UNIVERSITY OF RWANDA

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Department of Surgery

UNATTAINED OPERATIVE NEEDS FOR LONG BONE FRACTURES IN KIGALI PUBLIC REFERRAL HOSPITALS

A dissertation submitted in partial fulfillment of the requirements for the degree of Master of Medicine in Orthopedic Surgery in the School of Medicine and Pharmacy, College of Medicine and Health Sciences.

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DECLARATION

I declare that this dissertation entitled "**Unattained Operative Needs for Long Bone Fractures in Kigali Public Referral Hospitals**" is my own work except where specifically acknowledged. It has not been submitted for any other degree at university of Rwanda or any other institution.

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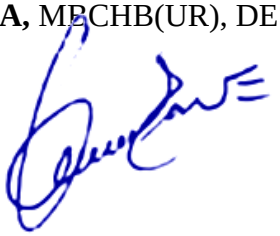
Signature: 

Date: **16/12/2020**

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Signature: 

Date: **16/12/2020**

DEDICATIONS

To IMBONERE, JABO, and INEMA for your love, support, and patience;

To my parents, brother, and sisters for your love and support;

To all lecturers, teachers, and fellows who shaped me;

To all comrades who are still struggling to make their dreams true ;

I dedicate this dissertation.

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LIST OF SYMBOLS AND ACRONYMS

A&E:	Accident and Emergency
AAOS:	American Academy of Orthopedic Surgeons
AO:	Arbeitsgemeinschaft für Osteosynthesefragen
CBHI:	Community-Based Health Insurance
CHUB	Centre Hospitalier Universitaire de Butare/University Teaching Hospital of Butare
CHUK:	Centre Hospitalier Universitaire de Kigali/University Teaching Hospital of Kigali
CEO	Chief Executive Officer
DALY:	Disability-Adjusted Life Year
DCO:	Damage Control Orthopedics
FDA:	Food and Drug Administration (USA)
HIV:	Human Immunodeficiency Virus
IQR:	Interquartile range
IRB:	Institutional Review Board
ISS:	Injury severity score
JOT:	Journal of Orthopedic Trauma
LMICs:	Low- and middle-income Countries
LOS:	Length of stay
MDGs:	Millennium Development Goals
MMI:	Military Medical Insurance
NSOAP:	National Surgical, Obstetric, and Anesthesia Plan
ORIF:	Open reduction and Internal Fixation
OTA:	Orthopedic Trauma Association
RMH:	Rwanda Military Hospital
ROM:	Range of motion
RSSB:	Rwanda Social Security Board
RTIs:	Road Traffic Injuries
SUFE:	Slipped Upper Femoral Epiphysis
WHO:	World Health Organization
YLD:	Years Lost because of Disability
YLL:	Years of Life Lost

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DEFINITION OF KEY TERMS

1. Operative needs

The operative needs or surgical needs is the number of subjects with a disease or condition requiring surgery within a population [1]. Needs for surgery are defined as the number of surgical procedures needed for a disease or condition in a population [2].

2. Long bones

Longs bones are type of bones which has tubular aspect and longer than they are wide. These include clavicle, humerus, radius, ulna, femur, tibia, fibula, metatarsals, metacarpals, and phalanges [3].

3. Fracture

Bone fracture is defined as the partial or complete disruption of the bone continuity secondary to direct or indirect forces [4].

4. Ubudehe [5]

A traditional Rwandan practice and culture consisting of collective action and mutual support to solve community problems. Since 2001, it is one of the home-grown solution that has a socioeconomic classifications used as key tool for social protection:

Category 1: Very poor and vulnerable citizen, unabe to have feeding without assistance and homeless.They benefit a free medical insurance.

Category 2: Citizen who can afford some form of rented accomodation or own low class houses, but are not employed. The afford to eat once or twice a day.

Category 3: Employed citizen or those who are employers of labour. Small farmers, who moved beyond subsistence farming,or who own small and medium scale entreprises.

Category 4: Wealthiest citizen, CEO of large scale entreprises and businesses, or full time employed.

ABSTRACT

Background: Traumatic injuries are among the leading causes of death and disabilities worldwide. Orthopedic injuries, especially long bone fractures, remain most common and are associated with the burden of morbidity and disability. Access to the appropriate surgical care remains challenging in low- and middle-income countries (LMICs). This study aimed to evaluate the burden of unattained operative needs for long bone fractures in Kigali public referral hospitals and associated factors.

Methodology: A cross-sectional study was carried out in two public referral hospitals located in Kigali. We screened patients with long bone fractures who presented within one week of injury and recruited patients whose fractures required operative management for optimal outcome according to the AO Surgery Reference. Pearson chi-square test and binary logistic regression analysis were used to evaluate for factors associated with unattained operative needs within six weeks of presentation.

Results: Among 281 patients with fractures requiring operative management, 68.3% were males and 31.7% were females. The median age was 33 years (IQR=19-47) with a bimodal distribution (6-10 years and 31-35 years). After 6 weeks, the unattained operative needs were 46.3%. Seven factors were significantly associated and related to unattained operative needs for long bone fractures: To miss the hospital admission on presentation (OR=28.187, p<0.001), closed fracture (OR=6.459, p<0.001), lower injury severity (OR=6.250, p=0.001), consulting outpatient clinic (OR=3.785, p<0.001), fracture without associated injuries (OR=2.146, p=0.047), upper limb fracture (OR=2.105, p=0.001), and being female (OR=1.679, p=0.045). Among patient-reported barriers to the access of surgical care for long bone fractures, the operative need was not acknowledged for 39.4%, the lack of implant and equipment for 24.1%, and lack of admission bed for 16.8%.

Conclusion: The unattained operative needs for long bone fractures in Kigali public referral hospitals remain important. Efforts should be put in the improvement of coordination through the referral and follow-up system for patients with identified associated factors and to address identified barriers to the access of surgical care for long bone fractures.

Keywords: Unattained, Long bones, Operative needs, Fractures, Kigali

CHAPTER ONE: INTRODUCTION

1.1. Background

Traumatic injuries are the third leading cause of death and disabilities worldwide for decades [6]. The World Health Organization (WHO) noted that road traffic injuries (RTIs) are the leading cause of death in young people aged 15-29 years globally [7]. Orthopedic injuries are common among all traumatic injuries with upper and lower limbs affected commonly[8–10] .

In higher-income countries (HICs), programs and initiatives for traumatic injury prevention through the understanding of injury mechanism and innovation of preventive measures (i.e. seatbelts, dashboard paddings, helmets, etc...) have been in place since 1961 [11]. The understanding of the role of the host (fatigue, alcohol influence, operator experience, etc…), agent (vehicle technical errors), and environment (weather, roads, worksite safety, etc…) have led to their effective control and reduced the risk for traumatic injuries [11,12]. The timely evacuation system to the trauma center, the availability of specialized trauma surgical care, and the ability to afford the surgical care are other parameters that may explain the improved traumatic injury outcomes in these countries [13–16].

In low- and middle-income countries (LMICs), there are absent or inefficient systems for the prevention of traumatic injuries, and accessibility to appropriate care of orthopedic injuries is limited [6]. Patients with injuries face challenges of accessibility, availability, and affordability of safe surgical care [17,18].

In our region, like in other LMICs, access to surgical management of orthopedic injuries remains challenging. A study that was done to assess musculoskeletal trauma care capacity in East, Central, and Southern Africa reported an alarming gap in human resources, diagnostic and treatment infrastructures, and unreliable supply of needed implants for safe surgical care [19]. In Northern Tanzania, by combining 4 parameters defining the accessibility to orthopedic surgical care (timeliness, surgical capacity, safety, and affordability) reported that 90% of the population didn't have access to orthopedic surgical services [20].

Even though musculoskeletal injuries are not associated with higher mortality compared to other traumatic injuries, they remain the leading cause of morbidity and increased

disability-adjusted life years (DALYs). In addition, the cost of care of musculoskeletal injuries was reported to be higher and causing socioeconomic burden to patients [6,21,22]. Among all trauma-related fractures, fractures of long bones are common both in HICs, and LMICs [8–10,23].

The advancing novel treatment in aesthesia, antibiotics, orthopedic implants, and surgical techniques has led to the increased preference of operative management of long bone fractures over non-operative management (e.g. cast, splint, traction, bracing,) especially in adults [24]. While having well-trained personnel, environmental safety, efficient supply, and logistics remains challenging in LMICs, the advantage of operative treatment over non-operative treatment is well documented especially for unstable, open, and complex fractures (intra-articular fractures and facture-dislocations) [25,26].

In our region, it has been reported that the operative needs for long bone fractures especially the lower limb is often unattained. In Uganda, a study on femoral and tibia fractures socioeconomic implication reported that only 56% were operated due to different patients' and hospital challenges [25]. In Tanzania, studies done on epidemiology and management of tibia and femur fractures reported higher prevalence of non-operative management (i.e. traction and casting) despite their known inferior functional outcome. Factors associated with challenges to attain operative needs for these fractures included patient's poor socioeconomic status, hospital's human resources and supply of needed implants[27,28].

Despite controversies, settings, and orthopedic surgeons preferences and experience, the superiority of operative management of long bone fractures is well documented for adult fractures and has narrowed the room for non-operative management [29–33]. Although in the pediatric population, the use of non-operative management is still valuable with good outcome, the use of novel techniques of fracture fixation (fluoroscopy-guided closed reduction and k-wire fixation, titanium flexible nails, cannulated screw fixation…) have been reported to provide superior outcome on open and unstable fractures of the upper and lower extremity [34–37].

In Rwanda, progressive efforts are being invested in the improvement of health care delivery including trauma care [38]. While traumatic orthopedic injuries have been reported to be common in Kigali referral hospitals, little is known about the access to orthopedic surgical care for long bone fractures [10,39].

1.2. Problem statement

There is no doubt that orthopedic injuries are the most common both in high-income countries, and low- and middle-income countries [8,9]. Despite those alarming data, the challenge of access to safe surgical care remains a concern globally and especially in LMICs [19,20].

Since 2018, Rwanda has embraced the global move toward the strengthening of emergency and essential surgical care. In this regard, the National Surgical, Obstetric, and Anesthesia plan 2018-2024 (NSOAP) was initiated with key targets of strengthening the surgical care of orthopedic traumatic injuries among others [38]. In Rwanda, there is a need for supporting data that will help to identify gaps and challenges facing the access to orthopedic trauma surgical care and long bone fractures in particular.

Although existing data revealed that orthopedic procedures are the most common procedures done for traumatically injured patients at a rate of 84.2% [39], there is no data on the unattained operative needs for long bone fractures and associated factors in Kigali public referral hospitals.

1.3. Research Question

What is the proportion of unattained operative needs for long bone fractures and associated factors in Kigali public referral hospitals?

1.4. Research hypothesis

There are significant proportion of unattained operative needs for long bone fractures in Kigali public referral hospitals associated with socio-economic status, fracture characteristics, injury severity, and deficient hospital resources.

1.5. Research objectives

1.5.1. General objective

To evaluate the proportion of unattained operative needs for long bone fractures in Kigali public referral hospitals and associated factors.

1.5.2. Specific objectives

a) To evaluate the proportion of unattained operative needs for long bone fractures in Kigali public referral hospitals;
b) To describe long bone fractures with indicated operative treatment and associated injuries in Kigali public referral hospitals;
c) To assess the association between unattained operative needs for long bone fractures and patients' socio-economics characteristics, fractures characteristics, associated injuries, and hospital resources factors.

1.6. Conceptual framework

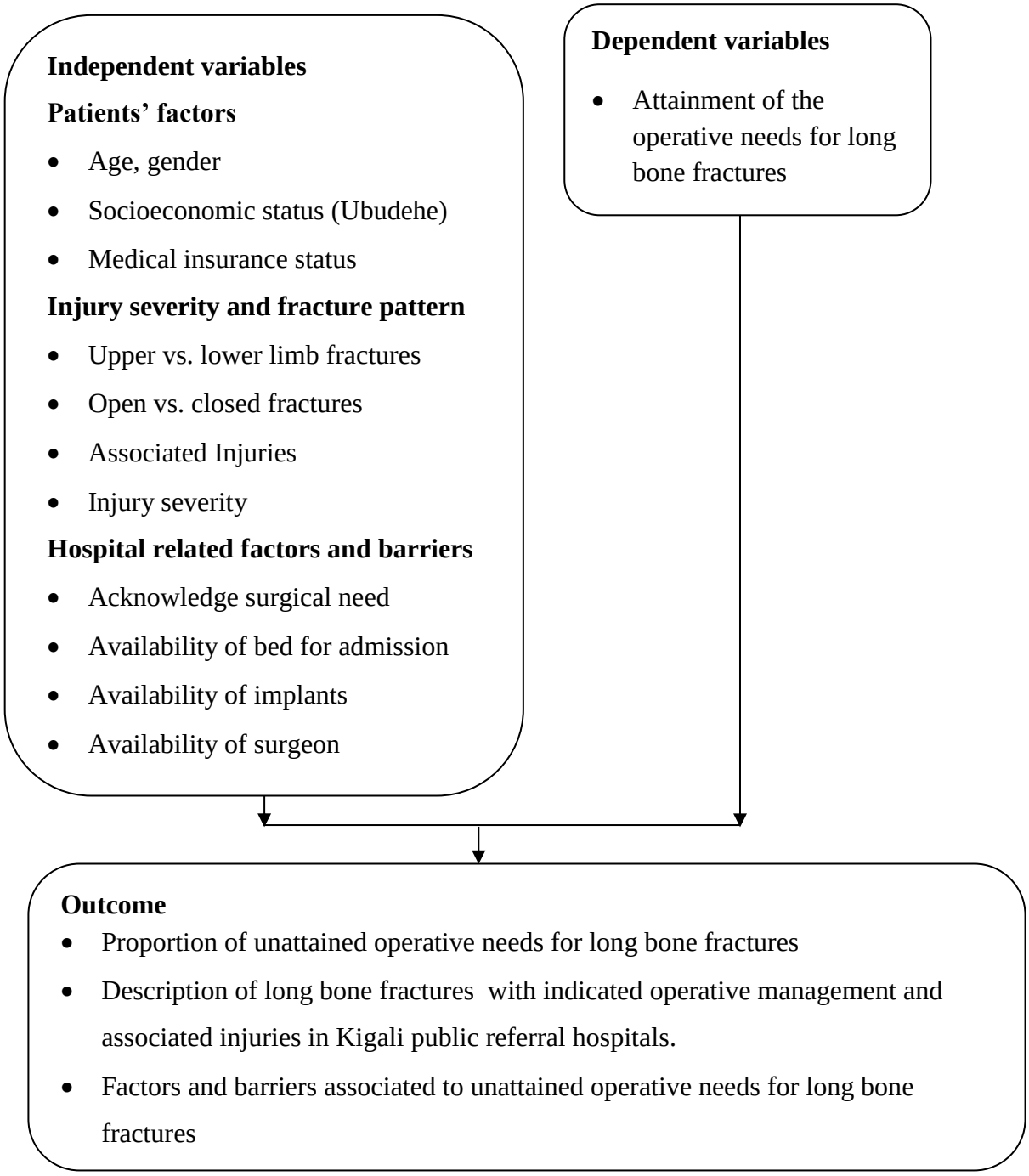

Figure 1. Conceptual framework

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

This chapter details the theoretical and empirical concepts of fractures of long bones, AO fracture classification and principles of management, the burden of musculoskeletal injuries, and challenges of access to the operative management of fractures, especially long bone fractures in LMICs.

