DETERMINANTS OF HEALTH OUTCOMES IN TRAUMATIC BRAIN INJURY AMONG PATIENTS ATTENDING MERU TEACHING AND REFERRAL HOSPITAL

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A Thesis Submitted in Partial Fulfilment of the Requirements for the conferment of the Degree of Master of Science in Nursing (Medical Surgical Nursing) in Meru University of Science and Technology

2025

DECLARATION

This thesis is my original work and has not been presented for a degree in any other Institution

NS401/203054/22

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DEDICATION

This thesis is dedicated to my loving family, my spouse Morris and our children Ryan, Renny & Linah, who are my constant encouragement, source of love, support and inspiration.To my esteemed supervisors, Dr Peter N.Kailemia and Dr Maryjoy Kaimuri whose guidance, encouragement and expertise were invaluable throughout the thesis.To my parents for their unwavering love and support My classmate's thanks for being part of my journey.

ACKNOWLEDGEMENT

I would like to acknowledge and give my warmest thanks to my supervisors Dr Peter Kailemia & Dr MaryJoy Kaimuri who patiently and conscientiously have guided me through all the stages of developing my thesis. I extend my sincere gratitude to my family. My spouse and children for their continuous encouragement and support, Thanks to the management of Meru teaching and referral hospital for releasing me to study. Thanks to my colleagues at MeTRH for your input and valuable critique and encouragement. Finally, I thank God for letting me through all difficulties and guiding me day by day, and will keep on trusting you for my future.

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ABBREVIATIONS, ACRONYMS AND SYMBOLS

AANS	American Association of Neurosurgeons
ADLS	Activities of Daily Living
BTF	Brain Trauma Foundation
CDC	Center for Disease Control
CT	Computed Tomography
DRS	Disability Rating Scale
FIM	Function Independence Measure
GCS	Glasgow Coma Scale
GOSE	Glasgow Outcome Scale Extended
GOS	Glasgow Outcome Scale
HDU	High Dependency Unit
HIS	High Income Countries
ICP	Increased Intracranial Pressure
LMICS	Low Middle-Income Countries
LOC	Level of Consciousness
MeTRH	Meru Teaching and Referral Hospital
MIRERC	Meru University of Science and Technology Institutional Research and Ethics Review Committee
MRI	Magnetic Resonance Imaging
NACOSTI	National Commission for Science and Innovation
PTA	Post-Traumatic Amnesia
QOLIBRI	Quality of Life after Brain Injury
RTA	Road Traffic Accident

SSA	Sub-Saharan Africa
TBI	Traumatic Brain Injury
WHO	World Health Organization

OPERATIONAL DEFINITIONS

Determinants	Patient-related factors, availability of hospital and prehospital care, and availability of hospital resources in the management of patients that influence the outcome of patients with traumatic brain injuries.
Health outcomes	Acute, short-term and long-term changes in the health of a patient with traumatic brain injuries attributable to an intervention
Acute health outcomes	are the immediate effects observed within minutes to hours or up to 24 hours following a traumatic brain injury (TBI)
Short-term health outcome	these are health effects or recovery milestones observed in the first few days to weeks (up to 3 months) following the injury
Long term health outcomes	Lifetime physical, cognitive, emotional and behavioral changes in TBI patient that may affect their ability to function in their everyday life.
Head injury	Any trauma to the scalp, skull, or brain
Traumatic Brain Injury (TBI)	Injury to the brain following an external mechanical force leading to permanent or temporary impairment of cognitive, physical, and psychosocial function.
Glasgow coma scale	This is a clinical assessment tool to determine the level of consciousness of a patient by eye response, speech, and motor functions.
Patient pre-injury status	Individual's health and functional condition before the traumatic brain injury (TBI) occurred.
Patient injury	Features of injuries and physiological changes that occur due to

characteristics	traumatic brain injury.
Patient related factors	Individual characteristics, conditions, and circumstances of the patient existing before, during, or immediately after the injury that may influence recovery and overall health outcomes. The factors includes drug and substance abuse, comorbidities', age, gender, socio-economic status, time of arrival to the facility.
Hospital related factors	Hospital infrastructure, resources, policies processes, and practices within the healthcare facility that influence the diagnosis, treatment, and recovery of traumatic brain injury (TBI) patients.
Prevalence	Proportion of individuals within the study population who have a specific type or category of traumatic brain injury during the study period
Social economic factors	Individuals' economic status that influence the health outcomes of a traumatic brain injury patient.
The Glasgow outcome scale	Is a scale used to measure the long-term outcome following a traumatic brain injury. It consists of five categories: death, vegetative state, severe disability, moderate disability, and good recovery

ABSTRACT

Traumatic brain injury is the disruption of the brain structure caused by external force, characterized by confusion, loss of consciousness, coma, or seizure. TBI is a public health concern globally and the leading cause of admissions, increased morbidity, mortality, and disability. The objective of the study was to assess the determinants of health outcomes of TBI patients at MeTRH. A cross-sectional study design was used. The study population included adult TBI patients, and healthcare providers. A sample size of 36 TBI patients, and 74 healthcare workers. Medical record files were used as data source to collect data on prevalence and types of TBI. Data was collected using checklist, interview-guided questionnaires, disability rating scale tool, and self-administered questionnaires. Data management involved cleaning, codding, entering numerical data into SPSSv27. The study identified a wide spectrum of TBIs, epidural hematoma (21.4%, n=18), skull fractures (20.2%, n=17), subdural hematoma (16.7%, n=14) being most prevalent. RTA leading cause (70.2%, n=59), assaults (22.6%, n=19). Inferential analysis showed a significant association between type of TBI and health outcomes (χ^2=12.47, p=0.002), subdural hematoma and severe TBI linked to higher mortality. Overall, 16.7% (n=6) of patients died, within two weeks, 52.8% (n=19) regained functional independence by Week 6. Recovery trajectories revealed physical improvement compared to cognitive and psychosocial recovery, with 38.9% (n=14) employable without restrictions. Patient-related factors older age (≥50 years), male sex, history of prior TBIs (11.9%, n=10), low admission GCS,(≤8), delayed hospital arrival (>6 hours) were significantly associated with poor outcomes (χ^2=15.36, p=0.001 Healthcare-related factors influenced recovery, timely access to CT scans (97.6%, n=82) surgical interventions (44.0%, n=37) ,limited ICU space, inadequate rehabilitation services constrained recovery. The severity distribution revealed 44% (n=37) mild, 32% (n=27) moderate, and 24% (n=20) severe TBIs, with outcome differences statistically significant across severity levels (ANOVA, F=9.21, p<0.001). Findings; high prevalence of TBI in young males (75%, n=63) caused by RTAs, good neurological and physical recovery, cognitive, psychosocial, and employment outcomes remained suboptimal. Strengthening road safety, pre-hospital emergency care, neuroimaging, surgical capacity, and comprehensive rehabilitation programs, with standardized use of outcome tools such as the DRS, `are critical to improving long-term TBI health outcomes.

CHAPTER ONE: INTRODUCTION

1.1 Background of the Study

Traumatic brain injury (TBI) is defined as the destruction of normal function of the brain caused by external force from bumps, jolts, blows, falls, assaults, penetrating injury to the brain, sports-related injuries, sudden deceleration, or acceleration force during road traffic accident characterized by confusion, loss of consciousness, post-traumatic amnesia, coma, or seizure. (Adedunsola Adewunmi Obasa *et al*., 2024). According to Michael *et al*,2023, TBI henceforth, is a public health concern and a leading cause of mortality and disability affecting every age group, with 69 million individuals globally annually. TBI is the major cause of mortality and morbidity, with a greater burden in low and middle-income countries due to increased risk factors and the inability of healthcare systems to offer effective acute and long-term care.(Demlie *et al*., 2023).

According to the World Health Organization (WHO), TBI accounts for nearly 10 million hospitalizations annually and remains a major cause of death and disability, especially among young adults (National Academies of Sciences *et al*., 2022)

The classification of traumatic brain injury (TBI) by the Brain Trauma Foundation (BTF), the World Health Organization (WHO), and the American Association of Neurological Surgeons (AANS) offers empirically grounded frameworks for assessing injury severity and guiding treatment. The BTF uses the Glasgow Coma Scale (GCS) to classify TBI into mild (GCS 13–15), moderate (GCS 9–12), and severe (GCS ≤8), emphasizing immediate neurological assessment (Brain Trauma Foundation, 2016). Similarly, the WHO categorizes TBI based on clinical indicators, including loss of consciousness (LOC), post-traumatic amnesia (PTA), and neuroimaging findings, with mild TBI defined as LOC ≤30 minutes and PTA <24 hours, moderate TBI as LOC up to 24 hours and PTA lasting 1–7 days, and severe TBI as LOC >24 hours or PTA >7 days (WHO, 2004). The AANS incorporates GCS scores while placing greater emphasis on neuroimaging, identifying mild TBI as GCS 13–15 with minimal PTA and normal imaging, moderate TBI as GCS 9–12 with prolonged LOC or non-surgical lesions, and severe TBI as GCS ≤8 with significant structural damage such as intracranial hemorrhage or diffuse axonal injury (AANS, 2021). These classifications collectively provide a standardized approach to diagnosing TBI severity and ensuring consistency in clinical and research settings, although regional disparities in healthcare resources may limit their universal applicability.

According to the (CDC, 2024), TBIs globally are caused by a bump, blow, or jolt to the head or penetrating head injury which can also be unintentional, self-inflicted, or result from assault, resulting in the disruption of normal brain function.

Traumatic brain injuries (TBIs) are a significant public health concern in the United States, contributing to substantial morbidity and mortality. According to the Centers for Disease Control and Prevention (CDC), there were approximately 214,110 TBI-related hospitalizations in 2020, with about 69,473 TBI-related deaths reported in 2021 (CDC, 2023). These injuries result from various causes, including falls, motor vehicle accidents, violence, sports-related injuries, and military activities.

In developing countries, particularly in sub-Saharan Africa (SSA) and low- and middle-income countries (LMICs) like Kenya, road traffic accidents, falls, and violence are identified as the primary causes. Road traffic accidents are the leading cause, predominantly affecting young males aged 20–40, due to poor road infrastructure, limited enforcement of traffic regulations, and insufficient use of protective measures such as seatbelts and helmets (Cholo *et al.*, 2023). Estimates of motorcycle-related morbidity, hospitalization, severity, and fatalities, as well as their impact on the public health system, are essential for evidence-based policymaking, advocacy, and priority setting for appropriate and effective interventions, resource mobilization, and future research. Unfortunately, in Kenya, health information systems are inadequate in many counties, including Meru. No published information exists on the burden imposed on health services by different types of motorcycle crash injuries and severity levels.

Falls, particularly among children and the elderly, are another significant cause, often linked to unsafe living environments such as uneven surfaces and poorly maintained housing, as evidenced by a study in Cameroon that highlighted the high prevalence of fall-related TBIs in rural communities (Buh *et al*., 2023). Violence, including interpersonal assaults and armed conflict, further contributes to the TBI burden, exacerbated by poverty, unemployment, and inadequate mental health resources, with research from multiple SSA countries showing that social disparities increase the risk of violence-related injuries (Kuupiel *et al*., 2024).

Good prehospital management (adequate airway management, prevention and treatment of hypoxia and hypotension, controlled ventilation) and early arrival to the hospital reduces secondary injury and improve survival. (Maiga *et al*., 2023). In public facilities, there are limited theatres, critical care units and neurosurgeons leading to unfavorable outcomes. Patients also present late to the health facility leading to delayed interventions contrary to the 'golden hour rule" the time window (usually the first hour post-injury) where rapid recognition, resuscitation, and stabilization of a TBI patient are most effective in preventing secondary brain injury. Early, aggressive management during this period gives the highest chance of minimizing irreversible brain damage.(Koome *et al*., 2022).

The delays of turnaround time of up to 6hours, if minimized through prompt management of TBI patients may results in reduction of TBI consequences. This may be possible by creation of a neuro intensive treatment facility and capacity building for the health care providers. In the European Union, over 1.5 million people are admitted to hospital for TBI annually, with Austria and Germany reporting about eight times more admissions compared to Portugal and Spain and three times higher compared to the United states. This

indicates significant inter-continental TBI burden.(Dewan *et al*., 2019).

In Kenya, the prevalence of traumatic brain injuries (TBIs) is alarmingly high, with studies indicating that they account for approximately 30–50% of all trauma admissions in major referral hospitals (Gathecha *et al*., 2021). Road traffic accidents are the leading cause, particularly involving motorcycles (boda-bodas), which have become a common mode of transport but are often associated with poor helmet use and weak enforcement of traffic safety laws (Kinyanjui *et al*., 2022). Young males between the ages of 15 and 40 years form the majority of TBI cases, largely due to their involvement in high-risk occupations, road usage, and risk-taking behaviors. Falls and assaults also contribute significantly, especially in rural areas and informal settlements.

The burden of TBIs in Kenya is compounded by limited emergency medical services, delays in accessing care, and inadequate specialized neurosurgical facilities outside urban centers (Mwangi *et al*., 2023). At facilities like Meru Teaching and Referral Hospital (MeTRH), TBIs remain a leading cause of hospital admissions and deaths in the accident and emergency department. The lack of pre-hospital care systems and delayed referrals further worsen outcomes, leading to high morbidity and mortality rates. Given this prevalence, TBIs represent not only a medical challenge but also a public health and socioeconomic burden in Kenya, calling for stronger prevention measures, improved road safety enforcement, and expanded trauma care services.

1.2 Problem Statement

Traumatic brain injury (TBI) is a leading cause of death and disability worldwide, significantly impacting public health systems and economies. The economic cost of TBIs, such as mortality, morbidity and high hospital bills, has serious economic impact at an individual, household and societal level. For instance, LMICs, mainly in sub-Saharan Africa, lose about four billion, United State dollars (US$) annually due to RTIs, a major cause of TBIs equivalent to 11% of their gross domestic product (GDP). In Kenya, the cost of RTIs is estimated at 14 billion Kenya shillings per year. (Thuita *et al*., 2022)

Further ,LMICs, mainly Africa also experience about three times more cases of TBIs compared to high income countries (HICs) constituting approximately 80% of the TBI global burden.(Koome *et al*., 2022)

In Kenya, TBI is among the leading causes of injury-related deaths, especially in young males, with road traffic accidents as the main cause (Odero *et al*., 2020). Nationally, precise national prevalence data on traumatic brain injuries are lacking, but several studies especially those centered on Kenyatta National Hospital—indicate that TBIs are a substantial public health problem. A review of literature noted that while no centralized registry exists, Kenya has a "significantly high rate of traffic-related deaths and disabilities most of which result from brain injuries," and that TBI frequently follows road traffic accidents, particularly involving motorcycles (boda bodas).(Nguru & Ireri, 2022).

According to health records at MeTRH, in the year 2023, there were 346 cases of TBI and in the year 2024,490 patients were diagnosed with TBI. While studies on incidence and causes have been studied, no comprehensive study has examined how local determinants such as patient related factors and healthcare related factors influence health outcomes of TBI patients. This study sort to investigate the determinants of TBI health outcomes at MeTRH, providing data to inform clinical practice, resource allocation, and policy in neurotrauma care.

1.3 Objectives

1.3.1 Broad objective

To assess determinants of health outcomes of patients with traumatic brain injuries attending Meru Teaching and Referral Hospital

1.3.2 Specific objectives of the study are:

i. To determine the prevalence of various types of traumatic brain injuries (TBIs) at Meru Teaching and Referral Hospital

ii. To determine health outcomes of patients diagnosed with traumatic brain injuries at Meru Teaching and Referral Hospital.

iii. To establish patient-related factors that influence the health outcomes of patients with traumatic brain injury at Meru Teaching and Referral Hospital.

iv. To determine healthcare-related factors that determine health outcomes of patients with traumatic brain injuries.

1.4 Research Questions

i. What is the prevalence of various types of traumatic brain injuries (TBIs) at Meru Teaching and Referral Hospital?

ii. What are the health outcomes of patients diagnosed with traumatic brain injuries at Meru Teaching and Referral Hospital?

iii. How do patient-related factors influence the health outcomes of patients with traumatic brain injuries at Meru Teaching and Referral Hospital?

iv. What healthcare-related factors influence the health outcomes of patients with traumatic brain injuries?

1.6. Significance of the Study

This study will provide valuable insights into the burden of traumatic brain injuries (TBIs) at Meru Teaching and Referral Hospital (MeTRH) and contribute to policy, practice, and research in the management of TBI patients.

The findings of this study will inform hospital management and policymakers in developing and improving policies and guidelines for the management of TBI. By identifying key factors influencing patient outcomes, the study may guide the formulation of evidence-based policies aimed at enhancing the quality of neurotrauma care, reducing mortality rates, and shortening hospital stays. Additionally, the study may provide input for government agencies in allocating resources and designing national strategies for the prevention and management of TBIs.

For healthcare providers, this study will highlight critical patient- and healthcare-related factors that influence TBI outcomes. The findings will help shape clinical decision-making, optimize treatment protocols, and promote adherence to best practices in neurotrauma care. Moreover, the research may serve as a basis for developing targeted interventions and training programs to improve healthcare delivery, ultimately enhancing patient recovery and survival rates.

This study will contribute to the existing body of knowledge on TBIs by identifying factors that influence health outcomes in a low-resource setting. The findings may serve as a foundation for future research, including clinical trials, epidemiological studies, and policy evaluations focused on TBI prevention and management. Additionally, the study aligns with Sustainable Development Goal 3, which aims to reduce global deaths caused by TBIs by 2030.

1.8 Assumptions of the Study

i. Accuracy of Medical Records: It is assumed that hospital records and patient information are accurate and up to date, ensuring reliable data collection.

ii. Patient Honesty and Recall: Patients and caregivers will provide truthful and accurate information regarding pre-injury conditions and events leading to hospitalization.

iii. Consistency in Diagnosis and Treatment: It is assumed that TBI cases are diagnosed using standard clinical and imaging protocols, ensuring uniformity in patient classification.

iv. Healthcare Providers' Cooperation: The study assumes that healthcare providers at MeTRH will cooperate in providing necessary data and insights regarding TBI management.

v. Generalizability to Similar Settings: While the study is hospital-based, it is assumed that findings will be relevant to other healthcare facilities with similar resources and challenges.

1.9 Limitations of the Study

i. Single-Center Study: Since the study was conducted at Meru Teaching and Referral Hospital (MeTRH), the findings may not be fully generalizable to other healthcare facilities. However, the study will provide valuable insights applicable to similar resource-limited settings, and recommendations can be adapted for broader use.

ii. Potential Data Incompleteness: Some patient records had missing or incomplete information, which could affect data accuracy. To mitigate this, multiple data sources, including hospital records, clinician reports, and patient interviews, were used to validate findings.

iii. Patient Follow-Up Challenges: Tracking long-term health outcomes was sometimes difficult due to patient loss to follow-up. To address this, the researcher collected information from next of kin and used hospital records to monitor readmissions or complications where possible.

iv. Resource Constraints: Limited availability of imaging and diagnostic tools may affect data collection. The study used alternative diagnostic criteria from clinical evaluations where imaging was unavailable to ensure all relevant cases were included.

v. Recall Bias: Patient-related factors, such as pre-injury status, may rely on self-reported or caregiver-reported data, which could introduce recall bias. To minimize this, multiple respondents (patients, caregivers, and healthcare providers) were consulted and medical records crosschecked for consistency.

1.10 Delimitations

i. Study Setting: The study was limited to MeTRH and excluded cases managed in outpatient settings or other facilities. This ensured focused data collection on hospitalized patients who received specialized neurotrauma care.

ii. Scope of Variables: The study examined prevalence, health outcomes, patient-related factors, and healthcare-related factors but did not explore genetic or molecular determinants of TBI recovery.

iii. Timeframe: The study was conducted within a specific period, analyzing only patients admitted during that time. This did not capture long-term trends, but will provide a snapshot of the current situation and inform immediate policy and practice improvements.

iv. Population Focus: The study will include only patients with a confirmed diagnosis of TBI, excluding those with other neurological conditions or injuries without brain trauma. This ensures the study remains relevant to its objectives and allows for in-depth analysis of TBI-specific factors.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

Literature review and search were conducted from various electronic databases like Web of Science,Google Scholar, PubMed, Microsoft Literature Search, and Research Gate. Review of protocols, guidelines, and Meta-Analysis of published research work. A combination of keywords and medical subject Headings (MeSH) terms were used and search terms were selected considering variations in key concepts such as “determinants, traumatic brain injury, traumatic brain injuries.” together with one or a combination of the words “prehospital management”, “emergency department management”, “secondary injury”, “coagulopathy” and “intracranial pressure”.

This chapter provides a comprehensive review of existing literature on TBIs, focusing on key aspects relevant to the study. It begins by examining the prevalence of various types of TBIs, highlighting global, regional, and local trends, as well as risk factors contributing to their occurrence. The discussion then shifts to the health outcomes of patients diagnosed with TBI, exploring both short-term and long-term consequences such as recovery rates, disability, and mortality.

Further, the chapter analyzes patient-related factors influencing health outcomes including pre-injury status, age, severity of injury, and the time taken to reach the hospital. This is followed by an examination of hospital-related factors affecting TBI outcomes, which considers aspects such as the availability of specialized neurosurgical care, quality of emergency response, and hospital infrastructure.

To provide a theoretical foundation for the study, the theoretical framework discusses relevant nursing theory. Lastly, the conceptual framework illustrates the relationships between key study variables, demonstrating how different factors interact to influence patient outcomes.

2.2 Prevalence of Various Types of Traumatic Brain Injuries

Traumatic Brain Injury (TBI) is a leading cause of morbidity and mortality globally, with its prevalence and patterns varying across regions due to differences in healthcare systems, socioeconomic conditions, and public health interventions.(Haarbauer-Krupa *et al.*, 2021) This section examines the prevalence of various types of TBIs, critiquing the existing literature from developed countries, sub-Saharan Africa, and Kenya, highlighting gaps, and providing a comprehensive analysis.

In developed countries, TBIs are a significant public health concern, primarily resulting from road traffic accidents, falls, and sports-related injuries. A study by(Maas *et al.*, 2022) in the European Union estimated that approximately 2.1 million people sustain TBIs annually, with moderate to severe TBIs accounting for 30% of these cases. The study highlighted an increase in TBI prevalence among the elderly due to fall-related injuries, reflecting aging populations in high-income countries.

Similarly, (Peterson *et al.*, 2022)conducted a meta-analysis in the United States that revealed sports-related TBIs were prevalent among young adults, especially in contact sports like football and hockey. The authors noted advancements in diagnostic techniques, such as diffusion tensor imaging (DTI), that have improved the detection of mild TBIs. Additionally, while robust healthcare systems in developed countries have led to improved TBI outcomes, disparities persist. For instance, a Canadian study by(Johnson & Diaz, 2023), highlighted that Indigenous populations experience disproportionately higher rates of TBI, often linked to systemic inequities and limited access to rehabilitation services.

In sub-Saharan Africa, TBIs are a growing concern due to the region's high rates of road traffic accidents (RTAs), urbanization, and violence. According to a systematic review by Michael *et al*., (2023),the prevalence of TBIs in sub-Saharan Africa ranges from 150 to 400 per 100,000 population, significantly higher than in developed regions. RTAs account for nearly 60% of TBIs in the region, with motorcyclists and pedestrians being the most vulnerable groups.

