IMAGING PATTERNS OF THORACIC INJURIES AMONG PATIENTS AGED 14 YEARS AND ABOVE AT MTRH, ELDORET, KENYA.

By

Dr. Bonyodon Benjamin Odhiambo

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Imaging Patterns of Thoracic Injuries among Patients aged 14 years and above at MTRH, Eldoret, Kenya.

Principal Researcher

Dr.Bonyodon Benjamin Odhiambo, (MBCHB (Moi), BPHARM (Nrb).

Registrar in Radiology and Imaging,

Moi University, School of Medicine

Supervisors

Prof. G.D, Onditi Elias MBCHB (NRB), MMED (NRB),

Associate Professor,

Department of Radiology and Imaging School of medicine

College of Health Sciences,

Moi University

Dr. E.N Onchagwa, MBCHB (NRB), MMED(NRB),

Lecturer, Department of Radiology and Imaging,

School of Medicine,

College of Health Sciences.

Moi University

DECLARATION

Student's Declaration

I declare that this thesis is my original work and that it has never been presented elsewhere for academic purposes or otherwise. No part of this work can be reproduced or transmitted in any form without prior written permission from the author or Moi University.

Bonyodon Benjamin Odhiambo

Registration number: SM/PGR/03/11

Registrar, Department of Radiology and Imaging

Moi University

Sign……………………….................................Date……......................………………

Supervisors' Declaration:

This thesis has been submitted for consideration with our approval as university supervisors.

Prof. G.D. Onditi Elias.

Department of Radiology and Imaging,
Moi University
Sign …………………………..........................Date ……........…………………

Dr. E.N. Onchagwa

Department of Radiology and Imaging sciences,

Moi University

Sign ……………………………......................Date ……….......……………………

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DEDICATION

This study is dedicated to my dear wife Seline, children and late mother Penina.

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LIST OF ABBREVIATIONS

AMPATH:	Academic Model Providing Access to Healthcare
CT Scan:	Computed Tomography Scan
CXR:	Chest Radiograph
HIV:	Human Immunodeficiency Virus
IQR:	Interquartile range
IREC:	Institutional Research and Ethics Committee
KNH:	Kenyatta National Hospital
MRI:	Magnetic Resonance Imaging
MTC:	Medical Training College
MTRH:	Moi Teaching and Referral Hospital
MVA:	Motor Vehicle Accidents.
RTA:	Road Traffic Accident
SES :	Socioeconomic status
USA	United States of America

OPERATIONAL DEFINITION OF TERMS

Imaging: refers to CT and plain radiography modalities used for diagnosing thoracic injuries

Thoracic injuries: These are damages to the thorax due to trauma, causing body wound or shock as a result of a sudden physical injury to the organs and tissues in the thoracic cavity and the chest wall.

Imaging Pattern: Types of injuries seen on the imaging radiograph such as fractures.

ABSTRACT.

IMAGING PATTERNS OF THORACIC INJURIES AMONG PATIENTS AGED 14 YEARS AND ABOVE AT MTRH, ELDORET, KENYA.

Background: Thoracic injuries form a major cause of trauma related mortality accounting for up to 25% of all trauma-related deaths world-wide. Imaging techniques constitute the main tools for either screening or definitive diagnosis of chest injuries. Local data related to thoracic injuries and treatment protocols are lacking in our setting.

Objective: To determine the imaging patterns of thoracic injuries.

Methods: A cross-sectional study was done among patients with a clinical diagnosis of chest injuries presenting at MTRH Radiology and Imaging department for Chest radiographs (CXR) and Computerized Tomography (CT) scan. A sample size of 166 participants was determined by the Fisher's Formula. Systematic random sampling was used to select every second participant. Plain chest radiography and computed tomography (CT,model Phillips MX 4000 dual, Shanghai, China) were used in imaging. The images were then interpreted by two independent consultant Radiologists. The data obtained was recorded manually and later analyzed using STATA version 13 statistical software. Descriptive statistics such as mean and median were used for continuous variables while the association between imaging patterns of thoracic injuries and socio-demographic factors were assessed using Chi square test. A p-value of less than 0.05 was considered significant.

Results: There were 170 participants who were sampled out of which 122(72%) were males. Over 90% of the participants presented with chest pain with the most common imaging pattern being haemothorax (64%),followed by pneumothorax (45%) and rib fractures (42%). The majority of injuries 70(41%) were caused by motor vehicle accidents (MVA). Decelerating mechanism of injury was significantly high among the male participants compared to the female, (39%) vs. 4(16%) (P=0.03).Females tended to have a lower risk of haemothorax compared to males with 56% of the females having haemothorax compared to 67% of males.

Conclusions: The most common imaging finding of thoracic injuries was haemothorax followed by pneumothorax and rib fractures. Motor vehicle accidents were found to be the leading cause of thoracic injuries with penetrating and blunt mechanisms of injuries occurring in nearly equal proportions. The median age of the participants was 35 years while the male gender and socioeconomic status were found to be associated with thoracic injuries. This study however, found no statistical significant association between age and the mechanism of injury.

Recommendations: There is need for another bigger study in a longer period.

CHAPTER ONE
INTRODUCTION

1.1 BACKGROUND INFORMATION

Trauma refers to a body wound or shock produced by a sudden physical injury as from violence or accident. It is the sixth leading cause of death worldwide accounting for about 20% of all mortality and is a serious public health problem with a significant social and economic consequences (Miller DL, 2007).The affected area of the body and percentage of total incidence (Soreide K, 2009), is used to classify trauma.

The aetiology and patterns of chest injuries have been reported in literature to differ from one part of the world to another partly because of variation in infrastructure,crime and violence, regional conflicts among other factors(Mock, Lormand, Goosen, Joshipura, &Peden, 2004; Monafisha KL, 2011; Odero, Khayesi, &Heda, 2003).

Globally, thoracic injuries form a major cause of trauma related morbidity and mortality accounting for 10-20% of admissions and 25% of all trauma related deaths(Bonatti H, 2008).It is only second to head injuries which are responsible for 30% of the incidences worldwide(Soreide K, 2009). Thoracic injuries can be sustained in isolation or in association with multiple injuries.The mechanisms of injuries are either through blunt or penetrating trauma. Injuries that may be associated with thoracic trauma include head,abdominal,spinal,extremities and maxillofacial injuries. The major causes of blunt injuries are road traffic accidents, assault and fall from a height. Gunshots and stab wounds constitute the main penetrating injuries(Tariq et al., 2011).

The major types of thoracic trauma include:

1. Trauma to the thoracic cage such as the rib fractures,frailchest,spinalinjuries,diaphragmatic hernia.
2. Trauma to the respiratory tract such as pulmonary contusion,laceration,airway obstruction and ruptured trachea.
3. Trauma to the cardiovascular system such cardiac tamponadeand ruptured aorta.
4. Pleural space disease such as pneumothorax and haemothorax.

These conditions may be responsible primarily for either respiratory or circulatory embarrassment or even death. Some of these injuries must be rapidly diagnosed and urgently be treated within a time frame of primary survey since they have a potential to cause death. They include airways obstruction, tension pneumothorax, frail-chest, cardiac tamponade, open pneumothorax and massive pneumothorax. CT and CXR cannot demonstrate thoracic injuries such as myocardial contusions. Non-specific methods like echocardiography and electrocardiography are used to predict outcomes(Azemi et al.). Definitive diagnosis is complex and can only be made in gross histological examination of the myocardium(Maenza, Seaberg, & D'Amico, 1996).

Various imaging techniques form the main tools for either screening or definitive diagnosis of chest trauma. Plain radiography of the chest and pelvis are often performed in major trauma. CT scan is however the gold standard in major trauma(B. N. Westaby S, 1990).It is never readily available in a resource limited environment and also expensive hence rarely used for initial screening**.** Of recent past, multi-detector CT(MDCT) is progressively changing the approach to thoracic trauma imaging (Mefire et al., 2010).MRI has advantages over CT in the evaluation of patients with suspected dorsal spine injuries. It provides excellent details of intervertebral discs, spinalligaments, paravertebral soft and other spinal contents such as cord and nerve roots.It can demonstrate cord edema,hematoma or disc compression(McGillcuddy EA, ; Ziegler DW, 1994).Chest radiographs remains the primary screening study for the assessment of chest trauma(B. N. Westaby S, 1990).Some studies have shown that ultrasonography has higher sensitivity than plain chest radiographs in detecting rib fracturesand haemothorax (McEwan & Thompson, 2007).Others have however shown that it is either equally sensitive or slightly better(Bland et al., 2009)while others describe it as less accurate (Soffer et al., 2004). For vascular injuries of the thorax, angiography remains the gold standard(Mattox, 1999).

Throughout history, age, gender and socioeconomic status (SES) have been linked to health outcomes such as disease and trauma.SES differences are found for rates of mortality and morbidity from almost every disease and condition.

(Antonovsky,1967,Illsley and Baker 1991).SES is a composite measure that typically incorporates economic status measured by income, social status measured by education and work status measured by occupation.(Dutton and Levine 1989).The three indicators are interrelated but not fully overlapping variables. Researchers often use either of the three variables (income, level of education and occupation) as a measure of SES. Marmot et al 1984, in the Whitehall study of mortality ranked SES interms of occupation. The lowest grade consists of unskilled workers. The next class consisting of clerical workers followed by professionals and executive levels.SES can also be grouped in a hierarchy from low, middle and upper classes.

This study therefore sought to describe the patterns of thoracic injuries at Moi Teaching and Referral Hospital (MTRH) with the view of improving the clinical outcomes.

CHAPTER TWO
LITERATURE REVIEW

2.1 Overview of thoracic imaging patterns.

Imaging patterns of thoracic trauma are those injuries which can be visualized on imaging modalities such as chest radiographs or CT scan images. The imaging patterns are diverse depending on tissues involved, aetiology and mechanisms of trauma (Massaga FA, 2010).Chest Radiographs are currently obtained as a screening examination for the vast majority of chest trauma patients and remains an excellent tool for early detection of life threatening injuries and patient triage (B. N. Westaby S, 1990). CT of the chest, however, is the gold standard and can demonstrate the majority of thoracic injuries in details.

Locally in Kenya, rib fractures have been found to be the most common pattern(Otieno T, 2004). In a study by Saidi and Nyakiamo at Aga Khan University hospital in Nairobi, it was found that that hemothorax and pneumo-hemothorax accounted for 47.4% of all the imaging patterns followed by rib fractures (Saidi, Nyakiamo, &Faya, 2002). A study by Al-Koudmani and his colleagues in Damascus Syria, found the most common patterns of thoracic injuries were pneumothorax, hemothorax, rib fractures and lung contusion accounting for 51%, 38% 34% and 15% respectively. Other injuries were relatively rare and included diaphragmatic injury 3.4%,frail chest 2.4% ,penetrating heart injury 1.2% and oesophageal rupture 0.2%.In New Delhi, India Mohta and Kumar demonstrated that rib fractures were the commonest pattern at 26.70% followed by pneumothorax at 20.80% and hemothoraxat18.64% (Mohta et al., 2006). In Nepal, it was found that the most frequent patterns were rib fractures at 51.20%, hemothorax 16.30%, pneumo-hemothorax 15.10% and pneumothorax 8.14% (Bajracharya, Agrawal, Yam, Agrawal, & Lewis, 2010). In another Nepalese study by Chapagain and colleagues; the commonest patterns were rib fractures, hemothorax, pneumothorax and pulmonary contusions accounting for 83%,57%,34% and 33% respectively (Chapagain, Reddy, Shah, & Shrestha, 2014).In Bugando Tanzania, Monafisha found the most frequent patterns were chest wall wounds at 30%,hemothorax at 21.30% and rib fractures 20.70% (Monafisha, 2011). Another study in Dar-es-Salaam Tanzania by Massaga and colleagues found rib fractures to be the commonest pattern contributing to upto 42.90% (Massaga, 2010).

2.2 Aetiologyofthoracicinjuries.

The aetiology and pattern of thoracic injuries have been reported in literature to differ from one part of the world to another partly because of variations in infrastructures, regional conflicts, civil violence and crime among other factors(Odero W, 2007), (Mock et al., 2004).

