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FACTORS RELATED WITH THE FUNCTIONAL OUTCOME OF PATIENTS WHO SUSTAINED TIBIAL PLATEAU FRACTURES

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A research dissertation submitted to the Faculty of Health Sciences, University of Pretoria, in fulfilment of the requirements for the degree of Master in Physiotherapy (MPhysT)

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30 MAY 2022

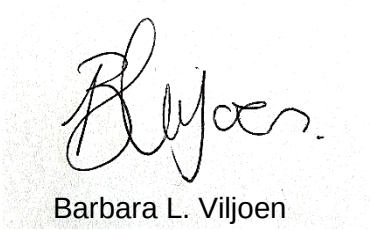
DECLARATION

I, Innocentia Lavhengwa Takalani Sivhugwana, declare that this dissertation is my original work. This dissertation is submitted for the degree of Master in Physiotherapy at the University of Pretoria. This dissertation has not been submitted before for examination at this or any other university.

ILT Sivhugwana
30 May 2022

DECLARATION: LANGUAGE EDITOR

This certifies that this document has been edited to ensure that the language is clear and free of errors. The logical presentation of ideas and the structure of the paper were also checked during the editing process. The language edit was performed by a professional editor and/or subject expert. The intent of the candidate's message was not altered in any way during the editing process. The quality of the edit has been guaranteed, with the assumption that the suggested changes have been accepted and have not been further altered without the knowledge of the editor and/or subject expert.



Barbara L. Viljoen

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ABSTRACT

The management of TPF has advanced over the years. However, even with the best medical intervention and physiotherapy rehabilitation, participants remain with lasting impairments and poor functional outcome including activity of daily living (ADL) limitation, poor return to vocational activities and restricted participation in recreational/sports, affecting their quality of life (QOL). Therefore, suggesting that other factors might play a role in functional outcome.

The aim of this study was to determine factors related with the functional outcome of patients after TPF. A quantitative analytical cross-sectional study of patients after TPF was undertaken. The study sample consisted of 86 patients who sustained TPF between 2015 and 2019 and received conservative or surgical intervention in three public hospitals in the Gauteng province. The KOOS-12 score, was used to determine functional outcome after TPF.

The mean KOOS-12 scores indicated significant findings between age groups in KOOS function (p=0.0076) and KOOS pain (p=0.0439) sub-scales. After TPF, the younger age group (20 to 39 years) participants experienced less pain with activities and were more functional in activities of daily living and sport/recreation activities, compared to participants in the older age group (40 to 60 years). The second significant finding was the statistically significant difference between gender in the KOOS-12 QOL (p=0.0102) sub-scale, indicating that female participants had better knee-related quality of life compared to male participants. In the linear analysis prediction of QOL sub-scale in relation to gender, there was a statistically significant difference (p=0.0102) indicating that female participants were the independent predictor of better knee-related quality of life after TPF. Ninety-one percent of patients reported partial to full return to work, while 56% of patients did not return to recreational sporting activities after injury.

Three barriers are identified that may affect the attendance of follow-up physiotherapy treatment sessions. Personal finances and social support are barriers that may play a role in how often the patient can return for follow-up sessions. Secondly, the number of outpatient sessions allowed by a health setting (hospital or clinic) may play a role in the final functional outcome of a patient. Because this may result in early discharge before the patient return to pre-injury functional level. Lastly, most of the patients work where they are paid per hour or per day. Attending physiotherapy treatment sessions is time consuming which imply the patient will lose a day's income.

Long term (more than three years) evaluation of patients after TPF revealed that prolonged recovery to regain pre-injured knee function should be expected and addressed during rehabilitation. Bearing this in mind, the importance of a detailed long-term rehabilitation program is essential. The program should include exercises to optimise joint function as well as information

and advice to prevent complications and address aspects such as healing time after a fracture (to address fear avoidance) and the advantages of adhering to the HEP (optimal function, decrease chances of developing OA). The lack of such a program is one of the main gaps identified in this study. The role of social support in patients' recovery after TPF is yet to be investigated, but involving family or caregivers in HEP may encourage and assist participants to adhere to an HEP.

In conclusion, age and gender are personal factors that influence functional outcome after TPF in the current study. It was also observed that participants presented with impairments long after TPF, with limited activity of daily living (ADL), return to vocational activities and participation in recreational activities, thus resulting in poor QOL. The knowledge of contextual and additional factors may help medical professionals to improve a patient's functional outcome and educate the patient with regard to expected functional outcomes and quality of life (QOL) after TPF. However, these factors are under researched and could benefit from in depth investigation.

Keywords: Tibial plateau fracture, quality of life, functional outcome, physiotherapy rehabilitation, International Classification of Functioning, Disability and Health (ICF).

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LIST OF ABBREVIATIONS / ACRONYMS

Abbreviation / acronym	Meaning
ADL	Activities of daily living
ARS	Activity Rating Scale
BBS	Berg Balance Scale score
BMI	Body mass index
CEO	Chief executive officer
CPM	Continuous passive motion
CT	Computed tomography
DVT	Deep venous thrombosis
FWB	Full weight bearing
KOOS	Knee Injuries and Osteoarthritis Outcome Score
KOOS-12	Knee injuries and Osteoarthritis Outcome Score (short version)
HEP	Home exercise programme
HSS	Hospital for Special Surgery knee score
LKS	Lysholm Knee Scoring Scale
ICF	International Classification of Functioning, Disability and Health
IKDC	International Knee Documentation Committee Subjective Knee Evaluation Form
NWB	Non-weight bearing
MRI	Magnetic resonance imaging
MVA	Motor vehicle accident
OA	Osteoarthritis
AO/OTA	Osteosynthesefragen/ Orthopaedic Trauma Association
ORIF	Open reduction internal fixation
OSK	Oxford Knee Score
PE	Pulmonary embolism
PWB	Partial weight bearing
ROM	Range of motion
SF-36	Short Form 36
SF-12	Short Form 12
TAS	Tegner Activity Score
TPF	Tibial plateau fracture/s
QOL	Quality of life
WOMAC	Western Ontario, and McMaster Universities Osteoarthritis Index

1 CHAPTER 1: INTRODUCTION

1.1 BACKGROUND

Tibial plateau fractures (TPF) are complex fractures of the proximal tibia involving the articular surfaces and surrounding soft tissue structures (Phan, Arnold and Solomon, 2017:2437). The fracture types range from non-displaced fragmented fractures (Type I – III) to complex fractures (Type IV – VI) with severe destruction of the joint lines and associated soft tissue structures (Kraus, Abele, Freude, Ateschrang, Stockle, Stuby et al., 2018:2-5). Type I – III fractures result from low velocity forces on the tibia, with no additional structure involvement (Kfuri and Schatzker, 2018:2252). Type IV – VI fractures are complex fractures resulting from high velocity forces, with additional structure involvement (Kfuri et al., 2018:2252). Complex TPF can involve structures surrounding the knee joint, which include ligaments, menisci, vascular structures, nerves, muscles and the articular cartilage (Kumar, Kumar and Venkatesh, 2020:2-5). The involvement of the structures surrounding the knee joint may therefor increase the risk of complications (including infections or thromboembolism) and impairments such as knee joint instability, pain, decreased knee range of motion (ROM) and muscle weakness (Kugelman, Qatu, Strauss, Konda and Egol, 2018:421; Iliopoulos, Agarwal and Khaleel, 2020b:277). When the impairments are not managed, patients may experience activity limitations and participation restrictions, affecting their quality of life (QOL).

After a TPF, a patient's level of function is a dynamic interaction between the impairments (such as pain and decreased range of motion), activity limitations (abnormal gait and climbing stairs) and participation restrictions (sports or recreational participation) which are influenced by environmental and personal factors (Mitra et al., 2019:1).

Tibial plateau fractures are associated with early and latent complications. Early complications include compartment syndrome, thromboembolism, infections, and worst-case amputation (Henkelmann, Frosch, Glaab, Lill, Schoepp, Seybold et al., 2017:2-5; Anand, Kumar and Ku, 2020:19). Latent complications include impairments such as osteoarthritis, non-union, knee joint stiffness or instability, muscle weakness and abnormal gait patterns. These impairments may lead to activity limitations such as stair climbing or standing up from a chair, difficulty returning to vocational activity or participating in recreational activities (Hap and Kwek, 2020:11; Kraus et al., 2018:2-7; Quintens, Van den Berg, Reul, Van Lieshout, Nijs, Verhofstad et al., 2021:201-9).

After a TPF, surgical or conservative intervention is required, surgical interventions after a TPF aim to restore articular congruity, axial alignment, knee joint stability, functional knee joint ROM

and thus, optimizing the patient's functional outcome (Mthethwa and Chikate, 2018:119; Alves, Wun, Alves, Christian, Mercadante and Hungria, 2020:405; Iliopoulos and Galanis, 2020a:2). Limited literature is available on conservative intervention after TPF. Extensive physiotherapy rehabilitation is important to both surgical and conservative interventions after medical intervention.

The aim of physiotherapy rehabilitation is to prevent complications and manage impairments after TPF, in order to assist patients to return to their pre-injury functional level (Alves et al., 2020:405; Anand et al., 2020:23; Iliopoulos et al., 2020a:2). However, limited literature on physiotherapy rehabilitation is available and controversy exists in the literature with regard to the most effective physiotherapy treatment program to prevent complications and manage impairments in order to optimise knee function. Rehabilitation programs include improvement of knee range of motion, muscle strengthening exercises, immobilisation of the knee joint in a knee brace after surgery, gait retraining and the necessity of ongoing rehabilitation, including home exercise programs (Arnold, Tu, Phan, Rickman, Varghese, Thewlis et al., 2017:2635; Phan et al., 2017:2437; Iliopoulos et al., 2020a:11). Because of the controversy illustrated in the literature on the rehabilitation program, it could be difficult to tell with certainty which rehabilitation programs are effective to prevent complications and restore knee function after TPF. Furthermore, the studies varied in terms of different outcome measures used to evaluate the functional abilities of patients after TPF, and the number of years after the injury; making it is difficult to compare or implement the findings of those studies (Arnold et al., 2017:2635; Phan et al., 2017:2437; Elsoe et al., 2018:280-8; Iliopoulos et al., 2020a:1-4).

The factors, identified in literature, that influence functional outcome of patients after TPF, include surgical intervention that was used, the fracture type, the time from injury to functional assessment, impairments such as range of knee motion (ROM), pain, gait training and presence of OA prior to injury (Elsoe and Larsen, 2017:1657-61; van den Berg, Reul, Nunes Cardozo, Starovoyt, Geusens, Nijs et al., 2017:1865-73; Jagdev, 2017:508-15; Reahl, Marinos, O'Hara, Howe, Degani, Wise et al., 2018:339-43; Kalmet, Van Horn, Sanduleanu, Seelen, Brink and Poeze, 2019:483-7) Limited literature is available on contextual and additional factors including personal factors (age, gender, or pre-injury level of activity), environmental factors (occupation or family support), complications (pre- or post-injury), conservative intervention, physiotherapy rehabilitation and multidisciplinary team approach that may influence the functional outcome after TPF (Arnold et al., 2017:2635; Phan et al., 2017:2437; Iliopoulos et al., 2020a:11). Knowledge of these factors may help healthcare professionals to plan interventions aimed at

improving patients' functional outcome and to also educate the patients with regard to expected functional outcomes and quality of life (QOL) after TPF.

1.2 PROBLEM STATEMENT

The management of TPF has advanced over the years. However, even with the best medical intervention and physiotherapy rehabilitation, patients continue to present with impairments that negatively affect functional outcome including ADL, return to vocational activities and participation in recreational/sports (van Dreumel, van Wunnik, Janssen, Simons and Janzing, 2015:1608-12; Mthethwa et al., 2018:119; Alves et al., 2020:405). The effect of these impairments increase the socioeconomic burden and affect the QOL of patients many years after TPF (Kabst, Tian, Kleber, Amlang, Findeisen, Lee et al., 2022:5). Literature on physiotherapy rehabilitation programs that may prevent or improve impairments influencing functional outcome after TPF, is currently limited. Factors identified that affect the functional outcome of patients after a TPF are limited to the surgical approach followed, the type of fracture, and gait training (Elsoe et al., 2017:1657-61; van den Berg et al., 2017:1865-73; Jagdev, 2017:508-15; Reahl et al., 2018:339-43; Kalmet et al., 2019:483-7). Limited research is available on contextual (personal and environmental) and additional factors that may affect the functional outcome of patients after a TPF. In the South African context, literature is even scarcer on the functional outcome of patients after TPF's. Only two articles, focussing on the effect of the surgical approach, could be found regarding the functional outcome of patients after TPF in the South African context (Pelser, 2010:75-82; Van der Walt and Ferreira, 2018:14-21). If contextual and additional factors that influence the functional outcome of patient after a TPF can be identified, it may assist in enhancement of the physiotherapy rehabilitation intervention program, to not only focus on impairments such as range of motion, muscle strength and pain, but also to educate the patient with regard to expected functional outcomes and quality of life (QOL).

1.3 RESEARCH QUESTION

What are the factors related with the functional outcome of patients who sustained TPF?

1.4 AIM

To determine the factors related with the functional outcome of patients who sustained TPF.

1.5 OBJECTIVES

To determine the functional outcome of patients after TPF, by means of the KOOS-12 questionnaire.

To determine the personal factors related to pain, functional limitations and quality of life of patients after TPF.

To determine the environmental factors related to pain, functional limitations and quality of life of patients after TPF.

To determine additional factors (identified in literature) related to pain, functional limitations and quality of life of patients after TPF.

1.6 DELINEATION AND ASSUMPTION

1.6.1 DELINEATION

Only patients from three public hospitals in Gauteng, diagnosed with TPF, were included.

1.6.2 ASSUMPTION

The researcher assumed that:

- Most patients present with functional limitation after TPF due to the nature of the fracture and limitation of surgical/ conservative intervention or physiotherapy rehabilitation.
- Patients from the three selected public hospitals are influenced by similar social and environmental factors.

1.7 SIGNIFICANCE/CONTRIBUTION

The significance of this study is once contextual and additional factors are identified that may influence the functional outcome of patients after a TPF, it may assist physiotherapists to improve the physiotherapy management approach and rehabilitation in both the short and the long term. In the short term, the findings may provide information to physiotherapists to discuss specific aspects/factors that may affect the functional outcome with patients before discharge, including education on the condition (fracture type). Although personal factors such as age and gender, and additional factors such as fracture type, cannot be changed, patients can be informed and advice on the effect of these factors on their functional outcome. Physiotherapists may assist patients to navigate hindrances associated with environmental and additional

factors; thereby involving a social worker for an example, in an instance where there is poor social support or physiotherapy follow up sessions' attendance due to lack of finances. Furthermore, in the long term, educating patients on the importance of adhering to given home exercise program and the implementation of multidisciplinary/interdisciplinary team intervention may facilitate recovery in functional ability, contribute to prevent or reduce long standing disability and improve a patient's quality of life.

1.8 DEFINITION OF KEY TERMS/CONCEPTS

Table 1.1: Definition of key terms/concepts as used in the study.

Phrase	Concept
Functional outcome	A functional outcome is defined as a measurable goal that helps a patient to perform specific activities of daily living (ADL) (Medical dictionary, 2009). In this study, it refers to an individual's participation in daily activities, how daily activities are affected by pain and the influence of impairments after TPF on the quality of life.
Activities of daily living	ADL refer to people's daily self-care (eating, bathing and dressing), work, household chores and leisure activities (Paul et al., 2019:16). In the hospital setting, a patient's ability or inability to participate in ADLs is used as a measure of their functional status (Paul et al., 2019:16). In this study, ADL activities include rising from a chair, standing, or getting in/out of a car (pivoting or twisting on the knee).
Quality of life	Quality of life (QOL) is defined as the overall general well-being of an individual, that incorporates objective signifiers and subjective evaluations of physical, material, social and emotional well-being (Karimi and Brazier, 2016:3). Quality of life can also refer to the experience an individual has of their lives and/or their living conditions, weighed by their personal values (Karimi et al., 2016:3). In this study, QOL refers to a patient's physical, social and emotional well-being, as well as their ability to participate and enjoy life events after TPF.
Chronic pain	Chronic pain is a condition in which someone experiences persistent pain for more than three months and when this symptom is associated with significant emotional misery and/or functional disability (Kumar, Elavarasi and David, 2016:87-8; Nicholas, Vlaeyen, Rief, Barke, Aziz, Benoliel et al., 2019:29). In this study, participants were assessed a year after injury to determine functional outcome after TPF. The effect of chronic pain on daily activities such as walking, climbing stairs, or sitting/lying was measured by a KOOS-12 questionnaire.

Tibial plateau fractures (TPF) is associated with complication and impairments that may limit function.

If contextual and additional factors that influence the functional outcome of patient after a TPF can be identified: May assist in enhancement of the physiotherapy rehabilitation intervention program that prevent complications and manage impairments in order to optimise knee function.

Functional outcome after TPF

Patients may remain with lasting impairments and poor functional outcome including activity of daily living limitation, poor return to vocational activities and restricted participation in recreational/sports, affecting their quality of life.

The study objectives

To determine the functional outcome of patients after TPF, by means of the KOOS-12 questionnaire.

To determine the personal factors related to pain, activities of daily living and quality of life of patients after TPF.

To determine the environmental factors related to pain, activities of daily living and quality of life of patients after TPF.

To determine additional factors (identified in literature) related to pain, activities of daily living and quality of life of patients after TPF.

The study aim is to determine the contextual factors related with the functional outcome of patients who sustained TPF.

FIGURE 1.1 Conceptual Framework

1.9 OUTLINE OF DISSERTATION

This section briefly outlines and describes the different chapters that follow in the dissertation.

Chapter 2

In this chapter, the relevant literature is reviewed to find out what research has already been done and identify what are the gaps within the research topic under study, in order to inform the research investigation.

Chapter 3

The methodological approach for this chapter is explained. The study design, procedures, study setting and ethical considerations are also explained in this chapter.

Chapter 4

The results of the study are presented in the following order: the recruitment process, univariate analysis and multivariate analysis of factors related to the functional outcome after TPF.

Chapter 5

The results of the study are analysed, discussed and compared to existing literature in order of significance**.**

Chapter 6

The dissertation is concluded and important findings are summarised.

Chapter 7

Recommendations for future studies are outlined and limitations to the current study are detailed.

1.10 SUMMARY

Chapter 1 presents the current background in relation to this research. It outlines and explains the problem statement, research question, aim and objectives, delineation and assumption, the significance of the study and lastly, provides a definition of key terms.

2 CHAPTER 2: LITERATURE REVIEW

2.1 INTRODUCTION

Tibial plateau fractures (TPF) are one of the most prevalent intra-articular fractures representing about 1% of all fractures and overall, 8% of the fractures that affect the elderly (Alves et al., 2020:405). Internationally, an incidence of 10.3 per 100,000 is reported annually, with the mean age of 56.6 years (Iliopoulos et al., 2020a:1; Lv, Zhang, Chen, Song, Zheng and Zhang, 2020:561). In both males and females, the highest incidence was between the ages of 35 and 54 years of age, with more males than females for both age groups (Iliopoulos et al., 2020a:1) Epidemiologic studies of TPF have been reported in Western and European countries, but none have been found in African countries by the researcher. These fractures are often caused by high-speed motor vehicle accidents, a fall from a considerable height, assaults, and high impact sports-related trauma such as football or skiing (Chandrashekar, 2018:606; Anand et al., 2020:19; Hap et al., 2020:11). Males are mostly injured because of falls from a considerable height or because of motor vehicle accidents, motorcycles, or other motor-powered vehicles, whereas females are injured mainly while cycling, a fall while walking and participating in an activity of daily living (ADL) (Iliopoulos et al., 2020a:1; Lv et al., 2020:565-8). Often, after recovering from a TPF, patients are functionally limited due to various reasons (Hap et al., 2020:11-5; Iliopoulos et al., 2020a:1).

The current study aims to identify factors related to the functional outcome of patients after they have sustained a TPF. In this chapter, firstly reviewed are the classification of the fracture type, mechanism of injury, anatomy of the knee joint, medical intervention and common complications after TPF. Secondly, the influence of the health condition (TPF) on body structure and functional impairments such as decreased knee range of motion, muscle strength and abnormal gait, are reviewed. Thirdly, the contextual factors that may be either barriers to or facilitators of the person's functioning after TPF are reviewed. Finally, the outcome measures used to determine functional outcome after TPF are reviewed.