2.2. Theoretical literature

2.2.1. Fractures and bone healing

Bones are connective tissues arising from embryonic mesoderm. They are composed of cells (osteoblast, osteocytes, osteoclast, hematopoietic cells), and extracellular matrix (hydroxyapatite, collagen, osteocalcin, osteonectin, osteopontin, cytokines, and growth factors) [40,41].

Bones play both mechanical and physiological functions. Mechanically they facilitate locomotion, protect, provide structural support to soft tissues. Physiologically they are major actors in calcium-phosphates metabolism, and hematopoiesis [40].

Bone fracture is defined as the partial or complete disruption of the bone continuity secondary to direct or indirect forces [4]. The fracture healing consists of anatomical, and biochemical processes that restore the bone continuity and properties. Although it is a multifactorial process, the viability of fracture fragments and stability are major factors for bone healing [42].

The fracture healing process starts with hematoma collection which contains different cell lineages including osteoprogenitor cells. The expression of inflammatory markers and growth factors leads to cell differentiation and formation of a cartilaginous matrix (callus), which is later replaced by bone matrix. The bone matrix undergoes remodeling to form solid lamellar bone under the impact of mechanical stresses. This process is continuous and overlapping in time. In general, under normal circumstances after 3 weeks the soft callus is in place and undergoes progressive hardening. After 6 to 8 weeks the callus is hard enough to withstand mechanical stress [43].

According to the United States Food and Drug Administration (FDA), the fracture non-union is defined as the failure of the fracture repair processes 9 months after injury. Serial

radiographs taken after every three months show no progression towards healing [44]. There is no consensus between physicians on the time definition of non-union as it has been defined from 2-12 months [45]. Fracture non-union is associated with prolonged pain, functional disability, reduced quality of life, psychosocial and financial burden [46,47]. While the treatment of non-union is demanding and costly, it makes more sense to ensure adequate fracture stabilization through immobilization and fracture fixation whenever possible and required [47,48].

Fracture mal-union is defined as the fracture healing with fragments in unsatisfactory position. It may result in limb shortening, deformities, and chronic pain secondary to the distorted biomechanics and associated degenerative joint disease on involved or adjacent joints. To prevent fracture mal-union, adequate reduction and stable fixation is paramount especially in intra-articular fractures [49].

2.2.2. Fracture classification and their clinical relevance

Fracture classification is a method used to describe the fracture in terms of localization, morphology, severity, or to guide treatment. The purpose is to facilitate inter-user communication, to assist documentation and research, to anticipate the prognosis, or dictate the management [50]. Even though multiple fracture classifications are used in orthopedics, the challenge of inter-observer reliability and validation remains to be widely accepted in practice[51].

Several fracture classifications describe one bone fracture and don't apply to other bones. In the efforts to have a standardized language and uniform data, a comprehensive classification of fractures of long bones was developed by Maurice E. Müller and now evolved into AO/OTA Classifications in a unified form [50]. This classification system has good to excellent accuracy and reliability [52].

2.2.3. The AO/OTA fracture classification for long bone fractures

The AO/OTA classification is a compendium of human bones fracture classification published in 1996 and updated in 2018 in the Journal of Orthopaedic Trauma (JOT) [50]. This system of fracture classification was developed by Maurice E. Müller and colleagues and adopted by AO Foundation in 1987 [53]. Although it is now extended to all bone fractures and incorporated dislocations and pediatric fractures, in the beginning, only long bone fractures were described [50].

Today, it is the official fracture classification system for AO, OTA, and JOT, available online, and used globally. It is a reliable, reproducible, and validated clasification for its role in the improvement of fracture information communication, storage, and management [54–56]. The AO/OTA classification uses numbers and alphabets to classify bone fractures according to the bone, the segment of the bone, and the type or pattern of the fracture lines which it subdivides into groups. Subgroups, qualifications, and universal modifiers are used to provide further morphological details on displacement, impaction, associated dislocations, bone quality, extension, etc…[50].

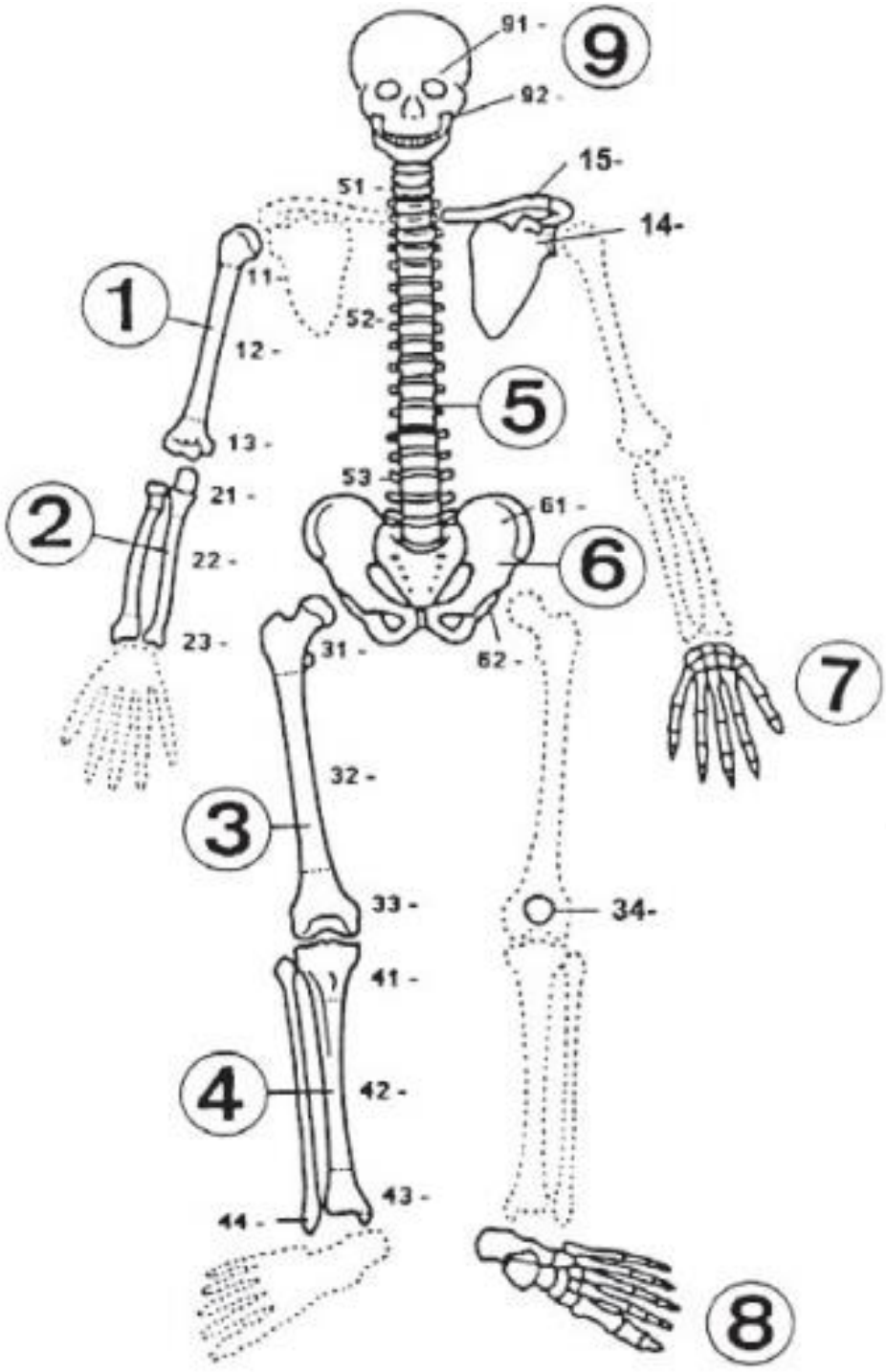

Figure 2. AO/OTA classification designation of bone and bone segment.
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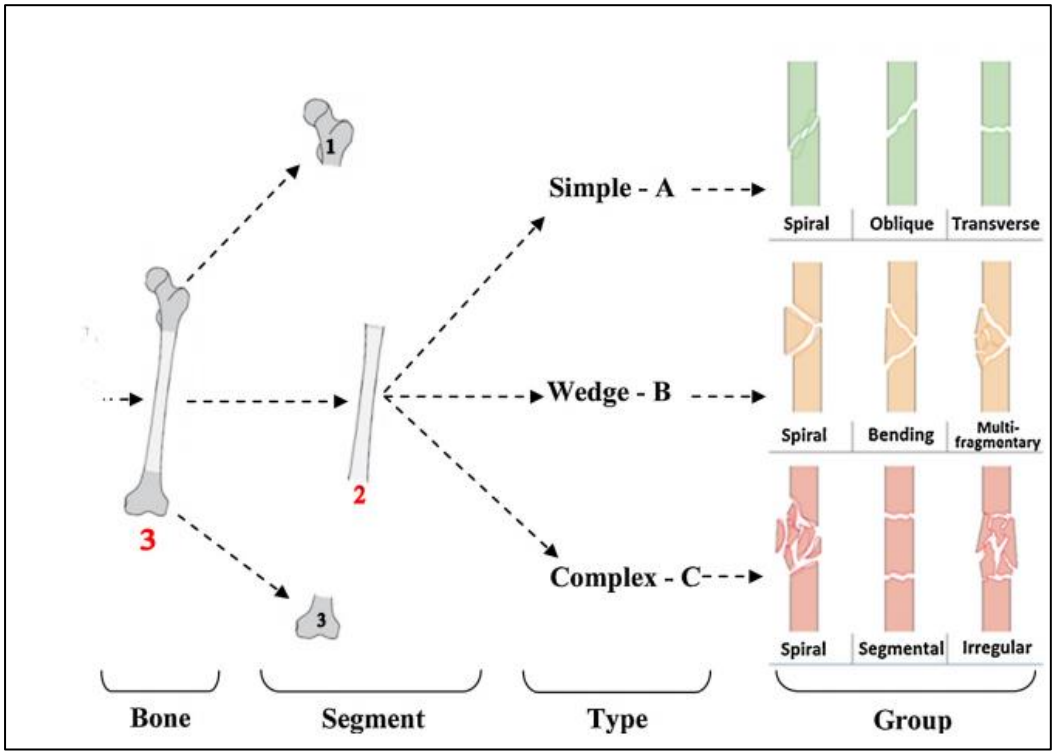

Figure 3. AO/OTA classification of bone shaft fracture

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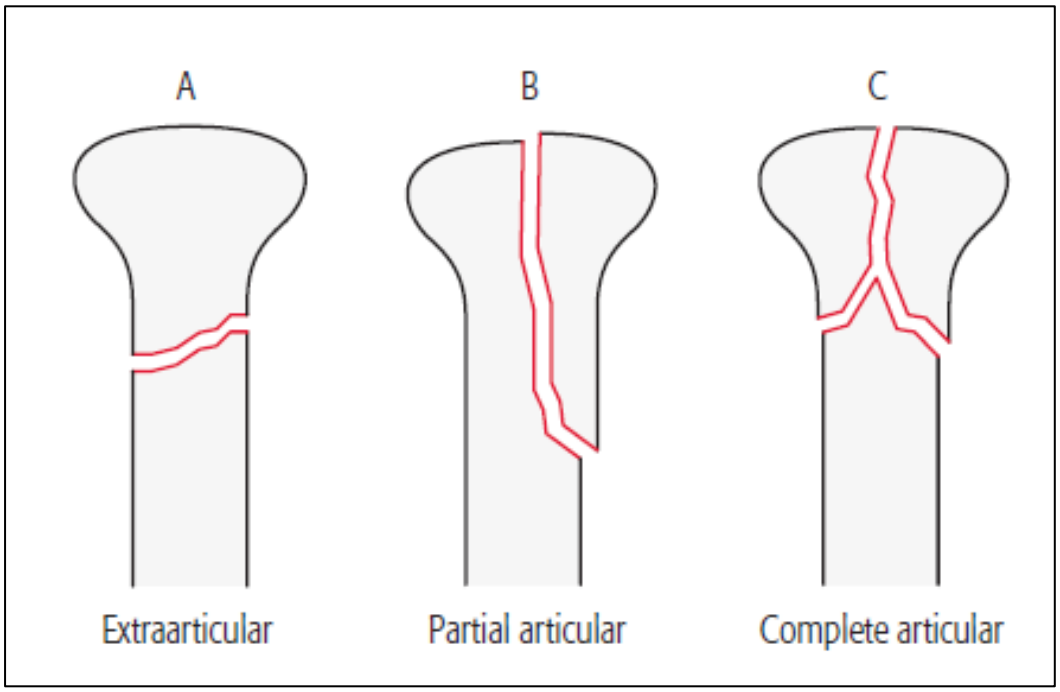

Figure 4. AO/OTA classification for end segment fractures

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2.2.4. General principles of long bone fractures management

Depending on the energy, the mechanism, the bone stock, and the skeletal maturity, different bone fractures patterns have been described in the literature. The analysis of the above components influences the choice of fracture management and the outcome [57,58].