In Kenya, various studies have shown that motor vehicle accidents (MVA) is the most common cause of trauma accounting for upto 50% of which 15% are attributed to chest injuries (Otieno T, 2004). Road traffic crashes were found to exert a huge burden on Kenya’s economy and healthcare due to sporadic and uncoordinated, ineffective interventions. Similar studies done in Uganda by Doruk and Renee and in both Tanzania and Nigeria show that road traffic trauma are the most common cause of chest injuries(Hsia RY, 2010).

In Pakistan, data on penetrating injuries is used as an indicator of violence in the country. This is because the Pakistani population is noted to have suffered more due to penetrating trauma in the recent past due to violence and political instability. It is more common and often attributed to gunshots and stab wounds(Tariq et al., 2011).

Other causes of chest trauma include assault, stab wounds, falls from heights among others. Kenyan studies by Woodsfield and Otienofound that fall from a height and assault were responsible for 22% and 13% respectively of trauma injuries (Otieno, Woodfield, Bird, & Hill, 2004).Meme- Murerwa on the other hand found that MVA was the leading cause of trauma contributing to 32.7%,followed by assault 23.80% and fall from a height 15% in a study conducted at Nakuru provincial general hospital (Meme-Murerwa HK, 2002).

In New Delhi, India Mohta and his colleagues found that MVA, fall from a height and assault were responsible for 39.10%, 24.80% and 20% respectively of thoracic injuries. These findings are also consistent with those of Ziegler and Agrawal in Pakistan (Chapagain et al., 2014; Mohta et al., 2006).

Globally, blunt thoracic injuries are the main causes of morbidity and mortality from general trauma injuries. In USA, about 20% of hospitalized trauma cases per year are due to thoracic trauma. The incidence of hospitalized thoracic trauma in the USA is 12 per million population per day or about 100,000 cases per year (LoCicero J, 1989).

Thoracic trauma is often associated with cardiac trauma due to anatomical proximity of the heart to the chest wall. The incidence of cardiac injury varied from 10% to 75% in the presence of chest injury in some autopsy and clinical case studies (Leinoff, 2000). In addition to cardiac injuries, thoracic trauma may also lead to injury of lungs, pleura, thoracic great vessels, diaphragm, trachea and oesophagus (Keough& Pudelek, 2001). Both penetrating and blunt forces can cause thoracic trauma. The most common feature of penetrating thoracic trauma is pneumothorax usually caused by gun shot or a penetrating wound. Demetriades (Demetriades, Velmahos, Rhee, & Chan, 2004)stated that rapid deceleration resulting from falls and direct impact and compression from motor vehicle crashes are common mechanisms of blunt thoracic injury. Approximately 25% of hospitalized injuries in motor vehicle accidents involve the chest. On the other hand, more than 60% of major chest trauma cases are related to motor vehicle crashes.

Clinical types of chest injuries varied in different studies depending on the causes; however most of them were associated with other injuries. Majority of patient in almost all of the studies were treated conservatively by no more than a chest tube. Although most of these patients managed to arrive at hospital for treatment, more deaths occurred within the hospital (Tedeschi Eckert, 2001). Closed tube thoracostomy is a simple and a lifesaving procedure but still is associated with many complications (D. Viano D, 1978; R. Morgan, 1994). This has been a challenge to many surgeons on this preventable cause of deaths.

Boot(Boot DA, 1999) states that in developed countries, trauma is the main cause of death in adults under 40 years of age. Approximately 20% of trauma deaths are directly related to chest trauma and of these around two-thirds occur as a result of motor vehicle accidents. Other causes of significant chest trauma include falls from a height, occupational injuries including falls and crush injuries, knife and gunshot injuries and domestic accidents.

Trauma can be broadly divided into two categories, blunt and penetrating. Blunt trauma imparts kinetic energy to the body, which leads to tissue damage either by direct impact or by inducing shearing forces within body tissues (Odero W, 2007). Penetrating injuries include knife and bullet wounds which, as well as damaging structures within the body, can also introduce infection. Major chest injuries seldom occur in isolation. Commonly associated injuries include those to the head, extremities, spine, abdomen and pelvis (Besson A, 1982; Massaga FA, 2010; Monafisha, 2011; Monafisha KL, 2011; Ogendi J, 2013).

Chest injuries cause high morbidities and mortalities because they involve vital organs. They affect mainly the young productive members of the societies (Misauno MA, 2007). Motor traffic injury is known worldwide as the commonest cause of chest injuries in developing and developed countries due to different risk factors (Ali N, 2004; Museru LM, 2002; Yee WY, 2006). Two different studies in Nigeria, showed different pattern in terms of type of injury one said blunt injury was common due to motor traffic injuries and the other said penetrating injury was common because of penetrating injury following civil war(Adebonojo SA., 1993).The pattern here refers to the type of injuries seen on the radiograph such as fractures in relation to the demographics of the patients. Most of studies in both developing and developed countries showed that blunt chest injuries are common due to motor traffic injuries (Odelowo EO, 1993).Chest injuries were noted to be common in young and middle age groups where males were commonly affected as compared to females. This was seen in most of the series(Al-Fallouji MAR, 1998; John GA, 1995; Otieno T, 2004). According to Cubasch and Degiannis, severe chest injuries are responsible for 25% of all trauma deaths, and in a further 25% they are a contributing cause of mortality(Herbert Cubasch, 2004).

2.3 Mechanism of Injury

Mechanisms of chest injury are usually divided into sub-sections as the pattern of injuries varies with the mechanism; blunt (acceleration or deceleration), penetrating (stab, low velocity, medium velocity and high velocity), blast, inhalation burns and foreign body aspiration Mechanism of injury is important in so far as blunt and penetrating injuries have different clinical courses.

Systematic review studies on thoracic injuries found that blunt trauma was more common than penetrating trauma(Mohta et al., 2006; Monafisha KL, 2011).These findings however, are inconsistent with a Nigerian study which found that penetrating trauma was more common than blunt trauma(Ali N, 2004).

Most blunt injuries are managed non-operatively or with simple interventions like intubation and ventilation and chest tube insertion. Diagnosis of blunt injuries may be more difficult and require additional investigations such as CT scanning (Shapiro MJ, 1996). In contrast, penetrating injuries are more likely to require operation, and complex investigations are required infrequently. Whereas (Webb WR, 1997) stated that patients with penetrating trauma may deteriorate rapidly, and recover much faster than patients with blunt injury. Many organs, such as the lung, are very elastic and will survive massive forces and function satisfactorily, whereas ribs will fracture. High velocity missiles passing cleanly through the lungs have produced surprisingly little damage in our experience (Gelman R, 1990).

2.4 Association between the imaging pattern of thoracic injuries and socio-demographic characteristics

Trauma outcomes are often associated with multiple factors including etiological factors, tissues affected, premorbid illnesses (Otieno T, 2004; Shorr, Crittenden, Indeck, Hartunian, & Rodriguez, 1987), socio-dermographic characteristics and even time of presentation(Hsia et al.).The socio-dermographic characteristics include gender, age, and socio-economic status. The vast majority of literature reviewed on trauma show predominantly male preponderances. In Nairobi Kenya a study by Odhiambo (Odhiambo, Guthua, Chindia, & Macigo, 2008) found that majority of the victims were males at 370(87.9%) and females at 49(11.6%)with a male to female ratio of 7.6:1 with a mean age of 29.7 (18.8-40.6) years .In Bugando Tanzania, there were 119(79.3%) males compared to 31(20.70%) females mean age of 32.17 years presenting with thoracic injuries with a peak incidence occurred between 21-30years (Monafisha KL, 2011).Chapagain and Jayapal in Nepal found that out of the 100 participants sampled,73(73%) were males while 27(27%) were females with a median age of 35years(Chapagain et al., 2014).

There was a paucity of literature related to association of chest trauma and socio-economic status. However, a study in Uganda by Doruk and Renee on ‘epidemiology of injuries presenting at the National Hospital Kampala’ found that the most victims presenting with MVA were passengers at 44%, pedestriansat 30% and drivers at 27%. Among these, students accounted for 20% and casual laborers' 17%. Others included civil servants and private employees at 11% and small business owners at 10%(Hsia et al.).

2.5 Imaging Management

It is mandatory to determine within the first few minutes whether an immediately life threatening problem exists, and the primary survey must take into account the mechanism of injury (Westaby S, 1994). The basis for successful management of patients with cardiothoracic trauma is effective resuscitation followed by immediate detection of life threatening conditions such as hypoxia, acidosis, low cardiac output (COP), cardiac or vascular injury (B. N. Westaby S, 1990). The diagnosis of chest trauma may be difficult and should therefore, depend on prediction and exclusion policy rather than direct manifestation of injury. More than 50% of these patients have an altered level of consciousness, which makes the clinical diagnosis difficult, and up to 35% are intoxicated (Bone L, 1986). Even the most serious intra-thoracic injuries can occur without obvious damage to the chest wall. Thoracic injuries occur in 60% of multi-trauma patients and are 2-3 times more common than intra-abdominal visceral injuries. Serious injuries due to blunt trauma particularly RTA, and myocardial contusion is often initially overlooked (Butchart EG, 1975; Chan RN, 1980). Most patients with catastrophic intra-thoracic conditions like severe injuries to the heart, aorta or major airways die at the scene of accident. Survival rate in this group depends on skilled personnel and a well-equipped emergency unit (Moylan JA, 1976). Most patients, who die after arrival to hospital with chest trauma, do so due to lack of an optimal management (Nagy K, 2000). The majority (85%) of patients with cardiothoracic trauma can initially be saved using chest tube thoracostomy and only 15% needs thoracotomy or sternotomy (Rashid M, 2000). Although CTT (closed tube thoracostomy) is a life-saving procedure, it is not without risk, especially when aggressively used in trauma patients. A clinical examination is sometimes unreliable in patients with chest trauma particularly with regards to cardiac, vascular or diaphragmatic lesions(Stratton, 1998).

Prevention of trauma is usually the most effective way to reduce the number of years lost with respect to life and productivity. This policy, which for MVC includes legislation of seat-belts, air bags, lower speed limits, better roads, and introduction of helmets to motor cyclists (thirteen times more likely to die than motor vehicle drivers) has lead to a considerable reduction in morbidity and mortality(Bried JM, 1987; Wilson RF, 1977). Fifty percent of fatal crashes are related to alcohol consumption, which was considered as a major risk factor in stab wounds of the heart and penetrating injuries of the lung(Waters JM Jr, 1973).

2.6 PROBLEM STATEMENT

Thoracic trauma is noted globally as a major cause of morbidity and mortality accounting for 20% of admissions and 25% mortality (Bonatti H, 2008). A prior knowledge of most common mechanisms and specific injuries would be very useful for management planning and emergency preparedness at the casualty, imaging units, surgical wards and clinics at MTRH.

2.7 JUSTIFICATION

The majority of chest injuries and deaths are preventable.Various studies have shown that most of the chest injuries can be treated by non-surgical approach with simple methods such as insertion of chest tube, antibiotics and good pulmonary toilet (Bender, 1990; Chalkiadaskis, 2000). Imaging of patients with thoracic trauma must be accurate and timely to avoid preventable death. Trauma surgeons prioritize imaging options based on the patient's hemodynamic status, associated injuries, and age.

Studying the mechanism of injury is important in management of these injuries. Blunt and penetrating injuries have different clinical courses. Most blunt injuries are managed non-operatively or with simple interventions like intubation and ventilation and chest tube insertion. Diagnosis of blunt injuries may be more difficult and require additional investigations such as CT scanning compared to penetrating injuries (Shapiro MJ, 1996).The imaging patterns of chest injuries at MTRH has not been analyzed.

A clearer understanding of the causes of injury patterns is essential for establishment of preventive strategies as well as treatment protocols (Avakans S, 1991). Such data is lacking at MTRH and there is no study which has been done. The study results will provide basis for planning in the management of such injuries.

