CAUSES AND PATTERNS OF HIP FRACTURES AMONG ADULT PATIENTS AT MUHIMBILI ORTHOPAEDIC INSTITUTE FROM 2019 TO 2020

Hamza Said, MD

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By

Hamza Said

A Dissertation Submitted in (Partial) Fulfillment of the Requirements for the Degree of Master of Medicine (Orthopaedics and Traumatology) of

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CERTIFICATION

The undersigned certifies that he has read and hereby recommend for acceptance by Muhimbili University of Health and Allied Sciences a dissertation entitled: **‘‘Causes and Patterns of Hip Fractures among Adult Patients at Muhimbili Orthopaedic Institute from 2019-2020”,** in (partial) fulfilment of the requirements for the degree of Master of Medicine (Orthopaedics and Traumatology) of Muhimbili University of Health and Allied Sciences.

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Dr. Kitugi S. Nungu (MD, MMed, Dip Epi. Biostatics, PhD, FCS (ECSA)

Lecturer, MUHAS and Consultant Orthopaedic &Traumatology Surgeon

(Supervisor**)**

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Date

DECLARATION AND COPYRIGHT

I, **Dr. Hamza Said,** declare that this **dissertation** is my own original work and that it has not been presented and will not be presented to any other University for a similar or any other degree award.

Signature……. **Date**…….

ACKNOWLEDGMENT

I would like to acknowledge my supervisor, Dr. Kitugi S. Nungu for the intelligent guidance and mentorship he rendered to me during the preparation of this dissertation. I equally extend my sincere thanks to Dr. Boniface, Executive Director of Muhimbili Orthopaedic Institute (MOI) for the permission of conducting this study.

I would like to thank all the Consultants, Specialists, Residents, Registrars and Nurses at MOI for all the valuable assistance and support they offered me during all the stages in the preparation and conducting this study.

DEDICATION

This dissertation is dedicated to my family members and my friends for their tireless support during my work.

ABSTRACT

Background

The population of older adults in sub-Saharan Africa has substantially increased (two times higher than in northern Europe) and is expected to grow rapidly than anywhere else by 2050. This is linked to increased rates of fracture in the hip region. However, there is a paucity of literature about causes and patterns among adult patients with hip fractures at Muhimbili Orthopaedic Institute (MOI)

Aim/broad objective

This study is aimed to determine the causes and patterns of hip fractures among patients aged 18 years and above admitted at MOI.

Materials and methods

A cross-sectional study was conducted from September 2019 to February 2020 on adult hip fracture patients admitted at MOI. Demographic information, mechanism of injury, associated injuries, and medical comorbidity were extracted from patient's files. A Singh index (SI) criteria determined osteoporosis on the anteroposterior plain radiographs of the pelvis in all patients aged 50 years and above who sustained a low-energy falls, whereby the score of ≤3 was graded as significant osteoporosis. A Statistical Package for the Social Sciences (SPSS version 25) for the analysis of data, and they were described as proportions (percentages) for categorical data and means for continuous. A Chi-square test was applied to check the association among the categorical/ordinal variables. A p-value that was found to be less than 0.05 was considered statistically significant.

Results:

The study included 178 hip fracture patients who met the criteria, of whom 60% (n=106) were males, and the rest were females. The mean age was 66 years, and more than half of patients (63%) were above 65 years of age. 138 patients (78%) sustained a low-energy injury, such as falls from standing height (FFSH) whereby the majority of them (94%) were aged 50 years and above with an almost equal ratio between both sexes (53% males versus 47% females). 40

patients (22%) sustained a high-energy trauma, mostly from motor traffic crash (MTC) (82%). Males were mostly involved in high-energy trauma (87%) compared to females (13%). Associated injuries were higher in the high-energy trauma (63%) than in the low-energy falls (1%). The trochanteric fractures were significantly higher in the low-energy injury (87%) compared to the femoral neck (81%) and subtrochanteric fractures (53%). In contrast, subtrochanteric fractures were almost equally distributed to both modes of injuries (i.e. high-energy and low-energy injury).

Conclusion:

The majority of hip fracture patients at MOI are low-energy fragility fractures mainly occur after 50 years of age. They are equally distributed between both genders and attributed to increasing age and osteoporosis. A few ones are due to high-energy trauma, mainly seen in young male patients aged less than 50 years, and are a result of MTC. The highest proportions of the trochanteric fractures occur in the low-energy falls, whereas half of the subtrochanteric fractures occur in high-energy trauma. Hence, the findings of the study may be used for the formulation and preparation of the management protocols of the hip fracture patients at MOI, for planning preventive measures, and encourage further researches on hip fractures.

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LIST OF ABBREVIATIONS

BMD	Bone Mineral Density
DXA	Dual-energy X-ray Absorptiometry
FFSH	Fall from Standing Height
HIV	Human Immunodeficiency Virus
KCMC	Kilimanjaro Christian Medical Centre
MOI	Muhimbili Orthopaedic Institute
MTC	Motor Traffic Crash
MUHAS	Muhimbili University of Health and Allied Sciences
O.T.	Orthopaedic and Traumatology
RTA	Road Traffic Accident
SI	Singh Index
SPSS	Statistical Package for the Social Sciences
TBI	Traumatic Brain Injury

DEFINITION OF KEY TERMS

Hip fractures occur between the articular margin of the femoral head and 5 cm below the lower border of the lesser trochanter (1). They are anatomically classified concerning the hip capsule as intracapsular fractures (i.e., femoral neck) and extracapsular fractures (trochanteric and subtrochanteric) (2).

Femoral neck (cervical) fractures are intracapsular fractures which anatomically classified as sub-capital, transcervical, and basicervical fractures (1).

Trochanteric fractures involve those occurring in the region that extends from the extracapsular basilar neck region to the area along the lesser trochanter proximal to the development of the medullary canal. They include both pertrochanteric and intertrochanteric fractures (3).

Subtrochanteric femur fractures can generally be defined as the fractures that occur within five centimetres (5 cm) of the distal extent of the lesser trochanter and represent an unstable injury (3).

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background

Worldwide, the incidence and prevalence of hip fractures are expected to rise exponentially because of the increased older-aged population (4,5). This has been linked to reduced bone density (BMD) and an increasing tendency to falls among older people (6). A very few hip fractures occur in younger patients (usually less than 50 years) and they are a result of high-energy trauma, mainly road traffic accidents (RTA) (7). In high-energy trauma, the patient evaluation according to advanced trauma life support (ATLS) should be done as other associated life-threatening injuries have been documented (7). Hip fractures are classified as intracapsular or femoral neck and head fractures and extra capsular that involves trochanteric and sub trochanteric fractures (1,2).

In the developed countries (especially Europe and North America), plenty of literature on hip fractures including aetiology is well documented. Because of their huge elderly population, hip fractures mostly occur in very senior citizens (more in older women than men) and mainly associated with osteoporosis and falls (8). Also, hip fractures rarely (less than 2 to 3%) occur in younger people under 50 years, usually due to the high-energy trauma (7,9). Contrary to the developed world, in Africa, especially in sub-Saharan Africa, there is scanty literature on hip fractures. It has been assumed to be very low compared to other parts of the world. This has been related to the lower prevalence of osteoporosis, and reduced life expectancy among African communities (10).

However, there is an increased number of older adults (aged ≥60 years) in sub-Saharan Africa (doubles that of northern Europe) and is projected to rise faster than elsewhere globally, increasing from 46 million in 2015 to 157 million by 2050 (11). The increased older-aged population has been found associated with increased rates of hip fractures as previously stated (4,5). Furthermore, rapid urbanization and overcrowding in many cities and towns in this

region with shortage and poor road infrastructures, has led to increased RTA and skeletal fractures including hip fracture (12,13).