Literature searches included the use of journals and books which were found via PubMed, Google scholar, CD-ROM, University of Pretoria online databases and Medline. The review included articles from 2015 to 2022.

Key words used for the literature search included: Tibial plateau fracture, quality of life, functional outcome after tibial plateau fractures, physiotherapy rehabilitation after tibial plateau

fractures, factors associated with functional outcome after tibial plateau fractures, International Classification of Functioning, Disability and Health (ICF).

2.1.1 BACKGROUND

The classification of TPF is important for assessment of the degree of injury, decision on a treatment plan and prediction of prognosis (Kfuri et al., 2018:2252-3). Thirty-eight classification systems have been used to define TPF, of which only two have been tested for inter- and intra-observer reliability (Kfuri et al., 2018:2252). The two systems are the Schatzker (0.91 intra-observer and 0.47 inter-observer reliability) and Osteosynthesefragen/Orthopaedic Trauma Association (AO/OTA) (0.80 intra-observer and 0.36 inter-observer reliability) classification systems, of which the former is most used to classify TPF (Kfuri et al., 2018:2253). The Schatzker classification system is composed of six condyle fracture types, classified by the fracture pattern and fragmentation of the bone anatomy (Figure 2.1) (Kfuri et al., 2018:2252-3). The severity of the fracture is indicated by the increasing numeric fracture type and associated with the amount of energy applied to the bone at the time of the incident (Kfuri et al., 2018:2252-3; Mthethwa et al., 2018:122). High energy trauma may cause a complex fracture pattern and is mostly associated with soft tissue injuries (Anand et al., 2020:19). Low energy trauma injuries are expected to cause less complex fracture patterns. However, if the bone is osteoporotic, a complex fracture pattern may occur from a low energy injury (Anand et al., 2020:19). The Schatzker classifications of TPF, as well as the description and the mechanism of injury are presented in Table 2.1 and illustrated in Figure 2.1 below.

Table 2.1: Schatzker classifications of tibial plateau fractures and the mechanism of injury.

Fracture type	**Description of the fracture and mechanism of injury**
Lateral TPF without depression (Type I)	Type I TPF is a split fracture of the lateral tibial plateau without articular depression (Verma, Venkateshaiah and Gajapurada, 2020:6). It results from valgus force combined with axial loading on the lateral femoral condyle, causing it to collide with the articular surface of the tibial plateau (Kfuri et al., 2018:2252). It is more common in younger people who have denser cancellous bone (Chandrashekar, 2018:606).
Lateral TPF with depression (Type II)	Type II TPF is a split, depressed fracture of the lateral tibial plateau (Verma et al., 2020:6). It has the same mechanism of injury as Type I, but more common in older patients, who have less dense metaphyseal bone. It may be associated with injuries to the medial collateral ligament (MCL) or anterior cruciate ligament (ACL) (Kfuri et al., 2018:2252).
Focal depression of articular surface with no associated split (Type III)	Type III TPF is an isolated depression of the lateral plateau (Verma et al., 2020:6). This injury is caused by axial forces that push the articular surface of the tibial plateau into the lateral tibial metaphysis. These injuries are associated with low energy injury and often seen in individuals with osteoporotic changes in bone (Kfuri et al., 2018:2253).
Medial TPF with or without depression (Type IV)	Type IV TPF is a fracture of the medial plateau with a split or depressed component (Verma et al., 2020:6). This fracture type results from high energy injury and is caused by varus force with axial loading at the knee. The risk of associated injuries is high, such as tibial eminence injuries, soft tissue injuries, as well as high risk of damage to the vascular structures (popliteal artery or peroneal nerve) and distraction injuries of the ligaments (Kfuri et al., 2018:2253).
Bicondylar TPF (Type V)	Type V TPF is a bicondylar plateau fracture with varying degrees of articular depression and displacement of the condyles (Verma et al., 2020:6). This fracture type results from high energy injury with complex varus and valgus forces acting upon the tibial plateau and may include injuries to the anterior cruciate ligament and collateral ligaments (Kfuri et al., 2018:2253).
TPF with diaphyseal discontinuity (Type VI)	Type VI TPF is a bicondylar tibial plateau fracture with diaphyseal metaphyseal dissociation (Verma et al., 2020:6). A mechanism of injury includes varus and valgus forces resulting in a transverse sub-condylar fracture with dissociation of the metaphysis from the diaphysis. Furthermore, these fractures may be open, often with extensive soft tissue injuries and risk of compartment syndrome (Kfuri et al., 2018:2253).

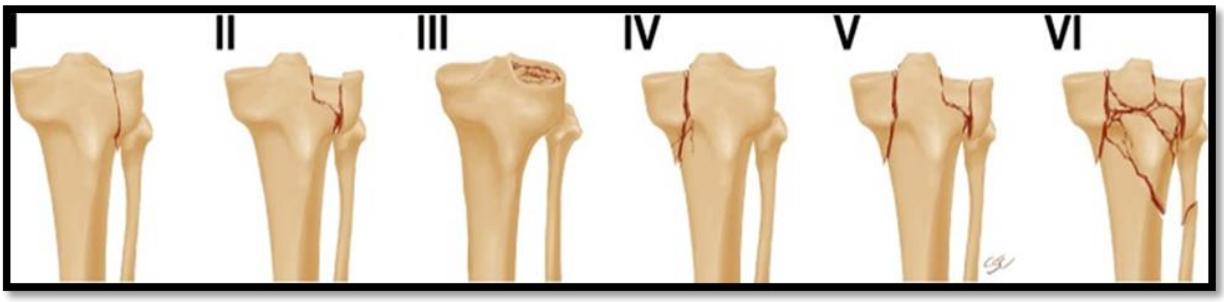


Figure 2.1: The six condyle fractures according to the Schatzker classification (Kfuri et al., 2018:2253)

Non-displaced fractures (Types I-III) may only affect the integrity of the tibiofemoral joint. Complex fractures (Types IV-VI), however, often affect the tibiofemoral joint, tibiofibular joint and surrounding soft tissue, including ligaments, menisci and muscles (Kfuri et al., 2018:2252). The ligaments that stabilise the tibiofemoral joint are the medial collateral ligament, anterior cruciate ligament, posterior cruciate ligament and fibular-/lateral collateral ligament (Abulhasan and Grey, 2017:2-3; Kumar et al., 2020:5). Disruption of these ligaments may lead to multidirectional instability of the tibiofemoral joint (Abulhasan et al., 2017:2-3; Kumar et al., 2020:5). Damage to the medial and lateral menisci will have an effect on the congruency of the joint and the 'locking' of the joint in full extension to optimally bear weight (Abulhasan et al., 2017:2-3; Kumar et al., 2020:5). The menisci also act as shock absorbers for the joint and damage may result in early degenerative changes in the joint (Abulhasan et al., 2017:3; Kumar et al., 2020:5). Furthermore, with high energy injuries (Types V-VI), the integrity of the intercondylar eminence is affected. The eminence serves as an attachment point for anterior and posterior cruciate ligaments, as well as the lateral and medial menisci. Disruption of the eminence may further contribute to instability of the tibiofemoral joint (Abulhasan et al., 2017:2-3; Kumar et al., 2020:5). The muscles that originate and insert on the tibia plateau are not only responsible for knee movement and function but affects the hip and ankle function as well. Injuries to these muscles often result in lower limb dysfunction (Abulhasan et al., 2017:3-4). High energy injury often results in open fractures and soft-tissue injuries, including the penetration of deep fascia that separates the lower leg into compartments containing muscles, vessels and nerves (Abulhasan et al., 2017:2-3; Kumar et al., 2020:5). The involvement of the deep fascia increases the risk of infections and damage to the arteries (superficial femoral, obturator or deep femoral artery) and nerves (femoral, obturator or sciatic nerve) in the lower limb (Abulhasan et al., 2017:2-3; Kfuri et al., 2018:2260). The damage of soft tissue structures with high energy injuries does not only increase the risk of complications (infections, chronic pain, decreased ROM or knee instability)

and thereby affecting functional outcome, but also influences the choice of surgical intervention (Arnold et al., 2017:2635; Phan et al., 2017:2437; Elsoe et al., 2018:280-8; Iliopoulos et al., 2020a:1-4).

Medical intervention depends on the severity of the fracture. The primary goal of the medical treatment of a TPF is to restore joint integrity and alignment (Anand et al., 2020:19; Hap et al., 2020:11). Conservative interventions are indicated in case of a Type I fracture, when there is no fragment displacement, depression of the tibial plateau, comminution, or associated ligamentous or meniscal injury (Pean, Driesman, Christiano, Konda, Davidovitch and Egol, 2017:375; Alves et al., 2020:405). Patients with Type I fractures are immobilised in a hinged knee brace or a cast with strict non-weight bearing (Mthethwa et al., 2018:123). Surgical interventions are preferred in complicated fractures (Types II–IV) to prevent secondary displacement and allow early mobilisation of the knee joint (Evangelopoulos, Chalikias, Michalos, Vasilakos, Pappa, Zisis et al., 2019:195). The most commonly used surgical interventions are open reduction and internal fixation (ORIF) (Kugelman et al., 2018:425). In the case of open fractures with severe soft tissue damage, external fixation with a circular frame is used, followed by an absolute repair when the soft tissue allows for such repair (Kugelman et al., 2018:425; Iliopoulos et al., 2020b:276). The circular frame is applied across the two joints (ankle and the knee joint), thereby preventing mobilisation both joints. Furthermore, weight bearing is delayed, awaiting ORIF (Kugelman et al., 2018:425; Iliopoulos et al., 2020b:276). The possibility of early complications such as infections, muscle stiffness or pain and latent complications such as decreased ROM or abnormal gait, may restrict participation in ADL, vocational and sporting activities (Kugelman, Qatu, Haglin, Konda and Egol, 2017:4; Kugelman et al., 2018:422; Iliopoulos et al., 2020a:3; Iliopoulos et al., 2020b:277; Kabst et al., 2022:1-5).

Tibial plateau fractures are associated with various complications such as infection, compartment syndrome, thromboembolism and osteoarthritis (OA). The first complication to be reviewed is post-operative infection. Post-operative infections at the site of the surgery after TPF are four to five times higher than other fractures treated with open reduction internal fixation (ORIF) (Henkelmann et al., 2017:1-7). Patients with post-operative infections are associated with high mortality rate (Henkelmann et al., 2017:1-7). The incidence of deep wound infection is associated with decreased knee range of motion, fracture non-union or pseudarthrosis, arthrodesis, ankylosis and in the worst-case scenario, an amputation (Henkelmann et al., 2017:1-7; Polat, Gurpinar, Polat and Ozturkmen, 2019:1720). Furthermore,

because of the above stated impairments, deep wound infections may result in poor knee function and impaired quality of life (Henkelmann et al., 2017:1-7; Hap et al., 2020:14).

Secondly, another serious complication that may occur after TPF is compartment syndrome. Swelling after injury in the leg may cause compression of the nerves and blood vessels and may ultimately lead to necrosis of tissue (Thabet, Simson, Gerzina, Dabash, Adler and Abdelgawad, 2018:88-92; Anand et al., 2020:19). A recent study reported that the incidence of compartment syndrome was 17% for closed, and 18.7% for open TPF's (Anand et al., 2020:19). The incidence of compartment syndrome was found to increase the risk of infection or non-union of the fracture (Anand et al., 2020:19). Literature illustrates the effect of the possible infection or non-union, attributing this to possible poor knee function (Henkelmann et al., 2017:1-7; Hap et al., 2020:14); limiting participation in activities of daily living or recreational activities.

Thirdly, the incidence of thromboembolism (deep vein thrombosis and pulmonary embolism) after TPF is as high as 16.3% (Zhu, Chen, Li, Zhao, Zhang, Meng et al., 2021:3). The risk factors associated with thromboembolism include being a male patient, open fracture and comorbidities such as hypertension (Zhu et al., 2021:3). The prophylaxis interventions of venous thromboembolism include mechanical devices such as graduated compression stockings, intermittent pneumatic compression devices and pharmacologic agents (Auer and Riehl, 2017:38-44; Zhu et al., 2021:1-8). Literature indicates that early weight bearing after TPF reduces the incidence of thromboembolism (Williamson, Iliopoulos, Jain, Ebied and Trompeter, 2018:1886-90). Many physiological benefits to early weight bearing are yet to be discussed, such as improved bone healing, but one can point out that patients may mobilise more when allowed to weight bear that none weight bearing gait with crutches, because weight bearing decreases energy expenditure and is thus less exhausting (Williamson et al., 2018:1886-90).

Lastly, a latent complication is the possible development of post-traumatic OA. Consequently, these intra-articular fractures may result in knee joint instability and ultimately in poor joint alignment (Jagdev, Pathak, Salunke, Maheshwari, Ughareja and Shah, 2017:2-4). The incidence of knee joint instability increases with Schatzker's TPF classification and associated ligament injuries or laxity, resection of the meniscus, and isolated cartilage damage (Jagdev et al., 2017:3; Arun, Subramaniam and Anush, 2020:256). A small percentage (2%) of patients may presented with varus or valgus deformity after TPF (Arnold et al., 2017:20). This may lead to abnormal gait patterns, joint degeneration and dysfunction (Kugelman et al., 2018:421; Iliopoulos et al., 2020b:277). Knee joint degeneration may lead to the development of post-traumatic OA. The incidence of post-traumatic OA increases up to 45% after TPF (Aurich,

Koenig and Hofmann, 2018:100). More complex fractures (Schatzker's Type V and Type VI) have a higher incidence (60%) of post-traumatic OA than less complex fractures (Wirbel, 2020:10). The radiological evidence of OA may be present on individuals who are asymptomatic and those patients may present with excellent functional outcome if the articular reduction and limb alignment are maintained (Jagdev et al., 2017:2-4; Polat et al., 2019:1720). Long-term physiotherapy rehabilitation may be indicated to prevent or manage the symptoms associated with post-traumatic OA, therefore limiting functional challenges that may occur.

Physiotherapy rehabilitation is indicated and essential after medical intervention to prevent and manage impairments, improve functional outcome and, ultimately, quality of life. However, controversy exists in the literature regarding rehabilitation protocols.

2.1.2 PHYSIOTHERAPY REHABILITATION AFTER TIBIAL PLATEAU FRACTURE

The goal of physiotherapy rehabilitation is to prevent complications after TPF and to assist patients to return to their pre-injury functional capacity (Iliopoulos et al., 2020a:2). These goals are achieved by preventing or managing impairments such as decreased knee range of motion (ROM), muscle weakness, knee instability and abnormal gait patterns in order to improve a patient's functionality and participation in vocational and sporting/recreational activities (Phan et al., 2017:2437; Hap et al., 2020:11). Currently, there are no standardised physiotherapy rehabilitation protocols to achieve these goals (Iliopoulos et al., 2020a:1-4). Physiotherapists create their own protocol with the input of the orthopaedic surgeon which is usually influenced by the surgical approach of the surgeon.

A scoping review by Arnold et al., (2017:2634-42) highlighted that rehabilitation protocols vary and that research is needed on these protocols to optimise recovery. In addition, a systematic review on physiotherapy management of TPF after fixation suggested that that literature with regard to physiotherapy rehabilitation after TPF is scarce and outcomes are often controversial (Iliopoulos et al., 2020a:1-5). Iliopoulos et al., (2020a:1-5) identified four focus areas in physiotherapy rehabilitation that influence the functional outcome. The four focus areas are: 1) post-operative range of motion (ROM) mobilisation and muscle strengthening, 2) the immobilisation method and period, 3) weight-bearing protocols and 4) ongoing rehabilitation (including home exercise programs) (Iliopoulos et al., 2020a:1-5).

Regarding post-operative range of motion (ROM) mobilisation, different approaches/points of view exist in relation to the type of mobilisation, as well as when to start knee joint mobilisation (Arnold et al., 2017:2635; Phan et al., 2017:2437; Iliopoulos et al., 2020a:11). In order to

improve knee joint ROM, mobilisation can be passive in the early stages of healing, active assisted or active as the movement improve, but the type of knee joint mobilisation and duration of the mobilisation remains debatable (Arnold et al., 2017:2635; Phan et al., 2017:2437; Iliopoulos et al., 2020a:11). Passive knee joint mobilisation can be done by either a physiotherapist or caregiver. The lower limb is physically moved in order to bend the knee or by using an external device such as the continuous passive motion machine (CPM) (Kabst et al., 2022:1-3). Continuous passive motion (CPM) was used immediately after surgical intervention and positive results showed improved knee joint ROM (Kugelman et al., 2017:4; Kugelman et al., 2018:422; Iliopoulos et al., 2020a:3; Iliopoulos et al., 2020b:277; Kabst et al., 2022:1-9). A prospective randomized controlled trial (n=60) reported that patients who received conventional physiotherapy (muscles strengthening and stretching exercises) and CPM training three times per day for 30 minutes, had significantly improved knee ROM, decreased pain levels and demonstrated better knee functionality and QOL as compared to patients who received only conventional physiotherapy (Kabst et al., 2022:1-9). Furthermore, CPM was found to reduce oedema formation and aid healing by halting granulation and fibrotic tissue formation (Kabst et al., 2022:1-9). Active assisted knee joint mobilisation involves active movement (heel slide, wall squats or cycling) of the lower limb in order to bend the knee joint with or without assistance. In a retrospective clinical study with 34 participants (n=34), active knee joint mobilisation was performed immediately after surgery (Evangelopoulos et al., 2019:194-5).. Another retrospective study (n=30) reported that static quadriceps exercises were done day one post-operatively and that active or active assisted mobilisation, from the second day post-operatively. The study showed that most patients (60%) had more than 120° of knee flection one year after TPF and that most patients had excellent to good functional outcome as measured by modified Rasmussen Clinical and Radiological Assessment criteria (Dindivanam, 2019:557). The specific benefits of early active knee joint mobilisation were not reported in the literature. Active assisted or active knee joint mobility is often done later in the rehabilitation program because some patients have to wear a knee range brace after surgical intervention (Arnold et al., 2017:2634-42; Chauhan, Slipak, Miller, Altman and Altman, 2018:136). The knee brace is prescribed by the orthopaedic surgeon post-operatively to assist with knee stability. Only when the brace can be moved from 0°-30° of knee flexion, the patient may begin active assisted or active knee joint exercises and muscle strengthening exercises (Arnold et al., 2017:2637). The time frame for unlocking the brace was not indicated in the studies reviewed. Even though not always specified (as passive, active assisted or active) in the literature, the benefits of early post-operative knee joint mobilisation are reported, including significant increase in knee ROM, breakdown of

synovial adhesions and capsular contractions, reduced muscle and bone atrophy, reduced pain, better knee functionality, and therefore, better quality of life (Arnold et al., 2017:2635; Kabst et al., 2022:1-5). However, with the mentioned benefits of early mobilisation, some patients presented with decreased knee ROM (0-105 degrees) 15 months after TPF (Kabst et al., 2022:1-5). The factors that contributed to this finding was not clarified. Kugelman et al (2018) indicated that factors that predict decreased knee ROM include personal factors such as non-white ethnicity and increasing age, impairments such as post-operative infection or articular depression, high energy Schatzker fractures (Types V-VI), increased body mass index (mean BMI was 27.16) and poor adherence to physiotherapy rehabilitation (Kugelman et al., 2018:422-6). A small percentage (3.7%) of patients may require secondary surgical intervention such as arthroscopic lysis of adhesions, due to arthrofibrosis (Kugelman et al., 2018:422-6). The likelihood of secondary knee surgery was increased by the following factors: open fractures, bilateral fractures, long hospital stay, long admission in intensive care and long application of external fixation (including ORIF after external fixation) (Reahl et al., 2018:341).

Knee joint immobilisation is prescribed by the orthopaedic surgeon depending on the fracture type and surgical approach. The hinge knee brace is used to ensure knee stability and controlled tibiofemoral joint movement while healing occurs (Arnold et al., 2017:2634-42; Chauhan et al., 2018:136; Iliopoulos et al., 2020a:3). A scoping review indicated that knee immobilisation was recommended by 30% of studies and the duration of the brace was reported by six studies, indicated three to six weeks (Arnold et al., 2017:2634-42). Post-operatively, the hinge brace is locked in full extension, and when to unlock the hinge brace is determined by the orthopaedic surgeon based on the fracture healing as monitored by radiographic image. The knee brace is unlocked from 0-30 degrees of flexion and unlocked further as recommended by the orthopaedic surgeon. When to wean a patient from a knee range brace, depends on the healing process and can range between two to 12 weeks (Polat et al., 2019:134-40). Contrary to the previous study, Chauhan and colleagues found there was no significant functional, clinical and radiographic difference between patients who were not immobilised and those immobilised in a range brace after TPF surgical intervention (Chauhan et al., 2018:136).