This was to ensure that all patients with thoracic injuries imaged in the department were captured.CXR is routinely used as the primary modality for investigation. The main views used are anteroposterior view with the patient supine for severely injured patients and posteroanterior view. It is cheap and readily available. It can demonstrate well primary injuries as rib fractures as well as complications such as hemothorax, pneumothorax and lung collapse. CT scan is the Gold standard for major chest trauma. It can demonstrate in details the majority of thoracic injuries. It is, however not available in most centers and relatively expensive.

2.8 RESEARCH QUESTIONS

1) What are the main imaging patterns, aetiology and mechanisms of thoracic injuries seen at Radiology and Imaging Department of MTRH?
2) What are the socio-demographiccharacteristics of patients presenting with thoracic injuries/
3) What is the association between the imaging patterns andsocio-demographic characteristics?

2.9 OBJECTIVES

2.9.1 Broad Objective

To determine the imaging patterns of thoracic injuries and their association with socio-demographic characteristics among patients seen at Radiology and Imaging department of MTRH, Eldoret, from November 2012 to November 2013.

2.9.2 Specific Objectives:

I. To describe the imaging patterns, aetiology and mechanisms of injuries, associated with thoracic injuries among patients 14 years and above seen at MTRH Eldoret.

II. To describe the socio-demographic characteristics of patients presenting with thoracic injuries at Radiology and Imaging department of MTRH, Eldoret.

III. To determine the association between the imaging patterns of thoracic injuries and socio-demographic characteristics of patients seen at MTRH Eldoret.

CHAPTER THREE
METHODOLOGY

3.1 Study Setting

The study was carried out at Moi Teaching and Referral Hospital radiology and imaging department. The hospital is located in Eldoret town, Uasin Gishu County. It is the second largest public referral Hospital in Kenya after Kenyatta National Hospital (KNH).It serves also as a Teaching hospital for School of Medicine, Moi University, Medical Training College (MTC) and Baraton School of nursing. It also houses the AMPATH consortium which facilitates care for patients with Human immunodeficiency virus (HIV) and other chronic diseases.

3.2 Study Design

This was a cross- sectional study involving interpretation of the chest Radiograph and computerized tomography (CT) findings.

3.3 Sample Size

The sample size was determined using corrected Fischer's formula for finite population.

$$n = \frac{z^2pq/d^2}{1+ (1/N(z^2pq/d^2 + 1)}$$

Where:

n= sample size

P = prevalence of rib fractures,0.207(20.70%), Bugando, probability of success(event occurring) (Monafisha KL, 2011).

q=1-p (0.793), probability of failure (event not occurring)

Z= standard normal deviation, 1.96; representing 95% confidence interval

d = level of significance, 0.05

N =540-population size(estimated number of patients seen with chest injuries yearly at casualty ,being 540 both done chest Radiographs and CT scan, from previous Hospital records.).

Substituting these figures, the minimum sample size found needed was 171

$$n = \frac{1.96^2 x 0.17 x 0.83}{0.05^2}$$

Adjusting for a finite population

$$N = \frac{252.24}{1 + \left(\frac{1}{540}\right)(252.24 + 1)}$$

n=171.

3.4 Sampling Technique

Systematic sampling technique was used to sample every fifth participant presenting with a thoracic injury until the desired sample size was attained. The average combined annual number of cases of thoracic injury seen at MTRH is 540cases and on daily basis approximately two patients were imaged using either CXR or CT-scan for thoracic injury investigations.

3.5 Eligibility Criteria

3.5.1 Inclusion Criteria

- Be aged 14 years and above
- Present with clinical signs/symptoms of chest injury within two weeks.
- Provided asigned informed consent.

3.5.2 Exclusion Criteria

- Critically ill and unable to provide informed consent
- Those who die on arrival
- Patients with co-morbid illnesses such as pulmonary tuberculosis or heart failure presenting with pleural effusion.

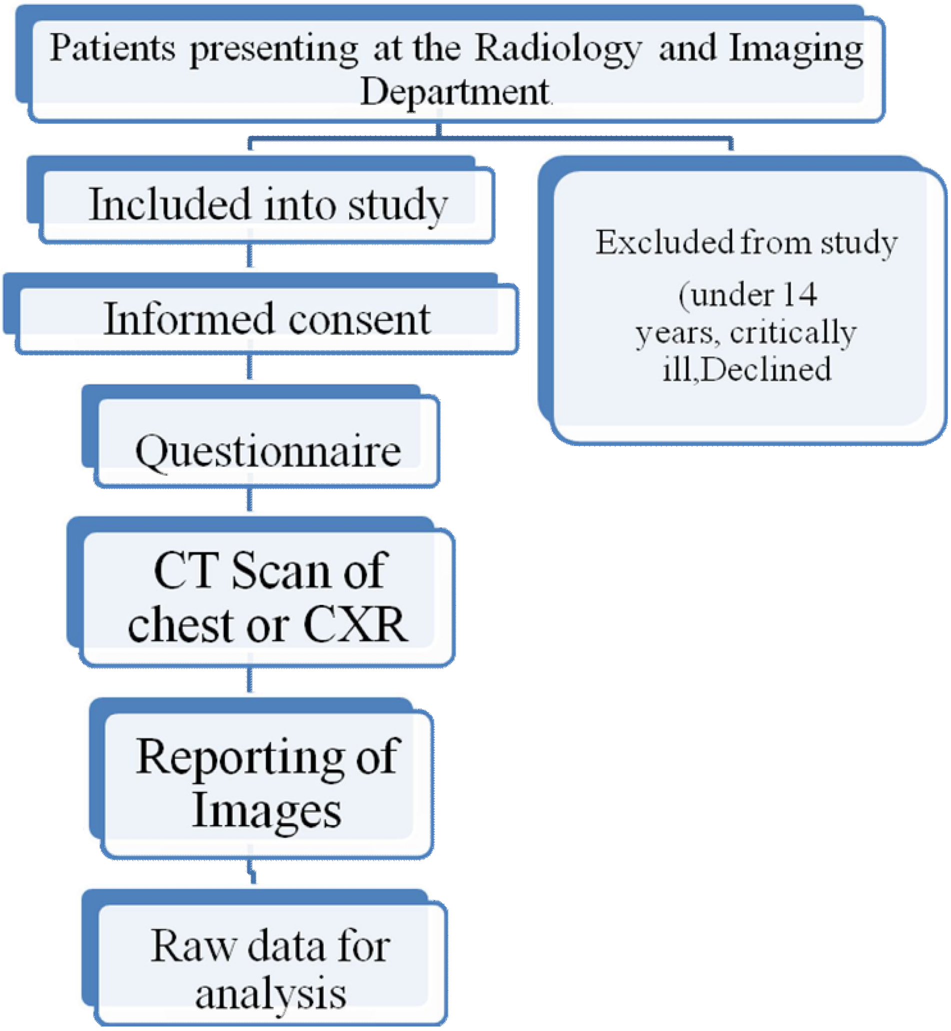

Figure 1: Recruitment Schema

3.6 Data collection and Management

All patients with history and clinical signs of thoracic injuries referred for chest radiographs and CT scans between November 2012 to November 2013 at radiology and Imaging department MTRH were sampled. Informed consent was obtained from each

Participant prior to the commencement of the study. The patients were interviewed on the nature of the injuries and the results were recorded in an interviewer administered questionnaires. They then underwent either CXR or CT according to the MTRH standard protocols as detailed in appendix IV. The images and records were reviewed by the Registrar in consultation and consensus with two independent consultant Radiologists. The data that was collected included demographics (age, gender and occupation), mechanisms, types and causes of injuries and other study relevant information. Data was cleaned, coded, entered and analyzed using STATA version 13.Data collection sheets were kept under lock and keys and electronic information was password protected.

3.7 Data Analysis

Data was collected, summarized and entered into computer access database. This was later transferred into excel and exported into STATA statistical software version for analysis. Data analysis was performed using STATA version 13 special edition. Categorical variables were summarized as frequencies and the corresponding percentages while age, the only continuous variable, was skewed therefore it was summarized as median and the corresponding inter quartile range (IQR). The test for association between the categorical variables was conducted using Pearson's Chi Square test. The risk rates were reported across the age categories and gender. Results were presented in form of tables and graphs. Results were considered statistically significant at p value of less or equal to 0.05.

3.8 Quality assurance

The data collection was done by a trained research assistant, the principal investigator with supervision of two consultant radiologists. The questionnaires were pretested before the study commenced. The parallel data entry was done to improve the accuracy of the data. Database was pass-worded to limit unauthorized access. Data cleaning and analysis was carefully done to maintain the integrity of data.

3.9 Ethical Considerations

Approval was sought from IREC (Institutional Research and Ethics Committee). Informed consent from patients or guardians was obtained. Those less than 18 years, the permission from their parents/guardian was sought. There was no direct benefit accrued to the participants from this research. Data was maintained with high degree of confidentiality and this was done by consenting in consultation room with limited access, storing filled questionnaires in lock and key data cabinets and pass-wording the access database .The results from the study will be published in reputable journals and distributed to public Libraries for general academic consumption. There was no conflict of interest in this study except for academic purposes only.

CHAPTER FOUR
RESULTS

4.1 Demographic characteristics

There were a total of 170 participants whose data was included for analysis. The median age was 35 (IQR: 25-47) years and the minimum and maximum ages were 14 and 93 years respectively. Majority of the participants were male representing 122(72%). This is shown in figure 1.

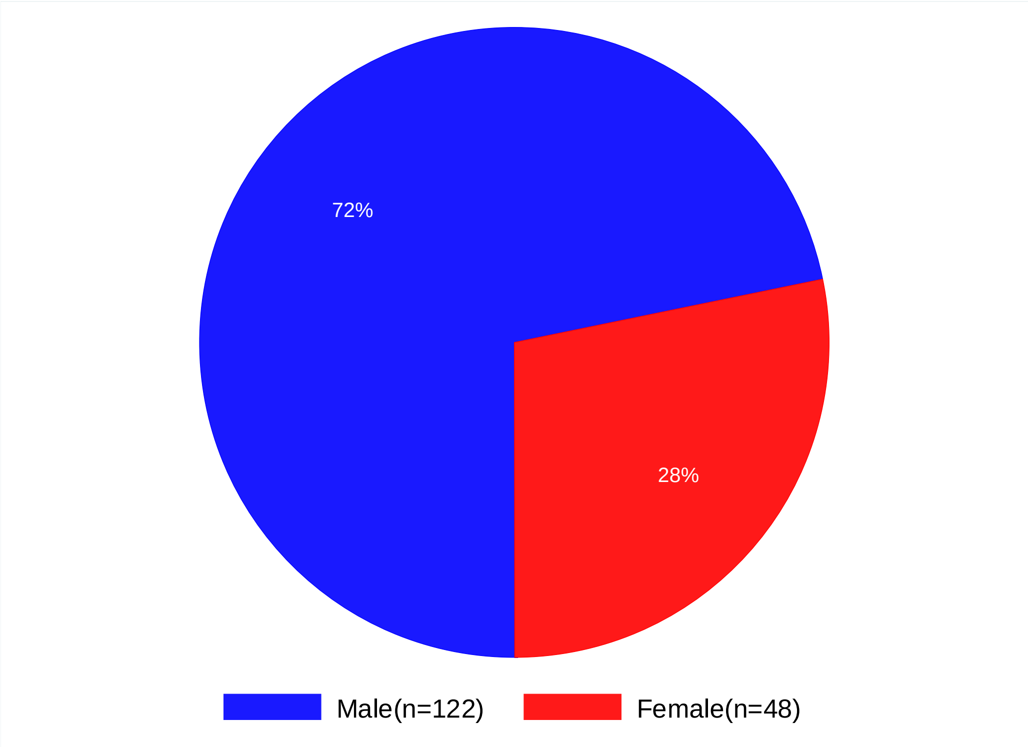

Figure 2: Gender of the participants

There were a total of 105(62%) participants of the lower class socioeconomic status (unskilled workers) who were included in the study. The least represented were the professionals who were mainly teachers accounting for 3% as shown in figure 3.