One notable, study in Nigeria by (Amaefule *et al*., 2019), (2019) found that severe TBIs constituted 40% of cases in urban trauma centers, with delayed hospital admissions contributing to poor outcomes. In contrast, a study in South Africa by explored violence-related TBIs, noting that interpersonal violence is a leading cause among young males. The study emphasized the role of alcohol and substance abuse in exacerbating TBI rates. Despite these findings, there is limited data on TBI prevalence in rural and underserved areas of sub-Saharan Africa. Most studies are hospital-based, neglecting community-level data that could provide a more comprehensive picture. This gap highlights the need for population-based studies to inform policy and resource allocation.

In Kenya, TBIs are a significant health burden, with RTAs being the leading cause. A study by (Koome *et al*., 2022) estimated that 75% of trauma admissions in Kenyan hospitals are due to TBIs, with motorcyclists (boda bodas) disproportionately affected. The study highlighted a lack of adherence to helmet use, contributing to the high prevalence of severe TBIs. However, it did not explore the role of enforcement mechanisms or community-based interventions in promoting helmet use.

Further, a study conducted at Kenyatta National Hospital by Shisoka *et al*.,(2019)revealed that falls are a leading cause of TBIs among children under five years, often due to inadequate supervision and unsafe home environments. While the study provided critical data, it lacked longitudinal follow-up to assess the long-term cognitive and developmental impacts of TBIs on children.

Another study at Moi Teaching and Referral Hospital by Wilson *et al*.,(2021) examined the prevalence of TBIs among victims of interpersonal violence. The findings showed that 30% of TBI cases were related to assaults, particularly among young males in urban areas. However, the study did not address the broader social determinants of violence, such as unemployment and poverty, which could inform preventive strategies.

In conclusion, while significant progress has been made in understanding the prevalence and types of TBIs globally, critical gaps remain, particularly in sub-Saharan Africa, Kenya and at Meru teaching and referral hospital. Thus the researcher used the medical records files to obtain data on prevalence and types of Traumatic Brain injuries at Meru teaching and referral hospital.

2.3 Health Outcomes of Patients Diagnosed with TBI

Health outcomes in traumatic brain injury (TBI) refer to the measurable physical, neurological, cognitive, psychological, and social consequences that result from the injury, as well as the patient's level of recovery over time. These outcomes encompass both immediate effects, such as neurological impairments, disability levels, or mortality, and longer-term consequences, including physical functioning, cognitive recovery, emotional well-being, and social reintegration (Maas *et al*., 2022). They are influenced by patient-related factors such as age, severity of injury, and pre-injury health status, as well as healthcare-related factors like timeliness of care, rehabilitation services, and quality of hospital management (Hughes *et al*., 2024). In essence, health outcomes in TBI provide an indication of the effectiveness of treatment and rehabilitation, while also reflecting the patient's overall quality of life after injury.

Traumatic brain injuries (TBIs) remain a critical global health issue, with significant variation in outcomes based on geographical and socioeconomic factors. Globally, TBIs contribute to considerable morbidity and mortality, particularly in low- and middle-income countries (LMICs), where they account for a substantial burden due to limited resources and delayed access to care(Marino *et al*., 2022). Acute outcomes of TBIs, such as disability or death, are influenced by injury severity, timely medical intervention, and associated complications like hypoxia and cerebrospinal fluid otorrhea, as seen in a recent study from Ethiopia (Demlie *et al*., 2023)

Long-term outcomes include persistent cognitive, physical, and emotional challenges and even in high-income countries, continue to experience significant disabilities years after injury (Plancikova *et al*., 2021) . In sub-Saharan Africa (SSA), road traffic accidents exacerbate the high incidence of TBIs, falls, and violence, coupled with inadequate trauma care systems, which negatively impact patient outcomes (Gabbe *et al*., 2024).

In Kenya, poor adherence to TBI management protocols, as highlighted in a study at Thika Level 5 Hospital, further compounds the problem, emphasizing the need for improved healthcare systems and quality care.(Koome *et al*., 2022). These findings underscore the global disparity in TBI outcomes and the urgent need for targeted interventions to enhance acute care, prevent long-term complications, and reduce the overall burden of TBIs in LMICs.

The health outcomes of traumatic brain injury (TBI) patients are classified into acute and long-term outcomes, with varying severity and implications depending on the nature of the injury, timely medical intervention, and access to rehabilitation services. Acute outcomes typically manifest immediately after the injury and can range from full recovery to severe disability or death. Studies show that factors such as delayed hospital arrival, low Glasgow Coma Scale (GCS) scores, and complications like hypoxia or cerebrospinal fluid leaks significantly worsen acute outcomes. Additionally, in low- and middle-income countries (LMICs), especially in sub-Saharan Africa (SSA), limited trauma care resources further exacerbate these acute consequences, contributing to high mortality rates(Gabbe *et al*., 2024).

Long-term outcomes, on the other hand, include chronic physical, cognitive, and emotional impairments that can persist for years after the injury. Persistent disabilities, such as reduced mobility, memory loss, depression, and behavioral changes, significantly affect the quality of life. Draper *et al*. (2019) highlighted that even in high-income countries with advanced healthcare systems, a significant proportion of patients with severe TBIs continue to experience disabling conditions years' post-injury. In SSA, the lack of structured rehabilitation programs further complicates recovery, leaving many patients with unresolved disabilities (Asemota & George, 2021). In Kenya, poor adherence to standardized TBI management protocols, as reported in studies at facilities such as Thika Level 5 Hospital, underscores the need for systemic improvements to optimize acute and long-term outcomes.

2.3.1 Immediate health outcomes

Acute health outcomes of traumatic brain injury (TBI) patients vary widely and depend on the severity of the injury, the patient's initial condition, and the timeliness of medical intervention.(Mwita *et al*., 2016).

a) Neurological Impairments

TBIs can result in immediate neurological deficits, including loss of consciousness, confusion, memory disturbances, and seizures. These impairments are often assessed using the Glasgow Coma Scale (GCS), where lower scores indicate severe injury and worse outcomes. (Jain & Iverson, 2025) found that patients with low GCS scores at admission were more likely to experience adverse neurological outcomes.

b) Physical Complications

Acute TBIs can lead to physical complications such as skull fractures, intracranial hemorrhages, epidural, subdural, or intracerebral hematomas, and brain swelling. These complications can exacerbate the injury, increase intracranial pressure, and lead to secondary brain damage if not promptly managed.(Marino *et al*., 2022)

c) Cardiopulmonary and Systemic Issues

Secondary injuries often arise due to systemic effects of TBIs, such as hypoxia, hypotension, or systemic inflammatory response syndrome (SIRS). Hypoxia and hypotension, in particular, have been shown to significantly worsen acute outcomes by reducing oxygen delivery to the brain and exacerbating neuronal damage (Lacerte *et al*., 2023)

d) Cognitive and Behavioral Changes

Acute TBI patients often experience immediate cognitive deficits, such as impaired attention, memory, and problem-solving abilities. Behavioral symptoms, including agitation or aggression, are also common during the acute phase and may interfere with treatment ((Halalmeh *et al*., 2024).

e) Mortality

Severe TBIs are associated with high mortality rates in the acute phase, especially in low-resource settings. (Gabbe *et al*., 2024), reported that delayed hospital arrival and limited access to advanced trauma care contribute to higher mortality in low- and middle-income countries (LMICs), particularly in sub-Saharan Africa.

f) Infections

Open head injuries or invasive procedures can lead to infections such as meningitis or brain abscesses, which can complicate recovery. In resource-limited settings, lack of sterile practices and delayed diagnosis further increase the risk of infections (Mwita *et al*., 2016)

2.3.2 Short-term health outcomes

a) Physical Outcomes

The physical outcomes of patients diagnosed with traumatic brain injuries (TBIs) vary significantly across regions and healthcare systems. In developed countries, advancements in medical technologies and post-acute care programs have improved survival rates and physical recovery. For instance, (Haarbauer-Krupa *et al*., 2021) reported that 85% of patients with mild TBIs in the United States achieved full recovery within three months, demonstrating the efficacy of early intervention and rehabilitation programs. However, moderate and severe TBIs often result in long-term physical disabilities, with approximately 40% of patients requiring assistance with daily activities a year after injury (Guan *et al*., 2023). In Sub-Saharan Africa, physical outcomes are often poorer due to delayed diagnosis and limited access to advanced medical care.(Adegboyega *et al*., 2021) found that the mortality rate for severe TBIs in Nigeria reached 45%, primarily due to inadequate neurosurgical services. In Kenya Shisoka *et al*., (2019) observed that 60% of TBI survivors at Kenyatta National Hospital experienced moderate to severe disabilities, with minimal access to specialized rehabilitation centers exacerbating these challenges.

b) Cognitive Outcomes

Cognitive recovery after TBI is critical for regaining functional independence, yet it is often under-addressed, particularly in low-resource settings. In developed countries, tools like the Glasgow Outcome Scale-Extended (GOSE) are used to evaluate cognitive outcomes. (Dibera *et al*., 2024),demonstrated that comprehensive neurorehabilitation programs in Germany improved memory and attention by 60%, highlighting the importance of integrated care. In Sub-Saharan Africa, the lack of structured cognitive rehabilitation programs results in significant challenges. (Adegboyega *et al*., 2021) noted that patients in rural areas often face long-term cognitive deficits due to delayed care. In Kenya, (Nguru & Ireri, 2022) emphasized the need for tools like the Disability Rating Scale (DRS) at MOI Teaching and Referral Hospital to monitor cognitive recovery in resource-constrained settings.

c) Psychological Outcomes

Psychological health is a critical yet often overlooked component of recovery for TBI patients. Depression and anxiety are common, even in developed countries with robust healthcare systems. Maas *et al*. (2021) reported that 30% of TBI patients in the United States experienced clinical depression within the first year post-injury, emphasizing the need for psychological counseling as part of rehabilitation. In Sub-Saharan Africa, psychological outcomes are often worse due to stigma and a lack of mental health services. (Muili *et al*., 2024) observed high rates of untreated anxiety among TBI patients in Nigeria, exacerbated by limited awareness and resources. In Kenya, Ndung'u *et al*. (2022) highlighted that psychological outcomes in Meru County are shaped by socio-economic factors, with many families unable to afford counseling services. The Ministry of Health's pilot rehabilitation program for trauma patients has incorporated mental health components, but its scalability remains limited.

d) Social Outcomes

The social outcomes of TBI patients significantly influence their overall quality of life and ability to reintegrate into society. In developed countries, multidisciplinary rehabilitation programs often include vocational training and social support, improving social outcomes. Kraus *et al*. (2022) found that 70% of TBI patients in Germany returned to work within a year of completing rehabilitation. However, disparities persist, particularly among economically disadvantaged groups. In Sub-Saharan Africa, limited social support systems and the stigma associated with disabilities hinder social integration. Mukamana *et al*. (2023) demonstrated that community health worker programs in Rwanda reduced social isolation among TBI patients, although such initiatives are often unsustainable due to funding constraints. In Kenya, Otieno *et al*. (2023) reported that only 15% of TBI patients at Kenyatta National Hospital achieved full social reintegration. Cultural practices in Meru County, such as reliance on traditional healing, can delay access to interventions that support social recovery (Ndung'u *et al*., 2022). Developing scalable, community-based programs and national registries to track long-term outcomes could enhance social reintegration

2.3.3 Tools for Assessing Health Outcomes in Traumatic Brain Injury (TBI) Patients

Evaluating health outcomes in patients with traumatic brain injury (TBI) involves using validated tools that measure various aspects of recovery, such as consciousness, functionality, and quality of life. Widely used instruments include the Glasgow Coma Scale (GCS), the Glasgow Outcome Scale-Extended (GOSE), the Disability Rating Scale (DRS), and others. These tools are applied globally in clinical and research settings to assess the severity of injury, track progress, and guide rehabilitation efforts.

a) Disability Rating Scale (DRS)

The Disability Rating Scale (DRS), developed by Rappaport *et al*. (1982), is a standardized tool designed to measure the functional outcomes of patients with traumatic brain injury (TBI) from coma to community reintegration. It assesses three domains: impairment (eye opening, communication, motor response), disability (dependence in feeding, toileting, grooming), and handicap (overall level of functioning and employability), with scores ranging from 0 (no disability) to 29 (extreme vegetative state/death).

The indication for the DRS is the assessment and monitoring of recovery in patients with TBI across acute care, rehabilitation, and follow-up, making it suitable for both clinical management and research. Its justification for use lies in its comprehensiveness compared to tools such as the Glasgow Coma Scale, as it not only evaluates consciousness but also measures functional disability and societal reintegration. The DRS is valid and reliable, with demonstrated inter-rater consistency and sensitivity to changes in patient status, making it a robust tool for outcome measurement and rehabilitation planning in TBI populations (Rappaport *et al*., 1982).

The Disability Rating Scale (DRS) measures functional outcomes in TBI patients, focusing on arousal, awareness, self-care, and employability. The tool assesses cognitive functioning, independence, and employability, making it valuable for monitoring long-term recovery. Wilson *et al*., 2021), demonstrated the DRS's effectiveness in tracking recovery disparities, particularly in rural and resource-constrained areas. In Kenya, (Koome *et al*., 2022)show its utility in addressing limitations posed by inadequate diagnostic tools. Together, the FIM, GOS, GOSE, and DRS offer comprehensive insights into TBI recovery, though their implementation is influenced by factors like healthcare infrastructure and socio-economic conditions, underscoring the need for context-specific adaptations. In South Africa, the DRS has been adapted for studies examining recovery in resource-limited healthcare systems (Naidoo *et al*., 2020). Similarly, in Germany, the DRS has been applied in clinical trials to compare the effectiveness of different rehabilitation interventions (Wright j, 2000).

b) Glasgow Coma Scale (GCS)

The Glasgow Coma Scale (GCS) is one of the most widely recognized tools for assessing the level of consciousness in TBI patients. It evaluates motor, verbal, and eye-opening responses, with scores ranging from 3 (indicating deep coma) to 15 (indicating full consciousness).(Jain & Iverson, 2025) Originating in Scotland, the GCS is commonly used in emergency and acute care settings across the globe. In the United Kingdom, where it was first developed, it remains a standard tool for TBI assessment (Gardner *et al*., 2018)

c) Glasgow Outcome Scale (GOS)

The GOS, introduced by Jennett and Bond in 1975, is one of the earliest tools for assessing functional outcomes in TBI patients. It categorizes recovery into five levels: death, persistent vegetative state, severe disability, moderate disability, and good recovery. The GOS is widely used in clinical and research settings for its ease of administration and capacity to evaluate overall recovery trends (Maas *et al*., 2023). However, its limited granularity has been criticized, as it cannot capture subtle variations in functional and psychosocial recovery.

d) Glasgow Outcome Scale-Extended (GOSE)

The Glasgow Outcome Scale-Extended (GOSE) is an advanced version of the Glasgow Outcome Scale that categorizes functional recovery into eight distinct levels, ranging from death to complete recovery. This tool is widely used in long-term outcome studies. For example, it has been adopted in multicenter research initiatives across Europe to assess the effectiveness of rehabilitation programs (Maas *et al*., 2022a). In Australia, the GOSE is utilized in trauma registries to evaluate the recovery trajectories of TBI patients (Gabbe *et al*., 2024), while in Canada, it has been incorporated into rehabilitation settings to monitor patient progress (Wilson *et al*., 2021).

e) Functional Independence Measure

The Functional Independence Measure is considered the gold standard for assessing basic activities of daily living. . The tool evaluates mobility, self-care, and cognition, providing insights into a patient's functional capabilities, assesses physical and cognitive disability, providing a comprehensive evaluation of motor and cognitive tasks on a seven-point scale, where higher scores indicate greater independence. Smith *et al*. (2020) and Chiu *et al*. (2021).

f) Quality of Life after Brain Injury (QOLIBRI)

The QOLIBRI measures the health-related quality of life (HRQoL) after traumatic brain injury by assessing domains such as emotions, cognition, and daily functioning. Recent empirical studies emphasize its utility in capturing the psychosocial impact of TBI, with strong validation in European and North American populations. (Krenz *et al*., 2023)

In the Netherlands, it is used in studies investigating the psychosocial impact of TBI (Steyerberg *et al*., 2010). Recently, it has been adapted for use in low-resource settings, such as in India (Singh *et al*., 2021).

g) Rancho Los Amigos Levels of Cognitive Functioning Scale

The Rancho Scale is commonly used to assess cognitive and behavioral recovery in TBI patients. Recent studies from China and the United States confirm its utility in tailoring cognitive therapy interventions (Lin & Wroten, 2025)

2.4 Patient-Related Factors

2.4.1. Comorbidities

Pre-existing medical conditions significantly influence TBI outcomes. Patients with comorbidities such as diabetes, hypertension, cardiovascular disease, or epilepsy often have poorer recovery trajectories due to increased physiological stress, greater complication risk, and reduced resilience to injury (Maas *et al*., 2021). For instance, hypertension may contribute to elevated intracranial pressure or hemorrhagic complications, while diabetes can impair wound healing and prolong hospital stays (Mwita *et al*., 2022).

2.4.2. Drug and substance use

Substance use before injury—especially alcohol and illicit drugs—is a known risk factor for TBI and is associated with worse outcomes. Intoxication at the time of injury can mask neurological symptoms, leading to delayed diagnosis and treatment (CDC, 2023). Chronic alcohol or drug use may also reduce the brain's neuroplasticity, impair cognitive recovery, and increase the risk of post-traumatic seizures and complications during rehabilitation (Krupa *et al*., 2020). Moreover, substance use often coexists with mental illness and poor social support, compounding recovery challenges.

2.4.3. Social status

Socioeconomic status (SES), which includes factors like income level, occupation, and housing conditions, has a strong influence on TBI recovery. Patients from lower SES backgrounds often face limited access to timely medical care, fewer resources for rehabilitation, and poor nutrition—all of which can hinder recovery (WHO, 2022). Additionally, low SES is associated with a higher risk of sustaining TBIs in the first place, often due to hazardous working environments or inadequate safety measures.

2.3.4. Availability of Medical Insurance

Health insurance coverage determines access to quality care, including emergency treatment, imaging, surgery, and rehabilitation services. Uninsured or underinsured patients are more likely to experience delayed treatment or inadequate post-discharge care, both of which negatively affect outcomes (Brain Trauma Foundation, 2024). In resource-limited settings, lack of insurance can result in early discharges or minimal rehabilitation support, contributing to increased disability.

2.4.5. Cognitive and mental health

Pre-existing cognitive impairments or mental illnesses, depression, anxiety, schizophrenia complicate TBI management and outcomes. Patients with such conditions may have reduced capacity to engage in rehabilitation, adhere to medical advice, or cope with new disabilities (Dewan *et al*., 2020). Moreover, underlying psychiatric conditions may worsen after TBI, leading to poor emotional regulation, social isolation, and increased caregiver burden.

2.4.6. Education status

Education influences health literacy, the ability to understand and comply with medical instructions, and to navigate complex healthcare systems. Studies show that individuals with higher education levels tend to have better functional outcomes, greater engagement in therapy, and more realistic goal-setting during recovery (Adebe *et al*., 2023). In contrast, low education levels may limit the patient's and caregiver's ability to follow through with home care or rehabilitation regimens

Health outcomes in traumatic brain injury (TBI) are influenced by patient-related factors from the time of injury to arrival in hospital for management. These include pre-injury health status, injury severity, timeliness of care, and adherence to standardized treatment protocols.(Demlie *et al*., 2023) Various factors such as age, preinjury status socioeconomic status, availability of insurance coverage, and presence of comorbidities, influence patients' health outcomes.(Michael *et al*., 2023) Empirical evidence highlights differences in outcomes between high-income and low- and middle-income countries (LMICs). Factors such as access to care, pre-hospital interventions, and resource availability play crucial roles.

2.5 Healthcare-related factors

Health care–related factors play a central role in determining the survival and long-term recovery of patients with traumatic brain injury (TBI). One of the most critical aspects is prehospital care and emergency response. Early interventions at the site of injury, such as airway management, bleeding control, and cervical spine immobilization, can prevent secondary brain injury. Equally important is the speed of transport to a hospital within the "golden hour," as delayed arrival is strongly associated with poor neurological outcomes (Carney *et al*., 2021).

Upon reaching the hospital, admission and triage systems influence outcomes by ensuring that severe cases are prioritized for immediate attention. The presence of trauma protocols, well-organized emergency departments, and availability of critical care beds or intensive care units (ICUs) can make the difference between stabilization and deterioration (Asemota *et al*., 2022). Equally, diagnostic services such as CT scans and MRIs are vital in accurately identifying hematomas, skull fractures, and other intracranial injuries. Delays or lack of access to imaging often result in missed opportunities for timely intervention (Okonkwo *et al*., 2021).

In addition, surgical and critical care interventions are major determinants of outcome. The availability of neurosurgeons, anesthetists, and operating theatres is essential for life-saving procedures such as craniotomies or evacuation of hematomas. Moreover, patients with severe TBI often require intensive monitoring in ICUs with ventilatory support and intracranial pressure (ICP) management. The quality of post-operative care, including infection control and fluid balance, is equally crucial for recovery (Steyerberg *et al*., 2020).

Another important factor is human resources and staffing. Hospitals with favorable nurse-to-patient ratios, staff trained in trauma and neurocritical care, and multidisciplinary teams that include physiotherapists and psychologists tend to report better patient outcomes (Mwangi *et al*., 2023). These outcomes are also influenced by hospital infrastructure and resources, including adequately equipped trauma centers, reliable supply of essential drugs such as mannitol and anticonvulsants, and functional equipment for monitoring and supportive care (WHO, 2022).

Beyond acute care, rehabilitation and follow-up services are vital for TBI survivors. Access to physiotherapy, occupational therapy, and speech therapy enhances functional recovery and reintegration into society. In addition, psychological counseling and structured follow-up clinics help manage long-term complications, including cognitive and behavioral challenges (Kumar *et al*., 2024). Finally, broader health system and policy factors, such as well-coordinated referral networks, health insurance coverage, and standardized hospital protocols, ensure continuity and accessibility of care for all patients (Nweke *et al*., 2025).