In Tanzania, there are very scanty pieces of literature on hip fractures especially causes and patterns. There is one recent study done by Tsabasvi et al. on hip fractures pattern at Kilimanjaro Christian Medical Centre (KCMC) in northern Tanzania (14). However, this study focused more on the fragility fractures of the hip and included only patients aged 50 years and above. Therefore, this study aims to determine the causes and patterns of hip fractures among adult (≥18 years) patients at MOI.

1.2 Problem Statement

It has been projected that as demographics change with an increasingly ageing population in developing countries, a great number of older patients having hip fractures are expected to rise exponentially by 2050 (4). This has been related to age-related osteoporosis and an increased tendency to falls among older people (6).

From sub-Saharan Africa. In Owerri Nigeria, Onwukamuche et al. found that 71% of hip fractures resulted due to severe trauma (about half from RTA) and are significantly higher in men. Meanwhile, 29% of hip fractures occur due to FFSH and significantly higher in women (15). At KCMC in northern Tanzania, Tsabasvi et al. reported that low-energy injuries (FFSH < 1-meter height) are the dominant cause (76%) of hip fractures with both sex contributed equally (14). However, this study focused more on the fragility fractures and included only patients ≥50 years.

Despite MOI receives and provides services to many trauma patients, there is no published data about the causes and patterns of hip fractures among adult patients. Therefore, the findings of this study will add information to the literature.

1.3 Conceptual Framework

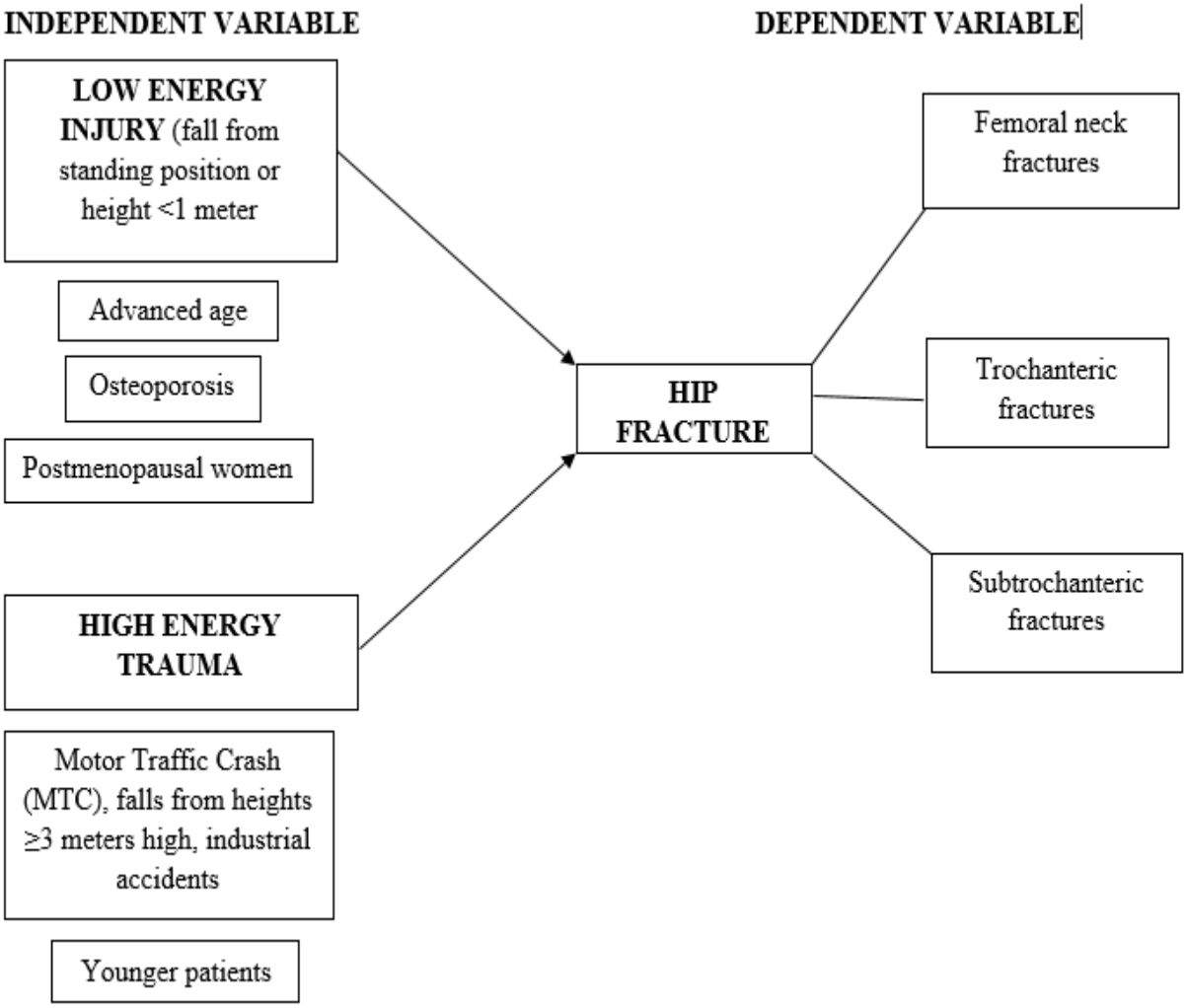

Figure 1: Conceptual framework

1.4 Rationale

By studying the clinical epidemiology of hip fractures among patients of 18 years of age and above at MOI, will help to identify the causes and hip fracture patterns among these patients, to lay the ground for formulating the management protocols, and possibly stimulate more local studies on hip fractures.

1.5 Research Questions

What are the causes and patterns of hip fractures among patients 18 years and above at MOI?

1.6 Objectives of the study

1.6.1 Broad objective

To determine the causes and fracture patterns among patients with hip fractures of 18 years of age and above at MOI 2019/2020

1.6.2 Specific objectives

1. To describe the demographic characteristics of patients in the study population
2. To identify the causes of hip fractures among patients with ages ranging from 18 years and above according to age and sex
3. To describe the hip fracture patterns among patients with age range of 18 years and above according to age, sex, and the causes
4. To determine the association between low-energy hip fractures (fragility hip fractures) and osteoporosis among patients aged 50 years and above.

1.7 Literature Review

Demographic characteristics of hip fractures

Worldwide, the incidence of hip fractures increases with an increased older-aged population and falls in older people (5,6). The risks of sustaining a hip fracture have been intensively studied especially in the developed countries (specifically Europe and North America). It has been related to advancing age, and female gender (8). Caucasians are mostly affected compared to other races, with the lowest rates seen in Africans (5). The reasons for the low incidence/prevalence of hip fractures among African communities have been related to reduced life expectancy, and environmental factors (5,10,16). Also, osteoporosis is assumed to be very low in Africa, as well as underreporting is reported to contribute to the lower rates of hip fractures (10).

Advancing age (50 years onwards), and female gender especially post-menopausal women have been well documented as the risk factors for hip fractures (6). Advancing age is related to weakened bone and an increasing tendency to falls in older people due to several factors. These include increased comorbidities, multiple medications taken by older people, and weak musculoskeletal system (6,17,18). The female gender (post-menopausal) is associated with a greater prevalence of hip fractures compared to men. The incidence is about two to three times higher in women than in men (6,19,20). This is because of low bone mass and greater falls in older women compared to men. Women have also been observed to live longer as compared to men (6,19).

However, in low-risk areas such as Africa and some parts of Asia, similar rates of hip fractures in both males and females have been reported (5,6). Hip fractures are significantly lower in rural areas as compared to urban in any country. This has been related to increased physical activities such as agricultural occupation in rural areas (6,21). In contrast to rural communities, the higher rates of hip fractures in urban have been attributed to decreased physical activity, an increase in trauma, lower vitamin D levels, and lifestyle factors that involve alcohol and smoking (22)

Despite the reduced incidence or prevalence of hip fractures in Africa, specifically sub-Saharan Africa, and paucity of researches, there is a report of increased life expectancy due to increased adult and older-aged populations in this region, which eventually lead to increased risk of hip fractures (11). Additionally, rapid urbanization and overcrowding, consequently lead to high-risk activities and prone to RTAs and fractures (including hip fractures) among adult communities (12,23). Some recent studies show an elevated number of hip fractures and osteoporosis in the region than previously reported. They suggested good quality studies to be conducted to characterize and determine the incidence of hip fractures and osteoporosis (16,22).