The weight bearing status after TPF is determined by the fracture type, medical intervention and evidence of union visible on the X-ray (Anand et al., 2020:20). Post-operative weight bearing can range from several weeks of non-weight bearing (NWB) gait with crutches, immediate weight bearing as pain allows, partial weight bearing (PWB) and followed by full weight bearing (FWB) (Kugelman et al., 2017:4; Kugelman et al., 2018:422; Iliopoulos et al., 2020a:3; Iliopoulos

et al., 2020b:277). Literature does not indicate with clarity the effect of weight bearing (NWP, PWB, FWB) on the clinical and functional outcome after TPF. A scoping review reported that NWB status in most studies was four to six weeks (39%), followed by seven to nine weeks or ten to twelve weeks (21%) and lastly three weeks (16%) (Arnold et al., 2017:2637). The average time for PWB in most studies (51%) was between four and six weeks, followed by seven to nine weeks (24%) and more than ten weeks (18%). Full weight bearing (FWB) was most often recommended between nine to 12 weeks (55%) (Arnold et al., 2017:2637-8). In other studies, NWB was continued for approximately 10-12 weeks, after which weight bearing was gradually started. (Kugelman et al., 2017:4; Kugelman et al., 2018:422; Iliopoulos et al., 2020a:3; Iliopoulos et al., 2020b:277). A retrospective study investigating the effect of immediate weight bearing after plate fixation of a TPF concluded that patients should be allowed to weight bear immediately (Williamson et al., 2018:1886-90). The authors reported that at three months post-operatively, patients who bear full weight immediately, compared to those who did not bear weight or bear weight partially, showed no difference of fixation demonstrated on the radiographs (Williamson et al., 2018:1886-90). A systematic review reported on the finding of a retrospective study that compared PWB and NWB after ORIF and no differences in clinical and functional outcome were observed, but patients in the PWB group were able to achieve FWB swiftly (Iliopoulos et al., 2020a:3). Immediate weight bearing after fracture fixation has many benefits, including “physiological benefits such as improved bone healing; decreased energy expenditure when mobilising; decreased risk of venous thromboembolism; socioeconomic benefits such as speed of return to work and a shorter stay in hospital” (Williamson et al., 2018:1886-90).

In the long term, some impairment continue to restrict performance of ADL and participation in vocational and sporting/recreational activities; emphasising the importance of the ongoing rehabilitation and home exercise programs (HEP) (Iliopoulos et al., 2020a; Iliopoulos et al., 2020b; Elsoe and Larsen, 2021). A prospective cohort study by Elsoe et al., (2021:284) reported that three years post-operatively, patients with TPF (n=56) had a higher mean Knee Injury and Osteoarthritis Outcome Score (KOOS) compared to 12 months’ follow-up. This study found significant ($p > 0.001$) improvement in the functional outcome over the three years in all KOOS domains (pain, other symptoms, ADL, and knee related quality of life) except function in the sport/recreation activity domain that remained the same. Furthermore, at three years the muscles that extends (quadriceps femoris) and flex (hamstrings, gracilis, sartorius, gastrocnemius, plantaris and popliteus) the injured knee, were found weak as compared to an uninjured knee (Elsoe et al., 2021:285). Another prospective study (n=102) indicated that at five

years after TPF, patients had a significantly improved functional outcome as measured by Short Musculoskeletal Function Assessment (SMFA) score, compared to one year follow-up, but pain score (measured by Visual Analogue Scale) and knee ROM were similar at five years compared to their one- year follow-up score (Gonzalez, Hildebrandt, Carlock, Konda and Egol, 2020:634-5).

Abnormal gait patterns after TPF were reported in a prospective cohort study (n=23) reported that at three years after TPF, patients had slower antalgic gait with a short stride, slower cadence, and shorter single limb support when compared to the affected side (Elsoe et al., 2017:1651). These abnormal gait patterns after TPF were attributed to a higher risk of developing post-traumatic arthritis (Elsoe et al., 2017:1659). A year after TPF, patients' gait pattern returns to normal as compared to the uninjured limb, except for the gait asymmetry patterns (single limb support or step length asymmetry) that persist (Elsoe et al., 2017:1659; Iliopoulos et al., 2020b:277; Elsoe et al., 2021:285). Long term (more than three years) evaluation of patients after TPF revealed that prolonged recovery to regain pre-injured knee function should be expected and addressed during rehabilitation (Elsoe et al., 2017:1659; Iliopoulos et al., 2020b:277; Elsoe et al., 2021:285). Optimal pre-injury knee function recovery observed in some patients was credited to the improved surgical techniques, modern pain management and physiotherapy rehabilitation (Gonzalez et al., 2020:634-5). However, the physiotherapy rehabilitation mentioned was not discussed, neither the HEP, nor the period that patients attended physiotherapy rehabilitation.

Few studies reported that physiotherapy rehabilitation contributed to satisfactory knee ROM and functional outcome achieved after TPF (Kugelman et al., 2017:4; Kugelman et al., 2018:422; Iliopoulos et al., 2020a:3; Iliopoulos et al., 2020b:277; Gonzalez et al., 2020:634-5; Elsoe et al., 2021:285). However, some impairment such as abnormal gait and muscle weakness might persist for more than three years, ongoing physiotherapy rehabilitation may be indicated, including more research investigating specific techniques, exercises and more emphasis on HEP adherence.

2.1.3 ACTIVITY LIMITATION AND PARTICIPATION RESTRICTION AFTER TIBIAL PLATEAU FRACTURE

There are functional challenges after TPF that limit ADL and restrict participation in vocational and sporting/recreational activities:

ADL limitation after TPF and contributing factors. The ADL limitations reported were mobility, self-care and daily activities such as climbing stairs, sitting and standing up from a chair and getting in/out of a bathtub (Evangelopoulos et al., 2019:394-8; Kabst et al., 2022:1). Some studies reported impairments such as pain and decreased knee ROM as a limiting factor for patients' ability to execute ADL such as mentioned previously (Unnikrishnan, 2017:808; Evangelopoulos et al., 2019:394-8; Kabst et al., 2022:1). Pain after TPF was associated with activities that increase knee joint forces, such as stair climbing, recreational sport and ADL that require squatting or kneeling (Evangelopoulos et al., 2019:394-8). Knee ROM of at least more than 90° of flexion is required for most ADL such as standing up from a sofa or getting in/out of a bathtub (Kabst et al., 2022:1). It was indicated previously that the pain intensity and knee ROM reach a plateau at about a year after TPF (Gonzalez et al., 2020:634-5). Among other techniques and exercises, physiotherapy rehabilitation must include pain management and also place more emphases on early knee joint mobilisation in order to achieve satisfactory knee ROM within a one-year period.

Another functional challenge is the ability to return to vocational activities after TPF. Limited studies were done to investigate return to vocational activities (Kraus et al., 2018:2-8; Hap et al., 2020:14). In a retrospective study (n=39), patients who had a higher workload, had a longer duration of incapacity to work post-injury, compared to those with a lower workload, and could only return to less physically demanding jobs with reduced working hours (Kraus et al., 2018:2-8). A retrospective cohort study reported that only 52% of patients were able to fully return to pre-injury level of work (Hap et al., 2020:14). Essentially, this highlights the impact of a TPF on the patient's quality of life and ability to return to pre-injury level of work, even after surgical fixation and a period of rehabilitation (Kraus et al., 2018:2-8). Neither of the two studies clearly indicated the impairments that limited participation in vocational activities.

The last functional challenge is the participation in sports or recreational activities after TPF. When possible, returning to physical activity after orthopaedic trauma has been found to improve the patient's physical and emotional health (Kugelman et al., 2017:2). A case series of 89 participants/patients reported that pre-injury, 88.8% of the patients were participating in sporting activities and only 62.9% of patients returned to sporting activity after one year. Most of the patients that returned to sporting activities shifted from high-impact sports to low-impact sports after injury, or reduced sports frequency and the activity duration per week. The limiting impairment was chronic knee pain and in order to participate in sporting activities, participants depended on the use of occasional (12.4%) and regular (4.5%) pain medication. Some factors

were identified that predict return to recreational athletics after operatively managed TPF. These include personal factors (white race, social alcohol use or younger age), increased knee ROM, low-energy Schatzker fractures (I-III) and absence of post-operative complications (Kraus, Martetschlager, Muller, Braun, Ahrens, Siebenlist et al., 2012:2847-51). A case-control study (n=169) reported that after TPF surgical intervention at six months, 31.6% patients returned to recreational activities and 52.4% at 15 months. In their final follow-up consultation, 70% of patients with TPF returned to sport and only 60% were able to return to their pre-injury level of sporting activity. Early return to sports was influenced by personal factors such as race, social alcohol consumption, increased ROM, post-operative complications, high level Schatzker classification (IV-VI) and polytrauma (Kugelman et al., 2017:2). Only two out of 11 professional or competitive athletes returned to compete at two years follow-up (Kugelman et al., 2017:2) Similar to the previous above mentioned study, one year after TPF, 68.4% of patients were able to participate in recreational activities after surgical intervention and 100% returned to sport after conservative management of TPF (Robertson, Wong and Wood, 2017:584; Quintens et al., 2021:203). Complex fracture type (Type V- VI) was associated with poor return to recreational/sporting participation (Kraus et al., 2012:2847-51; Kugelman et al., 2017:2). Patients who underwent an ORIF, had a 50% chance of returning to participation in recreational athletics by one year after the injury (Kugelman et al., 2017:2). Among other factors, fracture type and chronic pain are factors restricting recreational/sporting participation. Patients should be informed about the likelihood of a poor functional outcome in the long term and the possibility of not participating fully in recreational or professional sporting activities.

2.1.4 CONTEXTUAL FACTORS INFLUENCING FUNCTIONAL OUTCOME AFTER TIBIAL PLATEAU FRACTURE (TPF)

Contextual Factors that influence ADL limitation, return to vocational activities and recreational/sporting participation includes environmental and personal factors. Environmental factors are barriers or a facilitators for an individual's functioning and make up the physical, social and attitudinal environment in which people live and conduct their lives (Karhula, Saukkonen, Xiong, Kinnunen, Heiskanen and Anttila, 2021:2). Environmental factors affecting the functional outcome after TPF in the literature were limited to occupation (Kraus et al., 2018:2-8; Hap et al., 2020:14). More environmental factors that might influence functional outcome after TPF should be investigated such as home environment, social/family support, access to health care facility including follow up physiotherapy rehabilitation, transportation, or assistive equipment's. Personal factors are defined as a particular background information

about the life and lifestyle of an individual health condition or health states (Karhula et al., 2021:2). Very little is known about personal factors contributing to functional outcome after TPF. In literature it was mentioned that age, white race, increased body mass index and social alcohol consumption influence knee ROM and recreational/ sporting activities participation (Kraus et al., 2012:2847-51; Kugelman et al., 2017:2). The influence on TPF functional outcome of personal factors such as motivation to participate in rehabilitation including adherence to HEP, socioeconomic status or pre-injury physical activities is not known. Literature investigating personal and environment factors that influence functional outcome after TPF are limited and the influence of more contextual factors should be investigated.

2.1.5 MEASURES TO DETERMINE FUNCTIONAL OUTCOME AFTER TPF

Self-report measures in the form of a questionnaire are used to determine the function outcome after TPF. These questionnaires are known as patient-reported outcomes. Patient-reported outcomes, however, may be more reliable, effective, practical and easier to administer, compared to others. For this study, Knee injury and Osteoarthritis Outcome Score (KOOS) was selected. The reason that some of the commonly used outcome measures to assess function after knee injuries were not selected for the current study is outlined in Table 2.2.

Table 2.2: Commonly used outcome measures to assess knee function

Measures to determine functional outcome after TPF.	**Intended use**
Lysholm Knee Scoring Scale (LKS)	The LKS has eight sections that mainly assess instability of the knee (Ahmed, Said, Ramadan, Abd El-Radi and El-Assal, 2019:2). This scale does not measure functional outcome.
Oxford Knee Score (OSK)	The OKS consists of 12 questions on ADL and the effect of pain, specifically after a total knee replacement (Ahmed et al., 2019:2). The concept of QOL after TPF is not included this outcome measure.
International Knee Documentation Committee Subjective Knee Evaluation Form (IKDC)	The IKDC was designed for knee disorders and focuses on three categories: symptoms, sports activity and knee function (Ahmed et al., 2019:2). This outcome measure is very similar to the KOOS-12 questionnaire but takes 10 minutes to complete and does not include QOL.
Western Ontario, and McMaster Universities Osteoarthritis Index	The WOMAC has three sections: pain, stiffness and physical function. It is widely used in the evaluation of hip and knee osteoarthritis (Marot, Murgier, Carrozzo, Reina, Monaco, Chiron et al., 2019:777-80). WOMAC is one of the

(WOMAC),	most used to evaluate TPF and has three sub-scales: pain, stiffness and physical function. WOMAC is similar to KOOS-12 in pain and functional sub-scale, but it takes longer to complete (12 minutes) and even with two questions on stiffness, does not cover the QOL domain.
Tegner Activity Score (TAS)	The TAS was developed for knee injury and measures activity in three sections: ADL, recreation and competitive sporting activities (Flosadottir, Roos and Ageberg, 2017:1). TAS accommodates mostly sports/recreation activity participation evaluation, whereas the current study evaluated factors that influence functional outcome including activity limitation (ADL), participation restriction and QOL after TPF.
Activity Rating Scale (ARS)	The ARS was designed for patients with a knee injury and measures the frequency of participation in different sport-specific tasks/activities (Flosadottir et al., 2017:1). The ARS is similar to TAS, but focuses on sports rather than ADL and QOL assessment, which is crucial after TPF.
Short Form 12 (SF-12)	The Short Form 12 (SF-12) consists of 12 items that assess eight dimensions of health: physical functioning, role-physical, bodily pain, general health, vitality, social functioning, role-emotional and mental health (Kalmet et al., 2019:484). The SF-12 is known for mental health (QOL) evaluation. It also includes a few physical and pain assessment questions but not enough to evaluate impairments that may limit ADL or restrict participation after TPF.

KOOS-12 is the 12 item short form derived from the full-length KOOS (42 items) (Marot et al., 2019:779). KOOS-12 substantially reduces respondent burden (by 70%) from the original KOOS and for this reason, it was found easy to use in the clinical setting or for research purposes (Collins, Prinsen, Christensen, Bartels, Terwee and Roos, 2016:1317-29; Gandek, Roos, Franklin and Ware, 2019:1-7). “KOOS-12 is intended to elicit people’s opinions about the difficulties they experience due to problems with their knee and covers aspects of pain, functional limitations, and knee-related quality of life” (Marot et al., 2019:779). As with the full-length KOOS questionnaire, KOOS-12 can be used in the context of many knee disorders, including trauma, soft tissue injuries or osteoarthritis (OA) (Collins et al., 2016:1317-29). KOOS-12 has three patient-relevant sub-scales and each consists of four items, namely, KOOS-12 pain (four items on the aspect of pain), KOOS-12 ADL (four items on functional limitations and Sport/Recreation) and KOOS-12 QOL (four items on knee-related quality of life). Each sub-scale is scored separately (Annexure I). (Gandek et al., 2019:1-7). However, the KOOS-12 Summary score can be calculated as the average of the three sub-scales (KOOS-12 pain, KOOS-12 ADL and KOOS-12 QOL) and provides an aggregate measure of knee impact

(Gandek et al., 2019:1-7). The KOOS-12 was chosen for this study because with the three sub-scales (KOOS-12 pain, KOOS-12 ADL and KOOS-12 QOL) that can be scored separately, KOOS-12 provides multiple comparisons and interpretation of multiple outcomes after knee injury (Tibial plateau fracture) (Gandek et al., 2019:1-7). The KOOS-12 is a patient-administered questionnaire and takes two minutes or less to complete (Gandek et al., 2019:1-7).

The KOOS-12 score internal consistency reliability ranged from 0.75-0.82 (KOOS-12 Pain), 0.78-0.82 (KOOS-12 Function), 0.80-0.84 (KOOS-12 QOL) and 0.90-0.93 (KOOS-12 Summary). The KOOS-12 was reliable and as good to use as the original KOOS score in knee conditions and injuries and the most preferred to assess functional outcome after TPF (Collins, Misra, Felson, Crossley and Roos, 2011:1-30; Collins et al., 2016; Gandek et al., 2019:1-7). In general, a test-retest correlation of +0.80 or greater is considered to indicate good reliability. Reliability indicates a trustworthiness of an outcome measure, whereas validity indicates how good an outcome measure is for a particular condition (Collins et al., 2011:1-30; Collins et al., 2016; Gandek et al., 2019:1-7). These are more reason KOOS-12 was chosen to assess functional outcome/knee function after TPF.

2.2 SUMMARY

In conclusion, TPF are complex articular injuries which may result in complications that can greatly impact functional outcomes, limiting ability to execute ADL, return to vocational activities or restricting participating in recreational activities (Hap et al., 2020:13-4), therefore, increase the socio-economic burden and affect QOL of patients many years after TPF (Kabst et al., 2022:5). Many outcome measures were designed for knee condition/injury and the aspects most often included are functional outcome assessments, quality of life score and level of mobility assessment. Likewise, TPF functional outcome and quality of life after surgical intervention is often researched. However, the factors that influence those outcomes are seldom investigated.

It is evident from the literature review, that there are known factors that influence functional outcome after TPF; such factors include fracture type, surgical intervention and impairments (infections, knee ROM, knee instability, OA and abnormal gait). However, these factors are not known in the context of South Africa. Furthermore, various factors were poorly or not investigated and their influence on functional outcome is not clear or known. These factors include personal factors (pre-injury activity level), environmental factors (home and work environment, family support), conservative intervention, multidisciplinary intervention and

impairments (lack of muscle strength, immobilisation after surgical intervention, gait training) and associated injury to structures surrounding the knee (ligaments, meniscus or articular cartilages). Unfortunately, physiotherapy rehabilitation was among the poorly investigated factors. There is limited literature on physiotherapy rehabilitation after TPF and controversy exists in the available literature with regard to the most effective rehabilitation program to prevent complications and optimise knee function (Iliopoulos et al., 2020a:1-4). Long-term (more than three years) evaluation of patients after TPF revealed that prolonged recovery to regain pre-injured knee function should be expected and addressed during rehabilitation (Elsoe et al., 2017:1659; Iliopoulos et al., 2020b:277; Elsoe et al., 2021:285). Based on the identified gaps, more research on the factors related to the functional outcome after TPF is crucial and may be most beneficial to healthcare providers in order to improve TPF management and patient education.

3 CHAPTER 3: METHODOLOGY

3.1 INTRODUCTION

In this chapter, the methodological approach for this study is discussed. The study design, procedures, study setting and ethical considerations are also reported on.

3.2 STUDY DESIGN

A quantitative, analytical cross-sectional study design was used. Observational research was performed and data of variables was collected across a sample population at one given point. In the current study, data was collected from participants' previous medical records and an interview was conducted. Collecting data from the files or the interview did not influence/interfere with the participants' functional level at the point of data collection.

3.3 STUDY SETTING

The study took place in three public hospitals in the Gauteng province, South Africa.

- **Hospital A** is provincial tertiary hospital situated in Atteridgeville, Pretoria. The hospital has a total of 1113 beds which include 80 beds in the orthopaedic ward where patients with TPF are admitted. The hospital is affiliated with the University of Pretoria for the training of the Faculty of Health Sciences students.
- **Hospital B** is situated in the Pretoria CBD. The hospital is a tertiary health care institution, rendering specialized services to medically referred patients. The hospital has a total of 832 beds which include 76 beds in the orthopaedic wards where patients with TPF are admitted. The hospital is affiliated with the University of Pretoria and Sefako Makgatho Health Sciences University for the training of Faculty of Health Sciences students.
- **Hospital C** is provincial tertiary hospital situated in Ga-Rankuwa, north of Pretoria. The hospital has a total of 1652 beds which include 76 beds in the orthopaedic ward where patients with TPF are admitted. The hospital is affiliated with the Sefako Makgatho Health Sciences University for training of Faculty of Health Sciences students.