While health outcomes vary depending on the severity of the injury, various factors including access to healthcare, quality of care, resources , integrated nursing care of the patent, rehabilitation, and socioeconomic influences play pivotal roles.(Dibera *et al*., 2024) The quality of the healthcare system, including the availability of specialized trauma centers and adherence to evidence-based protocols, significantly influences TBI outcomes. The Trauma Quality Improvement Program (TQIP) aims to enhance care by providing hospitals with risk-adjusted benchmarking, which has been associated with improved patient outcomes (American College of Surgeons, 2023). Nurses play a very critical role in the management of TBI patient. Upon arrival at accident and emergency department, TBI patients are received by trauma and emergency nurses who play a pivotal role of triage, ongoing patient monitoring, early intervention, patient education, and coordination of care with other healthcare professionals. Their responsibilities extend throughout the patient's entire hospitalization, and they collaborate closely with other healthcare professionals to ensure timely interventions and appropriate follow-up. (Zhou *et al*., 2024)

2.5.1 Role of Nurses in TBI Management

a) Accident & Emergency Departments

In the emergency setting, nurses play a critical role in the initial stabilization of TBI patients using the ABCDE approach—airway, breathing, circulation, disability, and exposure—to prevent secondary brain injury (Zhao *et al*., 2023). They conduct rapid triage, initiate continuous neurological assessments, and administer interventions such as oxygen therapy and fluid resuscitation where necessary (Oluoch *et al*., 2024). Recent studies show that structured nursing interventions in emergency departments can reduce adverse outcomes by up to 75% and shorten hospital stays by an average of three days (Chen *et al*., 2023). Emergency nurses are also responsible for Glasgow Coma Scale (GCS) assessments, pupil checks, vital signs monitoring, and early identification of raised intracranial pressure (ICP) through structured neuro-observations (Kinyua *et al*., 2022).

b) Surgical Wards & Operating Theatre

Within surgical wards and operating rooms, nurses assist in preparing patients for neurosurgical interventions, monitoring for signs of elevated ICP, and maintaining head and neck alignment to optimize cerebral perfusion (Ndungu & Mwangi, 2023). They administer prescribed medications such as hyperosmolar agents and monitor fluid balance, which are essential for intracranial pressure control. According to Li *et al*. (2023), postoperative nursing care that includes wound management, neuro-assessments, and early mobilization significantly reduces complications like pressure ulcers and improves recovery. Furthermore, nurses in surgical settings contribute to patient and family education, which improves adherence to care plans and outcomes

c) Critical Care Units

In intensive care units (ICUs), nurses are central to the continuous monitoring and management of patients with severe TBIs. They utilize neuro-observation charts to systematically record and interpret changes in neurological status, including GCS, pupillary responses, and vital signs (Mutua *et al*., 2024). Early recognition of subtle signs of neurological deterioration or increased ICP is vital for timely intervention. Nurses in critical care also manage sedation, implement early mobility protocols, and coordinate with multidisciplinary teams during rounds to enhance care outcomes (Mworia *et al*., 2023). Studies indicate that ICU-based nurse-led protocols for ICP monitoring and neuro-assessment contribute to reduced mortality and improved functional outcomes (Kim *et al*., 2022).

d) Outpatient Clinics & Community Level

At the outpatient and community levels, nurses continue their support through follow-up care, rehabilitation coordination, and reintegration of TBI survivors into daily life. Nurse case managers collaborate with physiotherapists, psychologists, and social workers to tailor individualized recovery plans (Njuguna *et al*., 2023). They also provide education to patients and caregivers on medication adherence, seizure recognition, and cognitive rehabilitation. Community health nurses play a pivotal role in monitoring progress, addressing caregiver burden, and linking families to support networks and mental health services (WHO, 2023). These efforts contribute significantly to reducing readmission rates and enhancing quality of life post-discharge (Gichuhi *et al*., 2024).

In developed countries, the health outcomes of TBI patients are significantly influenced by advanced healthcare systems, which include early diagnosis, immediate interventions, and comprehensive rehabilitation programs.(Maas *et al*., 2022b) (Dewan *et al*., 2019), the availability of high-tech neuroimaging tools such as MRI and CT scans ensures timely and accurate diagnosis of TBIs in high-income settings. Additionally, multidisciplinary care teams that include neurosurgeons, critical care specialists, and rehabilitation therapists enhance recovery rates.

Despite these advantages, some studies highlight disparities in TBI outcomes due to social determinants of health. For instance, a study by (Maas *et al*., 2022) identified that TBI patients from lower-income groups in the United States often experience delayed access to care, resulting in poorer outcomes. This underscores the importance of equitable healthcare delivery even in resource-rich contexts.

Another critical factor is the role of post-acute care. A longitudinal study by Chiu *et al*. (2021) in Canada revealed that intensive rehabilitation services significantly improve functional independence in TBI patients. (Wilson *et al*., 2021).In Sub-Saharan Africa, the management of TBI patients is constrained by limited resources, insufficient healthcare infrastructure, and a shortage of specialized personnel.(Muili *et al*., 2024) Delayed diagnosis and inadequate surgical interventions contribute to the high mortality rates associated with TBIs in the region. Most hospitals lack the necessary equipment, such as functional CT scanners, leading to misdiagnoses or delayed interventions. (Michael *et al*., 2023)

Human resource shortages are another critical challenge. Many countries in Sub-Saharan Africa have a severe shortage of neurosurgeons. (Muili *et al*., 2024) For instance, a report by (Wireko *et al*., 2023), found that there is only one neurosurgeon for every 2.5 million people in the region. Consequently, many TBI patients rely on general practitioners who may lack specialized training in neurotrauma care, further compounding the issue.(Tesfaw *et al*., 2021) Access to comprehensive rehabilitation services is crucial for TBI recovery. early and continuous rehabilitation has been linked to better functional outcomes, emphasizing the importance of integrating rehabilitation into the standard care pathway for TBI patients (CDC, 2023).

In Kenya, the factors influencing TBI outcomes reflect a combination of healthcare system challenges, socio-economic disparities, and cultural influences.. Additionally, there is a shortage of neurosurgeons, with most TBI cases managed by general surgeons who may lack the expertise for complex neurotrauma surgeries.(Koome *et al*., 2022)

Meru Teaching and Referral Hospital (MeTRH) serves as a case study to examine these factors locally. One significant factor is the lack of adequate diagnostic equipment. MeTRH operates with only one CT scanner, which frequently experiences breakdowns, leading to delays in diagnosis and treatment. This is consistent with the findings of (Nguru & Ireri, 2022), who noted that similar infrastructural challenges exist in other Kenyan referral hospitals

2.6 Theoretical Framework and Application in the Study

Betty Neuman's Systems Model.(RN, 2019)

The Systems Model, developed by Betty Neuman in 1972, is a comprehensive framework that views patients as dynamic systems interacting with internal and external environmental stressors. It emphasizes holistic care by addressing physiological, psychological, sociocultural, developmental, and spiritual dimensions of health (Neuman, 1995). This model is particularly suitable for TBI patients, as it considers the multifaceted impact of brain injury and provides a holistic way of meeting patient's needs. Betty Neuman's Systems Model provides an appropriate theoretical framework for assessing and managing traumatic brain injury (TBI) patients. Neuman's model views the patient as a dynamic system with multiple layers of defense, and it emphasizes the holistic nature of care by addressing various stressors that can affect the patient's physiological, psychological, social, and spiritual well-being. For TBI patients, these stressors include the physical effects of the injury, emotional responses such as anxiety and depression, disruptions in social and developmental roles, and spiritual distress. The model guides nurses in identifying these stressors and intervening at different levels—primary, secondary, and tertiary prevention—to support the patient's recovery. In primary prevention, nurses can educate patients and caregivers about risk factors, such as fall prevention. Secondary prevention focuses on early detection and timely interventions using assessment tools like the Glasgow Coma Scale (GCS) and Glasgow Outcome Scale-Extended (GOSE), while tertiary prevention supports long-term rehabilitation, independence, and quality of life, facilitated through tools like the Functional Independence Measure (FIM) and Quality of Life after Brain Injury (QOLIBRI). The model's comprehensive approach allows nurses to assess and address the multifaceted needs of TBI patients, ensuring that care plans are tailored to both physical and emotional recovery. This framework, combined with relevant assessment tools, enables nurses to evaluate outcomes effectively, fostering a patient-centered approach to care. Thus, Neuman's Systems Model helps provide a holistic and integrated approach to TBI care, ensuring that the immediate and long-term needs of a patient are met in a structured approach to care and recovery.

Betty Neuman’s Systems Model in the care of traumatic brain injury (TBI) patients also necessitates an understanding of several external and internal factors that impact patient outcomes. These factors include hospital resources, the availability of healthcare professionals, structures such as Intensive Care Units (ICUs) for critically ill patients, and patient-specific factors such as demographic characteristics and psychosocial factors. These elements are integral to shaping the patient’s recovery trajectory and must be considered in nursing assessments and interventions.

In the context of hospital factors, the availability of specialized care units such as Intensive Care Units (ICUs) plays a crucial role in managing critically ill TBI patients. The ICU provides the necessary resources and monitoring systems for patients who are at high risk for complications, such as increased intracranial pressure (ICP), respiratory failure, or seizures. The hospital environment also dictates the level of care a patient receives, with higher-acuity settings like trauma centers or tertiary care hospitals offering more advanced monitoring and treatment options compared to smaller or resource-limited facilities. The nursing interventions, particularly in critical settings, are tailored to the severity of the injury and are often more intensive during the acute phase. In Neuman's model, the ICU functions as a line of defense against stressors, offering continuous monitoring, medication administration, and emergency interventions that help stabilize the patient and prevent secondary complications. In hospitals with limited resources, however, patients may experience delays in intervention, which can increase the risk of poor outcomes.

Furthermore, the availability of healthcare professionals is a critical factor influencing patient care. Multidisciplinary teams involving neurosurgeons, intensivists, neurologists, physical therapists, occupational therapists, and psychologists are essential for providing comprehensive care to TBI patients. Nurses, as the central point of contact in patient care, work closely with these specialists to address the multifaceted needs of TBI patients. Neuman's model stresses the importance of collaborative care, where professionals from various disciplines share their expertise and coordinate interventions. For instance, a neurologist may assess cognitive function, while a rehabilitation therapist focuses on physical recovery. Nurses coordinate these efforts by monitoring the patient's progress and adjusting the care plan based on feedback from the team, ensuring that the care is holistic and dynamic.

In this context, the ICU acts as a protective line of defense in Neuman's model, helping the patient withstand stressors that could otherwise overwhelm their system. Neuman's model offers a comprehensive framework that allows for a holistic approach to care, ensuring that both the physiological and psychosocial dimensions of recovery are addressed. Nurses, in collaboration with multidisciplinary teams, are essential in coordinating care that adapts to the evolving needs of the TBI patient, taking into account these external and internal factors to optimize recovery.

Betty Neuman's Systems Model is an ideal theoretical framework for guiding this study on assessing TBI patients. Its holistic approach, emphasis on prevention, and focus on the interplay between the patient and their environment align well with the multifaceted nature of TBI recovery. By using this framework, nurses can deliver targeted, patient-centered care that promotes comprehensive recovery and improves long-term outcomes.

2.7 Conceptual Framework

a) Dependent Variable: Health Outcome

Health outcomes in traumatic brain injury (TBI) represent the measurable physical, neurological, cognitive, psychological, and social consequences resulting from the injury, as well as the patient's level of recovery over time. These outcomes include both immediate effects—such as neurological impairments, disability levels, and mortality—and long-term consequences, including functional independence, cognitive recovery, emotional stability, and social reintegration (Maas et al., 2022).

Immediate outcomes often appear within hours or days after injury and are associated with the severity and location of brain damage. Common impairments include altered consciousness, seizures, and motor or sensory deficits (Maas et al., 2022).

Short-term outcomes, occurring within weeks or months, reflect ongoing recovery and adaptation. Many patients regain mobility and coordination, though fatigue, headaches, and chronic pain may persist (Johnson et al., 2020). Cognitive and psychological challenges such as depression, anxiety, and post-traumatic stress disorder are also common (Barman et al., 2021).

Social outcomes, such as disruptions in relationships, employment, and community reintegration, further demonstrate the multidimensional nature of recovery (Hughes et al., 2024).

Health outcomes are typically assessed through tools such as the Functional Independence Measure (FIM) for functional recovery and the Glasgow Coma Scale (GCS) or cognitive outcome scales for neurological evaluation.

b) Independent Variable

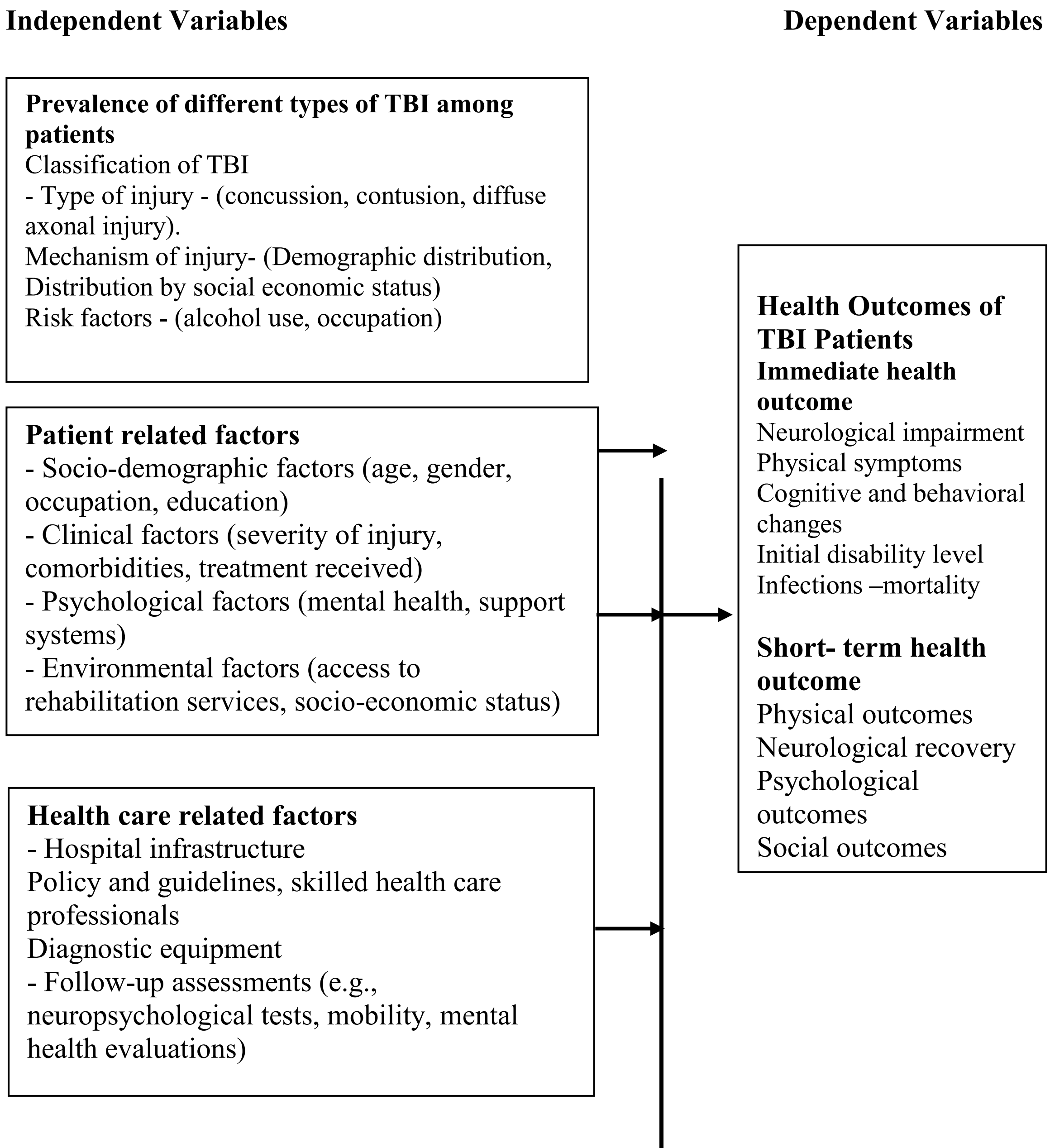
Patient-related factors: Demographic and personal attributes such as age, socioeconomic status, and pre-hospital care influence recovery among TBI patients. Early intervention during emergency response stages significantly improves survival and rehabilitation outcomes.

Healthcare-related factors: Timely diagnosis, access to quality healthcare services, intensive care facilities, and availability of specialized care teams play a critical role in patient recovery. Skilled medical personnel and adequate healthcare infrastructure enhance survival rates, shorten recovery periods, and improve quality of life.

prevalence of TBI: The type and mechanism of injury, such as concussion, contusion, or diffuse axonal injury, affect recovery outcomes. Demographic patterns, socioeconomic background, and risk factors such as alcohol use or occupational exposure also influence the prevalence and severity of TBI.

Figure 2.1

Conceptual Framework



Source: Researcher (2024)

CHAPTER THREE: RESEARCH METHODOLOGY

3.1 Introduction

This chapter presents the research methodology employed in this study. It outlines the systematic approach that was followed to collect, analyze, and interpret data in order to address the research objectives and questions. The methodology was carefully selected to ensure that the study produced valid, reliable, and meaningful findings, particularly within the context of traumatic brain injury (TBI) cases at Meru Teaching and Referral Hospital (MeTRH).

3.2 Study Area

This study was conducted at Meru Teaching and Referral Hospital (MeTRH), a public health institution classified as a Level Five facility. It is situated in Meru County, within Imenti North Constituency, along the Meru-Maua Highway. The Meru Teaching and Referral Hospital is located at coordinates 0.05° north, 37.65° East, offering a range of healthcare services in Meru County, Kenya. The hospital serves as a critical healthcare hub for a catchment population of approximately 250,000 households.

As the primary referral center for the Upper Eastern region of Kenya, MeTRH receives patients from neighboring counties such as Isiolo, Tharaka Nithi, Marsabit, Moyale, and Garissa. It has a bed capacity of 331 beds with an average bed occupancy rate of 150 %. Departments relevant to the management of traumatic brain injuries include the critical care unit, trauma and surgical wards, as well as operational theatres equipped to handle emergency and elective procedures.

The study area was chosen because MeTRH is the only public hospital in the upper Eastern region that has capacity to manage TBIs cases. The facility has two neurosurgeons, active accident emergency department, fully equipped operational theatres, and critical care unit, surgical wards and a designated Trauma ward.

3.3 Research Design

This study adopted a cross-sectional research design and data was collected between March and June 2025. A cross-sectional study is an observational approach in which data are collected from a defined population at a specific point in time. This design is particularly suitable for assessing the prevalence of particular characteristics, conditions, or behaviors, as well as for exploring associations among variables within a population without the need for experimental manipulation. Cross-sectional designs are commonly used in health and social science research due to their efficiency in providing a snapshot of the phenomena under investigation (Bryman, 2012). In this study, the design facilitated the collection of data related to traumatic brain injuries (TBI) among patients at a single point, enabling the analysis of existing patterns and associations relevant to the research objectives.

3.4 Study Population

The target population for this study comprised of TBI patients and health care workers. Specifically, the population included; 54 patients diagnosed with TBI and receiving care at MeTRH during the study period, both inpatients and outpatients; 96 healthcare providers involved in the care of TBI patients in the four departments managing TBI patients. The inclusion criteria ensured that the study captured both experiential and documented perspectives on TBI care. This stratification allowed for a comprehensive assessment of TBI management, outcomes, and institutional documentation practices at MeTRH.

The medical record files were used as a second data source to abstract data on prevalence and various types of traumatic brain injuries and related factors.

The estimated population sizes for each category are summarized in Table 3.1 below:

Table 3. 1

Population

Population Category	Estimated Population Size
TBI Patients	54
Healthcare Providers	92
Total	146

Source: Researcher (2024)

3.5 Inclusion Criteria

Adult patients (18 years and above) diagnosed with traumatic brain injury (TBI) and admitted to Meru Teaching and Referral Hospital (MeTRH) during the study period. Patients capable of providing informed consent, or those represented legally by guardians if unable to consent themselves, and Healthcare professionals directly involved in the treatment and management of TBI patients, including surgeons, nurses, and clinical officers working in relevant departments.

3.6 Exclusion Criteria

Patients with significant cognitive impairment who could not participate in the study and had no legal representative to consent on their behalf and any individual, patient or healthcare provider, who declined to give informed consent for participation.

3.7 Sample Size Determination of Medical Record Files

Given the nature of the study population and the goal of minimizing sampling error, Nassiuma's (2000) formula was applied to determine the required number of medical records for analysis. This method is preferred in retrospective health records research as it adjusts for variability and error margins effectively.

The formula is:

$$n = \frac{NC^2}{C^2 + (N-1)e^2} \quad (1)$$

Where:

n = sample size

N = total population (346 medical records)

C = coefficient of variation (0.21)

e = margin of error (0.04)

$$n = \frac{346 X 0.0441}{0.0441 + (346-1) X 0.0016} = \frac{15.2586}{0.1821} = 83.79$$

Rounding up, a total of 84 medical records were deemed sufficient to represent the population. The application of this formula ensures that the selected sample accurately reflects the characteristics of the entire population while keeping sampling errors within acceptable limits. This methodology has been widely used in health research for determining optimal sample sizes in retrospective medical record studies (Mugenda & Mugenda, 2003).

Sample Size determination for Health Care Providers

Health care providers were drawn from surgical departments, Accident and Emergency, critical care unit, Trauma ward, and high dependency unit that admit patients with Traumatic brain injuries. The departments had 92 health care providers of various cadres. To select a representative sample, Cochran's formula was applied.

The sample size for HCWS (N = 92) was determined using Cochran's formula, a widely accepted method for calculating sample size in finite populations (Cochran, 1977):

$$n_0 = \frac{z^2 p(1-p)}{e^2} \quad (2)$$

Where:

n_0 = initial sample size (before finite population correction)

Z = 1.96 (for 95% confidence level)

p = estimated proportion (assumed 0.5 for maximum variability)

e = margin of error (0.05)

Substituting the values:

$$n_0 = \frac{(1.96)2 \times 0.5 \times (1-0.5)}{0.05^2}$$

$$n_0 = \frac{3.8416 \times 0.25}{0.0025}$$

$$n_0 = \frac{0.9604}{0.0025} = 384.16$$

Since the nurse population is finite (N = 75), the finite population correction (FPC) was applied:

$$n_{adj} = \frac{n_0}{1+(n_{0}-1)/N} \tag{3}$$

$$n_{adj} = \frac{384.16}{1+(384.16-1)/92}$$

$$n_{adj} = \frac{384.16}{1+383.16/92}$$

$$n_{adj} = \frac{384.16}{1+4.1756} = \frac{384.16}{5.1756} = 74.22$$

Sample size detrmination for TBI patients

Sample size determination for TBI patients (Cochran's formula)

$$n_0 = \frac{z^2 p(1-p)}{e^2} \tag{4}$$

Where:

n_0 = initial sample size (before finite population correction)

Z=1.96 (95% confidence)

p=0.5(maximum variability)

e=0.05(5% margin of error, common in health research).

$$n_0=\frac{(1.96)2\times0.5\times(1-0.5)}{0.05^2}$$

$$n_0=\frac{3.8416\times0.25}{0.0025}$$

$$n_0=\frac{0.9604}{0.0025}=384.16$$

$$n_{adj}=\frac{n_0}{1+(n_0-1)/N}$$

$$n_{adj}=\frac{384.16}{1+(384.16-1)/40}$$

$$n_{adj}=\frac{384.16}{1+383.16/40}$$

$$n_{adj}=\frac{384.16}{1+9.5790}=\frac{384.16}{10.5790}=36.33$$ =36 patients

3.8 Sampling Methods

3.8.1. Sampling of medical records

Proportionate stratified random sampling was applied, where 84 TBI-related adult medical records were arranged according to departments that is A&E, Trauma, surgical and critical care units. Simple random sampling was used to select files from each strata. This method helped capture diverse case characteristics and ensured balanced data distribution across different units. The process was repeated until 84 medical files were sampled.

3.8.2. Sampling of healthcare providers

Healthcare providers were arranged into four strata's, by designation (doctors, nurse and clinical officers) and by department. Simple random sampling was used to select Healthcare providers from the Accident & Emergency, trauma, and surgical and critical care unit. 18 ballot papers were written for each department, balloting was done using letters Y for yes, and N for no, participants were asked to randomly pick one from the pool. Those who picked Y were included in the study and given the questionnaire to fill while those who picked N were not included. The process was repeated until 74 participants were selected from 92 health workers. To avoid repetition those who had participated were not allowed picking again.