Causes of hip fractures

The aetiology of hip fractures includes low-energy injury or a simple fall from standing heights which accounts for the majority of the patients (more than 90%) (1,6). Falls from standing heights (FFSH) mainly result in hip fractures among patients who are aged 50 years and above. The higher rates of FFSH and hip fractures occur commonly to post-menopausal women and they are twice/three times compared to men (6,7). Reduced bone mass and increased life span among women compared to men have well been documented as to why women tend to fracture more than men (6,19).

A very few hip fractures are a result of high-energy trauma mainly MTC and with some contribution from falls from high heights (9). They mostly occur to people less than 50 years of age and usually have an association with other life-threatening injuries. These include head, neck, chest, abdominal and pelvic, as well as injuries related to the extremities (3,9).

In sub-Saharan Africa, the risk factors for FFSH and hip fractures have a similarity with the other regions of the world (18). However, because of reduced longevity, high prevalence of Human immunodeficiency virus (HIV), and increased use of antiretroviral therapy among African communities together with other documented risk factors, hip fractures possibly occur earlier than the white population (24). Additionally, in contrast to the developed countries, in which more number of hip fractures are seen in older women than men, in the low-risk population such as Africa, the rates are similar in both genders (6). Ekezie CK, et al. and

Zebaze et al. reported higher rates of fragility hip fractures in women (10,25). Tsabavi et al. showed that fragility hip fractures are equal between both sexes (14). Further studies are needed as it is difficult to conclude from scanty literature with low power studies.

In Africa, specifically sub-Saharan Africa, there is rapid urbanization, and overcrowding among towns and cities, (12). All these are found to be associated with a high risk to MTC and fractures among the adult population and mainly men because of being involved in outdoor activities (12,15). Onwukamuche et al. in Owerri, Nigeria reported RTA as the leading cause of hip fractures (about half of all cases), and men were mostly involved (15). Tsabasvi et al. at KCMC reported only a few patients were involved in the high-energy trauma (<8%). However, this study focused more on the fragility fractures and involved only patients aged 50 years and above (14).

Patterns of hip fractures

Hip fractures can be divided anatomically into intracapsular which includes femoral neck fractures and extracapsular which include trochanteric (intertrochanteric and per trochanteric) and subtrochanteric fractures (1,2). Femoral-neck and trochanteric fractures are found to be nearly 90% of the total hip fractures that occur in approximately equal proportions (26). They are significantly associated with low-energy injury, that is, FFSH among patients aged 50 years onwards (7,27). On the other hand, subtrochanteric fractures account for 10-34% of all hip fractures. They mainly occur due to high-energy trauma in young patients and FFSH among older people (9).

Kim et al. observed that trochanteric fractures are found to be more common than cervical fractures among all ages and both sexes. The study included patients over 50 years of age, hence they suggest that osteoporosis is a significant health problem and linked to hip fractures (28). Two studies in Brazil and one in Morocco showed that trochanteric and femoral neck fractures were almost equal proportions in all ages and both genders (20,29,30). Since gender has not shown any significant association with hip fracture patterns, Ramalho et al. reported slightly higher proportions of trochanteric fractures (58.8%) in men than women (46.4%) (29).

Onwukamuche et al. in Nigeria showed femoral neck fractures were about three times higher than trochanteric fractures in FFSH, whereas subtrochanteric fractures resulted mainly in severe trauma (15). Tsabasvi et al. at KCMC found a predominance of trochanteric fractures in both fragility and non-fragility fractures. Femoral neck fractures had the highest proportion in the fragility fractures suggesting their association with low-energy injury. On the other hand, about half of the subtrochanteric fractures resulted from high-energy trauma (14). However, the study focused more on the fragility fractures and included only patients ≥50 years of age.

CHAPTER TWO

2.0 RESEARCH METHODOLOGY

2.1 Study design

We conducted a cross-sectional hospital-based study on all adult patients admitted after sustaining a hip fracture following trauma.

2.2 Study area

The study was conducted at MOI Dar-es-salaam, Tanzania, a specialized institute of Orthopaedics, Traumatology, and Neurosurgical care with a bed capacity of 350. It is the tertiary hospital for patients with skeletal trauma serving the city of Dar es Salaam and the country at large. The institute is also involved in researching in these fields to improve the management of patients. And at the same time, it is a Teaching hospital for the Department of Orthopedic and Traumatology of Muhimbili University of Health and Allied Sciences (MUHAS).

2.3 Study duration/period

This study was conducted for a total of six (6) months from September 2019 to January 2020.

2.4 Study population

All patients who sustained hip fractures and were admitted during the study period.

2.5 Inclusion criteria

- All patients aged 18 years and above.
- Those who are radiologically confirmed with hip fractures.

2.6 Exclusion criteria

- Bone diseases with metastasis (pathological fractures)
- Patients with congenital bone disease

- Those who are non-ambulant before sustaining the fracture. They are more likely to have pathological fracture secondary to disuse osteoporosis and/or other comorbidities.

2.7 Sampling Technique

A convenient, non-random sampling technique was used to select the appropriate patients based on inclusion criteria.

2.8 Sample Size Estimation

From a pilot study done from October 2018 to January 2019, 39 patients had hip fractures among a total of 411 patients aged 18 years and above with a radiologically confirmed diagnosis of fractures.

The sample size was estimated by using the following formula.

$N = \frac{z^2\, p(1-p)}{e^2}$, Where

N = Sample size, Z value for 95% confidence level = 1.96.

P = Proportion will be 0.095 of the patients with hip fractures.

Error rate (e) = 0.05

Therefore, the estimated sample size for 95% confidence interval.

$N = \frac{(1.96)^2\ 0.095(1-0.095)}{(0.05)^2}$

N for a 95% interval was approximately 132 patients.

One hundred thirty-two (132) patients were expected to be recruited. However, one hundred seventy-eight (178) patients of hip fractures were recruited during the study period (six months).

2.9 Variables

Causes of hip fractures (high energy trauma and low energy falls) as independent variables

- High energy trauma includes motor traffic crushes, fall from a height of above 2 meters, industrial accidents. Any associated injury was documented

- Low energy falls, such as standing position or height less than 1 meter high. Any associated injury was also documented

The dependent variable (hip fracture) was radiologically confirmed. Then,

- Anatomical location/fracture patterns were determined, whether
  - Intracapsular fracture (femoral neck) or
  - Extra capsular fracture (intertrochanteric/ subtrochanteric)

2.10 Data collection tools and methods

A prepared English version questionnaire has been applied to collect information during the study period. Demographic information (such as age, gender/sex, residence, and level of education) and causes of hip fractures (higher-energy trauma which included motor traffic crashes, falls from heights, and low-energy/trivial injury such as a simple fall from standing height <1 meter) were extracted from the patient's files (medical records). Any documented or reported presence or absence of comorbidity (such as hypertension, diabetes, HIV, stroke, dementia, chronic kidney disease, and asthma), especially for cases aged 50 years and above, was extracted. The interview with the patients or relatives was used to obtain some information which in the case was not available in the patient's files/medical records. Plain radiographs to confirm the diagnosis of hip fractures were done to all cases and retrieved from the MOI computer system. Anatomic classification, whether intracapsular fractures (femoral neck) or extracapsular fractures (inter/per trochanteric and subtrochanteric), was used (1,2). A simplified Garden classification system was used to assess intracapsular femoral neck fractures as either "non-displaced" type I and II or "displaced" type III and IV (31).