3.4 STUDY POPULATION AND SAMPLING

3.4.1 STUDY POPULATION

The population consisted of patients admitted at hospitals A, B and C with TPF between 2015 and 2019. Files of patients admitted during this period (2015-2019) were used to obtain contact information of patients.

3.4.2 INCLUSION CRITERIA

- Patients with TPF who were admitted to hospitals A, B, and C between 2015 and 2019.
- Patients who have contact details available in the patient file that is still in use.
- Patients aged 18-60 years.
- Patients who can read and understand English. The KOOS-12 is a self-administered tool, not yet translated into any other official South African languages.
- Patients who have pre-intervention radiographs.

3.4.3 EXCLUSION CRITERIA

- Patients diagnosed with pathological fractures (Lv et al., 2020:562).
- Patients diagnosed with neurological conditions (Prabhakar, Kumar and Azhagan, 2018:562).
- Polytrauma (Prabhakar et al., 2018:562).

3.4.4 SAMPLING METHOD

A non-probability consecutive sampling method was used; where by Medical files of patients who suffered TPF were selected if they met inclusion criteria. The use of this sampling method ensured that participants who met the inclusion criteria were included in the initial sampling frame, as part of a two stage sampling process.

3.4.5 SAMPLE SIZE

With the assistance of a biostatistician, a sample size calculation was done in relation to the objectives. A target sample size was 85 participants. This sample size would have at least 90% power to detect a statistically relevant deference when testing two-sided at the level of significant. The target sample size was reached and surpassed by one participant.

Participants were recruited in two stages to arrive at the sample size.

Stage one of participant's recruitment

Stage one of recruitment began with obtaining permission from the chief executive officers (CEO's) of all three hospitals to access medical records. This was done as part of the ethical procedure as well. Letters requesting approval from the chief executive officers was submitted to hospital A and hospital B (Annexure A). Hospital A issued conditional approval, followed by final approval after ethical clearance by the University of Pretoria Ethics Committee (Reference number: 380/2019). Hospital B issued approval after ethical clearance by the University of Pretoria Ethics Committee was obtained. Hospital C was added much later, after the required sample size could not be obtained in the first two settings (Annexure B).

After permission was received from the CEO, the researcher contacted orthopaedics units from each hospital and scheduled appointments with the unit managers telephonically. On the day of the meetings with the units' managers of the different hospitals, the researcher presented permission letters from the CEO and asked permission to access admission books. Each unit had admission books that have patient names, condition, file number, contact details, date of admission and date of discharge/demised/transfer. The researcher requested admission books from 2015 to 2019 from all three units. From each hospital, patients diagnosed with a TPF were identified and the list was compiled.

The researcher telephonically scheduled a meeting with the managers of each hospital's record department. On the appointed days, the researcher visited different record departments, presented the CEO permission letter and the list of patients compiled from admission books. Arrangements were made to access medical records using file numbers obtained from the admission books. In each hospital, files were arranged according to the patient list and a note was made next to the file number of deceased patients. From the medical records, the data for demographic and injury data collection sheet was completed and the information missing from the medical records was obtained during the interview. The contact details of patients were included in the patients list and those whose contact details were missing, were excluded from the study.

In each hospital, orthopaedic clinics were visited by the researcher to compare the patient list from the admission books with the documented list of patients who visited the clinic, either before or after management of TPF. This was also done in an attempt to find participants contact details missing from the admission books or hospital files. Furthermore, the physiotherapy departments of hospitals A, B and C were visited and follow-up appointment

dairies were checked for patients whose contact details were initially not in the medical records, or have changed after hospitalisation.

In the demographic and injury data collection sheet a question about fracture type was included. For this reason, researcher scheduled an appointment with managers of the radiography department of each hospital. On the day of the meeting, the researcher presented the CEO's permission letter and asked for permission to access the radiograph imaging. All patients who presented with a TPF in hospital C were classified by the radiologists with Schatzher classification of TPF and the fracture type was recorded in the patient's medical records. There were five patients in hospital C who did not have a TPF classification recorded on the medical records. On the day of the meeting with the manager of the radiograph department in hospital C, it was arranged with one of the radiologists to access the online imaging records and get access to the TPF classifications that were on the system. Hospitals A and B did not normally classify TPF with the Schatzher classification. However, there were a few patients that radiologists had classified with Schatzher classification in the MRI results. A professor who is responsible for the radiography departments of both hospitals A and B, allocated a radiologist from each hospital to assist with the classification of TPF according to the Schatzher classification system. The radiologists received the list of patients, full names and file numbers and on that list, and then added the classified fracture type. The patients' list was emailed to the researcher and the information was recorded on the data collection sheet summary by the researcher (Annexure J).

In each setting, patients were excluded for a few reasons, represented in Table 3.1. Some of the patients' contact details were no longer in use after hospitalisation and a couple of patients did not have contact details on their medical records. Some of patients refused to participate in the study and they did not provide reasons for non-participation. The radiographs of some patients could not be located, therefore, those patients were excluded from the study.

Table 3.1: The total number of patients with tibial plateau fractures from all settings

Total number of TPF	**Setting A (n=160)**	**Setting B (n=106)**	**Setting C (n=121)**
Over the age limit	2	1	2
Correctional facility	3	0	0

Articulate in English	1	1	0
Deceased	1	0	0
Traumatic brain injury	0	0	1
Polytrauma	12	6	7
Missing radiographs	22	3	0
Contact details no longer in use	49	46	44
No contact details	23	21	38
Refused consent	8	6	4
Study participants	39	22	25

Stage two of participants' recruitment

In stage two of participant recruitment, the researcher contacted all patients from the different settings who met the inclusion criteria, telephonically. The researcher read out and explained the informed consent (Annexure K). Participants who consented to participate in the study were asked to choose a convenient time to be contacted telephonically by the researcher and the research assistant, in order to complete the demographic and injury data collection sheet (Annexure I) for information that was not available in medical records. However, all participants were willing to answer a few questions immediately after consenting to the study. One participant was excluded because they could not understand a word of English. The researchers explained to them in their home language why they could not be part of the study and how much their interest in participating in the current study was appreciated.

The second scheduled phone call was done by a non-physiotherapist research assistant to conduct the KOOS-12 questionnaire. The research assistant was trained to give participants the same instruction regarding the completion of the KOOS-12 questionnaire and record the information accurately, as instructed by the developer of the tool. The research assistant installed automatic call recorder on the phone, audiotaped the interviews while conducting the KOOS-12 questionnaire and saved the interviews on a memory stick. The assistant was also trained and educated on patient confidentiality and at the end of interview, after the information was saved on the memory stick, each participant received a reference number according to the

hospital (e.g. B1 or A3). After the information was entered into the electronic data collection sheet summary (Annexure J) and saved on the memory stick, the interview was deleted from the phone. The memory stick was handed over to the researcher at the end of the interviews.

The researcher listened to each audiotaped interview and checked whether the information provided by the research assistance was accurate and consistent. The information on the audiotape and the electronic data collection sheet summary was equivalent for all participants. The researcher transcribed the data collected into a spread sheet, after which 86 participants became part of the main study. Cross-checking of the data was done by the researcher after it had been transferred to a Microsoft Excel spreadsheet.

3.5 DATA COLLECTION

3.5.1 RESEARCH TEAM

The research team consisted of two members, namely the primary researcher who is a qualified physiotherapist, and a research assistant. The research assistant, with no knowledge on physiotherapy, was chosen to improve the study quality by avoiding bias when conducting the KOOS-12 questionnaire.

3.5.2 QUALITY CONTROL

A valid and reliable instrument was used for data collection as indicated in the data collection and organisation sections. Bias was avoided by using a non-physiotherapist research assistant to conduct the KOOS-12 questionnaire, which was done telephonically and recorded, and to avoid emphasis on certain terms that might be of importance to the physiotherapist. Each audiotaped interview was transcribed by the research assistant. The primary researcher listened to all audiotaped interviews to check whether the information provided by the research assistance was accurate.

The research assistant was trained by the researcher for two hours on how to conduct the KOOS-12 questionnaire, record all the data collected and how to audiotape the interview with the participants. The research assistant was also trained and educated on patient confidentiality and how to handle emotional reaction elicited by the interview. The research assistant was to immediately stop the interview and politely ask whether they wish to be referred to the nearest clinic or hospital for counselling. Should the patient wish to do so, the assistant had to provide the contact details of their hospital/clinic counsellor and give them an opportunity to continue with an interview another time.

3.5.3 DATA COLLECTION INSTRUMENTS

Data was collected with a two-part questionnaire (Annexure I).

The first questionnaire was a demographic and injury data collection sheet which consisted of 13 questions including three on personal factors (age, gender and pre-injury activity); two on environmental factors (occupation, support), fracture type, impairments (pre/post intervention complications), medical intervention (surgical and conservative), physiotherapy rehabilitation, home exercise program (HEP), and other medical disciplines. The face validity for the demographic and injury data collection sheet was done at setting A. Three physiotherapists, including the chief physiotherapist, were asked whether the above questions covered all aspects of tibial plateau fracture in relation to functional outcome. They agreed with the tool and suggested inclusion of the affected limb, year of injury and mechanism of injury which was included in the data collection summary (Annexure J).

The second questionnaire was the KOOS-12 questionnaire (Collins et al., 2016:1317-29; Gandek et al., 2019:1-7). The KOOS-12 questionnaire was designed to assess short and long-term patient relevant outcomes following a knee injury. The KOOS-12 is a patient-conducted questionnaire and takes two minutes or less to complete (Gandek et al., 2019:1-7). KOOS-12 has three patient-relevant sub-scales, namely, KOOS-12 pain, KOOS-12 ADL and KOOS-12 QOL (Annexure I) (Gandek et al., 2019:1-7). Each sub-scale consists of four items measuring specific knee outcomes, these include pain experienced with progressively difficult ADL (KOOS-12 pain), functional limitations (KOOS-12 ADL), and knee-related quality of life (KOOS-12 QOL) (Gandek et al., 2019:1-7). Each sub-scale is scored separately enabling interpretation of multiple knee outcomes (pain, function or QOL). However, the KOOS-12 Summary score can be calculated as the average of the three sub-scales and provides an aggregate measure of knee impact (Gandek et al., 2019:1-7). The KOOS-12 questionnaire uses a Likert scale, and all four items in each sub-scale have potential answer options from 0 (No problems) to 4 (Extreme problems). Scores are transformed to a 0–100 scale, with zero representing extreme knee problems and 100 representing no knee problems (Collins et al., 2016:1317-29; Gandek et al., 2019:1-7). The KOOS-12 questionnaire was found reliable [0.75-0.82 (KOOS-12 Pain), 0.78-0.82 (KOOS-12 Function), 0.80-0.84 (KOOS-12 QOL) and 0.90-0.93 (KOOS-12 Summary)], valid (0.73-0.86) responsive, reproducible and good to use in knee conditions and injuries including tibial plateau fracture (Collins et al., 2016:1317-29; Gandek et al., 2019:1-7)

3.5.4 PILOT STUDY

A pilot study was done in hospital A from 22/10/19-23/10/19. There were 54 patients confirmed to have sustained TPF. For a pilot study 10% of the sample size is needed (Bell, Whitehead and Julious, 2018:153-6), therefore, the first nine participants to consent to the study were included in the pilot study. The aim of the pilot study was to highlight challenges to be managed before or during data collection. The main researcher and research assistant each assumed the same role as they would have in the main study, which required 85 participants. The data collected in the pilot study was not included in the main study. The participants were informed that they were part of the pilot study. The inclusion and exclusion criteria were the same as for the main study.

The following challenges were encountered during the pilot study:

- When the demographic and injury data collection sheet (Annexure I) was completed, participants found it difficult understand the variables low, moderate, or high activity level. To assist participants to understand activity level we decided to explain it as housebound (low), shopping (moderate) or outside activity (high). The question was changed to identifying the pre-injury level and whether the participants were able to return to the same activity level. Participants who indicated challenges with returning to the pre-injury activity level were asked to specify the activity or outside/sporting activity they were involved in.
- Initially, employment at the time of injury was established as “Yes” (employed) or “No” (unemployed). After the pilot study, participants were also asked whether they were able to resume the same work after TPF. This information was added in the demographic and injury data collection sheet (Annexure I). Participants were asked the kind of employment they were involved in before their injury, if they were unable to return to their previous employment.

3.5.5 TWO STAGES OF DATA COLLECTION

Data was collected in two stages: 1) collecting information for demographic and injury data collection sheet and knee injury, and 2) conducting the KOOS-12 questionnaire. To preserve the confidentiality of the participants, each participant was given a number attached with the alphabet given to the hospital (e.g. A6 or B4). That was how each patient appeared on the

demographic and injury data collection sheet and knee injury, data collection summary sheet and osteoarthritis outcome score (KOOS-12) spreadsheet.

Demographic and injury data collection sheet

The first stage of data collection was a demographic and injury data collection sheet designed to capture information on the patient's personal and injury characteristics. The sheet consisted of the following 13 questions as discussed in 3.5.3.

The gender, age at the time of injury and surgical/conservative intervention was recorded in the hospital file. Pre- or post-intervention complications such as post-surgical infections, amputation, or deep venous thrombosis were indicated in the hospital file. However, none of the participants in the current study experienced any pre- or post-intervention complications. The Schatzker classification system of TPF was used for the current study to diagnose fracture type. The process was discussed in paragraph 3.4.5 above.

A physiotherapy referral letter (blue card) was kept in the hospital files and for some participants the referring doctor noted in the file whether the patient was referred for physiotherapy treatments. Some patients' files did not indicate physiotherapy rehabilitation referral. The physiotherapy rehabilitation notes in the file indicated when, after the medical intervention the patient was seen, for how long, what kind of exercise or technics was done and what home exercise program/advice was given. Few patients had a discharge summary in the hospital file and most of them absconded physiotherapy rehabilitation. There were also some patients that were referred for physiotherapy rehabilitation sessions, but did not attend.

The information about the involvement of other disciples such as occupational therapist or psychologists, was available in the hospital file as well. The occupational therapist's note in the hospital files were noticed in cases of polytrauma where either the upper limbs were involved, or use of a wheelchair was indicated. However, none of the participants in the current study were attended to by other disciplines besides doctors, nursing staff, physiotherapists, radiologists and dieticians.

The information about occupation at the time of injury was available on the admission page in the hospital file. During the telephonic interview the researcher confirmed the information and established whether the participants were able to return to the same occupation after TPF. Participants who were unable to return to the previous vocational activity were asked to specify the kind of employment.

Pre-injury activity level was grouped in three categories and further defined to assist participants to understand activity level: housebound (low), shopping (moderate) or outside activity (high). Participants were asked about the activity level at the time of injury and whether they were able to return to the same activity level after TPF. Participants who indicated challenges with returning to pre-injury activities were asked to indicate which activity was limited and specify the outside activity/sporting activity they were involved in.

From the hospital files, it was difficult to establish social support, even though there was next of kin information on the admission page, or a physiotherapist's note indicating that the patient arrived with either a caregiver, parent/s, spouse or children. Therefore, participants were asked whether they had support from someone during the recovery period.

KOOS-12 questionnaire conduction

The second part of data collection involved the non-physiotherapist research assistant. Participants were asked to choose a convenient time to be contacted for conducting the KOOS-12 questionnaire (Annexure I). The research assistant telephonically contacted each participant that consented to the study and after the formal greetings, read out the KOOS-12 questionnaire instructions and questions on the tool, while recording the answers in the electronic KOOS-12 questionnaire. Each data collection sheet and audiotaped interview was saved on a memory stick according to the allocated numbering. The memory stick was handed over to the researcher at the end of the interviews.

The researcher listened to each audiotaped interview, checked whether the information provided by the research assistance was accurate and equivalent to the audiotape. KOOS-12 questionnaire has a free Microsoft Excel program that calculates the mean score for each sub-scale. The researcher downloaded the Microsoft Excel program and transcribed the participant's information from the KOOS-12 questionnaire into the Microsoft Excel program. The mean score for each KOOS-12 questionnaire sub-scale was calculated and the KOOS-12 Summary score was calculated from the average of the three sub-scales. Cross-checking of the data was done by the researcher after it had been transferred to a Microsoft Excel spreadsheet. An electronic copy of the spreadsheet and data collection sheet summary (Annexure J) was submitted to the statistician for processing.

3.6 ETHICAL CONSIDERATIONS

The research protocol was submitted for approval to the Faculty of Health Sciences Research Ethics Committee of the University of Pretoria (contact details: 012 356 3084/012 356 3085). The annual approval was granted on 19/01/2022.

No remuneration was offered for participation. All participants were informed that participation is voluntary. Consent forms (Annexure K) were presented to the prospective participants telephonically to provide them with further information on requirements, and the purpose of the study. Participants were informed that the telephonic interview with the non-physiotherapist assistance will be audiotaped. Calls were only made at a convenient time stated by a participant. The participants were informed that the total call time for the interview was two minutes. If the call elicited any emotional reaction as a result of possible trauma the participant experienced, the participant was provided with the contact details of their hospital counsellor. The participant was then given an opportunity to continue with an interview at another time. If, for any reason, the participant was excluded from the study, the researcher explained with clarity why this was the case.

The research team ensured that participants were treated fairly and that no discrimination, abuse or harassment of any kind took place during the entire research process. Each participant was allocated a number to keep their identity anonymous and the same number appeared on all data capturing sheets (demographic and injury data collection sheet and KOOS-12 questionnaire; Annexure I). All information obtained was treated as confidential and safely stored to guarantee confidentiality. The research report contains no personal information of any of the participants and the results will be made available to the participants on request. Data will be stored for 15 years at the University of Pretoria, Department of Physiotherapy.

3.7 DATA MANAGEMENT AND ANALYSIS

The data summary reports the mean, standard deviation, confidence interval (CI) and means difference. All testing was done at the 0.005 level of significance. The data summary for continuous data, pain, function (Activities of Daily Living and Sport/Recreation) and quality of life (QOL) were firstly analysed in a univariate analysis. The univariate analysis determined the relationship of single factors such as age, surgical intervention, to the functional outcomes (all three KOOS-12 sub-scale mean score). Demographic and clinical factors were measured on the binary/ordinal scale and data

summary reported frequency, percentage and cross tabulation. The relationships between functional outcome scores (KOOS-12 Pain, KOOS-12 Function, KOOS-12 QOL and overall score) and observed factors (demographical and injury data) were analysed using multivariable linear regression. Bonferroni corrections for multiple comparisons were used, and specific relationships were derived from the coefficients of the multiple regressions.

3.8 SUMMARY

Chapter 3 described the research methodology and study designed used in the study. A total of 86 participants were included in the study, with informed consent obtained telephonically from all 86 participants.

4 CHAPTER 4: RESULTS

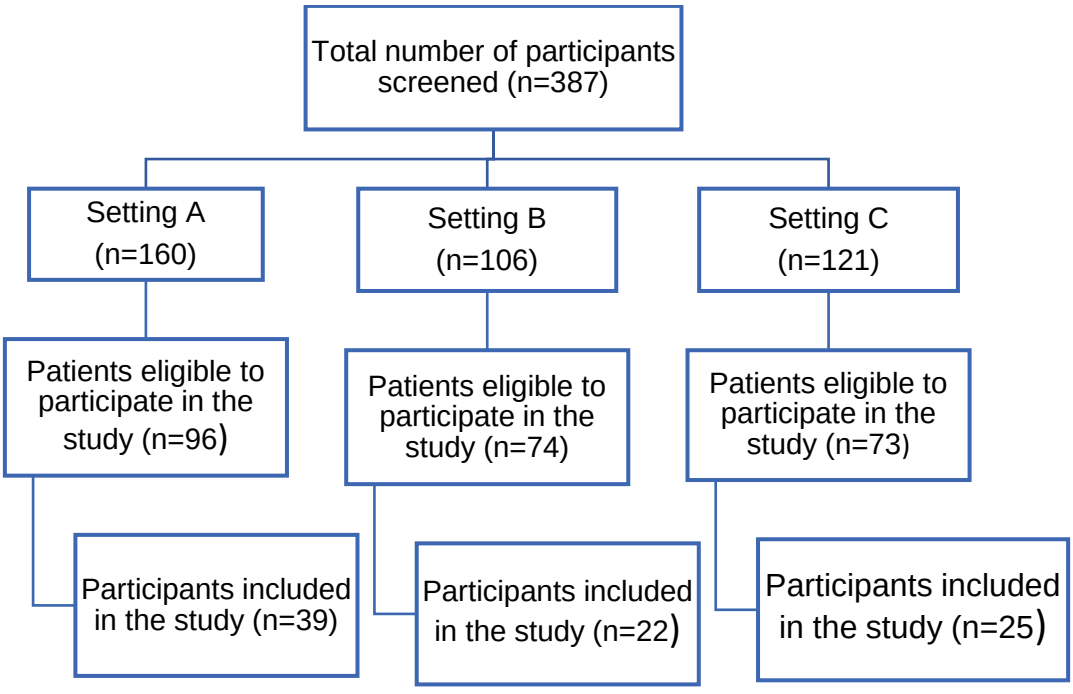
4.1 INTRODUCTION

In this chapter, the study results are presented by means of tables and graphs. The aim of the study was to determine the contextual factors related with the functional outcome of patients who sustained TPF. To identify the factors that are related to functional outcome after TPF, the multiple regression analysis was used to determine relationship between functional outcome as measured by KOOS-12 score, and the selected variables investigated.