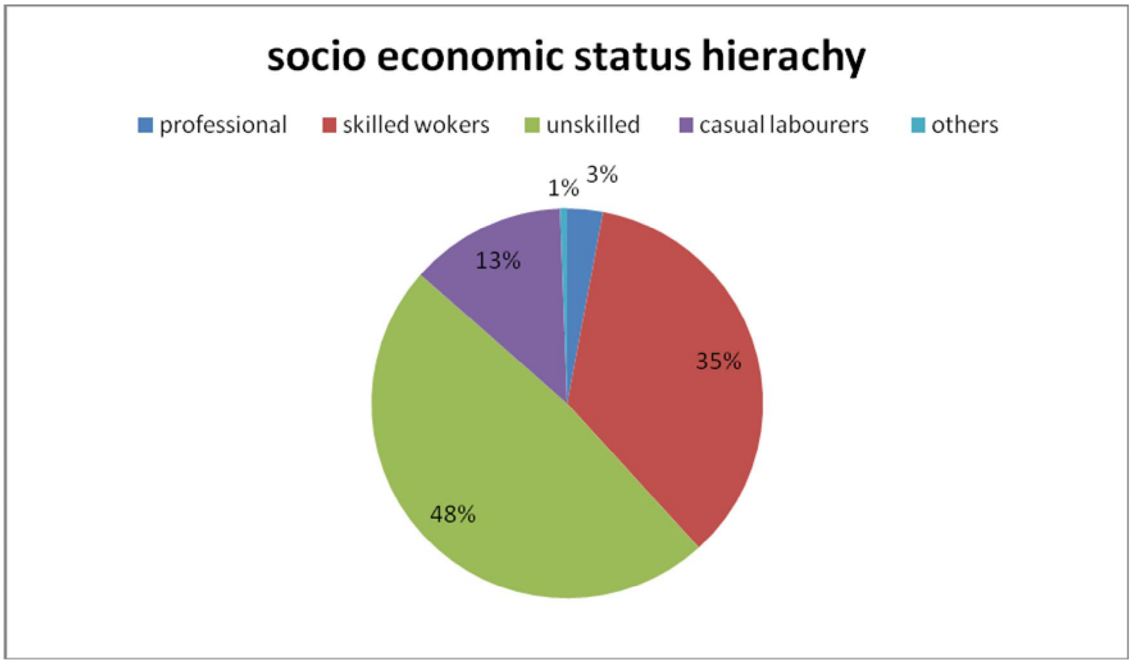

Figure 3: Classification of participants based on socioeconomic status

Among the 170 participants who responded to this question, 70(42%) were referrals from other health centers. A total of 28(16%) participants reported past medical history. Of this number, 20(71%) had no chronic illnesses. The remaining 8 each had one of the following conditions: peptic ulcer disease, abdominal distension, chest pain, and dysphagia, of the 15(9%) who had main visible injury, 14(93%) had chest wall wounds.

4.2 Aetiology and mechanisms of injuries

Over 90% of the participants presented with chest pain (Table 1). Five participants representing 3%, presented with hemoptysis. Dyspnoea was present in 77(48%) participants. Chest wall wound was present in 79(49%) participants and foreign body was seen in the chest walls of 6(4%). A total of 58(34%) participants had head injury, 14(8%) had abdomen injury, 4(2%) had pelvis injury, and 70(41%) had injuries of the limbs.

Table 1: Presenting symptoms and injuries

Characteristic	**Sample size**	**Levels**	**n(%)**
Chest pain	162	Yes vs. No	153(94%)
Chest wall wound	162	Yes vs. No	79(49%)
Dyspnoea	162	Yes vs. No	77(48%)
Limb injuries	170	Yes vs. No	70(41%)
Head injuries	170	Yes vs. No	58(34%)
Abdominal injuries	170	Yes vs. No	14(8%)
Foreign body in the chest wall	161	Yes vs. No	6(4%)
Hemoptysis	162	Yes vs. No	5(3%)
Pelvic injuries	170	Yes vs. No	4(2%)

The mechanisms of injury were decelerating and compression. One third of the participants experienced decelerating mode of injury while 29(27%) had compression. The road traffic accidents were classified as involving motor vehicle, motor cycle or bicycle. There were 70(41%) participant who had a RTA involving a motor vehicle, and 18(13%) involving motorcycle. Only one participant had an injury involving a bicycle.

Less than 10% had a fall as one of the sports injuries. Close to one fifth of the participants, 40(24%) had an assault (Table 2). Chest penetration injuries included gunshot, and stab wounds. Six, 4%, participants had gun shots, 25(15%) had stab wounds.

Table 2:Aetiology and mechanism of Injuries

Characteristic	Sample size	Levels	n(%)
Motor vehicle	170	Yes vs. No	70(41%)
Assault	170	Yes vs. No	40(24%)
Stab wounds	170	Yes vs. No	25(15%)
Motorcycle	140	Yes vs. No	18(13%)
Fall	170	Yes vs. No	15(9%)
Gun shot	170	Yes vs. No	6(4%)
Bicycle	140	Yes vs. No	1(0.7%)
Arrow wounds	170	Yes vs. No	1(0.6%)
Decelerating	108	Yes vs. No	36(33%)
Compression	106	Yes vs. No	29(27%)

Other types of penetrating injuries include burning which was reported in one participant, cut by a panga, reported in two participants, fall on a metal tube was reported in one participant, and an inhalation of a foreign body also reported in one participant. Among 16(9%) participants who reported the type of injury, 3(19%) reported being injured by a blunt object and 13(81%) reported that were injured by both blunt and penetrating object.

Table 3: Trauma Injuries

Characteristic	Sample size	Levels	n(%)
Haemothorax	170	Yes vs. No	109(64%)
Pneumothorax	170	Yes vs. No	76(45%)
Fractured ribs	170	Yes vs. No	71(42%)
Pulmonary contusion	170	Yes vs. No	68(40%)
lung collapse	170	Yes vs. No	66(39%)
Emphysema	170	Yes vs. No	40(24%)
Spinal injuries	170	Yes vs. No	16(9%)
Pulmonary laceration	170	Yes vs. No	16(9%)
Frail chest	170	Yes vs. No	13(8%)
Clavicles fractures	170	Yes vs. No	12(7%)
Diaphragmatic ruptures	170	Yes vs. No	11(6%)
Cardiac tamponade	170	Yes vs. No	11(6%)
Ruptured trachea	170	Yes vs. No	6(4%)
Foreign body	170	Yes vs. No	4(2%)
Ruptured aorta	170	Yes vs. No	3(2%)
Sternum fracture	170	Yes vs. No	1(0.6%)

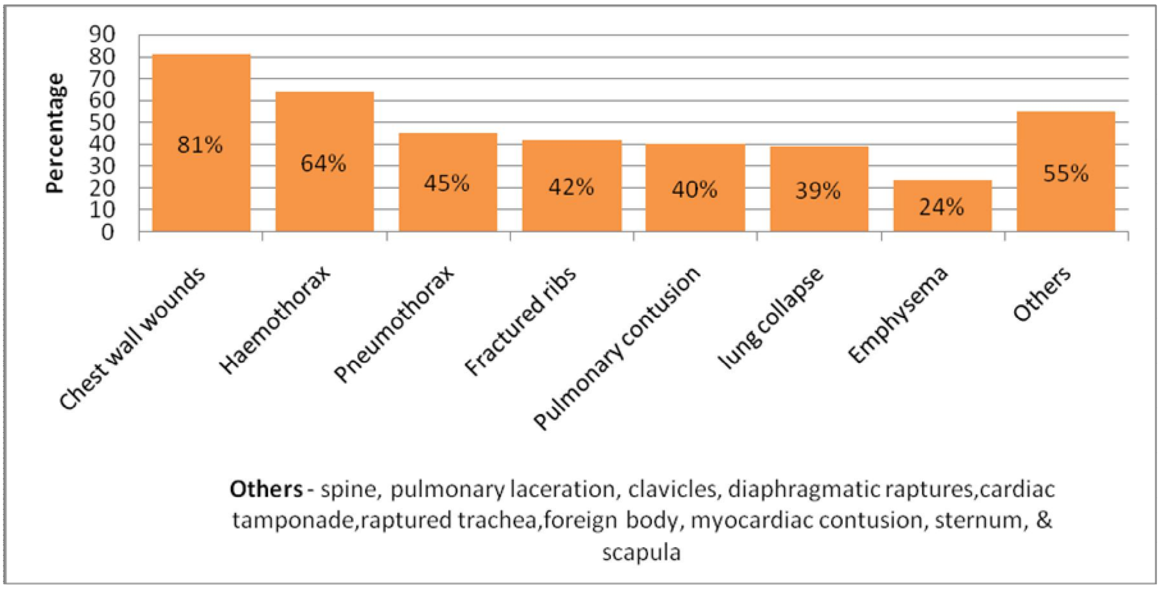

Figure 4: Imaging Patterns (n=170)

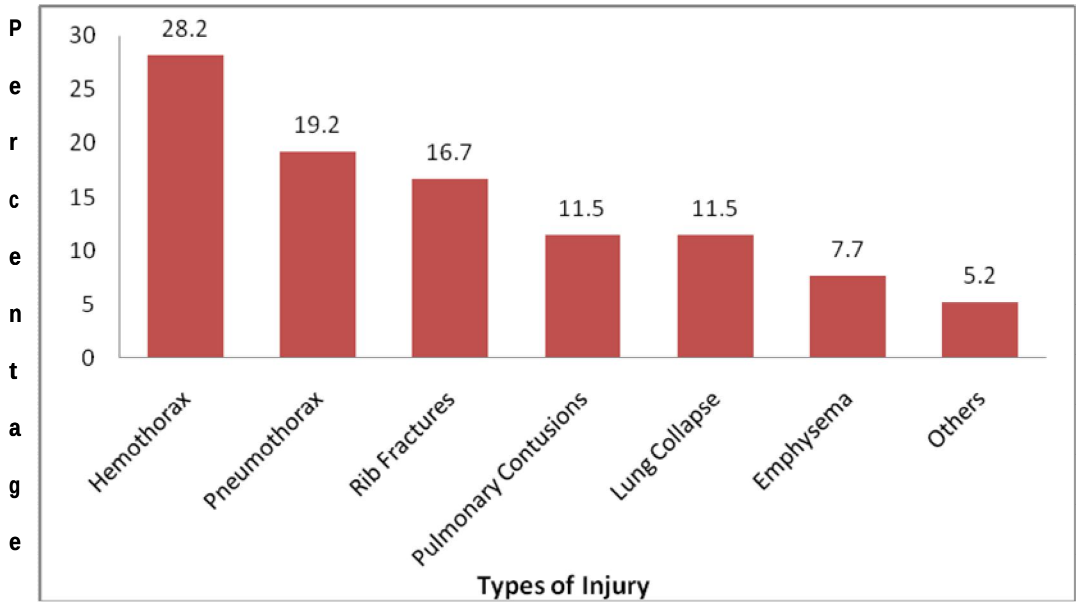

Figure 5: CT Scan Findings (n=36)

The types of thoracic traumas assessed were: trauma of the thoracic cage, trauma of the respiratory tract, trauma of the cardiovascular system, and the pleural space disease.

Under the trauma of the thoracic cage were the fractures of the ribs, chest wall wounds, frail chest, diaphragmatic raptures, foreign bodies, and emphysema.

There were 12(7%) participants who suffered fractures associated to clavicles (Table 3), one who had a fracture of the sternum, and 16(9%) who had fractures of the thoracic spine.

One hundred thirty seven, representing 81%, participants who had chest wall wounds, 13(8%) who had frail chest, 11(6%) who had diaphragmatic raptures, 4(2%) who had foreign bodies, and 40(24%) who had emphysema.

Trauma of the respiratory tract included pulmonary contusion, pulmonary laceration, ruptured trachea, and lung collapse. A total of 68(40%) had pulmonary contusion, 16(9%) had pulmonary laceration, 6(4%) had ruptured trachea, and 66(39%) had lung collapse. Trauma of the cardiovascular system included cardiac tamponade, myocardial contusion, and ruptured aorta. There were 11(6%) participants who had cardiac tamponade and 3(2%) who had ruptured aorta.

Pleural space diseases were pneumothorax and hemothorax. There were 76(45%) participants who had pneumothorax and 109(64%) who had hemothorax.