The trabecular patterns in the bone at the femoral neck and head were described on the anteroposterior radiographs of the pelvis using SI criteria for all hip fracture patients aged 50 years and above who sustained a low-energy falls/trivial injury i.e. FFSH. Osteoporosis was then estimated and graded as either less or equal to 3 (significant osteoporosis) or greater than 3 (no osteoporosis).

The gold standard for BMD examination and osteoporosis diagnostic is dual energy X-ray absorption (DXA) (32, 33). However, DXA scans are expensive and skill and well trained technical staff is required to acquire reliable and valid measurements (34). Hence are not available in all trauma centres including our institution. SI is an inexpensive simple method of assessing bone density at a site where fractures occur as described by Singh et al. in 1970 (35). Singh et al. suggested that BMD loss leads to characteristic shifts in the proximal femur's trabecular pattern on the front-postal plain pelvic x-rays. Six trabecular patterns were thus discussed grade 6 reflecting regular pattern, grade 4 osteopenia, grade 3 and lower grades of osteoporosis. However, due to the subjective nature of its undefined rating and cut-off level for osteoporosis, the SI was criticised for its little reliability. Studies have shown that the SI utility has been underestimated for predicting skeletal bone mass and that the index is substantially less than photon absorption methods (35, 36)

2.11 Data management and analysis

Information was entered and managed using a data analysis computer program, SPSS version 25. Demographic characteristics such as age group, sex, residence (urban vs. rural), and education level were described as proportions (or percentages), and age was described by means and standard deviation. The causes of hip fracture according to age and sex were described by proportions (percentages). The fracture patterns/locations were also described as proportions. The association between fragility hip fractures and osteoporosis was calculated using the Chi-square test and a p-value of less than 0.05 will be considered statistically significant.

CHAPTER THREE

3.0 RESULTS

A total of 197 patients with hip fractures were admitted during the study period (from September 2019 to February 2020). Nineteen patients were excluded from this study, as they did not meet the criteria. Only 178 patients met the criteria and were included in the study (figure 2).

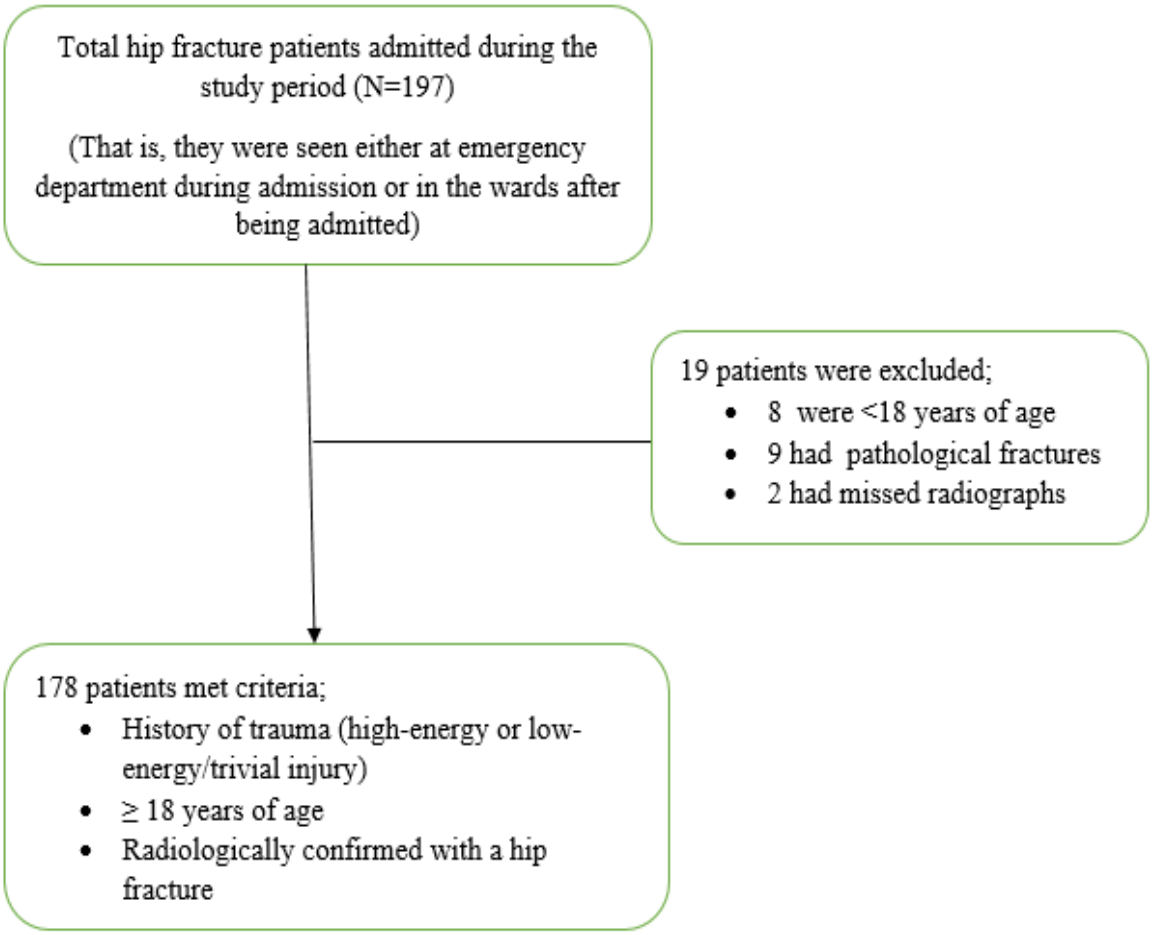

Figure 2: Enrolment of patients with hip fractures during the study period

Among 178 patients with hip fractures, males were higher 106 (60%), than females (Table 1). The mean age of all patients was 66 years, whereby significantly higher in females (73 years) (Table 1). The majority of patients (78%) were aged 50 years and above. Table 1 summarizes the mean ages of both males and females. The education level of the study population was from non-formal to higher learning in which two-third were non-formal and primary education (Table 1). The majority of patients with hip fractures resided in urban areas (Table 1).

Table 1: Demographic characteristics of the study population

Age (years)	GENDER			
	Male, n=106 (%)	**Female, n=72 (%)**	**Total, N=178 (%)**	**p-Value**
Less than 50	32 (30.2)	7 (9.7)	39 (21.9)	0.001
50−65	20 (18.9)	7 (9.7)	27 (15.2)	
66−80	36 (34.0)	35 (48.6)	71 (39.9)	
81 and above	18 (17.0)	23 (31.9)	41 (23.0)	
Mean age (years)	61.26	72.94	65.99	
Std. Error	1.94	1.83	1.43	
95% CI	57.44−65.09	69.34−76.55	63.16−68.82	
Education level				
Non-formal	25 (23.6)	41 (56.9)	66 (37.1)	0.001
Primary	38 (35.8)	18 (25.1)	56 (31.5)	
Secondary	26 (24.5)	7 (9.7)	33 (18.5)	
Vocational & higher learning	17 (16.0)	6 (8.3)	23 (12.9)	
Residence				
Urban	77 (72.6)	50 (69.4)	127 (71.3)	0.643
Rural	29 (27.4)	22 (30.6)	51 (28.7)	

CI=Confidence Interval, Std=Standard

The majority of the patients, 138 (78%), sustained a low-energy/trivial injury, which is an FFSH or height <1 meter (Table 2). Most of them (94%) were aged 50 years and above, with an approximately equal ratio between sex (53% males and 47% females) (Table 2). The mean age of patients in the low-energy injury is significantly higher (73.5 years) than that of high-energy trauma (Figure 3). Forty patients (22%) sustained a high-energy trauma whereby the majority (80%) were younger than 50 years of age (Table 2). Other associated musculoskeletal/visceral injuries were significantly higher in the high-energy trauma (62.5% vs. 1.5% in low-energy injury) (Table 2). More than half (52%) of hip fracture patients with high-energy trauma associated injuries were documented to have lower extremity injuries (Table 3). MTC was the highest mode of injury (82.5%) in the higher-energy trauma (Table 3).