The results of the study are presented in the following order: univariate analysis, and multivariate analysis of factors related to the functional outcome after TPF.

The sample size at the end of data collection was 86. The total number of patients and participants (n) involved during the various stages of the participant recruitment process, is presented by Flow chart 4.1.

Flow chart 4.1: Flow chart representing the participant recruitment process and number of participants included.



The study consisted of 58 males and 28 females. At the time of injury few participants were unemployed (36%) while the majority were employed (64%). Most participants (92%) had social support during the recovery period and only a few (8%) did not have social support.

The most prevalent mechanism of injury among the participants was falls from unspecified height (53%), followed by MVA (43%) and assaults (4.0%). The left lower limb was more affected (70%) than the right one (30%).

Tibial plateau fractures were classified by Schatzker classification and included Type I (10.5%), Type II (37.2%), Type III (8.1%), Type IV (16.3%), Type V (14.0%) and Type VI (12.8%) (Table 4.2, 4.3 and 4.4).

4.2 UNIVARIATE ANALYSIS

The univariate analysis determined the relationship of single investigated variables such as age, surgical intervention, to the functional outcomes (all three KOOS-12 sub-scale mean score). Each sub-scale of KOOS-12 score assesses functional outcome individually. Therefore, each factor was analysed against three KOOS-12 sub-scales: KOOS-12 Pain, KOOS-12 Function (Activities of Daily Living and Sport/Recreation) and KOOS-12 Quality of life (QOL).

Fracture types were reported in different groups (high energy injury and low energy injury). Age groups were reported on in two categories: young age group (20-39 years) and older age group (40-60 years).

The KOOS-12 Summary knee impact score was calculated as the average of the KOOS-12 Pain, KOOS-12 Function and KOOS-12 QOL scale scores. The KOOS-12 Summary score provides an aggregate measure of knee impact. The KOOS-12 sub-scales (Pain, ADL and QOL) mean and the KOOS-12 Summary knee impact score for each variable investigated, is presented in Table 4.1

Table 4.1: The KOOS-12 Summary knee impact score for each investigated variable.

Variable investigated	Category (n)	Mean Pain	Mean ADL	Mean QOL	KOOS-12 Summary
Gender	Male (58)	54.41	56.88	34.76	48.68
	Female (28)	65.29	63.07	50.46	59.61
Age	20-39 years (55)	61.60	65.33	42.90	56.61
	40-60 years (31)	51.48	47.44	34.48	44.47
Occupation	Unemployed (31)	57.00	58.77	40.74	52.17
	Employed (55)	58.49	58.96	39.38	52.64
Social support	No (7)	46.57	51.86	32.29	43.69
	Yes (79)	58.96	59.52	40.54	53.00
Pre-injury activity level	Low (12)	57.33	53.75	36.58	49.22
	Moderate (30)	63.13	65.27	47.07	58.49
	High (44)	54.59	55.96	35.86	48.80
Fracture type	Low energy injury (49)	60.71	61.31	41.90	54.64
	High energy injury (37)	54.30	55.70	37.19	49.03
Surgical intervention	No (19)	65.85	69.80	50.05	61.90
	Yes (67)	55.56	55.59	36.78	49.31
Conservative intervention	No (67)	55.76	55.97	37.08	49.60
	Yes (19)	65.68	69.21	49.74	61.54
Physiotherapy	No (26)	62.81	63.35	39.46	54.01
	Yes (60)	55.85	56.97	40.05	50.96
*HEP/advice	No (35)	62.06	61.89	38.09	54.01
	Yes (51)	56.84	56.84	41.10	51.59

*HEP = Home exercise program. All measures scored indicated 0 = worst possible and 100 = best possible score.

Table 4.1 illustrates that the variable “Conservative intervention: Yes" has the highest KOOS-12 Summary knee impact score. The variable “Social support: No” has the lowest KOOS-12 Summary knee impact score. KOOS-12 QOL sub-scale has the lowest mean score for all variables.

In Table 4.2, all investigated variables were analysed against the KOOS-12 Pain. In this sub-scale, the aspect of pain is assessed with increasingly difficulty activities.

Table 4.2: Linear relationships between the aspect of pain described in the KOOS-12 pain sub-scale of the KOOS-12 questionnaire and variables under investigation in this study

Variables investigated	Category (n)	Mean (SD)	95% CI	Mean difference	p-value
Gender	Male (58)	54.41 (25.87)	(47.61 ; 61.21)	10.87	0.0611
	Female (28)	65.29 (22.70)	(56.49 ; 74.09)		
Age	20-39 years (55)	61.60 (23.98)	(55.11 ; 68.08)	10.11	**0.0439**
	40-60 years (31)	51.48 (26.58)	(41.73 ; 61.23)		
Occupation	Unemployed (31)	57.00 (24.92)	(47.86 ; 66.14)	1.49	0.7945
	Employed (55)	58.49 (25.67)	(51.55 ; 65.43)		
Social support	No (7)	46.57 (36.92)	(12.43 ; 80.72)	12.39	0.2157
	Yes (79)	58.96 (24.05)	(53.58 ; 64.35)		
Pre-injury activity level	Low (12)	57.33 (18.94)	(48.96 ; 67.13)	7.48	0.3636
	Moderate (30)	63.13 (27.90)	(54.35 ; 75.48)		
	High (44)	54.59 (24.80)	(46.58 ; 62.58)		
Fracture type	Low energy injury (49)	60.71 (24.49)	(53.68 ; 67.75)	6.41	0.2459
	High energy injury (37)	54.30 (26.14)	(45.58 ; 63.01)		
Surgical intervention	No (19)	65.85 (24.85)	(54.23 ; 77.48)	10.29	0.1111
	Yes (67)	55.56 (25.09)	(49.39 ; 61.73)		
Conservative intervention	No (67)	55.76 (24.95)	(49.68 ; 61.85)	10.00	0.1316
	Yes (19)	65.68 (25.53)	(53.38 ; 77.99)		
Physiotherapy	No (26)	62.81 (27.70)	(51.62 ; 73.99)	6.96	0.2432
	Yes (60)	55.85 (24.08)	(49.63 ; 62.07)		
*HEP/advice	No (35)	62.06 (25.74)	(53.21 ; 70.90)	6.92	0.2141
	Yes (51)	56.84 (30.36)	(48.16 ; 62.11)		

*: Statistically significant ($p<0.05$). HEP = home exercise programme. Mean (SD) scores in the KOOS-12 Pain sub-scale and 95% CI by various factors.

There was a statistically significant difference ($p=0.0439$) between the participants in the younger age group (20 to 39 years) compared to the older age group (40 to 60 years) in the KOOS-12 Pain sub-scale. A mean difference of 10.11 points in the KOOS-12 Pain sub-scale

was recorded in Table 4.2. This finding demonstrates that the younger age group participants experienced less pain with activities after TPF, than the older age group participants.

The KOOS-12 Function sub-scale score is presented in Table 4.3. The focus in this sub-scale is functional outcome in activities of daily living and sport/recreation activities.

Table 4.3: Linear relationships between the functional outcomes described in the KOOS-12 Function sub-scale of the KOOS-12 questionnaire and variables under investigation in this study.

Variables investigated	**Category (n)**	**Mean (SD)**	**95% CI**	**Mean difference**	**P-value**
Sex	Male (58)	56.88 (27.79)	(49.57 ; 64.19)	6.19	0.3530
	Female (28)	63.07 (30.84)	(51.11 ; 75.03)		
Age	20-39 years (55)	65.33 (25.51)	(58.43 ; 72.22)	17.89	**0.0076**
	40-60 years (31)	47.44 (31.08)	(36.08 ; 58.88)		
Occupation	Unemployed (31)	58.77 (31.40)	(49.57 ; 64.18)	0.19	0.7945
	Employed (55)	58.96 (27.51)	(51.11 ; 75.03)		
Social support	No (7)	51.86 (30.23)	(23.90 ; 79.81)	7.66	0.5030
	Yes (79)	59.52 (28.77)	(53.07 ; 65.96)		
Pre-injury activity level	Low (12)	53.75 (33.09)	(50.50 ; 68.01)	6.70	0.3184
	Moderate (30)	65.27 (30.11)	(53.87 ; 72.68)		
	High (44)	55.96 (26.50)	(48.84 ; 65.82)		
Fracture type	Low impact injury (49)	61.31 (29.29)	(52.90 ; 69.71)	5.61	0.3746
	High impact injury (37)	55.70 (28.23)	(46.30 ; 65.11)		
Surgical intervention	No (19)	69.80 (26.07)	(57.60 ; 82.00)	14.21	0.0526
	Yes (67)	55.59 (28.94)	(48.48 ; 62.70)		
Conservative intervention	No (67)	55.97 (28.89)	(48.92 ; 63.02)	13.24	0.0767
	Yes (19)	69.21 (26.64)	(56.37 ; 82.05)		
Physiotherapy	No (26)	63.35 (26.02)	(52.83 ; 73.86)	6.38	0.35483
	Yes (60)	56.97 (29.91)	(49.24 ; 64.69)		
HEP/advice	No (35)	61.89 (26.46)	(52.80 ; 70.98)	5.05	0.4281
	Yes (51)	56.84 (30.36)	(48.30 ; 65.39)		

*: Statistically significant ($p<0.05$). HEP: home exercise programme. Mean (SD) scores in the KOOS-12 Function subs-scale and 95% CI by various factors.

There was a statistically significant difference(p=0.0076) between the participants in the younger age group (20 to 39 years) and older age group (40 to 60 years) in KOOS-12 Function sub-scale. The mean difference of 17.89 was recorded in the Table 4.3. This finding demonstrated that after TPF younger age group participants had better functional outcome in activities of daily living and sport/recreation activities compared to older age group.

The KOOS-12 QOL sub-scale score is presented in Table 4.4. This sub-scale focuses on the knee-related quality of life.

Table 4.4: Linear relationships between the knee-related QOL described in the KOOS-12 Quality of life sub-scale of the KOOS-12 questionnaire and variables under investigation in this study.

Variables investigated	Category (n)	Mean (SD)	95% CI	Mean difference	p-value
Sex	Male (58)	34.76 (26.16)	(27.88 ; 41.64)	15.71	0.0102
	Female (28)	50.46 (25.61)	(40.53 ; 60.40)		
Age	20-39 years (55)	42.90 (26.96)	(35.62 ; 50.20)	8.42	0.0800
	40-60 years (31)	34.48 (26.28)	(24.84 ; 44.12)		
Occupation	Unemployed (31)	40.74 (27.79)	(27.88 ; 41.64)	1.36	0.8232
	Employed (55)	39.38 (26.58)	(40.53 ; 60.40)		
Social support	No (7)	32.29 (33.02)	(1.75 ; 62.82)	8.26	0.4390
	Yes (79)	40.54 (26. 41)	(34.62 ; 46.46)		
Pre-injury activity level	Low (12)	36.58 (17.87)	(49.01 ; 69.58)	5.81	0.1924
	Moderate (30)	47.07 (32.45)	(55.78 ; 70.62)		
	High (44)	35.86 (24.08)	(46.82 ; 67.03)		
Fracture type	Low impact injury (49)	41.90 (25.29)	(25.27 ; 34.63)	4.71	0.4243
	High impact injury (37)	37.19 (28.97)	(27.53 ; 46.85)		
Surgical intervention	No (19)	50.05 (28.14)	(36.88 ; 63.22)	13.26	0.0526
	Yes (67)	36.78 (25.91)	(30.42 ; 43.16)		
Conservative intervention	No (67)	37.08 (25.82)	(30.78 ; 43.37)	12.38	0.0696
	Yes (19)	49.74 (28.88)	(35.81 ; 63.65)		
Physiotherapy	No (26)	39.46 (27.89)	(28.19 ; 50.73)	0.59	0.9263
	Yes (60)	40.05 (26.65)	(33.16 ; 46.93)		
HEP/advice	No (35)	38.09 (25.55)	(29.30 ; 46.87)	3.01	0.6124
	Yes (51)	41.10 (27.92)	(33.25 ; 48.95)		

*: Statistically significant ($p<0.05$). HEP: home exercise programme. Mean (SD) scores in the KOOS-12 QOL sub-scale and 95% CI by various factors.

There was a statistically significant difference ($p=0.0102$) between female and male participants in the KOOS-12 QOL sub-scale. The mean difference of 15.71 between males and females was recorded in Table 4.4. Female participants had better knee-related QOL after TPF compared to male participants.

There were no participants who presented with associated injuries or pre- and post-intervention complications in this study. There was no statistically significance difference between other investigated variables and the three KOOS-12 sub-scales as represented in Tables 4.2, 4.3 and 4.4. In this study, 55 (64%) of the participants were employed. Data reported in the demographic and injury data collection sheet (Annexure I) showed that only five (9.1%) participants were unable to return to previous employment. Eleven (20%) participants partially returned to previous employment while 39 (70.9%) participants fully returned to previous employment. Only 24 (55%) participants in high pre-injury activity level reported that they were not able to return to recreational sporting activities. Regarding physiotherapy rehabilitation, 73% of participants received one to two sessions of physiotherapy rehabilitation in the hospital and 27% of participants received three to ten sessions as a followed-up after discharge.

Participants were attended to by medical doctors, surgeons, radiographers, nursing staff, physiotherapists and sometimes a dietician. There was no referral to other multidisciplinary team members such as occupational therapists, social workers or psychologists. During the interviews, three participants were offered a referral to a psychologist and a social worker within their nearby hospitals, which they declined. They were emotionally deeply distressed and had social issues resulting from unemployment due to physical limitations.

4.3 MULTIVARIATE ANALYSIS

The multiple regression analysis was done for all the significant factors as the predictors for each of the three KOOS-12 sub-scales. Conservative (non-surgical) intervention had a marginally significant result in two sub-scales of KOOS-12 as indicated in Tables 4.3 and 4.4, and the highest KOOS-12 Summary knee impact score (Table 4.1). Therefore, non-surgical intervention was included in the multivariate analysis. Other factors were age and sex. Age was used as a covariate.

Table 4.5 presents the linear predicted mean KOOS-12 Pain score in relation to sex and surgical intervention, both with marginal significance.

Table 4.5 Predicted mean pain score in relation to sex and surgical intervention (adjusted for age)

Factor (outcome)	Category (n)	Mean	95% CI	Mean difference	p-value
Gender	Male (58)	54.41	(47.86 ; 60.69)	10.99	0.0550
	Female (28)	65.28	(56.04 ; 74.51)		
Surgical intervention	No (20)	65.81	(54.87 ; 76.75)	13.26	0.0526
	Yes (66)	55.44	(49.43 ; 61.46)		

In the KOOS-12 Pain sub-scale, gender (p=0.0550) or surgical intervention (p=0.0526) were not statistically significant (Table 4.5).

Adjusted linear prediction of mean KOOS-12 Pain score in relation to sex and surgical intervention is illustrated in Figure 4.1.

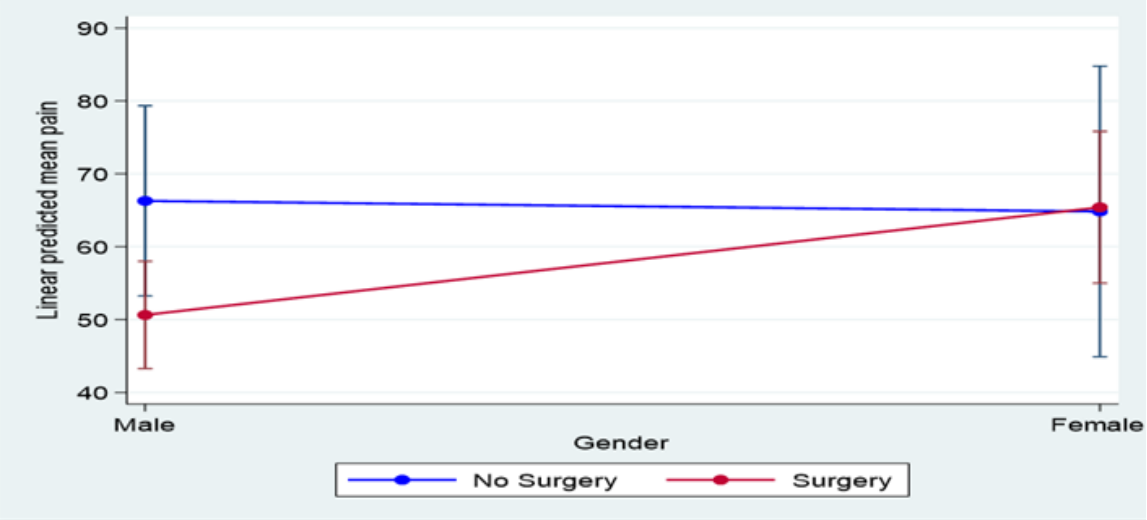


Figure 4.1: Adjusted prediction of sex and surgical intervention

There was no difference in the KOOS-12 Pain sub-scale for female participants in relation to surgical intervention or no surgical intervention, as shown in Figure 4.1. However, male participants who did not receive surgical intervention, experienced less pain with activities than those who received surgical intervention, as shown in Figure 4.1.

Table 4 presents the linear predicted mean KOOS-12 Function score in relation to sex and surgical intervention.

Table 4.6: Predicted mean KOOS-12 Function score in relation to sex and surgical intervention (adjusted for age)

Factor (outcome)	Category (n)	Mean	95% CI	Mean difference	P-value
Sex	Male (58)	56.71	(49.30 ; 64.12)	6.44	0.3530
	Female (28)	63.15	(52.49 ; 73.82)		
Surgical intervention	No (20)	69.70	(57.06 ; 82.32)	14.18	0.0526
	Yes (66)	55.52	(48.57 ; 62.46)		

In the KOOS-12 Function sub-scale, neither sex nor surgical intervention was statistically significant (Table 4.6).

Adjusted linear prediction of mean KOOS-12 Function in relation to sex and surgical intervention is represented in Figure 4.2.

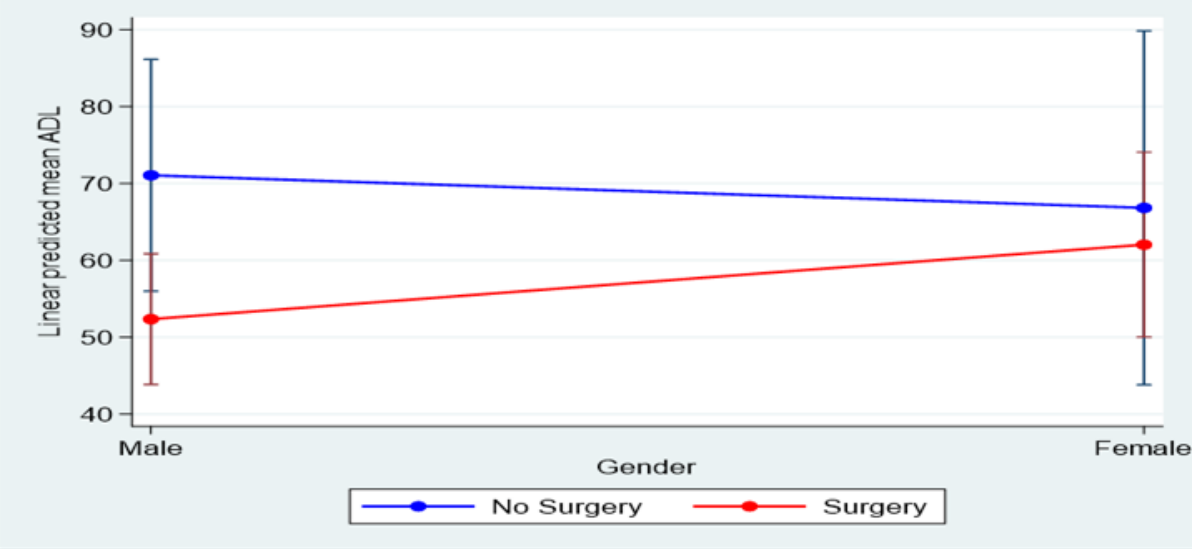


Figure 4.2: Linear predicted mean KOOS-12 Function score in relation to sex (gender) and surgical intervention.

