# PELVIC FLOOR DYSFUNCTION IN FEMALE PATIENTS AT TWO ACADEMIC HOSPITALS IN JOHANNESBURG, THREE MONTHS POST-PELVIC FRACTURE

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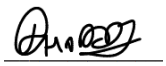
Johannesburg, October 2024

## Declaration

I, Nazreen Chopdat, declare that this dissertation is my independent, unaided work except to the extent indicated in the acknowledgement sections. This dissertation is being submitted for the degree of Masters in Physiotherapy at the University of the Witwatersrand, Johannesburg, South Africa. This script has not previously been submitted for any other degree or examination at this or any other university/faculty.

NAZREEN CHOPDAT 

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Name of candidate Signature of candidate

29 October 24 Johannesburg

_____ day of _____ 20_____ in_____

## Dedication

Dedicated to my parents, husband, and my little girl

## Presentations arising from this Study

SASP Physiotherapy Congress 2022 protocol presentation
World Africa Physiotherapy and SASP Congress 2024 oral presentation
University of the Witwatersrand Faculty of Health Sciences research day 2024 poster presentation

## Publications arising from this Study

SAUGA 4th Quarter 2022 newsletter article
(Two titles pending publication)
*(Changes in severity of pelvic floor dysfunction post-pelvic fracture: a reason to screen*
*Association between severity of pelvic floor dysfunction and type of pelvic fracture and orthopaedic management)*

## Abstract

Protocol identification: M210667 MED21-05-074

**Background:** Research is sparse on PFD* in females who sustained a pelvic fracture in South Africa. This study aimed to determine PFD symptoms and associated factors among females aged ≥18 years three months post-pelvic fracture

**Method:** A three-month quantitative longitudinal study was conducted **over 19 months**, at two South African teaching hospitals. History obtained from medical records and patient questioning; APFQ* used for PFD symptoms. Correlation tests and linear regression analysis were used.

**Results: Of 44 participants recruited, 37 completed the three-month follow-up.** Median age was 37 (interquartile range 30.5-58) years. PVA* accounted for 87.50% of multiple fractures (P=0.040). Bladder and bowel dysfunction were most common, with sexual avoidance a significant outcome following pelvic trauma. The injury directly or indirectly limited sexual activity in 45.45% participants. Significant changes were noted in Total (p=0.0216), Bladder (p=0.0062) and Sexual (p=0.0087) domain APFQ scores from preinjury to three months post-injury; and between subacute and three months post-injury, APFQ* Total (p=0.0361), Bladder (p=0.0002) and Bowel (p<0.0001) domain scores. Prolonged urinary catheter use, increased risk for higher scores of bladder PFD* (n=37, r=0.1585). Factors associated with less PFD at three months included number of vaginal deliveries preinjury (p-value 0.026, coeff -2.77, (95%CI: -5.17 to -0.36), and bedrest with non-weightbearing choice of treatment (p-value 0.046, coeff -4.00, 95% CI: -7.92 to -0.08).

**Conclusion:** PFD is present prior to and at three months post pelvic fracture with an increase in frequency and severity at three months. Symptoms are most prevalent in the subacute phase. The results of this study support the relevance of screening for PFD* within the early period and at three months for females following orthopaedic trauma.

**Clinical implications:** Screening for PFD should become standard practice for females' post-pelvic fracture in hospital and during outpatient follow-ups. Duration of catheterisation should be justifiable. Screening for bladder dysfunction is pertinent in patients requiring prolonged catheterisation, and patients requiring less conservative management. Guidance on safety to return to sexual activity is important to include as

part of routine follow-up orthopaedic sessions. Integrating PFD screening and management into standard orthopaedic practice can improve outcomes and quality of life of affected individuals.

*PFD: Pelvic floor dysfunction; PVA: Pedestrian vehicle accidents; APFQ: Australian pelvic floor questionnaire; POP: Pelvic organ prolapse

Key words: Pelvic fractures, Pelvic floor dysfunction, Female pelvic fractures, Australian pelvic floor questionnaire, Orthopaedic Management, Physiotherapy, South Africa, Screening, Early intervention

## Summary

Protocol identification: M210667 MED21-05-074

**Background:** Early identification and physiotherapy intervention of pelvic floor dysfunction (PFD) is important to improve quality of life. Research is sparse on the occurrence, and contributing factors of PFD in females who sustained a pelvic fracture in South Africa. Literature indicates that pelvic fractures are a risk factor for PFD impairments which may only manifest after discharge from the acute hospital setting. This study aimed to determine PFD symptoms and associated factors in female patients from two academic hospitals in Johannesburg, three months post-pelvic fracture and compare to preinjury symptoms.

**Method:** A quantitative pre-test, post-test same sample longitudinal study design was used. Participants included all females aged 18 years and older, recruited within three months of a pelvic fracture, from the orthopaedic wards and outpatient departments of Chris Hani Baragwanath Academic Hospital and Charlotte Maxeke Johannesburg Academic Hospital between January 2022 - July 2023. Medical history was sourced from records and patient questioning. The Australian Pelvic Floor Questionnaire (APFQ) was administered a total of three times; participants reported on symptoms prior to, in the subacute stage and three months post injury. Body-mass-index (BMI) and the Timed-up-and-go test were also utilized. Descriptive statistics, correlation tests and linear regression analysis were used.

**Results:** Of the 44 participants enrolled over 19 months between the two hospitals, 37 completed the three month follow up. Median age of participants was 37 years (IQR 30.5-58); 93.2% was black; and mean BMI: 27.4 (6.4 SD) (11 overweight, 11 obese). Motor vehicle accidents (MVA) (50%) and pedestrian vehicle accidents (36%) correlated with sustaining 50% and 87.50% of multiple fractures respectively (P=0.040). MVA also correlated with 50% sustaining only one fracture (P=0.040). Approximately 89% used a urinary catheter (UC) for median 10.5 days (IQR 6-20). UC duration correlated with bladder domain score (n=37, r=0.1585), urinary urgency (n= 37, r = 0.1155), urinary frequency (n= 37, r = 0.379) and incomplete bladder emptying (n= 37, r = 0.2850). All participants experienced at least one PFD symptom preinjury. Scores for each domain and total APFQ score increased significantly in the subacute stage. Significant change was noted in the Total (p=0.0216), Bladder (p=0.0062), and

Sexual (0.0087) domain APFQ scores from preinjury to three months post injury; and between subacute and three months post APFQ Total (p=0.0361), Bladder (p=0.0002) and Bowel (p=0.0000) domain scores. Types of symptoms with greater severities and incidence changed from preinjury to three months. Symptoms of pelvic organ prolapse affected up to 21.63% of participants compared to 57.88% participants affected by bladder, 78.38% by bowel, and 68.75% by sexual symptoms. Of the participants not sexually active at three months post pelvic fracture, 45.5% reported it to be directly or indirectly due to the injury. Bedrest with non-weightbearing choice of treatment was associated with lower APFQ scores (p-value 0.046, coeff -4.00, 95% CI: -7.92 - -0.08).

**Conclusion:** This study reveals that PFD is a common and worsening issue among females following a pelvic fracture. Symptoms persist and intensify over time. The findings highlight the importance for early detection and intervention which can improve outcomes and quality of life for affected individuals. This emphasizes the need for routine PFD screening from the acute stage to three months post injury. Minimizing catheterization duration, bladder PFD screening and providing guidance on safe sexual activity are crucial aspects of post-pelvic fracture care. These findings support the need for integrated PFD management in orthopaedic care.

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## List of Abbreviations

| | |
|---|---|
| APC | Anterior-posterior compression fracture of the pelvis |
| APFQ | The Australian Pelvic Floor Questionnaire |
| ATFP | Arcus tendinous fascia pelvis/ tendinous arch of the endopelvic fascia/ obturator fascia |
| BMI | Body-mass-index |
| CHBAH | Chris Hani Baragwanath Academic Hospital |
| CMJAH | Charlotte Maxake Johannesburg Academic Hospital |
| DHIF | Demographics and health information form |
| FI | Faecal incontinence |
| GIT | Gastrointestinal system |
| HIV | Human immunodeficiency virus |
| IBS | Irritable bowel syndrome |
| LAM | Levator ani muscles |
| LC | Lateral compression fracture of the pelvis |
| LMIC | Low-middle-income countries |
| MVA | Motor vehicle accident |
| NVD | Normal vaginal delivery |
| ORIF | Open reduction internal fixation |
| PFD | Pelvic floor (muscle) dysfunction |
| PFM | Pelvic floor muscle(s) |
| PFMT | Pelvic floor muscle training |
| PID | Pelvic inflammatory disease |
| POP | Pelvic organ prolapse |
| PVA | Pedestrian vehicle accident |
| QoL | Quality of life |
| RTA | Road traffic accident |
| SD | Standard deviation |
| STI | Sexually transmitted infection |
| SIJ | Sacroiliac joint |
| TrA | Transversus abdominus |
| TUGT | Timed-up-and-go test |
| UTI | Urinary tract infection |
| VS | Vertical shear fracture of the pelvis |

## List of key terms/ concept clarification

**Additive score:** the sum of the scores for each question within each domain on the APFQ which is out of 45 for bladder domain, 34 for bowel domain, 15 for prolapse domain and 21 for sexual domain.

**Coital incontinence:** a (NEW) complaint of involuntary loss of urine with coitus. This symptom might be further divided into that occurring with penetration and that occurring at orgasm (Haylen et al., 2010).

**Combined Mechanism (CM):** Fracture of the pelvis because of a combined mechanism of injury

**Constipation:** complaint that bowel movements are infrequent and/or incomplete and/or there is a need for frequent straining or manual assistance to defecate. (Rome II Criteria) (Haylen et al., 2010).

**Detrusor underactivity:** reduced strength and/ duration of detrusor contraction resulting in prolonged bladder emptying and failure to achieve complete emptying of bladder within a normal time span (Haylen et al., 2010).

**Dyspareunia:** complaint of persistent or recurrent pain or discomfort associated with attempted or complete vaginal penetration (Haylen et al., 2010).

**Faecal incontinence:** complaint of involuntary loss of normal or loose faeces (Haylen et al., 2010).

**Flatal/flatus incontinence:** complaint of involuntary loss of flatus (Haylen et al., 2010).

**Frequency:** complaint that urination or defecation occurs more frequently during waking hours than previously considered normal by woman (Haylen et al., 2010).

**Nulliparous woman:** a woman who has never given birth.

**Nocturia:** complaint of interruption of sleep one or more times because of the need to micturate. Each void is preceded and followed by sleep. (Haylen et al., 2010).

**Nocturnal enuresis:** complaint of involuntary urinary loss of urine which occurs during sleep (Haylen et al., 2010).

**Normal ranges for women with and without PFD:** mean domain and total scores for the APFQ determined by (Chen et al., 2022) during external validation of an online prediction model of the APFQ.

**ORIF:** a form of surgical management of orthopaedic fractures where implants (either plates, screws or an intramedullary nail) are used to stabilize the bone for the purpose of repairing the bone.

**Overactive bladder:** a syndrome formerly known as urgency incontinence comprises urinary urgency, usually accompanied by urinary frequency, and nocturia, with or without involuntary urine loss in the absence of urinary tract infection or other obvious pathology(Haylen et al., 2010; Jundt et al., 2015).

**Parity:** number of births that a female had after 20 weeks gestation.

**Parous women:** women who have given birth**.**

**Participant:** refers to the subject/patient participating in the study.

**Pelvic cavity:** a curved canal with a shorter anterior wall and longer posterior wall.

**Pelvic diaphragm:** comprises the levator ani and coccygeus muscles and the fascia overlying the superior and inferior aspects of these muscles (Moore & Dalley, 1999).

**Pelvic floor:** formed by the pelvic diaphragm, making up the inferior muscular layer of the true pelvic cavity and separates the pelvic cavity superiorly from the perineum (Chaudhry, Nahian, Chaudhry, 2018).

**Perineum:** lies inferior to the pelvic floor (Chaudhry, Nahian, Chaudhry, 2018).

**Phase one:** refers to the first phase of data collection which occurred at recruitment, and all the associated processes that were followed as outlined in section 3.5.3.1. Depending on when participants were identified, this phase could have been completed in the subacute period after sustaining the pelvic fracture or at three months post-pelvic fracture.

**Phase two:** the second phase of data collection and associated procedures that occurred at the three-month follow-up session.

**Preinjury symptoms:** PFD symptoms experienced by participants in the month prior to their pelvic fracture, as assessed by the APFQ which was administered at recruitment and relied on participants' retrospective recall of their bladder, bowel, pelvic and sexual patterns.

**Resultant score:** the additive score for each domain on the APFQ divided by the number of questions per domain and multiplied by ten to get a score out of ten per domain and a total score of 40 for the APFQ tool.

**Road traffic accidents:** the combined term for accidents occurring because of motor vehicle, pedestrian vehicle, and/or bicycle accidents regardless of the victim being the driver or passenger.

**Subacute phase/period/stage:** for this study, it refers to the first six weeks following a participant's pelvic fracture.

**Subacute phase symptoms:** comprise of PFD symptoms occurring within six weeks post-pelvic fracture, assessed on the APFQ either concurrently (for participants

recruited during this phase) or via retrospective recall (for those recruited at three months).

**Stress urinary incontinence:** loss of urine caused by elevation of abdominal pressure of any cause (cough, walking, rolling).

**Symptomatic participants:** participants who responded with an option that has a score > 1, to at least one question on the APFQ.

**Types of Pelvic fractures:** for this study, types of fracture refer to whether the patient sustained multiple fractures, only one fracture, fracture to an isolated pubic ramus, specific indication of joint or ligament involvement, and then involvement of specific bones/areas (the pubic rami, acetabular, sacrum, ischium, ileum).

**Urinary incontinence:** complaint of involuntary loss of urine.

**Urinary urgency:** complaint of a sudden compelling desire to urinate that is hard to suppress (Haylen et al., 2010; Jundt et al., 2015).

**Urinary urgency incontinence:** complaint of involuntary loss of urine due to sudden compelling desire to urinate that is hard to suppress (Haylen et al., 2010; Jundt et al., 2015).

**Vaginismus:** recurrent or persistent spasm of vaginal musculature that interferes with vaginal penetration (Rogers et al., 2018).

**Vestibulodynia:** pain of vestibule of at least 3 months' duration, without clear identifiable cause, which may have potential associated factors (Rogers et al., 2018)

**Vulvodynia:** vulvar pain of at least 3 months' duration, without clear identifiable cause, which may have potential associated factors (Rogers et al., 2018).

**Voiding difficulty:** defined as abnormally slow and or incomplete micturition (Chen, 2007); a departure from normal function or sensation, experienced by females during or following the act of micturition (Haylen et al., 2010).

# Chapter 1 Introduction

Chapter 1 introduces the background, rationale, and conceptual framework for this study.

## 1.1 Background

### 1.1.1 Pelvic Floor Dysfunction: Overview, epidemiology, trend, and impact on quality of life

Pelvic floor dysfunction (PFD) refers to a wide and varied group of conditions, affecting the pelvic floor, relating to the function or anatomy of the pelvic organs, and impacting continence, normal defecation, bowel emptying vs storage, or causing perineal pain (Neville, 2020; Silviera and Keller, 2019; Whiteside and Muffly, 2013). PFD symptoms are commonly clustered under five domains of dysfunction which includes the bladder domain (urinary- urgency, frequency, incontinence, retention, overactive bladder, residual urine), bowel domain (constipation, faecal incontinence (FI), flatus, straining), pelvic organ prolapse (POP)/ vaginal domain and related symptoms (heaviness, pressure), sexual domain (dyspareunia, vaginismus, coital incontinence) and pain domain (vulvodynia, vestibulodynia) (Baessler et al., 2009; Kenne et al., 2022; Whiteside and Muffly, 2013).

PFD in women are very common (Verbeek and Hayward, 2019); in parous women, urinary incontinence is experienced by 1 in every 3, 1 in 10 experience FI and POP develops in about 1 in 2 (Verbeek and Hayward, 2019). However the true prevalence is unfortunately difficult to determine as many women avoid seeking medical advice and treatment owing to misconceptions and embarrassment (Bhattarai and Staat, 2018). The true aetiology of PFD is still misunderstood and underestimated. Obesity, age, and parity are among the strongest proven risk factors associated with PFD (Carson et al., 2018; Kenne et al., 2022; Wu et al., 2014). PFD should therefore be screened for, particularly in older women and women with increased Body-mass-index (BMI) (Kenne et al., 2022).

Although PFD are generally not life-threatening, it greatly affects patients' quality of life (QoL) (Sinn, 2018). It impacts women's physical and psychosocial well-being through increased risk of depression, social isolation, stress, loss of independence,

self-confidence, and financial security (McConnell et al., 2020) among others. Physiotherapy treatment of pelvic floor disorders has been shown to improve QoL in women (Ptak et al., 2019). Regardless, patients seldom report their symptoms which persists for years (Brandt and Janse van Vuuren, 2019). Patients rather adjust their lifestyle to manage symptoms, consequently negatively impacting their health (Bø et al., 2015; Brandt and Janse van Vuuren, 2019).

Most evidence reviewed on PFD in females, particularly involving physiotherapy, is related to pelvic floor trauma during vaginal birth. There has been a rise in awareness and focus on pelvic health in the past decade across fields, but research on PFD in the orthopaedic patient population remains sparse. The multidisciplinary team treating trauma patients with orthopaedic and neuromusculoskeletal conditions do not routinely assess and manage PFD symptoms at an inpatient acute phase nor during follow up appointments (Yeo, 2019). While vaginal birth is a form of internal trauma to the pelvic floor, as will be discussed in 2.9.2, one would expect other trauma to the pelvis to have a similar impact on the pelvic floor.

### 1.1.2 Pelvic fractures: Epidemiology, trends and management

Levator ani muscle (LAM) tears mostly located at the point of origin is often the primary mechanism of pelvic floor injury associated with vaginal delivery (Shi et al., 2016). With the LAM inserting to the pelvic ring, one could suspect that a fracture to the pelvis affecting the pelvic ring, may affect the pelvic floor function. Chapter 2 explores this possibility.

Pelvic fractures, accounting for 2-8% of all skeletal injuries and usually occurring in polytrauma patients (Khanna et al., 2012; Sadeghpour et al., 2019) are predominantly high-energy type injuries associated with motor vehicle accidents (MVA) or falls (Welk et al., 2015). With road traffic accidents (RTA) remaining high in South Africa (OECD et al., 2019), and contributing significantly to South Africa's burden of disease (South Africa and National Planning Commission, 2012), it places the population at risk for pelvic fractures.

From April 2020 to January 2021, a total of 2 117 new lower limb fracture cases were seen by the physiotherapy department at Chris Hani Baragwanath Academic Hospital (CHBAH) (GPMDC, 2021), of which 54 (2.5%) were pelvic fractures

(CHBAH Physiotherapy Department, 2021). However, this number may be higher as some pelvic fracture patients with other injuries are classified and recorded as a polytrauma patient. Nearly 20% of polytrauma patients sustain a pelvic injury (Sadeghpour et al., 2019). Forty-nine percent of all (new and follow up) patients with pelvic fractures treated by the physiotherapy department. were involved in MVA's (CHBAH Physiotherapy Department, 2021).

There are limited studies on physiotherapy intervention for pelvic fractures; available literature focuses on the QoL, orthopaedic musculoskeletal impairments and functional limitations (Bazylewicz and Konda, 2016; Sobantu et al., 2017). In a review of the definitive treatment of pelvic fractures in orthopaedic literature, the focus was on orthopaedic management: conservative and surgical, weight bearing, bed rest, traction and surgery with no mention of assessing for PFD and/ addressing it (Bazylewicz and Konda, 2016; Coccolini et al., 2017). However, a female physiotherapy participant of a recent study by Sobantu et al. (2023) reported receiving referrals for PFD in patient's post-pelvic fracture, indicating the need for PFD management to be included in the orthopaedic management of these patients. Through a biopsychosocial lens approach, the presence of pelvic pain during sexual intercourse in female survivors of pelvic fractures was also identified in this study (Sobantu et al., 2023). By one year post injury, pelvic trauma patients have generally achieved bony consolidation and completed rehabilitation (Atkinson et al., 2005). A study done in South Africa (Pretoria), looking at QoL of patients following a pelvic fracture, did a retrospective review of medical records, noting down types of fractures sustained, concomitant injuries, management received, whether patients received physiotherapy, and the types of physiotherapy rehabilitation provided, QoL following the fracture and factors affecting QoL. They found that only 54.2% of patients with a pelvic fracture received physiotherapy for the fracture, which primarily focused on function, strengthening, mobilisation and chest physiotherapy (Sobantu et al., 2017).

With regards to the management of pelvic fractures, imaging is essential in patients who sustain pelvic fractures to assess bony trauma and injury to the genitourinary tract as patients may present with symptoms of incontinence (Nixon et al., 2021). Fracture classifications assist in deciding on mechanism of injury, stability of fractures and guide management. Detecting fracture patterns was shown to

facilitate detecting concomitant urological injury (Dincer and Ozturk, 2021); however, fracture type has not been shown to have an association with severity of PFD (McConnell et al., 2020; Wright et al., 2006). Choice of management impacts on the incidence of urogenital injury and sexual dysfunction; however, not all domains of PFD have been investigated (Ashkal et al., 2021a; Carson et al., 2018; Mbatha et al., 2023). Urinary catheters are often used for patients with pelvic fractures who are placed on traction or managed surgically (Nixon et al., 2021; Sørbye & Grue, 2013). A study by Saint et al. (2018) looking at the infectious and non-infectious complications post indwelling urinary catheterization, found that 20% of participants reported experiencing urinary leakage or difficulty starting or stopping urination; nearly 5% reported that it had led to sexual problems.

### 1.1.3 Pelvic floor dysfunction – a complication of pelvic fractures

South African and global orthopaedic led literature on complications post pelvic fracture, either does not mention PFD or uses an umbrella term i.e. “urethral/urogenital injuries” but does not indicate specific PFD symptoms (Ashkal et al., 2021a; Mbatha et al., 2023; Sobantu et al., 2017). The study done in Pretoria, found that one fifth of participants sustained injuries involving the urinary system (Sobantu et al., 2017); it is also the first South African physiotherapy study to highlight sexual dysfunction following pelvic fractures to my knowledge. There are a few studies that looked specifically at the different PFD symptoms present following pelvic fractures (Aşci et al., 1999; Baessler et al., 2004; Harvey-Kelly et al., 2014; McConnell et al., 2020; Welk et al., 2015). These studies found that bladder, bowel and/or sexual dysfunction symptoms were present following pelvic trauma in women interviewed retrospectively (Baessler et al., 2004); the prevalence of PFD was 67% following unstable pelvic fractures (Welk et al., 2015); and rate of sexual dysfunction following a pelvic fracture was 40% (Harvey-Kelly et al., 2014) among other results.

These are in keeping with findings from a recent 2020 physiotherapy study in Australia which included significant changes in bladder and bowel storage and voiding functions (McConnell et al., 2020). Scores for prevalence of bladder and bowel dysfunction were significantly higher in women at one year post pelvic fracture; and a significant reduction in sexual function one year post fracture in both male and female participants was noted. Pelvic fractures were therefore identified

as a risk factor for PFD. In McConnell's (2020) study, the PFD was detected long after the orthopaedic injury had healed, and patients were no longer attending out-patient services. The orthopaedic injury increases personal cost and loss for the significant proportion of women who do not regain their preinjury urogenital wellbeing (McConnell et al., 2020). McConnell et al 's (2020) findings showed that a screening process for PFD in the male and female pelvic trauma populations and targeted rehabilitation interventions are warranted. The feasibility of implementing early screening for urogenital dysfunction in these women have not yet been described (McConnell et al., 2020).

## 1.2 Limitations of existing literature

Studies were conducted in first world countries with likely differences in the health care/ hospital systems, patient management as well as lifestyle and population specific contextual factors compared to the South African context. The South African and Australian studies both had majority male participants (65% and 63% respectively). Most studies either collected PFD data pre and post injury from patients at ten months to one year or later after their injury; or did a retrospective review of the hospital records to identify patients and then contacted them causing an increased risk of recall bias. Not all PFD domains were investigated. Other studies only hinted to PFD as a complication by reporting on the percentage of umbrella terms (urogenital or urological disorders).

## 1.3 Problem Statement

Pelvic fractures, account for 2-8% of all skeletal injuries (Khanna et al., 2012; Sadeghpour et al., 2019). The anatomy and function of the pelvic floor muscles (PFM's) (explored in Chapter 2.9) theoretically indicate the risk for developing PFD following damage to the bony and fascial structures of the pelvis. PFD impacts QoL and, although not life threatening, it affects an individual's function, participation, and well-being through life. Early identification and intervention of PFD is important. Data on the profile of South African females with PFD and factors that contribute to PFD is scarce with available data focusing on obstetric related PFD. There is no mention in the literature of physiotherapists routinely screening for or addressing

PFD in orthopaedic patients to our knowledge. It is unknown which PFD symptoms are common following bone healing in female patients who have sustained a pelvic fracture compared to preinjury pelvic floor function. Studies that looked comprehensively at PFD post pelvic fractures were focused on males, done in high income countries, conducted retrospectively, or focused on sexual dysfunction. Findings were also not compared to patients' preinjury function as it was not always investigated. Insufficient data is available on female survivors of pelvic fractures (McConnell et al., 2020; Welk et al., 2015).

To our knowledge, the presence of PFD symptoms and associated factors in female patients who sustained a pelvic fracture had not been researched in South Africa. This study hypothesised that sustaining a pelvic fracture poses a risk for presenting with some form of PFD or worsening of a pre-existing symptom preinjury. The type of fracture sustained, and different forms of management received, are hypothesised to influence the severity of PFD symptoms reported.

Therefore, a study in real time, following bone healing, is needed to investigate if PFD symptoms are present following a pelvic fracture compared to participants' retrospective recall of their presentation preinjury, and if there is an association between pelvic fracture types, management types and PFD symptoms.

Figure 1-1 below illustrates the various topics and factors associated with this study and provides a directional flow of ideas to validate the likelihood of PFD following a pelvic fracture.

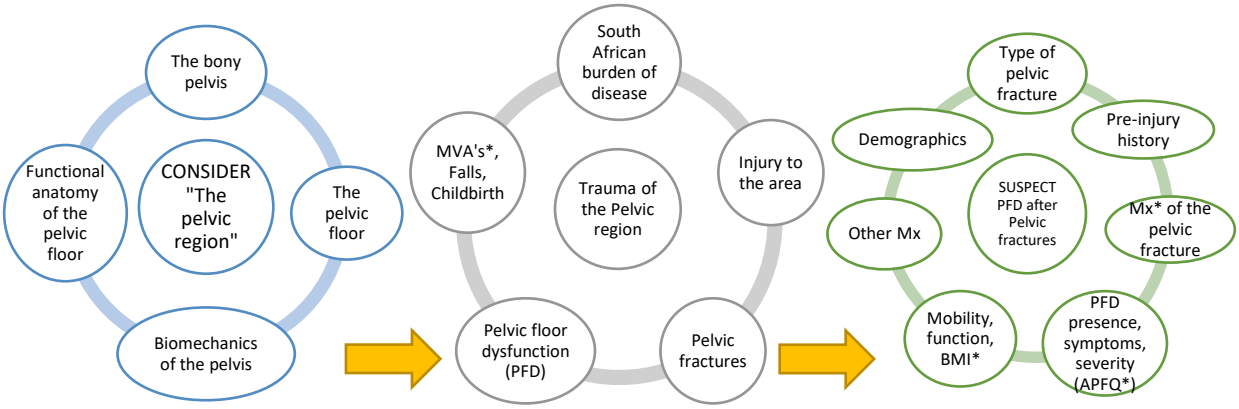


**Figure 1-1 Foundational Framework of this research study**

***Mx: management; BMI: Body-mass-index; APFQ: Australian pelvic floor questionnaire; MVA: Motor vehicle accident***

## 1.4 Research Question

What are the PFD symptoms and associated factors of PFD in female patients from two academic hospitals in Johannesburg, South Africa, three months after sustaining a pelvic fracture?

## 1.5 Aims and Objectives

The aim of this study was to determine if PFD symptoms are present at three months post pelvic fracture, and associated factors of PFD, in female patients from two academic hospitals in Johannesburg, South Africa, three months after sustaining a pelvic fracture.

The primary objective of this study was:

1. To determine and describe PFD symptoms present prior to and at three months post-pelvic fracture in female patients treated at two academic hospitals in Johannesburg

Secondary objectives were

2. To determine the demographics, preinjury medical history, injury history, types of fractures sustained, and management of these patient's post-pelvic fracture.
3. To compare symptoms of PFD present at three months post-pelvic fracture to PFD symptoms present prior to and in the subacute period post pelvic fracture
4. To determine factors (demographic variables, type of pelvic fracture sustained, the types of orthopaedic and supportive management received) associated with PFD scores.

## 1.6 Methodology

The methodology utilised for this study is discussed in Chapter 3. Briefly, this study used a quantitative pre-test, post-test same sample longitudinal study design, whereby the pelvic injury accounted as "the test". Data on PFD symptoms were collected concurrently on the Australian pelvic floor questionnaire (APFQ) from

female participants recruited from two academic hospitals after having sustained a pelvic fracture and compared to their retrospective recall of pre-injury PFD symptoms. Data regarding participants general medical history as well as pelvic fracture injury history and consequent orthopaedic management were collected through medical record review and participant questioning. Possible confounders were accounted for by measuring BMI and using the Timed-up-and-go test (TUGT). Data were analysed to detect change in APFQ scores, indicating incidence and severity of PFD, from preinjury to post-pelvic fracture, and for any associations between possible contributing factors (demographic, medical, injury and management history) and the APFQ scores and symptoms of PFD.

## 1.7 Significance

This is the first prospective study to our knowledge to research this topic in South African women after normal bone healing should occur, filling the identified gap in literature. We hoped for this research to provide insight on the presence of and contributing factors for PFD symptoms in females post pelvic fracture in a South African context. Data will hopefully guide if screening for PFD is warranted in the pelvic trauma population and if PFD is addressed in current physiotherapy management of these patients. We anticipate that it will provide guidance on which patients are at greater risk for PFD based on the fracture sustained and management received. The findings of this study may contribute to the development of policies and guidelines for the management of pelvic fracture patients in a South African context, components to be added to the current physiotherapy management of these patients, and the need for a biopsychosocial, multidisciplinary approach to the management of female's post-pelvic fracture.

## 1.8 Outline of this Dissertation

Figure 1-2 provides an outline of what is covered in each chapter of this dissertation. The first chapter outlined the link between PFD and pelvic fractures and the need for further research in this area. A problem statement was formulated, and a hypothesis generated for this study. Chapter 1 highlighted the research question, aims and objectives. It concludes with the potential significance of this study.

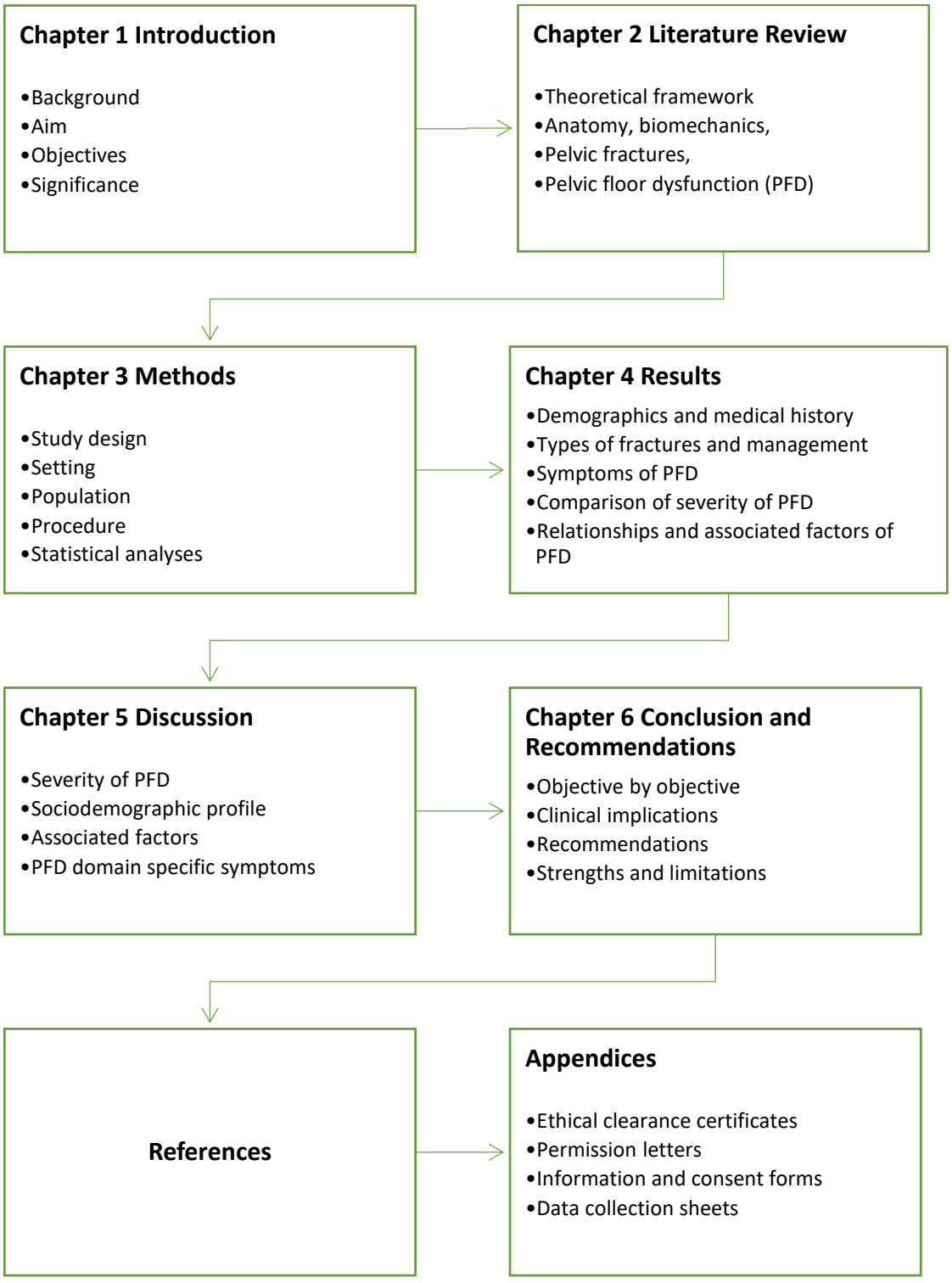


**Figure 1-2 Outline of the dissertation**

# Chapter 2 Literature Review

## 2.1 Introduction

Pelvic floor dysfunction (PFD) is a broad concept, affects multiple age groups and affects quality of life (QoL) of those suffering from it. Following a pelvic fracture, patients may think it is normal to have PFD, because of not being informed that it is a problem, and that it can be managed. Consequently, they may not seek help, thinking it is irrelevant, due to fracture healing being prioritised. Due to no definitive mention of screening for PFD in orthopaedic literature, I performed an informal interview with the orthopaedic pelvic and trauma surgeons at Chris Hani Baragwanath Academic Hospital (CHBAH) and Charlotte Maxeke Johannesburg Academic Hospital (CMJAH) on their focus in the wards and at outpatient department (OPD) follow-ups, and learnt that reviewing x-rays, patients' mobility, range, pain, and weight bearing were their routine focus without screening for PFD. Noting the foundational framework as presented in Figure 1-1, Figure 2-1 below depicts the continuous and interrelated concepts explored throughout the dissertation.

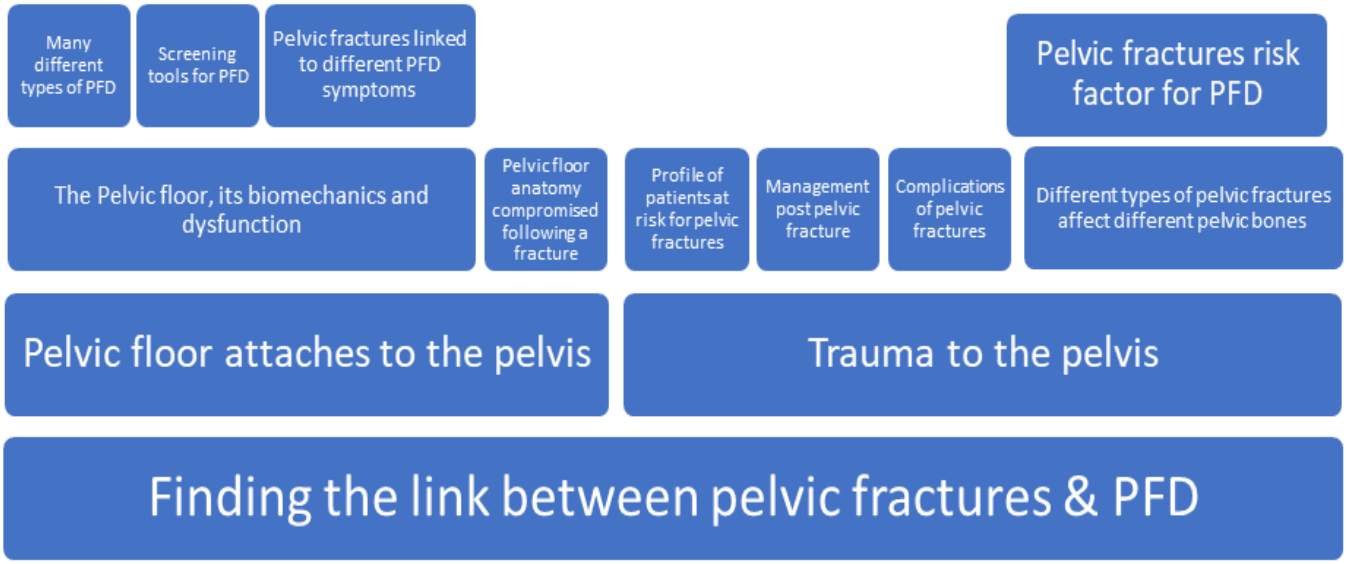


**Figure 2-1 Continuous and interrelated concepts discussed.**

***PFD: Pelvic floor dysfunction***

The literature review below will therefore explore the definitions, classifications, epidemiology and risk factors of PFD and pelvic fractures and then use the anatomy

and biomechanics of the pelvis and pelvic floor to explore how pelvic fractures can be a risk factor for PFD. It is presented in-line with the objectives of the study.

## 2.2 Search Strategy

The following electronic databases were searched for relevant literature: (1930 to March 2024, with majority between 2014 to 2023), Medline/PubMed, PubMed central, Wits libguides, Research Gate, Sage journals, Google Scholar, SpringerLink, SAJP, SAOJ, Wiley online library and the Science Direct Database. All types of study designs, quantitative and qualitative were included in the review. The search was limited to studies published in English. Peer reviewed research articles and textbooks were reviewed. The keywords used to channel the search were: pelvic fractures, pelvic floor dysfunction, orthopaedic urogenital injuries, pelvic floor dysfunction post pelvic fractures, pelvic anatomy, pelvic fracture management, health related QoL, physiotherapy, rehabilitation, barriers, South Africa, trauma. The reference lists in studies and review articles were also considered. South African government websites were also used to search for statistics specific to this study.

## 2.3 Introduction to the presence of pelvic floor dysfunction post-pelvic fracture in females

Limited research is available on PFD post pelvic fracture in females. The literature tends to use inclusive words like “urogenital/ urological” injuries to discuss such phenomena and does not specify PFD symptoms (Dincer and Ozturk, 2021; Sobantu et al., 2017, 2023). Previous research showed that patients who sustained a hip fracture, had PFD symptoms (Ohishi et al., 2012; Schimpf and Tulikangas, 2005; Skelly et al., 1992; Sørbye and Grue, 2013; Trads and Pedersen, 2015a). Of the available literature, the following key findings were found on the presence of PFD post-pelvic fracture:

A retrospective study by Baessler, Bircher and Stanton (2004) found that following pelvic trauma, women presented with bladder symptoms, bowel problems, and/or sexual dysfunction. A survey of 24 women who endured unstable pelvic fractures revealed a 67% prevalence of PFD (Welk et al., 2015). Patients with a pelvic fracture were at a higher risk of requiring a surgical procedure for stress urinary incontinence

(SUI) and required the surgery sooner compared to individuals who did not sustain a pelvic fracture (Welk et al., 2015). Hence indicating that pelvic fractures could be a risk factor for PFD. Later studies almost always cited these two studies, and their results continued to support this identified risk for PFD, as discussed throughout this chapter.

Studies by Welk *et. al* (2015) and Laycock and Holmes (2003) indicate that impairments may only manifest after discharge from acute hospital setting because of disruption of the ligamentous and neurovascular structures which are essential to the function of the pelvic floor. Disruption of these structures alone, may result in a higher risk of SUI or pelvic organ prolapse (POP) up to five years following the pelvic fracture even if the patient did not sustain a direct genitourinary injury (McConnell et al., 2020; Welk et al., 2015). The recent study in Pretoria, South Africa, done in patients two years to seven years four months post-pelvic fracture, found that urinary dysfunction (inclusive of urgency, urgency incontinence, increased frequency, discomfort with voiding and dysuria) was experienced in almost half of the participants, with males affected more than females (Sobantu et al., 2017). A fifth of their (Sobantu et al., 2017) participants also reported bowel dysfunction presenting as constipation and incomplete emptying, which is consistent with findings from Baessler et al. (2004). In McConnell's (2020) study, done in Australia, PFD was detected long after the orthopaedic injury had healed indicating that spontaneous resolution would not be expected, and that the patients would no longer be attending out-patient services. However, women who complain of PFD cannot be considered as being fully rehabilitated following pelvic trauma (McConnell et al., 2020).

Specific findings of McConnell et al. (2020) included significant changes in storage symptoms of urinary frequency greater than once per week, frequent SUI, voiding symptoms of poor urinary stream and straining to void as well as difficulties associated with bowel dysfunction. Although having a majority (63%) of male participants, this study's findings showed that a screening process for PFD in the pelvic trauma population and targeted rehabilitation interventions are justified.

## 2.4 The pelvic floor and its dysfunction defined

The pelvic floor can be seen as an intricate mesh made of ligaments, muscles and tendons which is pierced by the urethra, vagina, and the anus (Chaudhry, Nahian,

Chaudhry, 2018; Corton, 2005; Easley et al., 2017; Guthrie et al., 2010; Jorge and Bustamante-Lopez, 2022; Kotarinos, 2016; Lucente et al., 2017). The pelvic floor also comprises of a complicated and interdependent neuronal system for innervation, and a variety of connective tissue (Egorov et al., 2022; Jorge and Bustamante-Lopez, 2022; Lucente et al., 2017; Rossetti, 2016). These muscles are deeply located in the pelvis, making it difficult and invasive to be studied. Investigations have primarily relied on clinical examination, imaging, and computational modelling (Burnett et al., 2020).

PFD refers to conditions where these muscles, ligaments, and connective tissues in the pelvic region do not function properly. It is defined as variable weakness of the pelvic floor support structure with or without the displacement of the pelvic organs resulting in a series of syndromes affecting the position and function of the pelvic floor and pelvic organs (Li and Tian, 2021). PFD is a silent problem, of which only those living with it, understand its true magnitude (Parente et al., 2008).

### 2.4.1 Types of pelvic floor dysfunction

Table 2-1 highlights the common symptoms and types of PFD in females relevant to the anatomy or bodily system (based on information from (Brandt and Janse van Vuuren, 2019; Burnett et al., 2020; Chen, 2007; Haylen et al., 2010; Li and Tian, 2021)).

The field of PFD is slowly becoming acknowledged and explored with standardized use of terminology; unfortunately, there are still many differences in the definitions used in clinical practice and in research (Kenne et al., 2022). The most recent definitions of the types of PFD discussed in this paper are listed in the nomenclature according to the IUGA terminology (Haylen et al., 2010; Rogers et al., 2018). PFD is the umbrella term for a broad spectrum of symptoms and diagnosis. Some symptoms are often overlooked as a diagnosis (Chen, 2007). The dysfunction of the pelvic floor can lead to a wide and varied group of issues impacting continence, normal defecation, bowel emptying vs storage, sexual activity or causes perineal pain (Neville, 2020; Silviera and Keller, 2019; Whiteside and Muffly, 2013). Hence, PFD symptoms are commonly clustered under the five domains of dysfunction mentioned in 1.1.1 (bladder, bowel, vagina/ POP, sexual, and pain domains) (Baessler et al., 2009; Kenne et al., 2022; Whiteside and Muffly, 2013).

**Table 2-1 Types of pelvic floor dysfunction in females according to body systems**

**(Brandt and Janse van Vuuren, 2019; Burnett et al., 2020; Chen, 2007; Haylen et al., 2010; Li and Tian, 2021)**

| **Urinary system** | **Bowel system** | **Vaginal and Sexual system** | **Pelvic system** |
|---|---|---|---|
| Stress urinary incontinence (SUI) | Constipation | Vaginismus | Pelvic pain |
| Urinary urgency incontinence | Difficulty with defecation | Vulvodynia | Pelvic organ prolapse (POP) |
| Mixed incontinence | Faecal incontinence | Vestibulodynia | Uterovaginal prolapse |
| Urgency | Straining | Vaginal vault prolapse | Rectal prolapse |
| Frequent urination | Haemorrhoids | Pain with penetration | Bladder prolapse |
| Overactive bladder | Fissures | Difficulty with penetration | |
| Urinary retention | Abscess | | |
| Voiding difficulty and incomplete micturition | Obstructive bowel dysfunction | Coital incontinence – leakage during penetrative sex | |
| Dysuria | | SUI during sex | |
| Polyuria vs oliguria | | Climacturia - leakage at the time of orgasm | |
| Urinary obstruction | | | |
| Painful urination | | | |

### 2.4.2 Epidemiology of pelvic floor dysfunction in the general population

Millions of women around the world develop PFD (Kebede et al., 2023). Globally, literature shows vaginal birth trauma with urinary incontinence to be the most prevalent form of PFD in females (found in one in every three parous women) (Shi et al., 2016). There is limited but growing urogynaecology and physiotherapy literature on the epidemiology of PFD in South African women. Most available literature found were either focused on POP, urinary incontinence, PFD following pregnancy and/or childbirth, or cases of malignancy and surgery; or were done in women who were pregnant, postpartum or visiting gynaecology clinics which does not allow for accurate estimates of prevalence in the general population.

Studies in Western Cape, South Africa, found urinary incontinence to be prevalent in 27.5% of non-pregnant females working at a University (indicating non-pregnancy related symptoms) (Bailey et al., 2010) and in 28.2% of females who access primary healthcare (Jacobs, 2017). Patients with lower urinary tract symptoms have been found to have a higher prevalence of constipation compared to the overall population (Chen, 2007). Pelvic pain in females has a 3-25% prevalence rate (Ayorinde et al., 2015; Prather et al., 2007). Reports of POP globally vary greatly from 3 to 50% (Aiyegbusi et al., 2023; Brandt & Janse van Vuuren, 2019; Nygaard et al., 2013; Persu et al., 2011). The prevalence of other relevant PFD symptoms is discussed in-context throughout this study.

It is difficult to comment on the exact incidence and prevalence of different forms of PFD in one individual as studies frequently focus on only one type of PFD, or because patient's seeking help for one symptom may not disclose other symptoms.

Although pregnancy and vaginal delivery are the primary factors contributing to PFD, PFD prevalence in nulliparous women is 8-32% (Brandão et al., 2015; Parente et al., 2008; Ackah et al., 2022), A recent cross-sectional study done in Nigeria, showed a prevalence of 25.63% bladder, 53.75% bowel, 1.88% prolapse, and 23.13% sex related PFD in female college students who have never been pregnant (nulligravida). This is one of very few studies that investigated the full spectrum of PFD in non-institutionalized females. Their findings showed that 73.1% of nulligravida college students had at least one of the PFD assessed on the APFQ (Aiyegbusi et al., 2023). This is notably different to the 31.4% prevalence of PFD in community based women in Southern Ethiopia (Kebede et al., 2023). However, in the latter study, PFD was only assessed in response to questions about urinary incontinence, POP and FI, whereas the APFQ covers multiple dysfunctions in bladder, bowel, prolapse and sexual domains. This supports the view that the inconsistency in which PFD symptoms are assessed, and terminology used to describe the various symptoms clinically and in the literature is a significant contributor to the scarcity of detailed reporting on PFD epidemiology (Haylen et al., 2010; Kenne et al., 2022).

### 2.4.3 Tools used for screening for pelvic floor dysfunction

The use of standardized outcome measures for identification and assessment of PFD symptoms can assist in addressing PFD and providing rich data.

When screening for PFD in women with and without pelvic pain, multiple factors need to be evaluated and screened for. Questionning should include urinary incontinence or FI, bladder and bowel emptying habits, frequency and straining during urination or defecation, and dyspareunia (painful intercourse). Additionally, dysfunction related to performing daily activities, previous trauma or surgery, and menstrual history should also be considered during the evaluation process (Aiyegbusi et al., 2023; Brandt & Janse van Vuuren, 2019; Isidori et al., 2010; Janse van Vuuren et al., 2023; McConnell et al., 2020; Prather et al., 2007; Rogers et al., 2018).

PFD can be screened for using different standardized tools. These include but are not limited to:

- Pelvic Floor Distress Inventory (PFDI) and its short form (PFDI-20) which are recommended as grade A tools for assessing PFD and consist of three scales – Pelvic organ prolapse distress inventory 6 (POPDI-6), Colorectal-anal distress inventory 8 (CRAD-8) and Urinary distress inventory 6 (UDI-6) (Barber et al., 2005). These tools only focus on POP, bowel, and bladder dysfunction.
- Pelvic Organ Prolapse Quantification (POP-Q) which describes and helps staging prolapse and pelvic support (Persu et al., 2011).
- Female Sexual Function Index (FSFI) which assists with screening for and diagnosing sexual dysfunction in females (Rosen et al., 2000).
- Pelvic Floor Impact Questionnaire (PFIQ-7) assesses the impact that PFD has on different areas of one's life but does not include impact of sexual dysfunction (Barber et al., 2005).
- Short Personal Experiences Questionnaire assesses for experience and impact of sexual dysfunction (Dennerstein et al., 2001).
- Australian Pelvic Floor Questionnaire (APFQ) which assesses for bladder, bowel, and sexual dysfunction as well as POP (Baessler et al., 2009).