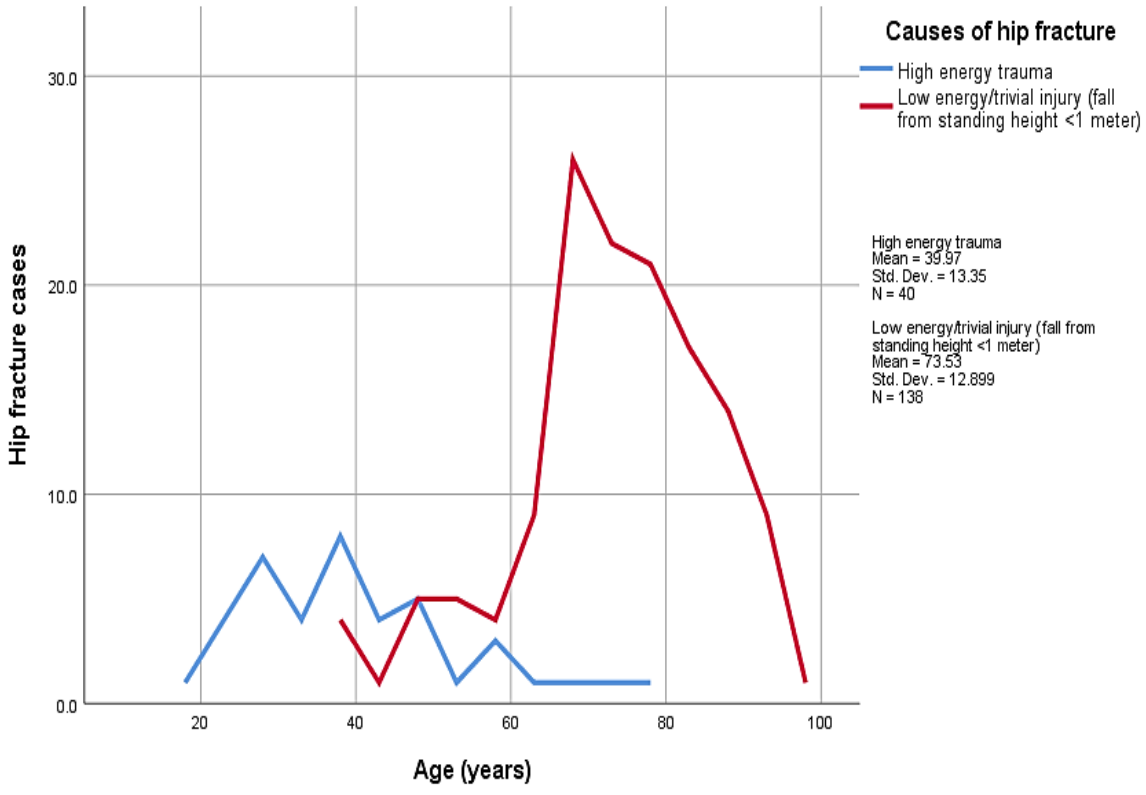

Figure 3: Distribution of hip fractures versus age among patients 18 years of age and above at MOI

Table 2: Causes of hip fracture among patients aged 18 years and above at MOI according to age and sex

Age (years)	High-energy trauma, n=40 (%)	Low-energy injury, n=138 (%)	Total, N=178 (%)	p-Value
Less than 50	32 (80)	7 (5.1)	39 (21.9)	0.001
50-65	6 (15)	21 (15.2)	27 (15.2)	
66-80	2 (5)	69 (50.0)	71 (39.9)	
81 and above	0 (0)	41 (29.7)	41 (23.0)	
Gender				
Female	5 (12.5)	67 (48.6)	72 (40.45)	0.000
Male	35 (87.5)	71 (51.4)	106 (59.55)	
Associated injuries				
Yes	25 (62.5)	2 (1.45)	27 (15.17)	
No	15 (37.5)	136 (98.55)	151 (84. 83	

Table 3: High-energy trauma and associated injuries

High-energy injuries	Frequency	Percentage
MTC-As, a pedestrian	13	32.50
MTC-As a car/bus driver	1	2.50
MTC-As, a passenger	7	17.50
MTC-As, a motorcyclist	12	30.00
FFH>2 meters high	5	12.50
other*	2	5.00
High-energy associated injuries		
Head/Neck		
Yes	11	44.00
No	14	56.00
Chest		
Yes	5	20.00
No	20	80.00
Spine		
Yes	1	4.00
No	24	96.00
Abdominal		
Yes	2	8.00
No	23	92.00
Pelvic		
Yes	7	28.00
No	18	72.00
Upper extremity (fractures/soft tissues)		
Yes	7	28.00
High	18	72.00
Lower extremity (fractures/soft tissue)		
Yes	13	52.00
No	12	48.00

* indicates one patient was fallen and hit by a heavy object and the second slipping down and landed on a stone while jogging.

Trochanteric fractures were significantly higher in patients aged 50 years and above compared to subtrochanteric fracture (58%) and cervical fractures (78%) (Table 4). The fracture pattern was also prevalent (87%) in patients who sustained a low-energy/trivial injury compared to 53% subtrochanteric and 81% cervical fracture (Table 4).

On the other hand, the subtrochanteric fracture was more prevalent in young patients of less than 50 years of age (42% compared to 22% cervical and 11% trochanteric fracture). The subtrochanteric fracture was also significantly higher (47%) in those patients who sustained a high-energy trauma compared to 19% cervical and 13% trochanteric fractures. However, in terms of proportions (low-energy vs. high-energy trauma) and (<50 years vs. ≥50 years), subtrochanteric fractures were almost equal in both modes of injury (1.1:1) and slightly higher in low-energy fracture patients aged ≥50 years (1.4:1) (Table 4).

There was no significant relationship when hip fracture patterns were cross-tabulated with sex (p-value >0.05) (Table 4). However, in terms of absolute numbers, the subtrochanteric fracture was higher (75%) in male patients compared to female patients (Table 4).

For the femoral neck fractures, basicervical was slightly higher compared to sub-capital and Transcervical (Table 4). According to the simplified Garden classification, all 79 patients with femoral neck fractures were classified as displaced (Garden 3 and 4) (Table 4).

Table 4: Hip fracture patterns among patients aged 18 years and above at MOI according to age and sex

Variables	Femoral neck fracture n=79(%)	Trochanteric fracture n=63(%)	Subtrochanteric fracture n=36(%)	Total n=178	P-Value
Gender					
Male	47 (59.5)	32 (50.8)	27 (75.0)	106	0.062
Female	32 (40.5)	31 (49.2)	9 (25.0)	72	
Age group (years)					
Less than 50	17 (21.5)	7 (11.1)	15 (41.7)	39	0.002
50 and more	62 (78.5)	56 (88.9)	21 (58.3)	139	
Causes of hip Fracture					
High energy trauma	15 (19.0)	8 (12.7)	17 (47.2)	40	<0.001
Low energy/trivial injury (falls from a standing height<1meter)	64 (81.0)	55 (87.3)	19 (52.8)	138	
Femoral neck fracture location	**Frequency (N=79)**	**Percentage**			
Sub capital	12	15.19			
Transcervical	29	36.71			
Basicervical	38	48.1			
Simplified Garden classification					
Displaced (3&4)	79	100			

Among 138 patients with hip fractures who sustained a low-energy injury (FFSH or height ≤1 meter), 7 patients (<50 years) were excluded. For the remaining 131 patients (≥50 years who sustained FFSH or height <1 meter), SI criteria were used to determine osteoporosis on the proximal femur (femoral head and neck) using anteroposterior plain radiographs of the pelvis. There was a significant relationship that osteoporosis increases with age from 50 years onwards (p-value <0.05) (Table 5).

Among 139 patients (≥50 years), hypertension was significantly higher compared to other comorbidities (Table 5). There was a significant association between the number of comorbidities with increasing age (≥50 years) among patients with hip fracture (p-value <0.05) (Table 5).