4.3 Association between imaging patterns of thoracic injuries and socio-demographics

From Table 4 it is evident that the risk of decelerating mechanism of injury was significantly high among the male participants compared to the female, 32(39%) vs. 4(16%) (P=0.036). There was no significant difference in the risk of compression between male and female (P=0.345).The risk of RTA penetration injury was significantly high among the male participants compared to female, 53(43%) vs. 12(25%), P=0.029. Compared to female participants, male tended to have a higher risk of motor vehicle accidents: 54(44%) vs. 16(33%), and RTA penetration injuries: 53(43%) vs. 12(25%). However, compared to female participants male participants tended to have low risk of motorcycle accidents: 10(10%) vs. 8(22%), assault: 27(22%) vs. 13(27%), and stab wounds: 15(12%) vs. 10(21%).Both male and female participants had similar risks of fall: male: 11(9%) vs. Female: 4(8%). Details are as shown in table 4.

Table 4: Association between gender, mechanism and aetiology of injury

			Male (n=122,72%)	**Female (n=48,28%)**	
Characteristic	**Sample size**	**Levels**	**n(%)**	**n(%)**	**P**
Decelerating	108	Yes vs. No	32(39%)	4(16%)	0.036
Compression	106	Yes vs. No	24(30%)	5(20%)	0.345
Motor vehicle	170	Yes vs. No	54(44%)	16(33%)	0.192
Motorcycle	140	Yes vs. No	10(10%)	8(22%)	0.062[f]
Bicycle	140	Yes vs. No	0	1(3%)	0.0264[f]
Fall	170	Yes vs. No	11(9%)	4(8%)	0.577[f]
Assault	170	Yes vs. No	27(22%)	13(27%)	0.493
Gun shot	170	Yes vs. No	6(5%)	0	0.132[f]
Stab wounds	170	Yes vs. No	15(12%)	10(21%)	0.157
Arrow wounds	170	Yes vs. No	0	1(2%)	0.282[f]

“f” – Fisher’s exact P value was reported when the cell value was <5.

As shown in table 5, it is evident that the risk of fractured ribs was significantly high among the male participants compared to the female participants, 43(48%) vs. 7(23%), P=0.019. The rest of the comparisons were not statistically significant.

Table 5: Association between gender and Imaging Pattern.

			Male (n=122,72%)	Female (n=48,28%)	
Characteristic	**Sample size**	**Levels**	**n(%)**	**n(%)**	**P**
Clavicles	170	Yes vs. No	10(8%)	2(4%)	0.288[f]
Sternum	170	Yes vs. No	0	1(2%)	0.282[f]
Spine	170	Yes vs. No	13(11%)	3(6%)	0.285[f]
Chest wall wounds	170	Yes vs. No	98(80%)	30(81%)	0.891
Frail chest	170	Yes vs. No	9(7%)	4(8%)	0.833
Diaphragmatic ruptures	170	Yes vs. No	8(7%)	3(6%)	0.623[f]
Foreign body	170	Yes vs. No	3(2%)	1(2%)	0.683[f]
Emphysema	170	Yes vs. No	27(22%)	13(27%)	0.493
Pulmonary contusion	170	Yes vs. No	46(38%)	22(46%)	0.330
Pulmonary laceration	170	Yes vs. No	9(7%)	7(15%)	0.125[f]
Ruptured trachea	170	Yes vs. No	3(2%)	3(6%)	0.221[f]
Lung collapse	170	Yes vs. No	42(34%)	24(50%)	0.061
Cardiac tamponade	170	Yes vs. No	8(7%)	3(6%)	0.623
Ruptured aorta	170	Yes vs. No	3(2%)	0	0.367[f]
Pneumothorax	170	Yes vs. No	49(40%)	27(56%)	0.058
Haemothorax	170	Yes vs. No	82(67%)	27(56%)	0.180
Fractured ribs	170	Yes vs. No	43(48%)	7(23%)	0.019

"f" – Fisher's exact P value was reported when the cell value was <5.

There was a tendency of having a higher risk of fractured clavicles among the male participants compared to the female, 10(8%) vs. 2(4%), P=0.288. The same trend is also evident with spinal injuries.

Male and female participants had similar risk of chest wall wounds, male: 98(80%) vs. Female: 30(81%), P=0.891. Similarly, male and female had equal risks of frail chest, diaphragmatic raptures, foreign bodies, emphysema, and cardiac tamponade. Female compared to male participants tended to have a higher risk of pulmonary contusion: 22(46%) vs. 46(38%), pulmonary laceration: 7(15%) vs. 9(7%), ruptured trachea: 3(6%) vs. 3(2%), lung collapse: 24(50%) vs. 42(34%), pneumothorax: 27(56%) vs. 49(40%). However, female compared to male participants they tended to have low risk of hemothorax, 27(56%) vs. 82(67%).

4.4 Association between imaging patterns of thoracic injury and age

Theassociations between age and the mechanism of injury were determined. However, there was a tendency of low risk of decelerating mechanism of injury among the younger (age<21 years) participants compared to those aged 21-40 and >40 years, 3(30%) vs. 22(38%) vs. 11(28%), P (=0.566). Similarly, the risk of compression was low among the participants aged <21 years compared to those aged 21-40 and >40 years; 2(20%) vs. 17(30%) vs. 10(26%), P=0.852.

The risk of motor vehicle accident was high among the participants aged >40 years and low among the participants aged<21 years; (age <21: 6(33%); 21-40: 34(37%); >40: 30(50%)), P=0.216. The risk of accidents due to motorcycle was significant among the participants aged 21-40.

The risk of injury due to fall was high among the older group compared to those aged <40 years ;< 21: 1(6%); 21-40: 4(4%); >40: 10(17%), P=0.037. The association between the injury due to assault and age was also determined and participants in the lower age group tended to have a higher risk compared to the other age groups, <21: 6(33%); 21-40: 25(27%); 9(15%) with P=0.116. The risk of stab wounds among the participants in the lower aged group was higher compared to the other age groups, 5(28%) vs. 16(17%), 4(7%), P=0.036.The risk of injuries due to RTA were not different across the age groups, 6(33%) vs. 34(37%) vs. 25(42%), P=0.761. The results on the association between age and the mechanisms of injury, and type of injury are as shown in table 6.

The association between age and trauma (table 7) was also determined and association between age andthe fractures of the ribs have the following p-values: Clavicles; P=0.906, Sternum; P=1.000, spine; P=0.633. The risk of chest wall wounds in the age categories are as follows; <21 years: 15(83%), 21-40 years; 77(84%), and >40 years; 45(75%) with the p-value=0.399. The risk of emphysema was high among the participants aged <21 years, 5(28%), compared to those aged 21-40: 21(23%) and >40 years: 14(23%). The risk of pulmonary contusion across the age groups had a P-value=0.785. The risk of lung collapse was significantly dropping across the age groups, 12(67%) vs. 33(36%) vs. 21(35%), P=0.037. The risk of pneumothorax across the age Group had P-value=0.619 with a high risk among those aged <21 years compared to the older participants; 10(56%) vs. 40(43%) vs. 26(43%). The risk of haemothorax across the age groups were; <21 years: 8(44%), 21-40: 69(75%) >40 years: 32(53%), with a p-value=0.005. The risk of rib fractures across the age groups was found to be P=0.991.

Table 6: Association between age, mechanism and aetiology of injury

			Age			
			<21 (n=18, 11%)	21-40 (n=92, 54%)	>40 (n=60, 35%)	
Characteristic	**Sample size**	**Levels**	**n(%)**	**n(%)**	**n (%)**	**P**
Decelerating	108	Yes vsNo	3(30%)	22(38%)	11(28%)	0.566[f]
Compression	106	Yes vsNo	2(20%)	17(30%)	10(26%)	0.852[f]
Motor vehicle	170	Yes vsNo	6(33%)	34(37%)	30(50%)	0.216
Motorcycle	140	Yes vsNo	1(7%)	12(16%)	5(10%)	0.576[f]
Bicycle	140	Yes vsNo	0	1(1%)	0	1.000[f]
Fall	170	Yes vsNo	1(6%)	4(4%)	10(17%)	0.037[f]
Assault	170	Yes vsNo	6(33%)	25(27%)	9(15%)	0.116[f]
Gun shot	170	Yes vsNo	0	6(6%)	0	0.093[f]
Stab wounds	170	Yes vsNo	5(28%)	16(17%)	4(7%)	0.036[f]
Arrow wounds	170	Yes vs No	0	1(1%)	0	1.000[f]

"f" – Fisher's exact P value was reported when the cell value was <5.

Table 7: Association between age and imaging pattern

			Age			
			<21 (n=18, 11%)	**21-40 (n=92, 54%)**	**>40 (n=60, 35%)**	
Characteristic	**Sample size**	**Levels**	**n(%)**	**n(%)**	**n(%)**	**P**
Clavicles	170	Yes vs. No	1(6%)	6(7%)	5(8%)	0.906[f]
Sternum	170	Yes vs. No	0	1(1%)	0	1.000[f]
Spine	170	Yes vs. No	2(11%)	7(8%)	7(12%)	0.633[f]
Chest wall wounds	170	Yes vs. No	15(83%)	77(84%)	45(75%)	0.399[f]
Frail chest	170	Yes vs. No	0	10(11%)	3(5%)	0.271[f]
Diaphragmatic ruptures	170	Yes vs. No	0	9(10%)	2(3%)	0.224[f]
Foreign body	170	Yes vs. No	0	4(4%)	0	0.239[f]
Emphysema	170	Yes vs. No	5(28%)	21(23%)	14(23%)	0.898[f]
Pulmonary contusion	170	Yes vs. No	7(39%)	39(42%)	22(37%)	0.785[f]
Pulmonary laceration	170	Yes vs. No	0	13(14%)	3(5%)	0.070[f]
Ruptured trachea	170	Yes vs. No	0	2(2%)	4(7%)	0.289[f]
Lung collapse	170	Yes vs. No	12(67%)	33(36%)	21(35%)	0.037
Cardiac tamponade	170	Yes vs. No	1(6%)	5(5%)	5(8%)	0.811[f]
Ruptured aorta	170	Yes vs. No	0	2(2%)	1(2%)	1.000[f]
Pneumothorax	170	Yes vs. No	10(56%)	40(43%)	26(43%)	0.619
Hemothorax	170	Yes vs. No	8(44%)	69(75%)	32(53%)	0.005
Fractured ribs	170	Yes vs. No	5(42%)	27(42%)	18(41%)	0.991

4.5 Association between Imaging patterns and socioeconomic status

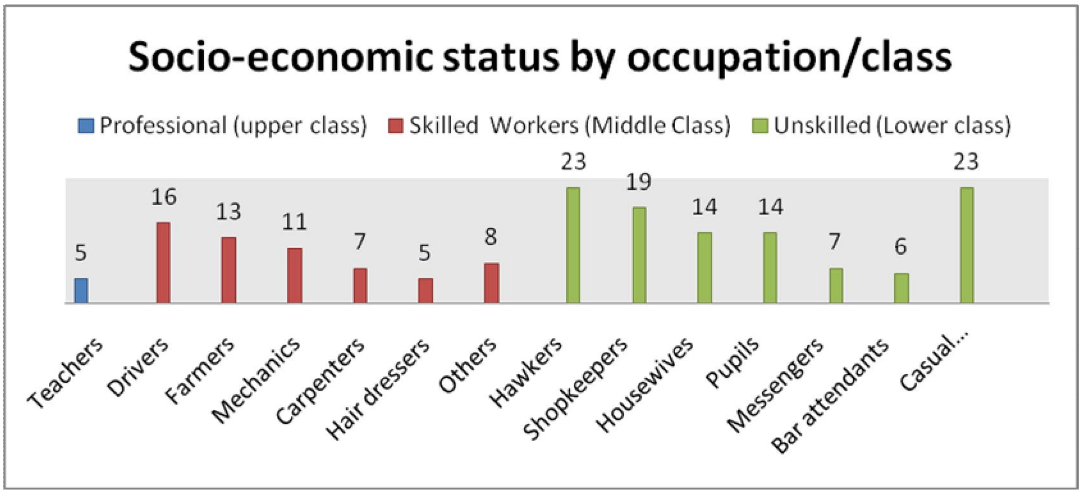

Figure 6: Socioeconomic status by occupation (class).

