specify:
AIS classification and level of injury:		**Spinal Surgery?**	Y/N: Specify:
Referring hospital/place admitted from (tertiary/regional/district/home/other):		**Associated Injury?**	Y/N: Specify:
Days to admission (Date of injury to date of rehabilitation admission):		**Ventilator Dependency (Y/N):**	
Rehabilitation length of stay in days (Date of rehabilitation admission to date of rehabilitation discharge):		**Alive at discharge from rehabilitation, Y/N:**	
Discharge destination:		**Assistive Device Used at Discharge:**	

APPENDIX B

Human Research Ethics Committee Approval from the University of the Witwatersrand:

UNIVERSITY OF THE
WITWATERSRAND,
JOHANNESBURG

R49 Mr M Alves

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)
CLEARANCE CERTIFICATE NO. M200852

NAME: **(Principal Investigator)**	Mr M Alves
DEPARTMENT:	School of Therapeutic Sciences Department of Physiotherapy Medical School University
PROJECT TITLE:	*The prevalence and profile of spinal cord injury in public rehabilitation units in Gauteng, South Africa: a retrospective population-based study*
DATE CONSIDERED:	2020/08/28
DECISION:	Approved unconditionallly
CONDITIONS:	Approved study sites shown on Annex 1 hereto **Additional site added 2021/03/04**
SUPERVISOR:	Ms S Pilusa and Ms K Mashola
APPROVED BY:	Dr CB Penny, Chairperson, HREC (Medical)
DATE OF APPROVAL:	2020/10/22

This Clearance Certificate is valid for 5 years from the date of approval. An extension may be applied for.

DECLARATION OF INVESTIGATORS

To be completed in duplicate and **ONE COPY** returned to the Research Office secretariat on the 3rd floor, Phillip Tobias Building, Parktown, University of the Witwatersrand, Johannesburg.

I/we fully understand the conditions under which I am/we are authorized to carry out the above-mentioned research and I/we undertake to ensure compliance with these conditions. Should any departure be contemplated from the research protocol as approved, I/we undertake to submit details to the Committee. **I agree to submit a yearly progress report**. When a funder requires annual re-certification, the application date will be one year after the date when the study was initially reviewed. In this case, the study was initially reviewed in **«Missing mail merge field»** and therefore reports and re-certification will be due in the month of **«Missing mail merge field»** each year. Unreported changes to the study may invalidate the clearance given by the HREC (Medical).

Signature of Principal Investigator

Date

APPENDIX C

Thelle Mogoerane Regional Hospital Study Approval:

GAUTENG PROVINCE
HEALTH
REPUBLIC OF SOUTH AFRICA

Enquiries: P/N Mabizela/P/N L. Mogoai
Directorate: Staff Development
Telephone number: (011) 8917109
Email: Thandiwe.Mabizela @gauteng.gov.za

Date: 09 March 2021

Mr. Michael Alves

Thelle Mogoerane Regional Hospital Management Team is pleased to grant you permission to conduct your study / research **On the Prevalence and profile of spinal cord injury in Public rehabilitation hospital in Gauteng South Africa: at Thelle Mogoerane Regional Hospital.** Your data will be conducted through obtaining information through **"Prospective data collection"** in your protocol for which you will obtain the ethics clearance certificate from the **University of Witwatersrand.**

The following condition must be adhered to:

- Once the research is finalized the results and recommendations of the research should be submitted to Staff development Department.

Dr
Chief Executive Officer
Thelle Mogoerane Regional Hospital
Date: .10/03/2021..........

Thelle Mogoerane Regional Hospital
Office of the CEO
10 -03- 2021
12390 Nguza Str, Vosloorus, 1475
Private Bag X01, Alrode, 1451
South Africa

"To be the best provider of quality health care services to the people of Gauteng"

South Rand Hospital Study Approval:

GAUTENG PROVINCE

HEALTH

REPUBLIC OF SOUTH AFRICA

SOUTH RAND HOSPITAL

1 Friars Hill Road, Rosettenville, 2190

ENQ: Office of the CEO
T: 011 681 2008
M: 072 704 3371
E: Nobantu.Maleka@gauteng.gov.za

To: Mr. M. Alves

RE: REQUEST FOR APPROVAL TO CONDUCT RESEARCH STUDY: THE PREVALENCE AND PROFILE OF SPINAL CORD INJURY IN PUBIC REHABILITATION HOSPITALS IN GAUTENG, SOUTH AFRICA: A RETROSPECTIVE, POPULATION-BASED STUDY

You are hereby granted permission to conduct the above noted study. Please ensure that the Ethics Committee approval letter is submitted as soon as it is received. South Rand Hospital pledges to provide the required support in terms of access as well as guidance, should it be required.

Regards.

Dr M.N. Maleka
CEO: South Rand Hospital
Date: 23 October 2020

Edenvale Hospital Approval:

GAUTENG PROVINCE
HEALTH
REPUBLIC OF SOUTH AFRICA

Gauteng Department of Health
Edenvale Regional Hospital
Enquiries: A.R Nemadzhilili
Telephones: 0113216193
© 082 4251180
E-mail: Rose.Nemadzhilili@gauteng.gov.za

To : Mr Michael Alves
From : A.R Nemadzhilili: Human Resource Development: Edenvale Regional Hospital
Date : 2020 November 5
Subject : **Permission to conducting a research study:**
The Prevalence and Profile of Spinal Cord Injury in Public Rehabilitation Hospitals in Gauteng, South Africa: A Retrospective, Population-Based Study

This communication serves to acknowledge the receipt of your request to conduct a research as stated above as well as to grant you permission to conduct a research study at Edenvale Regional Hospital.
Before conducting a research, arrange with specific departments: hospital Physiotherapist supervisor, Ms Makhosazana Makuwa, contact number: 011 321 6131, email: makhosazanam@hotmail.com

The permission is granted in line with the following code of ethics /research.