Table 5: Association between low-energy hip fractures and osteoporosis among patients aged 50 years and above at MOI

SI criteria for patients ≥50 years (lower-energy/ trivial injury)	**Age (in years)**			**Total, n=131 (%)**	**value**
	50 to 65, n=21 (%)	**66 to 80, n=69 (%)**	**81 and above, n=41 (%)**		
Osteoporosis	2 (9.52)	17 (24.64)	21 (51.22)	40 (30.53)	0.001
No osteoporosis	19 (90.48)	52 (75.36)	20 (48.78)	91 (69.47)	
Comorbidity (for patients ≥50years)	**n=27**	**n=71**	**n=41**	**n=139**	
None	17 (62.96)	25 (35.21)	7 (17.07)	49	0.016
Hypertension (HTN)	6 (22.22)	25 (35.21)	13 (31.71)	44	
Diabetes Mellitus (D.M.)	1 (3.70)	4 (5.63)	1 (2.44)	6	
Chronic Kidney Disease (CKD)	0 (0.00)	1 (1.41)	1 (2.44)	2	
HTN/DM/CKD	1 (3.70)	13 (18.31)	13 (31.71)	27	
HIV/AIDS	0 (0.00)	1 (1.41)	0 (0.00)	1	
Other	2 (7.41)	2 (2.82)	6 (14.63)	10	

S.I.: Singh Index

CHAPTER FOUR

4.0 DISCUSSION

The findings of this study show that the male to female ratio is 1.5 to 1. The majority of patients who sustained hip fractures are aged 50 years and above. Of these, more than half are older than 65 years. The mean age is higher among females, and most of the patients reside in urban areas. This implies that the risk of sustaining a hip fracture increases with advancing age, urbanization (sedentary lifestyle), and weakened bone due to old age.

Three studies (Nigeria, Morocco, and northern Tanzania) found a similar ratio (14,15,37). For only patients aged 50 years and above in this study, the ratio of males to females is almost equal. Therefore, a further increase in male proportion is explained by the involvement of patients less than 50 years in which males were mostly involved. However, worldwide studies have shown that the female predominance ratio ranges from 2–3 to 1 (12, 19, 23, and 24). Most of these studies, especially in the developed world, considered the elderly population with a hip fracture (as of more than 60 years of age) (25, 26). This is because the prevalence of osteoporosis and the risk of fracture are higher in postmenopausal women than in older men (6,19). Contrary to other studies in the developed world, in this study male to female ratio is equal for patients aged 65 years and above with hip fractures (Table 1). However, it is not captured in this study, this possibly could be explained by women are active and being involved in various activities in the African communities compared to men. Furthermore, other factors in men which could probably lead to secondary osteoporosis such as alcoholism, smoking, and other comorbidities which were not studied could explain this. Hence, further studies are needed to ascertain the risk factors for increased risk of fragility hip fractures among older people in our communities.

The results of this study show that low-energy injury, i.e., FFSH or <1 meter significantly accounts for the majority of hip fractures, with >90% of the patients are aged 50 years and above. A few patients (<50 years and mainly men) are involved in the high-energy trauma (mostly from MTC). The involvement of the majority of patients in the low-energy injury among patients aged 50 years and above suggests that the risk of sustaining hip fractures

increases with age due to reduced bone strength and an increasing tendency to falls among older people (6). Meanwhile, high-energy trauma (such as from MTC) among a few and mainly male patients aged less than 50 years of age suggests that significant force is needed to cause a hip fracture in the stronger bone (38). Additionally, this high-energy trauma may lead to other life-threatening and associated injuries as having been shown. Young patients (especially men) are at higher risk of sustaining high-energy hip fractures possibly because of being involved in high-risk outdoor activities. However, it was not studied in this research, some studies demonstrated involvement in outdoor activities and risk of MTC (10,15,38). Further researches are needed to find out the risk factors for sustaining high-energy trauma and low-energy falls among patients with hip fractures in our institution and probably other local hospitals.

The findings of this study suggest that sex is significantly related to the mechanism of injury with more men in the high-energy group (p-value <0.05). The reasons for this have already been explained above. We found that there are almost equal proportions of gender in the fragility fractures (low-energy injury, i.e. FFSH or height <1 meter). The reason for this, however, is not studied in this research but could probably be explained by different roles played by African women in the community compared to men and other factors which may lead to secondary osteoporosis in the older men as explained above in the demographics. This area needs further researches

The results of this study significantly suggest that fracture locations are related to the mode of injury and age (p-value <0.05). The highest proportions of the low-energy fractures (and mostly to patients ≥50 years) occur at the trochanteric region followed by the femoral neck. On the other hand, low-energy and high-energy fractures occur at approximately equal proportions in the subtrochanteric region. Additionally, the proportion of subtrochanteric fractures is slightly higher for patients ≥50 years of age than those <50 years of age (1.4:1). However, we found that sex is not significantly related to fracture location (p-value >0.05). Although, it is observed that higher proportions of males with subtrochanteric fractures than females (3:1).

The highest proportion of trochanteric fractures in the low-energy injury and advanced age (from 50 years onwards) compared to other patterns can be explained by age-related/senile reduced bone strength and increased tendency to fall in the older people, especially on their greater trochanter (18,39–41). Additionally, the Trochanteric region is usually affected more by osteoporosis than the femoral neck. Similar results of higher proportions of trochanteric fractures have been shown in several studies (20,29,42). However, other studies have shown the predominance of femoral neck fractures in the low-energy fragility fractures (14,15). Half of the subtrochanteric fractures that occurred in high-energy trauma (mainly in the young men <50 years) suggest that high force is needed to cause the fracture. Further researches in this area can provide evidences related to such circumstances.

We used an anteroposterior plain radiographs of the pelvis to determine osteoporosis on the proximal femur for hip fracture patients aged ≥50 years and who sustained a low-energy injury, i.e. an FFSH. We used SI criteria as it is a widely available and less expensive tool though it is less precise and high interobserver reliability. DXA is the gold standard in the assessment of BMD and diagnosing osteoporosis because of its high accuracy and low precision error (36,43). However, it is expensive and not available in our institution.

The results of this study suggest an association between fragility hip fractures and osteoporosis among patients aged ≥50 years (p-value <0.05). This can be explained by advancing age (senile osteoporosis), and post-menopausal women. Other possible contribution to osteoporosis may partly be attributed to some comorbidities (such as diabetes mellitus and chronic kidney failure), which were shown significantly associated with advancing age (p-value <0.05). However, it was not studied in this research, medications taken by older people with comorbidities could indirectly contribute to osteoporosis. Other risk factors for osteoporosis in Africa initially were assumed to be very low, but recent studies have shown an increasing trend and call for further researches on it (16,24).

4.1 Study Limitations

Unavailability of the DXA scan for diagnosing osteoporosis in our setting limits this study. However, SI was used instead but it is inferior to the DXA scan. A few radiographs had poor quality, which led to difficulties in reading and interpretation, such as classifying the fractures and determining osteoporosis. Furthermore, the radiologist was also not readily accessible all the time, and instead, at least two senior radiology residents were consulted to interpret radiographs.

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATIONS

Hip fractures are frequently seen at MOI. The majority of them are fragility fractures, i.e. due to FFSH in patients aged 50 years and above. Another significant contribution is from high-energy trauma, mainly from MTC, and this occurs mostly in young patients aged less than 50 years.

Sex is significantly related to the mode of injury. Men are mostly involved in high-energy trauma, whereby both sexes are almost equally distributed in the low-energy fragility fractures. We also found signs that the highest proportions of trochanteric fractures occur in the low-energy injury, whereas subtrochanteric fractures are distributed equally to both high-energy trauma and low-energy fragility fractures.

The study suggests evidence of an association between low-energy fragility hip fractures and osteoporosis among patients aged 50 years and above admitted at MOI. This may be attributed to increasing age (senile osteoporosis) and not limited to multiple comorbidities and their medications among older-aged patients.