Poor sexual health post pelvic fracture is found to be a prevalent issue in recent research (Sobantu et al., 2017). The APFQ is one of the few comprehensive screening tool to include female sexual health screening questions along with bladder, bowel and POP domains (Lin et al., 2017). Although relatively long compared to the PFDI-20, it takes less time to administer then combining the PFDI-20 and FSFI. The APFQ covers the questions asked in the PFDI-20 but uses more direct layman terms. APFQ was the

tool used in the Australian study by McConnell et al. (2020) that researched PFD following a pelvic fracture and guided the way Baessler et al. (2004) reported their results. Section 3.4.2 contains details on how the APFQ is scored, and the reliability and validity of the tool.

### 2.4.4 Impact of pelvic floor dysfunction

The literature, regardless of variation in terminology used, consistently shows that PFD significantly impacts women's QoL (Bilgic et al., 2019, 2019; Brandt & Janse van Vuuren, 2019; Carroll et al., 2022; Kenne et al., 2022; Skaal & Mashola, 2011; Verbeek & Hayward, 2019). For women with POP, improving QoL is the primary motivation for seeking treatment (Brandt & Janse van Vuuren, 2019; Carroll et al., 2022; Srikrishna et al., 2008). PFD and pelvic fractures result in substantial financial burdens for victims and their families, productivity losses, and increased rates of disability (Ferede et al., 2021). PFD affects overall physical and emotional wellbeing, influencing bladder and bowel control, sexual comfort, and pregnancy experiences. This leads to mental health concerns, including fear (of urinary or faecal leakage, pain, or discomfort during sexual intercourse and other activities), anxiety, depression, and reduced self-esteem. Consequently, women may avoid social events, travel, sexual activity, and certain daily activities and exercises, placing a burden on relationships, work, and social participation if left unaddressed (Bilgic et al., 2019; Brandt & Janse van Vuuren, 2019; Prather et al., 2007; Sobantu et al., 2017; Sologuren-García et al., 2024).

### 2.4.5 Management of pelvic floor dysfunction

The management of PFD typically involves a personalised, biopsychosocial and multidisciplinary approach (Ferrari et al., 2023), involving interdisciplinary collaboration, aimed to alleviate symptoms, improve QoL and enhance functional ability. Conservative management is first line of treatment and includes a combination of pelvic floor muscle training (PFMT), manipulations, behavioural modifications and lifestyle changes, pharmacological interventions, use of devices and equipment, alternative therapies, and most importantly patient education and support. When conservative management fails, surgery is considered following multidisciplinary meetings (Bo et al., 2017; Brandt and Janse van Vuuren, 2019; Davis, 2010; Ferrari et

al., 2023; Garrington et al., 2020; Grimes and Stratton, 2024; Malaekah et al., 2019; NICE, 2021; Torosis et al., 2024; Wallace et al., 2019; Xu et al., 2023). Table 2.2 provides a synopsis of most biopsychosocial options recommended and used to manage the variety of PFD symptoms.

The stigma, embarrassment and misconceptions regarding PFD diagnoses and related treatment prevent women from seeking medical advice (Bhattarai and Staat, 2018; Cox et al., 2021; Hambisa et al., 2023; Kenne et al., 2022) which is why awareness building and health education is fundamental in the prevention and management of PFD (Cox et al., 2021; Grimes and Stratton, 2024; NICE, 2021). For those that do seek medical care for pelvic floor related pain and dysfunction, complaints are commonly overlooked (Prather et al., 2007) or the causes often misdiagnosed and managed poorly (Zinn, 2015). Therefore, a thorough assessment is essential prior to choosing management (Melanie et al., 2018; NICE, 2021; Rogers et al., 2018). Physiotherapists, in South Africa, who complete postgraduate courses in pelvic and women's health are trained in comprehensive subjective assessment taking and physical assessments of the pelvic floor and surrounding biomechanic structures. Bø (2012) showed that physiotherapy has grade 1, level A evidence for effective management of PFD.

Despite emerging PFD research and increased practitioner awareness supporting the efficacy of physiotherapy, only 14.78% of practitioners refer patients to physiotherapy for PFMT (Janse van Vuuren et al., 2023). New 2024 guidelines for the management of PFD associated with high-tone pelvic floor muscles, unanimously agree that pelvic floor physiotherapy should be the first line of treatment for a minimum of six to eight weeks (Torosis et al., 2024). This is synonymous with previous and recent research on PFD, regardless of pelvic floor muscle tone, whereby conservative management, consisting of PFMT is first line of treatment (Ferrari et al., 2023; NICE, 2021). Regimens of PFMT is important in preventing and managing disorders of the pelvic floor during pregnancy, after delivery, for managing POP, urinary incontinence, FI, overactive bladder symptoms, SUI, sexual dysfunction and associated PFD symptoms (Bo et al., 2017; Bø, 2012; Bø et al., 2022; Frota et al., 2018; Garrington et al., 2020; Grimes & Stratton, 2024; Janse van Vuuren et al., 2023b; Laycock & Holmes, 2003; Malaekah et al., 2019; NICE, 2021; Ptak et al., 2019; Torgbenu et al., 2021, 2021; Wang et al., 2023; Zhu et al., 2022).

## Table 2-2 Overview of biopsychosocial approaches to the management of pelvic floor dysfunction

(Bo et al., 2017; Bø et al., 2022; Davies et al., 2008; Davis, 2010; Ferrari et al., 2023; Frota et al., 2018; Garrington et al., 2020; Grimes & Stratton, 2024; Hemaly et al., 2014; Laycock & Holmes, 2003; Malaekah et al., 2019; NICE, 2021; Nixon et al., 2021; Ptak et al., 2019; Rajamaheswari et al., 2013; Torgbenu et al., 2021; Torosis et al., 2024; Wallace et al., 2019; Wang et al., 2023; Xu et al., 2023; Yeo, 2019)

| **Behavioural modifications** | **Pharmacological interventions** | **Devices and equipment** | **Surgery** | **Alternative therapies** | **Physiotherapy and manipulations** |
|---|---|---|---|---|---|
| Diet changes (fibre intake, reduce caffeine, alcohol) | Anticholinergics | Self-intermittent catheterisation | Repair of pelvic organ prolapse or enterocele repair | Psychology including cognitive behavioural therapy | Breathing exercises (Diaphragmatic, deep breathing, breathe to poo) |
| Weight loss | Antispasmodics | Pessaries | Laser | Yoga | Joint mobilisation |
| Fluid intake (volumes, type, and timing) | Alpha- and alpha-adrenergic blockers | Intravaginal support devices | Mid-urethral slings or Pubovaginal slings | Qi gong | Pelvic floor manual therapy, trigger point and myofascial release |
| Toilet positioning | Topical Estrogen | Pelvic wands | Levator ani muscle repair | Yoni Balms | Pelvic floor relaxation exercises |
| Bowel habits | Laxatives | Dilators | Artificial urinary sphincter | Meditation | Pelvic floor strengthening exercises |
| Bladder retraining | Stool softeners | Electrical stimulation devices | Botulinum toxin injections | Acupuncture | Pelvic floor biofeedback |
| Self-intermittent catheterisation | Nonsteroidal anti-inflammatory drugs | Continence products | Vesicovaginal fistula repair | Mindfulness based interventions | Electrical stimulation |
| Using lubrication | Antidepressants | | Rectovaginal fistula repair | Herbal supplements | Core muscles training |
| Positions during sex | Phospholipase (PDE inhibitors) | | Sacral neuromodulation (InterStim) | Acupressure | Relaxation techniques and stress management strategies |
| Foreplay | Botulinum toxin injections | | Vestibulodynia excision/ vestibulectomy | Chiropractic care | Gait and balance training |
| Birth positions | Bulking agents e.g. Solesta | | Colostomy/Ileostomy | | Education on bladder, bowel and sexual habits, posture, pain neuroscience and body mechanics |
| Smoking cessation | Beta 3 agonists | | Perineoplasty | | Dry needling |
| | Analgesics | | Pelvic floor reconstruction | | Patient splinting |

## 2.5 Pelvic floor attaches to the Pelvis

The bony pelvis and pelvic floor are intimately connected as noted in Figure 2-2. The connective tissue of the pelvis (ligaments and fascia), the PFM's and the pelvic organs attach to the bony pelvis and are ultimately supported by it (Corton, 2005; Easley et al., 2017; Jorge and Bustamante-Lopez, 2022; Kotarinos, 2016). The pelvic bones are stiffer than pelvic tissues and serve as rigid points for attachment (Bhattarai and Staat, 2018). The sacrospinous and sacrotuberous ligaments attaches the pelvic floor to the bony pelvis (David et al., 2017). Section 2.9 provides a detailed account of the various attachment points and relates it to areas of pelvic fractures and subsequent PFD.

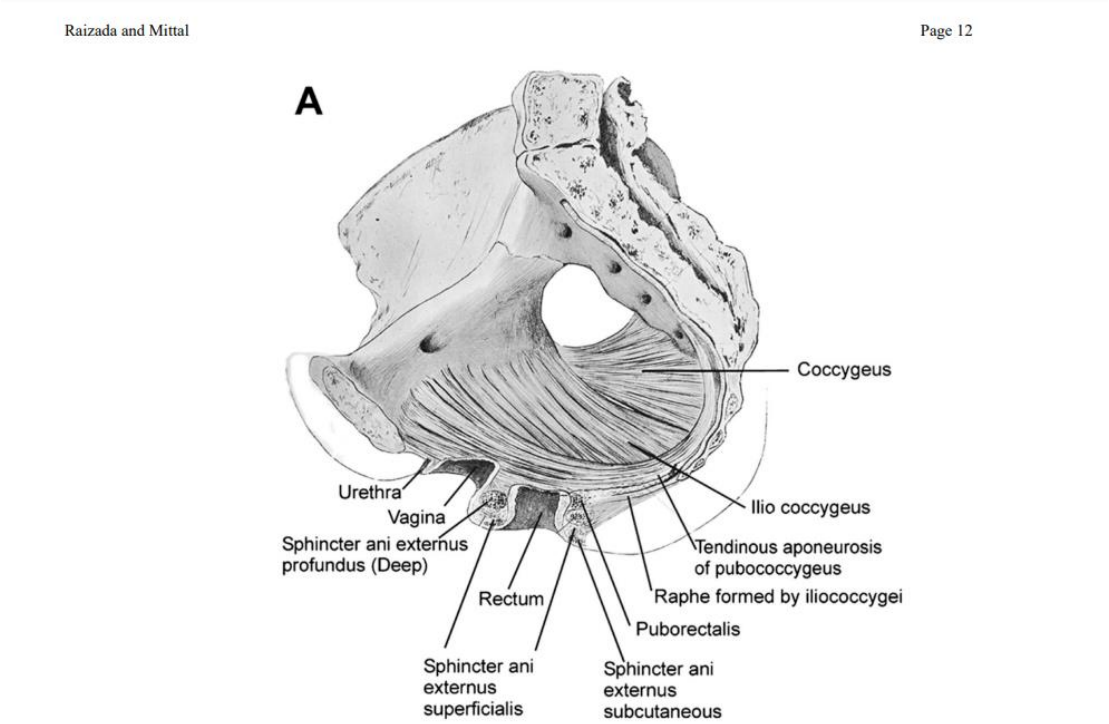


**Figure 2-2 Mid-sagittal section of the pelvis showing the pelvic floor muscles attached to the pelvis (Raizada and Mittal, 2008).**

## 2.6 The Pelvis and Pelvic Fractures

The pelvis, of key importance to a woman's proximal core stability complex, plays a role in the neuromuscular, proprioception, locomotor, reproductive, lymphatic, digestive and excretory body systems (Chaudhry, Nahian, Chaudhry, 2018; Corton, 2005). The female pelvic skeleton and its mechanisms are responsible for balance, support, the transmission of weight from the trunk and upper limbs to the lower limbs, as well as creating a protective cavity for containing and supporting its visceral

((urogenital) gynaecological and urologic organs, components of the gastrointestinal tract (GIT)), neurovascular and fascial structures (Jorge and Bustamante-Lopez, 2022; Coccolini et al., 2017; Corton, 2005; Schimpf and Tulikangas, 2005; Guthrie et al., 2010). The pelvis provides a route for urination, defecation and birthing an infant (Schimpf and Tulikangas, 2005).

Pelvic damage is uncommon as the pelvis is a distinctly stable structure, owing to the pelvic ring's mechanical and structural integrity (David et al., 2017). Consequently, high impact force is required to cause damage to the pelvis.

### 2.6.1 Trauma to the Pelvis: Pelvic Fractures

High-impact trauma leads to probable fractures of the pelvis and additional bodily injuries (David et al., 2017; Ferede et al., 2021; Mbatha et al., 2023; Palmprints et al., 2012; Zingg et al., 2021). Pelvic fractures have a global incidence of 3-8% of all fractures and accounts for approximately 3% of all skeletal injuries (Ferede et al., 2021; Zingg et al., 2021). The main mechanisms of injury for pelvic fractures have high energy disruptions, with major blunt force resulting in acute pelvic injury (Ashkal et al., 2021a). Pelvic trauma can also occur over time like in cases of avulsion fractures. In the elderly or patients with osteoporosis, low energy trauma can also result in pelvic fractures (Ashkal et al., 2021; David et al., 2017; Ferede et al., 2021; Palmprints et al., 2012; Zingg et al., 2021). An example of osteoporotic pelvic fractures are Low Energy Acetabular Fractures (LEAFs)(Gebre, 2021).

There is an increase in the number of hip and pelvic fractures found on MRI in occult hip fractures, or patients presenting with symptoms of a possible hip fracture but with negative plain radiographs. Ohishi et al. (2012) found occult pelvic fractures in patients presenting with symptoms of hip fractures; these included pubic ramus, ischium, sacrum, and acetabulum fractures. Pelvic fractures rarely occur in one site only. Ohishi et al. (2012) found 75% of cases had fractures on multiple areas of the pelvic ring, with an average of 2.64 pelvic fractures per patient. A significant 89.2% of patients with pubic fractures had at least one other fracture on the pelvic ring.

### 2.6.2 Mechanism of injury and Risk factors leading to pelvic fractures in South Africa

High impact mechanisms include blunt trauma such as motor vehicle accidents (MVA), pedestrian and bicycles hit by vehicles (PVA), as well as falls from great heights (Ferede et al., 2021; Palmcrantz et al., 2012; Zingg et al., 2021). Low impact includes any fall in the elderly. The most common cause in lower-middle-income countries (LMIC) is predominantly from road traffic accidents (RTA) (MVA's and PVA's), followed by falls from height and gunshot bullet injuries (Verma et al., 2020) which are applicable to South Africa, regardless of South Africa's recent classification as an upper- middle income country (Sobantu et al., 2023).

Although pelvic fractures are uncommon, the causes of pelvic trauma like RTA and falls, are common, with the pelvis and lower limbs being most vulnerable. RTA's remain high in South Africa placing the population at risk for pelvic fractures (OECD et al., 2019). Trauma is a major burden of disease in South Africa, similar to other LMIC's (Mbatha et al., 2023; South Africa and National Planning Commission, 2012). A study by Hardcastle et al. (2016) stated that trauma accounts for much of the emergency centre workload in South Africa, making up 25% of KwaZulu-Natal public hospitals emergency workload. Pelvic fractures usually occur in polytrauma patients (Ashkal et al., 2021; Khanna et al., 2012; Sadeghpour et al., 2019) with nearly 20% of polytrauma patients sustaining a pelvic injury (Sadeghpour et al., 2019).

### 2.6.3 Factors contributing to patient outcomes post pelvic fractures

Pelvic fractures are also associated with many complications, some of which are discussed in section 2.82.8. The severity of the fracture, type of treatment received, associated trauma and complications related to the pelvic fracture influences the presence of late morbidity (Verma et al., 2020). LMIC have other factors that influences patient profiles and outcomes. These factors include higher prevalence of communicable and non-communicable diseases (such as human-immuno-deficiency virus (HIV), diabetes, hypertension, anaemia), delays in time taken for imaging due to low ratio of imaging equipment to patients, longer waiting times for surgery due to high patient loads or competition for obstetric and medical emergencies, staff shortages, and electrical and water outages affecting care and surgery, among other resource

limitations (Ashkal et al., 2021; Hardcastle et al., 2016; Laher et al., 2019; Sobantu et al., 2023).

Figure 2-3 provides key deductions of sections 2.3 to 2.5.

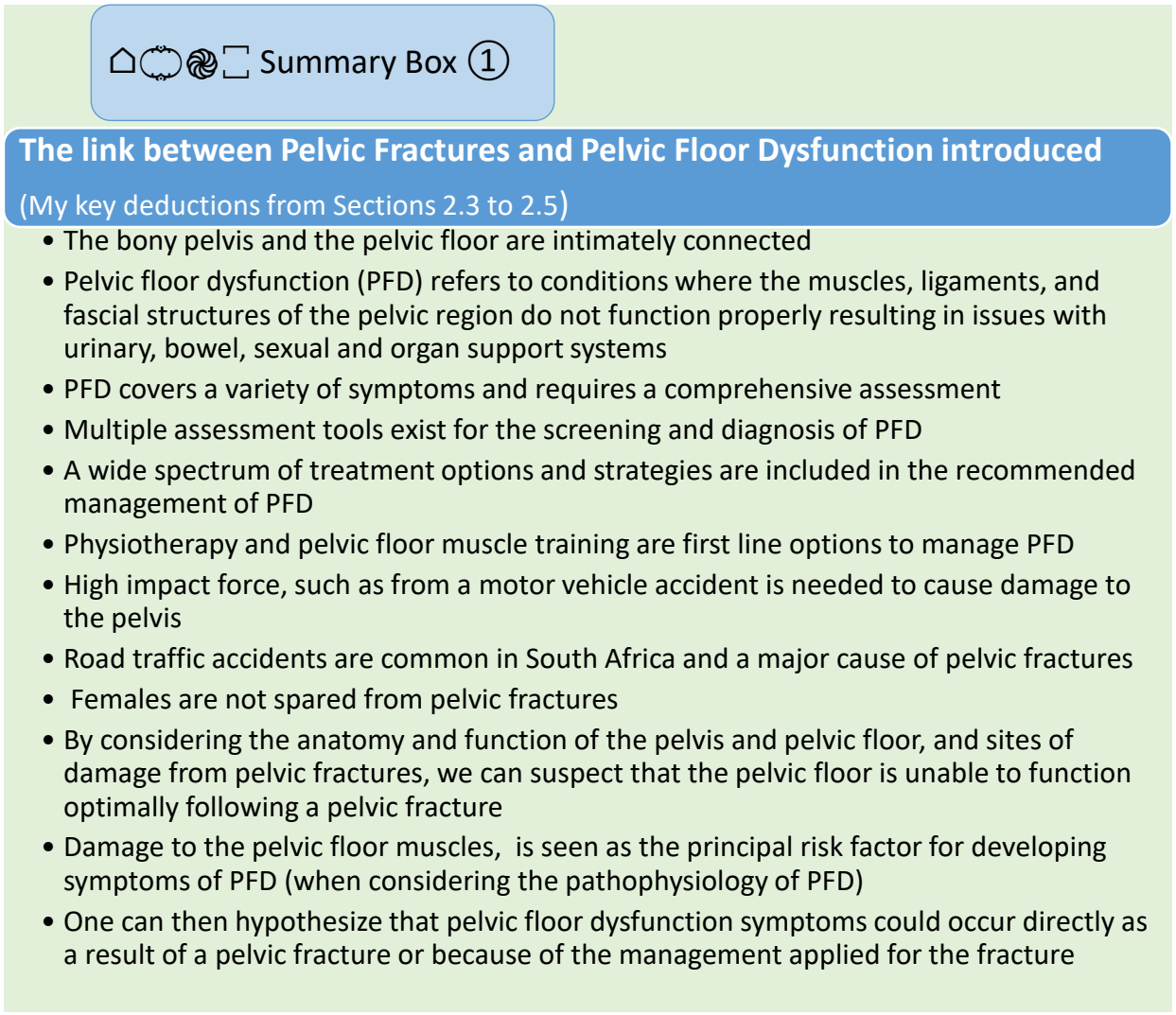


**Figure 2-3 Summary box 1: The link between Pelvic Fractures and Pelvic Floor Dysfunction introduced.**

## 2.7 Profile of victims of pelvic fractures and pelvic floor dysfunction

With MVA's and falls the predominant cause of pelvic fractures, patients at risk and victims of pelvic fractures are often young and sexually active (Odutola et al., 2012), or older and at risk of weaker PFM's. Ferede et al. (2021) found a high ratio of primarily young (15-35 years) males to females (7:1 ratio male to female) with pelvic fractures. This is similar to a study by Mbatha et al. (2023) who found 61% males in their

population with a mean age of 35 years. However, this does not preclude females from being at risk and victims of pelvic fractures (Ashkal et al., 2021; Baxter et al., 2005; Lee et al., 2019; Mbatha et al., 2023; Sobantu et al., 2017, 2023). Males are predominantly involved in heavy duty work and there is a higher number of male drivers than females (OECD et al., 2019; Statistics SA, 2021), placing males at higher risk for pelvic fractures. Data on trauma and fights in South Africa also report higher number of males involved in gunshot incidents (Ashkal et al., 2021b; Statistics SA, 2021) which is another cause of pelvic injuries.

Certain factors contribute to the risk for PFD including past medical and surgical history and especially birthing history/ history related to parity (NICE, 2021; Sologuren-García et al., 2024). As mentioned in chapter 1, age, obesity and parity showed statistically significant associations with presence of PFD (Carson et al., 2018; Chen, 2007; Chen et al., 2022; Kebede et al., 2023; Kenne et al., 2022; Sologuren-García et al., 2024; Wu et al., 2014). Parity is specifically associated with incontinence (Brandão et al., 2015; Parente et al., 2008; Ackah et al., 2022). The incidence of PFD increases with age making advanced age the most prevalent risk factor for PFD (Ackah et al., 2022; Bhattarai & Staat, 2018; Brandão et al., 2015; Burnett et al., 2020; Chen, 2007; Chen et al., 2022; Li & Tian, 2021). Some reasons include impaired detrusor contractility, reduced amounts of acetylcholinesterase-positive nerves and nerve axons in the detrusor muscle tissues (Bhattarai and Staat, 2018). In 2007, Chen reported that constipation was very common in the elderly, aged 65 years and older (Chen, 2007). Advanced age corresponds with women being post-menopausal; post-menopausal women report more PFD symptoms (Hambisa et al., 2023).

Since reproductive hormones play a role in preserving connective tissue (Hambisa et al., 2023; Padubidri and Daftary, 2014), it makes sense that menopausal and post-menopausal women are considered at increased risk for PFD. The postmenopausal low estrogen is associated with vaginal dryness affecting sexual function, changes in collagen, a reduction in skeletal muscle bulk, and reduced urethral blood supply, resulting in urogenital atrophy, sensory urinary symptoms and joint laxity (Frota et al., 2018; Kołodyńska et al., 2019). It is presumed that these cause disturbances in the endopelvic fascia as well. Other changes occurring during menopause that can lead to PFD, include reduced bone density increasing risk for osteoporosis, and joint laxity with resultant joint pain (Kołodyńska et al., 2019). These two are associated with gait

abnormalities, posture and speed which we can speculate to contribute to symptoms of urinary leakage. Since advanced age is a characteristic of victims at risk of pelvic fracture, we can expect them to report PFD symptoms on screening. It will be interesting to note if there is an association between the PFD symptoms and stage of menopause for our study population.

Prather et al. (2007) highlighted that BMI and Oxford scale grading of pelvic floor muscle strength are important physical examinations to perform when managing PFD. Figure 2-4 provides keys deductions of section 2.6 highlighting the profile of victims of pelvic fractures and PFD. Due to the factors mentioned, one can conclude that advanced age, vaginal delivery, weight, parity and menopause stage are factors already contributing to the presence of PFD. Hence, to appropriately determine if pelvic fractures influence the risk of PFD, these factors need to be considered as confounders. We expect higher reports of PFD symptoms among the older participants and sexual dysfunction among the younger victims of pelvic fractures.

Globally there is a higher prevalence of PFD in the primary care setting as noted in a study done in Iowa, US (Kenne et al., 2022). This corresponds with results of a study done in the regional and zonal areas (primary care settings) of Ethiopia (Hambisa et al., 2023). This Ethiopian study (Hambisa et al., 2023) found that women with less knowledge on PFD were more affected, as were those with economic constraints. The study also reported that their findings were consistent with a systematic review and meta-analysis conducted in LMIC. This implies that a higher prevalence of PFD may also be expected in South African primary care settings, as seen in the study by (Jacobs, 2017).

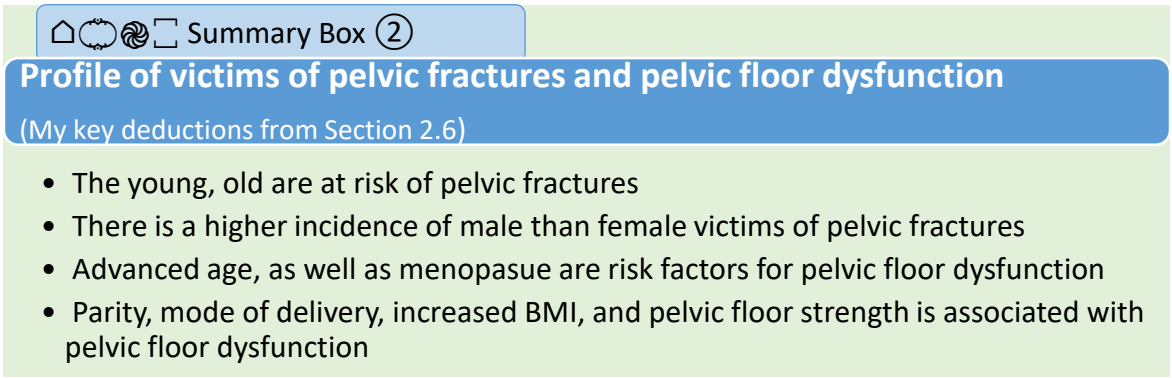


**Figure 2-4 Summary box 2: Profile of victims of pelvic fractures and pelvic floor dysfunction.**

## 2.8 Complications of pelvic fractures

Following trauma, a significant number of morbidity and mortality is linked to pelvic fractures as it is the most severe and life-threatening orthopaedic injury (Ashkal et al., 2021; Coleman et al., 2020; Ferede et al., 2021). Much of the mortality is associated with damage to multiple organs, major blood vessels and neural structures, with the fracture itself less commonly the cause of death (Ferede et al., 2021; Palmcrantz et al., 2012). Complications experienced while admitted to hospital can be divided into pelvic and non-pelvic related symptoms (Palmcrantz et al., 2012). Injuries commonly associated with pelvic fractures are peri-pelvic soft tissue, blood vessel and nerve injuries, subsequent paralysis, bladder injury, other fractures of the upper or lower extremities, or spine, followed by head and brain injuries, intra-abdominal injuries and thoracic injuries (Coccolini et al., 2017; Coleman et al., 2020; Ferede et al., 2021; Palmcrantz et al., 2012; Yang et al., 2014).

Nixon *et al.* (2021) reported that it is essential that imaging is done in patients who sustain pelvic fractures to assess bony trauma and for injury to the genitourinary tract as patients may present with symptoms of incontinence. The urinary system is vulnerable to tears and lacerations from the fractured bone fragments or the sheering forces causing the trauma (Ashkal et al., 2021a; Kong et al., 2011). This kind of trauma is documented in literature and managed with immediate or delayed reconstruction and has minimal long-term effects (Ashkal et al., 2021a; Black et al., 2006; Kong et al., 2011; Siada et al., 2017).

Patients are known to be put at risk of incontinence and PFD following pelvic trauma that results in urethral laceration (Black et al., 2006; Koraitim, 1999). A large proportion of this literature reporting on PFD post pelvic fracture is based on males. Insufficient data are available on female survivors of pelvic fractures (McConnell et al., 2020; Welk et al., 2015). Studies that looked at both genders, had a lack of representation of female participants (identified and recruited fewer females). As the bulk of pelvic fracture literature is from major trauma centres, it is expected that females with minor to moderate pelvic fractures are treated at regional hospitals, not reaching the major trauma centres, and hence not reported on, like explained by Palmcrantz et al. (2012). As mentioned in section 2.7, there is a higher incidence of pelvic fractures in males.

While male posterior urethral injuries are common after pelvic fractures, female urethral injuries are rare occurring in 0.05% of females compared to 2% males, and is likely due to the anatomy of the female pelvis and contents (Dorairajan et al., 2004; Zeffren et al., 2022). The female urethra is shorter than in males and not located externally making it less obvious to identify damage; it also places females at higher risk for vaginal injuries as opposed to urethral injury (Li et al., 2019). Sobantu et al. (2017) did not quantify the proportion of males vs females experiencing PFD symptoms or whether there was urethral laceration in females with incontinence or other PFD; additionally, there were predominantly male qualitative responses documented for PFD symptoms compared to female reports. However, their (Sobantu et al., 2017) data did show that females experience PFD post pelvic fracture. A recent study found that PFD is a common problem for female patients as reported by physiotherapists interviewed in the study (Sobantu et al., 2023).

Direct injuries to the urethra or bladder, although missed in some cases, and with a low prevalence (<6 out of 390), are often detected and addressed during the acute phase (Rajamaheswari et al., 2013; Welk et al., 2015). Radiological investigations for urogenital injuries, however, are not standard in acute trauma management and is only done in instances of obvious injury or patients complaints (Incagnoli et al., 2019). Over 40% of injuries associated with pelvic fractures are urogenital lesions, with up to 24% of patients who sustain a pelvic fracture, encountering a urethral injury and 20% a bladder laceration; vaginal and rectal lacerations are less common at 2-4% and 1-2% respectively (Tullington and Blecker, 2023). Urethral and bladder injury are often present following dislocated pelvic fractures (Milenkovic and Mitkovic, 2020). The literature is currently vague in describing what is meant by urogenital injuries and the symptoms experienced by patients. The Orthopaedic literature (Copeland et al., 1997) characterizes the functional impact that pelvic fractures have on the genitourinary system however, later studies do not include an assessment of genitourinary morbidity(Lefaivre et al., 2014). The long-term effects of damage to the pelvic floor support structures may also not be reported for years (Küpeli et al., 2001; Rajamaheswari et al., 2013).

The common neurovascular structures affected include presacral plexus, prevesical veins, internal iliac artery (anterior branches), obturator, pudendal, superior gluteal and lateral sacral arteries (Coccolini et al., 2017; Tullington and Blecker, 2023). These play

a crucial role in innervating and supplying oxygen and nutrients to the pelvic organs and muscles (Wobser et al., 2024). Thereby affecting the blood supply and venous drainage of the bladder, rectum, uterus, and external genitalia including the clitoris, the PFM's including those involved in urethral and anal closure, and the pudendal nerve (as the pudendal artery provides blood supply to the pudendal nerve which is responsible for innervation of most of the PFM's) (Jorge and Bustamante-Lopez, 2022; Kotarinos, 2016; Wobser et al., 2024). This affects the functioning of these structures and can lead to PFD as seen in detail in section 2.9. When looking at Figure 2-5 from Lee et al. (2019) below, one can note how widely located the branches of the internal iliac artery are and can consider their risk of damage with a break to any of the surrounding bones. Ileum and sacral fractures may cause most damage as the internal iliac artery can be damaged prior to branching out. Lee et al. (2019) provided an in-depth description of the various neurovascular structures and the fracture types that commonly cause damage to each structure. They noted that the superior gluteal artery and internal pudendal artery are most often affected. One can expect this especially with inferior pubic rami fractures and sacral or sacroiliac (SIJ) damage.

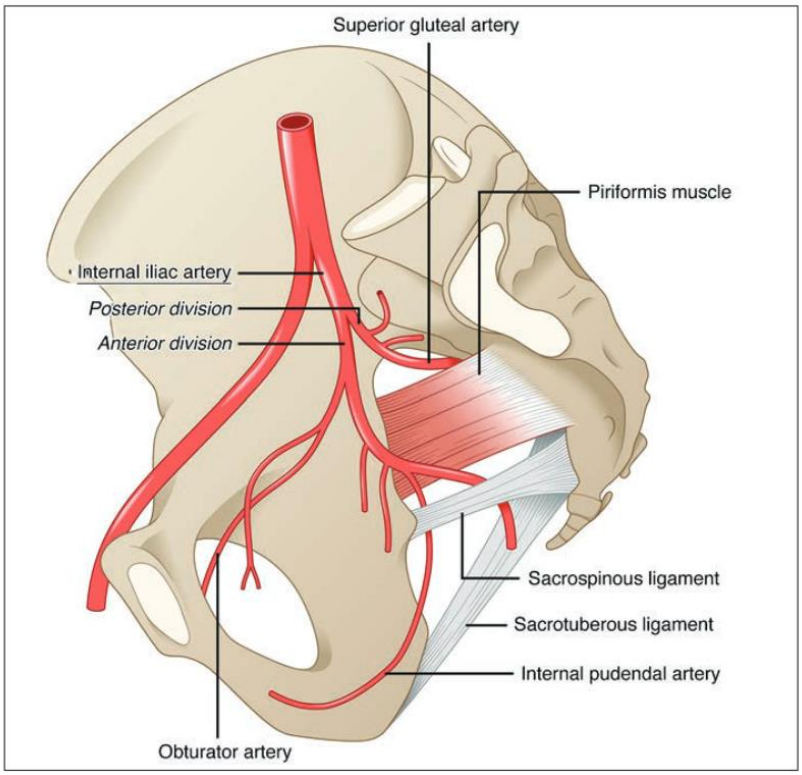


Figure 2-5 Illustration showing anatomy of the pelvic arterial system focusing on the arteries frequently injured and adjacent structures (Lee et al., 2019).

Pelvic fractures significantly affect mobilisation in patients. Gait disturbances, postural changes, chronic pain, genitourinary and/or rectal dysfunction and persistent neurological deficits are some of the long term issues faced by victims of pelvic trauma (Coleman et al., 2020; Ferede et al., 2021; Sobantu et al., 2023; Verma et al., 2020). Not being able to mobilise impacts on physical, social, psychological, and occupational health. Gait disturbances can be because of displacement of a hemipelvis causing shortening of the ipsilateral leg, or from weakness secondary to sciatic nerve or lumbar plexus injury (Verma et al., 2020). This is important to note, as gait disturbances can cause patients to take longer when trying to stand up and walk to get to the toilet causing secondary urinary leakage. This can be assessed for using the timed up and go test (Podsiadlo and Richardson, 1991; Wellmon, 2007). Associated injuries themselves can cause difficulty passing urine and stool or difficulty controlling it. The incident causing the pelvic trauma, the pelvic fracture itself and these associated difficulties can lead to psychological trauma (Ferede et al., 2021). Trauma is the third major cause of depression occurring in pelvic trauma survivors (Ferede et al., 2021). Depression is also associated with the incidence of PFD and chronic pain (Pierce & Christianson, 2015; Tinetti et al., 2018). Chronic pelvic pain was experienced in over 60% of traumatic pelvic fracture victims recruited in a study (McDonald et al., 2017;) as noted in Tullington and Blecker's (2023) book.

Damage to the nerves innervating the pelvic floor musculature, damage or weakness caused to the PFM’s themselves, the sphincters and the endopelvic fascia is not fully explored nor the resultant symptoms of PFD from what studies we reviewed. Some studies just state soft tissue injuries or urogenital injuries but there are no details on exactly what symptoms patients are experiencing. This next section will discuss how the anatomy and biomechanics of the pelvic floor and pelvic fractures can cause some of the issues mentioned above and symptoms of PFD.

## 2.9 Anatomy, biomechanics, and other predictive factors contributing to pelvic floor dysfunction following a pelvic fracture

The interaction between the anatomic structures of the female pelvic floor anatomy and their inter-related functions are among the most complex in the human body. The female pelvic floor is tasked with multiple biomechanical actions including micturition,

intercourse, pregnancy, childbirth, and defecation (Egorov et al., 2022; Lucente et al., 2017). The pelvic floor firmly supports the pelvic organs and maintains urinary and faecal continence by simultaneously counteracting intra-abdominal pressures (such as with a cough or lifting heavy objects), inertial forces and the force of gravity (Burnett et al., 2020; Easley et al., 2017). The suspension of the endopelvic fascia connected to the levator ani muscles (LAM) spanning the pelvic outlet, form the two mechanical support systems that allows for this dual function (Bhattarai and Staat, 2018; Burnett et al., 2020). Tim and Mazur-Bialy (2021) have provided a detailed review of how various factors including biomechanics, hip joint mobility and pelvic rotation can affect pelvic floor muscle contractions and PFD. They discuss in-depth the multiple functions and systems that the pelvic floor is involved in.

Through this section, one will note a) that in their origin, PFM's are integrated with the ligaments and fascia; functionally, implying that weakening of the fascial system will negatively affect the muscles ability to function and their supporting function; b) how pelvic trauma damage to these muscles and fascial systems can lead to different forms of PFD.  Figure 2-6 below provides a theoretical framework for this section.

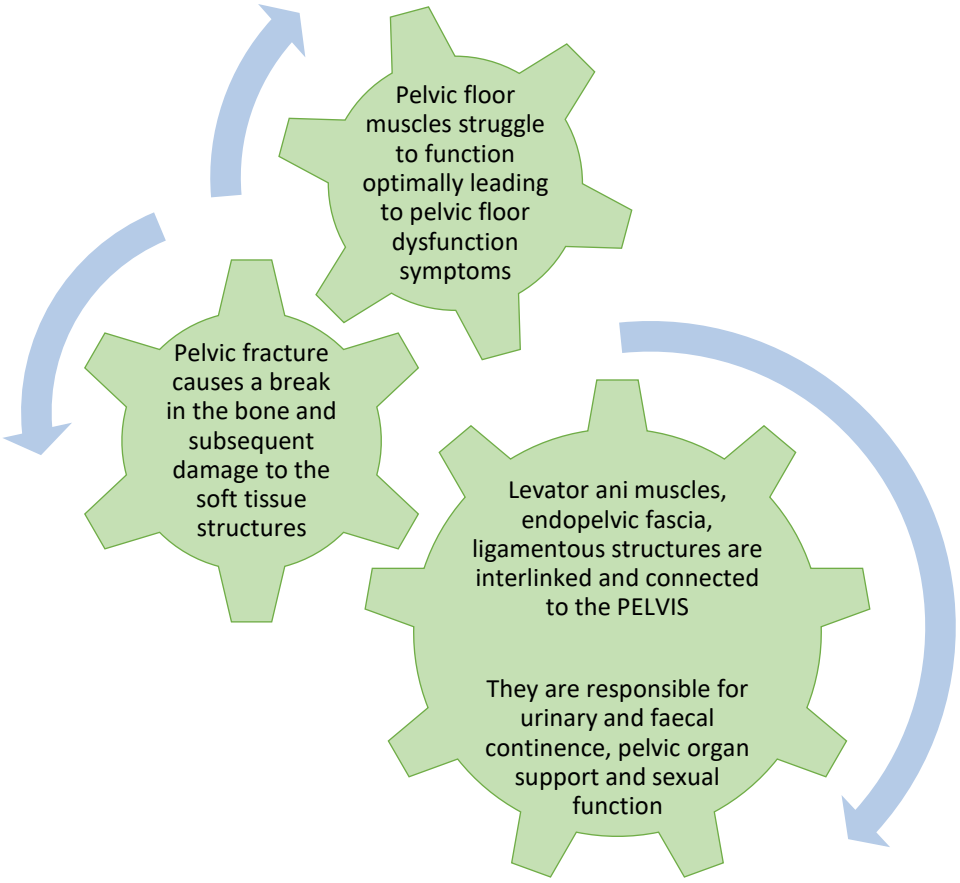


Figure 2-6 Theoretical framework of section 2.9 (start from bottom to top wheel).

### 2.9.1 Anatomy considerations of the Levator Ani Muscles and Endopelvic fascia

Figure 2-7 is a lateral view depicting the various muscles and shared originations involved in the urethral support system; Note the endopelvic fascia attachment to the levator ani muscle beside the urethra and how the levator ani muscle supports the vagina, rectum and urethrovesical neck (Ashton-Miller and Delancey, 2007).

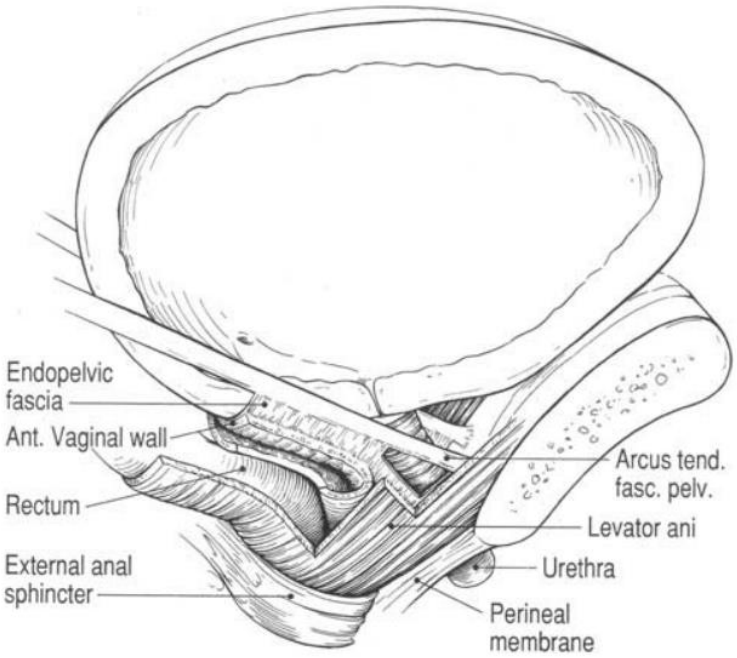


**Figure 2-7 Lateral view of the urethral support system.**

The pelvic diaphragm is formed by the correspondence between bilateral LAM, coccygeus, piriformis and obturator internus muscles (Burnett et al., 2020). These muscles will be discussed throughout 2.9. Injury to each individual part of the LAM, can result in a unique dysfunction; each part of the LAM has a unique function as each differs in its origin and insertion points (Shi et al., 2016). The LAM is formed by a combination of the puborectalis, pubococcygeus, and iliococcygeus muscles. The LAM are the main contributors to voluntary inhibition of urination and defecation (puborectalis and pubovaginalis component of pubococcygeus muscle) and supporting the pelvic viscera through elevating the pelvic floor, encouraging sphincter contraction and drawing the distal rectum and vagina forward and superiorly. It is critical in providing pelvic organ support (Fritsch et al., 2012; Raizada and Mittal, 2008) as seen in Figure 2-7. The mid-vaginal wall connects to the inside of the LAM's (pubovaginalis

component of pubococcygeus) via the endopelvic fascia, aiding in preventing the vagina moving ventrally toward the introitus during increases in intraabdominal pressures (Raizada and Mittal, 2008). These fibres contribute to urinary continence as they are responsible for the elevation of the urethra during contraction of the PFM's (Lucente et al., 2017). It is important to consider the anatomical coverage of the endopelvic fascia, which extends from the pubic symphysis (PS) to the sacrum and the ischial spine, as it provides three anatomical levels of support; laxity at each level is associated with a variety of different PFD symptoms.

Support is provided either by acting as a base or attaching the organs to other anatomical structures as noted in Table 2-3 (Bhattarai and Staat, 2018; Easley et al., 2017). Table 2-3 can help in understanding the proximity and dependence of the rectum, vagina, and urethra on the LAM and endopelvic fascia. If the endopelvic fascia is disturbed by pelvic trauma, there can be separation in the connection between endopelvic fascia and vagina, reducing the stiffness of the fascial layer that supports the urethra (Raizada and Mittal, 2008); thus can lead to SUI as well as POP and other forms of PFD (DeLancey et al., 2008; Nixon et al., 2021; Welk et al., 2015).

**Table 2-3 Endopelvic fascia levels of support, functions, and attachments**

| **Information derived from** (A. Bhattarai & Staat, 2018; Flusberg et al., 2021) | | | |
|---|---|---|---|
| **Endopelvic fascia level** | **Organ** | **Attachment site** | **Function and/or issues if level affected** |
| Level 1:<br>Uterosacral ligament complex (intermingling fibres of the cardinal/uterosacral ligament complex) | Apex of the vagina | Obturator muscle and sacrum | Laxity results in abnormal bladder emptying and uterine prolapse |
| | Cervix | Piriformis | |
| | Lower uterine segment | Coccygeus | |
| Level 2:<br>Endopelvic fascia covering the perineal muscles (perineal membrane, and pubocervical fascia) | Middle one half of the vagina | Levator ani muscles | Damage can result in Cystourethrocele, urethral-bladder hypermobility, SUI |
| | Bladder neck and urethra | Provides firm base | |
| Level 3:<br>Perineal muscles and perineal body (ischiocavernosus, bulbospongiosus, deep and superficial transverse perineal muscles) | Distal Vagina | Fuse with perineal structures | This level supports the distal vagina and maintains the anatomic position of the vagina and urethra |

### 2.9.2 Biomechanics of pelvic floor dysfunction following vaginal delivery as a predictor for dysfunction post pelvic fracture

A full understanding of the biomechanics involved in damaging neuromuscular and fascial components causing PFD postpartum is still missing (Brandão et al., 2015; Egorov et al., 2022; Lucente et al., 2017). However, more is known on pelvic floor damage from vaginal delivery than pelvic floor damage post pelvic fracture. We can only hypothesize based on available conclusions to predict how pelvic fractures may lead to PFD. Figure 1-1 in chapter 1 provides a framework on the link. The female pelvic floor soft tissues can sustain a variety of injury and trauma during vaginal delivery from varying forces of stress and strain, leading to PFD problems at some point in a women's life (Egorov et al., 2022; Lucente et al., 2017). The muscles mainly at risk of a stretch related injury during vaginal delivery is the LAM and the pubococcygeus muscles as they undergo the largest amounts of stretch and strain (Brandão et al., 2015; Parente et al., 2008). Injury of these muscles are associated with the postpartum development of urinary incontinence, FI, and POP (Hoyte et al., 2008; Parente et al., 2008).

If one assumes that the pelvic nerve and soft tissue injuries, and haematomas noted as the complications of pelvic fractures in the literature, are referring to damage to the LAM and the neurovascular structures surrounding the LAM, one can suspect the presence of involuntary urine leakage, FI and POP among other PFD symptoms following a pelvic fracture.

Pelvic fractures, trauma, and pelvic surgery are possible causes for genital scarring (Mirastschijski, 2020). Scar tissue adhesions and muscle tightness affects the elasticity of muscles (Brandão et al., 2015; Mirastschijski, 2020) which plays a role in vaginal delivery (Ashton-Miller & DeLancey, 2009). Considering the effects of scars on elasticity in relation to the biomechanics involved during labour, and the need for the PFM's to stretch, it can be expected that scar tissue adhesions and muscle tightness following a pelvic fracture may also affect the labour process in women who have experienced a pelvic fracture prior to pregnancy similar to the effects of episiotomy scars on delivery (Horak et al., 2014; Vallier et al., 2012b).

### 2.9.3 Asymmetry, tone and maintaining urinary and faecal continence in context of pelvic fractures

Pelvic fractures cause asymmetry of the pelvis depending on the rotational and vertical stability of the fracture. Urinary and faecal continence is achieved through the pelvic floor regulation of urogenital and rectal opening, which is dependent on normal muscular and connective tissue mechanical properties. However, pelvic asymmetry changes tone of the fascia disrupting pelvic floor muscle contractions. Changes in the muscle length of the muscles originating or attached to the pelvis also result in pelvic asymmetry (Easley et al., 2017; Tim and Mazur-Bialy, 2021). Normally, the muscle structures must work actively to release or apply pressure to complete specific tasks. The muscle fibres produce tonic contractions of the urethra and rectum, playing the role of bladder and anal sphincters (Chaudhry, Nahian, Chaudhry, 2018); and micturition and defecation occurs with relaxation of the PFM's (Easley et al., 2017; Egorov et al., 2022). Physiological functioning (such as controlling micturition and defecation), and muscle contractility can be affected with a decrease in PFM tone; decrease in PFM resting tone is found when there is greater laxity of the connective tissues (Egorov et al., 2022). Hence, if the endopelvic fascia is laxed, it may not allow for optimal PFM effect on the organs, as its attachment to the pelvic organs passively keeps them in correct orientation.

Table 2-4 shows a summary of the pelvic ligamentous anatomy and function. A link between SUI/POP and pelvic trauma was noted in case reports of pelvic fracture survivors (Baessler et al., 2004; Rajamaheswari et al., 2013; Welk et al., 2015). Pelvic fractures can cause ligamentous laxity leading to SUI. Laxity of the fascial and ligamentous suspension system causes pathological movement of the pelvic organs leading to involuntary urine leakage which is the aetiology of SUI (Bhattarai and Staat, 2018).

SUI is predicted with better accuracy by analysing pelvic floor deformation then urethral hypermobility. SUI in the elderly is associated with weak mid-urethra support and failed bladder neck closure (Bhattarai and Staat, 2018). In the elderly, this insufficiency is attributed to the collagen deficiency of pubo-urethral ligament, vaginal wall and LAM as well as LAM damage or denervation (Bhattarai and Staat, 2018). Intact pubo-urethral ligaments and associated muscular attachments help maintain continence by

contributing to stabilisation of the urethra to its normal anatomical position and maintaining an intact urogenital sphincter. Considering one of the pubo-urethral ligament insertion points, namely the posterior surface of each pubic bone (the other two being the vagina and urethra), displacement of and/or a break in either pubic bone could cause a break in this continuous sheet of connective tissue and affect its function.