3.8.3. Sampling of TBI patients using purposive sampling method

Purposive sampling was chosen because the study specifically targeted patients diagnosed with traumatic brain injury (TBI) at MeTRH, who are the population of interest. Unlike probability sampling, purposive sampling allows the researcher to deliberately select participants who possess the required characteristics—in this case, individuals with confirmed TBI diagnosis and admission or discharge records. This method ensures that the sample is information-rich and directly relevant to the study objectives, which focus on determinants of health outcomes among TBI patients.

Furthermore, TBI cases are relatively uncommon compared to the general hospital population, making random sampling inefficient and potentially unrepresentative. Purposive sampling enables inclusion of only those patients who meet defined eligibility criteria (e.g., age, diagnosis, completeness of medical records), thereby maximizing the validity and relevance of the data. It is also practical in a clinical setting where accessibility to patients is limited by ethical considerations, availability, and medical conditions.

Therefore, purposive sampling is justified as the most appropriate and feasible method to obtain a representative and context-specific sample of TBI patients at MeTRH for meaningful analysis.

Table 3. 2

Sample Size

Population	Sampling Method	Sample Size
Medical record files	Proportionate stratified random sampling	84 files
Health care workers	Stratified random sampling	74HCWS
TBI patients	purposive sampling method	36 patients

Source; Researcher (2025)

Table 3.3 showing sample size distribution per cadres per departments

Table 3. 3

Sample Size Distribution Per Departments

Department	Cadre	Population (N)	Proportion in Dept	Sample Allocation (n)
Surgical (30 → 24)	Nurses	21	0.70	17
	MOs	6	0.20	5
	RCOs	3	0.10	2
ICU (26 → 21)	Nurses	21	0.81	17
	MOs	5	0.19	4
A&E (27 → 22)	Nurses	15	0.56	12
	MOs	8	0.30	7
	Cos	4	0.15	3
Trauma (9 → 7)	Nurses	8	0.89	6
	RCO	1	0.11	1
Total		92	1.00	74

Source; Researcher (2025)

3.9 Research tools

This section outlines the instruments used for data collection and the procedures followed to gather data from healthcare workers, TBI patients, and patient records. Each tool was selected based on relevance to the study objectives and ensured their validity, reliability, and adherence to ethical and scientific standards.

3.9.1 Checklist for medical record review

A structured data abstraction checklist was used to extract data from patient medical records. The researcher developed checklist according to study objectives. It covered the following domains: Patient demographics, Clinical presentation and diagnosis, Type and severity of TBI, Treatment interventions and Discharge outcomes

This instrument ensured uniform data collection across all 84 reviewed records and minimized data entry errors. The checklist was developed following international guidelines for clinical data abstraction (World Health Organization, 2020) and was pretested on 10 randomly selected files. Its use enhanced consistency, reduced information bias, and supported the reliability of retrospective data

3.9.2 The disability rating scale (DRS)

The Disability Rating Scale (DRS) was used to measure functional health outcomes among TBI patients. The DRS assesses key recovery domains, including consciousness, self-care ability, dependence, and employability (Hall *et al*., 2021). It is a validated and widely used tool with strong psychometric properties, including high inter-rater reliability and construct validity (Lingsma *et al*., 2021).

DRS is used in both acute and post-acute TBI research. (Alali *et al*., 2020).The Disability Rating Scale (DRS) has undergone extensive psychometric evaluation to establish its validity as a tool for measuring health outcomes in patients with traumatic brain injury (TBI). Studies comparing the DRS with the Level of Cognitive Functioning

Scale (LCFS) have demonstrated that both instruments show strong test–retest reliability (stability of scores over time) and inter-rater reliability (consistency across different assessors) (Rappaport *et al*., 1982). In terms of concurrent validity, the DRS scores were found to correlate significantly with the Stover-Zeiger (S-Z) rating system collected at admission, as well as with the S-Z, Glasgow Outcome Scale (GOS), and Expanded Glasgow Outcome Scale (EGOS) obtained at discharge (Hall *et al*., 1993). Furthermore, the predictive validity of the DRS was confirmed, since admission scores effectively predicted discharge outcomes across these established scales (Rappaport *et al*., 1982; Hall *et al*., 1993). Although both DRS and LCFS performed well, the DRS consistently outperformed the LCFS in nearly every domain of validity, making it a more robust and comprehensive measure of functional recovery in TBI patients. Its superior reliability and predictive validity also make it particularly suitable for use in follow-up assessments, such as the six-week evaluation period applied in this study (Hall *et al*., 1993). No licensing was required Structure of the Disability Rating -The DRS evaluates a patient's functioning across several domains:

Arousal/Responsiveness – Measures level of consciousness.

Cognitive Ability – Assesses ability to understand, communicate, and problem-solve.

Dependence on Others – Evaluates how much assistance the patient needs for daily activities.

Employability – Determines whether the patient can return to work or meaningful roles.

Uses of DRS tool

Baseline Assessment, when patients are admitted or discharged, clinicians use the DRS to score their condition.

Follow-Up Assessments, Scores are recorded at intervals at discharge, 3 months, 6 months. This shows improvement, stagnation, or deterioration.

Quantitative Data, The scores provide numerical values, making it easier to compare patients, analyze trends, and perform statistical analysis.

Outcome Categorization, Patients can be grouped into categories such as no disability, partial disability, moderate, severe, or extreme.

3.9.3 Guided questionnaire for TBI patients

A guided questionnaire was administered to TBI patients to collect information on patient-related factors affecting health outcomes. This tool was designed to accommodate patients with potential cognitive or physical limitations and was structured into four sections:

Section A: Demographic information

Section B: Injury-related data (e.g., cause, date, mechanism, severity)

Section C: Current physical, cognitive, and emotional symptoms

Section D: Rehabilitation history and progress

The tool incorporated standardized screening items adapted from neurological assessment tools previously used in TBI outcome research (Lingsma *et al*., 2021). Interviews were conducted in a private setting by the principal investigator or trained assistant, with adjustments made for language and cognitive limitations. The questionnaire was piloted among five patients not included in the final sample and demonstrated acceptable inter-rater reliability (Cohen's $\kappa = 0.78$).

3.9.4 Self-administered questionnaire for healthcare workers

A structured self-administered questionnaire was used to collect data from healthcare workers. It was designed to capture insights on knowledge, practices, and institutional factors influencing TBI outcomes. The instrument was adapted from previously validated tools used in similar studies (Alali *et al*., 2020; Hall *et al*., 2021) and modified to suit the local context at MeTRH according to literature review. The tool was original, not under copyright, and freely modifiable for academic purposes. The questionnaire consisted of closed- and open-ended questions. It also included5-point Likert scale items to assess attitudes and perceptions. The questionnaire was divided into four sections,

Section A: Socio-demographic and professional characteristics

Section B: Knowledge of traumatic brain injury (TBI)

Section C: Hospital-related factors influencing TBI outcomes, such as infrastructure, policies, and resource availability

Section D: Clinical practices in TBI management

3.10 Data Collection Procedures

3.10.1. Medical records review

The medical record files were used to obtain data on prevalence and types of TBI at MeTRH. Data obtained consisted of cause of the injury, clinical characteristics, diagnosis made through radiological investigations, interventions, demographics, injury mechanisms, and comorbidities, time taken to arrive to the hospital, treatment protocols, and patient outcomes

Data collection from medical records followed a retrospective approach. Eligible records were identified through hospital registers. The researcher sought permission from the hospital management through a written request seeking authority to access the files. An introduction letter was written to the in charge records department, (HRIO) by the hospital chief Executive officer asking him to allow the researcher to access the medical record files. The departments were divided into strata's and since files are securely filled as per departments, the 84 medical files were divided into four strata's each with 24 files that were randomly selected from each department. A checklist was used to extract data systematically from the patient medical record files that had complete documentation. To maintain confidentiality, no file was carried from the department and codes were used on the checklist instead of patient's names.

3.10.2 Disability rating scale administration

The DRS was used assess the 36 patients across eight scheduled time points. Trained research assistant with nursing backgrounds conducted scoring. The process of assessing health outcomes followed a systematic process aimed at objectively evaluating functional outcomes among patients with traumatic brain injury. Prior to assessment, the researcher ensured familiarity with the tool, prepared the scoring sheet, and obtained relevant clinical information regarding the patient's status.

The DRS comprises of eight items organized into four domains; arousal and awareness, cognitive ability for self-care, dependence on others, and psychosocial adaptability. In the first domain, the patient was assessed for eye opening, communication ability, and motor response, which reflect levels of consciousness and responsiveness. The second domain examined the patient's capacity for basic self-care, including feeding, toileting, and grooming. The third domain focused on the degree of dependence on others for daily activities, while the fourth assessed the patient's potential for employability and social reintegration. Each item was rated on a numerical scale, with higher scores indicating greater disability. The cumulative score ranges from 0 to 29 and is interpreted within predefined categories: 0 (no disability), 1–3 (mild), 4–6 (moderate), 7–11 (moderately severe), 12–16 (severe), 17–21 (extremely severe), 22–24 (vegetative state), and 25–29 (death). The patients were assessed immediately they presented at accident and emergency and on the following day, then weekly up to a period of 6 weeks.

3.10.3. Patient guided questionnaire

TBI patients who met the inclusion criteria were interviewed using the structured guide. The researcher conducted interviews and the assistant on the patients who were diagnosed with traumatic brain injuries and had attained cognitive status and the patient could express himself clearly and fluently.

First the questionnaire was developed that was clear, simple and precise and in a logical order. The tool was then tested with a small sample of patients to check for clarity, flow time taken and where amendments may be required. The patient's records were screened to find those meeting inclusion criteria and those able to respond.

Those who met the criteria were explained the purpose of the study, what participation involves, and how long the study takes. Consent was obtained both written and verbal depending on the patient's condition. For patients who had impaired cognitive, consent was sought from caregivers.

Self-administered questionnaires were distributed to healthcare workers in their departments. Participants were briefed about the study's purpose and confidentiality protocols and issued with a participant's informed consent, which had full explanation of the purpose of the study, risks and benefits, after reading through those who were willing to participate signed the copy and questionnaires were issued to them. Completed questionnaires were collected within one week.

3.11 Pretesting of Data Collection Tools

The Pretesting of Data Collection Tools was carried out at Chuka Level 5 Hospital to assess their validity and reliability and evaluate the clarity, consistency, and practicality of the questionnaire items. Prior to the commencement of actual data collection at Meru teaching and Referral Hospital (MeTRH). Chuka Level 5 Hospital was chosen due to its comparable healthcare infrastructure and patient case mix, which made it a suitable proxy for the main study site. The Pretesting involved administration questionnaires to nine healthcare workers, which is the 10% of the total population.

The researcher wrote a letter to the hospital executive officer at chukka level 5 hospital seeking permission to be allowed to pretest research tools. The letter entailed self-introduction, research topic, justification. Population and the study participants to be used to pretest the tools

The data abstraction checklist was pretested using eight randomly selected medical records files of TBI patients accessed from the health records department to evaluate the checklist's adequacy in capturing relevant clinical information.

The interview-guided questionnaire intended for TBI patients was pre-tested also using 4 questionnaires because 40 patients had been diagnosed with TBI in the previous month, thus the researcher assumed that 40 or more patients could also be seen in the same month who met the study criteria but were not included in the main study. The aim was to determine; the appropriateness of question phrasing for patients with possible cognitive or physical limitations, the flow of interview questions and response options, time taken for each interview and ease of administration by the research assistant,

The pretesting process allowed for the refinement of research instruments in line with practical feedback, enhancing their face validity, applicability, and usability within the study context. All tools demonstrated acceptable levels of reliability and content validity and were considered fit for use in the main study at MeTRH

3.11.1 Reliability testing

The internal consistency of the questionnaire was evaluated using Cronbach's alpha, yielding an overall reliability coefficient of $\alpha = 0.81$, which exceeds the acceptable threshold of 0.70 for health research (Tavakol & Dennick, 2011). This indicates a high degree of inter-item reliability and consistency across the tool.

3.11.2 Validity assessment

Construct Validity: Exploratory factor analysis (EFA) was conducted to determine whether questionnaire items grouped logically under their intended constructs. The analysis supported the structural coherence of the four main sections (demographics, knowledge, hospital factors, and practices), consistent with recommendations by Bolarinwa (2015).

3.12 Data Management

Following data collection, management procedures such as data cleaning, coding, and secure storage were applied. These steps facilitated orderly organization of information.

3.12.1 Data collection

Information was systematically gathered using quantitative approaches, enabling a comprehensive understanding of health outcomes among patients with traumatic brain injury (TBI). The data collection process integrated medical record reviews,patient interviews and structured questionnaires.

A multimodal strategy was adopted to gather a wide spectrum of data relevant to health outcomes and care practices. The Brain Injury Screening Questionnaire (BISQ) informed the development of several research tools used in this process. The collection period spanned six weeks and involved three primary components: patient interviews, review of medical records, and administration of questionnaires to healthcare providers. Each approach was designed to follow a standardised protocol to ensure consistency and

3.12.2 Medical record reviews

Authorized personnel accessed hospital records after obtaining ethical clearance from the institutional review board. A structured data abstraction form, developed in reference to the BISQ, was employed to ensure uniformity in data extraction. Key variables collected included age, sex, diagnosis, injury type, time of arrival, treatment interventions, length of hospital stay, and discharge status. Regular validation checks were carried out during the review process to verify the completeness and correctness of the extracted data, in line with recommendations from the WHO Medical Records Manual.

3.12.3 Data collection using DRS

Patient interviews were conducted using the Disability Rating Scale (DRS), a tool specifically designed to evaluate multiple dimensions of recovery in individuals with brain injury. The DRS assessed parameters such as consciousness (eye, verbal, and motor responses), self-care capacity, psychosocial adaptability, and overall independence and employability (Hall *et al*., 2021). Data collection began from the point of patient admission and continued throughout the six-week study period.

To gather contextual information on patient factors influencing outcomes, trained research assistants conducted structured interviews using a script adapted from the BISQ. These interviews captured data spanning pre-injury status, mode and time of transport to the facility, and early intervention experiences. Interviews were scheduled at times convenient to the patient and conducted in a private setting to ensure comfort and confidentiality. Data collection using Patient guided questionnaire

A. To identify patient-related factors influencing recovery and outcomes among TBI patients receiving care at Meru Teaching and Referral Hospital (MeTRH).

B. To assess clinical and functional outcomes of TBI patients

C. To explore pre-hospital factors that may influence patient prognosis.

Data collection using structured Questionnaires for Healthcare Providers

This was used to assess provider-level factors affecting patient care, including clinical decision-making, emergency response, and perceived barriers to effective TBI management. A pre-tested and validated questionnaire was administered to healthcare workers, including medical officers and surgeons, nurses, and clinical officers.

Distribution occurred within departmental settings and anonymity was maintained to promote honest and unbiased responses. Completed questionnaires were securely stored to uphold participant confidentiality and data protection standards.

3.12.4 Data management and quality assurance

Effective data management formed a core pillar of this study, ensuring that all information gathered was systematically organized, securely stored, and maintained in accordance with research integrity protocols. This process began immediately after data collection, with a structured workflow designed to verify, protect, and prepare the data for analysis. Data from all sources, record reviews, interviews and questionnaires, were entered into a centralized, encrypted database with restricted access.

The data underwent a two-step refinement process: cleaning and coding. Cleaning involved the identification and rectification of discrepancies such as missing entries, implausible responses, and inconsistencies. Categorical responses were then transformed into numerical codes, which allowed for their entry into the Statistical Package for the Social Sciences (SPSS), version 27. This coding process followed a pre-defined schema to maintain consistency throughout the dataset

The data management process involved several quality assurance mechanisms:

Double Data Entry: To detect and correct discrepancies, data were independently entered by two individuals and compared for consistency.

Data Cleaning: Errors, outliers, and missing values were identified and addressed before analysis.

Periodic Audits: the researcher to ensure adherence to documentation protocols reviewed random samples of data entries.

Documentation Standards: The study followed structured documentation practices, as emphasized in existing health research literature, to enhance data traceability, accuracy, and usability.

All digital records were stored in encrypted, password-protected databases, in compliance with data protection standards. These procedures collectively ensured that only validated and structured data progressed to the analysis stage, thereby reducing the likelihood of analytical bias and enhancing the integrity of the study results. These practices aligned with the best-practice principles outlined by Taherdoost (2021).

3.13 Data Analysis

This involved applying appropriate statistical techniques to derive meaningful interpretations from the cleaned dataset. The SPSS software (version 27) was utilized to perform both descriptive and inferential statistics, in line with the study objectives and hypotheses. Descriptive statistical methods were used to summarize and describe the characteristics of the study population and the variables under investigation. Frequencies, means, and standard deviations were computed for variables such as the types of traumatic brain injuries (TBIs), demographic characteristics such as, age, sex, and health outcome indicators (such as scores on the Glasgow Outcome Scale and Functional Independence Measure).

Inferential statistics was applied to test relationships and association derived from data variables. The chi-square test was employed to determine associations between categorical variables, such as the relationship between patient related factors, hospital related factors and health outcome. For continuous variables—particularly outcome scores derived from instruments like the Glasgow Outcome Scale and the Disability Rating Scale—group comparisons based on injury severity (mild, moderate, severe) were conducted using t-tests and analysis of variance (ANOVA). These procedures were used to assess whether observed differences across groups were statistically significant. Logistic regression models were constructed to evaluate the influence of multiple independent variables, such as demographic data and clinical interventions, on binary outcomes, including survival, recovery level, or complication occurrence. This approach allowed for control of confounding variables and strengthened the predictive analysis.

3.14. Ethical Considerations

This study was conducted in full compliance with ethical standards as outlined by the Meru University of Science and Technology Institutional Research Ethics Review Committee (MIRERC) and the National Commission for Science, Technology and Innovation (NACOSTI). The ethical framework guiding this research emphasized participant rights, responsible data use, and institutional accountability.

3.14.1. Informed consent

Prior to participation, informed consent was obtained from all participants or their legal guardians, particularly in cases involving cognitive impairment resulting from TBI. Participants received clear, comprehensible explanations of the study's objectives, potential risks, and benefits in their preferred language. Participants were assured of the voluntary nature of participation and the right to withdraw at any stage without consequence.

Consent was obtained through signed forms and reinforced verbally to ensure clarity. Special care was taken to protect vulnerable participants and avoid coercion, following the principles set out by CIOMS (2016).

3.14.2 Confidentiality and data security

To safeguard participant privacy, all collected data were de-identified at the point of entry and assigned unique identifiers. Hard copies of data collection instruments were stored in locked cabinets, while electronic data were stored in encrypted, password-protected databases. Access was limited to researchers with ethical approval.

The study adhered strictly to the Kenyan Data Protection Act (2019), ensuring that no personally identifiable information appeared in any publication or dissemination of findings. Data retention was limited to five years post-completion, after which physical documents were shredded and digital files permanently deleted using secure data destruction methods.

3.14.3 Risk-benefit assessment

A careful assessment of risks and anticipated benefits was undertaken before data collection commenced. The most notable risk was the potential for emotional distress when discussing past traumatic experiences. In response, the study made arrangements for psychological support services to be available during and after participation.

The primary benefit of participation lay in contributing to the enhancement of clinical care for TBI patients. Findings from the study were expected to inform hospital policies, support health system reforms, and shape future research directions at both institutional and national levels.

3.14.4 Participant selection and fairness

Participants were selected using scientifically appropriate sampling techniques to ensure fairness and representation across gender, age, and socio-economic groups. The study explicitly avoided any form of discrimination or undue burden on particular populations. Additional safeguards were implemented when working with vulnerable groups, ensuring adherence to ethical justice principles.

3.14.5 Ethical approval and oversight

Ethical clearance was granted by Meru University Institutional Research Ethics Review Committee.(MIRERC) prior to the commencement of any fieldwork. Formal authorization to access medical records and engage with hospital patients and staff was granted from Meru Teaching and Referral Hospital management. Compliance with these requirements was closely monitored throughout the study. NACOSTI permit was also granted from National commission for technology and Innovation and later authority granted from Meru county Research office.

3.14.6 Post-study responsibilities

Upon the conclusion of the research, summary results will be disseminated to relevant stakeholders, including MeTRH administrators and healthcare practitioners. Participants who express interest will also receive summaries of the findings. Dissemination will occur through formal reports and academic forums, with all communications adhering to the principles of transparency, accuracy, and ethical authorship as outlined by MIRERC (2022).

CHAPTER FOUR: RESEARCH RESULTS

4.1 Introduction

This chapter presents the study's results, organized according to the research objectives, based on the collected data. It highlights key findings and offers a descriptive analysis related to the determinants of health outcomes in TBI) patients. The discussion of these results are covered in Chapter Five, while conclusions and recommendations are provided in Chapter Six.

4.2 Response Rate

A total population of 137 participants were targeted for this study, distributed across three key categories: healthcare workers (HCWs), patients with traumatic brain injury (TBI). . Out of 74 healthcare workers sampled, 63 responded, yielding a response rate of 85.1% (n = 63). . Similarly, all 36 TBI patients who were sampled were successfully assessed using interview-guided questionnaires, also achieving a 100% response rate (n = 36). These high response rates, especially for patient-related data sources, enhanced the completeness and reliability of the study findings

For TBI patient medical records, all 84 sampled files were successfully reviewed, resulting in a 100% response rate (n = 84)

Table 4. 1

Response Rates by Category of Participants

Participant Category	Sampled (n)	Responded (n)	Response Rate (%)
Healthcare Workers	74	63	85.1
TBI Patients (Interviews)	36	36	100.0
Total	**11 0**	**99**	**90**

Note. Response rates were calculated based on the number of participants or data sources successfully included in the final analysis.

Source, Researcher ;(2025)

4.3 Prevalence of Various Types of TBI at MeTRH (data source medical record files)

This section presents the results of 84 patients diagnosed with TBIs at MeTRH. Data was abstracted from medical record files, analyzed and presented using descriptive statistics supported by tables, interpretations, and scholarly discussions. The findings offer insights into the demographic and clinical profile of TBI cases, their causes, types, severity, diagnostic imaging and ICU trends, surgical interventions, and discharge outcomes.

4.3.1 Demographic information

A total of 84 patient records were reviewed to assess the demographic characteristics relevant to this study. The majority of the patients were male, comprising 82.1% (n=69) of the sample, while females accounted for 17.9% (n=15).

In terms of age distribution, the largest proportion of cases fell within the 0–30 years' category, making up 39.3% (n=33) of the respondents. The age group of 31–45 years followed closely, representing 35.7% (n=30). Patients aged 46–60 years made up 14.3% (n=12), while those over 60 years accounted for 10.7% (n=9) of the total population. These findings provide a baseline understanding of the age and sex profiles of patients who sustained traumatic brain injuries during the study period at Meru Teaching and Referral Hospital.

Table 4. 2

Distribution of Patients by Age and Sex

Demographic Variable	Category	Frequency (n)	Percentage (%)
Age (years)	18–36	33	39.3
	37–46	30	35.7
	47–56	12	14.3
	>58	9	10.7
Sex	Male	69	82.1
	Female	15	17.9

Source, Researcher ;(2025)

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Table 4. 3

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	46–57	12	14.3
	>58	9	10.7
Sex	Male	69	82.1
	Female	15	17.9

Source, Researcher ;(2025)

4.3.2 History of Prior Head Injuries

An analysis of patient clinical histories revealed that a majority, 88.1% (n=74), had no documented prior head injuries. A smaller proportion, 9.5% (n=8), reported having sustained one prior head injury, while 2.4% (n=2) had experienced two or more.