Figure 4.2 confirms that male and female participants who did not receive surgical intervention were more functional in ADL and sport/recreation activities than those who received surgical intervention.

Table 4.7 presents the linear predicted mean KOOS-12 QOL score in relation to sex and surgical intervention, both with marginal significance.

Table 4.7: Predicted mean KOOS-12 QOL score in relation to sex and surgical intervention

Factor (outcome)	Category (n=total)	Mean	95% CI	Mean difference	p-value
Sex	Male (58)	34.76	(27.88 ; 41.64)	15.93	**0.0102**
	Female (28)	50.46	(40,53 ; 60.11)		
Surgical intervention	No (20)	50.18	(38.83 ; 61.52)	13.54	0.0526
	Yes (66)	36.64	(30.40 ; 42.87)		

There was a statistically significant difference (p=0.0102) between female and male participants in the KOOS-12 QOL sub-scale score. The mean difference of 15.71 was recorded in Table 4.7. This finding demonstrates better knee-related QOL for female participants than male participants.

Adjusted linear prediction of mean KOOS-12 QOL score in relation to sex and surgical intervention is presented in Figure 4.3.

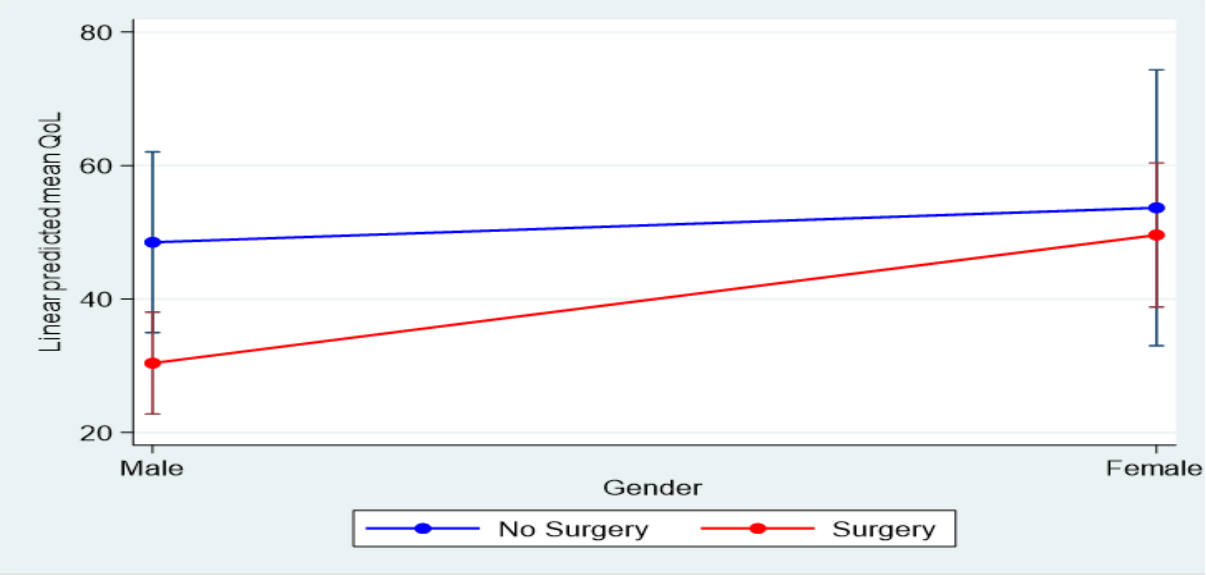


Figure 4.3: Display of linear predicted mean KOOS-12 QOL score in relation to sex (gender) and surgical intervention.

Figure 4.3 shows that male and female participants who did not receive surgical intervention had better knee-related QOL than those who received surgical intervention.

4.4 SUMMARY

Most participants were males, and the most common mechanism of injury was an MVA.

The first significant finding of the study was the statistically significant difference between the younger age group and the older age group in KOOS-12 Pain (p=0.0439) and KOOS-12 Function (p=0,0076) sub-scales. This finding indicates that after TPF, the younger age group (20 to 39 years) participants experienced less pain with activities, and they were more functional in activities of daily living and sport/recreation activities compared to the older age group (40 to 60 years).

The second significant finding was the statistically significant difference between female participants and male participants in the KOOS-12 QOL (p=0.0102) sub-scale. Female participants had better knee-related QOL after TPF compared to male participants.

In the linear prediction of the mean KOOS-12 Pain, KOOS-12 Function and KOOS-12 QOL scores in relation to sex and surgical intervention, only the KOOS-12 QOL sub-scale had a significant difference (p=0.0102), thereby demonstrating that female participants had better knee-related QOL than male participants.

Furthermore, the KOOS-12 QOL and KOOS-12 Function sub-scales indicate that female and male participants who did not receive surgical intervention were more functional than those who received surgical intervention.

5 CHAPTER 5: DISCUSSION

5.1 INTRODUCTION

In this chapter, the results of the study are interpreted, compared to existing literature, and discussed. Tibial plateau fractures (TPF) are known to cause functional limitations, restrict participation and ultimately result in poor quality of life (QOL), even with progressing medical intervention and physiotherapy rehabilitation (Kugelman et al., 2017:4; Kugelman et al., 2018:422; Iliopoulos et al., 2020a:3; Iliopoulos et al., 2020b:277; Gonzalez et al., 2020:634-5; Elsoe et al., 2021:285). The aim of the study was to determine factors related to the functional outcome of patients after TPF.

The main findings that have emerged from the study, and will be discussed, are:

I. The statistically significant effect of age observed in the KOOS-12 Pain and KOOS-12 Function sub-scales.
II. The statistically significant effect of gender observed in the KOOS-12 QOL sub-scale.
III. Although there was no statistically significant difference noted in the findings with regard to surgical/conservative intervention, occupation, pre-injury level, fracture type, physiotherapy rehabilitation and home exercise program (HEP), social support and multidisciplinary intervention, each will be discussed separately, under its own heading.

The main findings will be discussed in accordance with the objectives set for the current study, but the flow of the discussion will deviate from the order of the objectives outlined.

The first main finding to be discussed is the statistically significant effect of age observed in the KOOS-12 Pain and KOOS-12 Function sub-scales of the KOOS-12 [(P=0.0076) and (P=0.0439) respectively]. There was a statistically significant difference (p=0.0439) between the participants in the younger age group (20 to 39 years) compared to the older age group (40 to 60 years) in the KOOS-12 Pain sub-scale. A mean difference of 10.11 points in the KOOS-12 Pain sub-scale was recorded in Table 4.2. This finding demonstrates that the younger age group participants experienced less pain with activities after TPF, than the older age group participants. From these findings one may argue that participants in the younger age group were not limited by pain in execution of increasingly difficult activities and were more functional in activities of daily living and sport/recreation activities compared to the older age group (40 to 60 years). The items in the KOOS-12 Pain and KOOS-12 Function sub-scales include assessment of the ability to execute ADL, recreational sport participation and how the experience of pain affect daily function. The

results of the current study is in accordance with previous studies, where younger age was associated with satisfactory knee range of motion (ROM), return to participation in recreational sport activities and execution of ADL (Kugelman et al., 2017:6; Kugelman et al., 2018:423; Polat et al., 2019:1719). In a case-control study over 11 years, 169 patients aged 19–73 years were evaluated. It was observed that after 15 months, 52.4% of the patients returned to recreational sport participation. Younger age was found to be one of the significant (p=0.014) predictors to influence the return to sport participation. (Kugelman et al., 2017:6). A retrospective cohort study with a mean follow-up duration of 68.32 months and 26 patients (20–75 years) with Schatzker Type V and Type VI TPF reported that older participants had lower scores on the Oxford knee score than younger participants and these results indicated poor functional outcome in older participants. However, the results were not statistically significant (p=0.451) (Jagdev et al., 2017:3). In a prospective cohort (n=266) study, after 17-month follow-up, patients in the younger age group had statically significant (p=0.003) improvement with knee ROM compared to participants in the older age group (Kugelman et al., 2018:423). In a retrospective cohort review (n=52) study including participants between the ages 14–84 years, it was found that after 47 months, participants in the older age group (>40) had decreased knee ROM, restricted participation in recreational sports, functional limitation in some activities of daily living (ADL) and poor QOL in general (Polat et al., 2019:1719). Therefore, younger age was the predictor of better functional outcome (p=0.005) according to their findings (Polat et al., 2019:1719). Age in combination with high energy Schatzker fractures were independent predictors of decreased knee ROM, unsatisfactory functional outcome and poor QOL (Kugelman et al., 2018:422-6). In older participants, low energy trauma results in complex fracture patterns due to osteoporotic changes to the bone (Jagdev et al., 2017:3). Further, these fractures can be complicated by the participant's comorbidities, pre-existing joint conditions such as osteoarthritis, and low pre-injury activity level (Rozell, Vemulapalli, Gary and Donegan, 2016:126). This may explain why older participants experienced more pain with activities and presented with lower functional outcome after TPF.

The second main finding was the significant difference observed in the effect of gender in the KOOS-12 QOL sub-scale. Female participants demonstrated statistically significant (p=0.0102) better knee-related QOL after TPF than male participants (Tables 4.4 and 4.7). The KOOS-12 QOL sub-scale contains four items that address awareness of the knee dysfunction, lifestyle modifications to avoid potential knee damage, lack of confidence in the injured knee during activities, and the degree of difficulty experienced in activities because of the injured knee (Collins et al., 2011:1-30; Collins et al., 2016; Gandek et al., 2019:1-7). Difficulties experienced,

with the injured knee can be particularly challenging to participants who are more involved in strenuous physical activities such as strenuous prolonged positions or recreational activities. Most participants that access the settings in which the study was conducted, come from low socio-economic communities where they are involved in physically strenuous vocational activity such as gardening, construction work or domestic work; they also walk long distances to their work places or to make use of transportation. The inability to participate in the before-mentioned activities may greatly affect one's QOL. In the context of these communities, males are culturally expected to provide for the family and younger males participate in recreational sporting activities. Females, however, are mostly responsible to take care of the household. Similar to the current study, a case-control (n=169) study over 11 years reported that female sex (p=0.054) was one of the factors that predicted return to recreational/sporting activities (Kugelman et al., 2017:5). In a retrospective cohort study (n=36), it was concluded that female patients with Schatzker fracture type V had a significant (p=0.016) better functional outcome regarding QOL (Wirbel, 2020:1-5). These findings again indicate that QOL may be influenced by activities that an individual does, strenuous vocational activity or ADL. Contrary to the current study, a few studies reported that gender does not influence the functional outcome after TPF (Unnikrishnan, 2017:805; Schroder, Leite, Silva, Candido, de Almeida and de Oliveira, 2019:40-2; Verma et al., 2020:3). In these studies, similar functional outcome measures were used (KOOS, 12-Item Short Form Health Survey, Lysholm score and Modified knee scoring system of Hohl & Luck (1956)). The main difference between these three studies and the current study is that all three studies were done in second world countries as classified according to the World Bank classification system. In second world countries, socio-economic roles and responsibilities are not defined by gender, as in the current study. This may explain the contradictory finding.

Seven non-significant findings of importance will be discussed next.

1. Conservative intervention of TPF

Conservative (no surgical intervention) had the highest KOOS-12 Summary knee impact score (Table 4.1) and a higher mean score in two sub-scales (KOOS-12 Function and KOOS-12 QOL (Tables 4.3 and 4.4), but there was no statistically significant difference between surgical and conservative intervention in all KOOS-12 sub-scales (Tables 4.2, 4.3 and 4.4). In the linear prediction analysis of the KOOS-12 Pain and KOOS-12 Function sub-scales, it was demonstrated that both female and male participants who received conservative intervention were more functional than those who received surgical intervention (Figures 4.2 and 4.3). In a retrospective cohort (n=41) study that aimed to investigate functional and clinical outcome after

TPF managed with conservative intervention, it was reported that participants who were treated conservatively, achieved good to excellent functional outcomes (Pean et al., 2017:377). They also found that participants on whom surgery was not done because of other factors besides fracture type (p=0.002), or comorbidities (p=0.001) had significantly poor functional outcome (Pean et al., 2017:377). Similar to the current study, 20 (23%) participants received conservative interventions as a treatment of choice due to of the fracture type, which was a minimally displaced low impact injury fracture and they also displayed better functional outcome as compared to those who had surgical intervention (Tables 4.3 and 4.4). A retrospective cohort study (n=218) reported similar findings to the current study, where conservatively treated patients had significant better functional outcome in all KOOS sub-scales than operatively treated patients (van den Berg et al., 2017:1868-70). A systematic review of 27 studies reported 100% return rate to sports and to pre-injury level with conservatively managed TPF, as compared to the 70% return rate to sports for the surgically managed TPF (Robertson et al., 2017:584). Lastly, a retrospective cohort (n=41) study reported that participants who sustained low impact injuries, had a better functional outcome than participants who had high impact injury after surgical intervention, as measured by SF-36 scores (p=0.01) and mean WOMAC score (p=0.033) (Hap et al., 2020:12-3).

Conservative intervention is indicated for low energy TPF injury with no fragment displacement or soft tissue involvement (mostly Type I). This may explain why participants treated conservatively, reported a better functional outcome in the current study, as well as the other studies discussed.

2. Occupation

In the current study, no statistically significant differences in all KOOS-12 sub-scales were observed with regard to occupation (Tables 4.2, 4.3 and 4.4). In this study, 91% of participants reported partial to full return to pre-injury employment. Only five (9%) participants were unable to return to the pre-injury employment after suffering a TPF. Several studies reported similar findings to the current study, where most participants were able to return to pre-injury employment either partially or fully. However, some patients, due to unspecified physical limitations after TPF, had to reduce their working hours, work intensity, or take early retirement (van Dreumel et al., 2015:1610; Kraus et al., 2018:4; Hap et al., 2020:12-3).

After TPF, some patients may experience persistent impairments that limit vocational activities. This may lead to reduced working hours or loss of employment with subsequent detrimental financial implication to participants

3. Pre-injury activity levels

Pre-injury activity levels were divided into three categories: housebound (low), shopping (moderate) or outside activity (high). The majority of participants reported high levels of pre-injury activity (n=43; 50%) which indicated involvement in regular physical activities and/or recreational sports. However, there was no statistically significant difference between pre-injury activity levels and the functional outcome. In the current study, only participants (55.8%) in the high pre-injury level reported being unable to return to recreational sporting activities after TPF. Similar to the current study, in a retrospective cohort (n=71), only seven (27%) patients did not return to their pre-injury sports activity level, due to unspecified physical limitations after TPF (van Dreumel et al., 2015:1610). In another retrospective (n=89) study, 72% of the patients reported decreased pre-injury activity level, 25,6% resumed the same pre-injury activity level and only one patient had improved activity level after TPF (Kraus et al., 2018:4). Lastly, a retrospective cohort (n=41) reported that only four (13%) of patients had fully returned to pre-injury sporting activities and seven (23%) patients had only partially returned to sports and exercise. Majority of patients (64%) were not able to start on any sports or exercise at all. As in the current study, their results were not statistically insignificant (p=0.26). The most mentioned reason for not returning to pre-injury participation levels, was the fear of causing injury to the same knee (Hap et al., 2020:14).

4. Fracture types

In the current study fracture types were reported in different groups (high energy injury and low energy injury) (Tables 4.2, 4.3 and 4.5). There were no statistical significant difference in all KOOS-12 sub-scale between the fracture types was detected in the current study. Similar to the current study, a retrospective cohort (n=52) study reported no statistically significant difference between fracture type and functional outcome (p= 0.077) (Polat et al., 2019:1719). Contrary to the current study, high energy injury (Types V-VI) TPF is most likely be associated with poor functional outcome, compared to low energy injury (Types I-III) (Kugelman et al., 2017; Hap et al., 2020). A case-controlled comparison study (n= 38) over five years investigated patients with TPF Types V and VI. The purpose of this study was to assess the long-term functional outcome as indicated by gait patterns and quality of life. They reported that after TPF, patients had abnormal gait patterns compared to healthy controls. These patients had a slower antalgic gait with a short stride, slower cadence and shorter single limb support on the affected side. This study also reported lower quality of life results, both in the physical score and in the mental score as measured by a SF-12 questionnaire (Warschawski, Elbaz, Segal, Norman, Haim, Jacov et al., 2015:1542-5). A retrospective study (n=22) with the aim to present the medium-term results of surgically treated

high energy injury (Types V and VI) reported that patient ADL were limited, pain was reported in 77.2% and anxiety or depression in 40.9% of cases. Many of the patients showed arthritic changes on imaging, with only 6.3% of cases that had no arthritic changes. The authors concluded that 80% of patients could go back to work and perform ADL, despite early radiological arthritis, but the quality of life remains greatly affected (Evangelopoulos et al., 2019:394-8). More complex fractures (Schatzker Types V and VI) have a higher incidence (60%) of post-traumatic OA than less complex fracture (Wirbel, 2020:10). In another retrospective cohort (n=41) 42 months post-surgery, two outcome measures were used to evaluate functional outcome: The Western Ontario and McMaster University Osteoarthritis index (WOMAC) score and Short Form 36 (SF-36) general health survey. Both outcome measure scores were significantly lower in the Schatzker Types IV to VI; indicating low functional outcome and poor QOL respectively. Furthermore, 71% of patients reported partial to full return to work, while 65% of patients did not return to sports after injury (Hap et al., 2020:11-5). Complex fracture types (Schatzker Types V and VI) are associated with poor functional outcome including return to sports after injury, abnormal gait patterns and higher incident of OA.

5. Physiotherapy rehabilitation.

In this study there was no statistically significant difference between physiotherapy rehabilitation in all three KOOS-12 sub-scales (Tables 4.2, 4.3 and 4.4). Contrary to the current study findings, physiotherapy rehabilitation was proven to influence the functional outcome of patients after TPF (Jagdev et al., 2017:3; Anand et al., 2020:19; Iliopoulos et al., 2020a:1). However, the physiotherapy protocol mentioned in those studies was not discussed, how long patients attended physiotherapy rehabilitation and whether they received a home exercise program. In the current study 73% of participants received physiotherapy rehabilitation in the hospital and only 27% of participants received follow-up sessions after discharge. Most participants were unable to continue physiotherapy rehabilitation after being discharged from the hospital, either due to personal reasons, or a poor physiotherapy referral system. Personal and environmental factors such as lack of funds, long distances to walk and the usage of public transport were mentioned by participants as barriers to attend physiotherapy follow-up sessions. The few participants that could attend physiotherapy rehabilitation were only limited to few sessions per month (as per setting guidelines) and discharged soon after full weight bearing was achieved. Personal factors such as the availability of the caregiver, or environmental factors such as early return to work, may be possible barriers to frequent or long-term physiotherapy attendance. In the current study, most participants did not have sick leave and had to return to work as quickly as possible to avoid losing their job.

Participants prioritise work over physiotherapy rehabilitation follow-up sessions. In an attempt to assist these participants under the given circumstances they (59%) were given a home exercise program (HEP) or advice by the physiotherapists after discharge from the hospital. In this study, there was no statistically significant difference in the functional outcome between those patients who received an HEP and those who did not, in any of the KOOS-12 sub-scales (Tables 4.2, 4.3 and 4.4). Participants' adherence to or/and the content of the HEP/advice given, needs to be investigated.