High energy injury presents generally with comminuted fractures, segmental fractures, open fractures, multiple fractures, severe soft tissue injuries, or internal vital organ injuries. It may also present with a simple fracture pattern on a bone deemed to be hard to get the fracture easily [58]. The management of such injuries require the use of Acute Trauma Life Support (ATLS) protocol to be able to detect and treat life-threatening injuries, and then later, proceed to definitive fracture care. In some cases, the principles of damage control orthopedics (DCO) may apply by temporary immobilization of the fracture (cast, skin traction), debridement and external fixation of open fractures and reduction of dislocations associated while waiting the inflammatory phase to set down and proceed with definitive management (appropriate reduction and fixation) [57].

Low energy injury leads to simple fracture pattern (closed, spiral or oblique) and isolated to single bone or body part. They also occur on the fragile bones secondary to the pathologic process (infection, osteopenia, osteomalacia, or tumors). They are rarely associated with remarkable soft tissues or internal organ injuries. Such fractures generally benefit early definitive treatment (reduction and immobilization, or fixation) [57,58].

Open fractures and other fractures associated with severe soft tissue injuries or infection are treated with surgical debridement and antibiotic therapy. External fixation or internal fixation may be warranted depending on the fracture grade, soft tissues status, and available best evidences [59].

While the fracture union and functional recovery remain the goal of the fracture treatment, pre-injury health condition, level of function, and the impact of surgery on the patient need to be evaluated carefully especially in frail and elderly patients. This helps to avoid invasive surgical procedures and proceed with minimally invasive or non-operative treatment to minimize surgery-related morbidities and mortality [60].

Pediatric fractures present special patterns and morphologies. The thick periosteum, open growth plate, and elastic bones compared to their adult peers result in the occurrence of incomplete fractures (buckle, greenstick), and physeal fractures [50]. In addition, the healing

process of pediatric fractures is rapid and the remodeling of malunion is more effective to correct deformities left behind. The above facts favor non-operative management for pediatric fractures [61].

In summary, fracture healing needs a customized assessment and management to ensure adequate reduction and stable fixation and also to control all other factors that may compromise the healing process and functional recovery [44].

Table 1. Risk factors of bone fracture non-union [44]

Patient Dependent Factors
▪ Medical comorbidities (eg, diabetes, vascular disease) ▪ Advanced age ▪ Sex ▪ Smoking/nicotine use ▪ Alcohol abuse ▪ Nonsteroidal anti-inflammatory drug use ▪ Nutritional deficiency ▪ Radiation treatment ▪ Genetic disorders (eg, neurofibromatosis, osteogenesis imperfecta, osteopetrosis) ▪ Metabolic disease or endocrine pathology (eg, hypothyroidism, vitamin D deficiency)
Fracture Dependent Factors
▪ Pattern of bony injury ▪ Degree of comminution ▪ Adequacy of reduction and cortical apposition ▪ Interposed soft tissue ▪ Bone involved ▪ Fracture site on the bone ▪ Status of the soft tissues ▪ Extent of bone loss ▪ Stability of fracture fixation ▪ Infection

2.2.5. AO Surgery Reference guideline on long bone fractures management

For more than 60 years, the AO Foundation, an international non-profit organization from Davos, Switzerland has been leading in the provision of research, education, training, and guiding tools for fracture management [62,63].

It provides courses regarding the non-operative and operative treatment of fractures with theoretical and hands-on experience. The "Davos Course" is one of its courses that provide unique hands-on training to surgeons on sawbones or human specimens for specific implants use, surgical approaches, and techniques [62]. Through the AO alliance, the AO has improved the fracture care in LMICs through innovative solutions and local capacity building [64].

The AO Surgery Reference is a free of charge online application which is owned by AO Foundation that provides a complete guide on fracture management and follow-up protocols following AO/OTA fracture classification, current clinical principles, practices and available best evidences [63].

Table 2. Fractures to be treated surgically in skeletally mature patients according to AO Surgery Reference [50,59]

Bone	AO/OTA classification	Comments
Humerus	• 11A(1), 11B, 11C • 12(2) • 13A, 13B, 13C	(1)Displaced (> 5mm for greater tuberosity fractures) (2) Inadequate reduction, open fractures.
Radius and/or Ulna	• 2R1A, 2R1B(1), 2R1C(1), 2U1A(3), 2U1B, 2U1C • 2R2, 2U2(2) • 2U3(1), 2R3A(3), 2R3A(3), 2R3B , 2R3C	(1)Displaced, impaired ROM, (2)Displaced nightstick fracture (3)Displaced
Femur	• 31 • 32 • 33	
Tibia	• 41A(1), 41B, 41C • 42A1(2), 42A2, 42A3, 42B, 42C • 43A(1), 43B, 43C	(1)Displaced (2)Displaced and angulated
Ankle	• 44(1) • 44B(1) • 44C	(1)Bony ,displaced
Clavicle	• 15.1(1) • 15.2(2) • 15.3(2)	(1)Displaced (2)Displacement or shortening >2cm
Metacarpals and phalanges (hand)	• 77(1) • 78(2)	(1) unstable, shortening > 2mm, unacceptable angulation, rotation (2)Unstable, displaced , rotation
Metatarsals phalanges (foot)	• 87.1(1) • 87.2(1) • 87.3(1) • 87.4(1) • 87.5(2) • 88	(1) Displaced (2)Jones fracture, displaced shaft fracture

Table 3. Fractures to be treated surgically in skeletally immature (pediatric) patients by AO/OTA classification* [50,65].

Bone	AO/OTA classification	Comments
Humerus	11E/M(1) 12(2) 13E/M(3)	(1) >12years with more than 2/3 displacement or >45° angulation (2) Open fractures, polytrauma, floating elbow (3)Displaced fractures
Radius and/or Ulna	21rE/M 21uM/E 22u-D/6 22-D/4 22-D/5 23rM3/23rE3	Displaced with unacceptable reduction
Femur	31E(1) 31M(2) 32(3) 33E/33M(4)	(1)SUFE and unstable complete epiphysiolysis (2) Displaced greater trochanter(>1cm), and all neck, intertrochanteric fractures where c-arm available (3) >5years of age, unstable (4) Displaced epiphysiolysis and metaphyseal fractures
Tibia/fibula	41E/ 41M(1) 42(2) 43E/43M(3)	(1) Displaced >2cm unacceptable reduction (2) Open, soft tissues injury, floating knee, or unacceptable reduction (>50%translation, >1cm shortening, >10° angulation) (3) Unacceptable reduction, Displaced >2cm, any varus or >10° valgus angulation
Clavicle	15.1(1) 15.2 (2) 15.3(3)	(1) Irreducible posterior displacement (2) Adolescent (see adults protocol) (3) Open fractures
Metacarpals and phalanges (hand)	77 78	Idem as adults
Metatarsals and phalanges (foot)	87 88	Idem as adults

**Where the AO Surgery Reference was not yet complete, other best evidences were used.*

2.3. Empirical literature

2.3.1. The global health and the burden of orthopedic injuries

Global health is a field dedicated to the improvement and achievement of equity in healthcare through research, studies, and practices that address disparities regarding disease burden, access to care, and the associated demographic, geographic and socioeconomic factors [66,67].

The increasing awareness of non-fatal outcomes on the global burden of diseases has led to the establishment of a measure of their contribution. In this regard, the disability-adjusted life year (DALY) was adopted as a measure of the disease burden in a population. It is the sum of the years of life lost (YLL) secondary to premature mortality and the healthy years of life lost because of disability (YLD). It is the picture of the gap between the population's health status and the ideal one [6].

The Global Burden of Diseases Project reported that 85% of death and 90% of DALYs occur in the LMICs, mostly secondary to traffic injuries. These figures are expected to double from 1.3 million in 2004 to 2.4 million in 2030 [6,68].

Traumatic injuries are the third leading cause of death and disabilities worldwide for decades[6]. On the global scale, traumatic injuries kill more people than malaria, HIV, and tuberculosis combined especially in LMICs [69]. Musculoskeletal injuries are common among all traumatic injuries with upper and lower limbs being most affected [8–10]. Although such injuries have not been associated with higher mortality compared to head, chest, and abdominal injuries, they are associated with morbidities and higher DALYs [6,21,22,70].

While musculoskeletal injury related disability can be prevented through injury prevention and improving access to surgical care, in LMICs these mechanisms are absent or inefficient and access to appropriate care of orthopedic injuries is limited [6,13,15,16,70,71].

2.3.2. The indications and operative needs for long bone fractures

Non-operative fracture management has been used for millennia. In 1950s, the development of anesthesia, implants, antibiotics, and surgical techniques have drastically changed this practice [26]. Although non-operative management of fractures is still valuable and practiced on many fractures, the superiority of operative management of long bone

fractures over non-operative management (cast, splint, traction, bracing,…) is well documented especially for unstable, open, and complex fractures [29–37].

a) Clavicle and upper limb fractures

Clavicle fractures constitute 2-5% of all fractures and affect mostly younger active individuals. The middle third fractures, which are more prevalent, have been historically considered for non-operative management. New evidence suggests that such fractures with 100% displacement and more than 2cm shortening yield to higher non-union rate and reduced functional outcome and should be considered for surgery [72–74]. Also, open fractures, fractures with skin tenting, fractures associated with neurovascular injuries, and floating shoulder must be considered for surgical treatment [75].

Radiographic non-union of distal clavicle fractures accurs in 10-44%. However, both surgical and non-surgical management yield similar results, and the clinical relevance of non-union has not been established. In such fractures, the initial non-operative management may be warranted and the operative treatment may depend on the extent of displacement, and patient demand [76].

Acute medial clavicle fractures occur rarely. They often occur in the pediatric population with open physis. The closed reduction results in good outcome to be warranted. Operative management is reserved for non-reducible fractures and symptomatic non-union [77].
Humeral shaft fractures have generally good outcome with non-operative management (cast, functional brace) with around 90% union rate [78–80]. Malunion with $<30^0$ valgus/varus angulation and < 2-3cm of shortening is generally acceptable [81]. A randomized control study comparing minimally invasive bridging plate to non-operative management with functional brace reported good functional outcome, superior union rate, and less residual deformities in favor of minimally invasive bridging plate fixation [33] . The intramedullary nail fixation is associated with more complications especially restricted shoulder ROM, and pain [82].In general, operative management should relatively be reserved to: open fractures, polytrauma patients, floating elbow/ shoulder, fractures with vascular injuries, nerve deficit after reduction, and unacceptable reduction [81].

Displaced and multi-fragmented proximal humerus fractures in adults are generally treated operatively due to the risks of osteonecrosis, nonunion, malunion, or articular extension. The options range from percutaneous pinning, ORIF with plate and screws, and shoulder

arthroplasty. Minimally displaced and most pediatric fractures are treated non-operatively with a short course of sling immobilization and early physical therapy [83,84].

Fractures of the humerus around the elbow are treated surgically in general. Adults fractures commonly have articular extension which need anatomical reduction and stable fixation to allow early ROM .Arthroplasty should be opted for elderly patients with comminuted fractures [85]. For pediatric population, the distal humerus is the second site of fracture behind forearm fractures with supracondylar fractures, lateral and medial epicondyle fractures. They are managed operatively with percutaneous Kirschner wires or screw fixation as the non-operative management is limited to non-displaced or minimally displaced fractures [65].

The fractures of the forearm around the elbow include radial head, olecranon, and coronoid. They are often associated with dislocations. Apart from non-displaced fractures with stable elbow and without mechanical block, others are treated surgically [59].

Adult radius shaft fractures, middle and proximal ulna, and fractures of both bones are commonly treated surgically with plate osteosynthesis. This is due the long time to union required, and poor functional outcome associated with malunion and loss of radial bow [59,86]. Isolated nightstick fractures are treated non-operatively with short arm cast or braces [87].

Distal radius fractures are the most common fractures. They are high energy in younger patients and low energy in elderly with osteopenia. The choice of treatment depends on the initial displacement, integrity of volar/dorsal cortices, degree of comminution, and articular involvement. Secondary displacement is common in patients treated with cast and malunion of $>10^0$ of dorsal angulation, >3-5mm loss of radial height, or >2mm step off which are not well tolerated in younger adults patients [88–90].

Pediatric forearm and distal radius fractures are the most common fractures in that group. Fortunately, they are commonly greenstick or buckle fractures and are rarely complete and displaced. Non-operative management with closed reduction and casting is the mainstay of treatment. Operative treatment should be considered in cases of complete fractures, with $>15\text{-}20^0$ of angulation, $>45^0$ of rotation, and > 1cm of cortical apposition near the age of skeletal maturity [91]. The rise of novel operative techniques, intolerance of residual

deformities by parents and surgeons, has resulted in the increase of operative management of pediatric forearm and distal radius fractures despite research studies disapproval [92,93].

Most fractures on the hand tubular bones (metacarpal and phalanges) can be treated non-operatively with satisfactory outcome. The advent of Kirschner wires and mini-plates since the 1950s has raised a plethora of their use with good outcome. However, there is a lack of randomized trials to determine their superiority [94]. While surgical management in open and crush injuries of the hand offer the advantage of wound and soft tissues management and should be warranted, the operative management on closed fractures should be evaluated individually in consideration of bone involved, shortening, angulation, rotational deformity, articular involvement, and natural history [95].

b) Lower limb fractures

Adult femoral fractures are treated by traction or internal fixation. The intramedullary nailing of proximal, shaft, and some distal (without articular extension) femoral fractures yield better clinical and functional outcomes, decreased hospital length of stay (LOS), and is cost-effective compared to the non-operative treatment with skeletal traction [29,30]. Distal femur fractures have generally an articular extension and their treatment requires anatomical reduction of the articular surface and stable fixation with plate and screws to allow early range of motion (ROM). Non- operative option is reserved for patients who are unfit or who were functionally compromised before the injury [59].

Pediatric diaphyseal femoral fractures account for 1.7% of all fractures [96]. Their treatment options include bracing (Pavlic), spica cast, flexible nails, plating, and rigid nail fixation depending on the age and the presentation. In the effort to improve their treatment, the American Academy of Orthopedic Surgeons (AAOS) published a guideline in 2009 which recommends flexible intramedullary nailing and plate fixation for patients aged 5-11 years and rigid intramedullary nailing for patients of more than 11 years of age. Non-operative options are reserved for patients with less than 5 years [97]. This protocol is supported by current evidence on clinical and functional outcomes [35,37].