The findings of the study can be utilized by the institute (MOI) for the formulation and preparation of management protocols of hip fractures. We also recommend using the study findings to generate new hypotheses for future prospective studies on hip fractures.

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APPENDICES

Appendix I: Questionnaire

1. Demographic information;
    - Patient's file number……
    - Age……
    - Gender, (i) Male, (ii) Female
    - Female gender,
        (i) premenopausal period
        (ii) postmenopausal period; (less than 3 years, 3-5 years, more than 5 years)
    - Address/contact…… (i) urban (ii) rural
    - Education level; (i) Non-formal (ii) Primary (iii) Secondary (iv) Vocational and/or Higher learning
    - Tribe……

2. Information about a hip fracture; radiologically confirmed
    - (i) Plain radiograph, (ii) C.T. Scan (iii) MRI Scan
    - Anatomical location/ fracture patterns
        (a) femoral neck fracture
        (b) intertrochanteric fracture
        (c) subtrochanteric fracture
    - For intracapsular femoral neck fractures (FNFs), according to simplified Garden classification
        (a) Non-displaced fractures (type I and II)
        (b) Displaced fractures (class III and IV)
    - FNFs anatomical location, (a) Sub capital (b) Transcervical (c) Basicevical

- Using SI criteria to assess osteoporosis on hip fractures; (Only for patients aged 50 years of age and above who sustained low energy fracture and with no other pathologies identified)
- S.I. Grades (i) less or equal to 3, (ii) greater than 3

3. Causes of hip fracture. (circle or mark the response)
    - High-energy trauma; (i) Motor vehicle crushing (ii) motorcycle crushing (iii) fall from height >2 meters high, (iv) industrial accidents, (v) other…….
    - Any associated injuries reported/documented
        (i) Yes
        (ii) No
    - If yes,
        (i) Head or neck injury
        (ii) Chest injury
        (iii) Spine injury
        (iv) Abdominal injury
        (v) Pelvic injury
        (vi) Extremity injuries
        (vii) Other, mention……
    - Low-energy falls from standing position or height <1 meter.
    - Any associated injury reported/documented
        (i) Yes
        (ii) No
    - If yes;
        (i) Distal radius
        (ii) Proximal humerus
        (iii) Mild head injury
        (iv) Vertebral fracture
        (v) Other, mention……

4. Any comorbidity reported or documented
   (a) Non
   (b) Hypertension (HTN)
   (c) Diabetes mellitus (D.M.)
   (d) Chronic kidney disease (CKD)
   (e) HTN/DM/CKD or other comorbidities (multiple comorbidities/ at least two)
   (f) HIV/AIDS
   (g) Any other comorbidity……

5. Ambulation status for patients aged 65 years and above before history of trauma
   (a) Yes
   (b) Using any walking aid
   (c) No

Appendix II: Singh Index Criteria

Trabecular types in the proximal femur

Five trabecular types can be present in the proximal part of the femur:

- principal compression
- secondary compression
- primary tensile
- secondary tensile
- intertrochanteric

As osteoporosis progresses, these trabeculae get thinner and eventually disappear.

The six grades of the Singh index

Grade 6

- All trabecular groups are visible on the radiographic image.
- The upper end of the femur seems completely occupied by cancellous bone.

Grade 5:

- The principal tensile trabecula is accentuated.
- Ward's triangle appears prominent.

Grade 4:

- The principal tensile trabeculae are reduced (markedly) but still can be traced from the lateral cortex to the upper part of the femoral neck.

Grade 3: There is a break in the continuity of the principal tensile trabeculae.

Grade 2:

- Only the principal compressive trabeculae are seen prominently. The others have been more or less absorbed.

Grade 1:

- Even the principal compressive trabeculae are reduced in number and are no longer prominent.

Interpretation; **Grade 3** and **below** indicate definite osteoporosis.

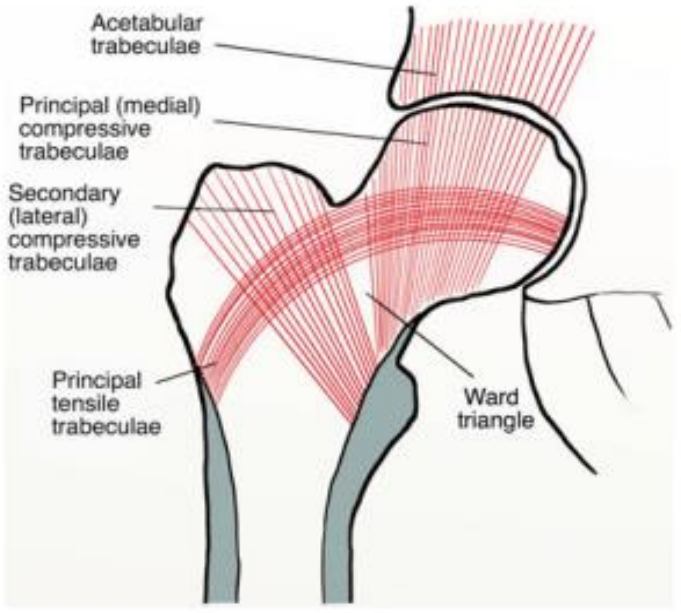

Figure 4: The trabecular patterns of the proximal femur(43)**.**

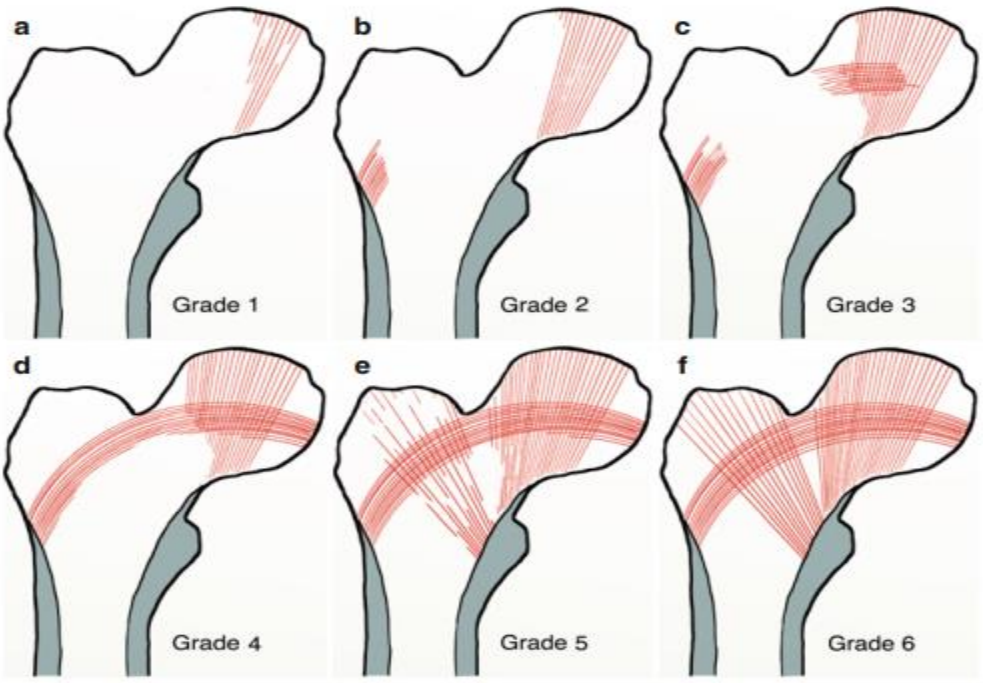

Figure 5: The six grades of the Singh index(43)**.**

Appendix III: Consent Form – English Version

Study Title: Hip fractures; Causes and Fracture Patterns among Patients Aged 18 years and above at MOI 2019/2020.

Part A:

Introduction

My name is Dr. Hamza Said, MMed student at MUHAS, Department of Orthopaedic and Traumatology. I am conducting a study on the proportion, causes, and fracture patterns/anatomical location of patients with hip fractures. I would like to conduct the research above as a requirement for the fulfilment of my postgraduate studies.