There was no significant association between socioeconomic status and the occurrence of thoracic injury. The risk of fractures to the clavicles was significantly higher among the skilled workers participants, 8(12%), compared to the unskilled workers (P=0.036). The risk of fractures of the spine were not significantly different between the skilled workers (professionals) and the unskilled workers (P=0.309) though there is a tendency toward a higher risk among the skilled workers, 8(12%), compared to the unskilled workers, 8(8%). This is shown in table 8.

Table 8: Association between socio economic status, mechanism and aetiology of injury

			Socioeconomic status		
			Unskilled workers (n=105; 62%)	**Skilled workers (Professionals) (n=65, 38%)**	
Characteristic	**Sample size**	**Levels**	**n(%)**	**n(%)**	**P**
Decelerating	108	Yes vs. No	23(29%)	13(45%)	0.097
Compression	106	Yes vs. No	19(24%)	10(37%)	0.191
Motor vehicle	170	Yes vs. No	53(50%)	17(26%)	0.002
Motorcycle	140	Yes vs. No	8(8%)	10(26%)	0.004
Bicycle	140	Yes vs. No	1(1%)	0	0.729
Fall	170	Yes vs. No	9(9%)	6(9%)	0.883
Assault	170	Yes vs. No	26(25%)	14(22%)	0.630
Gun shot	170	Yes vs. No	3(3%)	3(5%)	0.419[f]
Stab wounds	170	Yes vs. No	15(14%)	10(15%)	0.844
Arrow wounds	170	Yes vs. No	0	1(2%)	0.382[f]

"f" – Fisher's exact P value was reported when the cell value

The risk of chest wall wounds was high among the skilled workers 88(84%) and the unskilled workers 49(75%). However, the difference is not statistically significant (P=0.177). The risks of frail chest, diaphragmatic raptures, foreign body, and emphysema are not significantly different between the skilled workers and the unskilled workers

Participants, 7(11%) vs. 6(6%), 5(8%) vs. 6(6%), 3(5%) vs. 1(1%), and 11(17%) vs. 29(28%) respectively. However, the risk of emphysema among the skilled workers is lower than among the unskilled workers.

The risk of pulmonary contusion among the unskilled workers, 43(41%), was not significantly different from that of the skilled workers participants, 25(38%), P=0.747. On the other hand the risk of pulmonary laceration was significantly higher among the skilled workers compared to the unskilled workers, 12(18%) vs. 4(4%), P=0.001.The risks of ruptured trachea and the lung collapse among the unskilled workers compared to the skilled workers were similar, P=0.419 and 0.804 respectively. The risk of pneumothorax among the unskilled workers compared to the skilled workers was significantly higher, 53(50%) vs. 23(35%), P=0.035. On the other hand the risks of the haemothorax and fractured ribs among the unskilled workers compared to the skilled workers were similar, P=0.581, and 0.971 respectively.

The association between socioeconomic status and mechanism of injury, and type of injury was also determined (table 9).The risk of decelerating mechanism of injury was not different between the skilled workers and the unskilled workers, P=0.097. However, there a tendency for a higher risk of decelerating mechanism of injury among the skilled workers, 13(45%), compared to the unskilled workers, 23(29%).The risk due to compression was different between the skilled workers and the unskilled workers but the skilled workers tended to bear a higher risk compared to the unskilled workers, 10(37%) vs. 19(24%), P=0.191. The risk of motor vehicle injury was significantly higher among the unskilled workers compared to the skilled workers, 53(5%) vs. 17(26%), P=0.002. On the other hand, the risk of injury due to motorcycle was significantly higher among the skilled workers compared to the unskilled workers, 10(26%) vs. 8(8%), P=0.004.

The injuries due to fall or assault among the unskilled workers were similar to those among the skilled workers, 9(9%) vs. 6(9%), and 26(25%) vs. 14(22%), respectively.

The penetration injuries were similar across the socio-economic status. The risk due to stab wounds among the unskilled workers was similar to that of the skilled workers participants, 15(14%) vs. 10(15%), P=0.844. The risk due to RTA was however higher among the unskilled workers, 43(41%), compared to the skilled workers participants, 22(34%), though the difference is not statistically significant, P=0.354.

Table 9: Association between socioeconomic status and Imaging Pattern

			Socioeconomic status		
			Unskilled workers (n=105; 62%)	**Skilled workers (n=65, 38%)**	
Characteristic	**Sample size**	**Levels**	**n(%)**	**n(%)**	**P**
Clavicles	170	Yes vs. No	4(4%)	8(12%)	0.036
Sternum	170	Yes vs. No	0	1(2%)	0.382
Spine	170	Yes vs. No	8(8%)	8(12%)	0.309
Chest wall wounds	170	Yes vs. No	88(84%)	49(75%)	0.177
Frail chest	170	Yes vs. No	6(6%)	7(11%)	0.228
Diaphragmatic ruptures	170	Yes vs. No	6(6%)	5(8%)	0.417
Foreign body	170	Yes vs. No	1(1%)	3(5%)	0.157[f]
Emphysema	170	Yes vs. No	29(28%)	11(17%)	0.110
Pulmonary contusion	170	Yes vs. No	43(41%)	25(38%)	0.747
Pulmonary	17	Yes vs. No	4(4%)	12(18%)	0.001

laceration	0				
Ruptured trachea	170	Yes vs. No	3(3%)	3(5%)	0.419[f]
Lung collapse	170	Yes vs. No	40(38%)	26(40%)	0.804
Cardiac tamponade	170	Yes vs. No	8(8%)	3(5%)	0.333[f]
Ruptured aorta	170	Yes vs. No	2(2%)	1(2%)	0.674[f]
Pneumothorax	170	Yes vs. No	53(50%)	23(35%)	0.038[f]
Hemothorax	170	Yes vs. No	69(66%)	40(62%)	0.581
Fractured ribs	170	Yes vs. No	38(42%)	12(41%)	0.971

"f" – Fisher's exact P value was reported when the cell value was <5.

Figure 7: Normal Frontal Chest Radiograph

Figure 8: Postero-anterior erect chest radiograph of a 36 years old male with left pneumo-haemothorax

Figure 9: Supine chest radiograph of a 28 year old male with multiple fractures of the right ribs.

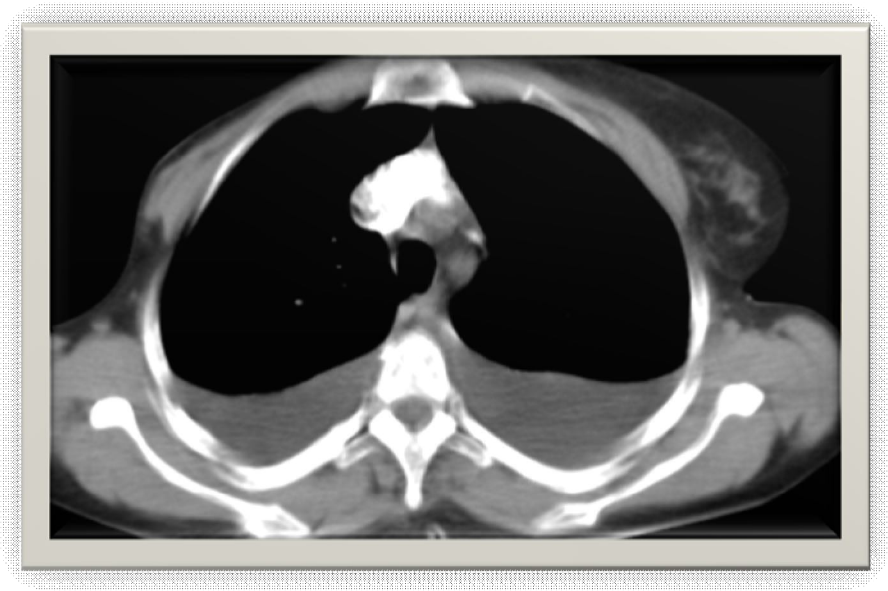

Figure 10: Axial CT scan of the chest for a 32 year old female with bilateral haemothorax

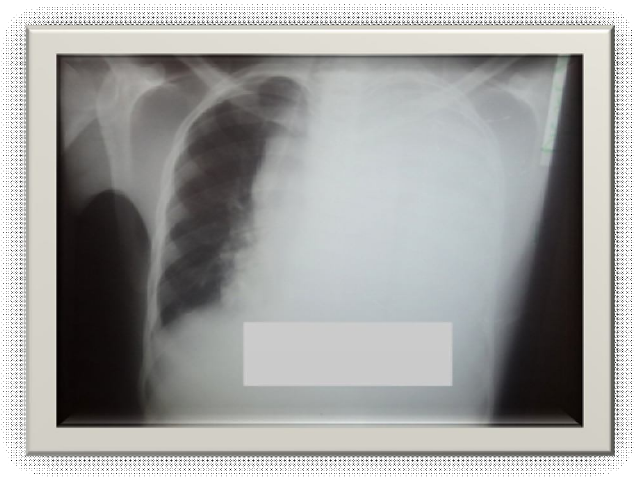

Figure 11: Supine chest radiograph of a 22 year old male with left haemothorax

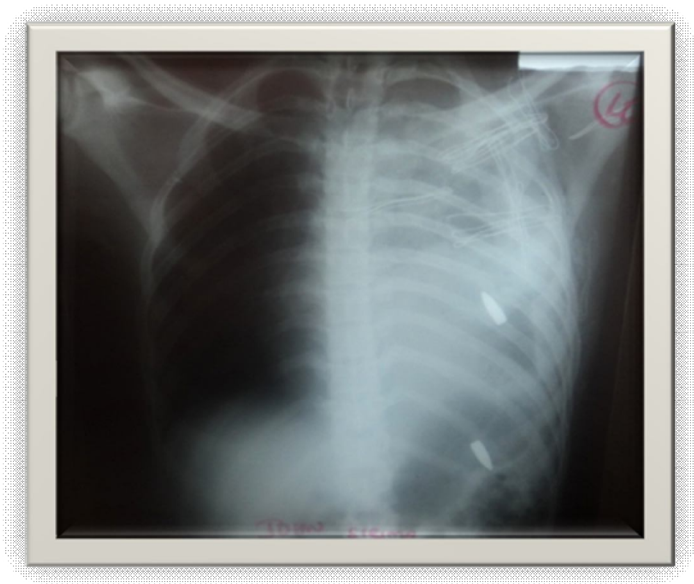

Figure 12: Supine chest radiograph of a 24 year old male with foreign bodies (bullets) in the left hemithorax.

CHAPTER FIVE
DISCUSSION

5.1 Socio-demographic characteristics

This study found that majority of the thoracic injuries occur among the middle age years (median 35 years) ranging between 25 and 47 years. However, there was 14 year old child and 93 year old man who were sampled in this study. Majority (72%) were of male gender and that mostly (62%) were unskilled workers. This is consistent withAl-Fallouj and John's findings(Al-Fallouji MAR, 1998; John GA, 1995) which noted that chest injuries were common among young and middle age groups where males were more affected than females(Al-Fallouji MAR, 1998; John GA, 1995). Since most of these injuries affects the middle ages and mostly male, this could be explained by the fact that economic activities tend to be active among these groups and often expose them to these thoracic injuries. The unskilled workers tend to move from one place to another, mostly on roads and that could explain high number of their cohort in this study.

A significant number of participants (42%) were referrals from other lower level health facilities. This shows that quite a number of facilities, mostly in rural areas, tend to lack radiological or imaging machines such as plain Radiography and CTscan that can be used to diagnose thoracic injuries. Therefore, the prognosis of treatment is poor, often contributed by delays and poor access to referral facilities and this could contribute to increased complications and mortalities. A study by Cusbach(Herbert Cubasch, 2004) indicated that severe chest injuries were responsible for 25% of all trauma deaths, and in a further 25%, they are a contributing cause of mortality. Cubasch and Degiannis' findings (Herbert Cubasch, 2004) are also similar to our study findings where the majority (84%) of the participants had no medical history related to thoracic morbidity or injury. However, among the 15 participants who showed visible injuries, 93% had chest wall wounds, a clear indication of occurrence of trauma. This could also be contributed by the nature of built up of our vehicles.