Stable minimally displaced tibia fractures, and the majority of pediatric fractures may still be treated by cast with favorable outcome[59]. Open, displaced, segmental tibia fractures are treated surgically with the intramedullary nail or minimally invasive plating [59]. Studies that

compared tibia intramedullary nailing and casting reported better outcome in favor of intramedullary nailing [31,32].

Metatarsal fractures are divided into 3 groups: first metatarsal, central metatarsals, and fifth metatarsal [50]. The treatment of the first metatarsal is intended to restore length, joint congruity, and alignment to conserve the weight transfer mechanics and prevent subsequent matatarsalgia and joint degeneration. Displaced fractures with $>10^0$ of angulation, 3-4mm displacement, rotational deformity, and/or intra-articular should be considered for surgery [59,98]. Middle metatarsal fractures are judged to be relatively stable due to surrounding soft tissues and most of them are treated non-operatively. Completely displaced fractures may be treated surgically to prevent subsequent transfer metatarsalgia and nerve irritation [98]. The fifth metatarsal fractures are the most common fracture of the midfoot. The fifth metatarsal bases fracture include avulsion fractures , Jones' fracture, and stress fracture according to Lawrence and Botte [99]. While avulsion fracture of the fifth metatarsal base is treated non-operatively, displaced Jones', stress fracture, and diaphyseal fractures are indicated for surgical fixation especially in athletes [59,98].

Fractures of the toes (phalanges) are the most common fractures on the foot. Although AO Surgery Reference advocate for k-wire fixation for these fractures [59], other authors reported that they are generally treated non-operatively with satisfactory outcome, except for fractures associated with dislocation and soft tissues injuries where the operative management is warranted [100].

2.3.3. Challenges of access to orthopedic trauma surgery in LMICs

Injuries are the major contributor to the global burden of surgical diseases and the biggest portion occur in LMICs. Different barriers have been reported to contribute to the limited access to surgical care in LMICs. They are subdivided into patient-related barriers, physicians related barriers, hospital-related barriers, and health care system structure related barriers. These barriers may have impact on accessibility, availability, affordability, and acceptability of surgical care [18].

Table 4. Barriers of access to surgery [18]

Patient-related barriers
Poor health education
Lack of social support
Lack of awareness about the importance of treatment
Financial costs
Beliefs about disease processes
Stigma
Physicians related barriers
Inadequate communication with the patient or the patient's family
Shortages of workers and unskilled staff
Inadequate remuneration
Hospitals related barriers
Waiting times
Opening times
Inadequate infrastructure
Poor equipment
Poor referral system
Health system related barriers
Disincentives to care-seeking behavior (e.g. disability grants)
Transport limitations
Poor coordination between health service providers.
Limited capacity of facilities to provide required procedures
Poor management of services and staff
Insecurity associated with healthcare delivery in areas of conflict

The limited access to orthopedic surgical care in LMICs has been a subject of investigations with focus to some fractures pattern. In general, the gap is notable with different contributing factors reported [19,20,25,27,28,101–105].

By using the chance tree and probability model, the evaluation of the access to orthopedic surgical care in Northern Tanzania revealed that almost 90% of the population don't have access to orthopedic surgical care [20]. Hollis et al. [28] did a study on patients admitted with needs of surgical care for femoral fractures in northernTanzania and reported that 40%

were treated non-operatively. A similar study on tibia and fibula fractures where72% were open and 19% were comminuted, 34% of them were treated non-operatively with cast [27].

In Uganda, a study that was done on patients with tibia and femur fractures with indicated surgical management reported that only 56% received operative treatment due to resource constraints with a median waiting time of 18days [25]. A notable annual increase of femur fractures and insufficient number of operations on femur were noted in Malawi central hospital whereby less than 25% of femur fractures were treated surgically in 2014. Available resources were not meeting the rapid rise of femur fractures [102].

Floating knee is one of the debilitating high energy orthopedic injury that requires surgical management for better clinical and functional outcome [103]. However, in Nigeria, a study reported that only 32% of patients with floating knee benefited a surgical fixation of both fractures, and 40% were treated non operatively on both femur and tibia fractures [106].

Despite the lack of data on the unattained operative needs for other long bone fractures, available sources have reported the use of substandard fixation techniques due to the lack of appropriate implants. They have resulted in variable outcomes far inferior to these of standard care [101,104].

The lack of appropriate theatres, orthopedic surgeons by training, and appropriate implants in Africa and other LMICs has influenced the rise of poor outcomes and the fear to perform orthopedic operations as appropriate. The surgeons balance the risks over potential benefits where the teaching "Don't close an open fracture and don't open a closed one!"[101].

A survey done in Malawi reported that 85% of orthopedic equipment and implants supply were donations and were not sustainable [105]. These donations are in most cases old fashion that failed in the first world, and they are also likely to fail in LMICs [101].

Although it has been reported that health care is free in some LMICs, the lack of supplies in stock is a challenge to access surgical care as many patients can't pay the supplies when out of stock in the hospital and must be purchased from outside sources [105].

2.3.4. The case of Rwanda on access to orthopedic trauma surgical care

Despite efforts invested in the health sector, the Ministry of Health recognizes gaps and challenges to overcome the burden of surgical disease in Rwanda [38]. Around 58.7% of the

population do not have access to surgical and anesthesia care in consideration of time, safety, and affordability [107].

Since 2018, the structure of the health system in Rwanda from bottom to the top is composed of 58,888 health workers, 670 health posts, 503 health centres, 36 district hospitals, 4 provincial hospitals, and 7 referral hospitals [38].

While NSOAP 2018-2014 targeted to have functional orthopedic services at each referral hospital and at least one orthopedic surgeon at each provincial hospital, only seven facilities can offer orthopedic trauma surgical care with variable limitations related to human resources and equipment [38]. In Kigali, Rwanda Military Hospital(RMH) and University Teaching Hospital (CHUK) are the only public referral Hospitals offering orthopedic services to the general population.

Since 2018, Rwanda has embraced the global move to strengthen of emergency and essential surgical care and anesthesia. In this regard, NSOAP 2018-2024 was initiated with key targets of strengthening the surgical care of orthopedic traumatic injuries among others [38]. In Rwanda, there is a need for supporting data that will help to identify gaps and challenges facing the access to orthopedic trauma surgical care and long bone fractures in particular.

Available data revealed that orthopedic procedures are most frequently done for traumatically injured patients at a rate of 84.2% [39]. However, there is no data on the unattained operative needs for long bone fractures and associated factors in Kigali public referral hospitals.

CHAPTER THREE: RESEARCH METHODOLOGY

3.1. Introduction

This chapter details the methods that were used in this study. The study settings, study design, inclusion criteria, exclusion criteria, sample size, sampling technique, data collection methods, materials and their validity, data management and analysis, and ethical considerations are discussed.

3.2. Study settings

This study was conducted in 2 public referral hospitals: Rwanda Military Hospital (RMH) and University Teaching Hospital of Kigali (CHUK). Both hospitals are major tertiary referral hospitals with facilities to treat orthopedic conditions. RMH and CHUK are hospitals with 405 and 519 bed capacity respectively. While at CHUK a dedicated orthopedic trauma theatre is operational, at RMH orthopedic theatre is shared by trauma and other elective orthopedic cases.They are both located in Kigali City at 17 kilometers distance each other.Patients are referred from district hospitals and others especially those in neighboring communities consult directly.

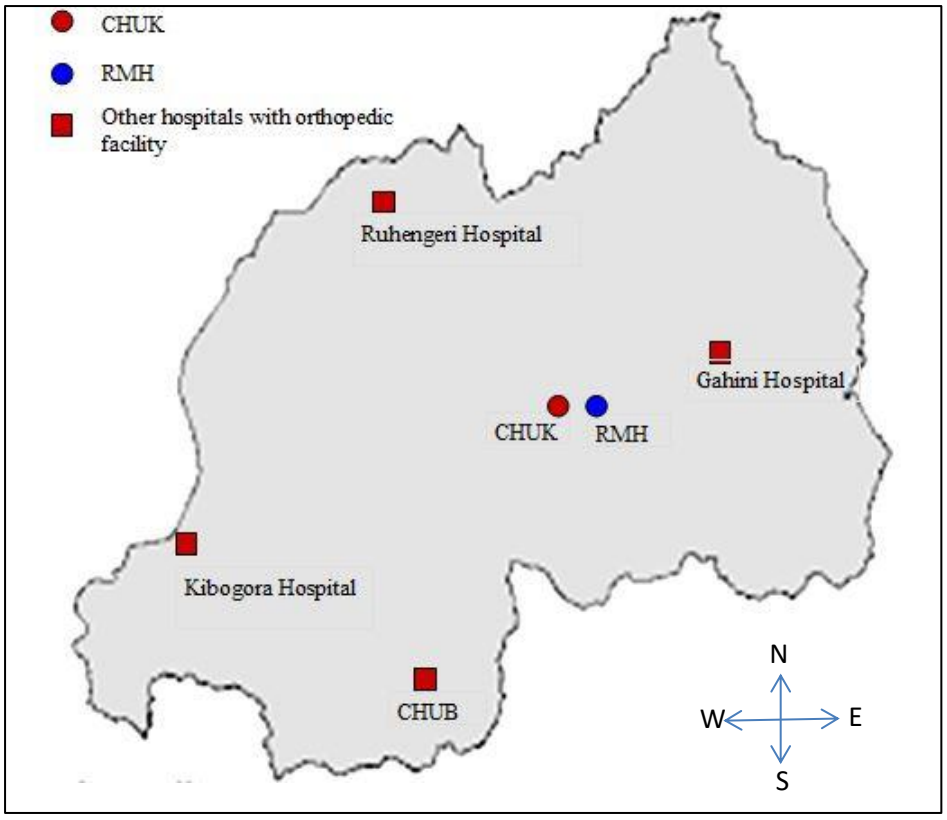

Figure 5. Geographic location of CHUK and RMH in Rwanda

3.3. Study design

A cross-sectional study was conducted on patients with long bone fractures requiring orthopedic trauma surgical management presenting at Accident and Emergency (A&E) and outpatients clinics assessed the unattained operative needs for these fractures within 6weeks of presentation and associated factors.

3.4. Inclusion criteria

We have screened all patients who presented with at least one long bone fracture at the emergency and outpatient clinic within 1 week of injury. The AO Surgery Reference [59,65] was used to identify and recruit patients with long bone fractures requiring operative management (i.e. operative management superior to non-operative management)

3.5. Exclusion criteria

Patients who died within 6weeks of presentation, patients who were lost for follow-up, patients with pathological fractures on tumor or infection, patients whose fractures were surgically treated before presentation, and patients whose fractures required joint replacement as management were excluded.

3.6. Sample size

A study that was done in Norway population for long bone fractures requiring hospital management reported that the incidence of the need for operative management was 76% [108].

Using the above proportion, with a confidence level of 95%, and the margin of error of 0.05, the sample size was calculated as follows:

$$n = \frac{Z^2 P(1-P)}{d^2}$$ [109]

Where:

n: sample size

Z: Standard normal variation which is equal **1.96** for 95% confidence level.

P: expected proportion in population. Here estimated **76%.**

d: absolute error or precision for type I error fixed at **0.05.**

n= 281patients

3.7. Sampling technique

In this study, we screened all patients presenting with at least one long bone fracture within 1week of injury and recruited those with at least one long bone fracture requiring the operative management.

3.8. Data collection methods

3.8.1. Data Collection Instruments

A data capture sheet was used to collect data. This included closed-ended questions and multiple-choice questions focused on the objectives of the research study. The investigator used AO Surgery Reference[59,65] to determine the need of operative management, AO/OTA classification[50] to describe the fracture pattern, and Injury Severity Score (ISS) categories to describe patient's injury severity(minor: ISS=1-8, moderate: ISS=9-15, serious:ISS=16-24, severe: ISS=25-49, critical: ISS=50-74, and maximum or fatal: ISS=75) [110,111].

3.8.2. Administration of data collection instruments

Data were collected by the administration of data capture sheet to patients with long bone fractures requiring surgical management after obtaining informed consent and assent where it applied. The investigator also used patient files and radiographic images for technical data related to patient injuries description. Remaining data were completed using phone call after 6 weeks of first presentation.

3.8.3. Reliability and validity

The data capture tool was designed based on the study objectives in an easy, specific, and comprehensive manner. It has been pretested on 10 cases and corrections were adopted. The sample size was estimated in consideration of a study done in Norway population on long bone fractures requiring hospital management [108] .

3.9. Data management and analysis

Collected data were recorded in hard copy format and kept in a locked cupboard till the desired sample size was reached. A password protected personal computer was used for data entry and analysis where only te investigators had access.We used Microsoft Excel

2010 for data entry and SPSS 24.0 for data analysis and to generate descriptive statistics in tables and graphs. Pearson Chi-square test was used to assess factors associated with unattained operative needs for long bone fractures. Binary logistic regression models were used to assess the odds ratio of not accessing surgical care for significantly associated factors with a 95% confidence interval. The p-value <0.05 was considered significant.

3.10. Ethical consideration

Informed consent and assent were obtained and signed voluntarily by participants after detailed explanations on the purpose of this research study and patients' rights involved. Patients had the right of refusing and withdraw from the study at any stage of the research. There was no financial or material motivation given to patients participating in this research study. Patients' data were kept confidential and only used for this research purpose. Only patient's hospital identification number were used on data capture tool instead of using patient's names.

This study was approved by the Institutional Review Board (IRB) at the University of Rwanda, College of Medicine and Health Sciences. The permission to collect data was obtained from RMH and CHUK respective Research and Ethical departments.

CHAPTER FOUR: RESULTS

4.1 Introduction

This chapter details the findings of this research study using descriptive statistics with charts and tables, and inferential statistics on factors associated with unattained operative needs.