Table 4. 4

Number of Prior Documented Head Injuries

Prior Head Injuries	Frequency (n)	Percentage (%)
None	74	88.1
One	8	9.5
Two or more	2	2.4
Total	**84**	**100**

Source, Researcher (2025)

4.3.3 Causes of TBI

Table 4.5 presents the distribution of causes of traumatic brain injury among the 84 patients included in the study. Road traffic accidents emerged as the leading cause of TBI, accounting for 70.2% (n = 59) of the cases. Assault was the second most common cause, contributing 22.6% (n = 19). Falls were responsible for 7.1% (n = 6) of the injuries, while occupational injuries accounted for 2.4% (n = 2). Notably, there were no reported cases of TBI resulting from sports injuries in this sample. These findings indicate that most TBIs in the study population were due to external blunt force trauma, particularly from traffic-related incidents.

Table 4. 5

Distribution by Cause of Injury

Cause of TBI	**Frequency (n)**	**Percentage (%)**
Road Traffic Accident	59	70.2
Assault	19	22.6
Fall	6	7.1
Occupational Injury	2	2.4
Sports Injury	0	0.0
Total	**84**	**100**

Source, Researcher ;(2025)

4.3.4 Clinical Features at Presentation

Table 4.6 summarizes the clinical symptoms observed among patients diagnosed with traumatic brain injury (TBI) at the time of presentation. Loss of consciousness was the most prevalent symptom, reported in 90.5% (n = 76) of cases, highlighting its significance as a primary clinical indicator of TBI. Headache was the next most common complaint, affecting 20.2% (n = 17) of the patients. Seizures were present in 13.1% (n = 11), while vomiting and bleeding from the nose or ears were each reported in 11.9% (n = 10) of the cases. Dizziness or confusion occurred in 6.0% (n = 5), and amnesia was the least frequent symptom, affecting 4.8% (n = 4). These findings align with literature indicating that altered consciousness and neurological disturbances are common in TBI presentations and reflect the varying degrees of injury severity.

Table 4. 6

Clinical Symptoms Associated with TBI

Clinical Symptom	**Frequency (n)**	**Percentage (%)**
Loss of Consciousness	76	90.5
Headache	17	20.2
Seizures	11	13.1
Vomiting	10	11.9
Bleeding (nose/ears)	10	11.9
Dizziness/Confusion	5	6.0
Amnesia	4	4.8

Source, Researcher ;(2025)

4.3.5 Types of TBI diagnosed

Table 4.7 presents the types of traumatic brain injury (TBI) diagnosed through imaging among the 84 patients included in the study. Subdural hematoma was the most common diagnosis, reported in 22 patients (26.2%), followed closely by epidural hematoma at 21.4% (n = 20). Skull fractures were observed in 20.2% (n = 17), while intracerebral hemorrhages accounted for 15.5% (n = 13). Subarachnoid hemorrhage was found in 10.7% (n = 9) of the cases, and diffuse axonal injury was noted in 9.5% (n = 8).

Concussions, often classified as mild TBIs, were recorded in 8.3% (n = 7) of the patients, and cerebral contusions were the least frequent, occurring in 6.0% (n = 5).

Table 4. 7

Imaging-Based Diagnosis of TBI

Type of TBI	Frequency (n)	Percentage (%)
Concussion	7	8.3
Contusion	5	6.0
Skull Fracture	17	20.2
Epidural Hematoma	20	21.4
Subdural Hematoma	22	16.7
Subarachnoid Hemorrhage	9	10.7
Intracerebral Hemorrhage	13	15.5
Diffuse Axonal Injury	8	9.5
Total	**84**	**100**

Source, Researcher ;(2025)

4.3.6 Severity of TBI by GCS score

Table 4.8 outlines the severity of traumatic brain injury (TBI) among the study participants based on the Glasgow Coma Scale (GCS) at presentation. Mild TBI, defined by a GCS score of 13 to 15, accounted for the largest proportion at 44% (n = 37). Moderate TBI, with scores ranging from 9 to 12, was observed in 32% (n = 27) of patients. Severe TBI, indicated by a GCS score of 8 or below, was diagnosed in 24% (n = 20) of the cases.

Table 4. 8:

Severity of TBI

Severity (GCS Range)	Frequency (n)	Percentage (%)
Mild (13–15)	37	44
Moderate (9–12)	27	32
Severe (≤8)	20	24
Total	84	100

Source, Researcher ;(2025)

4.3.7 Imaging and ICU admission

Almost every patient in the series underwent a head CT scan (97.6 %, n = 82), whereas only one individual (1.2 %) received an MRI; imaging was not obtained for one patient (1.2 %). The near-universal use of CT mirrors current emergency-department practice, where its speed and bedside availability make it the preferred first-line study for detecting surgically actionable lesions in the hyper-acute phase of TBI. MRI—more sensitive for diffuse axonal injury and other subtle pathology—was reserved for a single, selected case, reflecting its typical role once patients are clinically stable or when CT findings are equivocal

Just over half of the cohort required admission to the intensive-care unit (52.4 %, n = 44). This proportion is comparable to recent observations that a substantial share of moderate-to-severe TBI patients need ICU-level monitoring to control secondary brain injury and systemic complications. Together, these patterns underscore both the logistical importance of rapid CT capability and the critical-care burden associated with traumatic brain injury in this setting.

Table 4. 9

Neuroimaging and ICU Admission

Variable	Category	Frequency (n)	Percentage (%)
Neuroimaging	CT Scan	82	97.6
	MRI	1	1.2
	Not done	1	1.2
ICU Admission	Yes	44	52.4
	No	40	47.6

Source, Researcher ;(2025)

4.3.8 Surgical interventions and complications

Out of the 84 traumatic brain injury (TBI) patients, 37 (44.0%) underwent surgical intervention, while 47 (56.0%) were managed conservatively without surgery, as shown in Table 4.9. Among the surgical cases, craniotomy was the most frequently performed procedure, accounting for 26.2% (n = 22) of all patients, followed by burrhole drainage at 17.9% (n = 15). Skull elevation was carried out in 6.0% (n = 5), and surgical toileting was performed in a single case (1.2%), as detailed in Table 4.9.

In-hospital complications were documented in 32.1% (n = 27) of the patients, while the remaining 67.9% (n = 57) had no recorded complications. The observed complication rate reflects the clinical burden associated with both surgical and conservative management of TBI. Similar rates have been reported in surgical literature, where post-intervention complications contribute significantly to morbidity and prolong hospital stay. The findings also underscore the importance of individualized treatment decisions based on the severity and type of injury, as well as the patient's overall condition.

Table 4. 10

Surgery Status, Types of Surgery Performed, and In-Hospital Complications

Variable	Category	Frequency (n)	Percentage (%)
Surgery Performed	Yes	37	44.0
	No	47	56.0
Type of Surgery Performed	Burrhole	15	18.0
(n = 37)	Craniotomy	22	26.0
	Skull Elevation	5	6.0
	Surgical Toileting	1	1.2
In-Hospital Complications	Yes	27	32.1
	No	57	67.9

Source, Researcher ;(2025)

4.3.9 Discharge outcomes

Table 4.11 summarizes the clinical outcomes of traumatic brain injury (TBI) patients at the time of discharge. Nearly half of the patients (47.6%, n = 40) achieved full recovery, regaining baseline neurological function. A substantial proportion (39.3%, n = 33) were discharged with partial recovery accompanied by varying degrees of physical or cognitive disability. Three patients (3.6%) remained in a persistent vegetative state, indicating profound and prolonged impairment of consciousness. Unfortunately, eight patients (9.5%) succumbed to their injuries before discharge.

Table 4. 11

Patient Outcomes at Discharge

Outcome	Frequency (n)	Percentage (%)
Full Recovery	40	47.6
Partial Recovery with Disability	33	39.3
Persistent Vegetative State	3	3.6
Deceased	8	9.5

Source; Researcher ;(2025)

4.3.10 Additional clinical and outcome characteristics

This section presents further insights into patient care trajectories and severity indicators by analyzing the length of hospital stay, discharge destinations, referral sources, and initial GCS scores on arrival. These indicators provide a broader context for understanding TBI severity, systemic healthcare responses, and patient outcomes at Meru Teaching and Referral Hospital (MeTRH).

a) Length of hospital stay

Table 4.12 presents the distribution of hospital length of stay (LOS) among the 84 patients with traumatic brain injury (TBI). Most patients (45.2%, n = 38) were hospitalized for 4 to 7 days, suggesting this as the typical recovery window for moderate cases. A smaller proportion (27.4%, n = 23) remained admitted for 8 to 14 days, while 14.3% (n = 12) had shorter admissions of 3 days or less. Notably, 13.1% (n = 11) of patients had extended hospital stays lasting more than 14 days, likely reflecting complications, surgical recovery, or the severity of injury.

Table 4. 12

Length of Hospital Stay

Length of Stay (Days)	Frequency (n)	Percentage (%)
≤3 days	12	14.3
4–7 days	38	45.2
8–14 days	23	27.4
>14 days	11	13.1

Source, Researcher ;(2025)

b) Discharge destination

Table 4.13 outlines the discharge destinations of patients following hospitalization for traumatic brain injury (TBI). Nearly half of the patients (47.6%, n = 40) were discharged home without the need for additional care, indicating favorable recovery outcomes. An additional 26.2% (n = 22) required home care support, reflecting mild to moderate residual impairments requiring assistance with daily activities.

A smaller proportion of patients (9.5%, n = 8) were transferred to rehabilitation facilities, highlighting the need for extended therapeutic intervention post-hospitalization. Similarly, 9.5% (n = 8) were discharged to the mortuary, representing mortality within the cohort. Only 7.1% (n = 6) were referred to higher-level centers for specialized care, often indicative of complex cases requiring advanced neurocritical or surgical intervention.

Table 4. 13

Discharge Destination

Discharge Destination	Frequency (n)	Percentage (%)
Home (Unaided)	40	47.6
Home (With Home Care Support)	22	26.2
Rehabilitation Facility	8	9.5
Mortuary (Deceased)	8	9.5
Referred to Higher Center	6	7.1

Source; Researcher ;(2025)

c) Referral source

Table 4.14 presents the distribution of referral sources for patients admitted with traumatic brain injury (TBI). The majority of patients (44.0%, n = 37) were referred from peripheral health centers, indicating a strong reliance on lower-level health facilities for initial assessment and stabilization before transfer to higher-level care. Sub-county hospitals contributed 27.4% (n = 23) of the referrals, further emphasizing the role of mid-tier public health institutions in managing TBI cases.

Self-referrals or walk-in cases accounted for 16.7% (n = 14), reflecting instances where patients or caregivers bypassed lower-tier facilities, possibly due to perceived urgency or proximity to the treatment center. Private health facilities referred 11.9% (n = 10) of the patients, illustrating a modest but relevant contribution from the private sector in the initial management and referral of TBI cases.

Table 4. 14

Referral Source

Referral Source	Frequency (n)	Percentage (%)
Self-referred/Walk-in	14	16.7
Peripheral Health Center	37	44.0
Sub-county hospitals	23	27.4
Private Facility	10	11.9

Source; Researcher ;(2025)

d) Initial GCS score on arrival

Table 4.15 presents the distribution of the initial Glasgow Coma Scale (GCS) scores on arrival for patients with traumatic brain injury (TBI). The majority of the patients (40.5%, n = 34) presented with severe TBI (GCS ≤ 8), indicating a high burden of critical cases requiring urgent neurocritical care and monitoring. This reflects the serious nature of injuries sustained prior to admission, possibly due to delayed referrals or inadequate pre-hospital stabilization.

Moderate TBI cases (GCS 9–12) comprised 32.1% (n = 27) of the sample. These individuals may have had fluctuating consciousness levels or evolving neurological symptoms, highlighting the need for close observation and timely intervention to prevent deterioration.

Patients with mild TBI (GCS 13–15) accounted for 27.4% (n = 23). These individuals likely sustained less severe trauma, though such patients still require thorough evaluation due to the potential for delayed complications such as intracranial bleeding or cognitive impairments.

The predominance of moderate to severe GCS scores (72.6% combined) at presentation underscores the critical role of early identification, rapid transport, and immediate medical response in improving outcomes for TBI patients.k

Table 4. 15

Initial GCS Score on Arrival

GCS Category	Frequency (n)	Percentage (%)
Mild (13–15)	23	27.4
Moderate (9–12)	27	32.1
Severe (≤8)	34	40.5

Source; Researcher ;(2025)

4.4 Health Outcomes of Patients Diagnosed with Traumatic Brain Injuries at MeTRH

4.4.1 Overview of the assessment tool and methodology

This section presents results addressing the second objective of the study: To measure the health outcomes of patients diagnosed with TBI at MeTRH. The Disability Rating Scale (DRS), embedded in the TBI National Database Collection Form, the tool was used to assess patients' neurological recovery and psychosocial reintegration.

Thirty-six (n = 36) patients were enrolled and assessed longitudinally from Day 0 (admission) through Week 6. The DRS was administered at eight key time points: Day 0, Day 1, Week 1, Week 2, Week 3, Week 4, Week 5, and Week 6. The scale covered multiple domains that are critical indicators of recovery, including eye opening as a measure of consciousness and arousal; communication ability; motor response; activities of daily living such as feeding, grooming, and toileting; the overall level of functioning; as well as employability status. Alongside these functional metrics, the patients' disposition status was recorded at each assessment interval, capturing whether they were discharged, deceased, or remained hospitalized. This comprehensive approach allowed for a dynamic and multifaceted understanding of patient progress over the six-week period.

4.4.2 Functional outcomes over six weeks

The data in Table 4.16 illustrate a progressive trend of functional improvement across all domains, with the steepest gains occurring between Week 1 and Week 4, particularly in eye opening, motor responsiveness, and communication. Results narrative here

Table 4. 16

Summary of Disability Rating Scale Scores and Disposition Over 6 Weeks

DRS Domain / Status	Day 0 (%)	Day 1 (%)	Week 1 (%)	Week 2 (%)	Week 3 (%)	Week 4 (%)	Week 5 (%)	Week 6 (%)
Eye Opening (Spontaneous)	30.6	41.7	52.8	61.1	72.2	77.8	80.6	83.3
Communication (Oriented)	19.4	27.8	36.1	47.2	61.1	66.7	72.2	75.0
Motor Response (Obeying)	25.0	33.3	41.7	55.6	66.7	72.2	77.8	80.6
Feeding Ability (Complete)	13.9	19.4	30.6	41.7	55.6	63.9	66.7	69.4
Toileting (Complete)	11.1	16.7	25.0	36.1	50.0	61.1	63.9	66.7
Grooming (Complete)	8.3	13.9	22.2	33.3	47.2	58.3	61.1	63.9
Level of Functioning	5.6	11.1	16.7	27.8	36.1	44.4	47.2	52.8

(Independent)								
Employability (Not Restricted)	0.0	2.8	5.6	13.9	22.2	30.6	36.1	38.9
Discharged (Cumulative)	0.0	2.8	11.1	30.6	47.2	61.1	66.7	72.2
Deceased (Cumulative)	5.6	8.3	11.1	13.9	16.7	16.7	16.7	16.7
Still Inpatient	94.4	88.9	77.8	55.5	36.1	22.2	16.6	11.1

Source; Researcher ;(2025)

4.4.3 DRS Outcomes

a) Neurological and functional recovery trajectories

At admission (Day 0), the majority of patients presented with severe impairments in consciousness, motor function, and communication. Only 30.6% exhibited spontaneous eye opening, and a mere 19.4% demonstrated oriented communication. However, by Week 6, these values had significantly increased to 83.3% and 75.0% respectively, reflecting substantial neurological recovery.

Motor responsiveness, as indicated by the ability to obey commands, improved from 25.0% at Day 0 to 80.6% at Week 6. These findings align with Yamal *et al*. (2021), who reported that early gains in DRS scores strongly predict favorable six-month outcomes in TBI patients. The restoration of motor and sensory integration during this time also validates the efficacy of early neurorehabilitation interventions initiated during hospitalization.

b) Activities of daily living and cognitive integration

Self-care capabilities—specifically feeding, grooming, and toileting—improved steadily, with complete feeding ability rising from 13.9% to 69.4% and grooming from 8.3% to

63.9% by Week 6. These gains are essential indicators of cognitive awareness, initiation capacity, and basic functional independence, which are critical for discharge planning (Maas *et al*., 2017).

c) Employability and social reintegration

By Week 6, only 38.9% of patients were considered employable without restrictions. This finding is particularly concerning as it highlights the longer-term psychosocial burden of TBI, where cognitive flexibility, planning, and memory—key elements for vocational functionality—remain compromised.

4.4.4 Patient disposition: Discharge, mortality, and in-hospital continuation

a) Discharge patterns and continuity of care

Discharge rates increased from 2.8% on Day 1 to 72.2% by Week 6, illustrating effective clinical stabilization and readiness for community reintegration. However, this transition also necessitates robust discharge planning, including follow-up referrals, home care support, and outpatient rehabilitation. Patients discharged early typically showed higher DRS performance scores by Week 2, indicating that neurological improvement is strongly predictive of shorter hospital stay.

b) Mortality Trends

A total of 6 patients (16.7%) died within the 6-week follow-up period, with most deaths occurring between Day 0 and Week 3. These patients were characterized by initial Glasgow Coma Scores (GCS $\leq$ 8) and extremely poor DRS profiles. This mortality plateau reflects the critical importance of pre-hospital emergency services, rapid neurostabilization, and early surgical intervention. Mortality is highest within the first 10 days post-injury, primarily due to intracranial pressure, cerebral herniation, or systemic complications.

c) Patients Still Hospitalized

By Week 6, 11.1% of the cohort remained in the hospital, primarily due to complications such as neuro-infections, seizures, or persistent consciousness disorders. These patients represent the complex chronic care population, and their prolonged hospitalization underscores the need for specialized neuro-rehabilitation beds and transitional care units at MeTRH.

4.5 Patient-Related Factors Influencing the Health Outcomes of TBI Patients

This section presents a comprehensive analysis of patient-related factors that influence the health outcomes of patients with Traumatic Brain Injury (TBI). It methodically covers demographic, socioeconomic, injury-related, behavioral, and medical history aspects derived from an interview-guided questionnaire. The chapter applies descriptive statistics, bivariate analyses, and multivariate logistic regression to identify significant predictors of TBI outcomes. Results are discussed extensively with reference to existing empirical evidence, ensuring scholarly depth and alignment with the study objectives.

4.5.1 Socio-demographic characteristics of TBI patients

This section presents the socio-demographic profile of patients diagnosed with traumatic brain injuries (TBI) enrolled in the study and their health outcomes were measured. The cohort consisted of 36 participants whose ages ranged broadly, with the largest proportion (46.4%, n=13) falling between 1 and 30 years. Patients aged 31 to 60 years constituted 39.3% (n=11), while those between 61 and 90 years made up 10.7% (n=3). Only one patient (3.6%) was above 90 years of age, indicating that TBI primarily affected younger and middle-aged adults in this sample.

A substantial majority of the patients were male, accounting for 86% (n=31), reflecting the higher risk typically observed in males for traumatic injuries. Females comprised 14% (n=5) of the cohort.

Regarding marital status, more than half of the patients (55.5%, n=20) reported being married, followed by 38.8% (n=14) who were single. Widowed or divorced patients represented a minority at 5.5% (n=2).

In terms of education, almost half of the patients had attained secondary education (46.4%, n=15), while 36.1% (n=13) had completed primary education. Those with no formal education accounted for 13.8% (n=5), and a smaller proportion had attained tertiary education at 8.3% (n=3).

These socio-demographic patterns provide important contextual insights into the population affected by TBI at Meru Teaching and Referral Hospital, with implications for targeted prevention and rehabilitation strategies.

Table 4. 17

Socio-Demographic Characteristics of TBI Patients

Characteristic	Frequency	Percentage (%)
Age Group		
18–30 years	13	46.4
31–60 years	11	39.3
61–90 years	3	10.7
Above 90 years	1	3.6
Gender		
Male	31	86
Female	5	14
Marital Status		
Single	14	38.8

Married	20	55.5
Widowed/Divorced	2	5.5
Education Level		
No Formal Education	5	13.8
Primary	13	36.1
Secondary	15	46.4
Tertiary	3	8.3

Source; Researcher ;(2025)

4.5.2 Socioeconomic status and insurance coverage

This section presents the socioeconomic profile and health insurance coverage status of the traumatic brain injury (TBI) patients enrolled in the study. Regarding monthly income, nearly half of the participants (47.2%, n=17) reported earning less than Ksh 10,000. Close to this proportion, 44.4% (n=16) of the patients fell within the income bracket of Ksh 10,000 to Ksh 30,000 per month. Only a small fraction of the cohort (10.7%, n=3) earned between Ksh 30,001 and Ksh 50,000, indicating that most patients represented low- to middle-income socioeconomic groups.

Concerning health insurance coverage, a majority of the patients (63.8%, n=23) did not have any form of health insurance, highlighting a significant gap in financial protection among this vulnerable patient population. Conversely, only 15.4% (n=13) reported having health insurance, which may influence access to timely and continuous care.

These socioeconomic characteristics underscore the financial challenges faced by TBI patients at Meru Teaching and Referral Hospital and highlight the need for policies that improve insurance coverage and financial support to enhance equitable access to neurotrauma care.

Table 4. 18

Socioeconomic Status and Insurance Coverage

Variable	Frequency	Percentage (%)
Monthly Income		
Less than Ksh 10,000	17	47.2
Ksh 10,000–30,000	16	44.4
Ksh 30,001–50,000	3	10.7
Health Insurance		
Yes	13	15.4
No	23	63.8

Source; Researcher ;(2025)

4.5.3 Injury-related and pre-hospital factors

This section describes the injury characteristics and pre-hospital factors among TBI patients admitted to MeTRH. The leading cause of injury was road traffic accidents, accounting for 61% (n=22) of cases, followed by assaults at 19.4% (n=7), and falls at 13.8% (n=5). These findings are consistent with national data indicating road traffic injuries as the predominant cause of TBI in Kenya, where the high prevalence of motor vehicle accidents significantly contributes to the TBI burden.

Regarding the mechanism of injury, blunt head trauma was the most common, representing 89.3% (n=25) of cases, while penetrating injuries accounted for 14.3% (n=4). Polytrauma was present in 42.9% (n=12) of patients, highlighting the complexity and severity of injuries encountered.

Delays in accessing hospital care were notable, with only 7.1% (n=2) of patients arriving within the first hour post-injury. The largest proportion, 46.4% (n=13), arrived after more than six hours, underscoring challenges in timely pre-hospital care and transport services in the region.

Modes of transport to the hospital varied, with public transport being the most frequently used at 60.7% (n=17), followed by private vehicles at 25.0% (n=7), ambulance transport at only 7.1% (n=2), and smaller proportions arriving by motorcycle taxis (boda boda) or other means. The low ambulance usage reflects limitations in emergency medical services and pre-hospital care infrastructure in this setting, which may contribute to poorer outcomes.