Table 2-4 Basic summary of the pelvic ligamentous anatomy and function (derived from information from (David et al., 2017))

| **Plane** | **Ligament/s and location** | **Purpose** |
|---|---|---|
| Anteriorly | Symphyseal ligaments present between right and left pubic symphysis | Resists external rotation through the SIJ posteriorly |
| Posteriorly | Sacrospinous and sacrotuberous pelvic floor ligaments present anteriorly relative to the SIJ | Resists both shear and external rotation through the SIJ |
| | Posterior sacroiliac complex is the ligamentous structures present most posteriorly | Strongest ligaments in the body and most important for pelvic ring stability |
| | Together, the Pelvic floor ligaments and posterior sacroiliac complex | Provide stability to the pelvic ring |

### 2.9.4 Inflammation and muscle weakness secondary to pelvic fractures – risk factors for pelvic floor dysfunction

At the same time, fault in the tension of the PFM's can lead to ligament impairments and dysfunction (Tim and Mazur-Bialy, 2021).The PFM's are essentially thin muscle fascicles wrapped in connective tissue sheets as seen on MRI (Tuttle et al., 2014). This shows how vulnerable these muscles are to tears or injury. As is seen with muscle strain in other limb muscles, pelvic floor muscle strain is associated with inflammation. One of the complications of pelvic fractures are haematomas and pelvic swelling (Lee et al., 2019). Fractures causing instability of the pelvic ring can alter the haemodynamic status of the patient as the soft tissue and vascular disruptions can increase the internal volume which accelerates haemorrhage into the retroperitoneal space (Coccolini et al., 2017). Inflammation in the visceral area can trigger a protective response which increases the tone of the PFM's (Tim and Mazur-Bialy, 2021). Consistent tension in the muscles impedes local blood circulation, a leading cause of muscle fatigue,

development of tender points in the myofascial tissue and subsequent muscle failure/weakness (Enoka and Duchateau, 2008; Tim and Mazur-Bialy, 2021).

The bulbospongious (bulbocavernosus) muscle, situated superficially, near the vaginal entrance and connected to the perineal body (Jorge and Bustamante-Lopez, 2022) is important for sexual function in terms of muscle contractions, satisfaction and lubrication; increased EMG muscle activity/muscle spasm of this muscle is associated with vaginismus (Raveendran and Rajini, 2024; van der Velde et al., 2001). Considering the effects of muscle tension on blood circulation noted above, it can be expected that damage to this muscle from a fracture, causing tension in the bulbospongious muscle, may impede local blood circulation, subsequently affecting secretions of the greater vestibular gland, blood flow to the body of the clitoris, and cause sensory disturbances. These may cause allodynia around the clitoris and muscle spasm leading to dyspareunia and vaginismus.

Continence, in females, is also dependent on contributions from the mid-urethra (Dorairajan et al., 2004), more so than the bladder neck. This urethral support is primarily provided by the pubococcygeus muscle, puborectalis muscle and the vaginal wall (Easley et al., 2017) and weakness in these muscles contribute to large urethral excursion angles. Pelvic fractures may lead to weakness in these muscles, affecting continence.

## 2.10 Types and areas of pelvic fractures, muscle attachments and pelvic floor dysfunction

The biomechanics of different pelvic fracture types can result in a wide range of complications and damage to the bony, fascial, and ligamentous structures. Reports on functional and subjective outcomes are worse in patients who have sustained a pelvic ring fracture at some point in their life (Verma et al., 2020).

Figure 2-8 shows the anatomy of the pelvis and common landmarks on the innominate bones which can be used as a reference for landmarks mentioned throughout section 2.10.

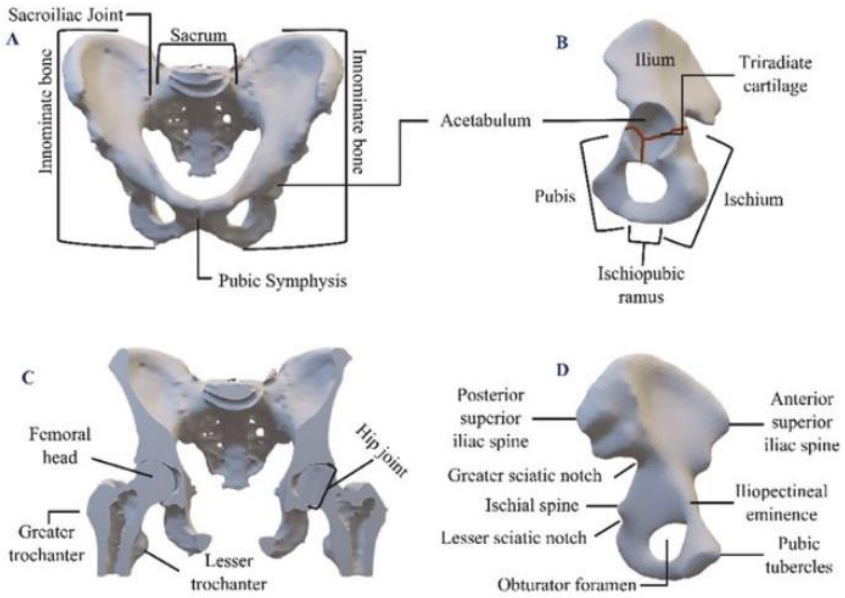


Figure 2-8 Depiction of the anatomy of the pelvic bone (A), the innominate pelvic bones making up the acetabulum (B), the hip joint and proximal femur (C), and anatomical landmarks of an innominate bone. (Gebre, 2021).

### 2.10.1 Summary of Pelvic fracture types

Pelvic ring fractures are clinically classified using different classification systems which help to standardize the descriptions of pelvic injuries. The commonly used systems include Tile, Young and Burgess, and Tile/AO classification systems (Milenkovic and Mitkovic, 2020). However, medical records barely include the classification of the pelvic fractures (Sobantu et al., 2017), only mentioning the bones fractured. This section discusses pelvic fracture types in the context of this study. There is a wide continuum of pelvic injuries from low to high energy fractures while most pelvic fractures are stable (Milenkovic and Mitkovic, 2020; Verma et al., 2020). The direction, magnitude, location and force of impact have a significant effect on the type and area of pelvic damage (Coleman et al., 2020; Li et al., 2022). Figure 2-9 highlights some principal characteristics to consider for pelvic fractures. Common types of pelvic injuries include pubic ramus fractures, ischiopubic ramus fractures and other areas of the ischium, iliac fractures, acetabulum and sacral fractures, PS dislocation and SIJ dislocation (Chaudhry, Nahian, Chaudhry, 2018). Some fractures disrupt the pelvic ring while others, such as iliac wing fractures, do not affect the pelvic ring (David et al., 2017).

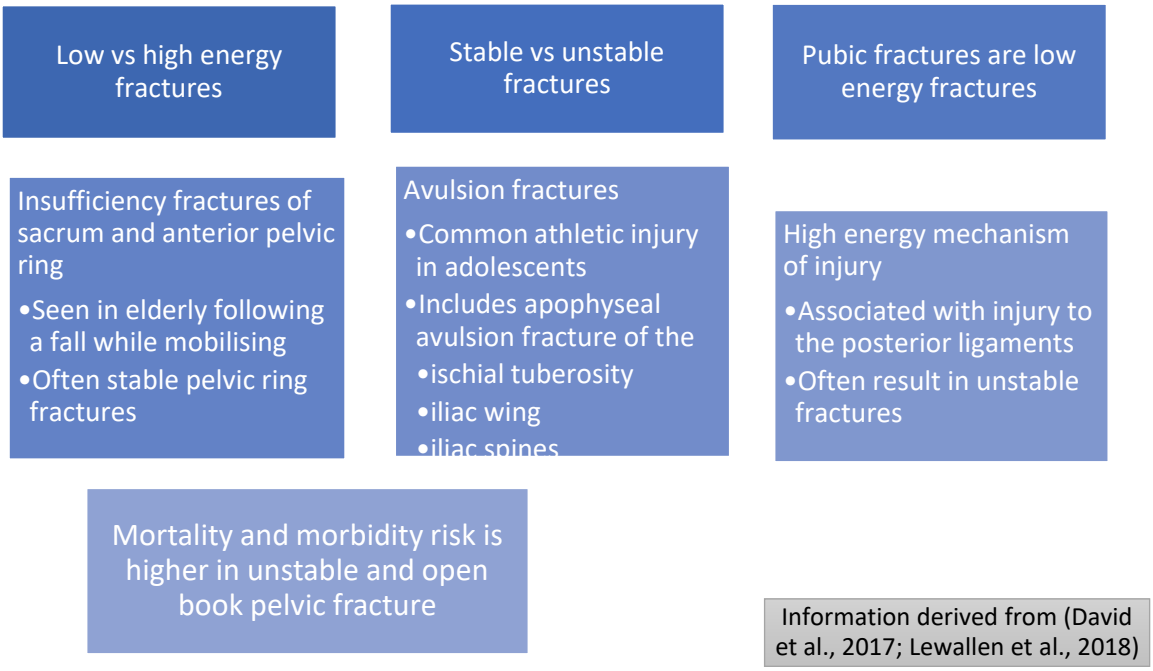


**Figure 2-9 Properties of pelvic fractures**

When the articular surface of the hip joint is involved in a fracture, it is regarded as an acetabular fracture. Although acetabular fractures are part of pelvic fractures, it warrants its own investigation on its pattern of fracture (David et al., 2017). Table 2-5 shows the locations on the pelvis commonly fractured, and the direction of force based on two classification systems.

**Table 2-5 Areas injured in context of Tile and Young-Burgess classifications**

| Derived from information from (David et al., 2017; Milenkovic and Mitkovic, 2020; Verma et al., 2020) | | | | | |
|---|---|---|---|---|---|
| **Classification systems** | | **Pathoanatomy and Biomechanical effect** | **Cause** | **Anatomical orientation** | **Areas injured** |
| **Tile** | **Young-Burgess** | | | | |
| Tile group A | APC I and LC I | External rotation of the injured hemipelvis | *Front or back impact?* | Anterior pelvic ring | Pubic symphysis and pubic rami |
| Tile group B | APC II and LC II | Lateral compression and internal rotation of hemipelvis | Side-impact MVA or PVA | Either anterior or posterior | Varied |
| Tile group C | APC III, LC III, VS and CM | Cephalad dislocation of the hemipelvis | Fall from heights | Posterior pelvic ring | Posterior iliac wing injuries, sacroiliac fractures and sacroiliac displacement |
| APC: Anterior-posterior-compression fracture; LC: Lateral compression fracture<br>VS: Vertical Shear fracture; CM: combined mechanism | | | | | |

Fracture type has not been shown to have an association with severity of PFD (McConnell et al., 2020; Wright et al., 2006). However, Li *et al.* (2019) looked at 25 cases to evaluate the association between pelvic fracture and vaginal injury and found that disruption of the anterior ring and an unstable pelvic ring may increase the risk for vaginal injury; disruptions can be caused by forces in the coronary and axial plane. The close relationship between the urethra and vaginal wall can explain the incidences of vaginal wall laceration following urethral injuries (Dorairajan et al., 2004).

Considering a significant amount of force is required to create a disruption in the pretzel like shaped anatomic ring, if one part of the pelvis is fractured, there is often an associated fracture or damage to other ligament/ muscle/ nerve structures within or outside of the pelvis (Carson et al., 2018; David et al., 2017; Lewallen et al., 2018; Siada et al., 2017). Therefore, fractures on the side of impact can cause contra-pelvic ring injuries (Li et al., 2022). Fractures to the anterior pelvic ring often occur in association with a disruption of the ring at another site and rarely occur in isolation (Carson et al., 2018; Courtney et al., 2014; David et al., 2017; Ricci et al., 2018).

Although this study did not classify the fractures using a classification system, the classifications can give us clues on the anatomical structures frequently damaged in combination.

### 2.10.2 Pelvic floor dysfunction and fractures to the pubic and ischium bones

Patients most commonly presenting with associated injuries, have a Tile Type A fracture classification which encompasses injury to the pubic rami (Ferede et al., 2021). Inferior pubic ramus fractures can affect urinary continence. Urethral closure is key for micturition and continence (Jung et al., 2012; Raizada & Mittal, 2008). Aside from the collateral direct injury to the urethra or bladder following a pelvic fracture, an MRI study of female patients following pelvic fracture demonstrated that almost half of the patients with pelvic fractures had disruption of their pelvic floor musculature (Gary et al., 2014) similar to the findings in women with significant SUI or POP with a history of vaginal delivery (Dietz, 2013). As mentioned earlier, the urethral sphincter assists in controlling micturition as voiding occurs following voluntary relaxation of the external sphincter muscle of the bladder (Jung et al., 2012). The urethral striated muscles, urethral smooth muscle and submucosal vascular elements provide sphincteric closure and

contribute to urethral closure pressure (Raizada and Mittal, 2008). The compressor urethrae muscle's role is to squeeze the urethra from its anterior point and pull the urethral meatus down and back, aiding urethral elongation to facilitate continence (Jung et al., 2012). In females, the compressor urethrae muscle originates as a small tendon from the ischiopubic ramus (Brandão et al., 2015; Jung et al., 2012) which is the inferior pubic ramus. Inferior pubic ramus fractures can affect the tautness of these fibres, injuring the muscle and lead to difficulty maintaining continence.

Ischiopubic rami fractures directly impacts on the stability of the sphincter muscle as well. The transverse perineus muscle have various layers from superficial to deep. All the layers originate from the medial surface of the ischial ramus (DeLancey and Shobeiri, 2010; Tim and Mazur-Bialy, 2021). These layers of muscle are important for fixing and stabilizing the perineal body. The sphincter urethrovaginalis muscle in females, the external anal sphincter, and the bulbospongiosus muscle in females attach to the perineal body and surrounds both the vagina and urethra (Jung et al., 2012; Raizada and Mittal, 2008). The external anal sphincter is responsible for closing the anal orifice and maintain faecal continence while the urethrovaginalis muscle acts as a sphincter for urinary continence and provides vaginal support for the organs (Jung et al., 2012; Kotarinos, 2016; Rossetti, 2016). Ischial rami fractures can place these muscles at risk for damage and dysfunction and can result in prolapse, FI or constipation (if external anal sphincter in spasm and tight causing anismus), urinary retention or urinary leakage, and sexual dysfunction as discussed for bulbospongiousus muscle in 2.9.4. Therefore, even if patients do not experience pure urethral injury following a fracture, dysfunction of the urethrovaginalis or compressor urethrae muscles may still cause voiding dysfunction.

The LAM originates from the pubic bone and the tendinous arch of the obturator fascia (ATFP), as well as the ischial spine (Raizada and Mittal, 2008). Fractures to these bones will not only cause a strain on the LAM but also affect its length by displacing its attachment sites. The ATFP is a band like thickening of the fascia between the pubic body and ischial spine on the surface of the obturator fascia. The obturator fascia is attached to the back of the superior pubic ramus. Hence the superior pubic ramus and the body of the pubis are core stabilising points for the muscles and fascia of the pelvic floor.

The medial and inferior fibres of the LAM is the puborectalis muscle. This muscle originates from the pubic bone on one side, runs posteriorly behind and around the rectum and back to insert to the pubic bone on the other side (Lammers et al., 2013; Lucente et al., 2017; Raizada and Mittal, 2008). It forms a U-shaped sling behind the anorectal junction, contributing to the anorectal angle by drawing the anorectal junction toward the pubis (Lucente et al., 2017). During stimulations, it was noted that majority of the pelvic floor contraction felt during a vaginal exam to assess the PERFECT score is produced by the puborectalis muscle (Egorov et al., 2022; Hoyte et al., 2008).

The puborectalis muscle is the component of the LAM most affected during childbirth (Dietz, 2013; Hoyte et al., 2008; Shi et al., 2016). It can be left at a stretch and affect ability to maintain faecal continence. In rotationally unstable fractures where there is displacement of the pubic ramus, the puborectalis muscle can be placed in a stretched state forcing continuous contraction, and cause muscle fatigue. Since the puborectalis muscle plays a role in maintaining faecal continence, overactivity and fatigue can cause FI as is noted post vaginal birth in some women (Ashton-Miller and DeLancey, 2009; Dietz, 2013; Enoka and Duchateau, 2008). On the other hand, with a posterior or neutral pelvic tilt, as is common in supine, semi-fowlers and crook lying which are the positions used by patients on bed rest or traction, the puborectalis muscle is tense. If puborectalis muscle is under tension, the rectum is not in an optimal position potentially making defecation difficult (Imai et al., 2015; Trads and Pedersen, 2015a).

### 2.10.3 Pelvic floor dysfunction and fractures to the sacrum and coccyx with associated ligamentous involvement

The SIJ is another vulnerable site (Li et al., 2022). The coccygeus muscle which supports the pelvic viscera and draws the coccyx forward facilitating pelvic floor contraction, originates from the sacrospinous ligament and ischial spine, and attaches to the inferior-lateral sacrum and coccyx. Figure 2-10 highlights the course of the sacrospinous and sacrotuberous ligaments; it shows the origination and attachment points of the sacrospinous ligament (from ischial spines, extends to the lateral margins of the sacrum and coccyx), and sacrotuberous ligament (extending from the ischial tuberosity to the coccyx). The sacrospinous ligaments and coccygeus muscles share the same bony attachments. The coccygeus muscles lies on the anterior aspect of the sacrospinous ligament (Lucente et al., 2017).

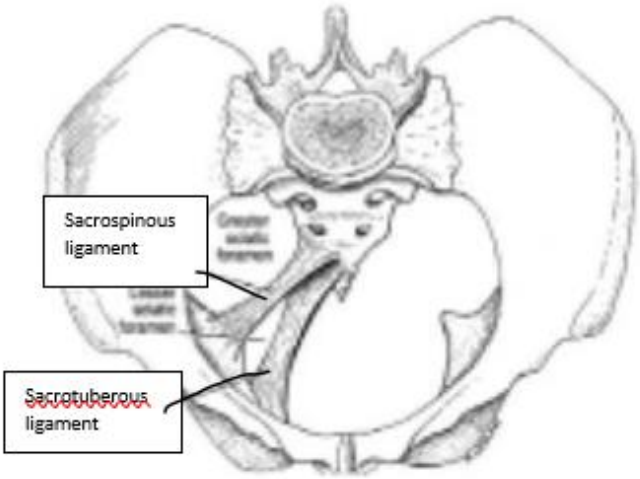


Figure 2-10 Female pelvis from above

In fractures like APC type II and III or fractures of the sacrum, coccyx or ischium, there is disruption of the anterior sacroiliac, sacrotuberous and sacrospinous ligaments. In fractures like these that cause disruption of the sacrospinous ligament, the coccygeus muscle, because of its origin point and course, can be affected. This is either by going into spasm (Mense, 2008), becoming disrupted with a tear or strain (Courtney et al., 2014), or due to the disruption in the ligament, causing coccygeus muscle's origin anchor to be unstable. All of these can cause pain, poor quality of movement and an incomplete contraction. The muscle may also develop fatigue implying that there will be a decline in its ability to maintain a maximal force and only sustain submaximal contractions (Enoka and Duchateau, 2008). The LAM nerve, which innervates the PFM's arises from the sacral nerve roots and runs along the superior surface of the coccygeus muscle (Lucente et al., 2017; Raizada and Mittal, 2008; Wallner et al., 2006). Injury to this nerve from the pelvic trauma or impingement from spasm of the coccygeus muscle can potentially lead to atrophy of the muscle or pelvic pain causing PFD (Lucente et al., 2017). Among the body's responses to trauma is changes in descending neural control. Hyperactivity of the PFM's is a common finding in women who have encountered abuse or trauma, a possible result of descending neural control changes manifesting as a muscle contraction (Padoa et al., 2021).

The piriformis muscle originates from the anterior surface of sacral ligaments two to four which are near the sacrospinous sacral attachment point. As above, with fractures causing disruption to the sacrospinous ligament, one would expect piriformis muscle injury or at the least, muscle spasm. Piriformis muscle spasm is a known contributor to

chronic pelvic pain (Lee et al., 2016). Piriformis is in close proximity to the sciatic nerve and can occasionally impinge the pudendal nerve (Grgić, 2013; Kiapour et al., 2020a). Pudendal nerve impingement can lead to pudendal neuralgia, sensory disturbances and/or multiple subsequent symptoms of PFD including urinary incontinence and dyspareunia and other problems with urination and defecation (Grgić, 2013; Lee et al., 2016).

The piriformis muscle spasm in itself can lead to piriformis muscle syndrome which includes symptoms of PFD and other symptoms which increases the risk for PFD (Grgić, 2013). An example of this is the obturator internus and piriformis muscles laterally rotate and/or abducts the hips which are important for positions needed for toileting and sexual activity. Decreased muscle fibre length, strength and endurance of these muscles, along with pain from these muscles can affect the ability to reach and maintain required positioning. The PFM's also become overactive to compensate for changes in hip joint mobility. Reduced hip joint mobility lead to pelvic tilt abnormalities from the tension changes in the obturator internus muscles (Tim and Mazur-Bialy, 2021).

### 2.10.4 Pelvic floor dysfunction and acetabular and iliac fractures

The piriformis muscle also has an attachment to the acetabulum (Carson et al., 2018; Chaudhry, Nahian, Chaudhry, 2018). Fractures to the acetabulum can cause similar issues as mentioned above in 2.10.3 The two most common locations of pelvic injury are the acetabulum and SIJ which are near the lumbosacral plexus. This explains why injuries of the lumbosacral plexus makes up most nerve injuries (Tullington and Blecker, 2023) in pelvic fracture victims. Biomechanical integrity studies support the hypothesis that PFD, specifically related to pressure-pain sensitivity, is present in women with lumbopelvic pain (Lucente et al., 2017). The incidence of lumbosacral plexus injury ranges from 1-30% in the literature (Giordano et al., 2016) and are associated with vertical shear (VS) type fractures in which all major ligaments are disrupted (Coleman et al., 2020).

The acetabulum is an attachment site for other non-pelvic floor muscles, as are the other pelvic bones (Wobser et al., 2024). Ohishi et al. (2012) investigated associated muscle injury in patients post hip and pelvic fractures. They noted that some muscle

injury accompanied 100% of participants in the pelvic fracture group with greatest incidence for obturator externus and adductor brevis muscle injury (Figure 2-11 (Ohishi et al., 2012)). MRI findings of adductor brevis, pectineus, obturator internus and obturator externus muscle injuries were associated with findings of pelvic fractures (Ohishi et al., 2012). This is important to note as these accompanying muscle injuries could indicate that the indirect force from these hip adductor and rotator muscles could be involved in the mechanism of injury along with the direct external impact to the pelvis from a fall or MVA. Hip fractures were associated with the incidence of other muscle injuries including gluteus- maximus, medius and minimus, quadratus femoris and vastus lateralis, all of which are not part of the pelvic floor but affect the pelvic sling (Ohishi et al., 2012). We can expect these muscles to also be injured in fractures of the ileum as these muscles originate from sites on the ileum (Wobser et al., 2024).

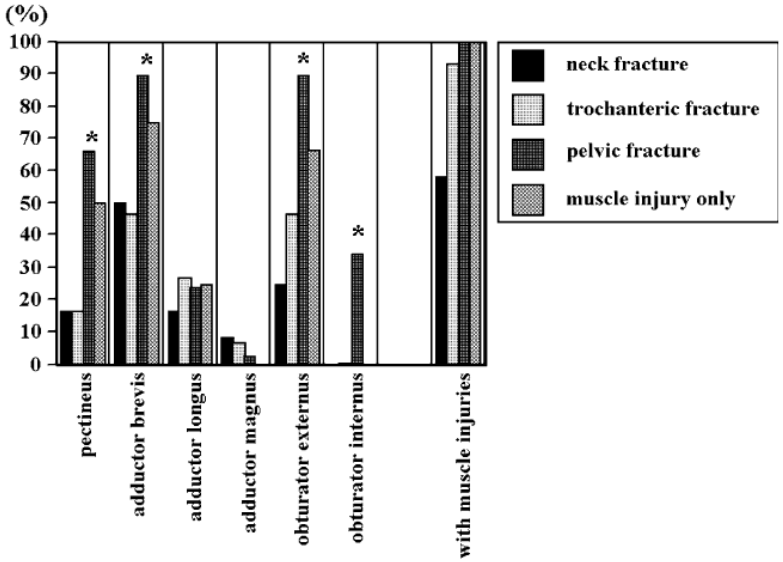


Figure 2-11 Muscle injuries around the groin in patients with hip or pelvic fractures (Ohishi et al., 2012)

Obturator internus muscle originates from the pelvic surface of the obturator membrane and surrounding bone; the obturator membrane forms part of the endopelvic fascia and attaches to the margins of the obturator foramen (Corton, 2005b; Rossetti, 2016; Standring, 2020; Wobser et al., 2024). The margins of the obturator foramen are noted in the Table 2-6 below (based on descriptions from Standring (2020) and Wobser et al. (2024)). The obturator membrane attaching partly to the acetabulum provides an anatomical understanding of why acetabulum fractures can also lead to PFD.

**Table 2-6 Borders of the obturator foramen**
**(based on descriptions from Standring (2020) and Wobser et al. (2024))**

| | | | |
|---|---|---|---|
| Superior | Superior pubic ramus and inferior margin of the acetabulum | Anterior | Pubic body |
| Inferior | Ischiopubic ramus (inferior pubic ramus) | Posterior | Ischiopubic ramus and acetabulum |

The relationship between the obturator membrane, endopelvic fascia and obturator foramen opens for possible speculation and reasoning of risk: If there is damage to any of the borders of the obturator foramen, it may affect the stability of the obturator membrane and subsequently the ATFP. Based on this anatomy, in fractures of the superior pubic ramus, the ATFP could also be disrupted and lose its stabilising tension. PFM avulsion and severe connective tissue disruption is more damaging to the functioning of the pelvic floor compared to the PFM tone changes (Egorov et al., 2022; Lucente et al., 2017). Considering this and that the ATFP and the body of the pubis are the origination points for the LAM muscles, if the stability of the foundation/ origination site is compromised, the muscles may unlikely function optimally. PFD is often as a result of poor quality of movement, and coordination of pelvic floor muscle contractions rather than only the strength of the muscles (Tim and Mazur-Bialy, 2021). Muscles function by contracting towards their origination (Enoka and Duchateau, 2008; Fritsch et al., 2012); a disruption in the bone and fascia, can make it difficult for the muscles to remain taut during a contraction and the synergy of the muscles movements can be affected.

## 2.11 Pelvic fracture management and risk for pelvic floor dysfunction

Aside from the fracture itself, the management of the pelvic fracture also impacts on the risk for developing PFD. Pelvic fracture management is dependent on the stability and severity of the injury as well as the haemodynamic stability of the patient (Bazylewicz and Konda, 2016; Wong and Bucknill, 2017).

Pelvic trauma management must be based on the patient's physiological status and the anatomy involved in the injury. The World Society of Emergency Surgery (WSES) guidelines suggest that optimal treatment should consider hemodynamic status, the

anatomical structures impaired and subsequent impact on pelvic ring functioning, and associated injuries (Ashkal et al., 2021; Coccolini et al., 2017). The aim of acute management is to restore homeostasis by controlling haemorrhage through resuscitation, and secondly restore mechanical stability of the pelvic ring by urgent stabilisation of the pelvis followed by imaging and surgery (Ashkal et al., 2021; Coccolini et al., 2017). Pelvic binder usage is increasing as part of acute management (Gabbe et al., 2013). This management principle is linked to decreased blood transfusion, systemic complications, hospital stay and survival

.

The damage sustained from a pelvic fracture can be managed conservatively or surgically. The decision to treat conservatively or with surgery is often at the senior surgeons discretion (Verma et al., 2020). Conservative management includes bed rest, graded weight bearing management according to pain tolerance, skin traction and cementing. Surgical procedures include skeletal traction, debridement, Open Reduction and Internal Fixation (ORIF), external fixation, spica casts (a cast encompassing the chest, pelvis and femurs and mainly used in small children), pelvic wrap device and pelvic packing. Pelvic binders, skin or skeletal traction is often applied for six to twelve weeks and decided on based on regular re-imaging and evaluation (Verma et al., 2020). Skeletal traction offers suitable stabilization for a VS injury (David et al., 2017).

Non-displaced fractures are frequently managed conservatively, while displaced fractures necessitate anatomical ORIF (Cacciola et al., 2021). This is to reduce the development of post-traumatic osteoarthritis. Minimally displaced fractures can also be managed conservatively but depends from case to case (David et al., 2017). The same applies to acetabular fractures where high risk patients or patients with minimally displaced fractures receive non-operative treatment with protected weight-bearing (Cacciola et al., 2021; Mbatha et al., 2023). Acute acetabulum fractures with significant acetabulum displacement or hip instability undergo ORIF (David et al., 2017). Pelvic fractures are mostly managed conservatively due to the inherent risks of surgery (Welk et al., 2015). Most (63%) participants in a study by McConnell et al. (2020) were managed conservatively while 38% were managed surgically. However, surgical intervention, is often the choice of treatment if hemodynamic or mechanical stability is compromised (Wong and Bucknill, 2017). In a study by Palmcrantz et al. (2012), 39% of patients underwent surgical procedures and the remainder were managed with bed

rest and partial weight bearing. Mortality was higher in the group not undergoing interventions (33% vs 27%). Of the patients studied by Ferede et al. (2021), 53.1% were managed non-operatively while 31.3% were referred to a specialized trauma centre. Hospitals like CHBAH have limited operation room time resulting in majority of pelvic injuries being prescribed conservative management compared to the higher reports of ORIF in research done in high income countries (Mbatha et al., 2023; Palmcrantz et al., 2012).

Skeletal traction and external fixation are the definitive method of treatment for Type C fractures (Milenkovic and Mitkovic, 2020). Both these methods are associated with pin site infections, and lateral femoral cutaneous nerve injury (McDonald et al., 2017; Tullington and Blecker, 2023). This nerve branches off the lumbar plexus and injury of it leads to sensory alterations such as numbness, tingling, or a burning sensation, as well as severe pain, felt in the lateral and anterior thigh and lateral buttock, known as meralgia paresthetica. This can progress to chronic pelvic pain. The meralgia paresthetica and the pelvic pain can hinder sexual function through difficulty with movement and dyspareunia symptoms. Both these management techniques involve confinement to the bed increasing the possibility of malunion and non-union (Milenkovic and Mitkovic, 2020). Gastrointestinal (GIT) disturbances, urogenital disorders, back pain, and problems with sitting, standing, and walking are lasting effects of malunion and non-union. Back pain, GIT disturbances and problems with mobilising are common contributing factors or symptoms that are also present in patients with PFD (Milenkovic and Mitkovic, 2020).

Pelvic trauma management must take a multidisciplinary approach (Coccolini et al., 2017) with physiotherapy playing an integral role in the rehabilitation team (Atkinson et al., 2005; Sobantu et al., 2017). Complications are reduced with early commencement of physiotherapy (Sobantu et al., 2023). The role of physiotherapy and physiotherapy management in pelvic fracture patients is not well documented in the literature and is primarily focused on assisting patients to return to normal mobility and functional independence (Sobantu et al., 2017). A South African study described that training of function was the primary rehabilitation provided to patients post pelvic fracture, followed by strength training, balance, and mobilisation exercises (Sobantu et al., 2017). Just over 50% of participants received physiotherapy with two thirds receiving physiotherapy for one to five days. Functional training consisted of bridging,

bed mobility including getting in and out of bed, and walking (Sobantu et al., 2017). The rehabilitation protocol used in another study was individualized according to patients associated injuries (Yu et al., 2023). The protocol included bedside rehabilitation exercises involving muscular stretches (active and passive), rolling and joint movements. Once fractures stabilized, the focus shifted to improving mobility by practicing wheelchair assisted ambulation and gait education using a walking frame or crutch (Yu et al., 2023).

It is difficult to determine if pelvic floor rehabilitation is included in the current treatment regimens. According to Guthrie et al. (2010), it is impossible to treat the bony and ligamentous injuries to the pelvis successfully, if associated visceral, soft tissue and neurovascular structures are not identified and managed. The literature indicates that intervention by urologists for bladder and sexual dysfunction is warranted but pelvic floor rehabilitation is not discussed (Schwartsmann et al., 2018). Sobantu et al. (2017) concluded that pelvic floor rehabilitation is omitted in the rehabilitation of pelvic fracture patients as PFMT was only noted in one medical record out of 236 records.

Separate from the break in the bone, there are important health care provided to manage the patient holistically. These include catheterisation, bed rest, and specific diets. The impact of these will be discussed under the specific PFD domains in section 2.12.

## 2.12 Domain specific pelvic floor dysfunction symptoms in relation to management of pelvic fractures

The symptoms that can be present post pelvic fracture can fall in one of four domains based on the APFQ. This section looks at domain specific symptoms and the literature around it.

### 2.12.1 Bladder and urinary dysfunction symptoms

The section on the anatomy and biomechanics covered much of the ways in which pelvic fractures can influence bladder and urinary dysfunction from a neuromusculoskeletal aspect. This section will look at other symptoms not discussed

elsewhere and contributing factors associated with pelvic fractures and its management that can cause PFD symptoms related to the bladder domain.

As mentioned earlier, most types of pelvic fractures require bed rest. Patients on bed rest rely on asking nurses to bring them a bedpan for passing urine or else need to use a diaper. Patients may avoid fluid intake to avoid needing to urinate as often. Cerebral perfusion can be decreased by the experience of thirst among other more complex causes (Tish and Geerling, 2020). Under-perfusion of the frontal lobes of the cerebral cortex is causally related to urge incontinence and reduced bladder sensation (Ashton-Miller and DeLancey, 2009; Clement et al., 2018; Tish and Geerling, 2020). This is a far-fetched assumption on how patients' fluid intake can impact bladder sensation.

Urinary retention has been reported in 87% of patients with a fractured hip (Skelly et al., 1992). If patients with hip fractures have such a high incidence of urinary retention, one can expect similar findings if not more in pelvic fracture survivors as the pelvis is directly connected to the bladder and pelvic floor. If urinary retention is undetected, it can lead to overflow incontinence, urinary tract infections (UTI's) and a decline in function (Tran and Puckett, 2024). Factors identified to contribute to urinary retention include acute confusion following an injury, immobility, use of analgesics and opioids, anaesthetic, and intravenous fluid intake (Skelly et al., 1992). These can lead to inability to void, bladder overdistention or a decreased awareness of bladder fullness. Frequent voiding of small urine volumes, or overflow incontinence can indicate urinary retention. Urinary retention is managed with either indwelling or intermittent catheterization (Skelly et al., 1992; Sørbye and Grue, 2013; Wald et al., 2005; Wilson, 2013). Postoperative management for repair of hip fractures includes use of indwelling catheterization even though Skelly et al. (1992) found that intermittent catheterization lead to satisfactory voiding resuming earlier rather than the use of indwelling catheterization.

Catheterisation poses risk for PFD (Saint et al., 2018; Wilson, 2013). The hip and pelvis are in proximity and fractures to both form orthopaedic patient populations. We can use the data on hip fractures to guide on the potential outcome of urinary catheter usage in pelvic fracture patients. Surgical repair after hip fractures is a risk factor for urinary incontinence as a urinary indwelling catheter is inserted preoperatively. Wald et al. (2005) explains that the preoperative catheter insertion is to reduce anaesthesia

and analgesia related postoperative bladder dysfunction but must be removed 24 hours postoperatively. A study done in Norway, in patients with a hip fracture, aged 65 years and older, examining incontinence after surgery with the use of indwelling catheters preoperatively, found that 46% of participants were already urinary incontinent before surgery and that the longer the indwelling catheter was kept in, the higher the risk for poorer outcomes. (Sørbye and Grue, 2013). This is significant to consider for pelvic fracture patients as patients requiring bed rest, traction or surgery often have an indwelling urinary catheter inserted.

Although older individuals may be able to manage their incontinence and toileting at home, after a hip fracture, it becomes a burden as they are dealing with imbalance, and are slower due to pain and fear of falling (Sørbye and Grue, 2013). If this is the case for hip fractures, one can expect the same factors affecting patient experience following a pelvic fracture, if not worse, due to the added range of movement contraindications for some types of pelvic fractures

### 2.12.2 Bowel dysfunction

The postoperative phase includes routine management such as the “use of morphine, change in normal medication and diet, immobilization and lack of privacy” when passing stool (Trads and Pedersen, 2015b). These are risk factors for developing constipation. Patients admitted in hospital are dependent on the food prepared by the hospital kitchen; patient satisfaction regarding menu and availability of cultural food choices are reduced according to a study done in private and public hospitals in South Africa (Ncube and Letsoalo, 2019; Saus and Sucheran, 2021). Out of eight public hospitals in Gauteng, only two abide to the recommended daily intake, while some are below and others above the recommended levels (Jiyana et al., 2018) Hospital shops often keep comfort snacks that are bought by patients or visitors for the patients (Stead et al., 2020). These may not always be healthy and gut friendly. These food scenarios can affect stool consistency and either lead to constipation or FI.

A study done in Denmark in patients post hip fracture, investigated constipation and stool consistency at admission, at discharge and at thirty days postoperatively compared to preadmission habits. The study found a significant change in the frequency of defecation, reported difficulty and frequency of dry and hard stool from

admission to discharge (Trads and Pedersen, 2015b). Normal defecation pattern was only re-established about 9 days after surgery. However, normal defecation patterns were not yet re-established by the thirty-day postoperative follow-up in 22.7% of their participants.

Constipation is not well defined. Patients and physicians define constipation differently. Due to the disagreement on the definition of constipation, it is difficult to determine a correlation between results from epidemiological studies and self-reported outcomes for constipation and number of bowel movements (Trads and Pedersen, 2015b). The validated North American Nursing Diagnosis Association – NANDA - definition of constipation is if a person's normal frequency of defecation is decreased together with difficult and incomplete passage of stool or hard and dry stool. Studies identified females and advanced age as risk factors for the development of constipation (Richmond and Wright, 2004). Trads and Pedersen (2015) found that hard and dry stools were more common at discharge in older patients. The prevalence of constipation in people living at home (and not admitted to hospital for any injury or sickness) has been reported to be 2-28% showing the importance of identifying preinjury habits (Tariq, 2007). Constipation in the general population is linked to avoiding public toilets. There are reports of poor quality of water, sanitation and hygiene in public hospitals of low- and middle- income countries like South Africa, giving an indication of the quality of toilets (Bouzid et al., 2018; Maphumulo and Bhengu, 2019) which are often at a distance from patients' beds.

Patients are often prescribed opioids for pain management, which are associated with constipation. In a study by Davies et al. (2008) constipation was found in 71.7% of patients following hip (neck of femur) fractures after using opioids postoperatively. Nutritional status and age were demonstrated as significant contributors to constipation occurring in participants. Laxatives are not routinely prescribed prophylactically; Davies et al. (2008) found that even when prescribed prophylactically, laxatives did not reduce the incidence of constipation. Trads and Pedersen (2015) observed the same thing.

Laxatives can result in an undesirable incidence of diarrhoea placing patients at increased risk of FI. FI is often multifactorial and occurs due to disruption of one or more continence mechanisms (Rao, 2004); these could be issues with the gut-brain

axis, bowel symptoms, disturbances in the anorectal complex, an issue with the enteric nervous system, sphincter injuries, gut microbiome, pudendal nerve damage, and issues with afferent and efferent functioning (Bharucha et al., 2022; Breit et al., 2018). Severity is determined by the quantity and consistency of the stool, frequency of leakage, and whether an individual experiences an urge or the stool leaks passively (Bharucha et al., 2022). Laxatives affect the consistency of the stool and the GIT motility. Following a traumatic incident, the body can remain in a fight and flight response unless appropriately downregulated, placing patients at risk of FI. In such cases, the FI is associated with a hyperactive sympathetic nervous system causing vagus nerve dysfunction (Breit et al., 2018). Although GIT motility is a parasympathetic nervous system function, under stress, the vagus nerve does not function optimally. This leads to neurotransmitter imbalances (i.e. increased serotonin) affecting the peristaltic reflex which increases GIT motility, causes colon spasms and forces the anal sphincters to relax and stool to leak. If the patient is also using laxatives, she may have less control of the looser stool.

Patients are placed on bed rest for non/minimally displaced fractures (Cacciola et al., 2021; David et al., 2017). Being on bed rest is important for maintaining the stability of the pelvis but results in decreased mobilisation. Mobilisation plays a role in improving gut health (Monda et al., 2017; Terzioğlu et al., 2013). Low intensity physical activity, like walking, reduces stool transit time (Monda et al., 2017) whereas inactivity reduces gut motility. Due to the pain, and position of bedrest or on traction, with decreased mobilisation, and the unfamiliar hospital setting, patients are not in an optimal environment and position to pass stool, causing constipation (Jundt et al., 2015). Fear avoidance behaviour is commonly associated with constipation. Patients who have encountered a fracture to their pelvis, can be afraid to pass stool in fear of further displacing the bones or bleeding. If not provided with any instruction and reassurance from the medical team, patients may not know if they are allowed to pass stool.
Patients on traction (often with VS and Tile type C fractures) are expected to maintain a certain degree of hip flexion, and hip flexion greater than 30-70 degrees, depending on how many weeks on traction, is contraindicated. Hip flexion greater than 45 degrees is contraindicated in patients managed with an external fixation (especially VS type fractures). These positions place the puborectalis muscle under tension and results in a small anorectal angle which makes passing stool difficult (Imai et al., 2015; Trads

and Pedersen, 2015). The position used for patients requiring traction, also affects the angle of the bladder neck and urethra which can cause incomplete voiding.

### 2.12.3 Pelvic Organ Prolapse dysfunction

Loss of support at the apex of the bladder accounts for about 50% of observed anterior prolapses (Easley et al., 2017). Findings like these are adding to the evidence that mechanics influences the onset of prolapse, especially since the pelvic organs rely on the pelvic floor as the primary load bearing support structure. Changes in the tissue elasticity, connective tissue weakening and dysfunctional activity from the PFM's are some of the pathologies affecting the pelvic floor. Each of these pathogeneses are common contributors to a variety of PFD symptoms. According to MRI results, applying biomechanics is critical to explain how the development of POP is influenced by altered loading conditions in an uninjured pelvis (Easley et al., 2017). Following a pelvic fracture, weightbearing is affected, indicating an alteration in loading of the pelvis, placing victims at risk of POP. Together, the pelvis and pelvic floor are of central importance to stability and mobility activities, comprising the primary load bearing structures (Easley et al., 2017).

The PFMs attach and span across the sacrum and stabilize the SIJ, in turn limiting its movement and assisting in transmission of shear forces (Kiapour et al., 2020b). Load transfer in different static and locomotion positions is facilitated from the lumbar spine to the lower extremities through the finely balanced attachments of the main ligaments connecting the pelvis to the spine at the SIJ. There is a co-dependency of the multitasking anatomical structures of the pelvis and the pelvic floor, resulting in pelvic floor diseases often being interrelated (Lucente et al., 2017) as is with POP. If there is damage to the sacrum, for example from a fracture, it will put tension on these muscles (Kiapour et al., 2020b). The PS deforms largely under any loading condition (Li et al., 2022). The dorsal part of the pelvis have higher loads compared to the anterior pelvis, making the anterior structures more fracture prone/ at risk of fractures (Ricci et al., 2018). Load transfer is reinforced by other trunk and lower limb muscles and ligaments which attach widely across the pelvis (Coccolini et al., 2017; Corton, 2005; Guthrie et al., 2010; Kiapour et al., 2020b). This matters because injury to these muscles can affect the pelvic floor. POP was present in 30% of women in a study by Easley et al. (2017) and resulted from injury or failure of the pelvic floor. This explains why most

patients with a POP have related PFD including urinary incontinence, FI, other voiding dysfunctions, pelvic pain and sexual dysfunctions (Egorov et al., 2022).

### 2.12.4 Sexual dysfunction

Among the types of PFD present post pelvic fracture, sexual dysfunction is the most extensively researched area. A study by Harvey-Kelly et al. (2014) looked at survivors at 36 months post injury and found that sexual dysfunction is a problem encountered by many pelvic fracture survivors but not all are seeking treatment. The rate of sexual dysfunction following a pelvic fracture was reported to be 40% (Harvey-Kelly et al., 2014). They also found that pelvic floor therapy might help; this is aligned with research showing that sexual function improvement is associated with PFMT (Verbeek and Hayward, 2019). Sexual complaints can be from urogenital or perineal injuries or neurogenic aetiology. In women, coital incontinence during penetration and urge urinary incontinence was observed when the bladder sustained injury. Perineal injury is associated with complaints of incomplete bowel emptying, urge FI, and irritable bowel syndrome (Baessler et al., 2004, 2009; Giordano et al., 2016) which can influence dyspareunia or feeling the urge to pass stool during penetrative sex.

Dyspareunia was reported in 56% of female patients post pelvic ring injury (David et al., 2017; Vallier et al., 2012b) and approximately 30% of all pelvic trauma patients (Giordana et al. 2016) have sexual complaints. The amount of symphyseal displacement following a fracture is of significance as it can predict the risk for dyspareunia; a measure of 5mm or more is associated with increased pain during intercourse (David et al., 2017). This means that patients with an APC type II and III and VS type pelvic fracture classifications should specifically be screened for PFD at least at their 3-month follow-up by which time one would expect them to have returned to sexual activity.

An important aspect of sexual dysfunction is a women's sexual experience. Common factors identified in the literature that influence this include women's self-consciousness on the image of their vagina (especially if they have a POP), dyspareunia, coital incontinence which is present in women with urinary incontinence, and the fear of leaking stool for patients with FI (Verbeek and Hayward, 2019). Fracturing one's pelvis, associated swelling, skin bruises and suturing from any

surgical management can affect an individual's mental image of their pelvis and confidence in exposing their perineum to a sexual partner. Post-traumatic stress disorder syndrome behaviour is a major cause of sexual dysfunction and is linked to common issues noted in the pelvic fracture related literature which include cosmetic complaints, the presence of scar tissue and asymmetry of the skeletal pelvis (Giordano et al., 2016).

## 2.13 Summary of chapter 2

This chapter discussed the anatomy of the pelvis and associated structures and explored the impact of pelvic fractures. The above literature review maps the complexity of PFD as might be related to pelvic fractures. Each symptom can be caused by a variety of reasons and biomechanical changes in the pelvic floor and surrounding structures. The ligaments, bones and especially the endopelvic fascia is shown to play significant roles in facilitating the correct execution of the roles of the pelvis and pelvic floor. Pelvic fractures affect the ligaments, bones and endopelvic fascia. A fracture can occur on one area or many areas of the pelvis. This could mean that pelvic fractures can also affect the pelvic floor and structures in a variety of ways causing varied PFD symptoms. Based on the anatomy, we may find PFD present following fractures of the pubic bone and fractures involving ligamentous structures. Pelvic fractures, subsequent complications and the management provided for pelvic fractures could place patients at risk for PFD.

# Chapter 3 Methods

In this chapter, I describe the methodology of the study. It includes the study design, setting, source of participants, sample size calculation and explanation, sample selection with inclusion and exclusion criteria, explanation and interpretation of the instrumentation and outcome measures used, the procedure, ethical considerations, and data analysis.

## 3.1 Study Design

A quantitative pre-test, post-test same sample longitudinal study design was used whereby participants PFD symptoms prior to a pelvic fracture were compared to PFD symptoms post pelvic fracture. Pelvic fracture/s and related orthopaedic management were the exposure/ intervention being tested. Participants were recruited when first identified and followed up at three months. I investigated the presence and symptoms of pelvic floor dysfunction (PFD at three months after sustaining a pelvic fracture and compared it to participants' retrospective responses (at recruitment) regarding their own PFD symptoms prior to the injury. Simultaneously weight, health, functional balance and mobility, fracture, and management types were investigated.
Data collection only commenced after ethical approval was obtained and approval by all responsible authorities was granted as detailed in 3.6.1

## 3.2 Study Setting

This study was conducted at The Chris Hani Baragwanath Academic Hospital (CHBAH) and the Charlotte Maxeke Johannesburg Academic Hospital (CMJAH), in the orthopaedic wards, out-patient department (OPD) clinics, and the physiotherapy OPD. Both hospitals have an emergency and trauma centre from which orthopaedic casualty patients are admitted. CHBAH has nine orthopaedic wards of which three house female patients with lower limb injuries. CMJAH has one female orthopaedic ward where patients are admitted for lower limb injuries.

## 3.3 Participants – study population and sampling

The study population were females who sustained at least one fracture to any part of the pelvis (see Table 3.2 below on specifications) between 30 September 2021 and April 2023, received management in the CHBAH or CMJAH orthopaedic units, and were available for recruitment within three months of their injury. Identification of potential participants and recruitment commenced in January 2022 at CHBAH, and from November 2022 at CMJAH and ended at both sites in July 2023. Figure 3-1 below provides a summary of the timelines and research activities completed for the recruitment and data collection aspect of this study.