- You must obtain the official clearance certificate, official approval and letter of permission from relevant committees.
- All the information obtained must be used for the purpose of the research
- The information will be utilized discreetly and confidentiality will be maintained always.
- You need to arrange the appointments with the specific and relevant departments or units where you will require the specific information prior conducting the research
- There should be no financial implication to the hospital.
- There should be no interruption of daily provision of services.
- The collection of data will be the responsibility of the researcher.

Your understanding and co-operation in this regard is highly appreciated.

....
Ms. A. R Nemadzhilili: Human Resource Coordinator

Date 2020 | 11 | 05

Recommended/not recommended

....
Dr. Z. G Zitha: Acting Chief Executive Officer: Edenvale Regional Hospital

Date 05/11/2020

Approved /not approved

Dr. George Mukhari Academic Hospital Approval:

GAUTENG PROVINCE
HEALTH
REPUBLIC OF SOUTH AFRICA

Dr. George Mukhari Academic Hospital

Office *of the Director Clinical Services*
Enquiries : Dr. C Holm
Tel : (012) 529 3691
Fax : (012) 560 0099
Email:Christene.Holm @gauteng.go.za
keitumetse.mongale@gauteng.gov.za

To Mr M Alves
Department of Health Sciences
University of Witwaterand

Date :22 September 2020

PERMISSION TO CONDUCT RESEARCH:NHRD GP_202008_083

The Dr. George Mukhari Academic Hospital hereby grants you permission to conduct research on "The prevalence and profile of spinal cord injury in Public rehabilitation hospitals in Gauteng, South Africa: A retrospective, population-based study" at Dr George Mukhari Academic Hospital

This permission is granted subject to the following conditions:

- [x] That you obtain Ethical Clearance from the Human Research Ethics Committee of the relevant University
- [x] That the Hospital incurs no cost in the course of your research
- [x] That access to the staff and patients at the Dr George Mukhari Hospital will not interrupt the daily provision of services.
- [x] That prior to conducting the research you will liaise with the supervisors of the relevant sections to introduce yourself (with this letter) and to make arrangements with them in a manner that is convenient to the sections.
- [x] Formal written feedback on research outcomes must be given to the Director: Clinical Services
- [x] Permission for publication of research must be obtained from the Chief Executive Officer

Yours sincerely

DR. C. HOLM
DIRECTOR CLINICAL SERVICES
DATE: 22/9/20.

Tshwane Rehabilitation Hospital Approval:

GAUTENG PROVINCE

REPUBLIC OF SOUTH AFRICA

FOR OFFICIAL PURPOSES ONLY (not to be completed by applicant)

Completed once reviewed by the Tshwane Rehabilitation Hospital Research Committee

TICK APPROPRIATE BOX	OUTCOME	COMMENT
	1. Pre-authorization to be utilized for ethics approval/NHRD registration number.	The researcher will be required to produce University Ethics Approval and NHRD registration number prior to commencing data collection at Tshwane Rehabilitation Hospital with nil material changes to proposal.
	2. Approved	Ethical clearance and NHRD registration
	3. Approved with amendment	
	4. Not Approved	

Chairperson of the Research Committee: PP ... SEUBENI

Date: 15/02/2021

CEO Tshwane Rehabilitation Hospital: PP ...

Date: 15/02/2021

Page 2 of 2

REQUEST FOR PERMISSION TO CONDUCT RESEARCH AT TSHWANE REHABILITATION HOSPITAL

APPENDIX D

Plagiarism Declaration:

PLAGIARISM DECLARATION TO BE SIGNED BY ALL HIGHER DEGREE STUDENTS

SENATE PLAGIARISM POLICY: APPENDIX ONE

I Michael Alexandre Alves (Student number: 710816) am a student registered for the degree of MSc Physiotherapy (Dissertation) in the academic year 2020.

I hereby declare the following:

- I am aware that plagiarism (the use of someone else's work without their permission and/or without acknowledging the original source) is wrong.
- I confirm that the work submitted for assessment for the above degree is my own unaided work except where I have explicitly indicated otherwise.
- I have followed the required conventions in referencing the thoughts and ideas of others.
- I understand that the University of the Witwatersrand may take disciplinary action against me if there is a belief that this is not my own unaided work or that I have failed to acknowledge the source of the ideas or words in my writing.
- I have included as an appendix a report from "Turnitin" (or other approved plagiarism detection) software indicating the level of plagiarism in my research document.

Signature: ______________ Date: 30 April 2021

1

APPENDIX E

Turnitin Report:

The Prevalence and Profile of Spinal Cord Injury In Public Rehabilitation Hospitals in Gauteng, South Africa A Retrospective, Population-Based Study

ORIGINALITY REPORT

7%	6%	3%	2%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Submitted to University of Witwatersrand Student Paper	1%
2	hdl.handle.net Internet Source	1%
3	wiredspace.wits.ac.za Internet Source	<1%
4	academic.oup.com Internet Source	<1%
5	asia-spinalinjury.org Internet Source	<1%
6	Whitlock, J.A.. "Functional outcome after rehabilitation for severe traumatic brain injury", Archives of Physical Medicine and Rehabilitation, 199512 Publication	<1%
7	agln.aspeninstitute.org Internet Source	<1%