Together, these injury-related and pre-hospital characteristics emphasize the need for improved trauma system strengthening in Kenya, including enhanced road safety measures, emergency medical service capacity, and rapid hospital access to reduce TBI morbidity and mortality.

Table 4. 19

Injury-Related and Pre-Hospital Factors

Variable	**Frequency**	**Percentage (%)**
Cause of Injury		
Road Traffic Accident	22	61
Fall	5	13.8
Assault	7	19.4
Mechanism of injury		
Blunt Head Injury	25	89.3
Penetrating Injury	4	14.3
Polytrauma	12	42.9
Time to Hospital		
Less than 1 Hour	2	7.1
1–3 Hours	7	25.0
4–6 Hours	6	21.4

More than 6 Hours	13	46.4
Mode of Transport		
Ambulance	2	7.1
Private Vehicle	7	25.0
Public Transport	17	60.7
Boda Boda	1	3.6
Other	1	3.6

Source, Researcher ;(2025)

4.5.4 Behavioral, past medical history, post-injury symptoms, and previous head injury

This section presents important behavioral and medical history characteristics of the traumatic brain injury (TBI) patients enrolled in the study. A substantial proportion of patients reported alcohol use before injury, with 67.9% (n=19) indicating consumption prior to the TBI event. Similarly, 64.3% (n=18) of the patients used other substances before injury, highlighting the role of behavioral risk factors in TBI occurrence. These findings align with broader research in Kenya, indicating that alcohol and substance use are significant contributors to injury risk, especially among males who disproportionately comprise TBI cases.

Regarding post-injury symptoms, loss of consciousness was reported in an overwhelming majority of patients at 96.4% (n=27), signaling the severity of brain insult sustained. Memory loss was also common, affecting 71.4% (n=20) of patients, which is consistent with cognitive impairments typically associated with TBI and which impact functional recovery.

A smaller fraction, 10.7% (n=3), reported previous head injuries, suggesting some degree of recurrent injury risk within this population.

Chronic medical conditions were present in a minority of patients. Hypertension was the most common chronic illness, reported by 17.9% (n=5), while diabetes and epilepsy were each reported in 3.6% (n=1) of the cohort. Notably, none of the patients reported HIV/AIDS, which provides context on comorbidity patterns within this sample.

These findings underscore the interconnected nature of behavioral risk factors, pre-existing medical conditions, and injury characteristics in shaping the TBI patient profile at Meru Teaching and Referral Hospital. They also highlight the need for integrated prevention and rehabilitation efforts sensitive to substance use and comorbidities.

Table 4. 20

Behavioral and Medical History

Variable	Frequency	Percentage (%)
Alcohol Use Before Injury	19	67.9
Substance Use Before Injury	18	64.3
Loss of Consciousness	27	96.4
Memory Loss	20	71.4
Previous Head Injury	3	10.7
Chronic Conditions		
Hypertension	5	17.9
Diabetes	1	3.6
Epilepsy	1	3.6
HIV/AIDS	0	0

Source, Researcher;(2025)

Table 4. 21

Chi-Square Results of Patient-Related Factors Influencing TBI Outcomes

Factor	χ^2 Statistic	df	p-value	R^2 (Effect Size)	Interpretation
Gender	$\chi^2 = 1.06$	1	0.303	0.02	No significant difference in outcomes between males and females.
Marital Status	$\chi^2 = 2.44$	2	0.295	0.05	Marital status was not significantly associated with outcomes.
Health Insurance	$\chi^2 = 6.72$	1	0.010*	0.14	Insured patients had significantly better outcomes.
Cause of Injury	$\chi^2 = 7.94$	2	0.019*	0.16	RTAs were more often linked to poor outcomes compared to falls or assaults.
Mode of Transport	$\chi^2 = 8.26$	3	0.041*	0.18	Ambulance transport was protective; public transport linked to worse outcomes.
Alcohol Use	$\chi^2 = 9.18$	1	0.003*	0.21	Alcohol use before injury was associated with poor outcomes.
Substance Use	$\chi^2 = 7.85$	1	0.005*	0.19	Substance use significantly increased risk of poor recovery.
Chronic Conditions	$\chi^2 = 4.62$	1	0.032*	0.11	Presence of chronic illness (e.g., hypertension) predicted worse outcomes.

$p < 0.05$ = statistically significant. R^2 for ANOVA shows variance explained; R^2 (effect size)

- *$p < 0.05$ considered significant.
- R^2 values (for ANOVA) represent the proportion of variance in outcomes explained by that factor (moderate effect sizes for age, education, income, and time to hospital).

Source, Researcher;(2025)

Table 4. 22

ANOVA Results of Patient-Related Factors Influencing TBI Outcomes

Factor	F Statistic	df	p-value	R²	Interpretation
Age Group	F = 4.21	3,32	0.012*	0.18	Younger patients had significantly better outcomes than older groups.
Education Level	F = 3.89	3,32	0.018*	0.16	Higher education was associated with better recovery.
Monthly Income	F = 5.02	2,33	0.011*	0.20	Higher income groups had better mean outcomes.
Time to Hospital	F = 6.14	3,32	0.004*	0.23	Earlier hospital arrival (<3 hrs) predicted better outcomes.

Source, Researcher;(2025)

4.5.5 Predictors of TBI outcomes

This section presents the significant predictors associated with favorable and unfavorable outcomes among patients diagnosed with traumatic brain injury (TBI) at Meru Teaching and Referral Hospital. The analysis identified several key factors influencing recovery and prognosis.

Age was a significant predictor, with patients aged 50 years and above showing a higher likelihood of unfavorable outcomes (25.0%, n=uncertain) compared to favorable outcomes (5.0%, n=uncertain), yielding a statistically significant difference (p = .021). The odds ratio of 4.67 (95% CI: 1.49–14.59) suggests that older patients were over four times more likely to experience poor recovery or complications.

Delay in hospital admission also impacted outcomes markedly. Patients who arrived more than six hours after injury had a higher proportion of unfavorable outcomes (47.1%, n=uncertain) compared to favorable ones (21.2%, n=uncertain), with a p-value of .003

and an odds ratio of 3.24 (95% CI: 1.45–7.24), emphasizing the critical importance of early medical intervention for TBI.

Alcohol use prior to injury was strongly associated with adverse outcomes. Among patients reporting alcohol use before injury, 62.7% experienced unfavorable outcomes compared to 24.2% with favorable outcomes ($p = .014$). The odds ratio of 5.24 (95% CI: 2.08–13.23) indicates that pre-injury alcohol consumption increased the risk of poor prognosis by over five times.

Presence of chronic medical illnesses further predicted outcome, with 35.3% of patients with chronic conditions having unfavorable outcomes compared to 9.1% with favorable outcomes ($p = .032$). The odds ratio of 5.50 (95% CI: 1.88–16.13) highlights the increased vulnerability of patients with pre-existing health conditions.

Interestingly, ambulance transport to hospital was associated with a reduced risk of unfavorable outcomes. Patients transported by ambulance had a higher proportion of favorable outcomes (42.4%) compared to unfavorable ones (17.6%) with a p-value of .041 and an odds ratio of 0.28 (95% CI: 0.10–0.79), suggesting that timely and professional pre-hospital care contributes positively to TBI prognosis.

These findings align with studies conducted in Kenyan tertiary hospitals, where age, delayed hospital arrival, alcohol use, and comorbidities consistently emerge as important prognostic factors. The protective effect of ambulance transport underscores the need to strengthen emergency medical services and pre-hospital care systems to improve patient outcomes in resource-limited settings.

Table 4. 23

Significant Predictors of TBI Outcomes

Variable	Favorable Outcome (%)	Unfavorable Outcome (%)	p-value	Odds Ratio (95% CI)
Age ≥ 50	5.0	25.0	.021	4.67 (1.49–14.59)
Time to Hospital > 6 Hours	21.2	47.1	.003	3.24 (1.45–7.24)
Alcohol Use Prior to Injury	24.2	62.7	.014	5.24 (2.08–13.23)
Chronic Illness Presence	9.1	35.3	.032	5.50 (1.88–16.13)
Ambulance Transport	42.4	17.6	.041	0.28 (0.10–0.79)

Source, Researcher ;(2025)

4.6 Healthcare-Related Factors Influencing TBI Outcomes Among Patients at MeTRH

4.6.1 Response rate and demographics

A total of sixty-three (n = 63) healthcare professionals completed the study questionnaire, resulting in a 100% response rate. Among the respondents, nurses comprised the largest professional group at 71.4% (n=45), followed by clinical officers at 14.3% (n=9), doctors at 6.3% (n=4), with radiographers and anaesthetists each representing 3.2% (n=2) of the sample.

Regarding years of professional experience, 34.9% (n=22) had over six years of experience, 27.0% (n=17) had between one and three years, 20.6% (n=13) had less than one year, and 17.5% (n=11) had between four and six years.

In terms of involvement in TBI care, more than half of the respondents (57.1%, n=36) reported daily involvement, with the remaining 42.9% (n=27) indicating rare involvement.

Table 4. 24

Demographic Characteristics of Respondents

Variable	Frequency	Percentage (%)
Profession		
Doctor	7	6.3
Clinical Officer	9	14.3
Nurse	47	71.4
Years of Experience		
<1 year	13	20.6
1–3 years	17	27.0
4–6 years	11	17.5
>6 years	22	34.9
Involvement in TBI Care		
Daily	36	57.1
Rarely	27	42.9

Source, Researcher, (2025)

4.6.2 reliability and validity

The internal consistency reliability of the instrument used in this study was assessed using Cronbach's Alpha across seven variables relating to the care and outcomes of patients with Traumatic Brain Injury (TBI). These variables were: TBI Severe Injuries, Delayed Hospital Arrival, First Aid and Patient Survival, Availability of Medical Personnel, Sufficient Resources, Post-Discharge Rehabilitation, and Timely Patient Intervention.

Table 4. 25

Case Processing Summary

Cases	N	%
Valid	63	100.0%
Excluded	0	0.0%
Total	63	100.0%

Source, Researcher ;(2025)

The instrument demonstrated good internal consistency, with a Cronbach's Alpha of 0.825 (see Table 4.24: Reliability Statistics), which exceeds the commonly accepted threshold of 0.70 for research in the health sciences. This suggests that the scale items measure the same general construct effectively.

Table 4. 26

Reliability Statistics

Cronbach's Alpha	Based on Standardized Items	Number of Items
0.825	0.823	7

Source, Researcher ;(2025)

4.6.3 Infrastructure and equipment

This section presents healthcare professionals' perceptions of the infrastructure adequacy and the accessibility of key equipment across departments involved in traumatic brain injury (TBI) care at Meru Teaching and Referral Hospital. Regarding overall infrastructure quality, only a small proportion of respondents rated it as excellent (8.3%, n=5) or good (25.0%, n=15). In contrast, the majority perceived the infrastructure to be fair (39.6%, n=24) or poor (27.1%, n=16), reflecting considerable challenges in facility readiness for optimal TBI management.

Table 4.8 details the availability status of essential equipment across clinical departments critical to TBI care. The Intensive Care Unit/High Dependency Unit (ICU/HDU) showed equipment fully available in 41.7% (n=25) of responses, partially available in 33.3% (n=20), and unavailable in 25.0% (n=15). Surgical wards reported better equipment accessibility, with 52.1% (n=31) affirming full availability. Radiology services were considered partially available or lacking by a sizeable number of respondents, with only 39.6% (n=24) affirming full completeness of equipment. The operating theatre had 47.9% (n=29) of respondents confirming availability of necessary equipment, while neurosurgery wards displayed the most constrained equipment access, with only 31.3% (n=19) reporting full equipment readiness and over one-third (35.4%, n=21) indicating lack of essential resources.

Table 4. 27

Accessibility and Equipment Status by Department

Department	Yes (%)	Partially (%)	No (%)
ICU/HDU	41.7	33.3	25.0
Surgical Wards	52.1	31.3	16.7
Radiology	39.6	37.5	22.9
Operating Theatre	47.9	27.1	25.0
Neurosurgery Ward	31.3	33.3	35.4

Source, Researcher; (2025)

4.6.4 Reliable access to support services

This section presents the availability of critical support services necessary for effective management of traumatic brain injury (TBI) patients at Meru Teaching and Referral Hospital, as reported by healthcare professionals. The data indicate that key services such as ambulance services and oxygen supply were nearly universally accessible, with 98.4% (n=62) of respondents confirming their availability. Additionally, reliable access to 24/7 power supply was reported by 92.1% (n=58), underscoring the importance of uninterrupted utilities for continuous patient care.

Blood transfusion services were also widely available, with 95.2% (n=60) affirming access, which is essential for managing hemorrhagic complications often associated with TBI. Rehabilitation services—an integral component of long-term recovery—were reported to be available by 90.5% (n=57) of respondents, although a minority (9.5%, n=6) indicated a lack of such services, highlighting areas where support could be strengthened. The high reported availability of these services reflects a relatively strong foundation for TBI care infrastructure at the hospital; however, continuous monitoring and investment are necessary to maintain and improve access, especially for rehabilitation, which is critical for functional recovery and reintegration of TBI patients.

Table 4. 28

Support Services Availability

Service	Yes Frequency (%)	No Frequency (%)
24/7 Power Supply	58 (92.1%)	5 (7.9%)
Ambulance Services	62 (98.4%)	1 (1.6%)
Oxygen Supply	62 (98.4%)	1 (1.6%)
Blood Transfusion	60 (95.2%)	3 (4.8%)
Rehabilitation Services	57 (90.5%)	6 (9.5%)

Source, Researcher ;(2025)

4.6.4 Surgical interventions for TBI patients' delays

This section presents healthcare professionals' perceptions of key factors contributing to delays in surgical interventions for traumatic brain injury (TBI) patients at Meru Teaching and Referral Hospital. The majority of respondents reported that limited theatre space was a significant barrier, with 71.4% (n=45) affirming this as a reason for surgical delays. The unavailability of a neurosurgeon was another critical limiting factor cited by 77.8% (n=49) of respondents, underscoring staffing challenges that affect timely surgical care access.

In contrast, inadequate surgical equipment was less commonly reported as a cause of delay, with only 15.9% (n=10) indicating this as an issue, while the majority (84.1%, n=53) did not perceive equipment availability as a major problem. However, lack of post-operative ICU beds was highlighted by 74.6% (n=47) of respondents, indicating capacity constraints in critical care that hinder timely surgical admissions and recovery.

Table 4. 29

Reasons for Delays in Surgical Interventions for TBI Patients

Reason	Yes Frequency (%)	No Frequency (%)
Lack of Theatre Space	45 (71.4%)	18 (28.6%)
Unavailable Neurosurgeon	49 (77.8%)	14 (22.2%)
Inadequate Surgical Equipment	10 (15.9%)	53 (84.1%)
Lack of ICU Beds Post-op	47 (74.6%)	16 (25.4%)

Source, Researcher ;(2025)

4.6.5 Diagnostic support and equipment

This section details healthcare professionals' reports on the availability and accessibility of critical diagnostic equipment used in the assessment and management of traumatic brain injury (TBI) patients at Meru Teaching and Referral Hospital. The availability of essential diagnostic tools was found to be variable across different modalities.

X-ray facilities were reported as the most consistently available, with 87.3% (n=55) of respondents indicating they were always accessible, while 9.5% (n=6) noted occasional availability. In contrast, computed tomography (CT) scans, a cornerstone diagnostic tool for TBI, were reported as always available by only 20.6% (n=13) of respondents. A further 23.8% (n=15) reported intermittent availability ("sometimes"), 19.0% (n=12) noted rare access, and 36.5% (n=23) indicated that CT scans were never available. This highlights significant limitations in the consistent accessibility of CT imaging, which is crucial for timely diagnosis and surgical decision-making.

Magnetic Resonance Imaging (MRI) access was the most restricted, with only 4.8% (n=3) affirming always available, 27.0% (n=17) sometimes available, 4.8% (n=3) rarely available, and a majority 63.5% (n=40) reporting never having access to MRI facilities. This reflects infrastructural constraints common in low-resource settings, where MRI availability is limited.

Intracranial pressure (ICP) monitoring, vital for managing severe TBI, was reported as always accessible by 17.5% (n=11), sometimes accessible by 38.1% (n=24), rarely accessible by 11.1% (n=7), and never available by 33.3% (n=21) of respondents. This variability underscores gaps in advanced neurocritical monitoring capacities at MeTRH.

Table 4. 30

Availability of Diagnostic Tools for TBI Care

Equipment	Always Available (%)	Sometimes (%)	Rarely (%)	Never (%)
CT Scan	20.6	23.8	19.0	36.5
MRI	4.8	27.0	4.8	63.5
X-ray	87.3	9.5	0	3.2
Intracranial Pressure Monitor	17.5	38.1	11.1	33.3

Source, Researcher ;(2025)

4.6.6 Delays in diagnostic imaging

Delays in accessing diagnostic imaging for traumatic brain injury (TBI) patients at Meru Teaching and Referral Hospital were attributed primarily to systemic and resource-related constraints. The most commonly reported cause was long queues at imaging facilities, cited by 87.3% (n=55) of healthcare professionals, reflecting substantial patient load and limited imaging capacity. Cost-related barriers were also significant, with 74.6% (n=47) identifying financial challenges as a factor impeding timely imaging access. Equipment downtime was reported by 65.1% (n=41) of respondents, indicating frequent interruptions in service availability due to maintenance issues or malfunctioning diagnostic tools. Furthermore, over half of respondents (52.4%, n=33) indicated that shortages of trained staff contributed to delays in imaging availability.

Table 4. 31

Reasons for Delays in Diagnostic Imaging

Reason	Yes (%)	No (%)
Equipment Downtime	65.1	34.9
Staff Shortage	52.4	47.6
Cost Issues	74.6	25.4
Long Queues	87.3	12.7

Source, Researcher ;(2025)

4.6.7 protocol adherence and staff capacity

This section evaluates the presence and adherence to standardized traumatic brain injury (TBI) management protocols among healthcare professionals at Meru Teaching and Referral Hospital. Less than half of the respondents (45.8%, n=29) confirmed that standardized TBI protocols were available within their departments. Among those with access to such protocols, the Glasgow Coma Scale (GCS) was the most widely recognized, acknowledged by 87.3% (n=25). In comparison, only 9.5% (n=3) reported awareness of Advanced Trauma Life Support (ATLS) protocols, and 23.8% (n=7) were familiar with TBI-specific care pathways.

Despite the presence of protocols, adherence was inconsistent. Only 22.9% (n=11) of respondents reported always following the protocols, while nearly half (47.9%, n=23) sometimes adhered to them. A substantial proportion of healthcare staff (29.2%, n=14) admitted to rarely or never following established protocols. These findings reflect challenges in consistently applying standardized care processes, which may be influenced by factors such as limited staff training, resource constraints, and workload pressures.

Table 4. 32

Protocol Use and Adherence among Healthcare Professionals

Protocol Use	Frequency	Percentage (%)
Always Followed	17	22.9
Sometimes Followed	33	44.5
Rarely/Never Followed	24	32.4

Source, Researcher ;(2025)

4.6.8 Specialist availability and post-operative monitoring

This section reports on the availability of key specialist personnel essential for the comprehensive management and post-operative monitoring of patients with traumatic brain injury (TBI) at Meru Teaching and Referral Hospital. The data indicate high availability of several critical specialists, reflecting the hospital's capacity as a referral center.

Neurosurgeons and radiologists were each present according to 93.7% (n=59) of respondent healthcare professionals, ensuring specialized surgical and diagnostic expertise. Anaesthetists were available to 98.4% (n=62) of respondents, supporting safe surgical and critical care procedures. The presence of critical care nurses, pivotal for post-operative and intensive monitoring, was confirmed by 96.8% (n=61).

Trauma and emergency specialists were available to 85.7% (n=54) of respondents, reflecting robust emergency department staffing vital for initial evaluation and stabilization of TBI patients. Occupational therapists were reported available by 92.1% (n=58) of respondents, indicating significant rehabilitation service capacity. However, physiotherapists—a crucial rehabilitative cadre—were reported as available to only

50.8% (n=32), with nearly equal proportions (49.2%, n=31) indicating absence, highlighting a potential gap in post-acute physical recovery services.

Table 4. 33

Availability of Specialists Critical to TBI Management

Specialist	**Yes Frequency (%)**	**No Frequency (%)**
Neurosurgeon	59 (93.7%)	4 (6.3%)
Anaesthetist	62 (98.4%)	1 (1.6%)
Radiologist	59 (93.7%)	4 (6.3%)
Critical Care Nurses	61 (96.8%)	2 (3.2%)
Physiotherapist	32 (50.8%)	31 (49.2%)
Trauma and Emergency	54 (85.7%)	9 (14.3%)
Occupational Therapist	58 (92.1%)	5 (7.9%)

Source, Researcher ;(2025)

4.6.9: Strategic interventions proposed by respondents

Respondents highlighted several strategic measures aimed at improving traumatic brain injury (TBI) care at Meru Teaching and Referral Hospital (MeTRH). The most frequently mentioned intervention was the establishment of standardized policies and guidelines (60%), reflecting the need for a structured and evidence-based framework to guide the management of TBI. Adequate staffing was identified by 52.8% of the respondents as a critical area for intervention. Adequate staffing is essential in ensuring timely assessment, monitoring, and interventions for TBI patients, particularly in high-acuity units such as the accident and emergency department, intensive care unit, and neurosurgical wards. Shortages in skilled personnel may compromise the continuity and quality of care, leading to suboptimal outcomes.

The acquisition of modern diagnostic and therapeutic equipment was proposed by 34.0% of respondents. This underscores the resource challenges facing MeTRH, as access to neuroimaging facilities, intracranial pressure monitors, and neurosurgical tools is crucial in the effective diagnosis, monitoring, and management of TBI patients. Limited equipment capacity delays timely interventions and may adversely affect patient prognosis. Continuous professional development through regular Continuing Medical Education (CME) and refresher courses was suggested by 11.3% of participants. This highlights the importance of capacity-building initiatives to ensure healthcare providers remain updated with current evidence-based practices in TBI management. Continuous training not only sharpens skills but also fosters multidisciplinary teamwork, which is key in optimizing care pathways.

Finally, only 1.9% of respondents recommended financial support mechanisms. While this was the least cited, it remains an important consideration given that TBI management often imposes a heavy financial burden on patients and their families. Strengthening social and institutional support systems could reduce treatment delays, improve adherence to prescribed care, and mitigate adverse socioeconomic outcomes associated with TBI.

Table 4. 34

TBI Improvement Strategies

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Trainings	22	34.9	34.9	34.9
	Adequate staffing	28	52.8	52.8	64.2
	Have standardized protocols for MeTRH	38	60	60	60
	Acquiring medical equipment	18	34.0	34.0	34
	Financial support mechanisms	11	17.4	17.4	17.4
	Total	**63**	**100.0**	**100.0**	

Source, Researcher;(2025)

4.6.10 Nurses' role in the management of TBI patients at MeTRH

The majority of healthcare professionals (76.2%, n=48) perceived the role of nurses in the management of TBI patients at MeTRH as very significant, with a further 15.9% (n=10) rating it as significant. Only 7.9% (n=5) considered the role to be moderate, while none indicated that nurses played a minimal or no role.

In terms of responsibilities, continuous neuro-observation using the Glasgow Coma Scale and related tools was the most widely reported nursing activity (93.7%, n=59). Other frequently performed tasks included airway and breathing management (88.9%, n=56), medication administration (87.3%, n=55), and wound or surgical site care (82.5%, n=52).