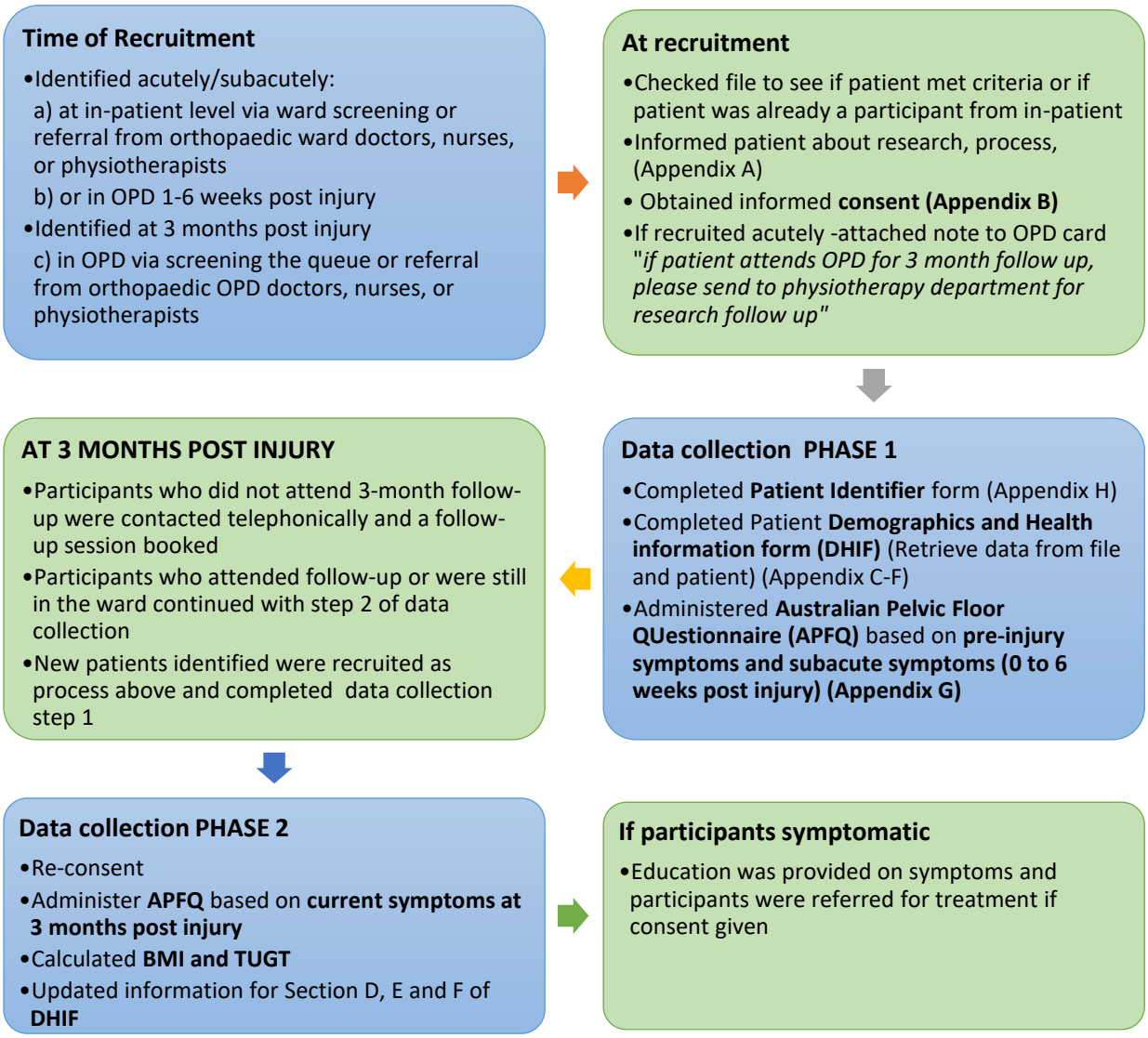


**Figure 3-1 Summary of recruitment and data collection procedure**

***OPD: Out-patient department; APFQ: Australian pelvic floor questionnaire; BMI: Body Mass Index; TUGT: Timed up and go test***

### 3.3.1 Source of Participants

Participants were recruited from the CHBAH and CMJAH trauma and female orthopaedic wards, the orthopaedic lower limb out-patient clinics and the physiotherapy orthopaedic OPD. Figure 3-2 below illustrates the normal journey of a patient who sustains a fracture to provide the context of when participants were recruited for this study. For the duration of the study, potential participants were sourced through referral by the orthopaedic ward and OPD doctors, nurses, physiotherapists, and clerks. I additionally screened the orthopaedic out-patient queues, on the clinic days, for any new potential patients. and existing participants attending their three months follow-up.

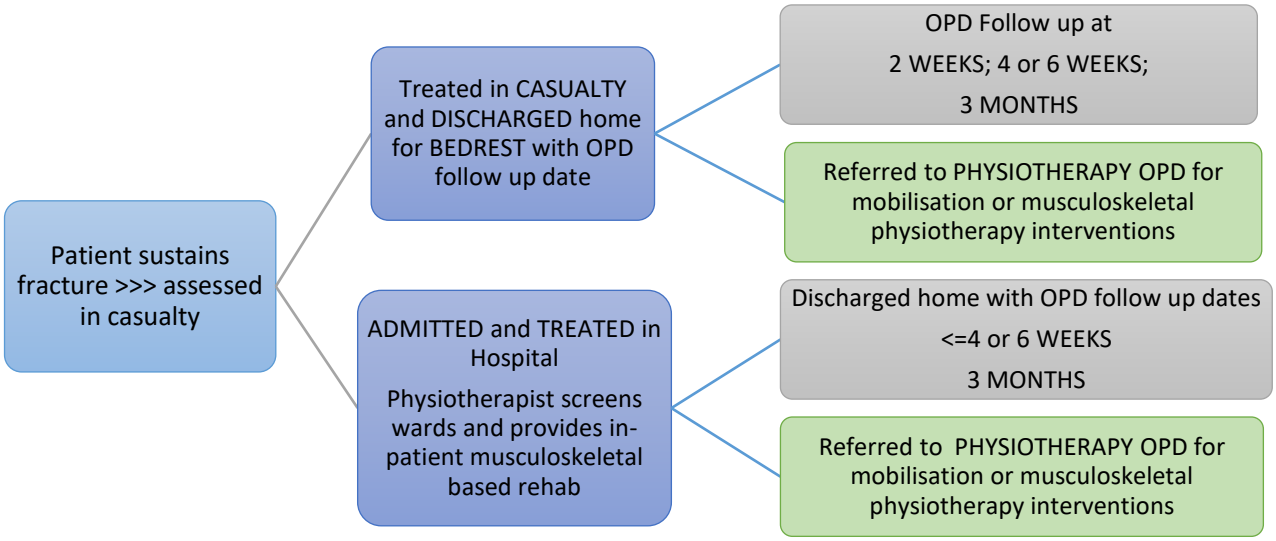


**Figure 3-2 Journey of the patient who sustained a fracture after arriving to casualty**

***OPD: outpatient department***

### 3.3.2 Sample Size

Total sampling was done, as all patients fulfilling the inclusion and exclusion criteria requirements during the study period and agreeing to participate in this study were recruited.

The number of patients with a pelvic fracture admitted at CHBAH between April 2020 and January 2021 (nine months) were reviewed to identify the likely expected sample size. The total number of patients (males and females combined) was 54 with the majority being male (approximately 3:1 ratio = 13 females over nine months). We anticipated the sub-population for female patients to be less. Using an algebraic equation with the data reviewed from CHBAH, we calculated an expected number of 34 patients to be identified. Based on a high risk for mortality following pelvic trauma and possible defaulters, we accounted for a 10% attrition rate. For a total of 16 months of data collection, from the two sites, we rounded this number off and expected enrolling approximately 30 participants.

**Table 3-1 Calculation of possible sample size**

| | | | |
|---|---|---|---|
| CHBAH (April 2020 to January 2021) | 9 months | 13 | |
| CHBAH | 16 months | X = 23.11 | 23.11 |
| CMJAH | 8 months | X = 11.5 | 11.5 |
| Attrition rate of 10% | 34.61 x 10% = 31 | | |

### 3.3.3 Sample Selection

Participants were identified at any point in their healing phase from day three to the end of three months following their injury. This was either as an in-patient from the wards or an out-patient. Participants identified in the outpatient setting included those discharged from casualty or the ward for follow-up at two weeks post injury, or those attending their four, six, eight week or three-month post injury follow up appointment.

Table 3.2 lists the inclusion and exclusion criteria used to check potential patients picked up during the screening process or referred to me. Recruitment was based on meeting inclusion criteria and providing consent to participate. Recruited participants were informed of the study (Appendix A), the aims, and the process to be followed by giving signed informed consent (Appendix B).

**Table 3-2 Exclusion and Inclusion criteria of participants for recruitment for this study**

| ***Exclusion criteria*** | ***Inclusion Criteria*** |
|---|---|
| • *Pregnant*<br>• *Concurrently sustained a TBI, lumbar spine (requiring surgical fixation), spinal cord, abdominal (requiring a lap), or urogenital injury (requiring surgical repair) that may have precipitated neurological dysfunction of elimination*<br>• *Zero to four months post-partum*<br><br>***Rationale for exclusion criteria***<br>• *Pregnancy and the 4th trimester post-partum are associated with temporary symptoms of PFD. Abdominal and urogenital injuries requiring surgical repair indicate high severity of damage and risk of increased intra-abdominal pressure either from the injury or the surgical procedure, which is linked to symptoms of PFD. Spinal surgery introduces risk of cauda equina signs which include symptoms of PFD. Injuries that affect cognition and neurology were also excluded as the study required the participants to answer questions.* | • Female<br>• Aged at least 18 years at time of injury<br>• Have no cognitive impairments (determined by patients being orientated to time, place, person and scoring 15/15 on the Glasgow Coma Scale)<br>• Sustained at least one pelvic fracture to the pubis, ilium, ischium, sacrum, or an isolated acetabular fracture. (Although none of the pelvic floor musculature originates from the acetabulum or shares a common fascia, the acetabulum is formed by all three of the pelvic bones and may be associated with a concurrent force impacting another part of the pelvis)<br>• For out-patients, attending their follow up appointment <= three month's post injury |

## 3.4 Instrumentation and Outcome Measures

Figure 3-3 below summarizes the assessments and outcome measures used in this study, when they were used and the reason for including them. A subjective assessment form was drawn up to collect participants' medical history and demographic information. Three standardized outcome measures were used in the study as explained below.

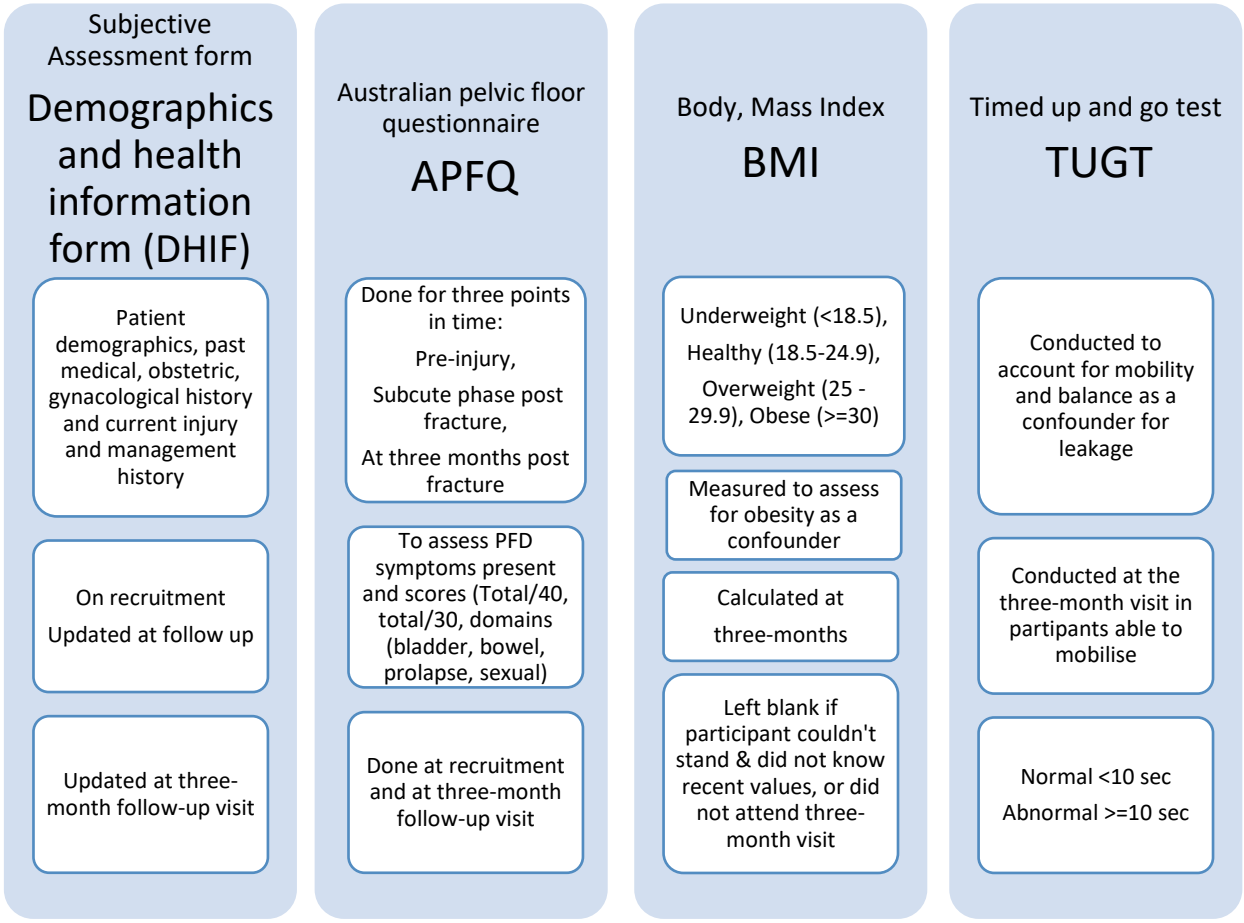


**Figure 3-3 Summary of outcome measures used**

### 3.4.1 Subjective assessment form: Demographics and health information form

Table 3-3 below tabulates the contents of the demographics and health information form (DHIF) (Appendices C - F) used which consisted of six sections (A-F). This is an assessment form compiled by the researcher on key background health information, related to the objectives of this study, that needed to be obtained about the participants as well as information on their injury and subsequent management provided. This assessment form was only compiled in English as we extracted as much of the information required in Sections B – F, from the participant's medical files.

Sections A-E were retrieved at recruitment. Sections D, E and F were updated at the three month follow up visit based on additional investigations done and management provided after recruitment, as noted in the patient's file.

#### *3.4.1.1 Medical History*

Participants' histories were obtained according to the questions highlighted in the DHIF. This information was primarily retrieved upon recruitment. We cross checked the information obtained from the medical records, with the participants and asked for any missing or additional information not available in the medical records using non-medical jargon that the participants were able to understand, and this was documented. Where a patient was unable to understand English, an interpreter asked the questions.

**Table 3-3 Sections of the Demographics and health information form**

| Appendix | Section | Description of data being collected |
|---|---|---|
| C | A | Patient demographics (age, ethnicity, marital status), co-morbidities (including respiratory conditions) |
| C | B | Preinjury urologic and gastrologic medical and surgical history |
| C | C | Obstetrics and gynaecological medical and surgical history |
| D | D | Current pelvic injury related history (mechanism of injury, type of pelvic fracture sustained, anatomical structure fractured, additional injuries sustained) obtained from the participant's medical records |
| E | E | Information on management received as per routine practice in the service consisting of details on type of management: conservative (bed rest, traction, casting, weight bearing) or surgical (type of surgery, associated management), number of days for each management, length of stay (LOS) in hospital, and use of urinary catheter during hospital stay |
| F | F | Physiotherapy management, and timed-up-and-go test |

#### *3.4.1.2 Fracture Type*

Section D of the DHIF prompted collection of data related to the type of fractures sustained. Fractures were documented based on the descriptions provided in the file by the orthopaedic doctors and by reviewing the radiological studies and reports obtained from all the participants' medical records. Description of fractures included the areas fractured as noted in

Table 3-4 and if one or multiple pelvic fractures were sustained. Where indicated, the classifications of the fractures were noted. We also noted participants with specific report of involvement or disruption of the SIJ, ligaments, and PS.

**Table 3-4 Categorisation of fractures**

| **Fracture categories** |
|---|
| Only one fracture |
| Isolated pubic ramus (only one ramus fractured, no other fracture) |
| Multiple pelvic fractures |
| Pubic rami involvement<br>(one or more pubic rami with or without other fractures)<br>Right superior pubic rami<br>Left superior pubic rami<br>Right inferior pubic rami<br>Left inferior pubic rami |
| Bilateral combined superior and inferior pubic rami |
| Bilateral inferior pubic rami |
| Sacral Involvement |
| Ilium involved |
| Ischial tuberosity involved |
| Acetabular Involvement |
| Significant sacroiliac joint or pubis symphysis displacement or injury noted |
| Sustained additional injuries |

*3.4.1.3 BMI*

Prather et al. (2007) highlighted that body mass index (BMI) is one of the important physical examinations to perform when managing PFD. Obesity is among the main risk factors associated with PFD (Carson et al., 2018; Kenne et al., 2022; Wu et al., 2014).

BMI was therefore calculated at the three-month follow up for all participants who were able to stand, to account for phenotype as a confounder. Weight and height were checked using a standard scale and height ruler in standing. For participants (n=2), who could not stand on a scale, they were asked their height and last weight weighed. If participants were unable to stand to be weighed and have height measured, or they did not know their height or weight, or were not weighed recently, their BMI was treated as missing data.

#### *3.4.1.4 Timed up and go test*

The timed up and go test (TUGT) was conducted in all mobilising participants at the three-month follow-up. For participants unable to mobilise, this data was omitted. This test, initially developed for use in older adults (Podsiadlo and Richardson, 1991), was performed to account for problems in functional mobility and balance that may be a confounding variable for urinary leakage. All participants had to wear their regular footwear and where needed, could use a walking aid. The test was conducted with the participant starting in a seated position in a chair (Wellmon, 2007). The participant then stood up upon our command, walked three meters at a comfortable pace, turned around, walked back to the chair, and sat down. The test is scored on the time taken; the timer starts at the same time as the command is given and stops when the patient returns to sitting. The TUGT has a high intratester and intertester reliability (ICC) in elderly populations with reporting's from 0.92 - 0.99. Construct validity has been demonstrated through correlation of TUGT scores with Barthel Index (Pearson r = -.79), gait speed (Pearson r = .75), step length (Pearson r = -.74), postural sway (Pearson r = -.48), and step frequency (Pearson r = -.59) (Steffen et al., 2002).

### 3.4.2 Australian pelvic floor questionnaire (Data collection tool)

The Australian Pelvic Floor Questionnaire (APFQ) (Baessler et al., 2009) (Appendix G), which is in the public domain, was administered a total of three times for each participant as described in the section on Data collection procedure. The APFQ is a validated interviewer-administered (Baessler et al., 2009) and self-administered (Baessler et al., 2010) pelvic floor questionnaire with four domains (urinary/bladder, bowel symptoms, POP symptoms and sexual dysfunction symptoms) that assesses all pelvic floor symptoms including severity of symptoms, bothersome, and quality of life impact in women with pelvic floor disorders. The domains correlate with the Urogenital Distress Inventory (short version), an established bowel questionnaire, the International Continence Society prolapse quantification and scores on the McCoy Female Sexuality Questionnaire (Baessler et al., 2009).

An online website survey version with a prediction tool for diagnosis also exists (*Survey - MyPelvicFloor, https://www.mypelvicfloor.com/Survey*) discussed with table 3.6. The APFQ has been translated and validated in multiple languages (French, Dutch, Danish,

Hindi, Italian, German, Serbian, Chinese, Japanese, Korean, Turkish, Persian, Spanish, Arabic, Urdu, Hebrew, Indonesian) and patient populations; however, it has not been validated in any of the official South African languages other than English.

For this study it was decided that it will be interviewer administered using the English version. During the pilot study (discussed below in section 3.5.2.) standardized cues (detailed in Table 3-7) based on colloquial South African terminology and common translations (e.g. “kak” or “kaka” instead of stool; “fart” instead of flatus or wind) were decided on and utilized to aid in overcoming the language barrier; where needed an interpreter assisted.

Additive scores are calculated separately per domain by adding the scores for each question within each domain (bladder, bowel, POP, and sexual symptoms). Resulting scores per participant are calculated by dividing the additive score by the number of relevant questions within each domain and multiplied by ten, giving a value of zero to 10 for each of the four domains and a maximum global PFD score of forty. Higher scores indicate more severe symptoms. Sections not applicable to participants are excluded from the total scoring. Table 3-5 describes the validity and reliability of the APFQ screening tool. The APFQ has been validated in groups of urogynaecological patients and applied in broad populations.

**Table 3-5 Validity and reliability of the Australian Pelvic Floor Questionnaire (Baessler et al., 2009)**

| DOMAINS | Cronbach’s α coefficients | Validity | Test-Retest Reliability | Bland–Altman plots |
|---|---|---|---|---|
| **Overall** | acceptable in all domains | | Kappa coefficients 0,5 - 1,0 | |
| **Bladder** | 0,72 | Spearman’s rho 0.80; p<0.001 | 77% to 99% | 0.13 (0.05) |
| **Bowel** | 0,82 | The Spearman coefficients average of 0,89; p<0.001 | 87% to 99% | 0.05 (0.05) |
| **Prolapse** | 0,95 | (Spearman correlations 0.25–0.68) but statistically significant | 96% to 98% | 0.08 (0.05) |
| **Sexual** | 0,81 | Spearman −0.73; p<0.001 | 85% to 100% | 0.11 (0.10) |

Recently, an online diagnostic prediction model was developed and internally and externally validated based on the APFQ and patient demographics (Chen et al., 2022) of a large (>3500) and multicentred patient source. Secondary analysis of the APFQ domains resultant scores found significant differences in mean scores for women with and without PFD, which can be used as the "normal" values to determine if an individual has or does not have PFD. Table 3-6 mentions the normal APFQ scores for women with and women without PFD based on this study's results.

**Table 3-6 Difference in mean APFQ scores^ for women with and without PFD based on a study by Chen et al., (2022)**

| | Women *without* PFD: Mean (95% CI) (n=3032) | Women *with* PFD: Mean (95% CI) (n=3032) | *p value** |
|---|---|---|---|
| **Bladder** | 1.15 (1.03 – 1.27) | 3.47 (3.40 – 3.55) | <0.0001 |
| **Bowel** | 0.95 (0.85 - 1.04) | 2.19 (2.13-2.24) | <0.0001 |
| **Sexual Function** | 2.87 (2.74 – 3.00) | 4.16 (4.07 – 4.25) | <0.0001 |
| **POP** | 0.38 (0.26 – 0.50) | 4.08 (3.95 – 4.21) | <0.0001 |
| **Total^** | 5.35 (5.07 -5.63) | 13.90 (13.69 – 14.11) | <0.0001 |

*APFQ* Australian pelvic floor questionnaire, *PFD* pelvic floor dysfunction, *POP* pelvic organ prolapse

*Two-sample unpooled *t* test, with difference between those with and without pelvic floor dysfunction significant across all domains

^ Score ranges: bladder, bowel, prolapse and sexual function = 0 to 10; total = 0 to 40

For the current study, the bladder domain was scored zero for participants still using a urinary catheter at the subacute or three-month phase if the reason for the urinary catheter was not related to PFD issues. In addition to the score out of 40, a total score out of 30 that excluded the sexual domain score was calculated for all participants in anticipation that some may not be sexually active at the time of questioning at three month's post pelvic fracture.

## 3.5 Data collection procedure

### 3.5.1 Research Assistant

For this study, I appointed and trained one research assistant (RA) as a backup for when I was unable to attend the clinics. The RA was a qualified male physiotherapist completing his MSc degree in physiotherapy at the time and had experience collecting data on PFD in pregnant women for another study. He assisted me with screening, recruitment, and data collection for two months for a total of 10 participants. Training included information on the process of the study, administering of the APFQ questionnaire and the amount of assistance that could be provided to the participants based on the pilot study findings, to ensure standardization of the methodology.

### 3.5.2 Pilot study

A pilot study, on three participants, was conducted over two clinic days, using all the data collection tools and following the same procedure as the main study (summarized in Figure 3-1 at the start of this chapter and detailed later in Main study). As participant one was at three months post injury, all the data collection could be done at the same visit including the TUGT and BMI measurements. For participants two and three, data were collected in the subacute phase and then at three months according to the main study procedure. Based on the pilot study experience, it was decided that recruitment and data collection could only start after day three of injury as participants were not emotionally ready for this type of discussion and questionnaire immediately following the injury

The pilot study was done specifically to assess the ease of administering the APFQ and to identify how much assistance/ prompting would be required, as well as ease of performing the TUGT. It allowed for assessing and improving the validity and reliability of the DHIF as well.

The TUGT was easy to administer; after the pilot study, markings were made in a specified area to standardize where the TUGT was to be performed for all participants.

Table 3-7 highlights the issues identified with the DHIF and the APFQ, and the standardized cues (explained below) chosen to overcome these that were implemented in the main study. For the first participant the APFQ was used as per the original terminology in the questions. The standardized explanations/ colloquial terminologies were tested in participant two's subacute questionnaire and tested for participant two's three-month follow-up and all three of participant three's questioning (preinjury, subacute, three-month-post) and then applied to the main study.

Unfamiliar and/or medical terminology such as diagnosis and procedure names made it difficult to obtain a response for some options on the DHIF during the pilot study. Participants may not always know these terminology/concepts, and healthcare practitioners may explain them in different ways, both leading to incorrect or no responses. To avoid such bias and standardize the way this data was obtained, definitions were provided to standardize how these terms were explained in instances where participants did not understand the medical term. Hence, the actual questions/information to be obtained were not changed, but different explanations being used between participants was avoided. Standardized definitions improved the validity and reliability of the DHIF and of participants responses.

Regarding the APFQ, participant one understood English and could understand the words, however she had difficulty understanding what some of the questions on the APFQ were asking and required prompting. To avoid bias throughout the study, standardized cues, colloquial words, and standardized explanations for certain questions were chosen for use in future such instances to prompt and help patients better understand questions where further explanations were necessary. Certain demonstrations while asking the questions were also chosen to allow for clarification and better understanding of questions. However, the actual questions were not changed, maintaining the validity and reliability of the tool. Therefore, although the APFQ can be self-administered or interviewer administered, because difficulty understanding the questions were noted, it was decided that I/RA was to administer the APFQ using the standardized prompting.

As changes made were mainly the use of sound, adding a visual demo of the statement or using the South African colloquial/translated African word as opposed to the medical

or western jargon, the data obtained from the pilot study were included in the main study.

**Table 3-7 Adjustments arising from pilot study**

| **Execution** | | |
|---|---|---|
| Only start data collection after day three of injury | | |
| Demographics and health information form and Australian pelvic floor questionnaire to be administered by researcher/ research assistant and not be given to participant to answer | | |
| **Demographics and health information form changes:** | | |
| **Section** | **Question label/option** | **We asked patients** |
| C | Has patient ever experienced amenorrhea? | Have you ever missed a period not related to pregnancy or did your menstruation start after the age of 15?" |
| C | When enquiring if patients had/have the following complications during and from pregnancy and/ labour, we did not use the medical terminology<br>a) "diastasis rectus/pubis"<br>b) "placenta previa" | a) Were your abdominal muscles very weak and bulging post birth?<br>b) Did you have excessive bleeding during second trimesters or delivery |
| E | Types of management received: skeletal traction | To explain skeletal traction, the participant was asked if they had screws placed above/below the knee with poles connecting to weights |
| **Australian Pelvic Floor Questionnaire – questions reworded** | | |
| **Domain-Question number** | **Question according to questionnaire** | **Our rephrased version of question asked and/demonstrations done** |
| Bladder Q3 | Do you wet the bed before you wake at night? | Did/do you ever pee in your sleep, before waking up and found sheets wet when you woke up? |
| Bladder Q8 | Do you have a feeling of incomplete bladder emptying? | Did/do you ever go to toilet to pee, but then feel/felt like more still wanted to come out? |
| Bladder Q13 | Do you have pain in your bladder or urethra when you empty your bladder? | Point to the surface areas of the bladder and urethra |
| Bowel Q16 – 27 | For bowel section of APFQ, if a participant did not understand the meaning of "bowels" and "stool", | "Poo/kaka" was used |
| Bowel Q21 | When you get wind or flatus, can you control it, or does wind leak? | When you need to make a poop, prr/ fart, can you hold it in, or does it just come out? |
| Prolapse Q28 | Do you have a sensation of tissue protrusion/lump/bulging in your vagina? | Do you feel like something firm (not discharge) is coming out of vagina, like baby when giving birth but smaller/ tampon falling out? |
| Sexual Q35 | Do you have sufficient vaginal lubrication during intercourse? | Do you feel/get wet enough in your vagina during intercourse? |

### 3.5.3 Main study

Figure 3-1 provided a detailed flow diagram of the timing of recruitment and the data collection process conducted for this study. Data collection was broken down into two phases. Figure 3-4 provides a quick overview of the data collected during each phase. Phase of collection did not always coincide with phase of healing in that all participants were not recruited in the subacute phase as explained in section 3.3.3. Figure 3-5 highlights a keynote regarding time of recruitment and data collection for participants recruited at three months post pelvic injury. For both phases, in the instance where participants were unable to understand English, a healthcare worker or family member in the setting were used as interpreters.

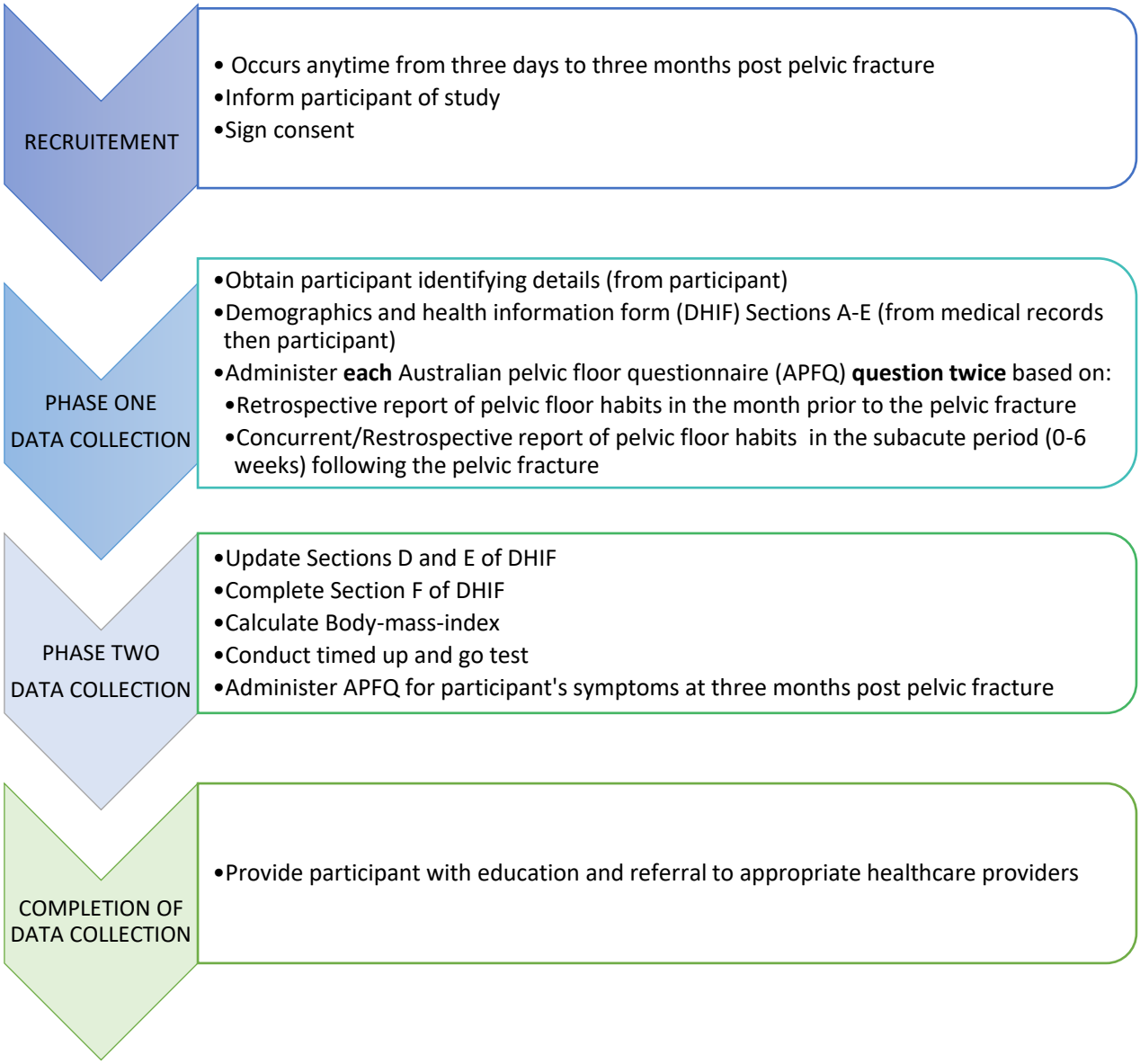


**Figure 3-4 Breakdown of data collected during each phase**

*3.5.3.1 Data collection Phase 1: At recruitment*

Following signed consent, participants' identifying details (Appendix H) and demographics (Appendix C) were retrieved. Sections A-E on the DHIF (Appendix C, D, E and F) was obtained as described in section 3.4.1.1 and 3.4.1.2. The APFQ (Appendix G) was then administered twice: first based on the patients' retrospective account of symptoms for the month prior to the fracture, and secondly based on the participants' current symptoms after the injury. However, each question was asked simultaneously for the different time points, for example: a participant recruited in the subacute stage following a pelvic injury was asked "how many times did you pass urine per day prior to your injury" and following her response for preinjury, she was asked the same question for the current time point "how many times do you pass urine a day currently after the injury?". This was done to avoid fatigue of answering all the questions twice.

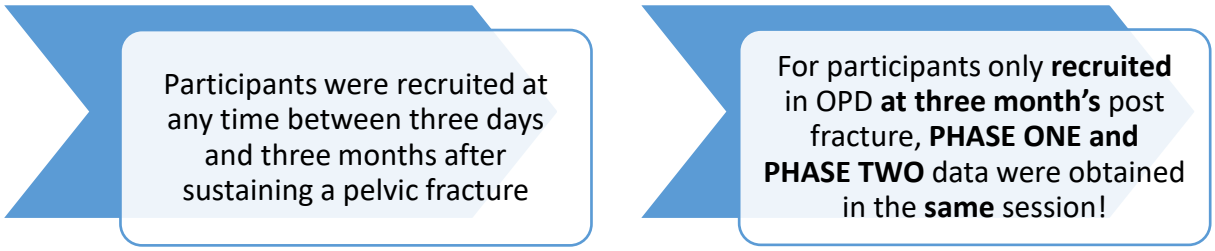


**Figure 3-5 Disclaimer regarding timing of data collection phases relative to time of recruitment**

*3.5.3.2 Data collection Phase 2: Follow-up visit at three months post pelvic fracture*

The second phase of data collection took place at three months post pelvic fracture. For participants still residing in hospital at three months post injury, phase two of the research process was completed in the ward. The remaining participants (recruited as in-patient's and discharged home, or as an out-patient in the subacute phase), completed phase two in OPD on their three months orthopaedic review date or corresponding physiotherapy follow-up date.

At the three month follow up, the APFQ was administered by either the researcher or the assistant to indicate current symptoms (at three month's post injury). The TUGT and BMI were calculated as detailed in 3.4.1.3 and 3.4.1.4. and recorded for all the participants who were able to mobilize and stand, respectively. The participants' files were checked for date of discharge, length of urinary catheter usage, and section D, E and F (Appendix D – F) were updated with any new information.

All participants were provided with general education and prevention strategies. Participants presenting with symptoms and consenting to treatment, were provided generic education and exercises/ strategies for their top three symptoms and referred to or booked for physiotherapy according to the standard catchment protocol of the hospitals.

Participants unwilling to complete phase 2 were asked if phase 1 data could still be included.

### 3.5.4 Measures taken to encourage participants compliance attending follow up visit:

- I presented my research protocol to the orthopaedic surgeons to familiarize them with my research and highlight what assistance I required. WhatsApp groups consisting of myself, the RA, the orthopaedic doctors, and physiotherapists were used whereby I would send reminders to them to refer patients to the physiotherapy department for me or inform me if there are potential participants at the clinic.
- Participants recruited in hospital, were provided with a research participant information sheet explaining that they were expected to contact me once receiving the date for their three month follow up appointment post discharge. A note was also attached to the participants OPD file informing the orthopaedic doctors of which patients were a research participant and to contact me if they arrived in OPD at three months post fracture.
- Closer to their three month follow up dates, participants were contacted individually via SMS or telephonically to remind them of the second phase of data collection and note down their appointment date with the doctors.
- If the participant gave consent at recruitment but did not attend their routine orthopaedic and/ research follow up appointment, they were contacted

telephonically to reschedule a date to come in for the research follow-up visit and re-imbursed for travel expenses.

- If they were unable to attend a follow-up visit in person, they had to re-consent and the APFQ was administered telephonically. Section E and F of the DHIF were also updated, and date of discharge asked. BMI and TUGT values were left blank.

## 3.6 Ethical considerations

### 3.6.1 Approvals

Ethical approval for this study was obtained from the Human Research Ethics Committee (Medical) (HREC-Med) of the University of the Witwatersrand (Appendix I). Approval for change of title was obtained from the Faculty Registrar of the University of the Witwatersrand faculty of Health Sciences (Appendix J) and HREC-Med (Appendix K). Permission was also obtained from the Medical advisory committees (MAC) of both study sites (Appendix L and M), the hospital CEO'S and heads of departments (Appendix N, O and P). The protocol was also submitted to the National Health Research Database (NHRD). Signed informed consent was obtained from participants prior to commencement of data collection as described in 3.3.2.

### 3.6.2 Provision of physiotherapy treatment

The research process did not interfere with the standard protocol for physiotherapy management of musculoskeletal and mobility impairments; therefore, patients requiring physiotherapy continued to be treated by the OPD physiotherapists within the first three months post-injury, and only met me or the RA at three months post injury for the research follow up questions.

### 3.6.3 Risk to patients

The risk to participants were low as they revealed their symptoms associated with their pelvic floor, urinary, bowel and sexual function and any associated opportunistic infections. The researcher expected the questionnaire to invoke an emotional response, but no participant indicated this. No need was found to refer any participant to the social worker as none needed to receive counselling. The TUGT was low risk

for injury and only tested in participants that were able to mobilise with or without an assistive aid.

## 3.7 Data management

All data were captured on a REDCap database (Harris et al., 2009, 2019) using a Smartphone or laptop. All information obtained and answers were recorded directly on RedCap, or on paper and later to RedCap. Each participant was allocated a unique participant number. Patient identifiers were anonymized, kept separate from data collection sheets and only accessible to me and my supervisor. Data were exported to Excel. Variables were created to describe some demographics, to determine participants with one or multiple fractures and isolated pubic ramus fractures, to categorize the common management types, to store the scores, to calculate the frequency for each symptom and the difference in frequency between time points, and to calculate the change in scores for specific symptoms between time points. Data is being stored in a password protected cloud-based storage and will be kept securely for minimum two years if a scientific publication arises from the study or six years if no publication arises, after which it will be deleted from all storage platforms. Data will be presented in a group if published in a journal, and no participants will be identifiable.

## 3.8 Data analysis

Table 3-8 provides the variables and details of data analysis performed for each objective. All analysis was carried out using either StataSE 17.1 or StataSE 18.0 (Statacorp, College Station Texas). Participant's demographics, medical histories, injury, and management history as well as PFD symptoms at the three time points (prior to pelvic fracture, subacute period post pelvic fracture and three months post pelvic fracture) were described. Age was reported as medians to compare to results from other studies, and in categories to determine the predominant ages in this population and to assess correlations between age groups and symptoms.

Categorical variables were summarised using frequencies and percentages while continuous variables were summarised using median and interquartile range (IQR) if not normally distributed, and mean and standard deviation (SD) if normally distributed.

Normality was assessed using a histogram plot with a superimposed normal curve. Pie charts and bar charts were used for categorical variables. The APFQ scores were described and compared between preinjury and three months post fracture, the preinjury and subacute period post pelvic fracture, and the subacute period and three months post pelvic fracture. Differences between mean scores were assessed using a paired T-test. Combined line and column charts were used to show the comparison between continuous variables to normal values. Linear regression was used to predict risk factors for the outcome of PFD and predict the APFQ score; results were reported as coefficients, 95% confidence intervals and p-values. The level of significance was set at 0.05.

Due to the sample size, multivariate logistic regressions could not be done to account for interrelated variables and confounders when determining associations between scores and fracture types and management; and to assess effect of confounders on the significant differences found between the scores for the different time points.

## 3.9 Summary of the methodology

This section discussed this study's methodology. The study setting, population, sampling, outcome measures, and procedure for data collection were explained. The results of the data collected, and data analyses will be discussed in Chapter 4 in relation to the study objectives outlined.

Table 3-8 Summary of study objectives and statistical analyses performed

| Objective | | Statistical tests |
|---|---|---|
| 1. | To determine and describe symptoms of pelvic floor dysfunction (PFD) prior to and at three months post-pelvic fracture in female patients treated at two academic hospitals in Johannesburg | Summarised continuous variables using means and Standard Deviation (SD). The proportion of PFD was reported using frequencies and percentages.<br>Linear regression was used to predict the total APFQ score preinjury and at three months using several variables such as age, pregnancies, parity, vaginal delivery (NVD), number of NVD, BMI, timed-up-and-go test score (TUGT), time of recruitment, menopause |
| 2. | To determine the demographics, preinjury medical history, types of fractures sustained, and management of these patient's post-pelvic fracture. | Summarised continuous variables using means (SD) if normally distributed or median (interquartile range (IQR)) if skewed. Categorical variables were reported using frequencies and percentages. Normality was assessed using a histogram plot with a superimposed normal curve. Pie charts and bar charts were used to present categorical variables. Age was reported as medians and in categories. |
| 3. | To compare symptoms of PFD present at three months post-pelvic fracture to PFD symptoms present prior to and sub-acutely post-pelvic fracture | Used a paired T-test to get significant differences between APFQ total and domain scores preinjury vs three months post fracture, and acute phase post fracture vs three months post fracture.<br>The proportion and comparison of PDF were reported using frequencies and percentages. |
| 4. | To determine factors (demographic variables, type of pelvic fracture sustained,<br>the types of orthopaedic and supportive management received) associated<br>with PFD scores | Correlation, Chi-square test and Linear regression were used to predict the total APFQ score at three months using several variables including one vs multiple fractures, and the several types of fractures and additional injuries, combinations of management, urinary catheter usage, duration of urinary catheter, and pelvic health physiotherapy to determine the association between the score/severity of PFD and the variables Significance was set at 5% and analysis was done using Stata 18. |

# Chapter 4 Results

## 4.1 Introduction

This chapter provides the results obtained from this study. The chapter presents number of participants meeting inclusion criteria vs number recruited, followed by descriptive and inferential statistics specific to the primary and secondary objectives. The demographic characteristics (4.3.1), comorbidities and medical history (4.3.2), injury types and mechanisms (4.3.3 and 4.3.4), management and treatment received (4.3.5) are summarised. Symptoms of PFD experienced by participants are described (4.5). The participants were followed-up for three months and comparisons were made with reference to baseline for both subacute and three months' time points. Data were analysed as described in section 3.8. Results are presented as tables, pie charts or bar charts. Exploratory analyses that were identified during data analyses are noted. Data collection occurred between January 2022 and July 2023 on participants who sustained a pelvic fracture between 30 September 2021 and April 2023.

## 4.2 Study population

The flowchart in Figure 4-1 shows the eligibility and number of participants through each stage of the study. All participants agreed for phase one data to be included in the study regardless of their participation at three months. All participants refusing to complete phase two, gave consent for phase one data to be included. A total of 44 participants were recruited of which 42 participants completed all the data for the subacute phase; 39 participants attended the three-month follow-up session. Only 37 participants fully completed all the APFQ questions for three months post injury. Some participants were lost to follow-up and one demised. Of the 44 participants, eight were from CMJAH while 36 were from CHBAH. Two participants were unable to speak English, for whom an interpreter was used.

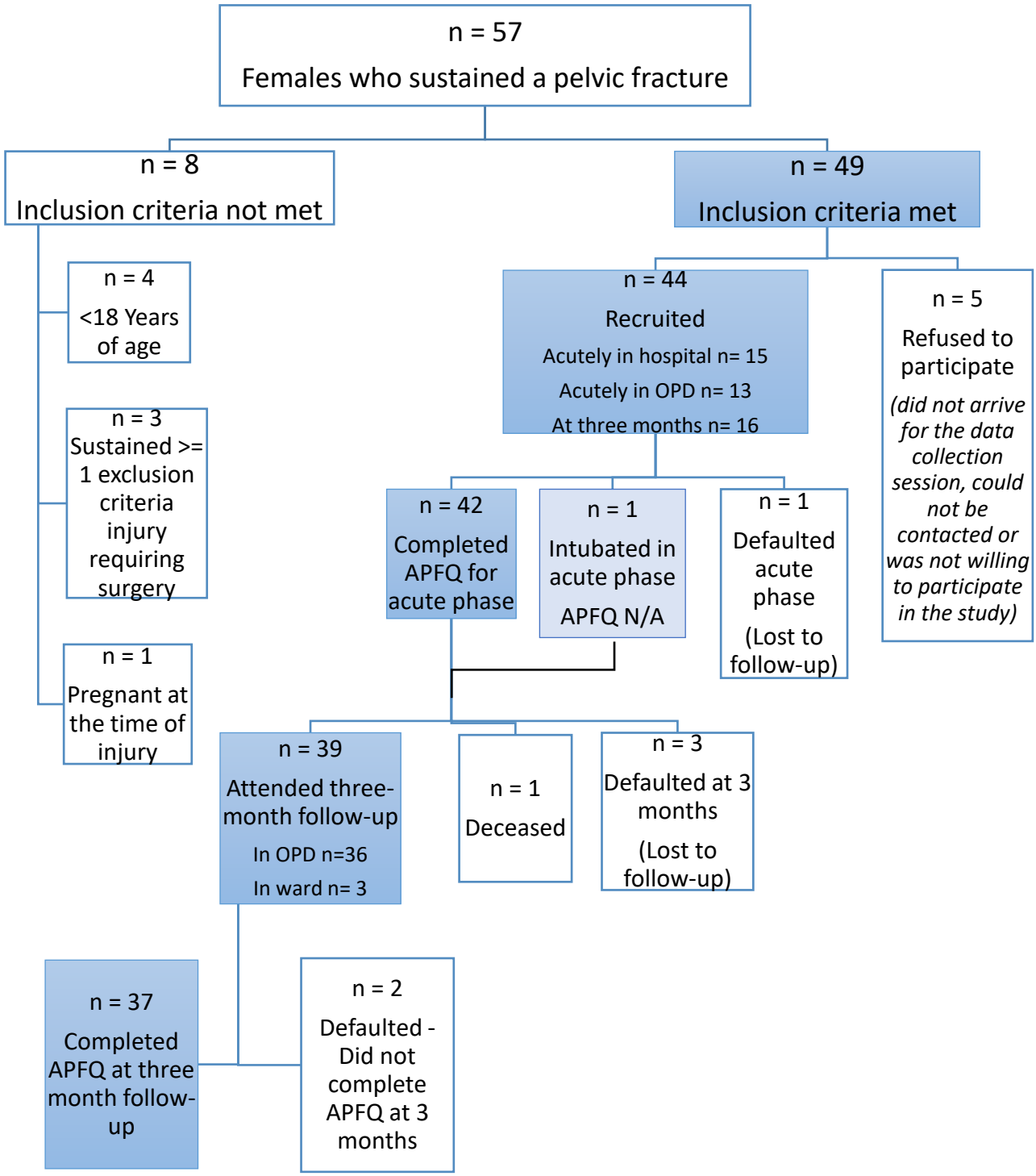


**Figure 4-1 Identification, screening, exclusion of participants**

***APFQ: Australian Pelvic Floor Questionnaire***

## 4.3 Demographics and injury related characteristics of the participants

The aim of this section is to describe participant's demographics, preinjury medical, urogynaecology, gastroenterology and obstetric history, mechanisms of injury, types of fractures sustained, and the orthopaedic management provided to patients which relate to the second objective of this study.

### 4.3.1 Age, ethnicity, BMI, marital status

Figure 4-2 shows that participants ages were right skewed with a median age of 37 years (interquartile range: 30.5 - 58).

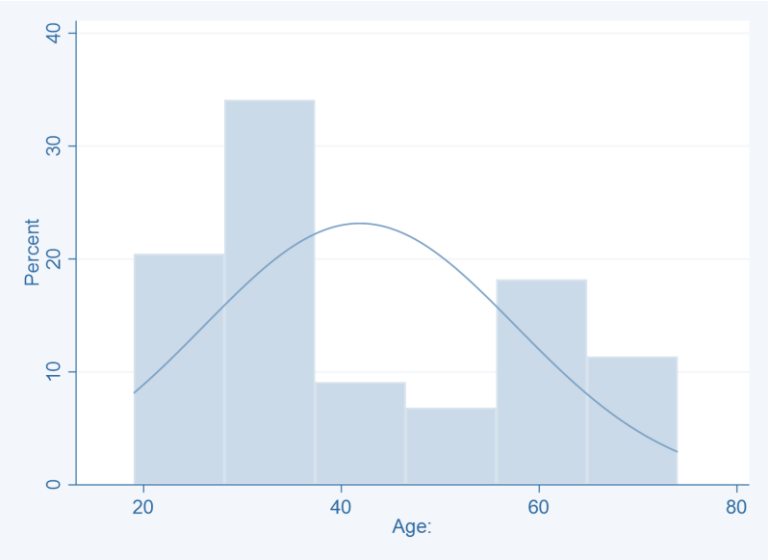


**Figure 4-2 Distribution of participants' age**

Table 4-1 shows the demographic characteristics of the participants. Twenty-five (56.58%) participants were in the age category 18-40 years, 12 (27.27%) participants were between 41–60 years age group, and seven (15.91%) participants were above 60 years. The oldest participant was 74 years old.