5.2 Aetiology and mechanisms of thoracic injuries

This study revealed that 33% of the participants experienced decelerating mode of injury while 27% had compression. There were 41%of the participant who had a RTA involving a motor vehicle, and 13% involving motor bicycle, one participant had an injury involving a bicycle while less than 10% had a fall.Another24%had thoracic injuries attributed to an assault. Chest penetration injuries included gunshot, stab wounds, RTA's, and arrow wounds. 4% of the participants had gunshots andanother15% had stab wounds. Only one participant in our study had an arrow wound.

This is consistent with findings of Max(Max Wintermark, 2002) and Demetriades (Demetriades et al., 2004) studies. Max's study on imaging of acute traumatic injuries of the thoracic aorta found that high-speed deceleration accident cause blunt traumatic aortic injuries associated with a very high mortality rate (Max Wintermark, 2002). The outcomes of treatment in resource limited settings could be low unlike in the West where with prompt diagnosis and surgery, up to 70% of the patients with a blunt aortic lesion reach the hospital alive and survive (Max Wintermark, 2002). Demetriades (Demetriades et al., 2004)showed that rapid deceleration resulting from falls and direct impact and compression from motor vehicle crashes are common mechanisms of blunt thoracic injury. They found that up to 25% of hospitalized injuries in motor vehicle accidents involve the chest. Moreover, more than 60% of major chest trauma cases are related to motor vehicle crashes (Demetriades et al., 2004).

Our study found that over 90% of the participants presented with chest pain with paltry 3% presenting with haemotypsis and 48% presenting with dyspnoea. Furthermore, the chest wall wound was present in 49% of the participants and 4% had foreign body seen in the chest walls. Another 34% of the participants had head injury, 8% with abdomen injury, 2%with pelvis injury, and 41%with injuries of the limbs. This seems to be consistent. Keough and Pudelek study findings (Keough&Pudelek, 2001)which showed that thoracic trauma was often associated with cardiac trauma due to anatomical proximity of the heart to the chest wall. They found that other than cardiac injuries, thoracic trauma caused more injuries to other organs such as lungs, pleura, thoracic great vessels, diaphragm, trachea and oesophagus (Keough&Pudelek, 2001). Furthermore, a study by Leinoff (Leinoff, 2000) found that the incidence rate of cardiac injury to vary from 10% to 75% in the presence of chest injury clinical case studies.

5.2 Association between imaging patterns of thoracic injuries and socio-demographic factors

The association between imaging patterns of thoracic injuries and socio-demographic characteristics (age, gender and occupation) were also assessed.

There were no statistically significant associations between age and the mechanism of injury. However, there was a tendency of low risk of decelerating mechanism of injury among the younger (age<21 years) participants compared to those aged above 21(P=0.566). Similarly, the risk of injury due to compression was low among the participants aged <21 years compared to those aged above 21years (P=0.852). The risk of injury due to motor vehicle accident was high among the participants aged >40 years and low among the participants aged<21 years (P=0.216). The risk of accidents due to motorcycle is common among the participants aged 21-40.However, the risk of injuries due to RTA were not different across the age groups (P=0.761). This is consistent with Al Fallouj (1998) and John et al (1993) which showed that chest injuries were noted to be common in young and middle age groups of less than 21 and mean of 35 years. However, our findings showed that the risk of injury due to fall was significantly high among the older group compared to those aged <40 years, (P=0.037). This could be attributed to lowering body physical stability and their increased vulnerability to falls with increase image. Furthermore, there was no statistically significant association between the injury due to assault and age (p=0.116), although participants in the lower age group tended to have a higher risk compared to the other age groups. This could be explained by the assumption that assault is widespread across all age groups and are more attributed to incidental participation irrespective of one'sage. The risk of stab wounds among the participants in the lower aged group (<21 years) was significantly higher compared to the other age groups (P=0.036). This could be due to more, often physical conflict activities, among the younger age group.

It was demonstrated that the risk of decelerating mechanism of injury was significantly high among the male participants compared to the female (P=0.036).However, there was a low risk of hemothorax among females compared to males. There was no significant difference in the risk of injury due to compression between male and female (P=0.345).These findings are consistent with AlFallouji's findings(Al-Fallouji MAR, 1998)which indicated that males were more affected than females. This could be explained by the fact that more males tend to be involved in more risky activities such as over speeding and sporty events which can lead to injuries. However, our study also showed that the male and female participants had similar risk of chest wall wounds (P=0.891). This could be attributed due to differences in the nature of soft tissues of the chest wall among genders. Females are known to have a weaker chest wall musculature than males.

Over half of the skilled workers participants presenting with thoracic injuries were drivers of motor vehicles who are often at risk of decelerating and compression injuries. The risk of injury due to compression was different between the skilled workers and the unskilled workers but the skilled workers tended to bear a higher risk compared to the unskilled workers (P=0.191).However, the risk of motor vehicle injury was significantly higher among the unskilled workers compared to the skilled workers (P=0.002). On the other hand, the risk of injury due to motorcycle was significantly higher among the skilled workers compared to the unskilled workers (P=0.004).The risk of injuries due to fall and/or assault among the skilled workers and unskilled workers were also similar (p=0.883 and p=0.630, respectively). This could be explained by the fact that the skilled workers, tend to travel more frequently to their work destinations and could be more exposed to decelerating injuries compared to unskilled workers, who has less frequency of travelling.

Our findings also showed that the risk due to stab wounds among the unskilled workers was similar to that of the skilled workers participants (P=0.844). This could be due to sporadic nature of distribution of violence activities across these groups. The risk due to MVA was however higher among the unskilled workers, 43(41%), compared to the skilled workers participants 22(34%); however, the difference was not statistically significant (P=0.354). This is due to the fact that the unskilled workers, often travelling by foot, are equally susceptible to motor vehicle accident.

This therefore shows that socio-demographic characteristics may not play much role in occurrences of specific thoracic patterns and often these patterns are incidental as per the nature, mechanism and cause of injury. There was very limited data on literature that has compared these associations.

5.3 Study limitations

Delayed presentations of patterns such as haemothorax and pulmonary contusion may have interfered with the results.

CHAPTER SIX
CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusion

The median age of patients with thoracic injuries presenting at MTRH was 35 years (IQR 25-47) .The most common imaging pattern washe mothorax. This was followed by pneumothorax. Motor vehicle accidents were found to be the leading cause of thoracic injuries with penetrating and blunt mechanisms of injuries occurring in nearly equal proportions. The male gender and unskilled labour were found to be significantly associated with thoracic injuries. Plain radiography plays a great role in primary screening and remains an excellent tool for early detection of life threatening thoracic injuries. In emergency setting, a quick radiograph check assists the primary team in patient triage. It is cheap and readily available. It, however, can not assess adequately certain tissues of the chest such as spinal nerves, blood vessels and ligaments. CT Scan however the documented gold standard for major thoracic injuries is and provides excellent details of most radiological patterns.

6.2 Recommendations

1. There is need for another bigger study in a longer period with CT scan and including complementing imaging modality such as ultrasonography. This has been documented to have a higher sensitivity than chest radiography in demonstrating rib fractures, haemothorax and is widely available.
2. Supplementary projections like lateral decubitus, lateral or thoracic inlet views may be required for suspected specific indications at request of a clinician or image interpreting radiologist.

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APPENDIX I: DATA COLLECTION FORM

DATA COLLECTION TOOL

Client serial number ------------

Demographics

Date -----------

Sex Male ▢

Female ▢

Age -------- in years

Occupation (type) -----------

IP/OP Number-------------

Referral----- Y▢ N▢

Presenting symptoms---

Past medical history--

Main visible injury (ies)---

Others:

Head ▢ N▢

Abdomen Y▢ N▢

Pelvis ▢ ▢

Limbs ☐ ☐N

Others (specify)..

History

1) Mechanism of injury:

Blunt:-

Decelerating Y☐ N☐

Compression Y☐ N☐

RTA:-

Motor vehicle Y☐ N☐

Motorcycle Y☐ ☐

Bicycle ☐ ☐N

Sports injury:- Y☐ N☐

Fall, ☐ ☐N

Assault ☐ Y ☐ N

2) Penetration chest injuries

Gunshot Y☐ N☐

RTA Y☐ N☐

Stab wounds Y☐ N☐

Arrow wounds Y☐ N☐

Others

(specify)..

3) Both blunt and penetrating------------------

4) Time of injury ------------------

5) Types of thoracic trauma Y ▢ N ▢

----

1) Trauma to the thoracic cage

a) Fractures to ribs

Clavicles Y▢ N▢

Sternum Y▢ N▢

Spine Y▢ N▢

Scapula Y▢ N▢

b) Chest wall wounds Y ▢ N▢

c) Frail chest Y ▢ N▢

d) Diaphragmatic ruptures Y ▢ N▢

e) Foreign body Y ▢ N▢

f) Emphysema Y▢ N▢

g) Others (brushes etc)-------------▢-------▢----------------------

2) trauma to the respiratory tract

a) pulmonary contusion Y▢ N▢

b) pulmonary laceration Y▢ N▢

c) ruptured trachea Y▢ N▢

d) lung collapse Y ▢ N ▢

3) trauma to the cardiovascular system

a) cardiac tamponade Y N

b) myocardial contusion Y N

c) ruptured aorta Y N

4) pleural space disease

a) pneumothorax Y N

b) haemothorax

c) Others(specify) ---------------------

APPENDIX II: INFORMED CONSENT FORM

a) Adults above 18 years of age

I have been explained to in details that I am being recruited into a study on imaging of thoracic injuries at MTRH. The investigator has also informed me that my participation in this study is voluntary and will not exclude me from treatment even if I were to opt out and that my confidentiality will be respected. I hereby accept to participate.

Sign: ………………………………………………………………………………………

Name:……………………………………………………………………………………….

Date:

………………………………………………………………………………………
.

b) Participants between 14 and 18 years of age: Guardians' consent

I have been informed and explained to that my child/kin is being recruited into a study of thoracic injuries at MTRH.The investigator has also informed me that his/her participation in the study is voluntary and will not exclude him/her from treatment even if he/she was to opt out and that confidentiality will be respected.I hereby accept and append my signature below.

Name ;---

Signature --

Date--

APPENDIX III: KISWAHILI CONSENT FORM:

Jina langu ni Daktari Benjamin O. Bonyo. Mimi ni daktari aliyefuzu nakusajiliwa na bodi ya madaktari wa Kenya (Kenya Medical Practitioners and Dentists Board). Mimi ni msomi wa shahada ya juu (Uzamili) ya udaktari (Radiology) katika chuo kikuu cha Moi University. Ningependa ujiunge na uchunguzi ninaofanya kuhusu ma majeruhi ya kifua katika hospitali kuu ya MTRH.

Matokeo yako yatawekwa kwa njia ya kuheshimu haki yako ya kutojulisha yeyote. Utajulishwa kuhusu matokeo yako na maana kwa afya yako. Hautakatazwa matibabu iwapo utachagua ama usichague kushiriki katika uchunguzi huu. Matibabu yafaayo yatapewa kulingana na matokeo yako.

Uwe huru kuuliza maswali yoyote.

IDHINI YAKO:

Walio na miaka 18 na zaidi

Nimeelezwa kwa maelezo kwamba nimeajiriwa katika utafiti ya picha ya majeruhi ya kifua katika MTRH. Mchunguzi pia amenieleza kuwa mwanangu hatakosa matibabu akikataa kushiriki katika uchunguzi huu na kwamba matokeo yake yatawekwa kwa njia ya kuheshimu haki yake ya kutojulisha yeyote.Nakubali kushiriki.

Sahihi: …………………………………………………..………………………….
Jina: ……………………….…………………..…………………………………
Tarehe:
………………………………………………………………………..………………….
Mshahidi
Jina ....Sahihi..