Purpose of the study

The purpose of this study is to assess the causes and fracture patterns of hip fractures. This information will help to know the clinical epidemiology of hip fractures in patients aged 18 years and above and to lay the ground for formulating preventive measures and possibly stimulate more local studies on hip fractures.

Study procedures

The primary information required from you is your particulars, as in the data collection sheet and filling of the questionnaire provided for the assessment of your condition.

Risks and benefits to the participant

No risks are directly related to the study. The benefits will be participating in a study that will result in better planning of preventive measures and regular assessments for those at risk.

Confidentiality

The data collection sheet is strictly confidential. Your name will not appear in it, and your telephone number is strictly for follow up purposes.

Participant information

Your participation in this study is voluntary, and failure to participate or withdrawal will not affect your management in any way at any stage.

Contacts and Questions

The researcher conducting this study is Dr. Hamza Said

Can be reached by email: hamzabinde@gmail.com, Mobile numbers: 0757-821-039, 0714570877.

Suppose you have any questions or concerns regarding the study and would like to talk to someone other than the researcher. In that case, you are encouraged to contact Dr. Kitugi S. Nungu and Dr. Joyce Masalu, Director of MUHAS Research and Publications Committee, MUHAS P.O.BOX 645001, Dar es Salaam. Telephone (+255) 222-152-489 Dar es Salaam.

Part B

Participant consent form

I have understood the above information, which has been fully explained to me by the investigator, and I voluntarily consent to participate.

Signature……

Or a participant's thumbprint.

Date……

Witness signature……

Appendix IV: Fomu ya kuomba ridhaa – Kiswahili

Utafiti: Mivunjiko ya Nyonga; Sababu na Sehemu au Namna ya Mvunjiko Miongoni mwa Wagonjwa Wenye Miaka 18 na Zaidi katika Taasisi ya Tiba ya Mifupa (MOI).

Scheme A:

Utangulizi

Naitwa Dk. Hamza Said, mwanafunzi wa shahada ya uzamili katika Chuo Kikuu cha Tiba ya Afya na Sayansi Shirikishi Muhimbili (MUHAS), Kitengo cha Mifupa (Orthopedic and Traumatology). Ninaendesha utafiti juu ya sababu na namna/sehemu ya mvunjiko wa mfupa wa nyonga kwa wagonjwa wenye kuanzia miaka 16 na zaidi. Ninaendesha utafiti huu kama hitaji la msingi kabisa ilikufanikisha masomo yangu ya shahada ya juu.

Kusudio la utafiti

Kusudio la utafiti huu ni kutathmini sababu na sehemu/namna ya mvunjiko wa nyonga kwa kundi tajwa hapo juu. Taarifa utakayonipa inaweza kusaidia kubaini sababu mbalimbali zinazopelekea tatizo na kupanga njia zitakazoweza kuepuka/kuzuia baadhi ya sababu zinazozuilika na uwezekano wa uangalizi kwa wakati kwa wale watakaokuwa katika hatarizaidi.

Taratibu za utafiti

Taarifa muhimu zinazozohitajika ni zakukuhusu mwenyewe kama zilivyo katika nyezo ya kukusanyia..

Hatari na faida

Hakuna hatari za moja kwa moja zitakazosababishwa na utafiti kwa mgonjwa. Faida ni kuwa kushiriki kwako katika utafiti huu kutawezesha mipango mizuri katika uzuiaji wa mvunjiko wa nyonga na kuwezesha tafiti zaidi baada ya kupata taarifa za mwanzo.

Siri

Taarifa katika huu utafiti ninakuhakikishia ni siri. Jina lako halitatumika wala kutokea popote na namba yako ya simu ni kwa ajili ya mawasiliano tu endapo itahitajika kufanya hivyo.

Taarifa za mshiriki wa utafiti

Ushiriki wako katika utafiti huu ni wa hiyari, na kukataa ama kujitoa katika utafiti hakutaathiri hatua yeyote katika matibabu yako kwa namna yeyote ile.

Anuani na maswali

Anayeendesha huu utafiti ni dk. Hamza Said

Anapatikana kwa anuani ya barua pepe: hamzabinde@gmail.com, namba ya simu ya kiganjani: 0757-821-039/ 0714570877.

Ikiwa una swali ama dukukuku lolote lile kuhusiana na utafiti na ungependa kuwasiliana na mtu mwingine tofauti na mtafiti, unahimizwa kuwasiliana na Dk. Kitugi S. Nungu au Dr. Joyce Masalu ambaye ni mkurugenzi wa kamati ya tafiti na machapisho MUHAS, S.L.P. 645001, Dar es Salaam. Simu (+255) 222-152-489 Dar es Salaam.

Sehemu B

Fomu ya ridhaa kwa mshiriki

Nimeelewa taarifa tajwa hapo juu kama nilivyoelezewa yote na mtafiti na nipo tayari kwa hiyari yangu kushiriki bila kulazimishwa.

Sahihi ……

Au sahihi ya dole gumba ya mshiriki.

Tarehe……

Sahihi ya Shahidi……

Appendix V: Approval of ethical clearance

MUHIMBILI UNIVERSITY OF HEALTH AND ALLIED SCIENCES
OFFICE OF THE DIRECTOR OF POSTGRADUATE STUDIES

P.O. Box 65001
DAR ES SALAAM
TANZANIA
Web: www.muhas.ac.tz

Tel G/Line: +255-22-2150302/6 Ext. 1015
Direct Line: +255-22-2151378
Telefax: +255-22-2150465
E-mail: dpgs@muhas.ac.tz

Ref. No. DA.287/298/01A/

16th September, 2019

Dr. Hamza Said,
MMed. Orthopaedics and Traumatology,
School of Medicine,
MUHAS.

RE: APPROVAL OF ETHICAL CLEARANCE FOR A STUDY TITLED:"HIP FRACTURE; CAUSES AND FRACTURE PATTERNS/LOCATIONS AMONG PATIENTS AGED 18 YEARS AND ABOVE AT MOI 2019/2020"

Reference is made to the above heading.

I am pleased to inform you that, the Chairman has, on behalf of the Senate, approved ethical clearance for the above-mentioned study. Hence you may proceed with the planned study.

The ethical clearance is valid for one year only, from **16th September, 2019 to 15th September, 2020.** In case you do not complete data analysis and dissertation report writing by **10th September, 2020,** you will have to apply for renewal of ethical clearance prior to the expiry date.

Dr. Emmanuel Balandya
ACTING: DIRECTOR OF POSTGRADUATE STUDIES

cc: Director of Research and Publications
cc: Dean, School of Medicine, MUHAS

Appendix VI: Introduction letter

MUHIMBILI UNIVERSITY OF HEALTH AND ALLIED SCIENCES

OFFICE OF THE DIRECTOR OF POSTGRADUATE STUDIES

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Telefax: +255-22-2150465
E-mail: dpgs@muhas.ac.tz

Ref. No. HD/MUH/T. 156/2017

17th September, 2019

Executive Director
Muhimbili Orthopaedics Institute
P.O. Box 65474
DAR ES SALAAM.

Re: INTRODUCTION LETTER

The bearer of this letter Dr. Hamza Said is a student at Muhimbili University of Health and Allied Sciences (MUHAS) pursuing MMed. Orthopaedics and Traumatology.

As part of his studies he intends to do a study titled: ***"HIP fracture; causes ad fracture patterns/locations among patients aged 18 years and above at MOI 2019/2010".***

The research has been approved by the Chairman of University Senate.

Kindly provide him the necessary assistance to facilitate the conduct of his research.

We thank you for your cooperation.

Muhimbili University of Health and Allied Sciences * DIRECTOR Postgraduate Studies * Box 65001

Ms. Sharifa Kamby
For: DIRECTOR, POSTGRADUATE STUDIES

cc: Dean, School of Medicine