4.2. Participants recruitment process

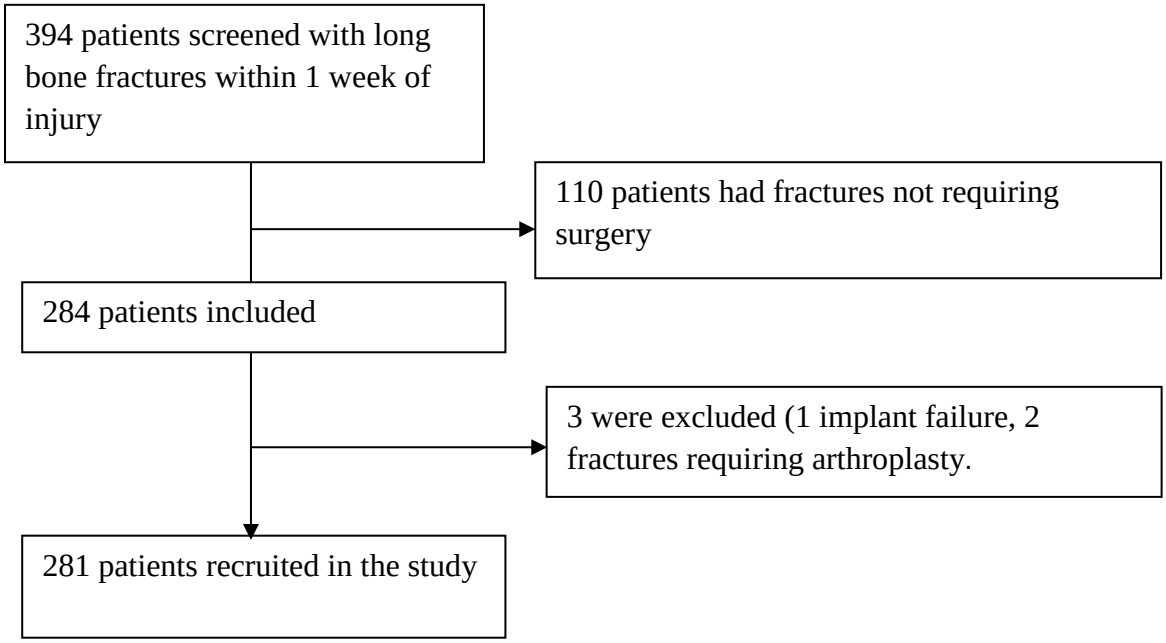

Figure 6. Participants recruitment process

In this study we screened in total 394 patients presenting at referral hospital with long bone fractures within 1 week of injury. Among them, 284 patients had at least one fractures requiring operative management. After excluding 1 patient with fracture on implant failure, and 2 patients with fractures requiring joint replacement, 281 patients remained in the study.

4.3. Demographic description of the patients with long bone fractures requiring surgical management

4.3.1. Age distribution

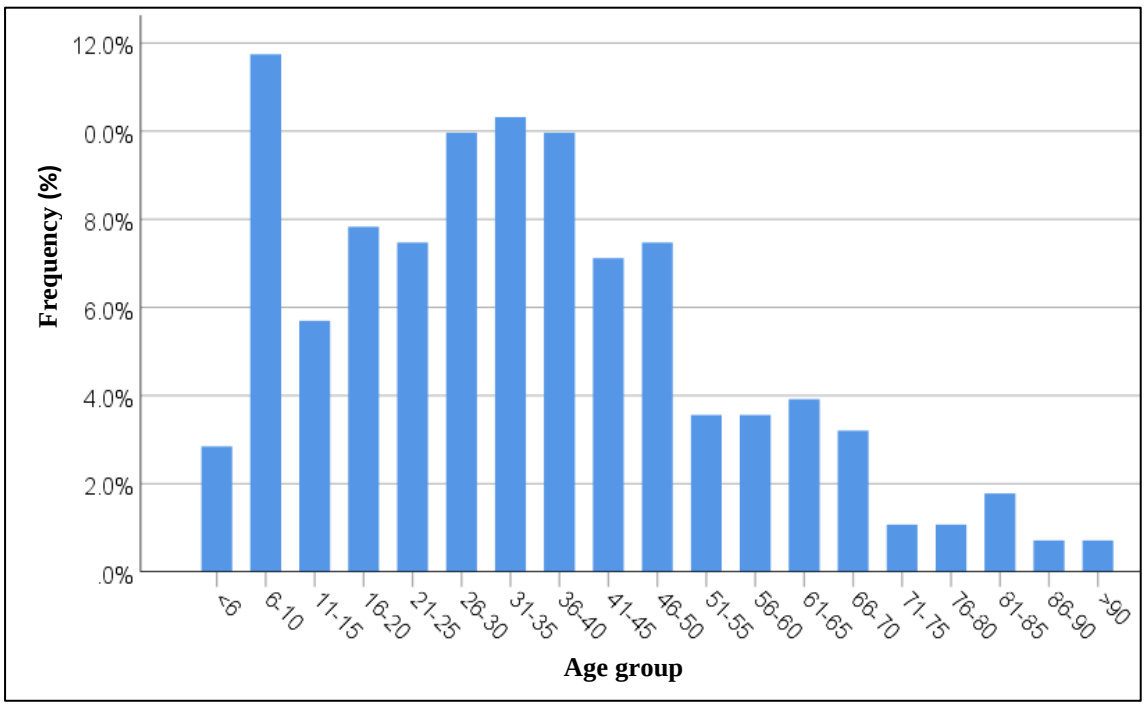

Figure 7. Age distribution of participants

The age of patients recruited ranged from 4 years to 100 years. The median age was 33 years (IQR=19-47). There was notable bimodal distribution at 6-10years of age accounting for 11.7% (n=33) and at 31-35 years of age accounting 10.3% (n=29). Patients with more than 16 years of age (IQR=28-50 years) represented 76.2% (n=214).

4.3.2. Gender distribution

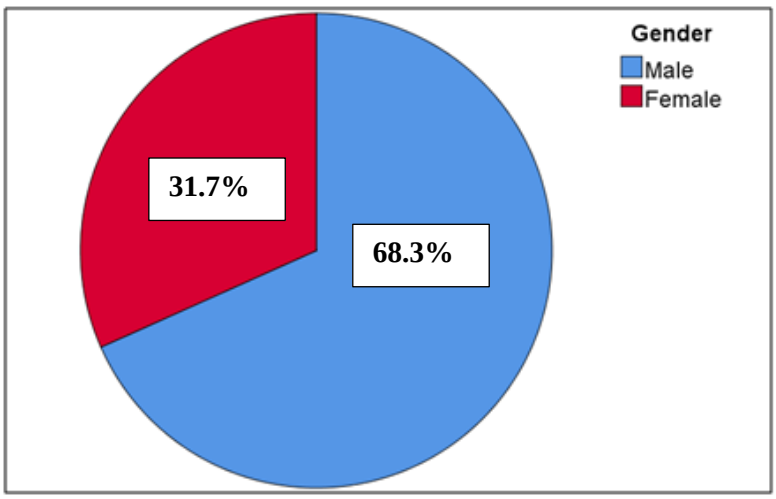

Figure 8. Gender distribution of participants

Among all participants, the majority of patients with long bone fractures requiring surgical management were males with 68.3% (n=192) while females were 31.7% (n=89).

4.3.3. Geographical distribution and referral hospital consulted

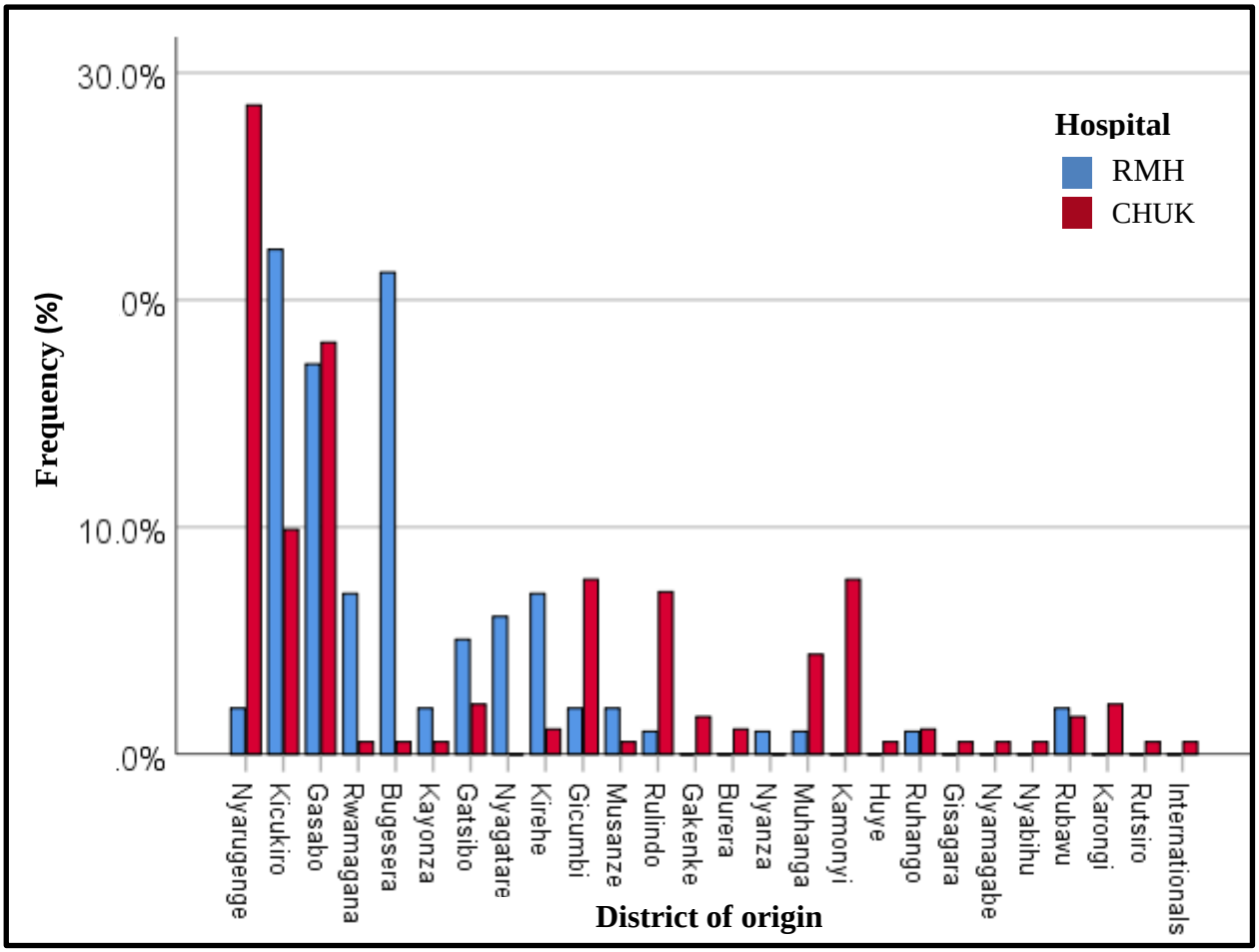

Figure 9. Distribution of patients by district of origin and consulted hospitals

Out of 30 districts, patients who were recruited came from 25 districts. The majority of patients consulting at RMH came from Kicukiro, Gasabo, and Bugesera with 22.2%, 21.2%, and 18.1% respectively. The majority of patients who consulted at CHUK came from Nyarugenge and Gasabo districts with 28.6%, and 18.1% respectively. No patients came from Rusizi, Nyamasheke, Nyaruguru, Ngororero, and Ngoma District. Only one patient came from a neighboring country.

4.4. Socio-economic description of patients with long bone fractures requiring operative management

4.4.1. Employment and source of income

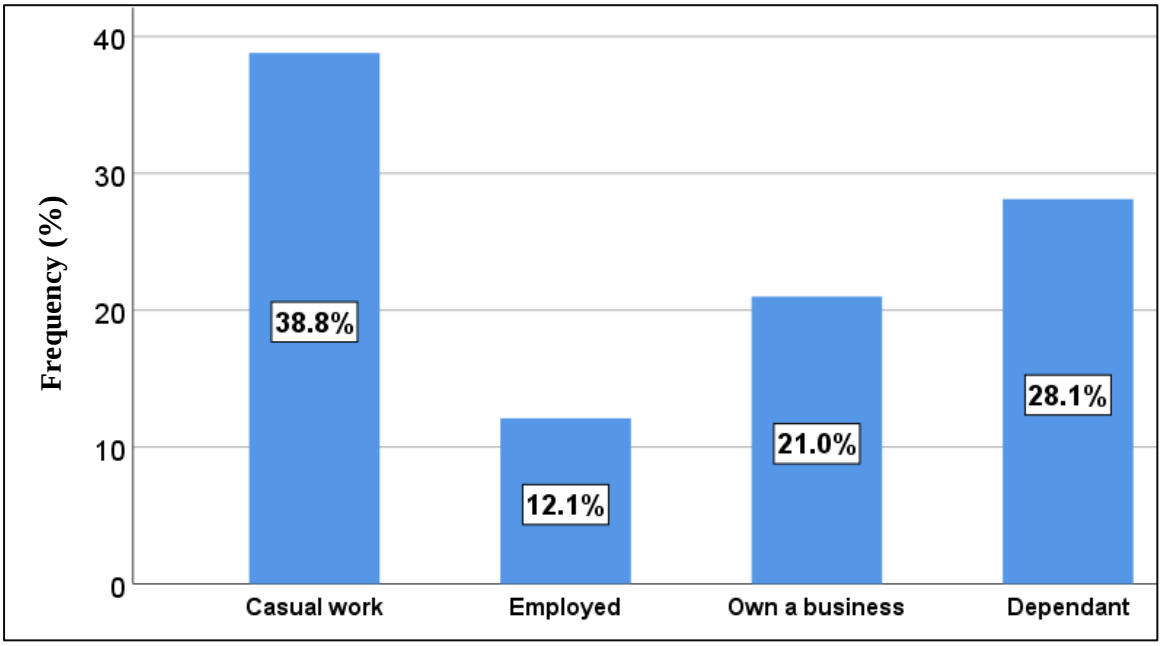

Figure 10. Employment and source of income of participants

Regarding the source of income and employment status, patients were grouped into 4 groups depending on wether they are casual workers, employed, owning businesses, or dependents. The modal group was of casual workers with 33.8% (n=109) while 28.1% (n=79) were dependents (children, older, or disabled).