Most of the participants were of the black race (93.18%, n=41), and 6.82% (n=3) coloured. No white, Asian, or Indian participated in this study. Single participants accounted for 47.73% (n=21) of participants while 16 (36.36%) had a partner and six (13.64%) were married.

Body mass index (BMI) was calculated for 39 participants who were able to stand on a scale at three month's post injury (n=37) or knew their weight and height (n=2). The

mean (SD) BMI of the participants was estimated to be 27.4 kg/m$^2$ (6.4). Most of the participants (34.09%, n=15) had a normal BMI.

**Table 4-1 Participant demographics**

| Variable | Categories | Summary statistic |
|---|---|---|
| Age (years), Median (IQR) | | 37 (30.5-58) |
| Age categories (years), n (%) | | |
| | 18-40 | 25 (56.82) |
| | 41-60 | 12 (27.27) |
| | 61+ | 7 (15.91) |
| Race, n (%) | | |
| | Black | 41(93.18) |
| | Coloured | 3 (6.82) |
| Marital status, n (%) | | |
| | Single | 21(47.73) |
| | Married | 6(13.64) |
| | Divorced | 1(2.27) |
| | Have a partner | 16(36.36) |
| BMI (kg/m$^2$), Mean (SD) | | 27.4 (6.4) |
| BMI categories n (%) | Underweight (<18.5 kg/m$^2$) | 2(4.55) |
| | Normal (18.5-24.9 kg/m$^2$) | 15(34.09) |
| | Overweight (25-29.9 kg/m$^2$) | 11(25.00) |
| | Obese (>=30 kg/m$^2$) | 11(25.00) |
| | Not specified | 5(11.36) |

### 4.3.2 Co-morbidities and medical history

Figure 4-3 shows the comorbidity distribution of the participants. Only 52.27% (n= 23) of participants had other underlying comorbidities. There were 36.36% (n=16) participants with HIV-infection, followed by 15.71% (n= 7) with hypertension and 9.09% (n= 4) with osteoarthritis.

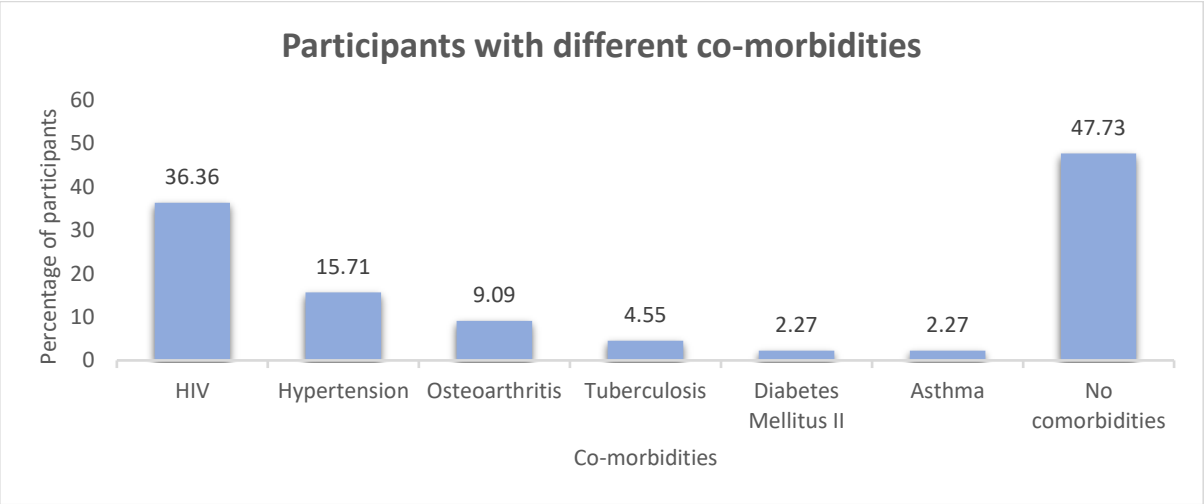


**Figure 4-3 The distribution of co-morbidities**

Figure 4-4 notes the distribution of urogynaecology conditions among participants. Regarding urogenital and gastroenterology history preinjury, 50% (n= 22) of participants had an existing condition.

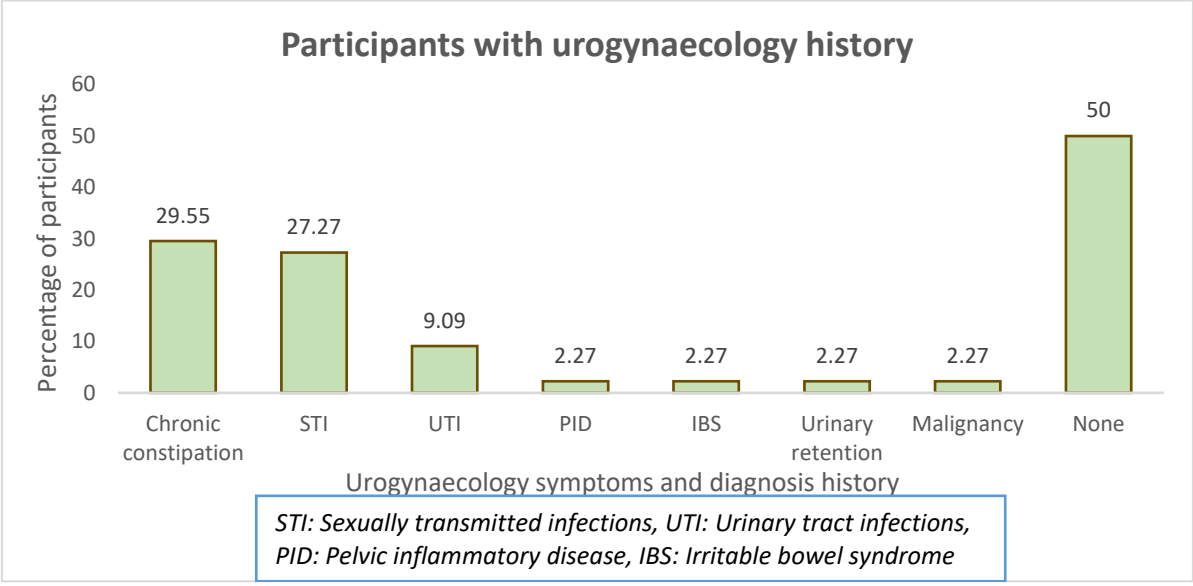


**Figure 4-4 Distribution of past urogynaecology diagnosis**

The most common conditions encountered by participants prior to their pelvic fracture were chronic constipation (29.55%, n=13) and sexually transmitted infections (STI) (27.27%, n=12). Recurrent UTI's were noted in four (9.09%) participants. Only one participant had a history of urinary retention and one a history of pelvic inflammatory disease (PID).

Medical, urogynaecology, gastrointestinal, and obstetric history are reported in Table 4-2. Only two participants (4.55%) were in menopause during the time of the study, while 13 (29.55%) were post-menopausal and 29 (65.91%) were premenopausal. Twenty-eight (96.55%) of the premenopausal women were still menstruating while one (3.45%) was experiencing secondary amenorrhea. A total of 29.55% (n=13) of participants experienced secondary amenorrhea at some point in their lives.

The obstetric histories in terms of the average number of pregnancies, live births, miscarriages, and mode of deliveries experienced per participant were summarised. The average number of pregnancies was two, with 34 (77.27%) participants having been pregnant at least once. The average number of live births was two and 29 (65.91%) had at least one live birth. Most of the women gave birth through normal vaginal delivery (59.09%, n=26) while seven (15.91%) gave birth through caesarean section at least once. There were 12 (27.27%) miscarriages, for which nine (20.45%) women underwent dilation and curettage.

**Table 4-2 Medical, urogynaecology, gastrointestinal and obstetric history**

| | **Variables** | **n (%)** | **Mean (SD)** |
|---|---|---|---|
| **Medical, urogynaecology and gastrointestinal history** | Other existing diagnosis | 22 (50.0) | |
| | Pelvic organ prolapse | 1 (2.27) | |
| | Hysterectomy | 2 (4.55) | |
| | Pre-menopausal | 29 (65.91) | 2.50 (1.94) |
| | Menopausal | 2 (4.55) | 2.58 (2.09) |
| | Post-menopause | 13 (29.55) | 3.46 (2.45) |
| | Experiences menstruation | 28 (63.64) | |
| | Experienced amenorrhea | 13 (30.9) | |
| **Obstetric History** | Pregnancies | 34 (77.27) | 2.3 (1.3) |
| | Parity/ Live births | 29 (65.91) | 1.7 (1.7) |
| | Caesarean section | 7 (15.91) | 0.3 (0.6) |
| | Normal vaginal delivery (NVD) | 26 (59.09) | 1.5 (1.8) |
| | Dilation and curettage | 9 (20.45) | 0.3 (0.7) |
| | Miscarriage | 12 (27.27) | 0.5 (1.0) |

Complications experienced during labour is reported in
Table 4-3. Regarding main labour complications, 13 (29.55%) of the participants had had perineal tear, 11 (25%) had episiotomy and 17 (38.64%) had perineal stiches.

**Table 4-3 Complications of labour**

| | Variables | n (%) |
|---|---|---|
| | Perineal stiches | 17 (38.64) |
| | Perineal tear | 13 (29.55) |
| | Episiotomy | 11 (25) |
| | Induced labour | 8 (18.18) |
| | Premature labour | 5 (11.36) |
| | Diastasis rectus | 1 (2.27) |
| | Placenta previa | 1 (2.27) |
| | Other | 2 (4.55) |

### 4.3.3 Mechanism of injury

Figure 4-5 below illustrates the distribution of mechanisms of injury. Motor vehicle accidents (MVA) was the mechanism of injury for 50% (n=22) of participants, followed by pedestrian vehicle accidents (PVA) (36.40%, n=16), adding up to a total of 86.40% of participants in this study sustaining their injuries from road traffic accidents (RTA).

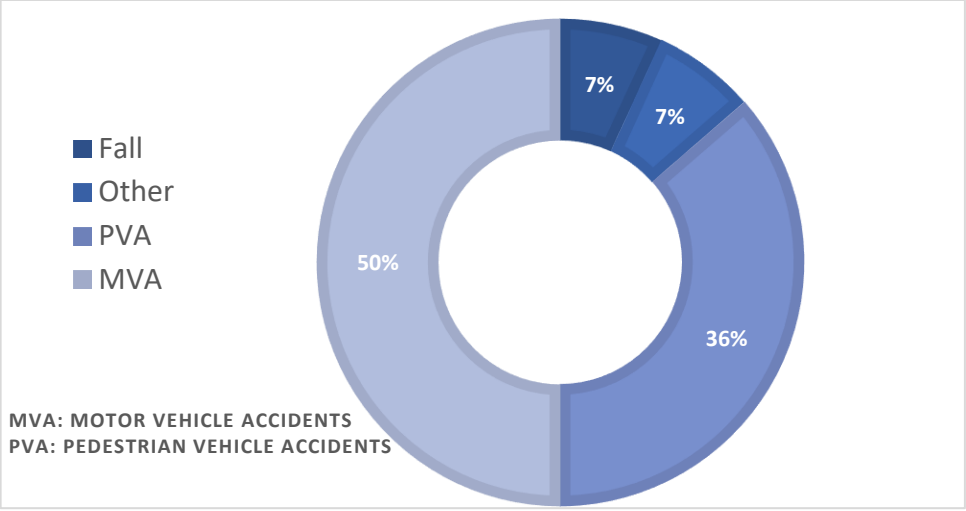


**Figure 4-5 Distribution of mechanism of injury**

A total of 65.79% of RTA's resulted in multiple fractures. Multiple fractures were sustained by 87.50% of participants who had a PVA and 50% of MVA victims. Fifty percent of MVA victims sustained only one fracture. Only 6.80% (n=3) of injuries were associated with falls. Other causes were reported as "gunshot wound", "building collapsing on patient", and "gate falling on patient".

### 4.3.4 Types of pelvic fractures sustained

Table 4-4 shows a detailed account, with subcategories, of the type of fractures sustained. Only five participants had a classification for pelvic fracture sustained noted in the file based on the Young and Burgess classification system and six of the acetabular fractures had a Judet and Letournel classification noted in the medical records. The remaining participants had details on the different bones or areas damaged but no specification according to a classification system. Based on the fracture classifications or specific note in the participants' files and radiology reports, 25% (n=11) of participants had significant displacement or injury of the SIJ or PS.

Figure 4-6 provides a graphical representation summarizing the main categories of fractures sustained. Fractures involving the acetabulum (47.73%, n= 21) were most common after fractures involving the pubic rami (79.55%, n= 35). Most participants who sustained an acetabular fracture had an inferior pubic rami fracture as well. In total, 35 (79.55%) of the participants had a fracture to at least one of the four pubic rami. Just over a third of participants sustained a break in only one bone or area. The remaining 63.64% (n=28) sustained fractures to multiple areas of the pelvis including the acetabulum. Fourteen (31.82%) participants sustained concurrent injuries to soft tissues or other lower limb, upper limb, or facial bones.

### 4.3.5 Description of management of participants

Table 4-5 displays the injury management history of the participants. The median length of stay was 13.5 days. Majority of the participants were admitted once (78.57%, n=33). In terms of supportive management, catheterisation was common in 88.64% (n= 39) of participants. Of the 88.64% (n=39) participants who were catheterized, 9.09% (n= 4) of participants still had a urinary catheter in situ by six weeks post injury.

**Table 4-4 Types of fractures sustained**

| Fracture types | n (%) |
|---|---|
| Only one fracture | 16 (36.36) |
| Isolated pubic ramus (only 1 ramus fractured, no other fracture) | 10 (22.73) |
| Multiple pelvic fractures | 28 (63.64) |
| Pubic rami involvement (1 or more pubic rami with or without other fractures) | 35 (79.55) |
| Right superior pubic rami | 7 |
| Left superior pubic rami | 15 |
| Right inferior pubic rami | 6 |
| Left inferior pubic rami | 15 |
| Bilateral combined superior and inferior pubic rami | 5 (11.36) |
| Bilateral pubic rami inferior | 3 (6.82) |
| Sacral Involvement | 7 (15.91) |
| Ilium involved | 7 (15.89) |
| Ischial tuberosity involved | 2 (4.55) |
| Acetabular Involvement | 21 (47.73) |
| Significant sacroiliac joint (SIJ) or pubis symphysis (PS) displacement or injury noted | 11 (25.00) |
| Sustained additional non-pelvic injuries | 14 (31.82) |

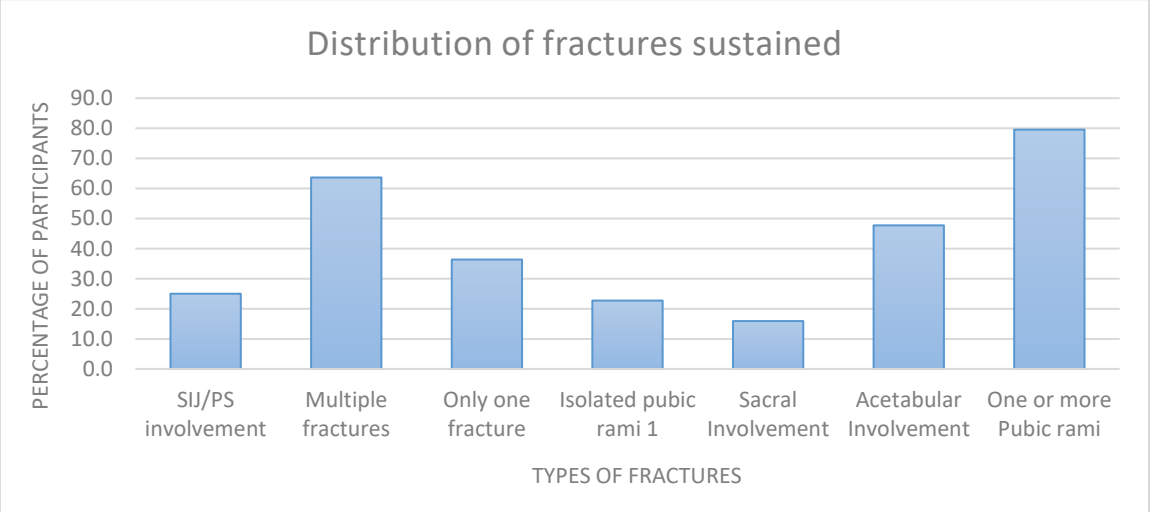


**Figure 4-6 Distribution of fractures sustained**

**Table 4-5 Management provided to participants**

| Management approach | Parameter estimated | Statistics |
|---|---|---|
| Average Length of stay | Median (IQR) | 13.5 (6.5-30.5) days |
| Average number of admissions | 0 | 1 (2.38) |
| | 1 | 33 (78.57) |
| | 2 | 8 (19.05) |
| **Supportive management** | | |
| Urinary catheter used | n (%) | 39 (88.64) |
| Urinary catheter still in situ by 2 weeks | n (%) | 17 (38.64) |
| Urinary catheter still in situ by 1 month | n (%) | 7 (15.91) |
| Urinary catheter still in situ by 6 weeks | n (%) | 4 (9.09) |
| Duration of urinary catheter use (in days) | Mean | 17.5 days |
| | Median (IQR) | 10.5 (6-20) |
| | Max | 63 |
| Received physiotherapy | n (%) | 40 (93.02) |
| Received pelvic health related physio | n (%) | 5 (12.50) |
| **Average duration of Treatment** | | |
| On bedrest | Median (IQR) | 6 (3-8) weeks |
| | Mean (SD) | 6.3 (4) |
| On skin traction (n=10) | Median (IQR) | 11.5 (3-38) days |
| | Mean (SD) | 20.8 (21.5) days |
| Non-weightbearing, (n=16) | Median (IQR) | 4 (1.5-6) weeks |
| | Mean (SD) | 4.5 (3.1) |
| **Number of surgeries for pelvic injury** | 0 | 31 (77.5) |
| | 1 | 7 (17.50) |
| | 2 | 2 (5.00) |

This prevented collection of their data on the bladder domain of the APFQ in the acute/subacute phase. These participants required prolonged catheterisation either due to being ventilated, for contraindications to mobilization, for surgery, or prevention of pressure sores. Since catheterization was not due to urinary dysfunction, these participants were scored zero for the bladder domain as during the time they were catheterised, no direct bladder symptoms related to PFD were encountered. Regardless of which phase of healing participants were at, a total of 93% (40) of participants received physiotherapy following their pelvic fracture, however only

12.50% (5) received pelvic health related physiotherapy (an explanation of the pelvic floor, PFD symptoms, and/or were prescribed pelvic floor exercises). The average duration on bedrest was six weeks (IQR: 3 – 8; SD 4), and four weeks to mobilize non-weightbearing (IQR: 1.5 – 6; SD 3.1).

In total, only nine (22.50%) participants required surgery directly to the pelvis (ORIF: n=1, debridement: n=1), two of whom needed two ORIF each.

Figure 4-7 shows how many participants received the different choices of treatment as part of their management. Bedrest was prescribed most frequently followed by weightbearing as tolerated in 93.18% (n=41) and 70.45% (n=31) of participants, respectively. Two of the three (6.82%) participants not instructed to observe bed rest were instructed to only do weight bearing as tolerated, and the other one was managed with skeletal traction. All 18.18% (n=8) participants who required an ORIF had an acetabular fracture. Debridement was performed in only one (2.27%) participant.

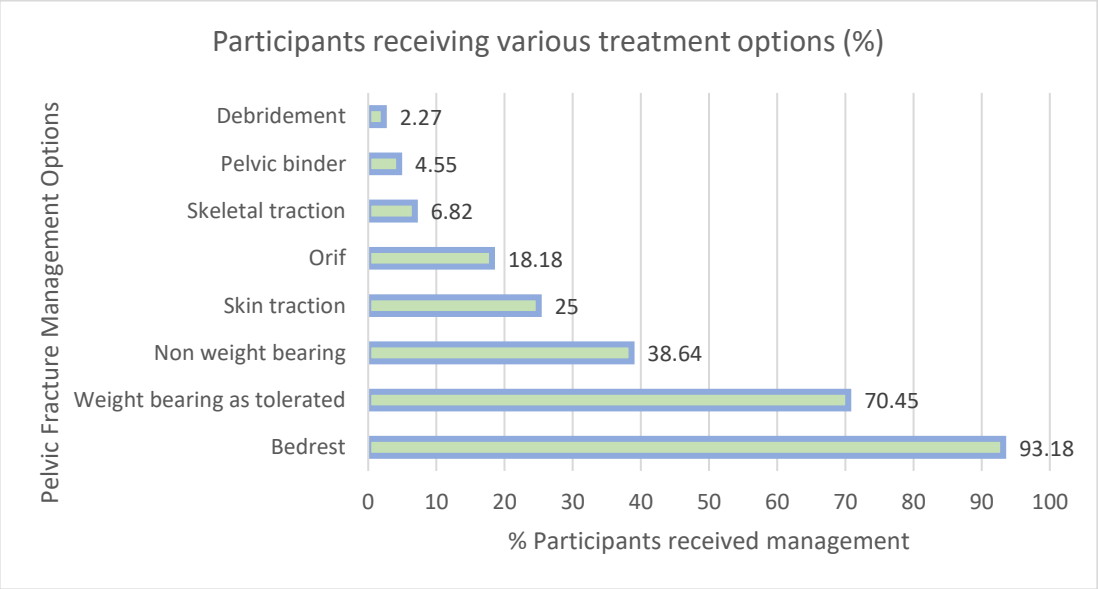


**Figure 4-7: Distribution of treatment provided to participants**

Figure 4-8 highlights the results related to the combinations of management provided. It is noted that six (13.64%) participants received standalone management strategies: three (6.82%) participants received bedrest, one (2.27%) skeletal traction and two (4.54%) weightbearing as tolerated. The remaining participants received combinations of management options. The pelvic binder and skin traction were used in combination with bed rest.

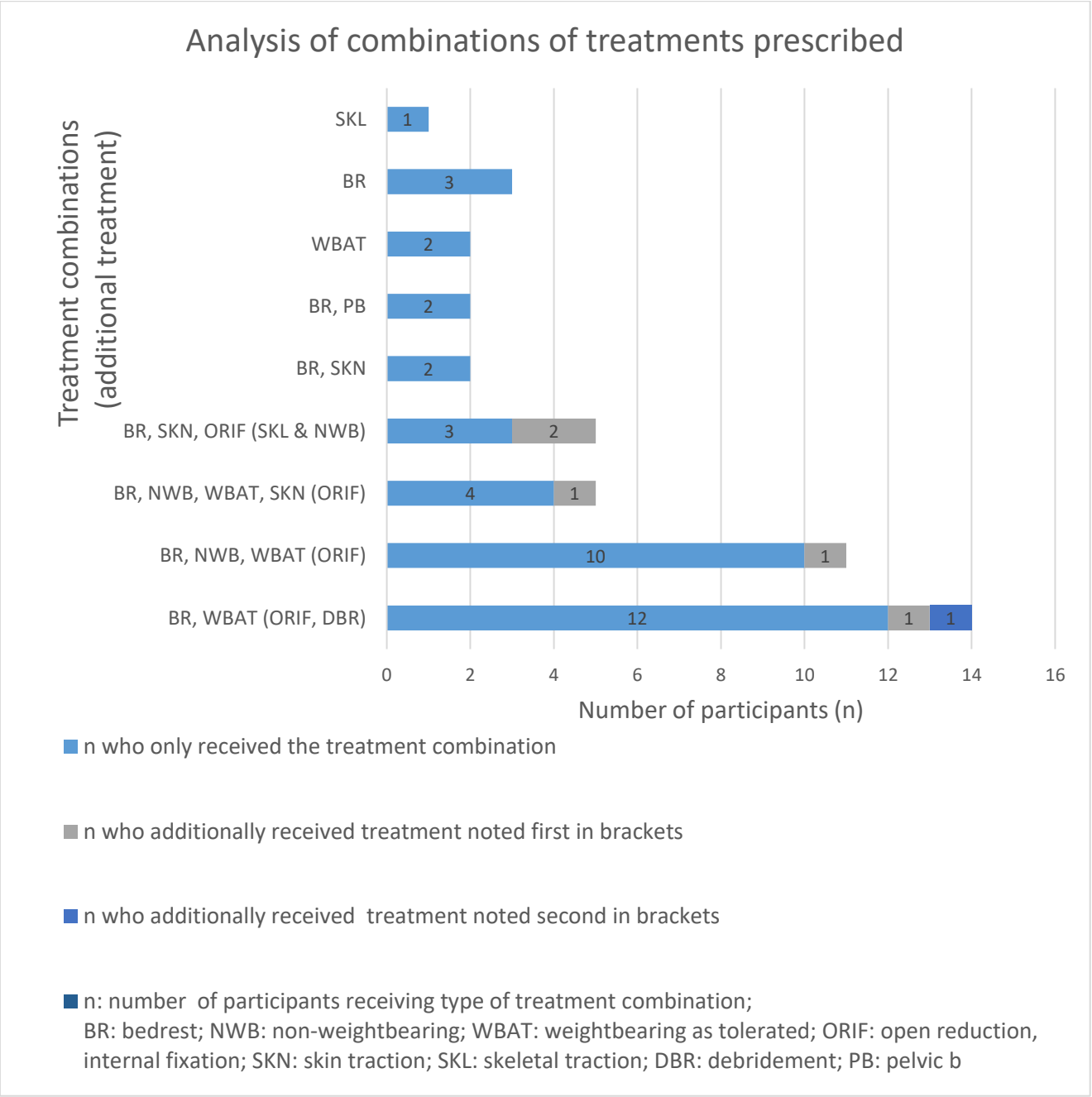


**Figure 4-8 Distribution of treatment combinations prescribed**

Majority of participants only required bedrest and weightbearing as tolerated; one participant additionally required an ORIF, and another received a debridement. Sixteen participants (36.36%) first needed to mobilize non-weightbearing prior to progressing to weightbearing as tolerated while another five (11.36%) progressed from non-weightbearing to full weightbearing.

## 4.4 Timed up and go test score

The timed up and go test (TUGT) was conducted in 37 of the participants. The shortest time taken was seven seconds, with the longest time in one participant was 120 seconds (Figure 4-9), an outlier to the other data by more than 60 seconds. The median score was 11 seconds (IQR: 9 - 20). There were 15 (34.09%) participants with normal time, 22 (50%) had abnormal time and seven (15.91%) had no score.

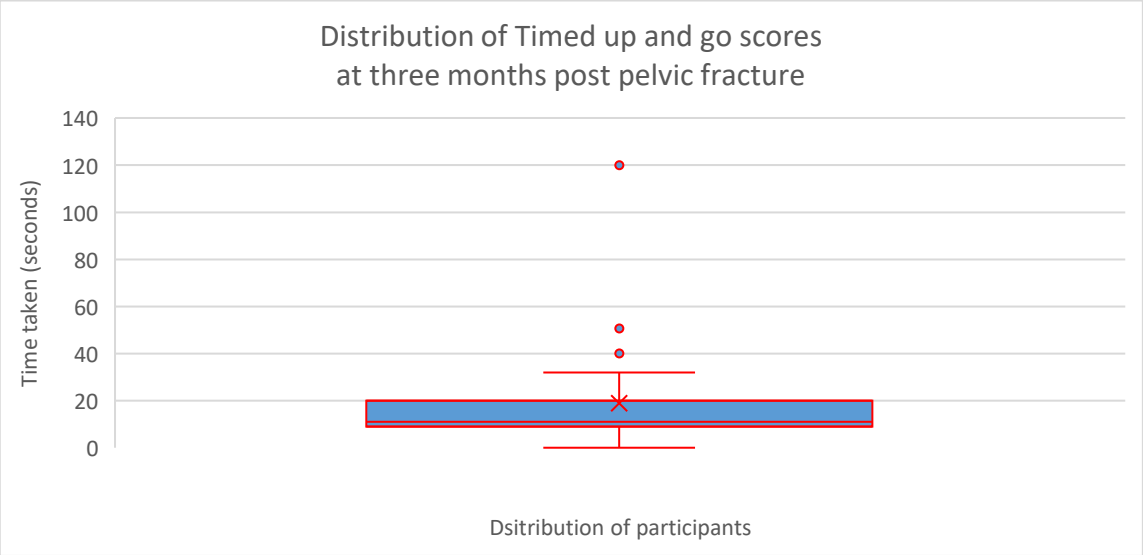


**Figure 4-9 Distribution of timed up and go scores**

## 4.5 Presence of pelvic floor dysfunction and scores

Participants' responses to the APFQ regarding their pelvic floor function preinjury, in the subacute period, and by the end of three months following the injury are described and discussed. A description of participants subjective assessment responses on involvement in sexual activity are also reported. The symptoms and APFQ scores between the three time points are compared.

### 4.5.1 Description of pelvic floor dysfunction symptoms

This sub-section describes and compares symptoms of PFD present at three months post-pelvic fracture to participants' baseline PFD symptoms present pre-pelvic fracture and those reported in the subacute period post-pelvic fracture. Table 4-6 shows the

different questions asked per domain on the tool and the related PFD symptom. Each question in the APFQ relates to a specific symptom of PFD and has four options to grade the severity of each symptom: 0 = not symptomatic, and 1-3 = symptomatic. Greater scores imply greater severity. For each question, the frequency of symptomatic occurrence, and the difference in frequency between the time points are tabulated. Watery stool was not experienced by any participants at any time point.

It is noted that participants experienced PFD symptoms preinjury. The symptoms most frequently reported by participants preinjury were constipation (68.18%), pain during intercourse (57.58%), vaginal tightness (55.88%), nocturia (54.55%), incomplete bowel emptying (54.55%), difficulty defecating requiring straining (40.91%), overwhelming urgency to empty bowels (43.18%), the use of laxatives (36.36%), incomplete bladder emptying (31.82%), and reports of variable stool consistency.
Of note, vaginal tightness (70.83%), pain during intercourse (68.75%), constipation (67.57%), straining to defecate (59.46%), nocturia (57.89%), incomplete bowel emptying (54.05), urgency (52.63%), urgency incontinence (39.47%), dysuria (37.84%), faecal urgency (37.84%), incomplete bladder emptying (36.84%) and weak urinary flow (31.58%) were the symptoms experienced with greatest frequency at three months post injury.

A change was noted in the number of participants experiencing almost all the symptoms sub-acutely post injury compared to what was reported preinjury. The difference in number of symptomatic participants between preinjury and subacute was much higher than the difference between preinjury and by three months post injury for all symptoms except those highlighted in blue. Differences in frequency of symptomatic participants between the time points are highlighted in grey. For 14 out of 44 of the questions (highlighted in green), the frequency by three months, reduced close to the frequency preinjury. For seven of the questions, a smaller percentage of participants reported symptoms by three months post injury compared to preinjury (highlighted in pink).

Symptoms that were experienced by more participants at three months post injury compared to preinjury, included urgency (52.63% vs 22.73%), urgency incontinence (39.47% vs 22.73%), SUI (23.68% vs 11.36%), weak urine flow/ straining (31.58% vs 6.82%), dysuria (37.84% vs 11.36%), and straining for defecation (59.46% vs 40.91%).

**Table 4-6 Frequency of participants reporting pelvic floor dysfunction symptoms on the Australian Pelvic Floor Questionnaire (APFQ) prior to, in the subacute period, and three months post pelvic fracture**

| Frequency of participants with a score>1 for each pelvic floor dysfunction question prior to, acutely, and three months post pelvic fracture | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Domain** | | | **Symptomatic Participants n (%)** | | | **Difference in % between time points** | | |
| | **Question** | **Symptom** | **Preinjury (A)** | **Subacute (B)** | **3 months (C)** | **∆ B -A** | **∆ C - B** | **∆ C - A** |
| **Bladder Domain** | Q1. How many times do you pass urine in a day? **> 7** | Frequency | 8 (18.18) | 15 (38.46) | 10 (26.32) | 20.28 | -12.14 | 8.13 |
| | Q2. How many times do you get up at night to pass urine? **> 1** | Nocturia | 24 (54.55) | 26 (66.67) | 22 (57.89) | 12.12 | -8.78 | 3.34 |
| | Q3. Do you wet the bed before you wake up at night? | Nocturnal enuresis | 3 (6.82) | 7 (17.95) | 5 (13.16) | 11.13 | -4.79 | 6.34 |
| | Q4. Do you need to rush/hurry to pass urine when you get the urge? | Urgency | 10 (22.73) | 23 (58.97) | 20 (52.63) | 36.24 | -6.34 | 29.90 |
| | Q5. Does urine leak when you rush or hurry to the toilet or can't you make it in time? | Urge incontinence | 10 (22.73) | 20 (51.28) | 15 (39.47) | 28.56 | -11.81 | 16.74 |
| | Q6. Do you leak with coughing, sneezing, laughing, or exercising? | Stress incontinence | 5 (11.36) | 10 (25.64) | 9 (23.68) | 14.28 | -1.96 | 12.32 |
| | Q7. Is your urinary stream (urine flow) weak, prolonged or slow? | Flow/ weak stream | 3 (6.82) | 27 (69.23) | 12 (31.58) | 62.41 | -37.65 | 24.76 |
| | Q8. Do you have a feeling of incomplete bladder emptying? | Voiding dysfunction | 14 (31.82) | 24 (61.54) | 14 (36.84) | 29.72 | -24.70 | 5.02 |
| | Q9. Do you need to strain to empty your bladder? | Detrusor underactivity | 10 (22.73) | 21 (53.85) | 9 (24.32) | 31.12 | -29.53 | 1.59 |
| | Q10. Do you have to wear pads because of urinary leakage? | Pad usage | 4 (9.09) | 16 (41.03) | 11 (29.73) | 31.94 | -11.3 | 20.64 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Q11. Do you limit your fluid intake to decrease urinary leakage? | Fluid intake | 6 (13.64) | 18 (46.15) | 10 (27.03) | 32.51 | -19.12 | 13.39 |
| | Q12. Do you have frequent bladder infections? | Infection | 9 (20.45) | 10 (25.64) | 3 (8.11) | 5.19 | -17.53 | -12.34 |
| | Q13. Do you have pain in your bladder or urethra when you empty your bladder? | Dysuria | 5 (11.36) | 24 (61.54) | 14 (37.84) | 50.18 | -23.7 | 26.48 |
| | Q14. Does urine leakage affect your routine activities like recreation. socializing. sleeping. shopping etc? | Quality / impact on social life | 4 (9.09) | 16 (41.03) | 11 (29.73) | 31.94 | -11.3 | 20.64 |
| | Q15. How much does your bladder problem bother you? | Bothersome | 11 (25.00) | 26 (66.67) | 17 (45.95) | 41.67 | -20.72 | 20.95 |
| **Bowel Domain** | Q16. How often do you usually open your bowels? | Frequency | 11 25.00) | 34 (79.07) | 11 (29.73) | 54.07 | -49.34 | 4.73 |
| | Q17. How is the consistency of your usual stool? | Consistency | 34 (77.27) | 39 (92.86) | 29 (78.38) | 15.59 | -14.48 | 1.11 |
| | Q18. Do you have to strain to empty your bowels? | Strain | 18 (40.91) | 32 (76.19) | 22 (59.46) | 35.28 | -16.73 | 18.55 |
| | Q19. Do you use laxatives to empty your bowels? | Strategies | 16 (36.36) | 15 (35.71) | 10 (27.03) | -0.65 | -8.68 | -9.33 |
| | Q20. Do you feel constipated? | Constipation | 30 68.18) | 32 (76.19) | 25 (67.57) | 8.01 | -8.62 | -0.61 |
| | Q21. When you get wind or flatus. can you control it. or does wind leak? | Flatus incontinence | 6 (13.64) | 10 (23.81) | 6 (16.22) | 10.17 | -7.59 | 2.58 |
| | Q22. Do you get an overwhelming sense of urgency to empty bowels? | Faecal Urgency | 19 (43.18) | 18 (42.86) | 14 (37.84) | -0.32 | -5.02 | -5.34 |
| | Q23. Do you leak watery stool when you don't mean to? | Faecal incontinence | 2 (4.55) | 5 (11.90) | 3 (8.11) | 7.35 | -3.79 | 3.56 |
| | Q24. Do you leak normal stool when you don't mean to? | Faecal incontinence | 1 (2.27) | 4 (9.52) | 3 (8.11) | 7.25 | -1.41 | 5.84 |
| | Q25. Do you have a feeling of incomplete bowel emptying? | Dysfunctional defecation | 24 (54.55) | 31 (73.81) | 20 (54.05) | 19.26 | -19.76 | -0.5 |
| | Q26. Do you use finger pressure to help empty your bowel? | Obstructed defecation | 7 (15.91) | 11 (26.19) | 7 (18.92) | 10.28 | -7.27 | 3.01 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Q27. How much does your bowel problem bother you? | Bothersome | 20 (45.45) | 32 (76.19) | 22 (59.46) | 30.74 | -16.73 | 14.01 |
| **Prolapse Domain** | Q28. Do you have a sensation of tissue protrusion/lump/bulging in your vagina? | Prolapse sensation | 4 (9.09) | 6 (14.29) | 4 (10.81) | 5.2 | -3.48 | 1.72 |
| | Q29. Do you experience vaginal pressure or heaviness or a dragging sensation? | Vaginal pressure | 8 (18.18) | 9 (21.43) | 8 (21.62) | 3.25 | 0.19 | 3.44 |
| | Q30. Do you have to push back your prolapse in order to void? | Voiding dysfunction | 0 (0.00) | 1 (2.38) | 0 (0.00) | 2.38 | -2.38 | 0 |
| | Q31. Do you have to push back your prolapse to empty your bowels? | Defecation dysfunction | 0 (0.00) | 0 (0.00) | 0 (0.00) | 0 | 0 | 0 |
| | Q32. How much does your prolapse bother you? | Bothersome | 6 (13.64) | 9 (21.43) | 8 (21.62) | 7.79 | 0.19 | 7.98 |
| **Sexual Domain** | Q33. Are you sexually active? | Yes | 32 (72.73) | 5 (11.63) | 15 (40.54) | -61.1 | 28.91 | -32.19 |
| | Q35. Do you have sufficient vaginal lubrication during intercourse? | Dryness | 7 (21.21) | 1 (20.00) | 4 (25.00) | -1.21 | 5 | 3.79 |
| | Q36. During intercourse vaginal sensation is: | Sensation | 10 30.30) | 4 (80.00) | 6 (37.50) | 49.7 | -42.5 | 7.2 |
| | Q37. Do you feel that your vagina is too loose or lax? | Vaginal laxity/ Hypotonic | 9 (27.27) | 3 (23.08) | 7 (35.00) | -4.19 | 11.92 | 7.73 |
| | Q38. Do you feel that your vagina is too tight? | Non-relaxing/ tight | 19 (55.88) | 11 (73.33) | 17 (70.83) | 17.45 | -2.5 | 14.95 |
| | Q39. Do you experience pain with sexual intercourse? | Dyspareunia | 19(57.58) | 3 (60.00) | 11 (68.75) | 2.42 | 8.75 | 11.17 |
| | Q40. Where does the pain during intercourse occur? | Vulvodynia vs deep pain | 21 (63.64) | 3 (60.00) | 11 (68.75) | -3.64 | 8.75 | 5.11 |
| | Q41. Do you leak urine during sexual intercourse? | Coital incontinence | 7 (21.21) | 0 (0.00) | 2 (12.50) | -21.21 | 12.5 | -8.71 |
| | Q42. How much do these sexual issues bother you? | Bothersome | 14(46.67) | 19 (76.00) | 23 (79.31) | 29.33 | 3.31 | 32.64 |

Usage of coping habits such as pad usage and limiting fluid intake increased. The incidence of prolapse symptoms increased in the subacute period but by three months reverted to the prevalence preinjury. The percentage of participants feeling bothered by their symptoms increased for all four domains.

Table 4-7 tabulates for each question, the number and percentage of participants who reported experiencing the option of greatest severity. Overall, a large increase in the frequency of severe symptoms was noted sub-acutely post pelvic fracture. By three months post pelvic fracture, the frequency of severe symptoms decreased but was still higher than what was reported preinjury. Only six symptoms had a decrease from pre to three months post pelvic fracture (highlighted in pink). The grey highlighted values indicate there was a change greater than 20% in the percentage of participants experiencing severe symptoms between the time points. The percentage of participants experiencing severe urinary, flatus and faecal urgency, stress incontinence, and vaginal laxity symptoms decreased from preinjury to three months post.

The symptoms with the greatest frequencies of “severe” responses preinjury were insufficient vaginal lubrication during intercourse (21.21%), pain at the vaginal entrance and deep inside during intercourse (15.15%), consistent vaginal tightness (14.71%), nocturia (13.64%), and urinary urgency (11.36%). Only 2.27% of participants found their bladder and bowel symptoms greatly bothersome. By three months, the symptoms with the greatest frequencies included straining for defecation, FI, constipation, and urgency incontinence. Reports of daily pad usage and participants always limiting their fluid intake to reduce and address urinary leakage was also noted. For the sexual symptoms, of those sexually active at three months, six to 33% of participants had severe reports for the various symptoms.

Table 4-7, 4-8 and 4-9 expand on the distribution of responses for each answer option for questions 15, 16, 17, 27, 32, 33, 36, 40 and 42 on the APFQ. Table 4-8 documents participants’ perspective of how much of bother they experienced because of the different domains. There is greater variation noted in the amount of bother between the timepoints for all three domains. Two more participants became bothered by their prolapse symptoms. Only one participant reported her prolapse symptoms to greatly bother her in the subacute period. Participants were bothered most by bowel domain symptoms in the subacute period followed by bladder domain symptoms.

**Table 4-7 Frequency of reports of severe pelvic floor dysfunction symptoms on the Australian Pelvic Floor Questionnaire (APFQ), prior to, acutely and three months post pelvic fracture/s**

| Frequency of reports of severe pelvic floor dysfunction symptoms. prior to. subacute and three months post pelvic fracture/s | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Domain** | | | **n (%) with high severity score per symptom (=3)** | | | **% Difference between time points** | | |
| | **Question** | **Symptom** | **Preinjury (A)** | **Subacute (B)** | **3month (C)** | **∆ B -A** | **∆ C - B** | **∆ C - A** |
| **Bladder Domain** | Q1. How many times do you pass urine in a day? **> 15** | Frequency | 0 (0.00) | 1 (2.56) | 1 (2.63) | 2.56 | 0.07 | 2.63 |
| | Q2. How many times do you get up at night to pass urine? **> 3 times** | Nocturia | 6 (13.64) | 11 (28.21) | 7 (18.42) | 14.57 | -9.78 | 4.78 |
| | Q3. Do you wet the bed before you wake up at night? **Always- every night** | Nocturnal enuresis | 0 (0.00) | 1 (2.56) | 1 (2.63) | 2.56 | 0.07 | 2.63 |
| | Q4. Do you need to rush/hurry to pass urine when you get the urge? **Daily** | Urgency | 5 (11.36) | 11 (28.21) | 4 (10.53) | 16.84 | -17.68 | -0.84 |
| | Q5. Does urine leak when you rush or hurry to the toilet or can't you make it in time? **Daily** | Urgency incontinence | 2 (4.55) | 12 (30.77) | 5 (13.16) | 26.22 | -17.61 | 8.61 |
| | Q6. Do you leak with coughing. sneezing. laughing or exercising? **Daily** | Stress incontinence | 1 (2.27) | 3 (7.69) | 0 (0.00) | 5.42 | -7.69 | -2.27 |
| | Q7. Is your urinary stream (urine flow) weak. prolonged or slow? **Daily** | Flow/ weak stream | 0 (0.00) | 9 (23.08) | 2 (5.26) | 23.08 | -17.81 | 5.26 |
| | Q8. Do you have a feeling of incomplete bladder emptying? **Daily** | Voiding dysfunction | 0 (0.00) | 9 (23.08) | 2 (5.26) | 23.08 | -17.81 | 5.26 |
| | Q9. Do you need to strain to empty your bladder? **Daily** | Detrusor underactivity | 0 (0.00) | 7 (17.95) | 1 (2.70) | 17.95 | -15.25 | 2.70 |
| | Q10. Do you have to wear pads because of urinary leakage? **Daily** | Pad usage | 0 (0.00) | 7 (17.95) | 3 (8.11) | 17.95 | -9.84 | 8.11 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Q11. Do you limit your fluid intake to decrease urinary leakage? **Always** | Fluid intake | 0 (0.00) | 10 (25.64) | 5 (13.51) | 25.64 | -12.13 | 13.51 |
| | Q12. Do you have frequent bladder infections? **>1/month** | Infection | 0 (0.00) | 0 (0.00) | 0 (0.00) | 0.00 | 0.00 | 0.00 |
| | Q13. Do you have pain in your bladder or urethra when you empty your bladder? **Daily** | Dysuria | 1 (2.27) | 5 (12.82) | 2 (5.41) | 10.55 | -7.42 | 3.13 |
| | Q14. Does urine leakage affect your routine activities like recreation, socializing, sleeping, shopping etc? **Greatly** | Quality / impact on social life | 0 (0.00) | 4 (10.26) | 1 (2.70) | 10.26 | -7.55 | 2.70 |
| | Q15. How much does your bladder problem bother you? **Greatly** | Bothersome | 1 (2.27) | 8 (20.51) | 5 (13.51) | 18.24 | -7.00 | 11.24 |
| **Bowel Domain** | Q16. How often do you usually open your bowels? **< 1/week** | Frequency | 2 (4.55) | 24 (55.81) | 3 (8.11) | 51.27 | -47.71 | 3.56 |
| | Q17. How is the consistency of your usual stool? | Consistency | 0 (0.00) | 0 (0.00) | 0 (0.00) | 0(0.00 | 0.00 | (0.00) |
| | Q18. Do you have to strain to empty your bowels? **Daily** | Strain | 0 (0.00) | 17 (40.48) | 2 (5.41) | 40.48 | -35.07 | 5.41 |
| | Q19. Do you use laxatives to empty your bowels? **Daily** | Strategies | 0 (0.00) | 2 (4.76) | 0 (0.00) | 4.76 | -4.76 | 0.00 |
| | Q20. Do you feel constipated? **Daily** | Constipation | 2 (4.55) | 18(42.86) | 5 (13.51) | 38.31 | -29.34 | 8.97 |
| | Q21. When you get wind or flatus. can you control it. or does wind leak? **Daily** | Flatus incontinence | 3 (6.82) | 3 (7.14) | 2 (5.41) | 0.32 | -1.74 | -1.41 |
| | Q22. Do you get an overwhelming sense of urgency to empty bowels? **Daily** | Faecal Urgency | 1 (2.27) | 1 (2.38) | 0 (0.00) | 0.11 | -2.38 | -2.27 |
| | Q23. Do you leak watery stool when you don't mean to? **Daily** | Faecal incontinence | 0 (0.00) | 0 (0.00) | 0 (0.00) | 0.00 | 0.00 | 0.00 |
| | Q24. Do you leak normal stool when you don't mean to? **Daily** | Faecal incontinence | 0 (0.00) | 0 (0.00) | 1 (2.70) | 0.00 | 2.70 | 2.70 |
| | Q25. Do you have a feeling of incomplete bowel emptying? **Daily** | Dysfunctional defecation | 1 (2.27) | 10 (23.81) | 2 (5.41) | 21.54 | -18.40 | 3.13 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Q26. Do you use finger pressure to help empty your bowel? **Daily** | Obstructed defecation | 0 (0.00) | 1 (2.38) | 0 (0.00) | 2.38 | -2.38 | 0.00 |
| | Q27. How much does your bowel problem bother you? **Greatly** | Bothersome | 1 (2.27) | 16 (38.10) | 5 (13.51) | 35.82 | -24.58 | 11.24 |
| **Prolapse Domain** | Q28. Do you have a sensation of tissue protrusion/lump/bulging in your vagina? **Daily** | Prolapse sensation | 0 (0.00) | 0 (0.00) | 0 (0.00) | 0.00 | 0.00 | 0.00 |
| | Q29. Do you experience vaginal pressure or heaviness or a dragging sensation? **Daily** | Vaginal pressure | 0 (0.00) | 0 (0.00) | 0 (0.00) | 0.00 | 0.00 | 0.00 |
| | Q30. Do you have to push back your prolapse in order to void? **Daily** | Voiding dysfunction | 0 (0.00) | 0 (0.00) | 0 (0.00) | 0.00 | 0.00 | 0.00 |
| | Q31. Do you have to push back your prolapse to empty your bowels? **Daily** | Defecation dysfunction | 0 (0.00) | 0 (0.00) | 0 (0.00) | 0.00 | 0.00 | 0.00 |
| | Q32. How much does your prolapse bother you? **Greatly** | Bothersome | 0 (0.00) | 1 (2.38) | 0 (0.00) | 2.38 | -2.38 | 0.00 |
| **Sexual Domain** | Q35. Do you have sufficient vaginal lubrication during intercourse? **No** | Dryness | 7 (21.21) | 1 (20.00) | 4 (25.00) | -1.21 | 5.00 | 3.79 |
| | Q36. During intercourse vaginal sensation is: **None/ no sensation** | Sensation | 1 (3.03) | 0 (0.00) | 1 (6.25) | -3.03 | 6.25 | 3.22 |
| | Q37. Do you feel that your vagina is too loose or lax? **Always** | Vaginal laxity/ Hypotonic | 1 (3.03) | 0 (0.00) | 0 (0.00) | -3.03 | 0.00 | -3.03 |
| | Q38. Do you feel that your vagina is too tight? **Always** | Non-relaxing / tight/ shortened | 5 (14.71) | 2 (13.33) | 8 (33.33) | -1.37 | 20.00 | 18.63 |
| | Q39. Do you experience pain with sexual intercourse? **Always** | Dyspareunia | 2 (6.06) | 2 (40.00) | 4 (25.00) | 33.94 | -15.00 | 18.94 |
| | Q40. Where does the pain during intercourse occur? **Always** | Vulvodynia vs deep pain | 5 (15.15) | 2 (40.00) | 2 (12.50) | 24.85 | -27.50 | -2.65 |
| | Q41. Do you leak urine during sexual intercourse? **Always** | Coital incontinence | 0 (0.00) | 0 (0.00) | 0 (0.00) | 0.00 | 0.00 | 0.00 |
| | Q42. How much do these sexual issues bother you? G**reatly** | Bothersome | 2 (6.67) | 2 (8.00) | 9 (31.03) | 1.33 | 23.03 | 24.37 |

**Table 4-8 Bothersome responses for each domain of the Australian Pelvic Floor Questionnaire (APFQ) for all three timepoints**

| Bothersome Question 15, 27, 32, 42 | Not applicable | Not at all | Slightly | Moderately | Greatly |
|---|---|---|---|---|---|
| **15) Bladder domain symptoms** | N | N | N | n | n |
| Preinjury (n=44) | | 33 | 7 | 3 | 1 |
| Subacute post injury (n=42) | 4 | 12 | 11 | 7 | 8 |
| Three months post injury (n=37) | | 20 | 8 | 4 | 5 |
| **27) Bowel domain symptoms** | | | | | |
| Preinjury (n=44) | | 24 | 15 | 4 | 1 |
| Subacute post injury (n=42) | | 10 | 5 | 11 | 16 |
| Three months post injury (n=37) | | 15 | 11 | 6 | 5 |
| **32) Prolapse domain symptoms** | | | | | |
| Preinjury (n=44) | | 38 | 6 | 0 | 0 |
| Subacute post injury (n=42) | | 33 | 7 | 1 | 1 |
| Three months post injury (n=37) | | 29 | 7 | 1 | 0 |
| **42) Sexual domain symptoms** | | | | | |
| Preinjury (n=44) | 11 | 16 | 10 | 2 | 2 |
| Subacute post injury (n=42) | 17 | 6 | 13 | 4 | 2 |
| Three months post injury (n=37) | 8 | 6 | 8 | 6 | 9 |

Table 4-9 highlights participants responses for the different types of stool consistency and frequency of defecation. Hard stool has a score of zero and did not contribute to the percentage of symptomatic participants in Table 4-6 for stool consistency, but we note that 23 (55%) participants had hard stool in the acute phase. Variable stool consistency had the most responses pre and three months post-injury. A significant change is noted in the distribution of responses for frequency of defecation in the subacute period post injury with 57% of participants passing stool less than once a week.