APPENDIX IV: Standard Operating Protocols (SOPs) for CT scan of chest and CXR

These are specific requirements aimed at achieving high quality standards and consistency among different operators and centers. For MTRH, the CT scan machine is a helical Phillips MX Dual two slice model from Shanghai, China. Patient positioning is HFS (head first supine) with arms positioned above the head. A Scout (Scanogram) image is then obtained of length between 350- 500mm.This is followed by serial axial images of 5mm slices pre- and post intravenous contrast at a feed of 6mm from thoracic inlet to the diaphragmatic sulcus both for lung and mediastinum windows. For lung window the window width and length are 1000 and -700 HU respectively. For mediastinum window 400 and 35HU respectively. Bone Window are modified from the existing images. 3D post processing images can be produced using SSD(shaded surface display) or MIP (maximum intensity projection) techniques in sagittal or coronal views to assess rib fractures. High Resolution CT with thin slices of 1.5mm if done to investigate interstitial changes in the lung parenchyma.

For CXR the standard projection for adults is postero-anterior, (PA) in full inspiration with a focus to film distance(FFD) of 150 cm. Supine (antero-posterior, AP) is done in major chest trauma and in children...In our study both PA and AP views were done depending on severity of the patient.

There is need to distinguish injury pattern such as haemothorax from pathologies like pleural effusion and pyothorax. They all may present with a homogenous opacities obliterating the costophrenic angles on radiographs.Haemothorax and pleural effusion present with fluid level(meniscus) but in the former there may be history of trauma and layering due to haematocritse dimentation. On CT there is high attenuation and fluid level with haemothorax. pyothorax appears on CXR as loculated/oval fluid collection containing gas. On CT it appears as fluid collection with broad contact with posterior chest wall and containing gas. It shows ring enhancement with intravenous contrast.

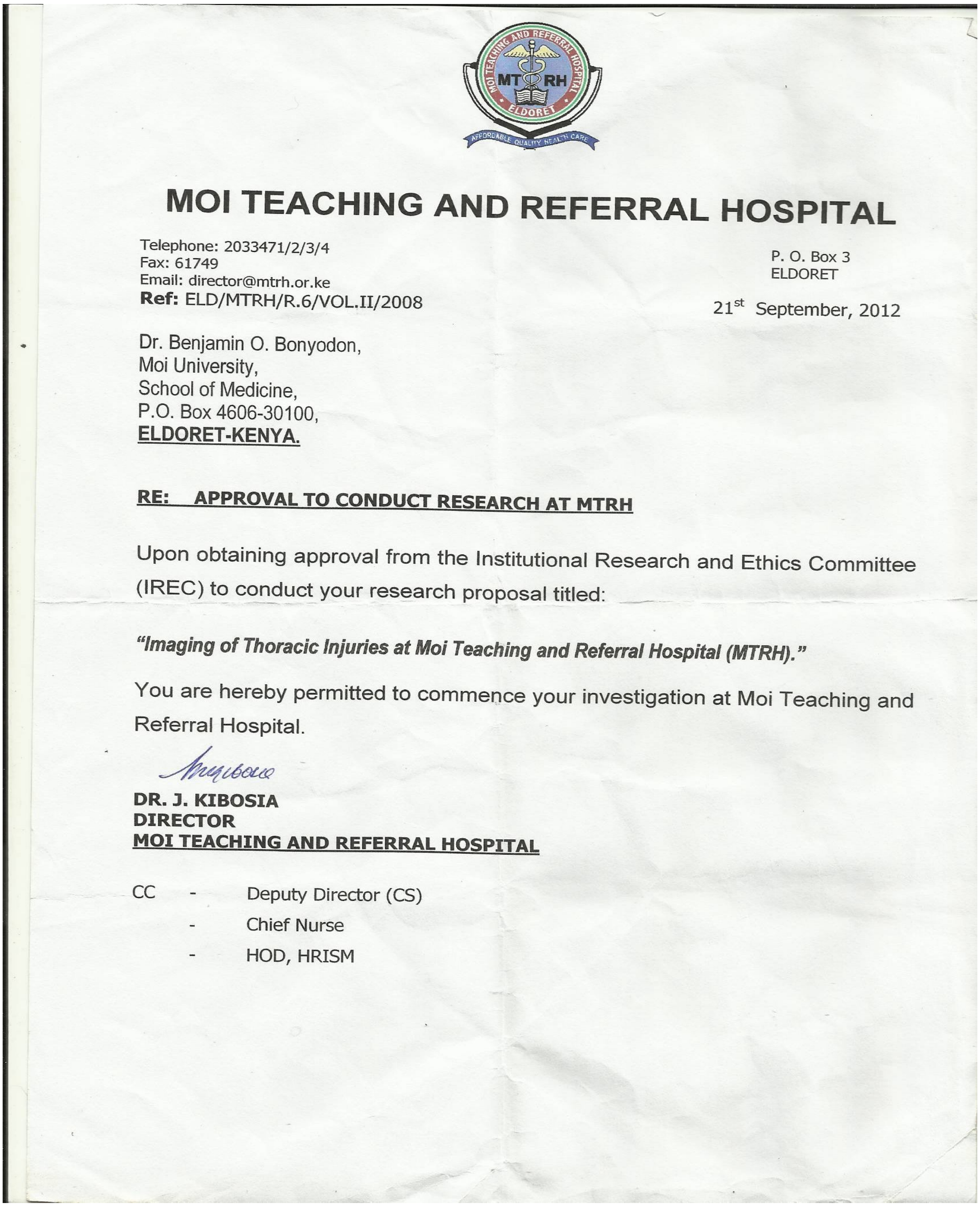
APPENDIX V: BUDGET

Item	Quantity	Unit cost in KSh	Totals in KSh	USD(1USD=80 Kshs)	Requested
Personnel Subsistence					
Research assistants	2	100*170	17,000		
Data Handling					
Printing	2,000	10	20,000		
Photocopying	4,000	2	8,000		
CDs (CT Images Storage)		20	2,000		
Printing/ Photocopying Paper	10 reams	500	5000		
Flash Disk 4Gb	1	2,500	2,500		
Stationery			1200		
Data Processing					
Statistician	1	20,000	20,000		
Secretarial Services	1	10,000	10,000		
Data Entry Clerks	1	7,500	7,500		
Equipment					
Digital Camera	1	15,000	15,000		
Computer (Laptop)	1	50,000	50,000		
Communication		-	10,000		
Publication		-	50,000		
Contingencies – 10%	**Misc**		18,820		
GRAND TOTAL			**207,020**		

APPENDIX VI: TIME FRAME

Activity	Duration	Time Frame
Overall period	24 months	march 2012-June 2014
Literature Search	2 months	March2012-April 2012
Developing Draft Proposal	2 months	May 2012-June 2012
Design of Instruments	1 month	July 2012
Submitting to IREC	1 month	August 2012
Soliciting for Funds	2 months	Sept 2012- oct 2012
Main Study (Data Collection/Data Handling)	8 months	Nov 2012-June 2013
Data analysis	2 months	July 2013-August 2013
Thesis Write up	2 months	Sept 2013-Dec 2013
Circulate report for critique	1 month	Jan 2014
Thesis Defense	3 months	Mar 2014- June 2014
Thesis Correction, Final Report	1 month	July2014

APPENDIX VII: MTRH PERMISSION



MOI TEACHING AND REFERRAL HOSPITAL

Telephone: 2033471/2/3/4
Fax: 61749
Email: director@mtrh.or.ke
Ref: ELD/MTRH/R.6/VOL.II/2008

P. O. Box 3
ELDORET

21st September, 2012

Dr. Benjamin O. Bonyodon,
Moi University,
School of Medicine,
P.O. Box 4606-30100,
ELDORET-KENYA.

RE: APPROVAL TO CONDUCT RESEARCH AT MTRH

Upon obtaining approval from the Institutional Research and Ethics Committee (IREC) to conduct your research proposal titled:

"Imaging of Thoracic Injuries at Moi Teaching and Referral Hospital (MTRH)."

You are hereby permitted to commence your investigation at Moi Teaching and Referral Hospital.

DR. J. KIBOSIA
DIRECTOR
MOI TEACHING AND REFERRAL HOSPITAL

CC - Deputy Director (CS)
- Chief Nurse
- HOD, HRISM

APPENDIX VIII: IREC APPROVAL

INSTITUTIONAL RESEARCH AND ETHICS COMMITTEE (IREC)

MOI TEACHING AND REFERRAL HOSPITAL
P.O. BOX 3
ELDORET
Tel: 33471//2/3

MOI UNIVERSITY
SCHOOL OF MEDICINE
P.O. BOX 4606
ELDORET
Tel: 33471/2/3

Reference: IREC/2012/125
Approval Number: 000893

21st September, 2012

Dr. Bonyodon Benjamin Odhiambo,
Moi University,
School of Medicine,
P.O. Box 4606-30100,
ELDORET-KENYA.

Dear Dr. Bonyodon,

RE: FORMAL APPROVAL

The Institutional Research and Ethics Committee have reviewed your research proposal titled:

"Imaging of Thoracic Injuries at Moi Teaching and Referral Hospital (MTRH)."

Your proposal has been granted a Formal Approval Number: **FAN: IREC 000893** on 21st September, 2012. You are therefore permitted to begin your investigations.

Note that this approval is for 1 year; it will thus expire on 20th September, 2013. If it is necessary to continue with this research beyond the expiry date, a request for continuation should be made in writing to IREC Secretariat two months prior to the expiry date.

You are required to submit progress report(s) regularly as dictated by your proposal. Furthermore, you must notify the Committee of any proposal change (s) or amendment (s), serious or unexpected outcomes related to the conduct of the study, or study termination for any reason. The Committee expects to receive a final report at the end of the study.

Yours Sincerely,

INSTITUTIONAL RESEARCH & ETHICS COMMITTEE
APPROVED
21 SEP 2012
P.O. Box 4606 ELDORET

PROF. E. WERE
CHAIRMAN
INSTITUTIONAL RESEARCH AND ETHICS COMMITTEE

cc:	Director	-	MTRH
	Principal	-	CHS
	Dean	-	SOM
	Dean	-	SPH
	Dean	-	SON
	Dean	-	SOD

APPENDIX IX: IREC REVIEW

INSTITUTIONAL RESEARCH AND ETHICS COMMITTEE (IREC)

MOI TEACHING AND REFERRAL HOSPITAL
P.O. BOX 3
ELDORET
Tel: 33471//2/3

MOI UNIVERSITY
SCHOOL OF MEDICINE
P.O. BOX 4606
ELDORET
Tel: 33471/2/3

Reference: IREC/2012/125
Approval Number: 000893

10th June, 2014

Dr. Bonyodon Benjamin Odhiambo,
Moi University,
School of Medicine,
P.O. Box 4606-30100,
ELDORET-KENYA.

INSTITUTIONAL RESEARCH & ETHICS COMMITTEE
10 JUN 2014
APPROVED
P.O. Box 4606-30100 ELDORET

Dear Dr. Bonyodon,

RE: APPROVAL OF AMENDMENT

The Institutional Research and Ethics Committee has reviewed the amendment made to your proposal titled:-

"Imaging Patterns of Thoracic Injuries seen among Patients Presenting at Radiology Department at MTRH".

We note that you are seeking to change your proposal title from;

1. ***"Imaging of Thoracic Injuries at Moi Teaching and Referral Hospital*** to ***"Imaging Patterns of Thoracic Injuries seen among Patients presenting at Radiology Department of Moi Teaching and Referral Hospital Eldoret, Kenya"***

The amendment has been approved on 10th June, 2014 according to SOP's of IREC. You are therefore permitted to continue with your research.

Note that this amendment approval will expire on the date of expiry of your Formal Approval. If it is necessary to continue with this research beyond the expiry date, a request for continuation should be made in writing to IREC Secretariat two months prior to the expiry date.

You are required to submit progress(s) regularly as dictated by your proposal. Furthermore, you must notify the Committee of any proposal change(s) or amendment(s), serious or unexpected outcomes related to the conduct of the study, or study termination for any reason. The Committee expects to receive a final report at the end of the study.

Sincerely,

PROF. E. WERE
CHAIRMAN
INSTITUTIONAL RESEARCH AND ETHICS COMMITTEE

cc:	Director	-	MTRH
	Principal	-	CHS
	Dean	-	SOM
	Dean	-	SPH
	Dean	-	SOD
	Dean	-	SON