4.4.2. Medical insurance and socio-economic category (Ubudehe)

Table 5. Medical insurance and socio-economic status of participants

		Medical insurance					
		CBHI	**RSSB**	**MMI**	**Others**	**None**	**Total %**
Socio-economic status(Ubudehe)	**Category 1**	12.5%	0.0%	0.0%	0.0%	0.7%	**13.2%**
	Category 2	32.4%	2.1%	0.4%	0.7%	7.8%	**43.4%**
	Category 3	24.2%	5.7%	2.5%	1.1%	2.1%	**35.6%**
	Category 4	0.0%	0.0%	0.0%	0.0%	0.4%	**0.4%**
	Unknown	0.4%	0.0%	0.4%	1.4%	5.3%	**7.5%**
Total %		**69.4%**	**7.8%**	**3.2%**	**3.2%**	**16.4%**	**100.0%**

According to Ubudehe socioeconomic classes used in Rwanda, the majority of participants were in category 2 (43.4%, n=122). The most common insurance was the community-based health insurance (CBHI) with 69.4% (n=195). Patients without insurance accounted for 16.4% (n=46).

4.5. Unattained operative needs

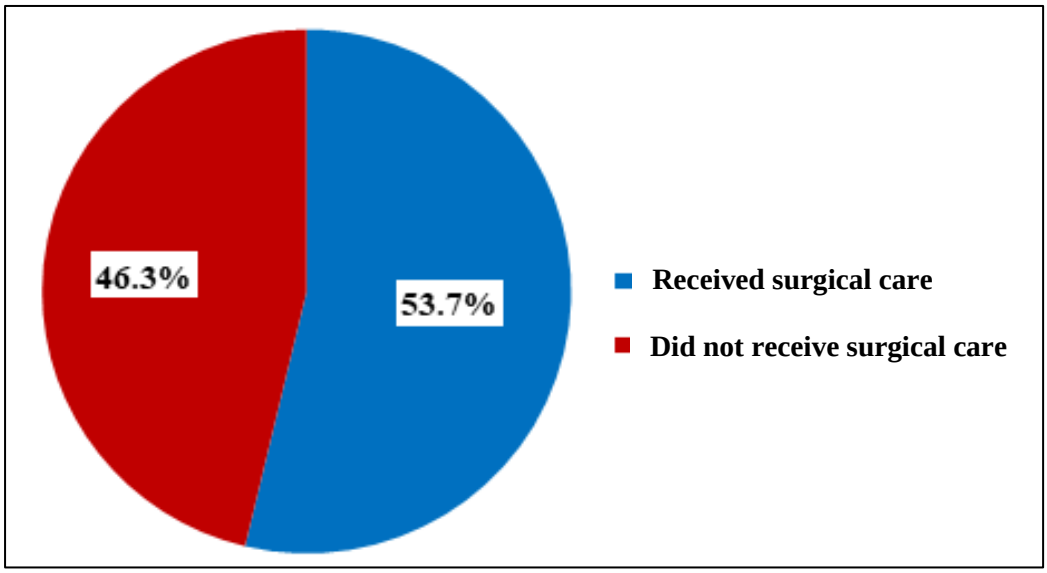

Figure 11. Proportion of unattained operative needs for long bone fractures

Among 281 participants with long bone fractures requiring surgical management, only 53.7% (n=152) were able to receive the indicated surgical care. The proportion of unattained operative needs for long bone fractures was 46.3% (n=130). This represents

patients with at least one long bone fracture requiring operative management which was not treated surgically as indicated.

Table 6. Unattained operative needs for long bone fractures by fractured bones

Fractured bone	N	% Operated	% Not operated
Humerus	61	49.2%	50.8%
Radius and/or Ulna	58	37.9%	62.1%
Femur	92	62.0%	38.0%
Tibia and/or fibula	108	65.7%	34.3%
Clavicle	3	0.0%	100.0%
Metacarpal	4	75.0%	25.0%
Hand phalanges	6	100.0%	0.0%
Metatarsals	2	100.0%	0.0%
Foot phalanges	3	66.7%	33.3%
Total	**337**	**57.3%**	**42.7%**

In consideration of fractured bones, we counted in a total of 337 long bone fractures requiring surgical management. The unattained operative needs for long bone fractures in consideration of fractured bones was 42.7% (n=193).

4.6. Description of long bone fractures and associated injuries

4.6.1. Participants' long bone fractures description

Table 7. Fractures description by bone, AO segments, and skin integrity

Bone fractured	AO classification	Closed fractures	Open fractures	Total	%
Humerus	11	8	0	8	2.4%
	12	13	3	16	4.7%
	13	35	2	37	11.0%
Radius and/or Ulna	21	4	1	5	1.5%
	22	21	2	23	6.8%
	23	30	0	30	8.9%
Femur	31	14	1	15	4.5%
	32	54	6	60	17.8%
	33	12	5	17	5.0%
Tibia and/or fibula	41	7	2	9	2.7%
	42	33	26	59	17.5%
	43	5	4	9	2.7%
	44	24	7	31	9.2%
Clavicle	15.2	2	0	2	0.6%
	15.3	1	0	1	0.3%
Metacarpal	77.(1-5).2	1	3	4	1.2%
Hand phalanges	78.(1-5).(1-3).2	1	4	5	1.5%
	78. (1-5).(1-3).3	0	1	1	0.3%
Metatarsals	87.(1-5).2	0	2	2	0.6%
Foot phalanges	88.(1-5).(1-3).2	0	3	3	0.9%
Total		**265**	**72**	**337**	**100.0%**

We cumulatively counted and classified long bone fractures by involved bone, bone segment, and overlying skin integrity. Among 337 fractures recorded, 265 (78.6%) were closed and 72 (21.4%) were open fractures. The highest proportion was for tibia and/or fibula fractures with 32.1% (n=108) followed by femoral fractures accounting 27.3% (n= 92) among all fractures.

4.6.2. Associated injuries and injury severity

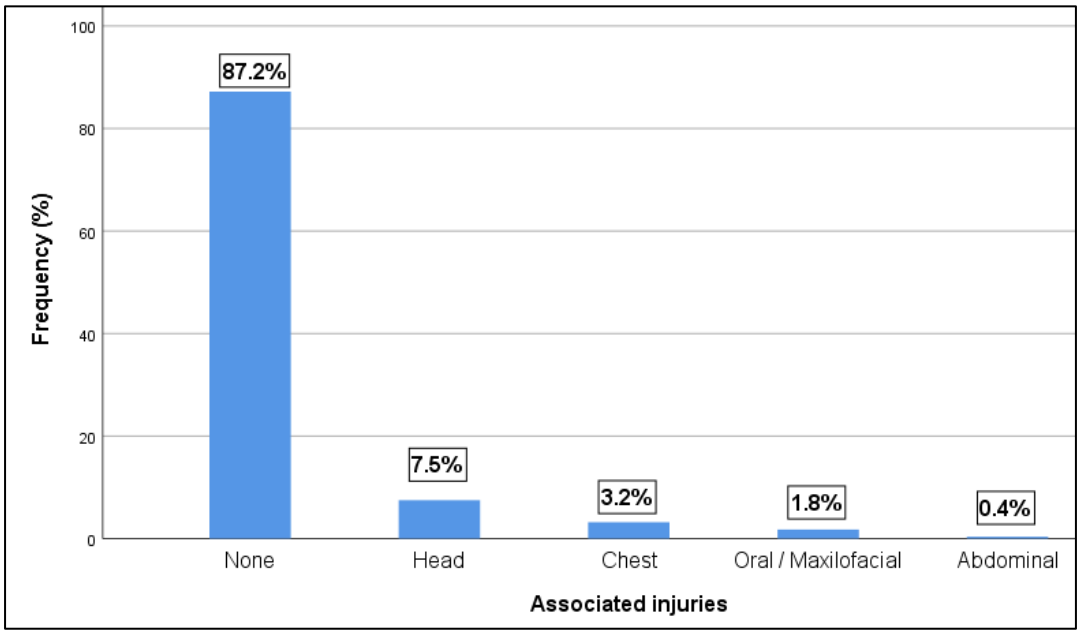

Figure 12. Injuries associated with long bone fractures

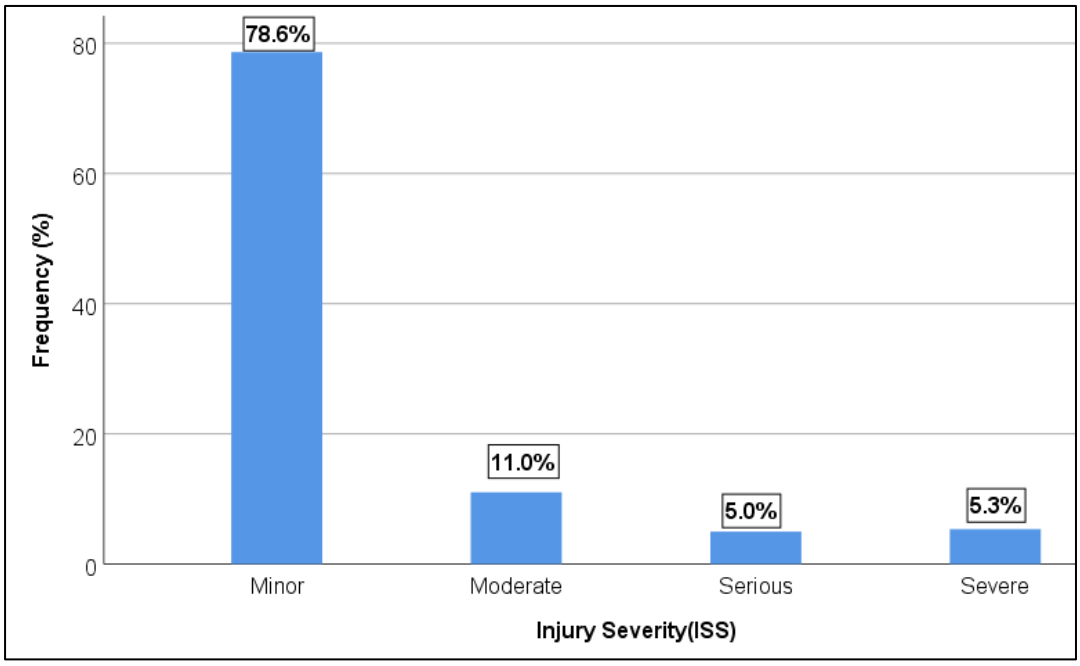

Figure 13. Severity of injuries in patients with long bone fractures

The majority of long bone fractures were not associated with other injuries in 86.6% of patients (n=245). Head injury accounted for 7.4% (n=21) and was the most common associated injury among patients with long bone fractures requiring surgical management. We used the Injury Severity Score (ISS) to assess the severity of participants' injuries. We found that 89.6% (n=252) of patients' injuries were of minor to moderate severity and the remaining had serious to severe injuries. There was no critical or fatal injury recorded.

4.7. Univariate analysis of factors associated with unattained operative need for long bone fractures

Table 8: Factors associated to the access to surgical care for long bone fractures

Variable		Operated n (%)	Not operated n (%)	Pearson chi-square	p-value
Gender	Male	111 (57.8)	81 (42.2)	4.051	**0.044**
	Female	40 (44.9)	49 (55.1)		
Age/ years(IQR)	≤16 (6-11)	32 (56.1)	25 (43.9)	0.166	0.684
	>16 (28-50)	109 (53.1)	105 (46.9)		
Fracture type	Closed	102 (45.7)	121 (54.3)	27.79	**<0.001**
	Open	49 (88.5)	9 (15.5)		
Medical insurance	Yes	130 (55.3)	105 (44.7)	1.446	0.229
	No	21 (45.7)	25 (54.3)		
Economic status (Ubudehe)	Category 1	25 (67.6)	12 (32.4)	6.355	0.174
	Category 2	63 (51.6)	59 (48.4)		
	Category 3	55(55.0)	45(45.0)		
	Category 4	0(0)	1(100)		
	Unknown	8 (38.1)	13 (61.9)		
Consultation settings	A&E	129 (62.0))	79 (38.0)	22.094	**<0.001**
	Outpatient	22 (30.1)	51 (69.9)		
Immediate admission	Yes	133 (83.1)	27 (22.9)	127.087	**<0.001**
	No	18 (14.9)	103 (85.1)		
Limb	Upper	61(46.2)	71(53.8)	10.843	**0.001**
	Lower	132(64.4)	73(35.6)		
Injury severity	ISS<16	126 (50.0)	126 (50.0)	13.714	**<0.001**
	ISS≥16	25 (86.2)	4 (13.8)		
Associated injuries	Yes	126(51.5)	119(48.6)	4.098	**0.043**
	No	25(69.4)	11(30.6)		

While the age (≤16 years vs. >16years), economic status, and having a medical insurance had no significant association to the access to surgical care, overlying skin integrity

(closed vs. open), consulted service (A&E vs. outpatient clinic), injury severity, immediate admission on presentation, associated injuries, and gender were significantly associated with the access to surgical care for long bone fractures.

4.8. Regression analysis of factors associated with unattained operative needs

Table 9. Odds ratio of inaccessibility to surgical management of long bone fractures

Factor	Odds ratio (95% CI)	p-value
Being female	1.679 (1.012 – 2.786)	**0.045**
Closed fracture	6.459 (3.026 - 13.783)	<**0.001**
Consulting outpatient clinic	3.785 (2.134 – 6.714)	**<0.001**
Not admitted on presentation	28.187 (14.722 – 53.968)	**<0.001**
Upper limb	2.105(1.348 – 3.287)	**0.001**
Minor to moderate injuries(ISS<16)	6.250 (2.114 – 18.478)	**0.001**
Fracture without associated injuries	2.146 (1.012 – 4.554)	**0.047**

The binary regression analysis revealed that patients who presented with closed fractures, patients with minor or moderate injury (ISS<16), patients who consulted at outpatient clinic, patients who were not admitted on presentation, and patients with upper limb fractures were less likely to be operated within 6 weeks of presentation. Being female and having isolated long bone fractures without associated injuries had weak significance.