**Table 4-9 Distribution of responses on the Australian Pelvic Floor Questionnaire (APFQ) regarding stool consistency and frequency of defecation**

| **Stool consistency** | **Soft** | **Firm** | **Hard** | **Variable** | **Watery** |
|---|---|---|---|---|---|
| Preinjury (n=44) | 10 | 13 | 6 | 15 | 0 |
| Subacute post injury (n=42) | 3 | 6 | 23 | 10 | 0 |
| Three months post injury (n=37) | 8 | 10 | 2 | 17 | 0 |
| **Frequency of defecation** | **Every other day/ daily** | **Less than every 3 days** | **Less than once a week** | **More than once per day** | |
| Preinjury (n=44) | 23 | 9 | 2 | 10 | |
| Subacute post injury (n=42) | 6 | 10 | 24 | 3 | |
| Three months post injury (n=37) | 20 | 8 | 3 | 6 | |

### 4.5.2 Description of participants involvement in sexual activity

Figure 4-10 illustrates participants' responses on their preinjury and post injury sexual activity status. Preinjury, three participants (6.82%) reported that they never engaged in sexual activity, 14 (31.82%) were no longer sexually active or sexually active less than once a week, and 27 (61.36%) were sexually active. In the subacute period, 88.10% (n=37) of participants were not sexually active of which 43.24% (n=16) reported that it was due to the injury. At some point following the injury, 20.45% (n=9) resumed sexual activity at least once while 72.73% were no longer sexually active. By three months post injury, those that had never been sexually active, remained inactive (n=3, 6.82%), 43.24% (n=16) engaged in sexual activity at least once, but only 13.51% (n=5) participants remained sexually active at three months. The remaining previously sexually active participants avoided or were not participating regularly in sexual activity post injury.

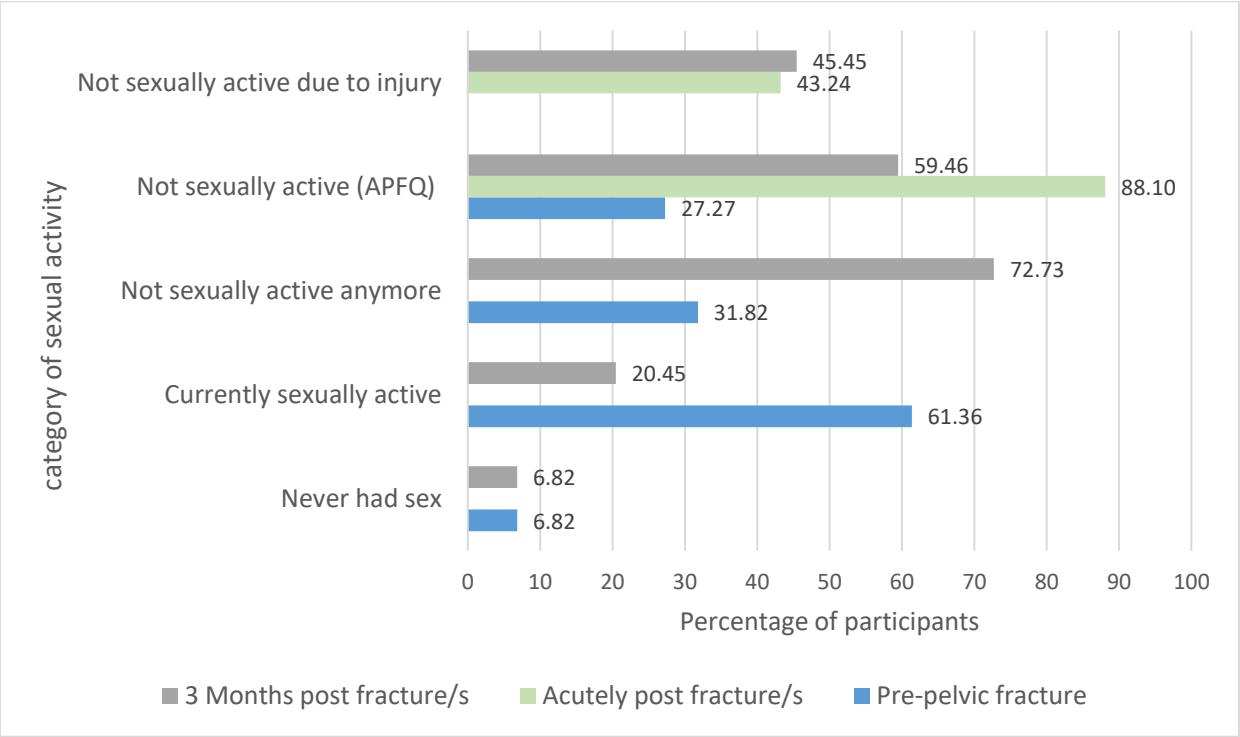


**Figure 4-10 Percentage of participants involved in sexual activity pre and post pelvic fracture**

***APFQ: Australian Pelvic Floor Questionnaire***

Table 4-10 describes the frequency for each option for the questions on frequency of sexual activity, vaginal sensation, and pain during intercourse. A greater percentage of those sexually active at each time point reported being symptomatic at three months compared to preinjury. In the subacute period, 88% participants were not sexually active. Participants were sexually active less frequently from pre to subacute to three months post pelvic fracture. Ten more participants were not sexually active at three months post- compared to preinjury. No participant engaged in daily sexual activity in the subacute phase compared to the ten participants preinjury, and only one participant resumed daily sexual activity or on most days by three months post injury. Pain during intercourse preinjury was experienced mainly at the entrance of the vagina; at three months post, pain was experienced deep inside more often than at the entrance. Based on participants responses to question 34 of the APFQ questionnaire on reasons for not being sexually active, 45.45% of those not sexually active anymore, reported that the injury, directly or indirectly, was the reason for not being sexually active by three months post injury.

**Table 4-10 Distribution of responses on the Australian Pelvic Floor Questionnaire (APFQ) questions 33, 36 and 40 regarding sexual activity**

| **Frequency of sexual activity** | **Not sexually active** | **Less than once a week** | **Once or more per week** | **Daily or most days** |
|---|---|---|---|---|
| Preinjury (n=44) | 12 | 13 | 9 | 10 |
| Subacute post injury (n=42) | 37 | 4 | 1 | 0 |
| Three months post injury (n=37) | 22 | 11 | 3 | 1 |
| **During intercourse, vaginal sensation is:** | **Normal/ Pleasant n (%)** | **Minimal n (%)** | **Painful n (%)** | **None n (%)** |
| Preinjury (n=33) | 23 (69.7) | 7 (21.21) | 2 (6.06) | 1 (3.03) |
| Subacute post injury (n=5) | 1 (20) | 1 (20) | 3 (60) | 0 |
| Three months post injury (n=16) | 10 (62.5) | 3 (18.75) | 2 (12.5) | 1 (6.25) |
| **During intercourse, the pain occurs…** | **Not applicable, I do not have pain n (%)** | **At the entrance to the vagina n (%)** | **Deep inside, in the pelvis n (%)** | **Both at the entrance and in the pelvis n (%)** |
| Preinjury (n=33) | 12 (36.36) | 9 (27.27) | 7 (21.21) | 5 (15.15) |
| Subacute post injury (n=5) | 2 (40) | 1 (20) | 0 | 2 (40) |
| Three months post injury (n=16) | 5 (31.25) | 4 (25) | 5 (31.25) | 2 (12.5) |

### 4.5.3 Interpretation and comparison of APFQ scores for pelvic floor dysfunction

Table 4-11 lists the number of participants who reported experiencing at least one PFD symptom per domain, the mean APFQ resultant and additive scores, and the minimum and maximum scores, for each domain on the APFQ and the total at baseline prior to-, in the subacute phase post- and at three months post- pelvic fracture. Additive and resultant scores are explained in section 3.4.2. To compare the resultant scores at three month's post pelvic fracture, to scores at baseline, and scores in the subacute phase following the fracture, analysis using Paired *t* Test found statistically significant changes ($P < 0.05$) as highlighted in bold in the last two columns. Only the Prolapse domain scores had no significant change for both time points.

**Table 4-11 APFQ scores for and frequency of PFD in participants prior to, subacute and 3 months post pelvic fracture**

| | Preinjury | Subacute | Three Months | P-VALUE *Preinjury = months* | P-Value Suba*cute = 3 months* |
|---|---|---|---|---|---|
| **Bladder** | | | | | |
| *n | 44 | 42 | 37 | | |
| n (%) symptomatic | 39 (88.64) | 39 (92.86) | 36 (97.29) | | |
| Mean (SD) - Resultant score | 0.95 (1.01) | 2.95 (2.21) | 1.82 (1.63) | **0.0062** | **0.0002** |
| Mean (SD) - Additive score | 4.27 (4.55) | 13.29 (9.94) | 8.19 (7.36) | | |
| Min additive score | 0 | 0 | 0.2 | | |
| Max additive score | 4 | 9 | 6 | | |
| **Bowel** | | | | | |
| *n | 44 | 42 | 37 | | |
| n (%) symptomatic | 39 (88.64) | 42 (100) | 33 (89.19) | | |
| Mean (SD) - Resultant score | 1.55 (1.23) | 3.26 (1.54) | 2 (1.55) | 0.1272 | **0.0000** |
| Mean (SD) - Additive score | 5.27 (4.18) | 11.07 (5.23) | 6.81 (5.26) | | |
| Min additive score | 0 | 1 | 0 | | |
| Max additive score | 4 | 6 | 6 | | |
| **Prolapse** | | | | | |
| *n | 44 | 42 | 37 | | |
| n (%) symptomatic | 9 (20.45) | 11 (26.19) | 10 (27.03) | | |
| Mean (SD) - Resultant score | 0.29 (0.65) | 0.79 (1.68) | 0.4 (0.71) | 0.5361 | 0.5216 |
| Mean (SD) - Additive score | 0.43 (0.97) | | 0.59 (1.07) | | |
| Min additive score | 0 | 0 | 0 | | |
| Max additive score | 3 | 5 | 2 | | |
| **Sexual** | | | | | |
| *n | 33 | 5 | 17 | | |
| n (%) symptomatic | 25 (75.76) | 4 (80) | 15 (88.24) | | |
| Mean (SD) - Resultant score | 1.5 (1.93) | 2.95 (2.17) | 2.2 (2.77) | **0.0087** | 0.381 |
| Mean (SD) - Additive score | 4.21 (4.2) | 6.2 (4.55) | 7.88 (5.63) | | |
| Min additive score | 0 | 0 | 0 | | |
| Max additive score | 9 | 5 | 10 | | |
| **Total /40** | | | | | |
| *n | 44 | 42 | 37 | | |
| n (%) symptomatic | 44 (100) | 42 (100) | 36 (97.29) | **0.0216** | **0.0361** |
| Mean (SD) - Resultant score | 4.29 (3.13) | 7.1 (3.9) | 5.94 (3.81) | | |
| Min additive score | 0.2 | 1 | 6 | | |
| Max additive score | 10 | 16 | 13.61 | | |
| **Total /30 (sex domain excluded)** | | | | | |
| N | 44 | 42 | 37 | | |
| Mean (SD) - Resultant score | 2.79 (2.10) | 6.58 (3.74) | 4.22 (2.85) | **0.0101** | **0.0003** |

**n: Number of participants for whom the domain was applicable; APFQ: Australian pelvic floor questionnaire; PFD: Pelvic floor dysfunction*

The percentage of symptomatic participants increased from preinjury (88.64%) to subacute (92.86%) to three months (97.29%) post pelvic fracture for the bladder domain. A statistically significant change in the results was found from preinjury to three months (P=0.0062) as well as between the subacute phase and three months post injury (P=0.0002). The max score reported for the bladder domain also increased. All 42 participants in the subacute phase experienced bowel domain PFD symptoms. The subacute phase mean resultant score (1.55, SD 1.23) was more than double the mean score preinjury (3.26, SD 1.54). A statistically significant change was found between the subacute phase and three months scores (P=0.0000). However, no significant change was noted when comparing the three months mean score to mean score at baseline.

Two participants developed symptoms of a POP during the subacute phase compared to baseline. One participant prolapse symptoms resolved by the three months follow-up. The maximum additive score reported for the prolapse domain increased from three preinjury to five in the subacute phase but decreased to two by three months. The mean resultant scores remained <1 for all three time points and no statistically significant change was noted. A reduction is noted in the number of participants sexually active from preinjury (n=33) to subacute post injury (n=5), and preinjury to three months post injury (n=17). A significant change (P=0.0087) was noted between the mean scores preinjury (1.5, SD 1.93) and by three months post-injury (0.4, SD 0.41).

All 44 participants had experienced PFD symptoms preinjury and in the subacute phase post injury, with a mean score of 4.29 (3.13 SD), and 7.1 (3.9 SD) respectively. One participant was not symptomatic at three months post injury. A statistically significant change in the mean scores were found between preinjury and three months (P = 0.0216) and subacute phase and three months (P = 0.0361). The resultant score is calculated by converting each domain score to a score out of 10, to determine a total APFQ score out of 40., When removing the sexual domain score of 10 (as the sexual domain was not applicable to most participants post fracture) to get a total resultant score out of 30, a greater change was noticed in the scores between the time points.

Figures 4-12 to 4-17 demonstrates the distribution of the mean total scores for this cohort and individual participants scores for each time point, per domain, in

comparison to the normal ranges for mean scores of the APFQ based on women with and without PFD that were assessed for external validation of an online prediction model of the APFQ in 2018 (Chen et al., 2022). The number of participants with scores between the normal ranges for those with PFD (yellow lines) and without PFD (blue lines) are noted. Participants with scores higher than the mean score for women with PFD is noted (scores above blue line). Participants without significant PFD are noted below the blue lines. Most participants bladder domain PFD symptoms were below the normal value for women with PFD. Twelve participants had bowel symptoms greater than the normal for those with PFD preinjury.

The bowel and sexual domains had higher frequencies of participants with scores indicating PFD at three months post injury. A difference can be seen in the proportions of scores compared to the averages discussed in Table 10, but due to a small sample size it may not be precise.

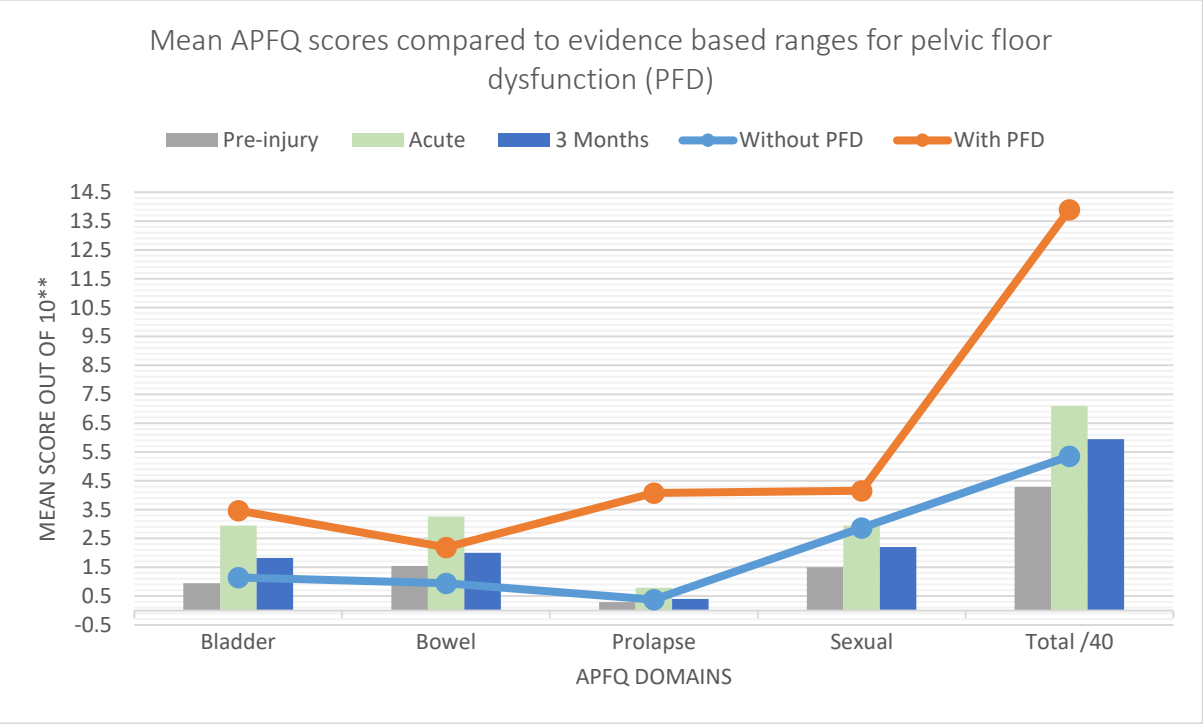


**Figure 4-11 Distribution of mean scores compared to evidence based normal ranges for pelvic floor dysfunction**

**(**Domain scores are out of 10, while the total score is out of 40)**

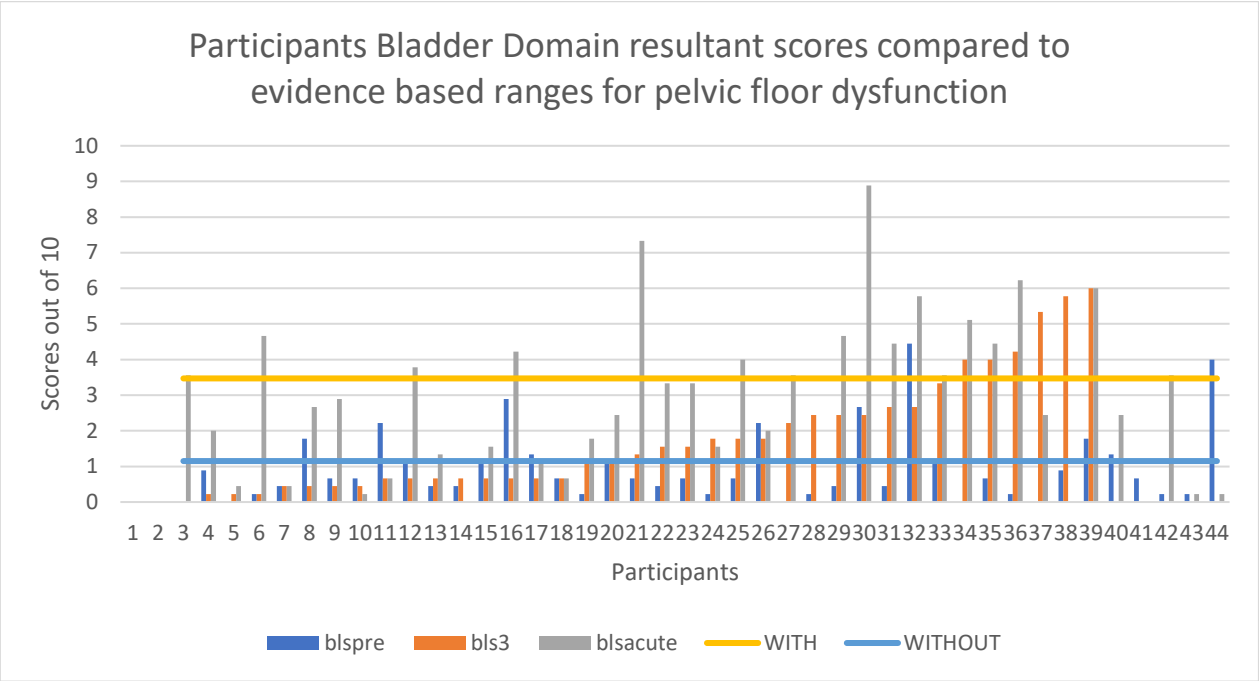


**Figure 4-12 Distribution of bladder domain scores in comparison to normal ranges for women with and without pelvic floor dysfunction**

**blspre: bladder domain score preinjury; bls3: bladder domain score at 3 months; blsacute: bladder domain score in the subacute phase post injury*

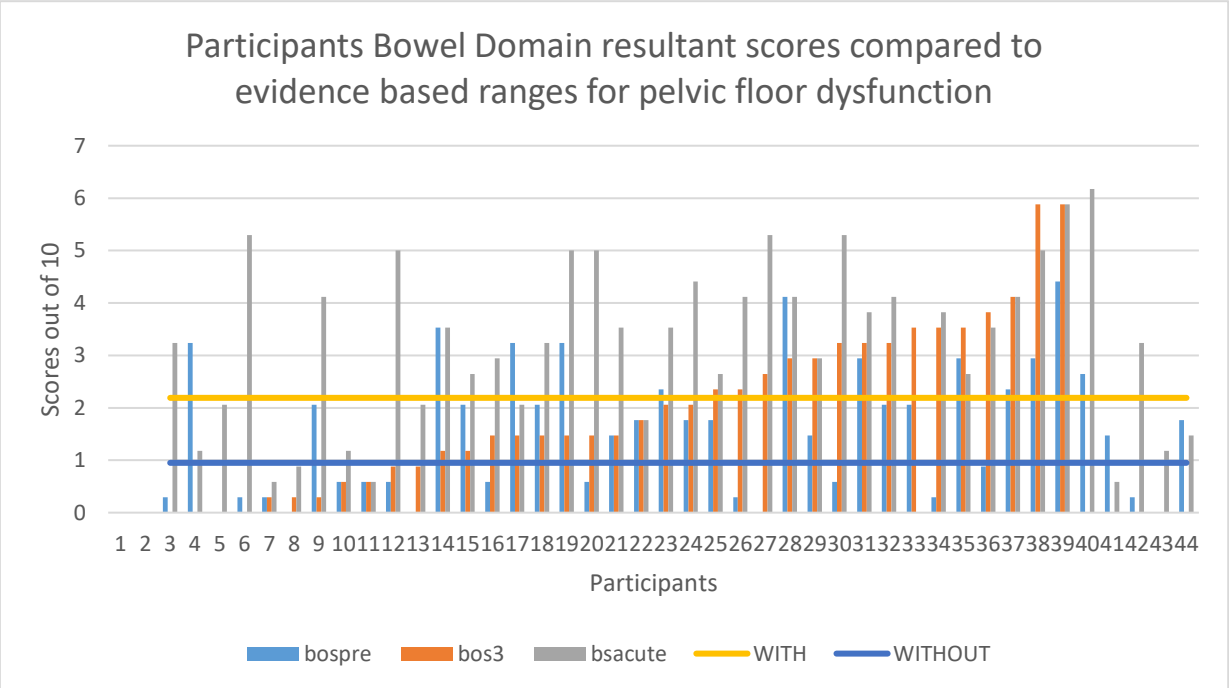


**Figure 4-13 Distribution of bowel domain scores in comparison to Normal ranges for women with and without pelvic floor dysfunction**

**bospre: bowel domain score preinjury; bos3: bowel domain score at 3 months; bosacute: bowel domain score in the subacute phase post injury*

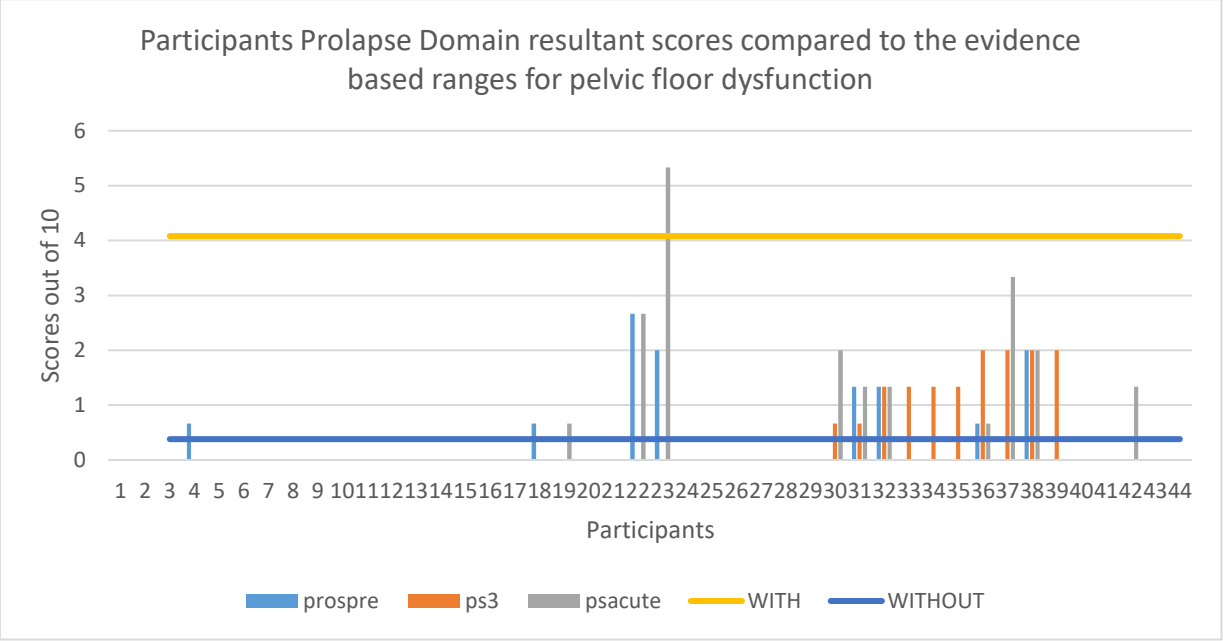


**Figure 4-14 Distribution of Prolapse domain scores in comparison to Normal ranges for women with and without pelvic floor dysfunction**

**prospre: prolapse domain score preinjury; ps3: prolapse domain score at 3 months; psacute: prolapse domain score in the subacute phase post injury*

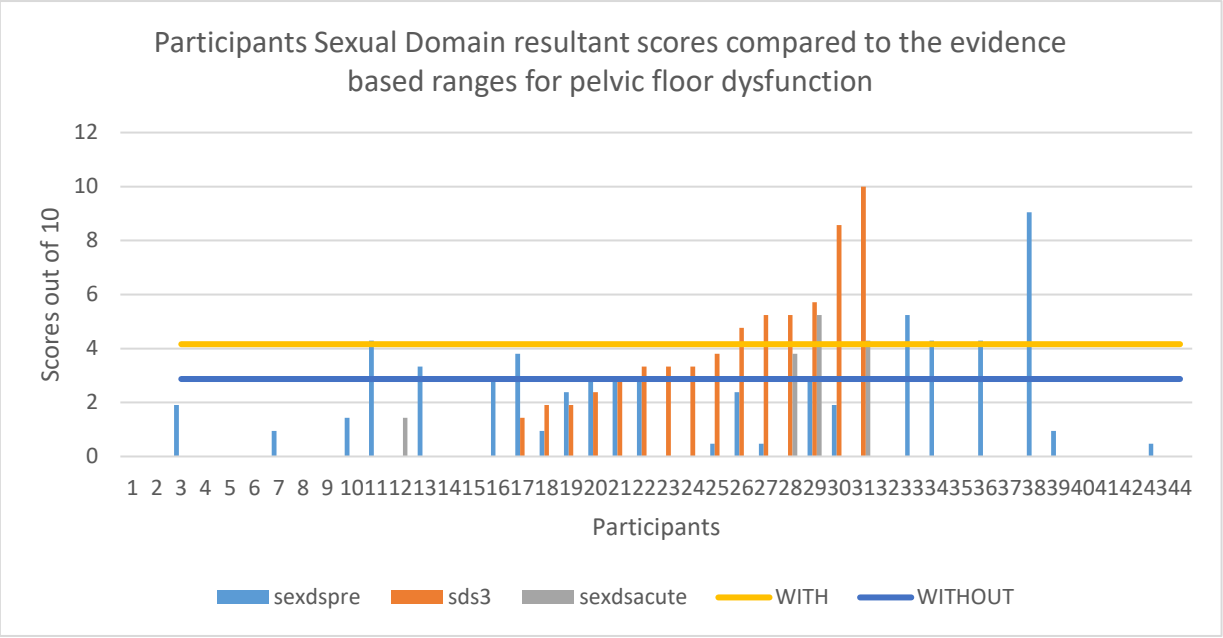


**Figure 4-15 Distribution of sexual domain scores in comparison to Normal ranges for women with and without pelvic floor dysfunction**

**sexdspre: sexual domain score preinjury; sds3: sexual domain score at 3 months; sexdsacute: sexual domain score in the subacute phase post injury*

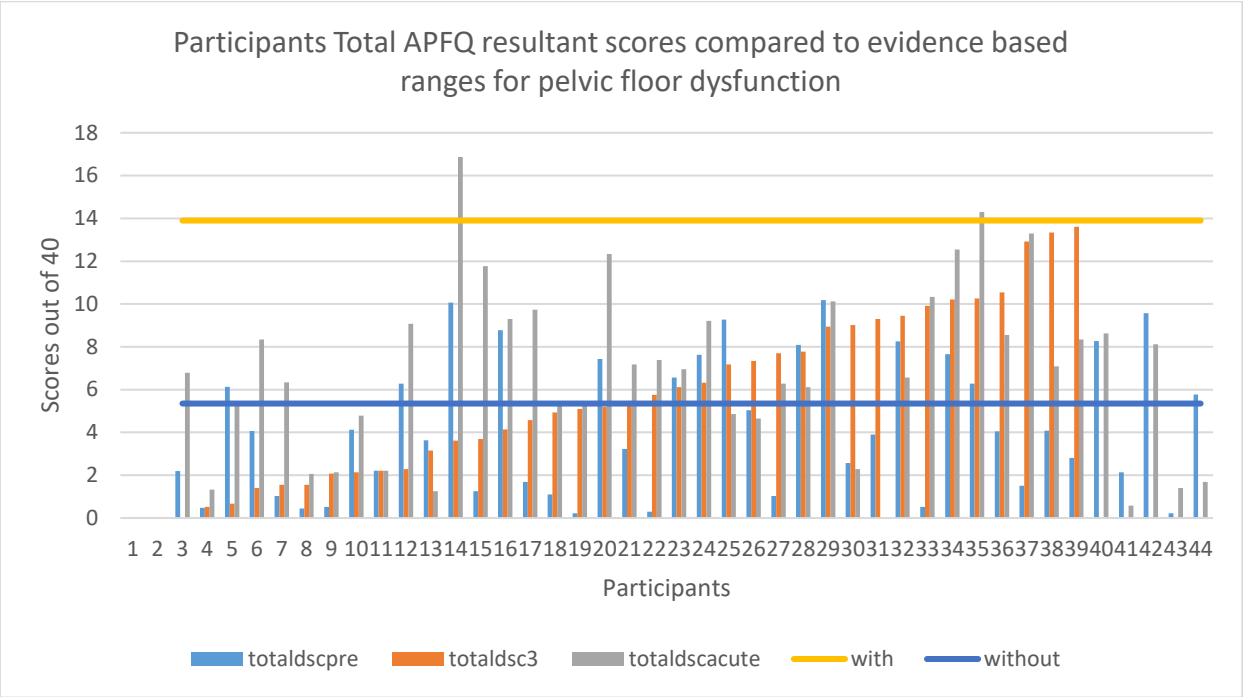


**Figure 4-16 Distribution of Total Australian Pelvic Floor Questionnaire resultant scores compared to Normal ranges for women with and without pelvic floor dysfunction**

**totaldspre: total score preinjury; totalds3: total score at 3 months; totaldsacute: total score in the subacute phase post injury*

## 4.6 Factors associated with Pelvic floor dysfunction

This section will discuss the associations found between scores and symptoms of PFD and time of recruitment, demographic variables, type of pelvic fracture sustained, the types of orthopaedic management received, supportive management received and TUGT scores at three months. Regression analysis, Oneway, Two-sample *t* Tests, and Paired *t* Tests were used to analyse the data for statistically significant associations. Significance level was set at 0.05.

### 4.6.1 Demographic variables

Table 4-12 presents the results of univariate linear regression analysis performed to assess for associations between participants ages, number of pregnancies, parity and BMI and participants total APFQ score preinjury and at three months post injury. Association between the three months score and the TUGT score at three months was

also analysed. Statistically significant association was only found for the number of live births and preinjury APFQ scores (p-value 0.046, coeff -0.53, (95%CI: -1.05 to -0.01). This is a weak negative association showing that as the number of live births increased, the score for PFD preinjury decreased by half. A significant association was noted between the scores at three months and whether a participant delivered vaginally, whereby NVD, resulted in a lower score by 2.76 points at three months. A weaker association was found for the number of vaginal deliveries with a 0.69 point decrease in the score. No associations were found with whether a participant had a miscarriage. There were no associations found between participants preinjury scores and their race (p=0.1840), which age category they fell in (p=0.6323) and whether they were pre- or post- or currently experiencing menopause. No associations were found between scores and whether a participant had a miscarriage.

**Table 4-12 Results on regression analysis for associations between total APFQ scores preinjury and 3 months post injury with demographic variables**

| | **Preinjury** | | | **TOTAL at 3 months** | | |
|---|---|---|---|---|---|---|
| **Variable** | **Co-efficient** | **95% CI** | **p-value** | **Co-efficient** | **95% CI** | **p-value** |
| Age | -0,05 | (-0,11) - 0,005 | 0,071 | -0,069 | (-0,14) - 0,02 | 0,116 |
| Pregnancies | -0,32 | (-0,84) - 0,21 | 0,229 | -0,45 | (-1,11) - 0,22 | 0,182 |
| Parity | -0,53 | (-1,05) - 0,01 | **0,046** | -0,58 | (-1,24) - 0,09 | 0,089 |
| Delivery by NVD | -1.84 | (-3.72) – 0.03 | 0.053 | -2.76 | (-5.17) – (-0.36) | **0.026** |
| Number of NVD | | | | -0.69 | (-1.35) - (-0.30) | **0.041** |
| BMI | -0,08 | (-0,25) - 0,08 | 0,319 | -0,12 | (-0,32) - 0,07 | 0,209 |
| Timed up and go | | | | -0,0008 | (-0,07) - 0,067 | 0,981 |

**NVD: normal vaginal delivery*

### 4.6.2 Association between PFD scores and pelvic fractures sustained

Using a Two-sample t test and linear regression tests, no statistically significant relationship was found between the total APFQ scores of participants subacute and three months post fracture, and the various types of fractures sustained (Table 4-4). No associations were found between specific symptom scores and types of fractures either.

### 4.6.3 Association between PFD scores and management provided for the pelvic fracture

Univariate linear regression analyses were done to determine if there were any association between the participants scores and the combination of management received, and the different types of management overall. A statistically significant association, with a strong coefficient wasnoted for participants who received bedrest with non-weightbearing as the choice of treatment (p-value 0.046, coeff -4.00, 95% CI: -7.92 - -0.08), whereby their scores were lower by four compared to those participants who received other additional management. No association was found when comparing the total APFQ and the bladder domain scores at three months to whether participants used a urinary catheter.

However, weak positive correlations were found between the duration of urinary catheter usage and the change in scores (from pre to three months post injury) for urinary urgency (n= 37, r = 0.1155), urinary frequency (n= 37, r = 0.379), incomplete bladder emptying (n= 37, r = 0.2850) and subsequently the bladder domain score (n= 37, r = 0.1585). Frequency of reporting weak flow was noted to have a very weak decreasing trend in participants who used the urinary catheter for a prolong period (n= 37, r = -0.0116). An increase in the TUGT scores correlated with a weak decrease in urinary leakage (n= 37, r = -0.0918). There was no significant difference noted in the mean scores of those who received pelvic health physiotherapy (n=5, 3.17; 0.78 SD) and those who did not (n=39, 4.47; 0.59 SD) (P=0.4174).

## 4.7 Summary of results section

This section looked at the results of the study in relation to the study objectives. All participants presented with some symptom of PFD prior to, in the subacute period and at three months post pelvic fracture. However, a significant change was noted when comparing the scores of PFD at three months to scores prior to and subacute post pelvic fractures in a cohort of predominantly black females. The next chapter will discuss the significant observations in the context of this study population and in relation to other literature to determine any similarities and differences between previous studies and identify trends in the data. This will facilitate drawing conclusions on the influence of pelvic fractures on PFD and provide guidance on what to implement in the clinical setting.

# Chapter 5 Discussion

## 5.1 Introduction

This section will discuss the results of this study in the context of literature and applying clinical reasoning to better understand the results. The aim of this quantitative pre-test, post-test same sample longitudinal study design was to determine pelvic floor dysfunction (PFD) symptoms and associated factors of PFD in female patients from two academic hospitals in Johannesburg, South Africa, three months after sustaining a pelvic fracture.

As noted in

Figure 5-1, the objectives are interlinked and contribute to each other. Therefore, the discussion will follow an interlinked order. The discussion will first provide an overview of the scores for the PFD. The descriptive results for demographics, medical history, types of fractures sustained, and the various management received will then be discussed in the context of PFD. Additional comments on the symptoms of PFD will be made prior to concluding this section.

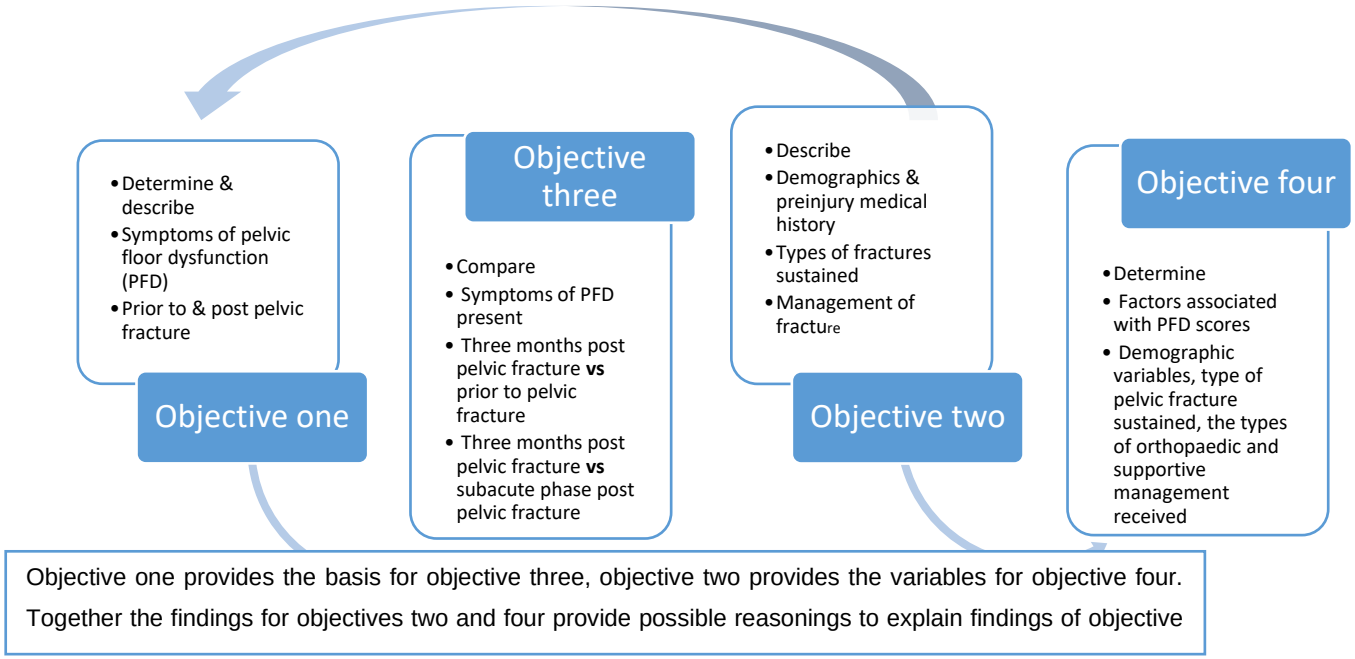


**Figure 5-1 Interrelated concepts between objectives**

## 5.2 Overview on presence of pelvic floor dysfunction

There is limited data available on the presence of PFD and PFD symptoms among females in South Africa. Jacobs (2017) reported that 28.2% of women in South Africa suffer from urinary incontinence. Pelvic organ prolapse (POP) is reported to occur in 46% - 73% of women in South Africa (Brandt and Janse van Vuuren, 2019). Other data on South African women is specifically related to postpartum symptoms. The preinjury results from this study will contribute to the data on PFD in females in Johannesburg, South Africa, as prior to the injury, the participants of this study were a random sample of women of different demographics.

The results of this study found that all women (n=44) had experienced some PFD symptom preinjury. This is synonymous with research that women will experience PFD at some point in their life (Egorov et al., 2022). This is much higher than the 16.6% of women with PFD reported by Baessler et al. (2004). A study done in Australia by McConnell et al. (2020), with only 3.8% of their population consisting of black aboriginals and immigrants (Australian Bureau of Statistics, 2024), also found PFD symptoms present in 44% of their females prior to sustaining a pelvic fracture, which indicates that regardless of ethnicity women are likely to present with PFD symptoms.

While the APFQ grades severity for each question/symptom, with a higher score indicating a higher severity of symptoms, Chen et al. (2022) developed an online prediction tool based on the APFQ to aid in diagnosing whether a woman has PFD or is only symptomatic. Comparing the results of this study to the mean scores of women without PFD, as found by of Chen et al., (2022), the baseline mean score for bowel domain of our cohort preinjury (1.55, 1.23 SD) was higher than their mean score (0.95) for women without PFD. However, it is below the recorded normal for women with PFD (2.19). Clinically this is important as it indicates that without a pelvic fracture, women in Johannesburg, South Africa are already at risk of significant bowel dysfunction, which supports the findings of Brandt and Janse van Vuuren (2019), Kenne et al. (2022) and Mahassadi et al. (2019). Some of the contributing factors such as diet, ethnicity, toileting habits are discussed topically through this chapter.

Table 5-1 lists the mean APFQ additive scores of this study and those reported by McConnell et al. (2020). When comparing the bladder, bowel and sexual domain additive scores to those reported by McConnell et al. (2020) for females preinjury, it is noted that the cohort of this study had higher baseline scores for all three domains. Our study did have a larger sample size for females.

**Table 5-1 Comparison of mean APFQ additive score findings from Current Study and McConnell et al., (2020)**

| | Preinjury | | Post pelvic fracture | |
|---|---|---|---|---|
| | **McConnell et al. (2020) Mean (SD)** | **Current Study Mean (SD)** | **McConnell et al. (2020) Mean (SD)** | **Current Study Mean (SD)** |
| **Bladder** | 3.67 (4.3) | 4.27 (4.55) | 10.39 (7.4) | 8.19 (7.36) |
| **Bowel** | 5.00 (3.1) | 5.27 (4.18) | 7.67 (4.0) | 6.81 (5.26) |
| **Sexual Function** | 2.23 (2.8) | 4.21 (4.2) | 5.08 (4.9) | 7.88 (5.63) |

The current study reported that participants in the subacute period following a pelvic fracture were found to have a significant change for most PFD symptoms compared to preinjury. It is expected to find a change in symptoms during the subacute phase as patients are experiencing pain, likely receiving opioid medication, fluids and drips which increase the fluid input and can lead to frequency. Baessler et al. (2004) though commented that women did not present with the PFD symptoms acutely and their PFD symptoms were therefore missed. The subacute mean total score (7.1, 3.9 SD) of patients in this study was still less than Chen et al. (2022)'s mean total score (13.9) of women with PFD. However, the mean score for the bowel domain (3.26, 1.54 SD) increased in the subacute phase compared to preinjury, and was higher than the mean (2.19) for women with PFD. The additive mean score for the bowel domain in the subacute phase (11.07, 5.23 SD) was also higher than what was found by McConnell et al. (2020) (7.67, 4.0 SD) at one year post injury. By three months post injury our participants' mean additive score for the bowel domain (6.81, 5.26 SD) was less than that reported by McConnell at one year post injury.

The results of this study found that 97.3% of participants reported at least one PFD symptom at three months post-pelvic fracture. This is less than the 100% of symptomatic participants preinjury. Only one participant did not report any symptom

compared to three participants in McConnell et al. (2020)'s study. It is peculiar though that this participant did not have any PFD symptoms as she sustained multiple unstable pelvic fractures. She required a second admission for an ORIF and was in hospital at three months post pelvic fracture. She had a TUGT score of 40 seconds and was mainly using a wheelchair. Her BMI was in the obese category. She had one abortion and no births. She was managed with bedrest, skin traction, ORIF and varied weightbearing instructions. With this collateral information, we can assume her sexual domain score at three months was zero as she was in hospital and not engaging in sexual function, hence not experiencing dysfunction.

Since McConnell et al. (2020) reported that 83% of participants presented with dysfunction in the bladder domain, we would expect this participant to have had bladder domain symptoms. However, as part of standard procedures for an ORIF, this participant probably had a urinary catheter inserted the week prior to our follow-up, which may have resolved the overactive bladder and urinary retention symptoms (incomplete emptying, straining and weak flow) she reported in the subacute phase. She reported that the pelvic health education on abdominal massage and breathing assisted with her subacute phase bowel symptoms (constipation, straining, incomplete emptying) as well as using occasional laxatives at home in that time.

At three months the mean total score (5.94, 3.81 SD) for the current cohort was still not regarded as having PFD according to the normal values (13.9) for PFD by Chen et al. (2022). However, there were individuals who had bladder and bowel dysfunction scores greater than or equal to scores for women with PFD; and majority participants had scores greater than the scores established for women without PFD. Additionally, about 40% of participants were found to have PFD based on their scores being equal to or greater than the mean scores for women with PFD. Considering this, it is possible that the scores were not equally distributed, and a few participants with very low scores, and the one participant with a total score of zero, skewed the data resulting in a lower mean score. Compared to APFQ additive scores reported at one year post pelvic fracture by McConnell et al. (2020) in Table 5-1, lower bladder and bowel domain scores were found, and higher sexual dysfunction scores. Patients may become comfortable and confident over time, decreasing the severity of sexual dysfunction by one year, whereas bladder and bowel function may worsen over time with progressive PFM's weakness, laxity, or inability to relax the muscle due to muscle memory of the

trauma. Future studies investigating the severity of PFD in the subacute phase, at three months and at one year post pelvic fracture are needed to determine if symptoms resolve temporarily at three months but worsen over time.

Separate from the statistically significant changes noted in the scores from preinjury to 3 months, the difference in the number of symptomatic participants between the timeframes for some of the symptoms also showed an increase of more than 20% for eight symptoms. This is clinically important as it guides HCPs on which symptoms to specifically screen for. Future analysis needs to be done to determine if these are statistically significant changes. Although the number of participants for each symptom reverted to the prevalence preinjury, it is possible that individual participants' score for each symptom/question may have changed. They could have improved on some symptoms and developed new symptoms keeping their score unchanged. It will be interesting to compare findings for each question on the domain. Section 5.5 elaborates on findings for specific symptoms compared to previous studies' findings.

## 5.3 Study population

The sample size of this study was found to be small, especially for performing multivariate regression analysis. Ideally, we were supposed to account for the effects of confounders on the relationship between scores and management received by adjusting for age, parity, births, BMI as well as test the effect of these variables independently on the APFQ scores. Due to the small sample size, we were unable to perform multivariate regression analyses and account for these likely contributing factors/confounders. This is noted as a limitation of this study. However, our sample size was comparative, when not larger, to the number of females recruited in other studies investigating pelvic fractures, for similar study sites and data collection periods. Although the sample size was small, this study still speaks to the importance of establishing PFD screening and management in females post pelvic fractures. It also highlights the gap in available research in this important clinical area.