6. Social support.

In this study, social support (family, friends, neighbours and community members) was the only environmental factor evaluated contributing factor to functional outcome of patients after TPF. There was no statistically significant difference between the patients who received social support and those who did not (Tables 4.2, 4.3 and 4.4). However, participants that had no social support had the lowest KOOS-12 Summary knee impact score, suggesting poor outcome. Participants were asked whether they had someone supporting them during the recovery period, but the researcher did not establish who the source of social support was, or what kind of support was given. The involvement of family/friends may be seen as a facilitator to improve the functional outcome of TPF patients. Family/friends may assist with transport to the nearest hospital/clinic for regular physiotherapy rehabilitation; they can encourage and assist with the HEP, which may improve adherence. In some instances, family may assist with finances or application for a temporary disability grant to those who may qualify; this may allow some individual to delay return to work and focus on recovery. However, the above expected support may not be feasible, given the socio-economic background of the participants in the current study. The family or friends themselves might have the same work and financial challenges. There were no studies found by the researcher that investigated social support after TPF. However, a scoping review by (Auais, Al-Zoubi, Matheson, Brown, Magaziner and French, (2019:1384) on the role of social factors in recovery after hip fractures reported that social support and socioeconomic factors were significantly related with better functional outcome, health related QOL and a decrease in mortality. Although this is a review of a different condition, the findings may be relevant to the TPF as a lower limb fracture.

7. Multidisciplinary intervention/involvement/approach.

Participants were attended to by medical doctors, surgeons, radiographers, nursing staff and physiotherapists. There was no referral to other multidisciplinary team members such as occupational therapists, social workers or psychologists. During the interviews, three participants were offered a referral to a psychologist and social worker, as they were emotionally deeply distressed and had social issues resulting from unemployment due to physical limitations, which they declined. Only one retrospective (n=22) study after a follow-up period of 56 months reported that 40.9% of their patients presented with anxiety or depression after TPF (Evangelopoulos et al., 2019:386). All patients who experience difficulty resuming their vocational responsibilities as before, could have been evaluated by an occupational therapist and maybe encouraged to engage in low intensity workload before they are forced to resign or are retrenched. However, most of those employment areas have no benefits after resigning and it may not be necessarily possible to negotiate for a lighter workload. Furthermore, with the involvement of the social worker, certain social issues could have been avoided or addressed, such as disability grants for those patients who qualify. A prospective controlled trial (n=668) investigated a rehabilitation team approach after knee fracture surgery to determine whether that would be associated with better functional outcomes; their team was composed of rehabilitation clinicians, therapists, orthopaedic clinicians and nurses (Liu, Zhou, Yang and Li, 2021:8-9). They found that between the control and trial groups, the trial group had significantly better function (measured by Hospital for Special Surgery knee score and Berg Balance Scale score outcome measures) , ROM and muscle strength than the control group (p=0.000) (Liu et al., 2021:8-9). This was the only study of its kind found which indicated the importance of an interdisciplinary, holistic team approach in the rehabilitation of these patients.

5.2 SUMMARY

This study found that participants level of functional outcome was related to factors such as surgical/conservative intervention, fractute type, occupation and pre-injury activity level. Participants' age and gender were found as significant factors related to functional outcome after TPF. These findings of the current study are in accordance with the literature. However, studies done in upper income countries had contradictory findings. Factors evaluated in the current study that need to be investigated into more depth include the physiotherapy rehabilitation program, HEP and multidisciplinary intervention.

6 CHAPTER 6: CONCLUSION

Tibial plateau fractures are complex articular injuries which may result in complications (impairments) that can greatly impact functional outcomes, limiting ability to execute ADL, return to vocational activities or restrict participation in recreational activities (Hap et al., 2020:13-4), therefore, increasing the socio-economic burden and affect QOL of patients many years after TPF (Kabst et al., 2022:5). The aim of the study was to determine factors related to the functional outcome of patients who sustained TPF.

In the current study, factors identified to be related to functional outcome after TPF are age and gender. The first main finding of the current study data analysis was the statistically significant difference between the younger age group and the older age group in KOOS-12 Function (p=0,0076) and KOOS-12 Pain (p=0.0439) sub-scales. The findings were in accondance with the literature stating that younger age was associated with satisfactory knee range of motion (ROM), return to recreational sport activities participation, execution of ADL and overall good QOL (Kugelman et al., 2017:6; Kugelman et al., 2018:423; Polat et al., 2019:1719). Persistant pain with activity and poor functional outcome in older participants were associated with age-related changes in bone density, comorbidities, pre-existing joint conditions or a low pre-injury activity level (Rozell et al., 2016:126; Jagdev et al., 2017:3).

The second factor identified to be related to functional outcome after TPF, was gender. Female participants reported significantly better functional outcome than male participants in the KOOS-12 QOL (p=0.0102) sub-scale. After TPF, female participants had better knee-related QOL compared to male participants. This finding was in agreement with other studies, in which females (personal factor) was associated with early return to sports participaton, better functional outcome and ultimately, good QOL compared to males sex (Kugelman et al., 2017:5; Wirbel, 2020:10).

Some factors evaluated in the current study were found to be not significant associated with functional outcome. These factors which include the physiotherapy rehabilitation program, home exercise program (HEP) and multidisciplinary intervention aproach need to be investigated into more depth in future studies.

6.1 PROFESSIONAL CONTRIBUTION

Unfortunately, literature on physiotherapy rehabilitation protocols after TPF is limited and different approaches exists in the available literature with regard to the most effective rehabilitation program to prevent complications and optimize knee function (Iliopoulos et al., 2020a:1-4).

In the literature reviewed and discussed, different approaches/points of view exist with regard to the physiotherapy management program. Most of the studies reviewed focus mainly on the hands-on physiotherapy program (mobilization of the joint, muscle strengthening and gait retraining) while hospitalized. From the discussion of this study, additional information with regard to the medical intervention, educating participants on healing process of a fracture (to address fear avoidance), the importance of adherence to the home exercise program and attendance of the follow-up treatment sessions must be addressed and shared with patients.

Three barriers are identified that may affect the attendance of follow-up physiotherapy treatment sessions. Personal finances and social support are barriers that may play a role in how often the patient can return for follow-up sessions. Secondly, the number of outpatient sessions allowed by a health setting (hospital or clinic) may play a role in the final functional outcome of a patient. Because this may result in early discharge before the patient return to pre-injury functional level. In case were outpatient sessions are space out due to the availability of physiotherapist in the setting, patient's recovery may be delayed and result in latent TPF complications. Patients are discharged once they can bear weight. Full weight bearing after a TPF does not guarantee optimal joint function which, in turn, may affect gait. The down referral system from hospitals to smaller hospitals and clinics may also affect the outcome of a patient. Often, in the more rural settings, clinics and hospitals do not have physiotherapists to follow up with the patients. Lastly, most of the patients work where they are paid per hour or per day. Attending physiotherapy treatment sessions is time consuming which imply the patient will lose a day's income. The latter two environmental barriers may affect the functional outcome of patients after TPF and highlights the importance of a detailed home exercise program (HEP)

Long term (more than three years) evaluation of patients after TPF revealed that prolonged recovery to regain pre-injured knee function should be expected and addressed during rehabilitation (Elsoe et al., 2017:1659; Iliopoulos et al., 2020b:277; Elsoe et al., 2021:285). Bearing this in mind, the importance of a detailed long-term rehabilitation program is essential. The program should include exercises to optimise joint function as well as information and advice to prevent complications and address aspects such as healing time after a fracture (to address fear avoidance) and the advantages of adhering to the HEP (optimal function, decrease chances of developing OA). The lack of such a program is one of the main gaps identified in this study. The role of social support in patients' recovery after TPF is yet to be investigated, but involving family or caregivers in HEP may encourage and assist participants to adhere to an HEP.

6.2 CLINICAL CONTRIBUTION

One study indicated that a multidisciplinary approach for patients after TPF results in significantly better function, knee range of motion and muscle strength than the control group (Liu et al., 2021:8-9). In the current study it was observed that some participants could have benefited from other medical disciplines such as social workers, occupational therapist and psychologist. Even though literature is limited on multidisciplinary approach after TPF, it is evident that patients can benefit from the implementation of a multidisciplinary approach.

7 CHAPTER 7: LIMITATIONS AND RECOMMENDATIONS

7.1 LIMITATIONS

The following limitations of the study are acknowledged:

1. The study only established whether participants were able to return to their previous vocational activities, but not the limiting factors and kind of jobs they were doing, except for those who reported difficulties with vocational activity.

2. The study did not determine the specific physical limitations that restricted return to pre-injury activity level. Only participants who indicated challenges with returning to pre-injury activity level were asked to specify the previous activity or outside/sporting activity.

3. Although the participants were asked whether they had someone supporting them (as an environmental factor) during the recovery period, the study did not establish whom, or what kind of support participants received.

4. The content of a home exercise program/advice given was not established in the current study. The effect of knee joint post-traumatic osteoarthritis on the functional outcome was not investigated in the current study.

5. The study reviewed medical records over a five-year period but did not investigate the short-term or long-term effect of TPF on functional outcome.

7.2 RECOMMENDATIONS

1. More effort should be made to ensure that all patients with TPF receive physiotherapy rehabilitation interventions in the hospital and after being discharged. Furthermore, patients should be followed up frequently and encouraged to honour their follow-up appointment and adhere to a given home exercise program (HEP). To address these, physiotherapist can ensure a follow-up booking for physiotherapy rehabilitation for patients presenting with TPF, before discharge from the hospital. The physiotherapist in the orthopaedic ward can also discuss the physiotherapy rehabilitation protocol with the orthopaedic surgeon and advocate for the referral of these patients for physiotherapy rehabilitation. When possible, patients that should be referred to the nearest clinics where they could benefit from home visits by the district physiotherapist. This can also address some personal and enviriomental factors that prevent patients from honouring given follow-up appointments or comply with HEP. Family involvement should be

encouraged during physiotherapy rehabilitation sessions to assist patients with HEP. Patients need to be informed about possible complications and the role of physiotherapy in preventing most of the complications, so that they understand the importance of attending physiotherapy rehabilitation. Litrature investigating the content of physiotherapy rehabilitation programs focusing on specific treatment technics and exercise programs is recommended, including the specific HEP given .

2. Factors that are related to functional outcomes after TPF are age and gender. All patients need to be informed, regardless of odds ratios. The difference may be emphasis with regards to patients older than 40 years and males need to be informed of the likelihood of functional limitations. Although fracture type influences the medical (surgical/conservative) intervention choice, patients who received surgical intervention need to be informed of the likelihood of having functional limitations, as compared to those without surgical interventions. Thorough education and advice (including pamphlets) regarding the recovery phase and what to expect, should be given to patients after a TPF. Patients should receive counselling (social worker, psycologists, doctors, physiotherapists, ect.) regarding possible functional limitations which may impact ADL execution, return to vocational activities, participation in recreational activities and QOL. Although all patients may benefit from extra support to cope with alteration of participation in activities, socio-economic status and mental health, male patients would benefit more.

3. Only one study was found which indicated the importance of an interdisciplinary, holistic team approach in the rehabilitation of these patients. In all settings, none of the participants were part of an interdisciplinary team approach after TPF. More research in this field is needed and based on the available literature, patients may benefit from this intervention approach. Interprofessional education should be emphasised in undergraduate training so that students could learn about the roles of other profesions in the management of patients. Programs that encourage an interdisciplinary, holistic team approach in the rehabilitation of these patients should be implemented and should include multidisciplinary team meetings or ward rounds and ongoing review of those programs. Patients with perceived or reported personal and/or environmental factors that may hinder recovery and affect QOL, should be referred to a relevant discipline (social worker, occupational therapist, etc.) before being discharged from the hospital.

4. Based on the gaps identified from the literature review and discussion chapters, more research in needed to investigate other personal and environmental factors that may influence functional outcome after TPF (socioeconomic status, home and work enviroment, etc.)

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ANNEXURES

ANNEXURE A: LETTER OF APPROVAL

Letter of approval to the chief executive officer of hospital A and hospital B

Date: 30 April 2019

Department of Physiotherapy, University of Pretoria

To Whom It May Concern:

My name is Innocentia Sivhugwana, and I am currently registered for a research project for a Master in Physiotherapy at the University of Pretoria.

Subject to approval by the University of Pretoria and the Ethics Department, this study will be using questionnaires to determine factors related with the functional outcome of patients who sustained tibial plateau fracture in the last five years. This study will require access to patients' medical record.

I am writing to ask for your permission to be allowed access to patient's medical records and to contact eligible patients and telephonically administer the questionnaire. This should not take a lot of time and can be conducted at a convenient time and date to be arranged.

All answers and results from the questionnaires are kept confidential and the results will be reported in a research paper available to all participants on completion.

If this is possible, kindly e-mail me at innocentiasivhugwana83@gmail permission to access patients and their records.

Looking forward to hearing from you.

Yours faithfully

Innocentia Sivhugwana

ANNEXURE B: LETTER OF APPROVAL

Letter of approval to the chief executive officer, hospital C

Date: 30 December 2019

Department of Physiotherapy, University of Pretoria

To Whom It May Concern:

My name is Innocentia Sivhugwana, and I am currently undertaking a research project for a Master in Physiotherapy at the University of Pretoria.

The study was approved by the University of Pretoria and the Ethics Department; this study will be using questionnaires to determine factors related with the functional outcome of patients who sustained tibial plateau fracture in the last five years. This study will require access to patients' medical record.

I'm writing to ask for your permission to access to patient's medical records and to contact eligible patients and telephonically administer a questionnaire. This should not take a large amount of time and can be conducted at a convenient time and date to be arranged.

All answers and results from the questionnaires are kept confidential and the results will be reported in a research paper available to all participants on completion.

If this is possible, kindly you e-mail me at innocentiasivhugwana83@gmail to confirm that you are willing to allow access to patients and their records.

Looking forward to hearing from you.

Yours faithfully

Innocentia Sivhugwana

ANNEXURE C: APROVAL LETTER HOSPITAL A

GAUTENG PROVINCE
HEALTH
REPUBLIC OF SOUTH AFRICA

KALAFONG HOSPITAL
PRIVATE BAG X396
PRETORIA
0001

ENQUIRIES : MS P MONYEPAO
TEL : 012 318 6929
FAX : 012 373 6791
EMAIL : Patricia.Monyepao@gauteng.gov.za
REF : KPTH 21/2019

TO: Ms I SIVHUGWANE

RE: PERMISSION TO CONDUCT RESEARCH

TITLE: FACTORS RELATED WITH THE FUNCTIONAL OUTCOME OF PATIENTS WHO SUSTAINED TIBIAL PLATEAU FRACTURES.

Permission is hereby granted for the research to be conducted at **Kalafong Provincial Tertiary Hospital**.

This is done in accordance to the "Promotion of Access to Information Act. No 2 of 2000".

Please note that in addition to receiving approval from the hospital research committee, you are still required to seek permission from the relevant departments.

Furthermore, collecting of data and consent for participation remains the responsibility of the researcher.

You are also required to submit your final report or summary of your findings and recommendations to the office of the CEO.

Approved:

DR K.E LETEBELE-HARTELL
SENIOR MANAGER: MEDICAL SERVICES
DATE: 27/09/2019

ANNEXURE D: APROVAL LETTER HOSPITAL B

GAUTENG PROVINCE
HEALTH
REPUBLIC OF SOUTH AFRICA

STEVE BIKO ACADEMIC HOSPITAL

Enquiries: Dr JS Mangwane
Tel No: +2712 345 2018
Fax No: +2712 354 2151
e-mail: joseph.mangwane@gauteng.gov.za

For attention: ___MS Innocentia Sivhugwana
NHRD Ref Number: GP_201909_001
SBAH Ref Number: _____SBAH 201909_01

Re: REQUEST FOR PERMISION TO CONDUCT RESEARCH AT STEVE BIKO ACADEMIC HOSPITAL

TITLE:

Factors related to the functional outcome of patients who sustained tibial plateau fractures

Permission is hereby granted for the above-mentioned research to be conducted at Steve Biko Academic Hospital.
This is done in accordance to the "Promotion of access to information act No 2 of 2000".
Please note that in addition to receiving approval from Hospital Research Committee, the researcher is expected to seek permission from all relevant department.
Furthermore, collection of data and consent for participation remain the responsibility of the researcher.
The hospital will not incur extra cost as a result of the research being conducted within the hospital.
You are also required to submit your final report or summary of your findings and recommendations to the office of the CEO.

Approved

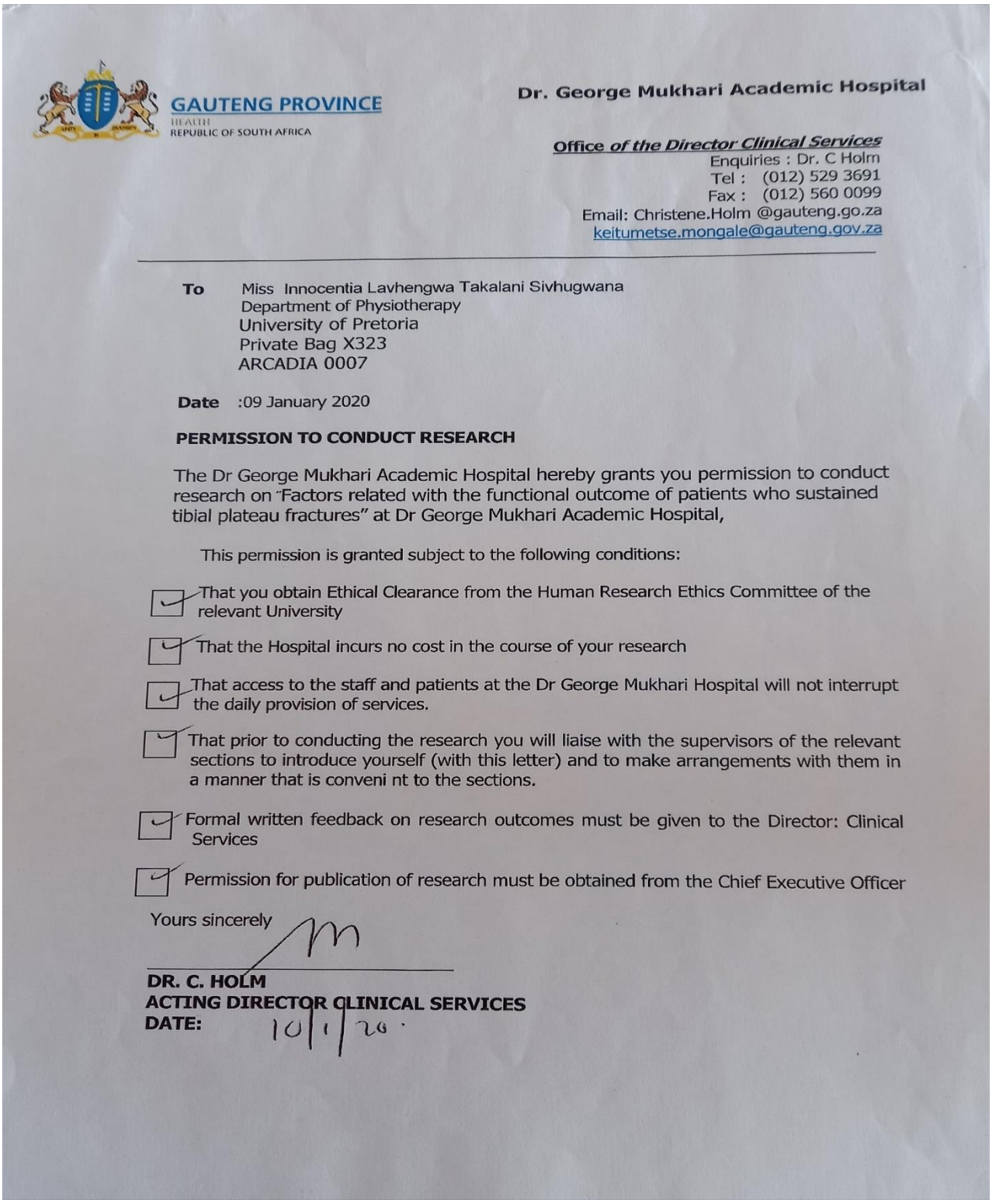
Comment:

GAUTENG PROVINCIAL REGERING
DEPT VAN GESONDHEID
STEVE BIKO ACADEMIC HOSPITAL
STEVE BIKO ACADEMIC HOSPITAL
Date: 2019 -09- 05
PRIVAATSAK/PRIVATE BAG X169
PRETORIA 0001
GAUTENG PROVINCIAL GOVERNMENT
DEPT OF HEALTH

Dr. J S. Mangwane
Manager: Medical Service

Steve Biko Academic Hospital, P.O. Box x169, Pretoria, 0001

ANNEXURE E: APROVAL LETTER HOSPITAL C



GAUTENG PROVINCE
HEALTH
REPUBLIC OF SOUTH AFRICA

Dr. George Mukhari Academic Hospital

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

To Miss Innocentia Lavhengwa Takalani Sivhugwana
Department of Physiotherapy
University of Pretoria
Private Bag X323
ARCADIA 0007

Date :09 January 2020

PERMISSION TO CONDUCT RESEARCH

The Dr George Mukhari Academic Hospital hereby grants you permission to conduct research on "Factors related with the functional outcome of patients who sustained tibial plateau fractures" at Dr George Mukhari Academic Hospital,

This permission is granted subject to the following conditions:

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

Yours sincerely

DR. C. HOLM
ACTING DIRECTOR CLINICAL SERVICES
DATE: 10/1/20

ANNEXURE F: FACULTY ETHICS APPROVAL LETTER

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

www.up.ac.za

Faculty of Health Sciences
School of Health Care Sciences
Room 3-75. HW Snyman North
University of Pretoria,
Private Bag X323
ARCADIA
0007
Tel: 012 356-3233
Joyce.mothabeng@up.ac.za

27 June 2019

Faculty Ethics Committee

Faculty of Health Sciences

University of Pretoria

To whom it may concern,

Evaluation of a protocol for the following student:

Student Innocentia Sivhugwna- Department of Physiotherapy (MPhysT); student number: 26160324

Title: FACTORS RELATED TO THE FUNCTIONAL OUTCOME OF PATIENTS WHO SUSTAINED TIBIAL PLATEAU FRACTURES

This letter serves to confirm that the above mentioned protocol was discussed by the Postgraduate Committee of the School of Health Care Sciences during the meeting of 22 May 2019.The proposal was accepted with minor changes, and the corrections were effected. It is hereby referred to your committee for ethical clearance.