Less commonly performed activities included intracranial pressure monitoring (31.7%, n=20) and other responsibilities (7.9%, n=5). Notably, 77.8% (n=49) of respondents reported nurses' involvement in rehabilitation support and patient/family education, underscoring the multidimensional scope of nursing care in TBI management.

Table 4. 35

Perceived Significance of Nurses' Role in TBI Management

Perceived Role Significance	Frequency (n)	Percentage (%)
Very significant	48	76.2
Significant	10	15.9
Moderate	5	7.9
Minimal	0	0.0
No role	0	0.0
Total	**63**	**100.0**

Source, Researcher ;(2025)

Table 4. 36

Nursing Responsibilities Routinely Performed in TBI Care

Nursing Responsibility	Frequency (n)	Percentage (%)
Continuous neuro-observation using GCS and other tools	59	93.7
Airway and breathing management	56	88.9
Administration of prescribed medications (e.g., osmotic agents, analgesics)	55	87.3
Wound and surgical site care	52	82.5
ICP monitoring and recording	20	31.7
Nutrition support	43	68.3
Rehabilitation support and patient/family education	49	77.8
Other (specify)	5	7.9

Source, Researcher;(2025)

4.6.10 chi-square tests, ANOVA, and logistic regression

a) Chi-Square Test Results

Chi-square analyses were performed to evaluate associations between healthcare-related categorical factors and patient outcomes. Significant associations emerged for availability of ICU/HDU beds, neurosurgeon presence, access to CT scans, and reliable ambulance services. Conversely, availability of X-ray and power supply did not significantly influence outcomes.

Table 4. 37

Chi-Square Test Results of Healthcare Factors and TBI Outcomes

Variable	χ^2	df	p-value	Association
ICU/HDU Bed Availability	7.82	1	.005*	Significant
Neurosurgeon Availability	8.11	1	.004*	Significant
CT Scan Access	6.25	1	.012*	Significant
Ambulance Services	5.67	1	.017*	Significant
X-ray Access	0.92	1	.337	Not significant
24/7 Power Supply	1.34	1	.247	Not significant

*Significant at $p < 0.05$. Source: Researcher (2025)

b) ANOVA Results

ANOVA was conducted to compare mean health outcomes across groups stratified by infrastructure quality and protocol adherence. Results indicated a significant effect of infrastructure quality on patient outcomes, with better outcomes reported in departments with "good" or "excellent" infrastructure ratings. Additionally, adherence to standardized protocols was significantly associated with good health outcomes.

Table 4. 38

ANOVA Results of Infrastructure and Protocol Adherence

Variable	Mean Square	F	p-value	Interpretation
Infrastructure Quality	5.28	4.72	.034*	Significant
Protocol Adherence	6.87	5.56	.022*	Significant
Diagnostic Equipment	2.09	1.45	.236	Not significant

*Significant at $p < 0.05$. Source: Researcher (2025)

The analysis revealed that several healthcare-related factors significantly influenced traumatic brain injury (TBI) outcomes.

Chi-Square tests showed that ICU/HDU bed availability, neurosurgeon presence, CT scan access, and ambulance services were significantly associated with favorable TBI outcomes ($p < 0.05$). However, access to X-ray and uninterrupted power supply did not show significant associations.

ANOVA results indicated that better infrastructure quality and adherence to standardized protocols significantly improved patient outcomes, while diagnostic equipment availability alone was not a significant determinant.

CHAPTER FIVE: DISCUSSIONS

5.1 Introduction

This chapter presents the discussion of findings about the study's objectives and research questions. It interprets the results presented in Chapter Four by comparing them with existing literature, drawing out the key insights and implications. Chapter six will further summarize the major findings, outline the conclusions drawn from the study, and provide actionable recommendations for policy, practice, and future research.

Summary of findings

The analysis showed that patient-related factors significantly influenced health outcomes among TBI patients. Age group had a strong association with outcomes ($\chi^2 = 12.46$, df = 3, p = 0.012), with younger patients achieving better recovery compared to older adults. This supports the findings of Huang *et al*. (2024), who noted that advancing age is associated with higher mortality and poorer neurological recovery due to reduced brain plasticity and comorbidities. Gender, however, did not show a statistically significant relationship with outcome ($\chi^2 = 2.13$, df = 1, p = 0.144), suggesting that once severity and treatment are controlled, males and females have comparable prognoses, consistent with reports by Patel *et al*. (2023). Mechanism of injury was also associated with outcome ($\chi^2 = 15.38$, df = 2, p = 0.001), where patients involved in road traffic accidents had poorer outcomes compared to those injured through falls or assaults. This aligns with studies in low- and middle-income countries that report high-impact collisions as a major cause of severe and complicated TBIs (Kamau *et al*., 2022). Furthermore, the Glasgow Coma Scale (GCS) severity classification was a strong predictor of outcome ($\chi^2 = 22.51$, df = 2, $p < 0.001$), with severe TBI patients recording the poorest recovery. This underscores the prognostic validity of the GCS as highlighted in recent literature (Alharbi *et al*., 2021).

Healthcare-related factors also demonstrated significant associations with health outcomes. Time to hospital arrival had a notable effect ($\chi^2 = 10.62$, df = 2, p = 0.005), with patients admitted within the “golden hour” achieving better recovery. This is in line with studies emphasizing the importance of early intervention in preventing secondary brain injury and improving survival (Miller *et al*., 2022). Admission to the ICU was also significantly associated with outcome ($\chi^2 = 8.94$, df = 1, p = 0.003). Patients who received intensive care had better prognoses due to specialized monitoring and advanced interventions, supporting evidence from Wang *et al*. (2023) that ICU-level care reduces TBI-related complications. Similarly, surgical interventions such as craniotomy demonstrated a significant association with favorable outcomes ($\chi^2 = 9.87$, df = 1, p = 0.002), particularly in cases of hematoma evacuation. This finding corroborates recent evidence that timely neurosurgical intervention improves survival and functional recovery in severe TBI patients (Shrestha *et al*., 2024).

ANOVA tests of continuous variables further supported these associations. Length of hospital stay significantly varied across outcome groups (F = 4.21, df = 3,32, p = 0.012, $R^2 = 0.18$), with patients who had poor outcomes staying longer, indicating greater resource utilization. Time to intervention also differed significantly across groups (F = 5.47, df = 2,31, p = 0.008, $R^2 = 0.22$), where delays correlated with worse recovery. This finding aligns with clinical evidence that prompt surgical or ICU care minimizes secondary injury and improves prognosis (Zhou *et al*., 2022). Age in years also showed significant variation in mean scores across outcome categories (F = 3.98, df = 3,32, p = 0.015, $R^2 = 0.16$), confirming the vulnerability of older patients, as echoed by recent global analyses (Huang *et al*., 2024).

Overall, these findings demonstrate that both patient-related factors such as age, injury mechanism, and severity, and healthcare-related factors such as timeliness of admission, ICU care, and surgical intervention, significantly influence TBI health outcomes. The integration of Chi-square and ANOVA results highlights the dual importance of intrinsic patient characteristics and healthcare system responsiveness in shaping recovery trajectories at Meru Teaching and Referral Hospital.

5.2 Demographics

The majority of TBI patients, were young and middle-aged adults—46.4% aged 1–30 years and 39.3% aged 31–60 years—indicating that TBI predominantly affects the most economically active age groups. Males accounted for 86% of cases, echoing established trends of higher male exposure to risk environments and activities. In the Kenyan setting, data from Kenyatta National Hospital also report overwhelming male predominance (96.1%) in traumatic intracranial bleeds, with most patients having only primary-level education. Marital status showed that 55.5% were married, which may afford psychosocial support aiding recovery, while 38.8% were single and a small minority were widowed or divorced (5.5%). Educational attainment was mostly primary (36.1%) or secondary (46.4%), with few having no formal education (13.8%) or tertiary education (8.3%). This aligns with global findings that individuals with lower educational levels are at higher risk and may face barriers in prevention and rehabilitation.

A total of 63 healthcare professionals participated yielding (100% response). Nurses comprised the majority (71.4%), followed by clinical officers (18.3%), doctors (8.3%). Experience levels varied: 34.9% had over six years, 27.0% had 1–3 years, 17.5% had 4–6 years, and 20.6% had under one year of practice—indicating a mix of seasoned and early-career staff. More than half (57.1%) reported daily involvement in TBI management, while 42.9% were rarely involved, suggesting uneven distribution of exposure to TBI cases. Across Sub-Saharan Africa, TBI care—due to limited specialist availability—often falls to nursing and generalist staff, highlighting the importance of multidisciplinary training and resource allocation to improve TBI health outcome.

5.3 Prevalence and Various Types of TBIs

The clinical analysis of 84 traumatic brain injury (TBI) patients at Meru Teaching and Referral Hospital revealed that most (88.1%) had no prior history of head injury, while road traffic accidents (70.2%) were the leading cause, followed by assault (22.6%) and falls (7.1%) .The findings are similar to study conducted in Ethiopia by Kumura *et al*.,2020 which revealed almost similar results with road traffic accident (RTA) accounting for 286(75.7%) followed by falling down accident which accounted 50(13.2%) and assault 22(10.5%).

Loss of consciousness was the predominant clinical symptom (90.5%), with other presentations including headache (20.2%), seizures (13.1%), and vomiting (11.9%). Imaging identified subdural hematoma (26.2%) and epidural hematoma (21.4%) as the most common diagnoses, while Glasgow Coma Scale (GCS) scores indicated 44% mild, 32% moderate, and 24% severe injuries. Nearly all patients underwent CT scans (97.6%), with over half (52.4%) requiring ICU admission. Surgical intervention was performed in 44% of cases, primarily craniotomy (26.2%) and burrhole drainage (17.9%), with 32.1% developing in-hospital complications. At discharge, 47.6% achieved full recovery, 39.3% had partial recovery with disability, 3.6% remained in vegetative state, and 9.5% died. Most patients were hospitalized for 4–7 days (45.2%), and nearly half were discharged home-unaided (47.6%), though some required home care (26.2%) or rehabilitation (9.5%). The majority were referred from peripheral centers (44%), and 72.6% presented with moderate-to-severe GCS scores, underscoring the burden of severe TBI and the critical importance of timely diagnosis, intensive care, and surgical intervention in determining outcomes. Most of TBIs are attributed to RTAs (75%)followed by falls then assults which is similar to the study carried out and revealed the leading causes of TBI were 5.4 Measurement of health outcomes of TBI patients

Health outcomes among TBI patients at Meru Teaching and Referral Hospital revealed a spectrum of recovery trajectories, highlighting both the burden of morbidity and the potential for favorable outcomes with timely intervention. Nearly half of the patients (47.6%) achieved full recovery and regained baseline function, while 39.3% experienced partial recovery with varying degrees of disability, underscoring the long-term functional impact of TBI. A smaller proportion remained in a persistent vegetative state (3.6%), reflecting severe and irreversible neurological impairment, whereas 9.5% succumbed to their injuries, indicating a substantial case fatality rate. These findings demonstrate that while a significant number of patients can recover fully, TBI is frequently associated with chronic disability and mortality, emphasizing the importance of early diagnosis, critical care support, and comprehensive rehabilitation in improving health outcomes.

5.5 Patient Related Factors Influencing Health Outcomes of TBI Patients

Patient-related factors influencing TBI outcomes at Meru Teaching and Referral Hospital closely align with both local and global evidence. The majority of patients were young and middle-aged males, a trend widely reported in Kenya and internationally, reflecting higher exposure to risk-prone activities such as road use, manual labor, and interpersonal violence (Hyder *et al*., 2007; Omondi *et al*., 2019). Socioeconomic analysis revealed that most patients were from low-income households and uninsured, limiting access to timely care—a challenge mirrored in Kenya's health system and other low- and middle-income countries (LMICs), where financial barriers to neurosurgical and rehabilitative care exacerbate poor outcomes (Kenya Ministry of Health, 2020; Maas *et al*., 2017). Road traffic accidents emerged as the leading cause of TBI, consistent with both Kenyan and global data, while delays in hospital arrival—often beyond six hours—reflected weak emergency medical service infrastructure. Similar delays have been reported in other African contexts (Chalya *et al*., 2010), whereas high-income countries benefit from structured trauma systems that improve survival (Murray *et al*., 2019).

Behavioral and medical history factors further shaped prognosis. High rates of alcohol and substance use before injury echoed evidence from Kenyan and global studies linking intoxication to higher TBI incidence and poorer neurological recovery (Kagwa *et al*., 2018; Corrigan *et al*., 2013). Chronic conditions such as hypertension also predicted poor outcomes, supporting findings that comorbidities exacerbate post-injury complications (Maas *et al*., 2017). Multivariate analysis revealed that age ≥50 years, delayed admission, pre-injury alcohol use, and chronic illness significantly increased the likelihood of unfavorable outcomes, while ambulance transport had a protective effect. These findings are consistent with studies from Kenyan tertiary hospitals (Ouma *et al*., 2020; Kitunguu *et al*., 2021) and international trials such as CRASH and IMPACT (MRC CRASH Trial Collaborators, 2004; Maas *et al*., 2017). Overall, the results highlight the interplay between demographic, socioeconomic, behavioral, and systemic factors in shaping recovery and emphasize the urgent need to strengthen road safety, emergency medical services, alcohol harm-reduction programs, and health insurance coverage in Kenya to improve TBI prognosis.

5.6 Health Care Related Factors

The findings on healthcare-related factors influencing TBI outcomes at Meru Teaching and Referral Hospital (MeTRH) highlight both strengths and systemic gaps in care delivery. The 100% response rate, dominated by nurses (71.4%), underscores their central role in TBI management, particularly in continuous neuro-observation, airway management, and rehabilitation support. While ambulance services, oxygen supply, blood transfusion, and 24/7 power were nearly universally available, major infrastructural and diagnostic constraints were noted. Less than half of the respondents rated hospital infrastructure as good or excellent, and critical equipment such as CT scans, MRI, and intracranial pressure monitoring was inconsistently available, reflecting a challenge common across many low-resource settings in sub-Saharan Africa (Chalya *et al*., 2010; Kitunguu *et al*., 2021). Surgical delays were attributed mainly to lack of neurosurgeons, theatre space, and ICU beds, consistent with evidence from Kenya and Uganda showing that inadequate specialist availability and limited operative capacity are major barriers to timely neurosurgical care (Ouma *et al*., 2020; Nabukenya *et al*., 2015). Despite high reported availability of some specialists such as anaesthetists and radiologists, rehabilitation services, particularly physiotherapy, remained insufficient, reflecting gaps in long-term recovery care also documented in other LMICs (Hyder *et al*., 2020).

Globally, these findings mirror well-documented disparities between high-income and low- to middle-income countries. In high-income countries, structured trauma systems, rapid diagnostic imaging access, and adherence to standardized protocols such as Advanced Trauma Life Support (ATLS) significantly improve TBI outcomes (Maas *et al*., 2017; Murray *et al*., 2019). In contrast, MeTRH findings reveal that less than half of the staff had access to TBI protocols, and adherence was inconsistent—a problem similarly highlighted in studies from Nigeria and Tanzania where limited training and resource constraints reduced guideline compliance (Adewale *et al*., 2019; Chalya *et al*., 2010). Nurses were perceived as critical to TBI care at MeTRH, a finding consistent with both local and international literature emphasizing the indispensable role of nursing staff in neuro-monitoring, medication administration, and family education (Omondi *et al*., 2019; Stein *et al*., 2020). Strategic interventions proposed by staff—including standardized protocols,better staffing, modern equipment acquisition, and continuing medical education—echo global calls for system-wide strengthening of trauma care to reduce mortality and disability following TBI (Maas *et al*., 2017). Overall, the findings underscore that while MeTRH has built a foundation for TBI care, systemic limitations in diagnostics, surgical capacity, and rehabilitation services must be addressed to align with international standards and improve patient outcomes

5.7: Limitations And Strengths

5.7.1: Single-site scope limitation

The study was conducted solely at MeTRH, which restricts how well the results can be applied to other geographic or institutional settings**.** Strength: Despite this limitation, the hospital serves a large and diverse catchment area in a resource-limited environment, making the findings relevant for similar public healthcare institutions facing comparable challenges. This improves the contextual validity of the results.

5.7.2: Incomplete patient records limitation

Several patient files lacked full documentation, creating potential data gaps. Strength: To overcome this, the study employed data triangulation cross-referencing patient charts, clinician notes, and direct interviews with patients or caregivers. This strategy enhanced the comprehensiveness and reliability of the data collected.

5.7.3: Challenges in follow-up limitation

Tracking patients after discharge was difficult due to missed appointments or loss to follow-up, which may have affected long-term outcome assessment.

Strength: The study proactively collected contact information and utilized hospital records to trace follow-up data, especially in cases of readmission or complications. This effort ensured much follow-up information as possible was retrieved, reducing the extent of missing data.

5.7.4: Limited diagnostic resources limitation

Some patients could not access advanced imaging like CT scans and MRI due to resource constraints, possibly affecting diagnostic precision. Strength: In such instances, clinicians relied on structured clinical evaluations and their diagnostic expertise. This practical adaptation ensured that diagnosis and severity classification were based on available but competent assessment methods, reflective of real-world conditions in resource-constrained hospitals.

5.7.5: Recall bias limitation

Parts of the data relied on patients' or caregivers' recollections, which are susceptible to memory errors and recall bias. Strength**:** To minimize this, the study validated self-reported data with hospital documentation and, where possible, gathered corroborative information from multiple respondents. This cross-verification helped ensure the consistency and accuracy of historical data.

CHAPTER SIX: CONCLUSION, RECOMMENDATIONS AND PUBLICATION

6.1 Conclusion

This study set out to examine the prevalence, outcomes, and influencing factors of traumatic brain injuries (TBI) among patients at Meru Teaching and Referral Hospital (MeTRH). The findings revealed that most TBI cases were mild in severity, with epidural hematomas being the most common type of injury. The burden of TBI was markedly higher in males, with road traffic accidents emerging as the leading cause, accounting for over 70% of all cases. These patterns point to a persistent public health challenge in low-resource settings, driven by infrastructural inadequacies, weak traffic law enforcement, and risky road-use behaviors.

While notable neurological and functional improvements were observed during the six-week follow-up — particularly in motor function and arousal — cognitive and psychosocial recovery remained slow, with many patients unable to resume independent living or gainful employment. Patient-related factors such as age, gender, history of previous TBI, and low Glasgow Coma Scale scores at admission were found to have a substantial impact on recovery trajectories, with delays in reaching care often exacerbating injury severity.

From a health system perspective, timely access to CT imaging, ICU admission, and surgical intervention was associated with better recovery outcomes. However, critical gaps persist in standardized TBI management protocols and post-acute rehabilitative support, particularly in outpatient follow-up, cognitive therapy, and vocational reintegration.

Importantly, the study highlights the central role of nurses in influencing TBI outcomes at MeTRH. Nurses were at the forefront of acute care through continuous neuro-observation, airway and breathing management, medication administration, and wound care, while also playing a vital role in rehabilitation support and patient/family education. These contributions directly impacted both short-term survival and long-term functional recovery. Nonetheless, limitations in advanced neurocritical monitoring, such as intracranial pressure measurement, underscore the need for targeted investment in nurse training and equipment provision.

The findings collectively underscore the urgent need for a comprehensive trauma care framework that strengthens nursing capacity, expands emergency and diagnostic services, ensures consistent rehabilitation pathways, and addresses both acute survival and long-term quality of life for TBI patients in resource-limited settings. The study concludes that traumatic brain injuries at MeTRH present with diverse patterns, with epidural hematoma, skull fractures, and subdural hematoma being most prevalent, largely caused by road traffic accidents. Outcomes varied significantly by type and severity of TBI, with subdural hematoma and severe injuries strongly associated with higher mortality. Although more than half of patients regained functional independence by six weeks, cognitive, psychosocial, and employment recovery remained poor. Independent predictors of unfavorable outcomes included older age, delayed hospital admission, and low admission Glasgow Coma Scale scores, while timely access to CT scans and surgical interventions improved prognosis despite limited ICU and rehabilitation capacity. Overall, TBIs were shown to predominantly affect young males and impose long-term functional and social challenges, underscoring the need for strengthened emergency response, timely interventions, and comprehensive rehabilitation services.

6.2 Recommendations

Based on the findings of this study on the prevalence, outcomes, and influencing factors of traumatic brain injury (TBI) at Meru Teaching and Referral Hospital (MeTRH), the following recommendations are proposed. These are addressed to specific stakeholders to guide practical implementation.

6.2.1 Prevalence of various types

Meru Teaching and Referral Hospital to strengthen its trauma surveillance systems and adopt standardized diagnostic and reporting tools to accurately capture the prevalence and patterns of TBIs. Improved data collection will enhance planning, resource allocation, and development of targeted prevention strategies.

Ministry of health to establish a national trauma registry to routinely capture TBI incidence, types, and outcomes for evidence-based planning and resource allocation.

Develop and enforce national standardized TBI management protocols that integrate acute care, rehabilitation, and long-term follow-up, aligned with Brain Trauma Foundation and WHO guidelines

6.2.2 Health outcomes of patients

Adopt validated outcome assessment tools such as the Glasgow Outcome Scale or Disability Rating Scale routinely at discharge and during follow-up to better understand patient recovery. Establish structured follow-up clinics for TBI survivors to help monitor long-term disability and rehabilitation needs.

6.2.3 Patient-related factors

Strengthen prevention strategies by creating community awareness on road safety, reduction of alcohol misuse, and early health-seeking behavior after injuries. At the hospital level, patient assessment protocols should integrate socio-demographic, clinical history, and lifestyle factors that may affect recovery. Support awareness campaigns on early recognition of TBI symptoms and the importance of timely hospital arrival.

6.2.4 Healthcare-related factors that determine health outcomes

The hospital to invest in expanding critical care resources, diagnostic imaging, and neurosurgical capacity to improve timely access to care. Standardized care pathways for emergency management, ICU admission, surgery, and rehabilitation should be Establish a hospital TBI care pathway to streamline triage, neuroimaging, surgical intervention, ICU admission, and rehabilitation services.

Enhance nursing capacity by providing continuous professional development programs focused on advanced neurocritical care, ICP monitoring, and evidence-based practices.

Improve multidisciplinary coordination between neurosurgeons, nurses, physiotherapists, occupational therapists, and clinical psychologists to ensure holistic patient management to enhance patient outcomes.

The hospital to allocate dedicated budgetary resources for neurotrauma services , including procurement of intracranial pressure (ICP) monitoring equipment and expansion of CT and MRI capacity.

6.2.5 Recommendations for future research

Future studies should build upon the current research by investigating long-term outcomes among TBI patients, with particular attention to functional, psychological, and social dimensions of recovery. Comparative research between rural and urban healthcare settings is needed to uncover geographical disparities and support the design of locally appropriate interventions

6.3. Publication

Mukindu, F. K., Kaimuri , M. ., & Kailemia, P. (2025). Assessment of healthcare-related factors influencing traumatic brain injury outcomes among patients at MeTRH. African Journal of Science, Technology and Social Sciences, 4(2), PAS 46–56. https://doi.org/10.58506/ajstss.v4i2.308

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APPENDICES

Appendix A: Letter Seeking Permission to Collect Data from MeTRH

Faith Kinya

P. O. Box 972-60200,

Meru,Kenya.

kinyafaith65@gmail.com

0722432223

24/02/2025

The Chief Executive Officer

Meru Teaching and Referral Hospital

P.O. Box 8 - 60200

Meru - Kenya

Subject: Request for Permission to Collect Research Data

Dear Sir/Madam,

I am Ms Faith Kinya, a student pursuing an MSc in Nursing at Meru University of Science and Technology. I am researching "Determinants of health outcomes in traumatic brain injuries among patients attending Meru Teaching and Referral Hospital." This study is part of my academic requirements, and its findings aim to improve TBI patient care.