The incidence of pelvic fractures, especially in females appears to be sporadic. Over twenty nine months, Ferede et al. (2021) identified 66 (1.97%) pelvic fractures out of 3250 trauma patients (male and female combined); they recruited 64 of the 66, of which only eight were females. Verma et al. (2020) identified 112 patients with a pelvic

fracture over a ten-year period of whom only 15 were females. A study done at a trauma centre in Kwa-Zulu Natal, South Africa, recruited 42 (47.7%) females over 29 months which the authors reported as being higher than reported by other trauma centres and attributed it to their centre receiving only severe cases with milder cases treated at smaller units (Palmcrantz et al., 2012). One of the study sites (CHBAH) used for the current study is also a trauma site, and the cases found in this study were both mild and severe fracture cases. It is possible that some patients who sustained a pelvic fracture were missed as they may have been discharged from casualty and recovered spontaneously without attending an orthopaedic follow up at two or four weeks. With regards to studies that also investigated PFD following a pelvic fracture, McConnell et al. (2020), over a period of 22 months recruited 18 female patients who sustained a pelvic fracture; Baessler et al. (2004) recruited 24 women retrospectively. In the context of the diagnosis being studied (pelvic fractures in female patients), the total and resultant sample size (44 and 37 by three months) found in this study provides a good reflection of the population.

## 5.4 Demographics, injury and management related characteristics

### 5.4.1 Sociodemographic history of participants

This study looked at a wide group of participants in terms of age, BMI, and parity, providing us with a view of multiple possibilities within a cohort. Only the distribution for ethnicity was skewed to the right. This study had a wide variety of participants in terms of age and BMI and reflects a representation among women.

#### *5.4.1.1 Age of participants*

This study found that more than half of this cohort were in the age range of 18 – 40 with a median age of 37 (IQR 30.5 – 58) years old. Our findings are very similar to Sobantu et al. (2023) who reported 73.7% of patients with a pelvic fracture were in the age range of 18 - 39. It is comparative to the age of participants investigated by Ferede et al. (2021) who reported a mean age of 31.93 (12.1 SD) for patients with a pelvic fracture and the majority in a similar age range to the participants of the current study. McConnell et al. (2020) however reported the mean age of patients with a pelvic fracture in their study was 54 (SD 16.7) years old which is also higher than the mean

age of 30 of participants in study by Baessler et al. (2004). Odutola et al. (2012) reported that the young are more often victims of pelvic fractures.

Most of our participants were premenopausal and still menstruating. While other studies (Brandt and Janse van Vuuren, 2019; Burnett et al., 2020; Hambisa et al., 2023; Kenne et al., 2022; Nygaard and Shaw, 2016) found an association between post-menopausal women and PFD symptoms, this study did not find any clinically or statistically significant difference. With just under two thirds of our study participants still experiencing menstruation, we can assume that these are the prime childbearing ages for most, which is worrisome. Considering some of the complications of pelvic fractures (discussed in section 2.8), there could be struggles during pregnancy and childbirth at some stage. David et al. (2017) noted that caesarean section was required more often as mode of delivery in women with a history of a pelvic ring fracture (David et al., 2017; Vallier et al., 2012). Nine of 23 participants in study by Li et al. (2019) conceived and delivered babies successfully; however six required caesarean section.

It is also the ages to be youthful and socialize or party, however, PFD symptoms affect women's recreational activities and willingness to participate. A recent study done in younger females of childbearing ages, with POP, found that QoL was affected for all domains of the P-QOL questionnaire and even though severity of the POP was low, impact on QoL scores were high (Carroll et al., 2022). Their main concerns were participating in sport/exercise, flawed perceptions regarding their mothering abilities, and fear that their condition will exacerbate (Carroll et al., 2022). Brandt and Janse van Vuuren (2019) reported that POP and associated urinary and bowel symptoms of PFD in women caused restrictions to participate in social activities with family and friends, intimate relationships, and ability to participate in physical activity, which affected their QoL. This could be due to physical discomfort, pain, difficulty with activity and movements, emotional distress including anxiety, depression, feeling embarrassed, shame, and lack of self-esteem, poor perception of self-image and body image, decreased libido vs dyspareunia and difficulties with sex, and urinary symptoms of leakage or frequency, all of which lead to social isolation, withdrawal and decreased QoL (Munno et al., 2023; Srikrishna et al., 2008; Verbeek & Hayward, 2019). Section 5.5.1 explores the data obtained from this study that indicate the impact of PFD and POP on QoL. It is important to consider that sexual domain bothersome scores may be influenced by POP symptoms, even if POP symptoms do not cause as much bother.

#### *5.4.1.2 Relationship status and sexual function implications*

The predominant age group of this study's participants are likely to be sexually active. The results of this study found that half of the participants had a partner which could indicate they are involved in some degree of sexual activity. Although 47.7% of this study's participants were single, this does not exclude them from wanting a partner in the future nor being sexually active. Some participants of this study reported that their partners left them because of the fracture. Having sustained a pelvic fracture can make it difficult to find a partner as disability can be expected following a pelvic fracture, hence affect QoL and wellbeing as described by Harvey-Kelly et al. (2014); Sobantu et al. (2017); and Verma et al. (2020). Sexual activity is commonly affected following a pelvic fracture, details of which is discussed in section 5.5.5.

#### *5.4.1.3 Race/Ethnicity*

Van der Walt et al. (2014) found ethnicity to be independently associated with PFM strength. The current study reported that majority (93.2%) of female patients who sustained a pelvic fracture and were taken to one of two academic hospitals in Johannesburg, were of black ethnicity. The remaining 6.8% were coloured. This is not surprising, as 76.4% of the 4.4 million population in the City of Johannesburg are black African according to Statistics SA (2011). One of the study sites used, Chris Hani Baragwanath Academic hospital (CHBAH), is situated in Soweto, a peri-urban region of Gauteng, where black Africans make up 98.5% of the population and coloureds account for 1% (Statistics SA, 2011). CHBAH, the third largest hospital in the world is a tertiary academic institution. CMJAH, opened in 1979, is the primary teaching hospital for the University of the Witwatersrand and is situated in an urban part of Gauteng, Parktown. Both academic hospitals used in this study are referral hospitals that provide health services to large catchment areas and receive referrals from private health care practitioners, primary healthcare centres, secondary level hospitals and hospitals from neighbouring provinces. Most of these patients cannot afford medical aid. The patient population at CHBAH and CMJAH are therefore diverse and represent central Johannesburg and Johannesburg South areas. This study provides a good reflection of the population mostly admitted to these hospitals.

Our findings are consistent with other studies by Abdool (2017), Ashkal et al. (2021), Brandt and Janse van Vuuren (2019), Madombwe and Knight (2010), Mbatha et al. (2023), and Sobantu et al. (2017) done in South Africa that reported a higher ratio of black Africans among their study populations. Regarding race and PFD, Skaal and Mashola, (2011) reported that some form of PFD is common among black ethnic populations compared to white women. Kenne et al. (2022) also reported that women of black ethnicity have a higher risk for presence of PFD, but a lower risk for urinary incontinence and POP compared to white, Asian and women of other races. This is different to findings by Abdool (2017) who found increased incidence of POP among black African females. Females of black race are three times more likely than females of white race to experience sexual dysfunction according to a study done in gynaecological malignancy survivors (Frimer et al., 2019).

While culture and race have an influence on perceptions of sexual function and acknowledgment of sexual dysfunction (Bhavsar & Bhugra, 2013; Campbell & Stein, 2014; Frimer et al., 2019; Heinemann et al., 2016; Mpondo et al., 2018; Ramlachan & Naidoo, 2024), there is no recent research to the best of our knowledge clearly indicating that race and culture affect patients' willingness to discuss their sexual symptoms with healthcare professionals. On the contrary, despite black South African families viewing overt sexual discussions as inappropriate (Mpondo et al., 2018), studies that included black South African females, or females of black race from other parts of the world, reported high number of participants as appreciating the opportunity to discuss their sexual health (Ramlachan & Naidoo, 2024). During data collection for this study, many participants were glad to discuss their sexual health and shared their concerns willingly providing more information than asked on the APFQ. In fact, two older participants asked about when they can resume sexual activity as it is important for them. They were concerned about safe positions for their pelvic fracture and requested advice. Some participants, surprisingly more the younger participants, were shy to answer the sexual domain questions during data collection phase one. However, none refused to answer any of the questions from all four domains (except those who defaulted from the study completely). Hence, race did not impact on participants willingness to respond on to bladder, bowel, prolapse and sexual function.

Of note, race and culture play a role in diet and choice of snacks and meals (Ojo et al., 2023; Peltzer, 2002) which impacts on bowel function. For the preinjury and three-

month post injury bowel domain questions, many participants in this study reported that certain symptoms were prevalent when they ate certain foods that form part of their staple diet at home (e.g. increased flatulence when eating cabbage), or certain daily food choices prevented certain symptoms (e.g. daily apple and banana equated to good bowel movements). However, while they were in hospital in the acute stage post injury, they were not eating these foods which may have influenced improvements or worsening of bowel symptoms during the acute stage post pelvic injury.

#### *5.4.1.4 BMI*

More than a third of participants in this study had a normal BMI, and half were either overweight or obese with a mean (SD) BMI of 27.4 kg/m$^2$ (6.4). This is similar to Kenne et al. (2022) who had predominantly overweight and obese women with a similar mean (SD) BMI of 29.42 kg/m$^2$ (8.01). They found an association between BMI and the presence of PFD in their participants (except for POP). This concurs with findings from a study in the United States that found incidence and severity of PFD associated with BMI (Wu et al., 2014). Bilgic et al. (2019) noted that obese women had more frequent urinary incontinence and worse sexual function compared to nonobese women. However, Van der Walt et al. (2014) who noted black females to have a higher BMI, reported that his participants with a higher BMI, had increased PFM strength. Unlike these studies, this study did not find a correlation between BMI and total score for PFD. Carson et al. (2018) concluded that morbid obesity is associated with increased risk for complications and longer length of stay in hospital. This is something that can be investigated further in future studies.

#### *5.4.1.5 Co-morbidities and medical history*

This study reported HIV infection and chronic constipation to account for the commonest pre-existing health conditions. HIV infection is associated with reports of UTI (Skrzat-Klapaczyńska et al., 2018). We can also expect HIV infection to mimic symptoms of pelvic pain if it results in pelvic inflammatory disease (Skrzat-Klapaczyńska et al., 2018). Chronic constipation was found in 62.5% (n=65) of black African women in a study done in West Africa (Mahassadi et al., 2019a). This relates to findings by Kenne et al. (2022) that black females are at greater risk of bowel dysfunction. Since this study had a predominantly black African population, we could postulate similar reasonings for our results. One could argue though, that considering

the current modern lifestyle, with unhealthy food options easily available, stress levels high and fast paced lifestyles, constipation is becoming more prevalent among all ages and races. Most victims may suffer in silence, or ignorance that it is normal for them.
One participant had a POP diagnosis preinjury and is discussed in 5.5.4. There were two participants with a hysterectomy whom we would expect are at risk of or symptomatic for POP. Surprisingly, both these participants did not have any POP symptoms at all three time points. However, the one had the highest preinjury total APFQ score, and both did not return to sexual activity in the subacute phase and three months post pelvic fracture. This supports studies reporting hysterectomy as a risk factor for PFD (Wu et al., 2014).

#### *5.4.1.6 Parity and mode of delivery*

There were ten nulliparous women in the current study. No associations were found between number of pregnancies and the APFQ scores for PFD. Of the women who had at least one pregnancy, only 29 delivered a live baby, seven of which had a caesarean section. Kenne et al. (2022) and Baessler et al. (2004) could not describe a relationship between PFD and parity and nulliparous vs multiparous women respectively. In the current study, a statistically significant negative relationship was found for parity and the total scores for PFD prior to the pelvic fracture (P=0.046). This indicates that participants who birthed more babies, had lower scores for PFD. This is contrary to what is expected and reported in other studies; however, other studies analysed associations of parity to specific symptoms of PFD and to the presence of the symptom, while the current study analysed for an association with collective scores for four domains of PFD. Wu et al. (2014) found increasing parity to be associated with increased prevalence rates of one or more PFD including urinary incontinence, FI, and POP.

A relationship was found in the current study between vaginal delivery as well as number of vaginal deliveries, and the participants total APFQ scores at three months post pelvic fracture. Those who had a vaginal delivery, and those with more vaginal deliveries had lower APFQ scores three months post pelvic fracture. Reasoning for the associations noted for parity and NVD for the current study need to be investigated further and can only be speculated at present.
A study done to assess pelvic floor morphology in South African women found that females of black ethnicity had significantly different pelvic floor dynamics than

Caucasian and South Asian women (Abdool, 2017). The study also reported that 15% black females encounter levator ani trauma following vaginal delivery. On speculation, it is possible that because of the changes during pregnancy and vaginal delivery to the pelvic floor, anatomical changes that are reported to occur post pelvic fracture like levator ani avulsion, had already occurred to the PFM's decreasing the risk of the pelvic fracture causing new changes that can lead to PFD. It is also possible that because of pregnancy, vaginal delivery, and associated education received during those experiences, these women gained awareness their pelvic floor biomechanics and were regularly training their PFM's prior to the injury, reducing the effect of the fracture on their pelvic floor, subsequently reducing the incidence and severity of PFD symptoms.

Van der Walt et al. (2014) noted increased strength in the PFMs of nulliparous South African black females, suggesting that black females have a stronger baseline PFM prior to pregnancy and NVD. Van der Walt et al.'s (2014) findings reinforced the belief that a black females PFM's is well-resourced to withstand intra-abdominal forces acting on the urinary tract. These concepts can support speculations of multiple vaginal deliveries indicating multiple pregnancies and opportunity for the pelvic floor to withstand intra-abdominal forces while carrying the weight of a foetus. Therefore, our participants may have unknowingly trained their PFMs to manage change in forces during their pregnancies. Van der Walt et al. (2014) also found that less frequent defecation, which may imply increase straining, was associated with weaker PFM's. Females who birthed by NVD, likely experienced defecating with postpartum perineal tenderness. Hence, they may have been more likely to attempt defecation sooner after a pelvic fracture compared to those who never experienced NVD and feared pain.

### 5.4.2 Mechanism of injury and Types of fractures sustained

#### *5.4.2.1 Mechanism of injury*

The results of this study revealed that transport accidents (motor vehicle accidents (MVA) and pedestrian vehicle accidents (PVA)) were the mechanism of injury for majority (86.4%) of participants. Orthopaedic patients admitted at the two hospitals from which participants were recruited for this study are often victims of MVA's or PVA's. Nationally, transport accidents are the third most common cause of non-natural causes of death (Statistics SA, 2011). Ferede et al. (2021) and Palmcrantz et al. (2012)

concur with the findings of this study, as they also found that transport/ road traffic accidents accounted for 56.3% and 59% respectively of their study participants' mechanism of injury. The study by Sobantu et al. (2017) also reported MVA's followed by PVA's as the primary mechanisms of injury, which reflects the South African setting. This is supported by findings from Ashkal et al. (2021) and Mbatha et al. (2023). These findings concur with findings of studies from other parts of the world (Baessler et al., 2004; Harvey-Kelly et al., 2014; McConnell et al., 2020; Odutola et al., 2012; Ohishi et al., 2012).

The young are seen as more active and likely to be traveling daily. Majority of the participants were within the working age group and would probably travel to work daily. Considering 61.8% of the population in the City of Johannesburg do not own a car (Statistics SA, 2011), and only 21.8% of women in South Africa possess a driver's licence (Statistics SA, 2021), we could postulate that most participants either rely on public transport where the vehicles have less safety features such as airbags, or they walk from place to place, increasing their risk of injury from MVA's and PVA's. This is more common in black African's which made up majority of our participants, as only 13.4% have a driver's licence compared to females of other racial groups (Statistics SA, 2021). If black South African women are more likely to use public transport, they will need to walk between places. Public transport usually has specific pick up and drop off spots as opposed to door-to-door transport, placing women at increased risk for PVA's.

#### *5.4.2.2 Association between mechanism of injury and fracture type*

An association was found between mechanism of injury and whether participants sustained multiple or only one fracture to the pelvis. This concurs with findings by Sobantu et al. (2017). Fourteen of the sixteen (87.50%) participants that encountered a PVA in the current study, sustained multiple fractures to the pelvis. Half of the participants that had an MVA also had multiple fractures. Since the pelvis requires high impact force to sustain a fracture, we can assume that 65.79% of the transport accidents (MVA's and PVA's) encountered by most of this study's participants were severe enough to cause fractures to multiple areas of the pelvis. Those that sustained only one fracture from transport accidents may have had smaller impact accidents.

*5.4.2.3 Types of fractures sustained*

Our results are similar to those found by Ohishi et al. (2012) who also had a higher incidence of multiple fractures as opposed to only one fracture to the pelvis. However, no associations were found between types and number of fractures sustained, and the APFQ scores for PFD. This is consistent with McConnell et al. (2020) who did not find an association in type of fracture sustained and degrees of PFD reported. Baessler et al. (2004) also could not find an association between PFD symptoms and Type B or Type C fracture types. However, Lee et al. (2019) reported that the patterns of fractures can help predict the risk for bladder rupture and they reported significant associations between fracture types and severity of vaginal injury.

Similar to the study of Baessler et al. (2004), it is possible that the current study could not determine an association due to a lack of power/smaller sample size as well as no standardized classification of fractures. In the current study, 63.64% of participants sustained multiple fractures to the pelvis and 11.36% sustaining bilateral combined superior and inferior pubic rami fractures. Of the type of fractures identified in this study, pubic rami fractures (79.55%) were most common followed by acetabular fractures (47.73%). These findings are similar to what was reported by Li et al. (2019). Li et al. (2019) found 80% of patients who suffered pubic ramus fractures, 50% of whom had bilateral fractures and 20% had compromised PS. They noted that severity of vaginal injury was worse with compromised PS ($p=0.024$). Ohishi et al. (2012) found 75% of cases also had fractures on multiple areas of the pelvic ring; and a significant 89.2% of patients with pubic fractures had at least one other fracture on the pelvic ring. Our study reported at least one other fracture in 56.82% of patients with fractures to the pubic rami.

From the victims of acetabular fractures in the current study, most sustained pelvic (inferior pubic rami) fractures as well. This is important to note as based on the anatomy and biomechanics of the pelvic floor discussed in chapter 2, the pubic ramus, specifically inferior pubic rami provide most pelvic floor muscle attachments, the damage of which could lead to PFD. However, no association was found between the scores for PFD and incidence of inferior pubic ramus fracture in this study. Odutola et al. (2012) found 32 participants with combined pelvic and acetabular fractures. Mbatha et al. (2023) noted that female sex and having combined pelvic and acetabular fractures are among factors previously noted to be associated with poorer outcomes

or complications. They had 18% of participants with combined pelvic and acetabular fractures. The current study did not find any association between PFD scores and prevalence of acetabular fractures. Acetabular fractures were included in this study as the acetabulum is formed by all three of the pelvic bones and may be associated with a concurrent force impacting another part of the pelvis, affecting the endopelvic fascia.

#### *5.4.2.4 Additional injuries*

The results from our study also showed that participants did not only sustain fractures to the pelvis but about a third sustained injuries to additional body structures and systems. Mbatha et al. (2023) reported 88% of their cases had associated injuries, however they did not find PFD complications. McConnell et al. (2020) and Sobantu et al. (2017) among other studies also reported their participants sustaining additional injuries in the presence of pelvic fractures. While other studies (Baessler et al., 2004; Odutola et al., 2012; Sobantu et al., 2017; Wright et al., 2006) reported urethral, vaginal and genitourinary injuries, none of these injuries were noted in the medical records of this cohort. No associations were determined between presence of additional injuries and PFD symptoms and scores.

#### *5.4.2.5 Classification of fractures*

Upon reviewing the results of this study, an inconsistency was noted in the description of fractures in medical records. Only a quarter of patients had a pelvic fracture classification, based on a standardized classification system, noted in their medical records which included the radiology reports. One would expect that since these hospitals were academic hospitals, standardized classification systems would be used. These findings are consistent with McConnell et al. (2020) and Sobantu et al. (2017) who found minimal classification of fractures in medical records. Reporting using classification systems especially for pelvic and acetabulum fractures are important (Coccolini et al., 2017; Coleman et al., 2020; Dincer and Ozturk, 2021).

Physiotherapists specifically rely on the classifications to determine precautions and contraindications for rehabilitation. More importantly, the classifications help identify areas injured, the stability and severity of the fractures and the appropriate management (Coccolini et al., 2017; Coleman et al., 2020; Khanna et al., 2012; Mbatha et al., 2023). It could help to identify patients requiring additional screening for

urogenital injuries and PFD and would make determining associations between fracture types and other variables standardized. As described in chapter 2, certain classification of fractures may pose greater risk for PFD.

Since one of two classification systems were used between the 11 participants of this cohort that did have a classification, we could not look for a correlation between PFD symptoms and specific classifications. It could be suggested to have a group of radiologists and orthopaedic surgeons review the radiography reports, classify all the fractures, and investigate if there are any associations. Ashkal et al. (2021); Baessler et al. (2004) and Mbatha et al. (2023) had orthopaedic doctors and radiologists as part of the research team, or they were done in high-middle-income countries where information was retrieved from their hospitals or health systems databases. This allowed for standardized classification of the fractures or the use of ICD 10 codes to identify participants who sustained pelvic fractures.

### 5.4.3 Management of the fracture and supportive management provided

#### *5.4.3.1 Management of the fracture*

The current study reported bedrest (93.8%) followed by adjustments in weightbearing as the most frequently prescribed management. This is slightly less than the 97.9% managed with bed rest in a study by Sobantu et al. (2017). Bedrest may increase patients' risk for constipation following their orthopaedic injury (Copanitsanou, 2018). An association was noted between the APFQ score at three months and participants who were managed with only bed rest and who were non-weightbearing. These participants were found to have lower scores. It may be that these participants injuries were mild and only required conservative management, therefore less damage was encountered by the pelvis, reducing the risk for PFD symptoms.

In terms of surgical management, only one fifth of participants underwent some surgery to manage their pelvic injury. Eight had surgery directly to the pelvis, two of whom also had surgery to apply the Steinman pins for skeletal traction. One participant only had surgery for the skeletal traction. Baessler et al. (2004) reported only 20% of participants being managed conservatively with bedrest and physiotherapy, while 46.7% compared to our 20% being managed by ORIF, and the remainder with external fixation. No

participant in this study was managed with external fixation for their pelvic fracture. Harvey-Kelly et al. (2014) reported that UTI's and ORIF are significant risk factors for sexual dysfunction. Despite the use of pelvic binders being encouraged in the literature (Ashkal et al., 2021a; Coccolini et al., 2017), it was used in only two participants in the current study.

This is in-keeping with data from other South African studies and other major trauma centres where the pelvic binder is not used as often (Ashkal et al., 2021b; Giordano et al., 2016; M. J. Lee et al., 2019; Palmcrantz et al., 2012; Schwartsmann et al., 2018; Siada et al., 2017). Though, there were no blunt or open pelvic fracture incidences in this study which might explain why only two participants were managed with a pelvic binder. Prehospital care is an important contributor to the compliance of the pelvic binder as it forms part of the acute management (Coccolini et al., 2017; Siada et al., 2017). Nonetheless, several South African studies reported uncoordinated, fragmented and insufficient prehospital care systems in place (Bhattarai et al., 2023) which may contribute to the infrequent use of the pelvic binder. The hospitals from this study and the other studies receive referrals from multiple other centres and various paramedic services. This may cause inconsistency in the emergency care provided to trauma patients, including pelvic binder use.

#### *5.4.3.2 Length of stay*

The average length of hospital stay calculated for this study was 13.5 days with the longest recorded length of stay being 104 days. Mbatha et al., (2023) reported an average length of stay of 24 days (SD 21) while Sobantu et al. (2017) reported a range of 1-67 with most admitted for one month. Some participants from the current study were discharged home from casualty and not admitted to hospital while about a fifth required a second admission. The greatest number of times a patient was admitted was twice, with 78.57% only requiring one admission. Staying in hospital involves communal toilets or the use of the bedpan, dependency on food from hospital kitchen and the identity of being sick or ill. Based on an essay on the senses and its impact on defecation, I presume these can affect patient's toileting habits, promote hovering over toilet seat, avoiding defecation, limiting foods eaten and delay normal bladder-bowel regulation (Hemaly et al., 2014; Trads & Pedersen, 2015b; van der Geest & Zaman, 2021).

The main reasons for some requiring a second admission were for surgery after failed conservative management, for further management of additional injuries sustained, or due to complications of the pelvic fracture or management received. These included soft tissue complications such as pressure sores from bed rest at home, UTIs, urinary retention post previous urinary catheter usage and requiring catheterisation. To my knowledge, nothing was noted in the literature on number of admissions required following a pelvic fracture. Fritz et al. (2020) reported that the time taken before a patient receives treatment is an independent risk factor for developing pressure ulcers, with every day of waiting causing a 10% increase in risk.

The hospitals used for this study although tertiary academic hospitals, still have characteristics of LMIC hospitals. This includes the factors that cause delays in time for imaging, surgery and resource limitations discussed in chapter 2.5.3. Patients awaiting non-emergency surgeries are sometimes discharged home for bedrest and re-admitted when there is place on the waiting list. This can place patients at increased risk of developing complications. Others are kept in hospital due to long waiting times for treatment resulting in long length of stays. Increased length of stay may affect the morale of patients and risk development of depression; it increases risk for hospital acquired infections, decreases interactions between patients and their partners and increases the cost to the health system (Mahassadi et al., 2019b). As noted in Sections 2.4.4 and 2.8, depression and morale are associated with presence of PFD and chronic pelvic pain (McDonald et al., 2017; Pierce and Christianson, 2015; Tullington and Blecker, 2023). Depression and stress can also impact on severity of PFD (Pierce and Christianson, 2015). Increased length of stay has also been associated with the occurrence of UTI's (Copanitsanou, 2018).

#### *5.4.3.3 Urinary catheter usage*

Indwelling catheterization increases the risk for UTI's (Skelly et al., 1992; Sørbye and Grue, 2013; Wald et al., 2005). McConnell et al. (2020) reported UTI's in 22% (n=4) of participants post pelvic fracture compared to 6% (n=1) reported preinjury. Urinary catheter usage was found in majority of participants and mainly consisted of indwelling catheterization. One of the limitations of this study is that 9.1% (n=4) of participants still had a urinary catheter in situ by six weeks post pelvic fracture/s. This prevented the bladder domain symptoms to be assessed in the acute and subacute phase. Three

of these four participants had an increase in their bladder domain scores at three months post while the fourth participant remained symptom free from pre to post injury.

The current study could not find an association between use of the urinary catheter and APFQ scores, and specific urinary symptoms for PFD; however, an association was found for duration of usage of the urinary catheter for those variables. Additionally, the participant who used the catheter the longest (63 days) had the second highest score for the bladder domain at three months post pelvic fracture. The participant with the higher score, had a high baseline score as well. It could therefore be noted that prolonged usage of the urinary catheter results in higher bladder domain scores. Based on the other associations, this may be secondary to increase in frequency of urinary urgency, urinary frequency, and incomplete bladder emptying. These are reported complications of prolonged indwelling catheter usage (Copanitsanou, 2018; Sørbye and Grue, 2013; Wald et al., 2005). Prolonged duration of urinary catheter usage was also associated with a decrease in reports of weak urinary flow.

Another curious improvement was observed in the change in scores for weak flow, incomplete emptying and urinary frequency, from preinjury to three months post injury in 13 (41%) participants who used the catheter. This improvement is contrary to findings from work by Skelly et al. (1992) in patients who sustained hip fractures. These are symptoms of overactive bladder and urinary retention which we expect to increase with immobility, use of intravenous fluids, analgesics and opiates, anaesthesia, and acute confusion following trauma. These two symptoms benefit from intermittent catheterization. Van der Walt et al. (2014) noted that black South African women have a higher prevalence of overactive bladder. It may be that these 13 participants were unaware of their overactive bladder and urinary retention symptoms being problematic preinjury and by being catheterized for their pelvic fracture, they incidentally benefitted in relieving their symptoms, which they may not have sought help for if they did not sustain the fracture.

#### *5.4.3.4 Physiotherapy management*

The results of the current study reported physiotherapy as part of the management of majority of participants. Baessler et al. (2004), McConnell et al. (2020), and Sobantu et al., (2017, 2023) also reported physiotherapy rehabilitation as part of the management of patients. They also noted that pelvic health related management was

not included. As noted in the results of this study, patients report high scores for PFD for bladder and bowel symptoms in the subacute phase. Some common reasons for refusal of physiotherapy treatment in the orthopaedic ward include pain, fatigue, poor nutritional status, and the effects of polypharmacy such as constipation and diarrhoea. Despite patients complaining to physiotherapists about this, and physiotherapy being effective in assisting with these complaints, physiotherapists may not always address these issues. Brandt and Janse van Vuuren (2019), Jacobs (2017), Laycock and Holmes (2003), and Skaal and Mashola (2011) have reported the benefits of physiotherapy in the management of PFD. A significant relationship was not determined between pelvic health physiotherapy and APFQ scores in the current study. Unfortunately, very few participants (n=5, 12.50%) in this study received physiotherapy related to pelvic health (most received an explanation of the pelvic floor, PFD symptoms, and/or were prescribed pelvic floor exercises) which may have affected the results of the analysis.

The low number could be because of the lack of knowledge on PFD among physiotherapists and treatment strategies (Janse van Vuuren et al., 2023a; Sobantu et al., 2023). In South Africa, PFD and rehabilitation does not form a significant part of undergraduate physiotherapy studies. Postgraduate courses are available for further training in this field, but no diploma or Master of Science by coursework options are available for furthering studies. This is one limitation to improving access to training and subsequent access to healthcare for PFD.

Other barriers to the accessibility of pelvic floor rehabilitation may include time constraints due to high patient loads for therapists and prioritisation criteria's, staffing, the lack of privacy in a ward environment, lack of implementation equipment, language barriers, and availability of translated patient resources, as well as insufficient cross-disciplinary cooperation (Chinyakata et al., 2021; Scheffler et al., 2015; Wang et al., 2023). Overall barriers to pelvic floor rehabilitation, willingness to receive such treatment and adherence to treatment plans include poor help-seeking behaviour from females experiencing symptoms, patient beliefs and perceptions regarding the symptoms, patient perceptions regarding the efficacy of physiotherapy for pelvic floor, cultural and religious concerns regarding the appropriateness of certain treatment strategies, laziness, boredom and forgetfulness, perceived lack of utility, time constraints, financial constraints, , and travel issues (Bhavsar & Bhugra, 2013; Brandt

& Janse van Vuuren, 2019; Hambisa et al., 2023; Tinetti et al., 2018; Wang et al., 2023; Xu et al., 2023; Zoorob et al., 2017). More than half the participants of a study looking at the barriers to receiving pelvic floor therapy to treat high-tone PFD reported anxiety related to the concept of pelvic floor physiotherapy likely due to a lack of information provided to them on this form of treatment (Zoorob et al., 2017).

The academic hospitals used in this study often have community service physiotherapists as well as third- and fourth-year students treating in the wards, who may not be trained in PFD symptoms. Pelvic fractures form a part of the fourth-year curriculum, hence patients who have sustained a pelvic fracture may be assigned to the fourth-year students. It is therefore important that training on screening for and educating patients on PFD becomes a part of the fourth-year orthopaedic undergraduate training programmes. This will allow the rehabilitation of pelvic fractures to take a biopsychosocial approach and address not just the mobility and pain aspects but also the pelvic health related symptoms.

## 5.5 Elaboration on domain specific symptoms of pelvic floor dysfunction

Table 5-2 summarizes and compares the frequency of participants experiencing various types of PFD in this study and other studies that investigated PFD in females post pelvic fracture.

### 5.5.1 Quality of life

Harvey-Kelly et al. (2014) reported a decrease in QoL of 77.5% (62) of their study population following traumatic pelvic fracture, with sexual dysfunction an independent risk factor post injury. Bothersome is associated with a decrease in QoL (Brandt and Janse van Vuuren, 2019; Mahassadi et al., 2019; Skaal and Mashola, 2011). This study reported higher percentages of participants that felt bothered by symptoms of each domain in the subacute phase and 3 months post injury compared to bother reported preinjury. Prolapse domains did not seem to cause much bother with most symptomatic participants being slightly bothered. Bowel and sexual symptoms caused most bother preinjury and by three months post injury. This is similar to the 72%

**Table 5-2 Comparison of frequency of pelvic floor dysfunction symptoms after pelvic fracture across different studies**

| Study | Time post pelvic fracture | Dysuria | Urinary Urgency | Urgency incontinence | Stress incontinence | Urinary frequency | Pad usage | Weak urine stream/ straining | Faecal Urgency/ incontinence | Flatus Incontinence | Constipation | Frequency <3/week | Straining with defecation | Incomplete bowel emptying | Dyspareunia |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Current Study** | *Pre* | 11.36 % (5) | 22.73 % (10) | 22.73% (10) | 11.36% (5) | 18.18% (8) | 9.09% (4) | 6.82% (3) | 43.18 % (19) | 13.64 % (6) | 68.18% (30) | 25% (11) | 40.91% (18) | 57.55% (24) | 11.36% (19 of 32) |
| | *3 months post* | 37.84 % (14) | 52.63 % (20) | 39.47% (15) | 23.68% (9) | 26.32% (10) | 29.73% (11) | 31.58% (12) | 37.4% (14) | 16.22 % (6) | 67.57% (25) | 29.73% (11) | 59.46 (22) | 54.05% (20) | 37.84% (11 of 15) |
| **(McConnell et al., 2020)** | *Pre* | | 17% (3) | 6% (1) | 6% (1) | 6% (1) | | | | | | | | | |
| | *12–13 months post* | | 44% (8) | 22% (4) | 17% (3) | 44% (8) | | 11% (2) | | | | | | | Decrease sex |
| **(Baessler et al., 2004)** | *Pre* | 0 | 8.33 (2) | 8.33% (2) | 8.33% (2) | 16.67% (4) | 4.17% (1) | 0 | 0 | 8.33% (2) | | 4.17% (1) | 0 | 0 | 12.5% 2 of 16 |
| | *Median 29 month post* | 20.83 % (5) | 37.5% (9) | 29.17 (2) | 45.83% (11) | 37.5% (9) | 20.83% (5) | 16.67% (4) | 12.5% (3) | 12.5% (3) | | 8.33% (2) | 37.5% (9) | 33.33% (8) | 47.06% 8 of 17 |
| **(Sobantu et al., 2017)** | *2-7 years 4 months post* | Yes | | "Can't hold in" reported | Almost 50% - worse in males | Frequent urination reported | | | 20% | | 20% | | | 20% | |
| **(Odutola et al., 2012)** | *> 1 year post* | 35% new urinary dysfunction; 25% new sexual dysfunction | | | | | | 75% of the 25% new sexual dysfunction, also had urinary dysfunction | | | | | | | 3% |

reported by McConnell et al., (2020) for bother caused by bowel domain symptoms. Participants were bothered most by bowel domain symptoms in the subacute phase, with more than half of participants experiencing hard stools, followed by bladder domain symptoms. Bowel issues repeatedly stand out for this cohort.

This study supports findings by Baessler et al. (2004) on pad usage and SUI having a higher impact on QoL. In the current study, pad usage increased from 9.09% preinjury to 29.73% at three months which was the exact same percentages noted for participant reports of urinary leakage to affect their routine activities pre and 3 months post fracture. There was a 20.64% increase in participants using pads and reporting routine activities to be affected. These findings indicate that urinary incontinence and leakage post pelvic fracture may directly affect QoL.

### 5.5.2 Bladder domain

From preinjury to three months post injury, the number of participants experiencing urinary urgency doubled, with a subsequent increase in urgency incontinence, nocturnal enuresis increased, four times more participants had a weaker urine flow, almost three times more participants wore pads because of urinary leakage, 26.5% more participants experienced dysuria, urinary leakage affected 20.6% more participants routine and recreation activities, and an additional 20.9% felt bothered (to varied extents) by their urinary symptoms. Baessler et al. (2004); McConnell et al. (2020); and Sobantu et al. (2017) also noticed a substantial increase in these symptoms as noted in Table 5-2. For seven of the questions, there were a smaller number of participants reporting symptoms by three months post injury compared to preinjury, opening the question of can a pelvic fracture somehow facilitate recovery of certain PFD symptoms. Nocturia reduced, but fluid limitation habit increased, which could be the reason for participants not waking up as often at night. Incidence of infection decreased, likely from antibiotics received as part of their treatment in hospital. If they had urinary retention prior to injury, then the catheterization may have helped to reduce these symptoms. Due to the fracture, patients may have avoided public settings and gatherings, decreasing their chance of using public toilets and picking up an infection. The results showed that participants were not sexually active as often or at all, which decreases the chance of contracting UTI associated with sexual function.

The results showed that half of the participants had an abnormal TUGT score at three months post pelvic fracture. Increased time taken to stand up and walk to the toilet was expected to cause episodes of urinary leakage. An unexpected association found was that of the TUGT score and urinary leakage. While the TUGT was included in this study to account for issues with mobility causing urinary leakage as opposed to PFD causing leakage, it was found that higher TUGT scores correlated with a decrease in incidence and frequency of urinary leakage among participants. It is possible that participants with higher TUGT scores knew that they had difficulty mobilising or mobilise slowly and therefore adjusted their daily activities and prevented symptoms of leakage. They may have chosen not to hold on or wait for a second urge after experiencing the first urge to urinate allowing them to make it in time to reach the toilet without the bladder filling more and risking leaking. These participants may also be using a wheelchair to mobilise in the home and therefore able to get to the toilet in time upon feeling the urge, instead of mobilising to the toilet. Some participants reported keeping a bucket in their room for urination so as not to walk far to the toilet; considering the bucket was near and easily accessible, they did not experience leakage.

### 5.5.3 Bowel Domain

For five of the twelve bowel domain questions, there were five less symptomatic participants by three months post injury compared to preinjury. Although the results in Table 4-6 showed that there was no significant change in number of symptomatic participants for bowel symptoms, Table 4-9 showed that 54.76% of participants passed hard stool acutely post pelvic fracture compared to 13.63% of participants preinjury. Acutely, 57.14% of participants also passed stool less than once a week compared to 4.55% of participants preinjury. One participant reported that she passed her first stool on day ten post injury. With more than 50% of participants not having passed stool within a week of sustaining their fracture. It would be interesting to investigate the duration that lapses prior to the first bowel movement post pelvic fracture.

Chronic constipation was reported as a baseline condition for 13 (29.6%) participants for whom bothersome scores would be a better indicator of change. Although there was a minute decrease in constipation reported (pre to post: 68.18% to 67.57%), variable stool consistencies, straining and FI all of which increased by three months,

can be indicators of constipation (Mahassadi et al., 2019a; Richmond and Wright, 2004). Other studies did not comment on constipation in pelvic fracture patients but discussed straining, reduced frequency, and incomplete emptying. Sometimes incomplete emptying and constipation can lead to faecal impaction and faecal overflow that presents as diarrhoea. Hence faecal urgency can be caused by constipation. If constipation improved, and the urgency was caused by faecal overflow, then that could be a reason for the urgency also improving by three months. This study results support Baessler et al. (2004)'s findings regarding increase in a low defecation frequency (<3 times a weeks) pre to post pelvic injury (25% to 29.73% compared to 4.17% to 8.33%). Percentage frequency of flatus incontinence also increased in both studies, however in our study the number of participants remained the same.

Difficulty defecating and requiring straining was experienced by 18.55% more participants compared to a 37.5% increase reported by Baessler et al. (2004). Constipation and straining may also cause debilitating abdominal pain. Pain may be managed with opioids which can worsen constipation and other symptoms. These all limit the patient's ability to exercise. Constipation including reduced frequency in defecation are noted as complications of stasis (Copanitsanou, 2018). Bedrest is a form of stasis. Since majority of this cohort was managed with bedrest, they had to adjust positions for defecation. Imai et al. (2015) suggested higher reclining angles for defecating with a bedpan as it is safer and more effective allowing better intrarectal pressure and reducing abdominal straining needed for defecation. Pelvic fractures have contraindications to the amount of recline allowed. Trying to defecate with a bedpan in supine and limited recline angles may have been frustrating and difficult for participants to persevere for long durations.

Some participants mentioned avoiding bowel movements due to pain, no urge, and avoiding the use of the bed pan. Some participants reported that they were afraid to ask the nurses for the bed pan and were anxious to pass stool behind the curtains out of fear of the smell of their stools reaching their neighbouring patients. These may explain some of the straining and the increase in incomplete emptying (73.81%) in the subacute phase. While this cohort's frequency for incomplete bowel emptying decreased from 57.55% preinjury to 54.05% at 3 months post pelvic fracture, Baessler et al. (2004) reported 33.33% developed this issue up to 29 months post pelvic fracture.

Bowel symptoms affected two additional participants by three months post injury. Less incidences of hard and watery stool consistency were noted at three months. Patients may have been prescribed stool softeners and laxatives to assist with the hard stools reported during the subacute phase. The staple diet of majority of this study's population includes maize meal in the form of "pap" which is often served with vegetables such as cabbage and a protein. Fruits are also consumed. While maize meal is a form of fibre, it can cause variable stool consistencies but keeps one regulated. In CMJAH and CHBAH, pap is not a frequently served meal. Participants' digestive systems may not be acquainted with the meals served in the hospital and not all participants could be visited by family members regularly who could bring them home foods. This may have led to some of the bowel and stool changes, especially in the subacute phase. However, variable stool consistency was reported more frequently at three months, indicating that participants had still not established a regulated bowel habit after returning to their regular diet and home toilets. Trads and Pedersen (2015) found that 22.7% of orthopaedic patients with hip fractures did not re-establish normal defecation within the first days postoperatively. It is recommended that a qualitative study be done to explore the reasons for participants avoiding defecation.

### 5.5.4 Prolapse Domain

In terms of POP, acutely, there were new incidences of symptoms, but by three months post injury, the number of symptomatic symptoms was the same as preinjury. Considering more participants were straining during defecation in the subacute phase, this could have increased abdominal pressures contributing to the development of POP. The only changes worth noting is that the prolapse symptoms became a bother in two more participants by three months post injury, and in the subacute phase the severity of bother increased. Baessler et al. (2004) reported that none of the participants complained of POP preinjury with three new incidences of the feeling of vaginal prolapse post pelvic fracture.

No significant differences were noted between the different time points for the prolapse domain scores. Although Abdool, (2017) found greater pelvic organ descent and greater distensibility in black South African women, creating the expectation of prolapse, prolapse was not as common in this cohort with only one participant reporting a POP diagnosis as a medical history and 27% (n= 10) participants being

symptomatic. Of these participants, it is noted that only one participant's subacute phase prolapse score was high and regarded as a PFD, when comparing it to the scores for women with PFD established by Chen et al. (2022). However, all symptomatic participants' scores for all three of the time points were greater than that of women without PFD from the study by Chen et al. (2022), which could mean that these participants have mild grade II or severe grade I pelvic organ prolapses. However, the participant with the preinjury POP diagnosis defaulted at three months, meaning the other symptomatic women had not been assessed and diagnosed for these symptoms.

Symptoms with a greater frequency that were reported in the subacute phase for the prolapse domain and reverted by three months included the sensation of a bulge or tissue protrusion in the vagina, voiding dysfunction from the prolapse, as well as vaginal pressure, heaviness or dragging sensation. These symptoms are found to be associated with abnormal pelvic floor anatomy, hiatal ballooning and levator avulsion (Abdool, 2017). Therefore, these temporary experiences by the participants of this study may have been due to swelling of the perineum due to the pelvic fracture causing abnormal pelvic floor anatomy and mimicked these symptoms of a POP. Li et al. (2019) described how the vaginal smooth muscle contracts as part of a post-traumatic stress reaction which prevents vaginal bleeding in the event of vaginal injury. This could explain some of the symptoms experienced. Two participants who were not bothered by their preinjury POP symptoms, became bothered by three months post pelvic fracture. One participant became greatly bothered in the subacute phase but with a possible change in symptoms by three months, the bothersome improved. Changes in pressure systems, oedema, and damage to pelvic floor structures may have resulted in worsening of the POP symptoms.

Bailey et al. (2010), Brandt and Janse van Vuuren (2019), Egorov et al. (2018), and Munno et al. (2023) discussed the incidences of other bladder symptoms of PFD present in patients with POP. Considering this, it will be interesting to investigate if there is an association between the scores of participants with prolapse symptoms and their scores of the other domains.

### 5.5.5 Sexual Function Domain

The percentage of sexually active participants significantly dropped from preinjury to three months post-injury with an increase in the percentage of sexually active participants experiencing symptoms. This supports Copeland et al. (1997)'s report of 2% participants post pelvic fracture discontinuing sexual activity and 31% presenting with new onset of dyspareunia. It was difficult to compare the number of participants experiencing symptoms of sexual dysfunction between the different time points as the number of sexually active participants significantly dropped during the subacute phase and only increased slightly by three months post injury (preinjury 32, acutely 5, at three months 15). A greater percentage of those sexually active at each time point reported being symptomatic at three months compared to preinjury.

Dyspareunia was a primary complaint, changing from 11.36% preinjury to 37.84% 3 months post. Preinjury to post-injury (Baessler et al., 2004) reported a change in reports of dyspareunia from 12.5% to 47.06% participants. Dyspareunia was reported by 25.7% female participants post pelvic fracture in study by Vallier et al. (2012) and 26.7% participants by Li et al. (2019). Wright et al. (2006) reported that women with symphyseal diastasis were at increased risk of sexual, bladder and bowel dysfunction. Li et al. (2019) found an increase in severity of vaginal injury in fractures with a compromised PS and in VS fractures. While this study did not find an association between total APFQ score and PS displacement, it is recommended to assess for a relationship between dyspareunia and fracture types.

Sexual dysfunction bothered 79.31% of participants three months post injury compared to 46.67% preinjury, of whom 31% were greatly bothered. As noted in the results, almost half the participants stated that the pelvic fracture, directly or indirectly, was the reason for not being sexually active by three months post-fracture. One participant reported that she did not have pain during intercourse, however, she could not experience deep penetration because of stiffness and pain in her legs which impacted her sexual experience. Decreased hip range of movement is one of the themes found by Sobantu et al. (2017) as factors affecting spousal and sexual relations; being scared, difficulty, tiring quickly, pain, poor self-esteem and change in family dynamics were the other themes found.

This shows us that even in cases where a fracture may not affect the pelvic floor, it is still important to screen for issues with sexual function. By screening, we can open the safe space needed for patients to inform us of these difficulties and subsequently we can arrange for the appropriate form of management. Addressing the musculoskeletal limitations in the legs, endurance training, providing education and desensitization techniques to alleviate fear or referral to other HCPs as needed for emotional and psychological complaints are some of the ways we can improve issues with sexual function. Participants from this study reported not being informed of safety to commence sexual activity by their orthopaedic surgeons. Four participants in a study by Baessler et al. (2004) described sexual relations as “off-putting due to scars, disturbed anatomy and pain”. Bilgic et al. (2019); and Harvey-Kelly et al. (2014) discussed how sexual dysfunction affects QoL and function. If physiotherapists want to implement a biopsychosocial approach to patient management and encourage patient centred care using the International Classification of Function (ICF) in identifying dysfunction and planning treatment, they cannot ignore sexual function as part of activities of daily living.

## 5.6 Assumptions on anatomical changes and educational factors leading to results of this study

The ability of the urinary and anal sphincters to function optimally to maintain continence can be affected by laxed or non-relaxing PFM’s, and weak PFM’s. The results of the current study showed that urgency, urge and stress incontinence, and FI increased by three months post pelvic fracture despite increased limiting of fluid intake. Anatomical changes to the pelvic floor due to the fracture, use of the catheter, muscle relaxant medication received as part of management of the fracture and soft tissue injuries, and reduced mobility may have caused laxity and or weakness to the muscles. Non-relaxing PFM’s leading to fatigue of the muscles could have been caused by pain experienced by participants, tension in the muscles from anatomical changes, and positioning in bed, and while mobilising non-weightbearing. Tightness of the vagina was actually experienced by 70.83%, and the vaginal tightness question was answered by all participants at three months, not only those sexually active. One participant’s severity of vaginal laxity decreased by three months which could have been due to these same contributors to non-relaxing pelvic floor muscle. Weak flow and the dysuria experienced by participants could indicate the presence of weak, laxed or non-relaxing

PFM's. Another indication of non-relaxing PFM's is the reporting of pain at the entrance of the vagina during intercourse.

The decrease in frequency of severe experiences of urinary, faecal and flatus urgency and stress incontinence by three months may be from concurrent changes to the pelvic floor secondary to the pelvic fracture that may have assisted in reducing tension if that was the preinjury cause for these symptoms. It could also be as an overflow strengthening of the core and pelvic floor from the rehabilitation that was provided for the pelvic fracture.

Education may have played a role in the change of symptoms from the subacute phase to three months post. It is possible that because of being asked the questions on the APFQ, it created awareness of PFD symptoms which may have led to participants making lifestyle adjustments. Additionally, during the subacute phase when participants were recruited and reported constipation or watery stools (or other symptoms) when completing the APFQ, ethically education and strategies to assist the participant could not be withheld from the patient. It is possible that the education (e.g., advice to inform the doctor of their symptoms and subsequently receive pharmacological and dietician management, abdominal massage, toilet positioning, adding fibre to diet, effect of exercise on bowel movement, fluid intake) provided could have aided in reducing symptoms and influenced the results found at three months. This could apply for those with dysfunctional defecation and urgency as well. Regardless, the bowel domain remained the most significantly affected domain for this cohort. To test this, it is recommended that a study be done to review PFD symptoms between participants that are recruited and receives physiotherapy pelvic health related education in the subacute phase with participants who do not meet a physiotherapist in the subacute phase (completes APFQ and returns to therapist) or is only recruited at three months. The current study did not find any difference in the scores of those recruited at three months vs those recruited in the subacute phase.