Sincerely yours,

JDMothabeng.

Professor DJ Mothabeng

Chairperson: Research and postgraduate committee

School of Health Care Sciences

ANNEXURE G: ETHICS APPROVAL LETTER

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Faculty of Health Sciences

Institution: The Research Ethics Committee, Faculty Health Sciences, University of Pretoria complies with ICH-GCP guidelines and has US Federal wide Assurance.
- FWA 00002567, Approved dd 22 May 2002 and Expires 03/20/2022.
- IORG #: IORG0001762 OMB No. 0990-0279 Approved for use through February 28, 2022 and Expires: 03/04/2023.

Faculty of Health Sciences **Research Ethics Committee**

20 January 2022

Approval Certificate
Annual Renewal

Dear Miss ILT Sivhugwana,

Ethics Reference No.: 380/2019 – Line 3
Title: Factors related with the functional outcome of patients who sustained tibial plateau fractures

The **Annual Renewal** as supported by documents received between 2020-02-03 and 2022-01-19 for your research, was approved by the Faculty of Health Sciences Research Ethics Committee on 2022-01-19 as resolved by its quorate meeting.

Please note the following about your ethics approval:
- Renewal of ethics approval is valid for 1 year, subsequent annual renewal will become due on 2023-01-20.
- Please remember to use your protocol number (380/2019) on any documents or correspondence with the Research Ethics Committee regarding your research.
- Please note that the Research Ethics Committee may ask further questions, seek additional information, require further modification, monitor the conduct of your research, or suspend or withdraw ethics approval.

Ethics approval is subject to the following:
- The ethics approval is conditional on the research being conducted as stipulated by the details of all documents submitted to the Committee. In the event that a further need arises to change who the investigators are, the methods or any other aspect, such changes must be submitted as an Amendment for approval by the Committee.

We wish you the best with your research.

Yours sincerely

On behalf of the FHS REC, Dr R Sommers
MBChB, MMed (Int), MPharmMed, PhD
Deputy Chairperson *of the Faculty of Health Sciences Research Ethics Committee, University of Pretoria*

The Faculty of Health Sciences Research Ethics Committee complies with the SA National Act 61 of 2003 as it pertains to health research and the United States Code of Federal Regulations Title 45 and 46. This committee abides by the ethical norms and principles for research, established by the Declaration of Helsinki, the South African Medical Research Council Guidelines as well as the Guidelines for Ethical Research: Principles Structures and Processes, Second Edition 2015 (Department of Health)

Research Ethics Committee
Room 4-60, Level 4, Tswelopele Building
University of Pretoria, Private Bag x323
Gezina 0031, South Africa
Tel +27 (0)12 356 3084
Email: deepeka.behari@up.ac.za
www.up.ac.za

Fakulteit Gesondheidswetenskappe
Lefapha la Disaense tša Maphelo

ANNEXURE H: LETTER OF CLEARANCE FROM THE BIOSTATISTICIAN

Date: 23 / 7 /2019

LETTER OF CLEARANCE FROM THE BIOSTATISTICIAN

This letter is to confirm that,

Name(s): Ms Innocentia Sithungwana

from the University of Pretoria

discussed with me the study titled _____

_____

_____

I hereby confirm that I am aware of the project and also undertake to assist, if possible, with the Statistical analysis of the data generated from the project.

The analytical tool(s) that will be used is (are) Multivariable linear regression and descriptive statistics. Please refer 'Statistical considerations' section in protocol.

_____

_____

to achieve the objective(s) of the study.

Name: PJ Becker (Tel: 012-319-2203)

Signature _____

Research Office,

Faculty of Health Sciences, UP

BIOSTATISTICS
Faculty of Health Sciences
Research Office
2019 -07- 23
UNIVERSITY OF PRETORIA

ANNEXURE I: DATA COLLECTION INSTRUMENT

DEMOGRAPHIC AND INJURY DATA COLLECTION SHEET

Patient number …….

1. Age when the injury occurs

2. Gender: male female

3. Occupation at the time of injury: **Yes (employed) No (unemployed)**

After the injury were you able to return to the same employment?

4. Level of activities before an injury

LOW (Housebound) **MODERATE** (Shopping) **HIGH** (Outdoor activities)

5.Did you receive social (family, friends, neighbours, or community) support during the recovery phase after the injury?

Yes **No**

6. Diagnoses/ fracture types (Schatzker classification)

Type I	Type II	Type III	Type IV	Type V	Type VI

7. Other injuries:

8. Pre- intervention complications: **yes** **No**

9. post-intervention complications: **yes** **No**

10. Surgical intervention: **yes** **No**

11. Physiotherapy: **yes** **No.**

whether yes for how long?

12. Any other medical disciplines: **yes** **No.**

Whether yes for how long?

14. Home exercise program/advice given upon discharge: **yes** **No.**

Physiotherapist Data collection date

ILT SIVHUGWANA

KOOS-12 KNEE SURVEY

INSTRUCTIONS: This survey asks for your views about your knee. Answer every question by marking the appropriate box, only one box for each question. If you are unsure about how to answer a question, please give the best answer you can

Pain

1. How often do you experience knee pain?

Never	Monthly	Weekly	Daily	Always
☐	☐	☐	☐	☐

What amount of knee pain have you experienced the **last week** during the following activities?

2. Walking on a flat surface

None	Mild	Moderate	Severe	Extreme
☐	☐	☐	☐	☐

3. Going up or down stairs

None	Mild	Moderate	Severe	Extreme
☐	☐	☐	☐	☐

4. Sitting or lying

None	Mild	Moderate	Severe	Extreme
☐	☐	☐	☐	☐

Function, daily living

The following questions concern your physical function. By this we mean your ability to move around and to look after yourself. For each of the following activities please indicate the degree of difficulty you have experienced in the **last week** due to your knee.

5. Rising from sitting

None	Mild	Moderate	Severe	Extreme
☐	☐	☐	☐	☐

6. Standing

None	Mild	Moderate	Severe	Extreme
☐	☐	☐	☐	☐

7. Getting in/out of a car

None	Mild	Moderate	Severe	Extreme
☐	☐	☐	☐	☐

8. Twisting/pivoting on your injured knee

None	Mild	Moderate	Severe	Extreme
☐	☐	☐	☐	☐

Quality of Life

9. How often are you aware of your knee problem?

Never	Monthly	Weekly	Daily	Constantly
☐	☐	☐	☐	☐

10. Have you modified your life style to avoid potentially damaging activities to your knee?

Not at all	Mildly	Moderately	Severely	Totally
☐	☐	☐	☐	☐

11. How much are you troubled with lack of confidence in your knee?

Not at all	Mildly	Moderately	Severely	Extremely
☐	☐	☐	☐	☐

12. In general, how much difficulty do you have with your knee?

None	Mild	Moderate	Severe	Extreme
☐	☐	☐	☐	☐

Thank you very much for completing all the questions in this questionnaire.

ANNEXURE J: DATA COLLECTION SHEET SUMMARY

DEMOGRAPHIC AND INJURY DATA COLLECTION SHEET

Patient	Year of injury	Mechanism of injury	Limb	DEMOGRAPHIC AND INJURY DATA COLLECTION SHEET												
				1	2	3	4	5	6	7	8	9	10	11	12	13
A1	2015	falls	L	50	M	-yes-unable-driver	moderate	yes	IV	n	no	no	SUR	Yes 3x	No	yes
B5	2019	MVA	L	21	F	no	high unable soccer	yes	VI	no	no	no	SUR	no	No	no
C2	2018	assaults	R	34	M	yes	moderate	no	I	no	no	no	CONS	Yes 1x	No	no

1=Age, 2=Gender, 3=Occupation, 4=Level of activity, 5=Social support, 6=Fracture type, 7=Other injuries, 8=Pre-intervention complications, 9=post-intervention complications, 10=Surgical or conservative, 11=Physiotherapy, 12=Other discipline, 13=Home exercise program.

KOOS-12 SCORE

	KOOS-12 score											
patient	1	2	3	4	5	6	7	8	9	10	11	12
A1	Weekly	None	mild	Extreme	None	Extreme	None	None	Weekly	mildly	Mildly	Mild
B5	Daily	Mild	severe	Mild	Mild	Mild	Mild	Mild	Daily	mildly	Mildly	Severe
C2	never	none	moderate	none	none	none	none	none	never	Totally	mildly	Moderate

ANNEXURE K: PARTICIPANT'S INFORMATION & INFORMED CONSENT

STUDY TITLE: Factors related with the functional outcome of patients who sustained tibial plateau fractures.

Principal Investigator: Innocentia Lavhengwa Takalani Sivhugwana

Supervisor: Dr E. Korkie

Institution: University of Pretoria

Daytime telephone number: 0815077112

DATE AND TIME OF INFORMED CONSENT DISCUSSION:

Dd	**month**	**year**	**Time of a call**

Dear Prospective Research Participant

Dear Mr /Ms /Mrs …….

1) INTRODUCTION

You are invited to volunteer for a research study. I am doing this research for a Physiotherapy Master's degree purposes at the University of Pretoria. The information in this document is provided to help you to decide whether you would like to participate. Before you agree to take part in this study, you should fully understand what is involved. Whether you have any questions, which are not fully explained in this document, do not hesitate to ask the researcher. You should not agree to take part unless you are completely happy with the kind of questions that will be asked.

2) THE NATURE AND PURPOSE OF THIS STUDY

1. The aim of this study is to determine factors related with the functional outcome of patients who sustained tibial plateau fracture (breakage of the upper part of the shin bone) by means of a questionnaire. By doing so, we wish to learn more about factors related with the activity of daily living, quality of life and the pain of patients after a breakage of the upper part of the shin bone.

3) EXPLANATION OF PROCEDURES AND WHAT WILL BE EXPEXTED FROM PARTICIPANTS

This study involves answering some questions regarding your personal information (age, occupation, history of your injury), participation activities of daily living (stair climbing), pain (when standing) and quality of life (changes in lifestyle since you broke your leg) after a breakage of the upper part of the shin bone.

We would like you to answer a questionnaire telephonically. The questionnaire consists of 12 items (questions) and will take approximately two minutes. The interview will be audio-taped for quality purpose. The research assistant, who is not a physiotherapist, will phone you at the convenient time that you will choose. He/she will read the

questionnaire and tick relevant blocks for you as you answer the questions. The researcher will keep the completed questionnaires and audiotape in a safe place to make sure that only people working on the study will have access to it. Your name will not be written on the questionnaire or stated in the audio tapping. This will ensure that your answers are kept confidential (so nobody will know what you have answered).

The questionnaire consists of one/two/three parts:

Part 1: Socio-demographic information which involves answering some questions about your age, hobbies, where you live, employment, etc.

Part 2: Health Questionnaire which involves answering some questions about your medical history, any symptoms you may have that could indicate an illness, any medication you are using, etc.

4) RISK AND DISCOMFORT INVOLVED

There is no foreseeable physical discomfort or risk involved. Whether there are questions that are too sensitive for you to answer, you do not need to answer them.

Some questions may be sensitive, such as questions about history of your trauma. The researcher can refer you for counselling whether these questions upset you.

……

5) POSSIBLE BENEFITS OF THIS STUDY

This study may help the healthcare provider to identify the factors associated with the functional outcome in patients and provide evidence-based rehabilitation, advice and reference to other relevant disciplines whether needed. On discharge, patients can be given advice and overview of what to expect in the short and long term. This can prevent residual disability and improve a patient's functional outcome and quality of life.

6) ETHICS APPROVAL

This Protocol was submitted to the Faculty of Health Sciences Research Ethics Committee, University of Pretoria, Medical Campus, Tswelopele Building, Level 4-59, Telephone numbers 012 356 3084/012 356 3085 and written approval has been granted by that committee. The study has been structured in accordance with the Declaration of Helsinki (last update: October 2013), which deals with the recommendations guiding doctors in biomedical research involving humans. A copy of the Declaration may be obtained from the investigator should you wish to review it.

7) INFORMATION

If you have any questions concerning this study, you may contact: Innocentia Sivhugwana at 0815077112.

8) CONFIDENTIALITY

All records from this study will be regarded as confidential. All results will be published or presented in such a way that it is not possible to identify the participants.

9) COMPENSATION

You will not be paid to take part in the study. There are no costs involved for you to be part of the study.

9) CONSENT TO PARTICIPATE IN THIS STUDY

- I confirm that the person requesting my consent to take part in this study has told me about the nature and process, any risks or discomforts, and the benefits of the study.
- I have also heard and understood the above written information about the study.
- I have had adequate time to ask questions and I have no objections to participate in this study.

- I am aware that the information obtained in the study, including personal details, will be anonymously processed, and presented in the reporting of results.
- I understand that I will not be penalised in any way should I wish to discontinue with the study and my withdrawal will not affect my employment or student status.
- I am participating willingly.
- I am aware that the interview will be audio tapped and I agree to it.

Participant's name (Please print) Date

…… ……..

Participant's signature (last name & initials) Date

…… ……..

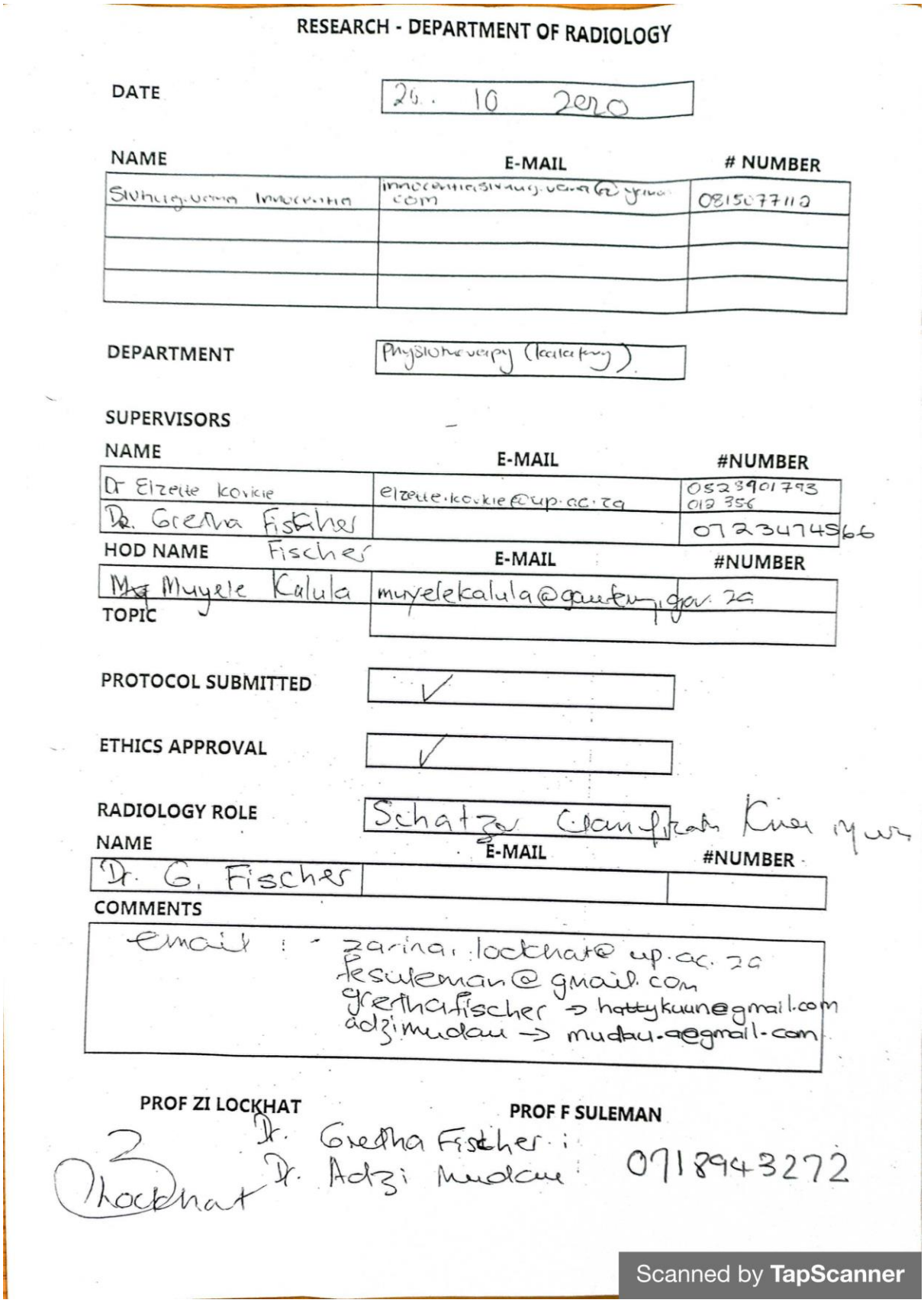
Researcher's name (Please print) Date

INNOCENTIA SIVHUGWANA …….

Researcher's signature Date

ILT SIVHUGWANA ……

ANNEXURE L: THE RADIOLOGIST COMMUNICATION



RESEARCH - DEPARTMENT OF RADIOLOGY

DATE: 26. 10 2020

NAME	E-MAIL	# NUMBER
Sivhugwama Innocentia	innocentiasivhugwama@gmail.com	0815077110

DEPARTMENT: Physiotherapy (Faculty)

SUPERVISORS

NAME	E-MAIL	#NUMBER
Dr Elzette Kovkie	elzette.kovkie@up.ac.za	0523901793 012 356
Dr. Gretha Fischer		0723474566

HOD NAME Fischer	E-MAIL	#NUMBER
Mr Muyele Kalula	muyelekalula@gauteng.gov.za	

TOPIC

PROTOCOL SUBMITTED: ✓

ETHICS APPROVAL: ✓

RADIOLOGY ROLE: Schatzer Clamfrom Kuen Myer

NAME	E-MAIL	#NUMBER
Dr. G. Fischer		

COMMENTS

email : - zarina.lockhat@up.ac.za
fesuleman@gmail.com
grethafischer → hattykuun@gmail.com
adzimudau → mudau.a@gmail.com

PROF ZI LOCKHAT

Lockhat

PROF F SULEMAN

Dr. Gretha Fischer :
Dr. Adzi Mudau : 0718943272

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