4.9. Patient-reported barriers to the access of surgical management of long bone fractures

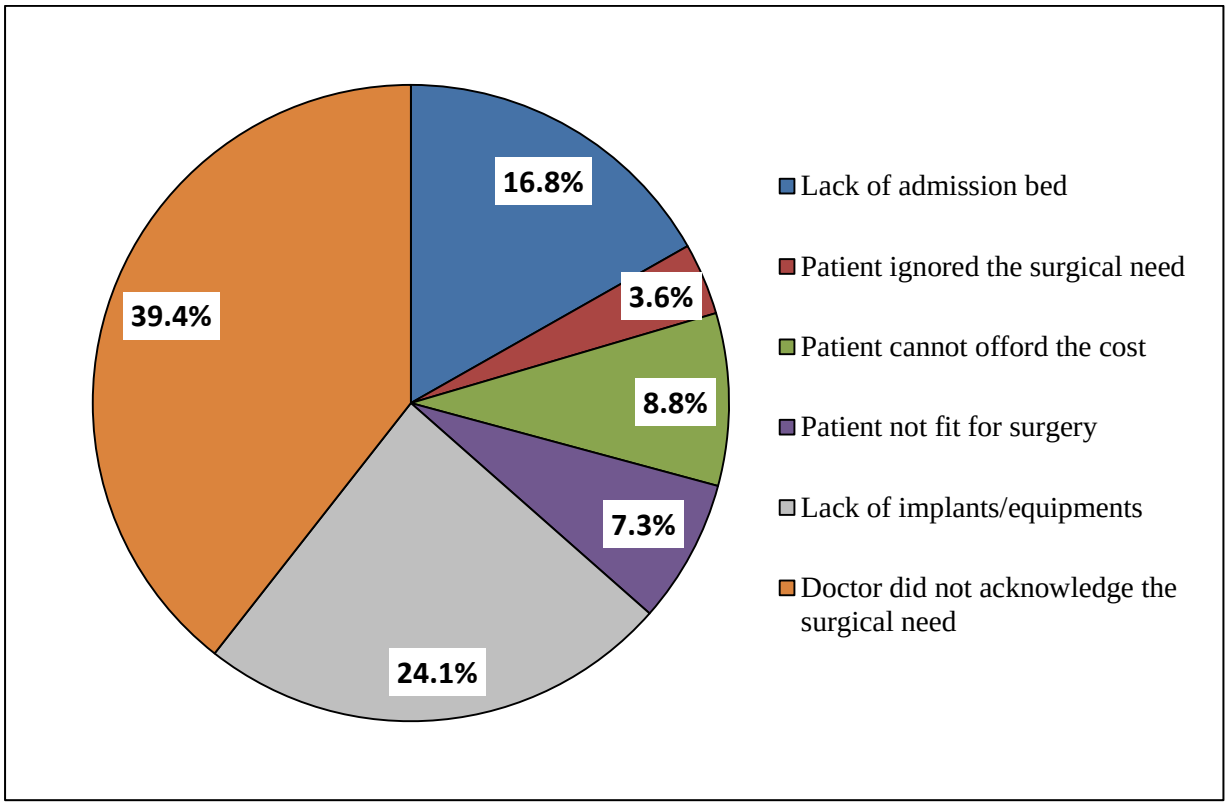

Figure 14. Patient-reported barriers to the access of orthopedic surgical care for long bones fractures

In this study, 137 patients had different barriers to access the indicated surgical care for their long bone fractures. Among barriers, 39.4% (n=54) reported that consulted doctors didn't acknowledge the operative need. Lack of surgical implants occurred in 24.1% (n=33), and lack of admission bed occurred in 16.8% (n=23) of cases.

Patients with lower limb fractures were likely to face the lack of implants and equipment than those with upper limb fractures (29 patients vs. 4 patients). There was a tendency from consulted doctors to miss the acknowledgment of operative need for upper limbs compared to lower limb fractures (39 patients vs. 15 patients). The lack of a surgeon was not reported among barriers.

CHAPTER FIVE: DISCUSSION

5.1. Operative needs for long bone fractures and patients characteristics

This study reveals that males were more likely to have long bone fractures requiring operative management than females (68.3% vs. 31.7%). The median age of patients with long bone fractures was 33years (IQR=19-47). Although the age distribution presented a bimodal distribution (6-10 years and 31-35 years), 76.2% of fractures occurred in people aged more than 16 years (IQR=28-50). Mbanjumucyo et al. [10] reported similar findings among trauma patients presenting at CHUK whereby 77.7% were males and the median age was 30 years. Clelland et al.[27] also found that tibia fractures were common in males (78%) than in females (22%) and the modal age group was 21-30 years. The above findings support previous WHO report that younger adults and male gender were more likely to have traumatic injuries [7].

Differently, Meling et al. [108] studied the epidemiology of long bone fractures that required in-hospital treatment in Norway and reported that 59% were females and 41% were males while the median age was 61years (IQR=24-81). This difference may be a result of the advanced population age in Norway and other European countries compared to sub-Saharan African countries as reported in CIA World Factbook [112].

The geographic distributions of patients revealed that the majority of patients who consulted at RMH were from Kicukiro, Gasabo, and Bugesera while those from Nyarugenge and Gasabo consulted at CHUK.This distribution matches their catchment area. However, an important number of patients consulted from districts located far from Kigali where there are no orthopedic services (i.e. Muhanga, Gicumbi, Kirehe, Nyagatare, Gatsibo,….) and very few patients came from districts which have hospitals that offer orthopedic services (i.e. Nyamasheke, Kayonza, Huye, Musanze). This reveals the beneficial outcome of having orthopedic services at the nearest hospitals, and the need to initiate orthopedic services in districts where they don't exist as planned in NSOAP 2018-2024 [38].

In consideration of affected bones, fractures of the lower limb accounted for 62.7% and were mainly fractures of femur and tibia (59.3%). Fractures of the upper limbs accounted for 36.3%. Mbanjumucyo et al. [10] reported relatively similar findings whereby lower extremity injuries accounted for 72% of all extremity injuries presenting at CHUK [10]. In

Taiwan, Pan et al. [9] reported that lower limb fractures represented 52% of limb fractures and were more likely to present at trauma centers compared to upper extremity fractures. Future planning should consider availing sufficient infrastructures, implants, and equipment for long bone fractures in consideration of their frequency.

5.2. Unattained operative needs for long bone fractures and associated factors

In this study, 46.3% of patients with long bone fractures who consulted in Kigali public referral hospitals have not received the indicated surgical management. Although no similar study was done previously in the region, the unattained operative needs have been reported for different bone fractures. In Tanzania, studies by Clelland et al.[27] and Hollis et al.[28] on femoral and tibial fractures reported that the unattained operative needs ranged from 34-40% . In the study by O'Hara et al. [25], only 56% of femoral and tibial fractures received the indicated surgery in Uganda national referral hospital. Young et al. [102] reported notable annual increase of femur fractures and insufficient number of operations on femur fractures in Malawi central hospital whereby less than 25% of femur fractures were treated surgically in 2014, and available resources were not meeting the rapid rise of femur fractures.

Akinyola et al.[106] reported that only 32% of patients with floating knee benefited a surgical fixation of both fractures, and 40% were treated non operatively on both femur and tibia fractures. In our study, we have found relatively similar results whereby unattained operative needs for femur and tibia fractures were 38.0% and 34.3% respectively.

Our findings show that 86.6% of long bone fractures requiring surgical management were not associated with other injuries and 89.7% of patients injuries were minor or moderate(ISS<16). No critical or fatal case was recorded. While these fractures represented the majority, they were likely to have no access to surgical treatment compared to fractures associated with other injuries (OR=2.146, p=0.0437) and those associated with serious or severe injuries (OR=6.25, p=0.001). This may explain the findings of the previous reports that orthopedic injuries were not associated with higher mortality but were likely to cause morbidity and disability especially in LMICs where limited access to safe surgical care is predominant [6,70].

Closed fractures accounted for 78.6% (n=265) and had a significant likelihood to have no access to the indicated surgical management compared to open fractures (OR= 6.459,

p<0.001). Although the role of early debridement and fixation for open fractures is well documented and remains a standard of care, closed fractures with an indication of surgery present better outcomes with early operative management compared to non-operative management [29–37,59]. Efforts should be put in mobilizing resources so that operative management is provided whenever indicated, and not selectively.

In addition, patients who consulted at the outpatient clinic instead of accident and emergency (A&E) and those who were not admitted on presentation had significantly less chance to receive indicated surgery (OR=3,785, p<0.001, and OR=28.187, p<0.001 respectively). Although the outpatient clinic is not the ideal setting to consult in case of trauma, there is a need to improve the way such patients are followed up so that they can get the indicated surgery in a timely manner. This will require improved coordination within the existing referral and follow-up system in the hospital and between health facilities [18].

Patients who were not admitted or who consult the outpatient clinic have generally isolated fractures with minor or moderate injuries. Although these injuries may not be complicated if not admitted or referred at the outpatient clinic, they lead to long-term disabilities if not treated adequately and timely [6,70]. The analysis of barriers revealed that upper limb fractures were likely to be considered for non-operative management and were less likely to be admitted for surgery compared to lower limb fractures (39 patients vs. 15 patients) and they finally had less chance to access to indicated surgery (OR=2.105, p=0.001).

We found that females had slightly less chance to access the indicated operative management of long bone fractures compared to males (OR=1.679, p=0.045). A study done in Pakistan reported that females had more challenges to access surgical care. They reported that the odds ratio of delay to seek and reach surgical care for females was 1.9 and 4.5 respectively [113]. While Rwanda has made progress towards gender balance in different social fields, further investigations are needed on barriers that women face to access surgical care [114,115].

There was no association between access to surgical care and age as determined by skeletal maturity (<16years vs.≥16years). Disparities in equipment and implants needed to treat fractures in each group are well known: the efficiency of percutaneous pinning and flexible nails in pediatric population does not apply to adults, and the use of intramedullary nails in

adults can not be reproduced in pediatric population [59,65]. However,this factor was not significantly affecting the access to orthopedic surgical care.

The socio-economic status and medical insurance were not associated with having access to surgical care for patients with long bone fractures. This confirms the progress made towards the universal health coverage without socio-economic discrimination. However, in conjunction with the reported proportion of unattained operative needs this finding can be criticized. In the survey by Algeo [105], the lack of supplies in stock was reported to be a challenge to access to surgical care despite a so-called "free health care " as many patients in LMICs cannot afford supplies when they are out of stock in the hospital and must be purchased from outside sources.

Among barriers noted from patients who were not able to receive indicated surgical management for long bone fractures, failure to acknowledge the surgical need as indicated by the patient not being informed that his/her fracture needed surgical care accounted for 39.6% of all barriers. Patients with the upper limb fractures were more affected by this barrier than those with lower limb fractures (39 patients vs. 15 patients). The consulted personnel were either a general practitioner, a resident in emergency medicine, a resident in orthopedics, a consultant in emergency medicine, a consultant in general surgery, or a consultant in orthopedic surgery. In this regard, different hypotheses like poor communication between the doctor and patient, having a different selection criteria to that provided by AO, disparities in knowledge among treating personnel, and others which may need to be investigated to find out the root causes. Ologunde et al. [18] identified poor communication and inadequate skills as major physician related barriers of acess to surgical care. They also emphasized on the impact of weak referral system and poor service coordination as potential health system related barriers which handicap the access to surgical care.

The lack of implants or equipment was reported in 24.1% as a barrier to access for the indicated operative need for long bone fractures. This has led to opting for non-operative management where surgery was indicated. Simillary, studies done in Uganda and Tanzania on femoral and tibial fractures reported the lack of implants as mojor barrier to the access of indicated surgery and led to the option of non-operative management in 34-44% of cases [25,27,28]. The survey by Algeo [105] reported that implants in LMICs are mainly donations which are in most cases old fashion and not sustainable. These implants may not provide

any advantage in complex injuries like proximal femur fractures or fractures with articular extension and surgeons may choose not to operate on such patients. In LMICs, substandard treatment was reported to be common due to lack of appropriate implants made for specific fractures [101,104].

5.3. Limitations of the study

This study reflects broadly unattained operative needs for long bone fractures and associated factors. However, it doesn't specify the factors and barriers of access to surgical care for each fracture or specific group of patients..

The sample size calculation was based on a study done in Norway.Although there was no similar study in our region to be used, difference in the population demography, social, cultural and economic status represents a flaw to our methods.

For some patients recruited, the investigator was involved actively in diagnostic and treatment decision making which may be a source of interviewer bias.

The study reports general results while it was done in two centres with different administrative, organizational structure, and different challenges regarding infrastructures and ressources. This study doesn't provide institution specific guidance toward addressing factors and barriers of access to long bone fractures surgical care.

CHAPTER SIX: CONCLUSION AND RECOMMENDATIONS

6.1. Conclusion

The results of this study revealed an important proportion of unattained operative needs for long bone fractures. Although we can not predict the outcome of these fractures, it has been reported that the poor access to surgical care contributes to the burden of preventable disability and DALYs worldwide especially in LMICs.

Patients with closed fractures, upper limb fractures, isolated fractures with minor to moderate injury severity, and those who consult at the outpatient clinic or who are not admitted on presentation were significantly less likely to have access to indicated surgical care. Despite progress made in gender balance, this study reveals that females still have lesser access to orthopedic surgical care. Failure to acknowledge the surgical need, lack of implants, and the limited capacity of admission were among barriers faced by those who were not operated.

Efforts should be put in the improvement of coordination through the referral and follow-up system for patients with identified factors associated with poor access to orthopedic surgical care for long bone fractures and in addressing identified barriers.

6.2. Recommendations

6.2.1. To referral hospitals

- To put in place, adopt, and adhere to a protocol of treatment of long bone fractures for efficient identification of those which need operative management besides the personal clinical judgment.
- To initiate the monitoring of trauma patient's appointments and schedules for surgery in outpatient clinics or those treated as ambulatory at A&E with isolated fractures and minor or moderate injuries.
- To have an efficient logistic planning for supplies especially for orthopedic implants and equipment.
- To ensure that the doctor at A&E or outpatient clinic has enough skills to decide, communicate, and orient patients on the appropriate orthopedic treatment channel.

6.2.2. To the Ministry of health

- To introduce functional orthopedic services at each referral and provincial hospitals that can provide basic orthopedic trauma surgery to the local community.
- To consider the burden of orthopedic injuries and related preventable disabilities in their planning and ensure an efficient and sustainable supply of required resources for orthopedic trauma surgery.

6.2.3. For future research

- To investigate disparities in treatment planning for long bone fractures among personnel involved in fractures management in Kigali public referral hospitals**.**
- To investigate the outcome for patients with long bone fractures who were not operated in this study.