## 5.7 Summary of discussion

This section compared the results of this study to that of other studies done on the same topic as well as identified literature to explain some of the trends identified in this study. Symptoms of PFD are present in females post pelvic fracture with greater

severity than prior to injury. Multiple symptoms of bladder and sexual dysfunction are repeatedly reported complications of pelvic fractures as supported by this study's findings, irrespective of bladder and vaginal wall injury. Although bowel dysfunction is identified post pelvic fracture, specific symptoms of bowel domain dysfunction are not explored enough. Results of this study supports the findings of the existing literature on bowel dysfunction. Symptoms of POP was barely reported by previous studies and not significant in this study compared to the symptoms of the other domains. Pelvic fractures affect patients' willingness to participate in sexual activity, with pain a contributing limiting factor. While studies like this study, that looked at fracture types in terms of specific areas on the pelvis, did not find any relation between fracture type and severity of PFD, other studies that used classification systems, identified statistically significant associations for certain fracture types. Fracture type, management of fractures as well as other variables such as urinary catheter usage, mobility, length of stay, diet, medication, pain and education need to be explored further to determine clinically significant associations and supplement the results of this study.

# Chapter 6 Conclusion and Recommendations

This study determined the presence of PFD symptoms prior to, in the subacute phase and three months post pelvic fracture in 44, 42, and 37 female patients respectively from two academic hospitals in Johannesburg. The demographic and medical history of participants, types of fractures sustained, management received among other variables were described. Mechanism of injury was found to be associated with whether multiple or one fracture is sustained. We investigated PFD in bladder, bowel, prolapse, and sexual domains, in real time after sustaining a pelvic fracture using the APFQ and followed up to three months post pelvic fracture. Information on patients' symptoms was collected directly from the patient. The symptoms were compared to participants' symptoms reported preinjury and in the subacute phase following the fracture. Relationships were established between scores of PFD symptoms and number of vaginal deliveries, duration of urinary catheter usage, timed up and go scores and the choice of bedrest with non-weightbearing as choice of management. The study noted a statistically significant change in the mean APFQ scores from preinjury to three months post pelvic fracture. The severity of PFD at three months post pelvic fracture is significant.

## 6.1 Conclusion based on objectives of the study

### 6.1.1 To determine and describe PFD symptoms present prior to and at three months post-pelvic fracture in female patients treated at two academic hospitals in Johannesburg

This study determined that symptoms of PFD was experienced by all 44 participants preinjury, however the mean total APFQ score for PFD was less than the normal score for women with PFD. The symptoms experienced frequently by women of this cohort preinjury primarily involved bladder dysfunction (incomplete bowel emptying, straining for defecation, faecal urgency, and variable stool consistency). Other frequent symptoms included dyspareunia, vaginal tightness, nocturia and incomplete bladder emptying. Laxatives were used frequently preinjury. Only few participants were greatly bothered by their symptoms preinjury. PFD symptoms of the bladder, bowel, and sexual domains of the APFQ are experienced frequently by three months post pelvic

fracture. The most frequently experienced symptoms per domain included Bladder domain: nocturia, urgency, urgency incontinence, dysuria, incomplete bladder emptying and weak urinary flow; Bowel domain: constipation, straining to defecate, incomplete bowel emptying, faecal urgency and hard stools; Prolapse domain: experiencing vaginal pressure/heaviness and sensation of a bulge in the vagina; and Sexual domain: vaginal tightness and dyspareunia. The total mean APFQ score for PFD was higher than the evidence normal score for women with PFD indicating that women have diagnosable PFD three months post pelvic fracture. A significant association was noted between the APFQ scores and the combination of bedrest and non-weightbearing as choice of treatment. Up to nine participants were greatly bothered by symptoms.

### 6.1.2 To determine the demographics, preinjury medical history, types of fractures sustained, and management of these patient's post-pelvic fracture

Primarily black African females aged 18 – 74 years old with a mean BMI of 27.4 kg/m2 (SD 6.4) were recruited. Majority of participants were married/with a partner and sexually active prior to the pelvic fracture. HIV-infection was the most prevalent underlying comorbidity followed by hypertension and osteoarthritis. Chronic constipation and sexually transmitted infections were common underlying diagnosis. Most women were still menstruating or else post-menopausal. While 77.27% were pregnant at least once, only 65.9% gave birth with an average of 2 pregnancies and 2 births per person. Obstetric complications were described. Road transport accidents, made up of MVA (50%) and PVA (36.4%) accounted for 86.4% participants mechanism of injury. Multiple fractures to the pelvis were reported in 63.64% participants. The most common areas fractured were the pubic ramus, followed by acetabulum with most acetabulum fractures having concurrent inferior pubic rami fractures. A significant association was noted between mechanism of injury and sustaining multiple fractures ($p = 0.040$). Urinary catheterisation was common post pelvic fracture as was receiving physiotherapy. However, pelvic health physiotherapy was uncommon. Bedrest was choice of management for majority participants.

### 6.1.3 To compare symptoms of PFD present at three months post-pelvic fracture to PFD symptoms present prior to and in the subacute phase post pelvic fracture

A significant change was noted in APFQ scores between the time points ($p$<0.05) (total score: pre to three-month $p$= *0.0216*; subacute to three months $p$=0.0361; bladder score: pre to three months $p$=0.0062; subacute to three months $p$=0.0002; bowel score subacute to three months *p<0.0001;* sexual score pre to three months $p$=0.0087). Frequency and severity of symptoms increased in the subacute phase but improved by three months post injury. However, a statistically significant change was still noted in the severity of symptoms at three months post pelvic fracture compared to those reported preinjury. In the subacute phase, bowel changes were most significant (p<0.0001) compared to three months post injury. Bladder related dysfunction persisted the most at three months. Pelvic fracture affected sexual domain most, in that many participants avoided sexual activity or were unable to resume to preinjury frequency.

### 6.1.4 To determine factors (demographic variables, type of pelvic fracture sustained, the types of orthopaedic and supportive management received) associated with PFD scores

Delivery by NVD and number of NVD were related with lower APFQ scores. Type of pelvic fracture was not found to affect the total score for PFD and the bowel domain score in the subacute phase and at three months post pelvic fracture. A larger sample size may be needed to determine the association between dyspareunia/sexual dysfunction and displacement of the PS or SIJ. The duration of urinary catheter usage correlated with the bladder domain score; an increase of duration decreased the frequency at which participants experienced some bladder symptoms (urinary urgency, urinary frequency, incomplete bladder emptying). The choice of bedrest with non-weightbearing was associated with a decrease in APFQ score.

## 6.2 Clinical/Practical Recommendations

Based on the findings of this study and the results of other studies discussed, it is recommended that screening for symptoms of PFD be included in the standard care of orthopaedic female patients following a pelvic fracture. Nurses and orthopaedic surgeons should also enquire about patient's bowel patterns throughout admission. Prolonged usage of the urinary catheter should be avoided. Advice on safety to resume sexual activity should be part of routine discussions at orthopaedic follow-ups. It should become standard practice to classify all fractures using standardized classification systems; this will allow for better treatment planning for patients and improve opportunity for research and evidence-based practice.

To ensure a biopsychosocial approach to managing pelvic fractures is used, sexual activity, should be included in the ICF assessment of participation and function, and PFD symptoms should be considered when determining body structure impairments that affect participation. Based on the symptoms identified, protocols for the physiotherapy rehabilitation of patients who sustain pelvic fractures should include demonstration of evidence based abdominal massage techniques, modified toileting positions with higher reclined angles for patients on bedrest, and correct toileting position for those who can sit, education on benefits of exercise on bowel movements, bladder awareness and training, cueing, pelvic floor exercises with a focus on contraction and relaxation, and referral to dieticians

To allow for these inclusions into physiotherapy rehabilitation practice, future and qualified physiotherapists must be empowered in providing holistic management of orthopaedic conditions. It is recommended that the curriculum for undergraduate training of physiotherapists be reviewed to include education on screening for and providing early intervention education for PFD. Investing in postgraduate training in pelvic health for physiotherapists treating in trauma units will be beneficial for the South African health system and improve access to specialist care for patients.

## 6.3 Recommendation for Future Research

Future studies should aim to compensate for small sample size, reduce the number of participants withdrawing from the study by non-attendance, reflect a variety of races, overcome recall bias, standardize classification of fractures, standardize recruitment and utilize translated outcome measures. The English version of the APFQ should be validated in a South African population and with cultural adaptations. There is also a need for it to be translated in at least two other official languages of South Africa.

We advise that future multicentre studies be conducted around Johannesburg or include other provinces as well to gain a better understanding of females across South Africa. Sample size should be based on recommendations by Baessler et al. (2004) based on their data (44 patients would be necessary to show an association for SUI, 56 for urinary urgency symptoms, 120 for incomplete bowel emptying and 322 for dyspareunia). To overcome the risk of participants withdrawing from the study by non-attendance, allocating a budget for reimbursing participants for their transport and booking specific dates for follow-ups is recommended.

From the inconclusive results from this study, we recommended that a randomised clinical trial be done to compare those who receive and those who do not receive physiotherapy that includes pelvic health promotion. Future studies must also collect data in real time from admission or the subacute phase, but follow-up participants for longer than three months to see if PFD symptoms improve and when sexual activity resumes or reverts to previous frequency habit. Based on trends identified, future studies should investigate for any statistical significance between specific PFD symptoms and fracture types and management (e.g., dyspareunia and fracture types), between bladder and sexual dysfunction symptoms, and for each PFD symptom between different time points. Although this study used participants' recall of their preinjury PFD symptoms to determine if PFD symptoms post pelvic fracture are significant, it is recommended that a study with a control group of participants who did not sustain pelvic fractures be done. This will also aid in filling the gap in research on prevalence of PFD in females in South Africa.

Future studies can include a qualitative component, physical examinations, urodynamic, anorectal and pelvic exams to support findings from the APFQ. Addition of a qualitative component can allow one to explore the reasons for participants

avoiding defecation, reducing frequency of sexual activity, prolonged catheterisation, and other points queried in the discussion. Collecting information on pain and medication will assist in interpreting results and determine relationships between some symptoms and contributing medication. The use of a bed scale will improve accuracy of BMI data collected. Inclusion of a urogynaecologist assessment will assist in screening for any missed vaginal injuries. Similarly, inclusion of an orthopaedic surgeon in the research team or approached alongside a radiologist will be useful to classify the fractures at admission, review the radiography reports and review fractures during the progression of management for new findings, and investigate if there are any associations.

A study to determine the current physiotherapy practice in rehabilitation following pelvic fractures, as well as the beliefs and knowledge on PFD of physiotherapists treating pelvic fracture victims is recommended.

## 6.4 Strengths and Limitations

Some of the strengths of this study include a sample size larger than other similar studies done, collecting data in real time, and following up sooner after the pelvic fracture, the use of a standardized outcome measure that has comparable values in the literature, recruitment of participants from two study sites, one peri-urban and the other urban. All eligible participants were recruited. Attempts were made to improve the cultural relevance of the APFQ using standardized cues. These standardized cues and other standardized explanations and suggestions assisted in avoiding bias and maintain validity and reliability of the data.

There are a couple of factors in this study that should be considered with interpretation of the results. Firstly, patients with pelvic fractures can be discharged from casualty and due to inadequate health information systems in the public sector hospitals, it may be difficult to contact them. This made it difficult to identify and investigate PFD in all patients who sustained a pelvic fracture. Recruitment depended on referral of potential participants from the orthopaedic surgeons and physiotherapists allowing for some patients to be missed. Obtaining information on PFD symptoms post pelvic fracture was dependent on participants attending their routine orthopaedic or physiotherapy follow-up. We relied on the information in the file for fracture type and with missing

radiography results, a standardized classification system could not be used limiting the ability to compare results of our study to results of other studies in terms of associations relating to fracture types. The sample size may bias the interpretation of our findings and relationships identified. It also limited the type of analysis that could be performed. A larger number of patients may have resulted in more statistically significant findings and allowed for us to account for confounders. Information on multiple related variables were collected but due to the small sample size we could not control for all the interactive variables in analysing the scores for PFD. There was predominantly one racial group identified which, although reflecting the study setting well, it does not provide an adequate reflection of baseline PFD in females in Johannesburg and South Africa. There was a variation but no standardization of at which point participants were recruited. Although the study did not find any difference in the scores of those recruited in the subacute phase and those recruited at three months, 1) there is a larger risk of recall bias for preinjury and acute PFD symptoms in those recruited at three months and 2) a risk of influencing improvement of three months PFD symptoms for those recruited in the subacute phase, and likely made aware of and educated about PFD.

In certain instances, participants had to answer each question twice (for preinjury and subacute, or subacute and three months post). Although, responses for each time point were collected simultaneously for each question as outlined in chapter 3, it is still a possible confounder since participants may have become fatigued answering the same questions or mixed their responses on what was experienced when. As most participants had not fully returned to sexual activity by three months, it was difficult to comment on sexual dysfunction post pelvic fracture. Since some participants still had a catheter in situ in the subacute phase and were assigned a zero for the bladder domain score, it may affect the mean scores. Although the APFQ inquires on certain QoL factors, it does not give a full view of the impact of PFD on QoL.

In terms of data collection tools and procedures, certain limitations were noted. Although the APFQ was interviewer-administered, with standardized cues, it was only available in English and no other official South African languages, nor was it validated in a South African context. Cultural factors and language barriers need to be considered. The assistance of an interpreter where needed for language barriers, could have influenced the results on what the patient understood of the question, what was answered and what was reported by the interpreter. The DHIF was only compiled

in English. In instances where information was not available in medical records, especially regarding passed surgical history and obstetric history, the patients may not have understood what complications were being enquired about, despite the use of an interpreter. Standardized translations of these diagnosis/procedures should be considered for future studies. Recall bias is a problem when participants must remember what they were last weighed which was done for two patients who were unable to stand on a scale and should be noted for future research. Although I encountered difficulty finding a female research assistant, the male research assistant could have impacted on the results as it is possible that the female participants would not have felt comfortable answering questions regarding these personal topics if being interviewed by a male.

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# Appendix

## Appendix A Information sheet

WITS UNIVERSITY

**STUDY INFORMATION DOCUMENT**

**Study title:** Pelvic Floor dysfunction in Female patients at CHBAH, 3 months post-pelvic fracture

**Good day Mr/Mrs** _____
My name is Nazreen Chopdat and I am a physiotherapist at the Chris Hani Baragwanath Academic Hospital with a special interest in Pelvic and Women's Health Physiotherapy. You are invited to take part in a research study for a master's degree in Physiotherapy. Please read the following information carefully. You are welcome to contact me, the researcher if there is anything that is unclear or that you require more information on.

I am doing research on whether having a pelvic fracture can contribute to symptoms of bladder, bowel, and sexual problems. Research is a process used in seeking new knowledge. In this study we want to learn if women in a South African context are at risk of pelvic floor dysfunction if they sustain a pelvic fracture and hence to decide if it is important to assess for symptoms of pelvic floor dysfunction in female patients who sustain pelvic fractures.

If you choose to participate in the study:

1. Your medical history as well as history of your injury and management will be retrieved from your file or you will be asked about any missing information and this information will be recorded.
2. Either during your in-patient hospital stay or at your out-patient appointment, you will be asked questions for a questionnaire relating to your bladder, bowel, sexual and pelvic function on symptoms experienced prior to your injury and at the time after your injury. The researcher will read out the questions for you and elaborate or translate where needed.
3. On the appointment date for your follow up with the orthopedic doctors 3 months after your injury, you will be required to come to the physiotherapy department.
4. At this appointment, you will be required to provide answers for the same questionnaire regarding your symptoms based on your present experience at the time, 3 months after the injury.
5. You will also be required to do a short physical assessment whereby the researcher will time how long it takes you to stand up from a chair, walk 3 meters, turn around and walk back to the chair.
6. Your participation in the study, if you consent, will commence while you are an in-patient or at 3 months after your injury, if identified as a female patient with a pelvic fracture and will end after completing the questionnaire at 3 months post injury.
7. If you do not come to the physiotherapy department at the 3-month follow up, the researcher will contact you telephonically to arrange a date.
8. No hands-on physical assessments or invasive procedures will be conducted
9. It will take approximately 20 to 30 mins to complete the questionnaire and the timed up and go test.
10. If you present with significant symptoms that require intervention, you will be given the option to be booked into the standard physiotherapy system for pelvic floor dysfunction.

By being a part of this study, there is no risks to you and all diagnosis made will be explained to you. However, due to the nature of some of the questions, you may experience emotional distress, in which case a protocol has been put into place, whereby you will have the option of

receiving a counseling session at no cost to you. By participating in this study, you will be screened for pelvic floor dysfunction, which is not a standard practice, hence benefitting you with the opportunity for early detection and prevention of any symptoms. If you present with significant symptoms that require intervention, you will be given the option to be booked into the standard physiotherapy system for pelvic floor dysfunction.

Your participation in this study is completely voluntary and refusal to participate will not involve any penalty. If you choose to not take part in the study, the treatment you get at the hospital will not change at all.
You do not have to pay anything to be part of the study, nor will you be paid or reimbursed to participate. You can also stop being a part of the research at any time and will not need to provide a reason for withdrawing. In the case of withdrawing, all data collected on you, will be destroyed unless you allow us to still use it.
We will not use your details such as your name or hospital number anywhere on our records. All personal information will be treated with strictest confidence and will only be available to the principal investigator and her supervisor. Due to the use of questionnaires, anonymity of data will be maintained. All data collected in the course of the study will be securely retained for two (2) years, if a scientific publication arises from the study and six (6) years, if there is no publication. Thereafter it will be destroyed accordingly.

The results of the research will be shared with other physiotherapists as a written paper. If you wish, we can share the results of the study with you on the provided contact details.

For inquiries, you can contact during office hours (08:00 – 16:00, Monday to Friday)
Nazreen Chopdat, Principal Investigator, +27 76 911 3260 or by e-mail at:
nchopdat.physiotherapy@gmail.com
Corlia Brandt, Supervisor, +27 11 717 2014 or by e-mail at: Corlia.Brandt@wits.ac.za .

This study has received approval from the Human Research Ethics Committee (Medical) of the University of the Witwatersrand, Johannesburg ("Committee"). A principal function of this Committee is to safeguard the rights and dignity of all human subjects who agree to participate in a research project and the integrity of the research.
If you have any concern over the way the study is being conducted, please contact the Chairperson of this Committee who is Professor Clement Penny, who may be contacted on telephone number 011 717 2301, or by e-mail on Clement.Penny@wits.ac.za. The telephone numbers for the Committee secretariat are 011 717 2700/1234 and the e-mail addresses are Zanele.Ndlovu@wits.ac.za and Rhulani.Mukansi@wits.ac.za

Thank you for reading this Study Information Sheet.

Date: April 2021

Kind regards,

Nazreen Chopdat

## Appendix B Participant Consent forms

WITS UNIVERSITY

### PARTICIPANT CONSENT SHEET

***Title: Pelvic Floor dysfunction in Female patients at CHBAH, 3 months post-pelvic fracture***

***Participant***

1. I have been given a Participant Information Sheet which explains the nature and processes involved in this study, which is attached hereto;
2. I was given time to read it, or had it read to me, in the language I best understand;
3. I was given time to ask any questions I wanted to and found any answers given to me to be reasonable and satisfactory;
4. I believe I fully understand why the study is being conducted and what the intended outcomes will be;
5. I understand that there will be no immediate benefit to me, should I agree to participate, nor will I receive any payment; conversely, participation will not cost me anything but my time;
6. I understand that, even if I initially consent to take part in the study, I may subsequently withdraw at any time and would not be required to give any reasons; if that happened, any data collected about me for the purposes of the study would immediately be destroyed, unless I give consent for it to be retained
7. I have been given a range of contact details, listed below. If I require further information or become concerned about any aspect of this study I am free to speak to any of these contacts.

***Researcher/ Research Assistant***

I have explained the information in the research participation information sheet to the participant or had it explained to the participant in a language he/she understands. I have answered all questions to the best of my ability. Consent has been given voluntarily by the research participant

Name: _____ Signature: _____ Date: _____

**Contact details:**

Nazreen Chopdat, Principal Investigator, +27 76 911 3260 or by e-mail at: nchopdat.physiotherapy@gmail.com.

Corlia Brandt, Supervisor, +27 11 717 2014 or by e-mail at: Corlia.Brandt@wits.ac.za.

Professor CB Penny, Chairperson of the Human Research Ethics Committee (Medical) at the University of Witwatersrand, on telephone no. 011 717 2301, or by e-mail at Clement.Penny@wits.ac.za.

Ms. Z Ndlovu or Mr Rhulani Mkansi, Committee Secretariat, telephone nos.: 011 717 2700 or 1234, or by e-mail at: Zanele.Ndlovu@wits.ac.za or Rhulani.Mkansi@wits.ac.za

Name of Participant: _____ Date: _____

Signature or mark: _____ Place: _____

Witnessed by:

Name of Witness: _____ Date: _____

Signature: _____

## Appendix C  Demographics and health information form – Section A, B and C



# Patients Demographics And History

**Demographics**

Age:

_____

Ethnicity

○ Asian ○ Black ○ Colored ○ Indian ○ White

Marital Status:

○ Single ○ Married ○ Divorced ○ In a relationship/Have a partner

Co-morbidities (Select all that apply):

☐ HPT ☐ DM ☐ RVD ☐ TB ☐ Osteoporosis ☐ Osteoarthritis ☐ Asthma ☐ COPD
☐ Nil

**Past Medical History - Urology and Gastro specific**

Select all applicable conditions that you encountered prior to your injury

☐ Recurrent UTI's (Urinary Tract Infections) ☐ Previous PID (Pelvic Inflammatory Disease)
☐ Sexually Transmitted Infections ☐ Irritable Bowel Syndrome ☐ Chronic constipation
☐ Previous lower GI surgery (e.g. bowel resection etc.) ☐ Previous Pelvic Surgery ☐ Acute/recurrent urinary retention ☐ Malignancy (Any type of Cancer diagnosis made) ☐ Nil

Year of Surgery

_____

Malignancy Type (diagnosis made)

_____

**Gynecological and Gestational History**

Menstruating

○ Yes ○ No

Have you ever experienced Amenorrhea?

○ Yes ○ No

Is it Primary or secondary?

○ Primary ○ Secondary

What had caused the secondary Amenorrhea?

_____

Menopause History

◯ Pre-menopausal ◯ Menopausal ◯ Post-menopause

Sexual Activity (Prior to injury)

◯ Never had sex ◯ Currently Sexually Active ◯ Not sexually active anymore

Sexual Activity (Post Injury)

◯ Never had sex ◯ Currently sexually active ◯ Not sexually active anymore

Gestational History - Number of Pregnancy's

_____

Gestational History - Number of births/deliveries

_____

Gestational History - Number of miscarriages

_____

Gynecological History - Number of caesarian sections

_____

Gynecological History - Number of normal vaginal delivery

_____

Gynecological History - Number of Dilation and Curettage (DNC)

_____

Please Select all relevant complications/requirements experienced during or after pregnancy/labour

☐ Perineal Tear ☐ Need for Episiotomy ☐ Diastasis Rectus ☐ Diastasis Pubis ☐ Perineal Stitches
☐ Induced Labour ☐ Premature labour ☐ Placenta Previa ☐ Other ☐ Nil ☐ not applicable

Gynecological History - Select any diagnosis/procedures applicable to you

☐ Endometriosis ☐ Hysterectomy ☐ Pelvic Organ Prolapse ☐ Circumcision ☐ Other
☐ Nil

Year of surgery

_____

please provide details of other diagnosis

_____

## Appendix D Demographics and health information form – Section D

**Injury History**

Date of injury

_____

Date of recruitment:

_____

Date of follow up

_____

Current days post injury

_____

What was the Mechanism of your current pelvic injury?

☐ MVA ☐ PVA ☐ Fall ☐ Assault ☐ Other

Specify

_____

Type of pelvic fracture sustained

☐ Superior Pubic Rami Fracture R ☐ Superior Pubic Rami Fracture L ☐ Inferior Pubic Rami Fracture R
☐ Inferior Pubic Rami Fracture L ☐ Bilateral Superior Pubic Rami Fracture ☐ Bilateral Inferior Pubic Rami Fracture ☐ Acetabular Fracture ☐ Sacral Fracture ☐ Pelvic ring fracture ☐ Ischial Spine fracture
☐ Iliac Blade fracture ☐ Other ☐ Other

Specify type of fracture

_____

Specify type of fracture

_____

Specify type of fracture

_____

Additional Injuries Sustained

_____

Additional Injuries Sustained

_____

## Appendix E Demographics and health information form – Section E

| **Injury Management History** | |
|---|---|
| Date of admission in hospital | _____ |
| Date of discharge from hospital | _____ |
| Length of stay in hospital | _____ |
| Number of admissions | _____ |
| Did you have to make use of a urinary catheter? | ◯ Yes<br>◯ No |
| Duration of urinary catheter use (in days) | _____ |
| Which of the following did you receive as part of the management of your pelvic injury? (Select all that apply) | ☐ Bedrest<br>☐ Skin Traction<br>☐ Skeletal Traction - Steinmann Pin<br>☐ Non-weightbearing<br>☐ Weightbearing as tolerated<br>☐ External Fixation<br>☐ ORIF - Open reduction and internal fixation<br>☐ Minimally invasive surgery using fluoroscopy<br>☐ Pelvic Binder<br>☐ Debridement<br>☐ Vacuum dressing<br>☐ Cement/Casting/POP |
| What other management did you receive for any other injuries sustained? | _____ |
| Duration on bed rest - number of weeks | _____ |
| Duration on skin traction - number of days | _____ |
| Duration on Skeletal traction - number of days | _____ |
| Type of cast<br>◯ Above Knee ◯ Below Knee ◯ Spica ◯ Other | |
| Duration in cast - number of weeks | _____ |
| For how long did you have to walk non-weightbearing (in weeks)? | _____ |
| How many surgeries did you have for your pelvic injury? | _____ |

## Appendix F Demographics and health information form – Section F

**Physiotherapy Management**

Did you receive physiotherapy after your injury?

◯ Yes
◯ No

Did the physiotherapist/s explain to you about your pelvic floor, urine and bowel symptoms and/or give you pelvic floor exercises?

◯ Yes ◯ No

**BMI and TUG**

What is your weight (in Kg)?

_____

What is your height (in centimeters)?

_____

BMI

_____

Timed up and go score (in seconds)

_____

## Appendix G Australian Pelvic Floor Questionnaire and recording table

Australian Pelvic Floor Questionnaire- Screening Tool

# AUSTRALIAN PELVIC FLOOR QUESTIONNAIRE

Patient's Name: _____

Date of Birth: _____

Date completed: _____

*Please circle your most applicable answer. Consider your experience during the last month.*

**BLADDER FUNCTION** ( ___ / 45)

**Q1. How many times do you pass urine in a day?**
0 Up to 7
1 Between 8-10
2 Between 11-15
3 More than 15

**Q2. How many times do you get up at night to pass urine?**
0 0-1
1 2
2 3
3 More than 3 times

**Q3. Do you wet the bed before you wake up at night?**
0 Never
1 Occasionally - less than once per week
2 Frequently - once or more per week
3 Always - every night

**Q4. Do you need to rush/hurry to pass urine when you get the urge?**
0 Can hold on
1 Occasionally have to rush – less than once/week
2 Frequently have to rush – once or more/week
3 Daily

**Q5. Does urine leak when you rush or hurry to the toilet or can't you make it in time?**
0 Not at all
1 Occasionally – less than once per week
2 Frequently – once or more per week
3 Daily

**Q6. Do you leak with coughing, sneezing, laughing or exercising?**
0 Not at all
1 Occasionally – less than once per week
2 Frequently – once or more per week
3 Daily

**Q7. Is your urinary stream (urine flow) weak, prolonged or slow?**
0 Never
1 Occasionally – less than once per week
2 Frequently – once or more per week
3 Daily

**Q8. Do you have a feeling of incomplete bladder emptying?**
0 Never
1 Occasionally – less than once per week
2 Frequently – once or more per week
3 Daily

**Q9. Do you need to strain to empty your bladder?**
0 Never
1 Occasionally – less than once per week
2 Frequently – once or more per week
3 Daily

**Q10. Do you have to wear pads because of urinary leakage?**
0 None . Never
1 As a precaution
2 When exercising / during a cold
3 Daily

**Q11. Do you limit your fluid intake to decrease urinary leakage?**
0 Never
1 Before going out
2 Moderately
3 Always

**Q12. Do you have frequent bladder infections?**
0 No
1 1-3 per year
2 4-12 per year
3 More than one per month

**Q13. Do you have pain in your bladder or urethra when you empty your bladder?**
0 Never
1 Occasionally – less than once per week
2 Frequently – once or more per week
3 Daily

**Q14. Does urine leakage affect your routine activities like recreation, socializing, sleeping, shopping etc?**
0 Not at all
1 Slightly
2 Moderately
3 Greatly

**Q15. How much does your bladder problem bother you?**
0 Not at all
1 Slightly
2 Moderately
3 Greatly

**Other symptoms** (haematuria, pain etc.)

_____

_____

**BOWEL FUNCTION** (____ / 34)

**Q16. How often do you usually open your bowels?**
0 Ever other day or daily
1 Less than every 3 days
2 Less than once a week
0 More than once per day

**Q17. How is the consistency of your usual stool?**
0 Soft
0 Firm
0 Hard (pebbles)
1 Variable
2 Watery

**Q18. Do you have to strain to empty your bowels?**
0 Never
1 Occasionally – less than once per week
2 Frequently – once or more per week
3 Daily

**Q19. Do you use laxatives to empty your bowels?**
0 Never
1 Occasionally – less than once per week
2 Frequently – once or more per week
3 Daily

**Q20. Do you feel constipated?**
0 Never
1 Occasionally – less than once per week
2 Frequently – once or more per week
3 Daily

**Q21. When you get wind or flatus, can you control it, or does wind leak?**
0 Never
1 Occasionally – less than once per week
2 Frequently – once or more per week
3 Daily

AUSTRALIAN PELVIC FLOOR QUESTIONNAIRE

# AUSTRALIAN PELVIC FLOOR QUESTIONNAIRE

Patient's Name: _____

Date of Birth: _____

Date completed: _____

**Q22. Do you get an overwhelming sense of urgency to empty bowels?**
0 Never
1 Occasionally – less than once per week
2 Frequently – once or more per week
3 Daily

**Q23. Do you leak watery stool when you don't mean to?**
0 Never
1 Occasionally – less than once per week
2 Frequently – once or more per week
3 Daily

**Q24. Do you leak normal stool when you don't mean to?**
0 Never
1 Occasionally – less than once per week
2 Frequently – once or more per week
3 Daily

**Q25. Do you have a feeling of incomplete bowel emptying?**
0 Never
1 Occasionally – less than once per week
2 Frequently – once or more per week
3 Daily

**Q26. Do you use finger pressure to help empty your bowel?**
0 Never
1 Occasionally – less than once per week
2 Frequently – once or more per week
3 Daily

**Q27. How much does your bowel problem bother you?**
0 Not at all
1 Slightly
2 Moderately
3 Greatly

**PROLAPSE SYMPTOMS** (____/15)

**Q28. Do you have a sensation of tissue protrusion/lump/bulging in your vagina?**
0 Never
1 Occasionally – less than once per week
2 Frequently – once or more per week
3 Daily

**Q29. Do you experience vaginal pressure or heaviness or a dragging sensation?**
0 Never
1 Occasionally – less than once per week
2 Frequently – once or more per week
3 Daily

**Q30. Do you have to push back your prolapse in order to void?**
0 Never
1 Occasionally – less than once per week
2 Frequently – once or more per week
3 Daily

**Q31. Do you have to push back your prolapse to empty your bowels?**
0 Never
1 Occasionally – less than once per week
2 Frequently – once or more per week
3 Daily

**Q32. How much does your prolapse bother you?**
0 Not at all
1 Slightly
2 Moderately
3 Greatly

**Other Symptoms:** (problems: walking / sitting, pain, vaginal bleeding)
_____
_____
_____

**SEXUAL FUNCTION** (____/21)

**Q33. Are you sexually active?**
☐ No
☐ Less than once per week
☐ Once or more per week
☐ Daily or most days

*If you are not sexually active, please continue to answer questions 34 & 42.*

**Q34. If you are not sexually active, please tell us why?**
☐ Do not have a partner
☐ I am not interested
☐ My partner is unable
☐ Vaginal dryness
☐ Too painful
☐ Embarrassment due to the prolapse/incontinence
☐ Other reasons: _____

**Q35. Do you have sufficient vaginal lubrication during intercourse?**
0 Yes
1 No

**Q36. During intercourse vaginal sensation is:**
0 Normal / pleasant
1 Minimal
1 Painful
3 None

**Q37. Do you feel that your vagina is too loose or lax?**
0 Never
1 Occasionally
2 Frequently
3 Always

**Q38. Do you feel that your vagina is too tight?**
0 Never
1 Occasionally
2 Frequently
3 Always

**Q39. Do you experience pain with sexual intercourse?**
0 Never
1 Occasionally
2 Frequently
3 Always

**Q40. Where does the pain during intercourse occur?**
0 Not applicable, I do not have pain
1 At the entrance to the vagina
1 Deep inside, in the pelvis
2 Both at the entrance & in the pelvis

**Q41. Do you leak urine during sexual intercourse?**
0 Never
1 Occasionally
2 Frequently
3 Always

**Q42. How much do these sexual issues bother you?**
☐ Not applicable
0 Not at all
1 Slightly
2 Moderately
3 Greatly

**Q43. Other symptoms?**
(faecal incontinence, vaginismus etc)

## Appendix H Particicpants Identifiyng Details

# Patient Identifier Info

| | |
|---|---|
| Record ID | _____ |
| **Participant Information** | |
| Patient GT/P Hospital Number | _____ |
| Name: | _____ |
| Surname: | _____ |
| Contact Details 1: | _____ |
| Contact Details 2: | _____ |
| Catchment: | _____ |
| Date of birth: | _____ |

## Appendix I Ethical Clearance Certificate

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

R49 Ms N Chopdat

**HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)**
**CLEARANCE CERTIFICATE NO. M210667**

| | |
|---|---|
| **NAME:** (Principal Investigator) | Ms N Chopdat |
| **DEPARTMENT:** | School of Therapeutic Sciences<br>Department of Physiotherapy<br>Medical School<br>University |
| **PROJECT TITLE:** | *Pelvic floor dysfunction in female patients at CHBAH, 3 months post-pelvic fracture* |
| **DATE CONSIDERED:** | 2021/06/25 |
| **DECISION:** | Approved unconditionally |
| **CONDITIONS:** | |
| **NOTE:** | If contact information regarding student study participants is required, please contact the Registrar's office - <Nicoleen.Potgieter@wits.ac.za> |
| **SUPERVISOR:** | Dr C Brandt |
| **APPROVED BY:** | Dr CB Penny, Chairperson, HREC (Medical) |
| **DATE OF APPROVAL:** | 2022/01/20 |

**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 **June** and therefore reports and re-certification will be due in the month of **June** each year. Unreported changes to the study may invalidate the clearance given by the HREC (Medical).

Signature of Principal Investigator — Date: 21 January, 2022

## Appendix J Change of Title Approval Letter

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

Private Bag 3 Wits, 2050
Fax: 027117172119
Tel: 02711 7172076

Reference: Mrs Sandra Benn
E-mail: sandra.benn@wits.ac.za

30 January 2024
Person No: 854826
TAA

Miss N Chopdat

Dear Miss Nazreen Chopdat

**Master of Science in Physiotherapy: Change of title of research**

I am pleased to inform you that the following change in the title of your Dissertation for the degree of **Master of Science in Physiotherapy** has been approved:

| | |
|---|---|
| From: | **Pelvic floor dysfunction in female patients at CHBAH, 3 months post-pelvic fracture** |
| To: | **Pelvic floor dysfunction in female patients at two academic hospitals in Johannesburg, 3 months post-pelvic fracture** |

Yours sincerely

Mrs Sandra Benn
Faculty Registrar
Faculty of Health Sciences

## Appendix K Change of Title Ethics Clearance Certificate

UNIVERSITY OF THE WITWATERSRAND JOHANNESBURG

R49 Ms N Chopdat

**HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)**
**CLEARANCE CERTIFICATE NO. M210667**

**NAME:** Ms N Chopdat **DEGREE:** MSc (Physio)
**(Principal and Co-Investigators)**

**DEPARTMENT:** School of Therapeutic Sciences
Department of Physiotherapy
Medical School
University

**PROJECT TITLE:** *Pelvic floor dysfunction in female patients at two academic hospitals in Johannesburg, 3 months post-pelvic fracture*

*Change of study title noted on 16 February 2024*

**DATE CONSIDERED:** 25 June 2021

**DECISION:** Approved unconditionally

**CONDITIONS:**

**NOTE:** If contact information regarding student study participants is required, please contact the Registrar's office <Nicoleen.Potgieter@wits.ac.za>

**SUPERVISOR:** Dr C Brandt

**APPROVED BY:**
Professor P Ruff, Chairperson, HREC (Medical)

**DATE OF APPROVAL:** 20 January 2022 **EXPIRY DATE:** 19 January 2027

**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** in the format available at https://wits.ac.za/research/researcher-support/research-ethics/ethics-committees/. This report is due annually, for the duration of the Clearance Certificate, beginning on the first anniversary of Date of Approval above. Unreported changes to the study may invalidate the clearance given by the HREC (Medical).

Signature of Principal Investigator

16 February 2024
Date

## Appendix L Medical Advisory Committee (MAC) Approval Chris Hani Baragwanath Academic Hospital

**GAUTENG PROVINCE**
HEALTH
REPUBLIC OF SOUTH AFRICA

MEDICAL ADVISORY COMMITTEE

CHRIS HANI BARAGWANATH ACADEMIC HOSPITAL

**PERMISSION TO CONDUCT RESEARCH**

Date: 2nd December 2021

**TITLE OF PROJECT:**

Pelvic floor dysfunction in female patients at CHBAH, 3 months post-pelvic fracture.

**UNIVERSITY:** Witwatersrand

**Principal Investigator**: Nazreen Chopdat.

**Department: Physiotherapy**

**Supervisor** : Dr C Brandt

**Permission Head Department** (where research conducted): Yes

**NHRD No. 202111 056**

The Medical Advisory Committee recommends that the said research be conducted at Chris Hani Baragwanath Academic Hospital. The CEO / management of Chris Hani Baragwanath Academic Hospital is accordingly informed and the study is subject to:-

- **Permission having been granted by the Committee for Research on Human Subjects of the University of Witwatersrand.**
- The Hospital will not incur extra costs as a result of the research being conducted on its patients within the hospital
- The MAC will be informed of any serious adverse events as soon as they occur
- Permission is granted for the duration of the Ethics Committee Approval.

.....
Recommended
(On behalf of the MAC)
Date: 02/12/2021

.....
Approved/Not Approved
Hospital Management
Date: 06/12/2021

## Appendix M Research Cluster Committee Approval Charlotte Maxeke Johannesburg Academic Hospital

GAUTENG PROVINCE
HEALTH
REPUBLIC OF SOUTH AFRICA

CHARLOTTE MAXEKE JOHANNESBURG ACADEMIC HOSPITAL
UNIVERSITY OF THE WITWATERSRAND
Cluster Research Committee
7 Jubilee Rd, Parktown 2196, Johannesburg
Enquiries: Office of the CEO
Ms. T. Ndlovu; Tell: 011 488 4211 Fax 011 488 3753
Ms M. Khumalo Tel: 011 717 2536
Email: Mandisa.Khumalo@wits.ac.za

Dear Ms Nazreen Chopdat

The Charlotte Maxeke Johannesburg Academic Hospital (CMJAH) Research Cluster Committee has reviewed your request to research" Pelvic floor dysfunction in female patients at two academic hospitals in Johannesburg, 3 Months post-pelvic fracture".

I am pleased to inform you that you have been granted to research Charlotte Maxeke Johannesburg Academic Hospital provided that;

1. Charlotte Maxeke Johannesburg Academic Hospital will not anyway incur or inherit costs as result of the said study.
2. Your study shall not disrupt services at the study sites.
3. Strict confidentiality shall be observed at all times.
4. Informed consent shall be solicited from patients participating in your study.

**The data collection to be started only after obtaining the Human Research Ethics Committee (HREC) *unconditional approval*.**

Kindly note that it is a requirement at CMJAH that for *unconditional approval* to be granted, all pending documents highlighted below are to be submitted as soon as they are available or within 3 months, and if not applicable, kindly elaborate. Failure to comply with the above-stated requirements may result in the withdrawal of this research's approval at CMJAH.

| | |
|---|---|
| Head(s) of Department(s) Approval Letter | Provided |
| Human Research Ethics Committee Approval | Provided |
| The National Health Research Database Registration | Provided |
| Data Collection Sheets | Provided |
| Informed Consent Documents | Provided |

Kindly forward this office with the results of your study on completion of the research.

I wish you every success with your research.

Yours sincerely,

Ms G. Bogoshi
Chief Executive Officer

GAUTENG PROVINCE
HEALTH
REPUBLIC OF SOUTH AFRICA

CHARLOTTE MAXEKE JOHANNESBURG ACADEMIC HOSPITAL
UNIVERSITY OF THE WITWATERSRAND
Cluster Research Committee
7 Jubilee Rd, Parktown 2196, Johannesburg
Enquiries: Office of the CEO
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Ms M. Khumalo Tel: 011 717 2536
Email: Mandisa.Khumalo@wits.ac.za

**HOSPITAL PERMISSION TO CONDUCT RESEARCH - CMJAH CLUSTER RESEARCH COMMITTEE**

**DATE RECEIVED**: 11/08/2022 09:53 AM

**Application letter from the researcher Y/N**: **Yes**

**Degree Related Research Y/N**: **Yes** **Which Degree**: **MSc (Physiotherapy)**

**Undergraduate or Postgraduate coommittee approval Y/N**: **Yes**

**Non-degree purpose research Y/N**: **Specify**:

**HREC Approval Y/N**: **Provisional approval** **HREC Number**: **M210667**

**NHRD Registration Y/N**: Yes **NHRD Number**: **GP_202111_056**

**Clinical Trial**: **No** **Trial Registry Number**: **1234**

**Title of Research Project** : Pelvic floor dysfunction in female patients at two academic hospitals in Johannesburg, 3 Months post-pelvic fracture".

**Name of Principal Investigator**: **Ms Chopdat Nazreen**

**Name of Supervisor/Co-investigator**: **Dr Corlia Brandt**

**CHECKLIST**

- Is the study methods clear and the rationale for the study well motivated? **Yes**
- Is the research cost to the hospital reasonable and justifiable? **Yes**
- Does the research need support from other staff and allied staff? **Yes**
- Are the study coordinators, research and registered nurses explicitly stated? **No**
- LETTER OF PERMISSION FROM HODS TO CONDUCT RESEARCH? **Yes**
- Postgrad Assessor Group Approval (if for degree purposes)? **Yes**
- Data collection sheet reasonable? **Yes**
- Consent form and information sheet satisfactory? **Yes**
- HARDCOPY OF PROTOCOL AND ALL RELEVANT DOCUMENTS? **Yes**

**DECISION** **Approved**

**OTHER COMMENTS**: All required documents attached, applicant have been following up (August 2022) with old email of Thandi (who exited CMJAH).

**NAME OF ASSESSOR**: **Mosiamo Edward**

**Deputy Director Physiotherapist**

**CMJAH**

**SIGNATURE**: 

**DATE SIGNED OUT**: **11 /09 /2022**

**GROUP**:

**Appendix N Letter of support to conduct research at CMJAH from Head of Department of Physiotherapy**

GAUTENG PROVINCE
HEALTH
REPUBLIC OF SOUTH AFRICA

**CHARLOTTE MAXEKE JOHANNESBURG ACADEMIC HOSPITAL**
**PHYSIOTHERAPY DEPARTMENT**

**OFFICE OF THE DEPUTY DIRECTOR PHYSIOTHERAPY**

Enq: Mosiamo Edward
Tel:0114884206
Ref: 1/7/2/3/1

Date: 13/06/2022

Ms. G Bogoshi
Chief Executive Officer
Charlotte Maxeke Johannesburg Academic Hospital (CMJAH)
17 Jubilee Road, Parktown
Johannesburg, 2193

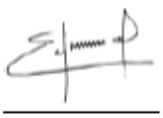
Dear Ms. G Bogoshi

**Re: Pelvic Floor Dysfunction in female patients at two academic hospitals in Johannesburg, 3 Months post-pelvic fracture – Letter of Support**

On behalf of Charlotte Maxeke Johannesburg Academic Hospital – Physiotherapy Department, please accept this letter of support to Ms. Nazreen Chopdat a Postgraduate Physiotherapist student from University of the Witwatersrand in her application to request permission to conduct a study at CMJAH. **The title of the study is: "Pelvic floor dysfunction in female patients at two academic Hospitals in Johannesburg, 3 Months post-pelvic fracture".** Physiotherapy department OPD is one of the department indicated in her proposal, methodology-study setting to conduct her study.

We would like to thank Ms. Nazreen Chopdat from Wits for choosing our facility to conduct such an important study. Feel free to contact the Physiotherapy Department should more information be required.

Yours in service



**Mosiamo Edward**
Deputy Director Physiotherapist
Charlotte Maxeke Johannesburg Academic Hospital
Ext: 011 488 4206 / *56636
Cell: 082 726 1019
Edward.mosiamo@gauteng.gov.za

**Appendix O Permission to conduct research from Head of Department of Orthopaedics at CHBAH**

GAUTENG PROVINCE
HEALTH
REPUBLIC OF SOUTH AFRICA

Chris Hani Baragwanath Academic Hospital
Physiotherapy Department
Contact: Elizma
Haarhoff
Tel: +27 (0)11 933 8927 (#6457)
Email: Elizma.Haarhoff@gauteng.gov.za

Chairman
Wits Human Research Ethics Committee (Medical)

To whom it may concern

Re: Permission to undertake research on patients from the Orthopaedic Department

The purpose of this letter is to grant Mrs. Nazreen Chopdat, as the principal investigator, permission to conduct her Physiotherapy Masters degree research project, at the orthopaedic lower limb out-patient clinic and orthopaedic wards, at Chris Hani Baragwanath Academic Hospital.

Her project is entitled: *Pelvic floor dysfunction in female patients at CHBAH 3 months post pelvic fracture*

This approval is subject to all the conditions set by the Wits Human Research Ethics Committee (Medical), and all the necessary approvals from the various authorities.

Provisional Wits Human Research Ethics Committee (Medical) approval has been obtained.
*Protocol Ref No: M210667 MED21-05-074*

Yours Sincerely,
Prof Magobotha

CHRIS HANI BARAGWANATH ACADEMIC HOSPITAL
P.O. BOX BERTSHAM, RSA
01 OCT 2021
OUTPATIENT DEPT

Prof. S.K Magobotha
P O Box 1249, Boksburg 1460
Tel: 011 365 1565
kellyd@mweb.co.za

## Appendix P Permission to conduct research from CHBAH Physiotherapy department

GAUTENG PROVINCE
REPUBLIC OF SOUTH AFRICA

**CHRIS HANI BARAGWANATH ACADEMIC HOSPITAL**
**PHYSIOTHERAPY DEPARTMENT**
**CONTACT: ELIZMA HAARHOFF**
**EMAIL: Elizma.Haarhoff@gauteng.gov.za**
**TEL: 011 933 8927 (#6457)**

**PERMISSION FOR RESEARCH FROM PHYSIOTHERAPY DEPARTMENT**

**DATE:** 25 October 2021

Permission is hereby granted to Me. Nazreen Chopdat, as the principal investigator, to conduct her Physiotherapy Masters degree research project at the Physiotherapy Department of Chris Hani Baragwanath Academic.

**NAME OF RESEARCHER:** Nazreen Chopdat

**TITLE OF RESEARCH PROJECT:** Pelvic Floor Dysfunction in Patients at CHBAH, 3 months post-pelvic fracture

**OBJECTIVES & METHODOLOGY OF STUDY:** See attached protocol

**CONFIDENTIALITY OF PATIENTS MAINTAINED:** Yes

**COST TO HOSPITAL:** Nil

**APPROVAL BY WITS HREC:** Provisional approval: M210667 M21-05-074 (see attached letter)

**SPECIFY ANY RESTRICTIONS:**

HREC clearance certificate be obtained prior to onset of study

The researcher must adhere to the agreement regarding logistics, working hours and record keeping that was reached between herself and the Physiotherapy Department – refer to attached agreement.

Kind Regards

Elizma Haarhoff
(Assistant Director: Physiotherapy)

## Appendix Q Turnitin Report

turnitin

# Digital Receipt

This receipt acknowledges that Turnitin received your paper. Below you will find the receipt information regarding your submission.

The first page of your submissions is displayed below.

| | |
|---|---|
| Submission author: | Nazreen Chopdat |
| Assignment title: | Final Research Report, Dissertation & Thesis submissio... |
| Submission title: | Final dissertation |
| File name: | 2164_Nazreen_Chopdat_Final_dissertation_51649_150024109... |
| File size: | 5.18M |
| Page count: | 229 |
| Word count: | 58,232 |
| Character count: | 328,644 |
| Submission date: | 29-Oct-2024 10:49AM (UTC+0200) |
| Submission ID: | 2501275972 |

PELVIC FLOOR DYSFUNCTION IN FEMALE PATIENTS AT TWO ACADEMIC HOSPITALS IN JOHANNESBURG, THREE MONTHS POST-PELVIC FRACTURE

Nazreen Chopdat

MSc (Physiotherapy) University of the Witwatersrand

Student number: 854826

Supervisor: Prof Corlia Brandt, Department of Physiotherapy, Faculty of Health Sciences, University of the Witwatersrand

A dissertation submitted to the Faculty of Health Sciences, University of the Witwatersrand, Johannesburg, in fulfilment of the requirements for the degree of Master of Science in Physiotherapy by research.

Johannesburg, October 2024

# Final dissertation

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