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APPENDICES

APPENDIX I: DATA CAPTURE SHEET

1. **REFERRAL HOSPITAL:**
    a. RMH
    b. CHUK
2. **CONSULTATION SETTINGS`**
    a. Outpatient clinic
    b. Accident & Emergency service
3. **PATIENT HOSPITAL ID: ……..**
4. **TELEPHONE (for patients, parent or guardian): …….**
5. **AGE:** …….
6. **SEX:**
    a. MALE
    b. FEMALE
7. **DISTRICT OF RESIDENCE**: ……
8. **ECONOMIC CLASS (UBUDEHE)**:
    a. 1
    b. 2
    c. 3
    d. 4
    e. Unknown
9. **SOURCE OF INCOME**
    a. Casual worker
    b. Employed
    c. His/her business
    d. Dependant

10. MEDICAL INSURANCE

a. CBHI
b. RSSB/RAMA
c. MMI
d. Others
e. No insurance

11. DATE AND TIME OF INJURY: ……. /……/…….

12. DATE AND TIME OF CONSULTATION: ……. /……/…….

13. FRACTURE DESCRIPTION

No	**Bone (AO)** ***1.*** *Humerus,* *2.Radius/Ulna* *3.Femur* ***4.*** *Tibia/fibula* ***77.****Metacarpals* ***78.****phalanges(hand)* ***87.****Metatarsals* ***88.****Phalanges(foot)* ***15.****Clavicle*	**Segment (AO)** *1, 2, 3, 4*	**Skin integrity** ***1.*** *Closed* ***2.*** *Open*	**Operation** ***1.*** *ORIF* ***2.****Debridement ±OREF* ***3.****CRPP* ***4.****Flexible Nailing* ***5.****Amputation* ***6.****Non-operative*	**Status after 6 weeks(**only where operations were indicated**)** ***1.*** *Operated* ***2.*** *Not Operated*
1					
2					
3					
4					

14. ASSOCIATED INJURIES

a. Abdominal trauma (including pelvic injuries)
b. Spine injury
c. Head injury
d. Chest injuries
e. Maxillofacial injuries
f. None

15. INJURY SEVERITY SCORE (ISS): ……

16. DECISION ON PRESENTATION

a. Immediate admission
b. To be admitted later
c. Non-operative treatment opted

17. BARRIERS TO ACCESS TO SURGICAL MANAGEMENT (*If Not Operated after 6 weeks*)

a. Were you informed that your fracture(s) needed operative management? **YES / NO**
b. If **YES** on **(a),** did u considered the operative management important and attended surgery advice? **YES/ NO**
c. If **YES** on **(b)** have you been considered for admission and had difficulties to be admitted for surgery? **YES / NO**
d. If **YES** on **(b),** were you informed that there are no implants or equipment for your fracture(s) treatment?
e. If **YES** on **(b),** have you had the issue to find a surgeon able operate on your fracture(s) in this hospital **YES / NO**
f. If **YES** on **(b),** was the cost a barrier to access the indicated surgery for your fracture(s)? **YES / NO**
g. If **YES** on **(b),** were you informed that you were not fit to undergo surgery despite the indication?

APPENDIX II. INFORMED CONSENT AND ASSENT FOR THE RESEARCH STUDY

I am **Dr. NKURIKIYUMUKIZA Laurent** a postgraduate doctor in Orthopedic Surgery in the University of Rwanda. I am conducting a research study entitled "**Unattained operative needs for long bone fractures in Kigali public referral hospitals**". This requires participation of patients with long bone fractures which may require operative (surgical) management who present at accident and emergency services or outpatient clinics at RMH or CHUK. The study aims to evaluate the proportion of unattained operative needs for long bone fractures in Kigali public referral hospitals and associated factors.

In this regard:

1. I am inviting you/your child to participate in this research study. You may not have to decide today whether or not you / your child will participate in the research. Before you decide, you can talk to anyone you feel comfortable with.

2. Your decision for participation in this study is entirely voluntary. You may also choose to change your mind later and stop participating at any stage of this research.

3. Your/your participation will not affect the service or treatment you will receive from this hospital.

4. There may be some words that you do not understand. I will take time to explain. If you have questions later, you can ask them to me.

5. Long bone fractures are common and some fractures like yours / your child's may require a surgical operation as part of treatment. We are aiming to have the information on the proportion of patients with long bone fractures not accessing the indicated operative management and associated factors.

6. We are going to ask you questions and use the information in your/your child hospital file to collect necessary data on your/your child condition and treatment plan.

7. There are no specific risks to participate in this research study. You / your child will be managed according to hospital guidelines and available resources.

8. The delays and lack of access to services (including surgery) that may occur will not be caused by your participation to this research study. We are investigating that matter too.

9. We will call you on provided phone number to get update on your/your child treatment course or use the hospital file information.

10. You will not be provided any incentive for your / your child participation in this research study.

11. The information that we collect from this research project will be kept confidential. Any information about you/your child will have a number on it instead of your/ your child name.

12. The results of this study will be shared with you if you wish by provided phone contact.

Informed assent (for participants with age between 5 and 18 years)

1. I am going to give you information and invite you to be part of this research study. You can choose whether or not you want to participate. We have discussed this research with your parent(s)/guardian and they know that we are also asking you for your agreement.
2. If you decide to participate in the research, your parent(s)/guardian also have to agree. But if you do not wish to participate, you will not be enrolled be in this research study.
3. If you decide not to be in this research study, it is acceptable and nothing changes. This is still your hospital; everything stays the same as before. Even if you say "yes" now, you can change your mind later and it's still acceptable.
4. You may discuss anything in this form with your parents or friends or anyone else you feel comfortable talking to.
5. There may be some words you don't understand or things that you want me to explain more about. Please ask me and I will take time to explain.
6. We are interested to know proportion of patients including children like you with long bone fractures which may need surgical operation but are not accessing surgical care in this hospital. This is why I am inviting you to participate in this research
7. We are going to ask questions to your parents or guardian on your condition and we will use information told to the doctors who is treating you.
8. You will be treated like other patients of you age with the same condition that the hospital can offer.
9. You will not directly benefit from this research but you will contribute greatly to the science by helping us to treat better such injuries in the future.
10. We will not tell other people that you are in this research and we won't share information about you to anyone who does not work in the research study.

11. At the end of this research study, we may give you information on its outcome if you wish via your parents phone contact.

If you have any questions you may ask them now or later, even after the study has started. If you wish to ask questions later, you may contact any of the following:

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CERTIFICATE OF THE INFORMED CONSENT/ASSENT ACT

I have read this information (or had the information read to me). I have had my questions answered and know that I can ask questions later if I have them. I agree to take part in this research study entitled "**Unattained operative needs for long bone fractures in Kigali public referral hospitals".**

Name of participant ……..

Name and Signature of the person giving consent……

Assent decision for pediatric participant to participate in the study: **YES / NO**

Signature of the investigator…….

Date: …….

APPENDIX III : AMASEZERANO YO KWEMERA KWINJIZWA MU BUSHAKASHATSI

Nitwa **Dr. NKURIKIYUMUKIZA Laurent.** Ndi Umuganga wiga icyiciro ya gatatu cya kaminuza mu kubaga amagufa n'ingingo muri Kaminuza y' u Rwanda . Ndimo gukora ubushakashatsi bwiswe **""Unattained operative needs for long bone fractures in Kigali public referral hospitals"** tugenekereje mu Kinyarwanda **"Imvune z'amagufa maremare zitabona ubuvuzi bwo kubagwa mu bitaro bikuru bya bya Leta muri Kigali".Mur u**Ubu bushakashatsi turinjizamo abarwayi bafite imvune z'amagufa maremare zisaba kuvurwa zibazwe bivuriza kuri serivisi y'inkomere cyangwa bivuza bataha mubitaro bya Gisirikare by'U Rwanda RMH ndetse n'Ibitaro Bikuru bya Kaminuza bya Kigali CHUK. bugamije gusuzuma ingano y'abarwayi bafite imvune z' amagufa maremare zikeneye kubagwa batagera kuri ubwo buvuzi ndetse n'impamvu zibitera. Ni muri urwo rwego :

a. UMURWAYI cg UMUBYEYI W'UMWANA

1. Nsaba mwebwe/ cg umwana wawe kutwemerera kwinjizwa muri ubu bushakashatsi. Ufite umwanya uhagije wo guhitamo kwinjizwamo, umaze gusobanukirwa. Wemerewe kubaza n'undi muntu wizeye kugeza impungenge zishize.

2. Icyemezo cyawe/cg cg umwana wawe ni ubushake busesuye. Wemerewe no kwisubiraho ukava muri ubu bushakashatsi igihe cyose wabishakira mbere y'uko ubu bushakashatsi burangira.

3. Kwinjira muri ubu bushakashatsi kwawe/ cg umwana wawe ntacyo bizahindura kuri serivisi z'ubuvuzi uzabonera mubitaro.

4. Mu bisobanuro, ushobora kumva hari ibyo udasobanukiwe. Mfite umwanya uhagije wo kugusobanurira ibibazo byose byerekeye ubu bushakashatsi.

5. Imvune z'amagufa maremare ziriganje kandi abarwayi bafite ubu burwayi bakenera kuvurwa babazwe. Ubu bushakashatsi bugamije kumenya ingano y'abarwayi bafite imvune z'amagufa maremare zikenera kubagwa batagera kuri ubwo buvuzi ndetse n'impamvu zibitera.

6. Ndakenera kukubaza ibibazo ndetse nkoreshe ifishi yawe/ cg umwana wawe yo mu bitaro kugirango mbone amakuru nkenerwa muri ubu bushakashatsi arebana n'uburwayi bwawe / cg umwana wawe ndetse n'ubuvuzi bukenewe.

7. Nta ngaruka zizwi zakugeraho zijyanye no kwitabira ubu nushakashatsi. Ubuvuzi buzatangwa nkuko amabwiriza n'ubushobozi bw'ibitaro bubiteganya.

8. Ugutinda kubona cg kubura serivisi z'ubuvuzi (harimo no kubagwa) bishobora kuba ntibizaba biturutse kuri ubu bushakashatsi. Natwe nibyo tugamije gusuzuma.
9. Nzakenera kuguhamagara kuri telefoni cg ndebe mu ifishi yawe yo mu bitaro kugirango menye amakuru yerekeye aho ubuvuzi bwawe/ cg umwana wawe bugeze.

10. Nta gihembo cyangwa insimburamubyizi uhabwa kugirango winjire mu bushakashatsi.

11. Amakuru tuzakusanya azabikwa mu ibanga. Ntaho izina ryawe/ cg umwana wawe rizagaragara kuko tuzakoresha umubare umuranga aho gukoresha izina.

12. Ibizava muri ubu bushakashatsi uzabimenyeshwa nubikenera binyuze kuri telefoni mugihe uzaba ubyifuje.

UMWANA (Imyaka 5-18)

1. Ngiye kugusobanurira nanagusaba kwemera kwinjira miri ubu bushakashatsi. Ushobora kwemera cyangwa ukabyanga ntakibazo. Naganiriye n'umubyeyi wawe ibyerekeye ubu bushakashatsi none nawe turagusaba kubyemera.
2. Nuhitamo kubujyamo n'ababyeyi bawe turabasaba ko babyemera. Nubyanga nabyo ntacyo bitwaye rwose ntabwo tuzagushyiramo.
3. Nuhitamo kutinjizwa muri ubu bushakashatsi nakibazo kandi ntacyo bizahindura ku buvuzi uzahabwa uzavurwa nkuko bisanzwe bigenda.No mugihe utwemereye kubujyamo, wemerewe kwisubiraho igihe cyose ubishakiye ntakibazo.
4. Hari ibindi bisobanuro ukeneye wambaza cyangwa ukabaza undi muntu wisanzuraho.
5. Mu byo tuganira niwumva aho udasobanukiwe umbaze ngusobanurire rwose.
6. Tugamije kumenya ubwinshi bw'abarwayi b'imvune z'amagufa maremare zikeye kubagwa, harimo n'abana nkawe batabasha kubona ubwo buvuzi muri ibi bitaro.
7. Ndakenera kubaza umubyeyi wawe ibibazo byerekeye uburwayi bwawe no gukoresha amakuri yabwiwe muganga wakuvuye
8. Uzavurwa nkuko abandi muhuje uburwayi bavurwa mu bushobozi bwibitaro.
9. Nta nyungu ya nonaha yerekeranye n'ubu bushakashatsi ubona ariko kwemera kwawe bizafasha mu kongera ubumenyi no kuvura neza ubu burwayi mu gihe kizaza.
10. Ibyo tuzakusanya bizaguma ari ibanga ntawundi uzamenya ko wagiye muri ubu bushakashatsi uretse ababukoraho.

11. Nidusoza ubu bushakashatsi nubyifuza uzamenyeshwa ibyavuyemo binyuze kumurongo wa telefoni mwatanze.

Niba hari ikindi kibazo ufite wakibaza nonaha cg undi munsi. Nukenera kubaza wabaza aba bakurikira:

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ICYEMEZO CYO KWEMERA KWINJIRA MU BUSHAKASHATSI

Ndemera ko nasomye /nasomewe ibyerekeye ubu bushakashatsi kandi ko ibibazo byanjye byasubijwe . Nemeye kubushake kwinjira muri ubu bushakashatsi bwiswe" **Unattained operative needs for long bone fractures in Kigali public referral hospitals."**

Amazina y' winjijwe mu bushakashatsi

……..

Umukono w'uwinjiye mu bushakashatsi/umubyeyi cg umuhagarariye:

……

Icyemezo cy'umwana ku kwinjizwa mu bushakashatsi : **Yego / Oya**

Umukono w'umushakashatsi…….

I taliki: …….

APPENDIX IV: TIME FRAME FOR RESEARCH ACTIVITIES

	2019/2020											
	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	July	Aug
Proposal drafting												
IRB submission												
Data collection												
Data analysis												
Manuscript drafting												
Submission of the manuscript												
Dissemination of results												

APPENDIX V: BUDGET

Item	**Quantity**	**Unity Price (FRW)**	**Total (FRW)**
Paper printing	1600	100	160000
Manuscript binding	15	2000	30000
Communication (airtime, transport, internet)	12	25000/month	300000
Locker an padlock	1	20000	20000
Pen	20	150	3000
Dissemination and publication	1	100000	100000
Total			613000