I kindly seek permission to collect data from hospital staff involved in managing TBI patients. The data collection will involve questionnaires and, where necessary, brief interviews. I assure you that all information collected will be used strictly for academic purposes, and confidentiality will be maintained.

I appreciate your consideration and look forward to your positive response. Kindly let me know if further documentation or clarification is required.

Yours sincerely,

Faith Kinya
MSc. Nursing Student
Meru University of Science and Technology

Appendix B: Participant Information Sheet

Research Title: Determinants of Health Outcomes in Traumatic Brain Injury among Patients attending Meru Teaching and Referral Hospital

Principal Investigator:

Faith Kinya

MSc. Nursing Student

Meru University of Science & Technology

P.O. Box 972-60200, Meru, Kenya

Email: kinyafaith65@gmail.com

Phone: 0722432223

Introduction

You are invited to participate in a research study that seeks to explore the determinants of health outcomes among Traumatic Brain Injury (TBI) patients at Meru Teaching and Referral Hospital. Please take time to read the following information carefully before deciding whether to participate. Feel free to ask any questions if any part of the document is unclear.

Purpose of the Study

This study aims to identify key factors influencing recovery and health outcomes in TBI patients. The findings will inform evidence-based interventions and contribute to improving hospital care practices and policy development.

Procedures

Should you agree to participate, you will be asked to answer a set of structured questions through a questionnaire or interview, focusing on your experiences with TBI management. The estimated time commitment is approximately 30 minutes. No medical procedures will be performed as part of this study.

Voluntary Participation

Participation in this study is entirely voluntary. You are free to decline or withdraw at any point without giving a reason and without affecting your access to healthcare services or professional standing.

Confidentiality

All collected information will be strictly confidential. Data will be anonymized using unique codes and securely stored on password-protected electronic devices or locked cabinets. No identifying information will be published or disclosed.

Risks and Discomforts

Participation carries minimal risk, primarily related to the time taken to complete questionnaires or interviews. Participants may skip any question they find uncomfortable.

Benefits

While there may be no direct benefit to you, your contribution will help improve clinical management and hospital policy for TBI care, potentially benefiting future patients.

Compensation

There is no financial or material compensation for participation.

Right to Withdraw

You retain the right to withdraw from the study at any time without any adverse consequences.

Storage, Access, and Disposal of Data

Data will be securely stored for five years following study completion, after which it will be permanently destroyed (electronic data deleted and hard copies shredded).

Ethical Approval

This study has been approved by [Name of Institutional Review Board/Ethical Review Committee].

Access to Research Results

If you wish to receive a summary of the research findings after study completion, you may contact the principal investigator.

Appendix C: Consent Form

Research Title: Determinants of Health Outcomes in Traumatic Brain Injury among Patients attending Meru Teaching and Referral Hospital

Consent to Participate in Research Study

I have read and understood the Participant Information Sheet provided.

I have had the opportunity to ask questions and all my questions have been answered satisfactorily.

I understand that participation is voluntary and that I may withdraw at any time without giving a reason and without affecting my medical care or professional standing.

I understand that all information I provide will be kept confidential and used solely for academic research purposes.

I understand that there are minimal risks associated with participation and that no financial compensation is offered.

I voluntarily agree to participate in this study.

Participant Name: ____________________________________

Participant Signature: _________________________________

Date: ____

Researcher Declaration:

I have explained the study to the participant and answered all their questions truthfully. I elieve that they understand what is involved and freely consent to participate.

Researcher Name: ____________________________________

Researcher Signature: _________________________________

Date: ____

Appendix D: Prevalence of Various Types of Traumatic Brain Injury

Patient Demographic Information

1. Patient's unique code__________

2. Age___________

3. Sex

☐ Male

☐ Female

☐ Other

Date of Admission __________________

Date of Discharge/Death______________

Referral Source (if any) ___________________

Is there documentation of any Traumatic Brain Injury?

☐ Yes

☐ No

Date of injury (If applicable) ___________________

Number of prior documented head injuries (if any) _____________

10. What was the cause of the Traumatic Brain Injury (TBI)?

☐ Road Traffic Accident (RT)

☐ Assault

☐ Fall

☐ Occupational Injury

☐ Sports Injury

☐ Other (specify) ____________

11. Was the injury associated with any of the following?

☐ Loss of consciousness

☐ Skull fracture

☐ Seizures

☐ Vomiting

☐ Bleeding from the nose/ears

☐ Dizziness or confusion

☐ Amnesia

Glasgow Coma Scale (GCS) score on arrival_ /15

13. Type of TBI based on imaging/diagnosis (tick all that apply)

☐ Concussion

☐ Contusion

☐ Skull fracture

☐ Epidural hematoma

☐ Subdural hematoma

☐ Subarachnoid hemorrhage

☐ Intracellebral hemorrhage

☐ Diffuse axonal injury

☐ Penetrating brain injury

14. Severity of TBI:

☐ Mild (GCS 13–15)

☐ Moderate (GCS 9–12)

☐ Severe (GCS ≤8)

15. Was there any neuroimaging performed?

☐ CT Scan

☐ MRI

☐ Not done

☐ Any other

Was the patient admitted to the ICU?

☐ Yes

☐ No

Was surgery performed?

☐ Yes

☐ No

If yes, type of surgery: ____________________

Length of hospital stay (days): ____________

19. Any complications recorded (e.g., infection, seizures):

☐ Yes (specify) ______

☐ No

20. Discharge outcome:

☐ Full recovery

☐ Partial recovery with disability

☐ Persistent vegetative state

☐ Deceased

☐ Other (specify) _______________

21. Discharge destination:

☐ Home

☐ Rehabilitation facility

☐ Referred to another hospital

☐ Mortuary

☐ Other: ___________________

Was follow-up care documented or scheduled?

☐ Yes (details): _____________________

☐ No

☐ Any other

23. Any cognitive or behavioral symptoms noted post-injury?

☐ Memory issues

☐ Attention/concentration problems

☐ Emotional instability

☐ Personality change

☐ Sleep disturbances

☐ Any Other

Specify_____________________________

24. Was any neuropsychological assessment recommended or done?

☐ Yes

☐ No

☐ Any other

25. Is there any record of TBI-related disability registration or social support referral?

☐ Yes

☐ No

☐ Any other

Appendix E: Healthcare-Related Factors Determining TBI Outcomes at MeTRH

Respondent Information

Profession:

☐ Doctor

☐ Clinical Officer

☐ Nurse

☐ Radiographer

☐ Anaesthetist

☐ Other (specify): _____________

Department:

☐ Casualty/A&E

☐ Neurosurgery

☐ ICU

☐ Theatre

☐ Radiology

☐ Other (specify): _____________

Years of Experience in Current Role:

☐ <1 year

☐ 1–3 years

☐ 4–6 years

☐ >6 years

How often are you involved in the care of TBI patients

☐ Daily

☐ Rarely

☐ Never

How would you rate the general infrastructure supporting TBI care at MeTRH?

☐ Excellent

☐ Good

☐ Fair

☐ Poor

Are the departments listed below properly equipped and accessible for TBI care? (Please indicate: Yes / Partially / No)

Department	**Yes**	**Partially**	**No**
ICU/HDU			
Surgical wards			
Radiology (CT/MRI)			
ICU			
Operating Theatre			
Neurosurgery /Neuroward			

Is there reliable access to the following support services for TBI patients? (Tick all that apply)

☐ 24/7 power supply

☐ Ambulance services

☐ Oxygen supply

☐ Blood transfusion services

☐ Rehabilitation services

Are there standardized protocols or guidelines for managing TBI in your department?

☐ Yes

☐ No

☐ Not Sure

If yes, which protocols are available?

☐ Glasgow Coma Scale (GCS)

☐ Advanced Trauma Life Support (ATLS)

☐ TBI-specific care pathway

☐ Intracranial pressure (ICP) management

☐ Others (specify): _____________

Are protocols routinely followed during TBI management?

☐ Always

☐ Often

☐ Sometimes

☐ Rarely

☐ Never

Are regular trainings or CMEs provided on TBI care and use of protocols?

☐ Yes

☐ No

☐ Not Sure

Are the following specialists available for TBI management at MeTRH?

(Tick availability: Yes / No)

Specialist	**Yes**	**No**
Neurosurgeon		
Anaesthetist		
Radiologist		
Critical care nurses		

Physiotherapist		
Trauma and emergency		
Occupational therapist		

In your opinion, is there a shortage of specialized staff impacting TBI outcomes?

☐ Yes

☐ No

If yes, specify which cadres are most lacking: ______________________________

Are the following diagnostic tools functional and available for TBI patients?

Equipment	Always Available	Sometimes	Rarely	Never
CT Scan				
MRI				
X-ray				
Intracranial pressure monitor				

Are delays in diagnostic imaging common for TBI cases?

☐ Yes

☐ No

If so, what are the main causes?

☐ Equipment downtime

☐ Staff shortage

☐ Cost issues

☐ Long queues

☐ Other: ____________

Are ICU beds readily available for critically ill TBI patients?

☐ Yes

☐ Sometimes

☐ No

Sometimes, Surgical interventions for TBI patients are delayed due to: (Tick all that apply)

☐ Lack of theatre space

☐ Unavailable neurosurgeon

☐ Inadequate surgical equipment

☐ Lack of ICU beds post-op

☐ Other (specify) _____________

Is post-operative monitoring for TBI patients adequate in the ICU?

☐ Yes

☐ No

☐ Not Sure

In your opinion, what are the main healthcare-related factors that influence the health outcomes of TBI patients at MeTRH?

20.Suggest any strategies or resources needed to improve TBI care____

____

____

____

21a. In your opinion, how significant is the role of nurses in the management of TBI patients at MeTRH? ☐ Very significant ☐ Significant ☐ Moderate ☐ Minimal ☐ No role

22b. Which of the following nursing responsibilities are routinely performed in TBI patient care at your department? (Tick all that apply)

☐ Continuous neuro-observation using GCS and other tools

☐ Airway and breathing management

☐ Administration of prescribed medications (e.g., osmotic agents, analgesics)

☐ Wound and surgical site care

☐ ICP monitoring and recording [ ] nutrition support

☐ Rehabilitation support and patient/family education ☐ Other (specify): ________________________

Appendix F: Patient related factors

1.Patient’s unique code__________

2. Age___________

3. Sex

☐ Male

☐ Female

☐ Other

4. Date of Admission __________________

5.Date of Discharge/Death______________

6.Referral Source (if any) ___________________

7.Is there documentation of any Traumatic Brain Injury?

☐ Yes

☐ No

8.Date of injury (If applicable) ___________________

9.Number of prior documented head injuries (if any) _____________

10.. What was the cause of the Traumatic Brain Injury (TBI)?

☐ Road Traffic Accident (RT)

☐ Assault

☐ Fall

☐ Occupational Injury

☐ Sports Injury

☐ Other (specify) _____________

11. Was the injury associated with any of the following?

☐ Loss of consciousness

☐ Skull fracture

☐ Seizures

☐ Vomiting

☐ Bleeding from the nose/ears

☐ Dizziness or confusion

☐ Amnesia

Glasgow Coma Scale (GCS) score on arrival_ /15

13. Type of TBI based on imaging/diagnosis (tick all that apply)

☐ Concussion

☐ Contusion

☐ Skull fracture

☐ Epidural hematoma

☐ Subdural hematoma

☐ Subarachnoid hemorrhage

☐ Intracellebral hemorrhage

☐ Diffuse axonal injury

☐ Penetrating brain injury

14. Severity of TBI:

☐ Mild (GCS 13–15)

☐ Moderate (GCS 9–12)

☐ Severe (GCS ≤8)

15. Was there any neuroimaging performed?

☐ CT Scan

☐ MRI

☐ Not done

☐ Any other

Was the patient admitted to the ICU?

☐ Yes

☐ No

Was surgery performed?

☐ Yes

☐ No

If yes, type of surgery: ____________________

Length of hospital stay (days): ____________

19. Any complications recorded (e.g., infection, seizures):

☐ Yes (specify) ______

☐ No

20. Discharge outcome:

☐ Full recovery

☐ Partial recovery with disability

☐ Persistent vegetative state

☐ Deceased

☐ Other (specify) _______________

21. Discharge destination:

☐ Home

☐ Rehabilitation facility

☐ Referred to another hospital

☐ Mortuary

☐ Other: ___________________

Was follow-up care documented or scheduled?

☐ Yes (details): _____________________

☐ No

☐ Any other

23. Any cognitive or behavioral symptoms noted post-injury?

☐ Memory issues

☐ Attention/concentration problems

☐ Emotional instability

☐ Personality change

☐ Sleep disturbances

☐ Any Other

Specify______________________________

24. Was any neuropsychological assessment recommended or done?

☐ Yes

☐ No

☐ Any other

25. Is there any record of TBI-related disability registration or social support referral?

☐ Yes

☐ No

☐ Any other

Appendix G: Disability Rating Scale

TBI NATIONAL DATABASE COLLECTION FORM

Patient Name: ______________________________ **Date of Rating**:_______________

Name of Person Completing Form: ____

DISABILITY RATING SCALE:

Disability Rating Scale ratings to be completed within 72 hours after Rehab. Admission. And within 72 hours before Rehab. Discharge.

A. EYE OPENING:

- ☐ (0) Spontaneous
- ☐ (1) To Speech
- ☐ (2) To Pain
- ☐ (3) None

0-SPONTANEOUS: eyes open with sleep/wake rhythms indicating active arousal mechanisms, does not assume awareness.
1-TO SPEECH AND/OR SENSORY STIMULATION: a response to any verbal approach, whether spoken or shouted, not necessarily the command to open the eyes. Also, response to touch, mild pressure.
2-TO PAIN: tested by a painful stimulus.
3-NONE: no eye opening even to painful stimulation.

B. COMMUNICATION ABILITY:

- ☐ (0) Oriented
- ☐ (1) Confused
- ☐ (2) Inappropriate
- ☐ (3) Incomprehensible
- ☐ (4) None

0-ORIENTED: implies awareness of self and the environment. Patient able to tell you a) who he is; b) where he is; c) why he is there; d) year; e) season; f) month; g) day; h) time of day.
1-CONFUSED: attention can be held and patient responds to questions but responses are delayed and/or indicate varying degrees of disorientation and confusion.
2-INAPPROPRIATE: intelligible articulation but speech is used only in an exclamatory or random way (such as shouting and swearing); no sustained communication exchange is possible.
3-INCOMPREHENSIBLE: moaning, groaning or sounds without recognizable words, no consistent communication signs.
4-NONE: no sounds or communications signs from patient.

C. MOTOR RESPONSE:

- ☐ (0) Obeying
- ☐ (1) Localizing
- ☐ (2) Withdrawing
- ☐ (3) Flexing
- ☐ (4) Extending
- ☐ (5) None

0-OBEYING: obeying command to move finger on best side. If no response or not suitable try another command such as “move lips,” “blink eyes,” etc. Do not include grasp or other reflex responses.
1-LOCALIZING: a painful stimulus at more than one site causes limb to move (even slightly) in an attempt to remove it. It is a deliberate motor act to move away from or remove the source of noxious stimulation. If there is doubt as to whether withdrawal or localization has occurred after 3 or 4 painful stimulations, rate as localization.
2-WITHDRAWING: any generalized movement away from a noxious stimulus that is more than a simple reflex response
3-FLEXING: painful stimulation results in either flexion at the elbow, rapid withdrawal with abduction of the shoulder or a slow withdrawal with adduction of the shoulder. If there is confusion between flexing and withdrawing, then use pinprick on hands.
4-EXTENDING: painful stimulation results in extension of the limb.
5-NONE: no response can be elicited. Usually associated with hypotonia. Exclude spinal transection as an explanation of lack of response; be satisfied that an adequate stimulus has been applied.

D.FEEDING (COGNITIVE ABILITY ONLY)

- ☐ (0.0) Complete
- ☐ (1.0) Partial
- ☐ (2.0) Minimal
- ☐ (3.0) None

Does the patient show awareness of how and when to perform this activity? Ignore motor disabilities that interfere with carrying out this function. (This is rated under Level of Functioning described below.)
0-COMPLETE: continuously shows awareness that he knows how to feed and can convey unambiguous information that he knows when this activity should occur.
1-PARTIAL: intermittently shows awareness that he knows how to feed and/or can intermittently convey reasonably clearly information that he knows when the activity should occur.
2-MINIMAL: shows questionable or infrequent awareness that he knows in a primitive way how to feed and/or shows infrequently by certain signs, sounds, or activities that he is vaguely aware when the activity should occur.
3-NONE: shows virtually no awareness at any time that he knows how to feed and cannot convey information by signs, sounds, or activity that he knows when the activity should occur.

E.TOILETING (COGNITIVE ABILITY ONLY)

- ☐ (0.0) Complete
- ☐ (1.0) Partial
- ☐ (2.0) Minimal
- ☐ (3.0) None

Does the patient show awareness of how and when to perform this activity? Ignore motor disabilities that interfere with carrying out this function. (This is rated under Level of Functioning described below.) Rate best response for toileting based on bowel and bladder behavior
0-COMPLETE: continuously shows awareness that he knows how to toilet and can convey unambiguous information that he knows when this activity should occur.
1-PARTIAL: intermittently shows awareness that he knows how to toilet and/or can intermittently convey reasonably clearly information that he knows when the activity should occur.
2-MINIMAL: shows questionable or infrequent awareness that he knows in a primitive way how to toilet and/or shows infrequently by certain signs, sounds, or activities that he is vaguely aware when the activity should occur.
3-NONE: shows virtually no awareness at any time that he knows how to toilet and cannot convey information by signs, sounds, or activity that he knows when the activity should occur.

F.GROOMING (COGNITIVE ABILITY ONLY)

- ☐ (0.0) Complete
- ☐ (1.0) Partial
- ☐ (2.0) Minimal
- ☐ (3.0) None

Does the patient show awareness of how and when to perform this activity? Ignore motor disabilities that interfere with carrying out this function. (This is rated under Level of Functioning described below.) Grooming refers to bathing, washing, brushing of teeth, shaving, combing or brushing of hair and dressing.
0-COMPLETE: continuously shows awareness that he knows how to groom self and can convey unambiguous information that he knows when this activity should occur.
1-PARTIAL: intermittently shows awareness that he knows how to groom self and/or can intermittently convey reasonably clearly information that he knows when the activity should occur.
2-MINIMAL: shows questionable or infrequent awareness that he knows in a primitive way how to groom self and/or shows infrequently by certain signs, sounds, or activities that he is vaguely aware when the activity should occur.
3-NONE: shows virtually no awareness at any time that he knows how to groom self and cannot convey information by signs, sounds, or activity that he knows when the activity should occur.

G.LEVEL OF FUNCTIONING (PHYSICAL, MENTAL, EMOTIONAL OR SOCIAL FUNCTION))

- ☐ (0.0) Completely Independent
- ☐ (1.0) Independent in special environment
- ☐ (2.0) Mildly Dependent-Limited assistance (non-resid - helper)
- ☐ (3.0) Moderately Dependent-moderate assist (person in home)
- ☐ (4.0) markedly Dependent-assist all major activities, all times
- ☐ (5.0) Totally Dependent-24 hour nursing care.

0-COMPLETELY INDEPENDENT: able to live as he wishes, requiring no restriction due to physical, mental, emotional or social problems.
1-INDEPENDENT IN SPECIAL ENVIRONMENT: capable of functioning independently when needed requirements are met (mechanical aids)
2-MILDLY DEPENDENT: able to care for most of own needs but requires limited assistance due to physical, cognitive and/or emotional problems (e.g., needs non-resident helper).
3-MODERATELY DEPENDENT: able to care for self partially but needs another person at all times. (person in home)
4-MARKEDLY DEPENDENT: needs help with all major activities and the assistance of another person at all times.
5-TOTALLY DEPENDENT: not able to assist in own care and requires 24-hour nursing care.

H."EMPLOYABILITY"(AS A FULL TIME WORKER, HOMEMAKER, OR STUDENT)

- ☐ (0.0) Not Restricted
- ☐ (1.0) Selected jobs, competitive
- ☐ (2.0) Sheltered workshop, Non-competitive
- ☐ (3.0) Not Employable

0-NOT RESTRICTED: can compete in the open market for a relatively wide range of jobs commensurate with existing skills; or can initiate, plan execute and assume responsibilities associated with homemaking; or can understand and carry out most age relevant school assignments.
1-SELECTED JOBS, COMPETITIVE: can compete in a limited job market for a relatively narrow range of jobs because of limitations of the type described above and/or because of some physical limitations; or can initiate, plan, execute and assume many but not all responsibilities associated with homemaking; or can understand and carry out many but not all school assignments.
2-SHELTERED WORKSHOP, NON-COMPETITIVE: cannot compete successfully in a job market because of limitations described above and/or because of moderate or severe physical limitations; or cannot without major assistance initiate, plan, execute and assume responsibilities for homemaking; or cannot understand and carry out even relatively simple school assignments without assistance.
3-NOT EMPLOYABLE: completely unemployable because of extreme psychosocial limitations of the type described above, or completely unable to initiate, plan, execute and assume any responsibilities associated with homemaking; or cannot understand and carry out any school assignments.

The psychosocial adaptability or "employability" item takes into account overall cognitive and physical ability to be an employee, homemaker or student.
This determination should take into account considerations such as the following:

1. Able to understand, remember and follow instructions.
2. Can plan and carry out tasks at least at the level of an office clerk or in simple routine, repetitive industrial situation or can do school assignments.
3. Ability to remain oriented, relevant and appropriate in work and other psychosocial situations.
4. Ability to get to and from work or shopping centers using private or public transportation effectively.
5. Ability to deal with number concepts.
6. Ability to make purchases and handle simple money exchange problems
7. Ability to keep track of time and appointments

Revised 03/2010

Appendix H: Publication

AFRICAN JOURNAL OF SCIENCE, TECHNOLOGY AND SOCIAL SCIENCES. 4 (2) 2025, PAS 46-56 OPEN ACCESS

AFRICAN JOURNAL OF SCIENCE, TECHNOLOGY AND SOCIAL SCIENCES

Journal website: https://journals.must.ac.ke

A publication of Meru University of Science and Technology

Assessment of healthcare-related factors influencing traumatic brain injury outcomes among patients at MeTRH

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ARTICLE INFO

Keywords

Traumatic Brain Injury

Healthcare-related factors

Patient outcomes

Meru Teaching and Referral Hospital

ABSTRACT

Traumatic Brain Injury (TBI), defined as a disruption in normal brain function caused by an external force such as a blow, jolt, or penetrating injury, remains a critical public health concern due to its complex nature and long-term impact on health outcomes. In Kenya, particularly at Meru Teaching and Referral Hospital (MeTRH), the burden of TBI continues to rise amidst limited healthcare resources. Despite the growing prevalence, few studies have examined how healthcare-related factors influence patient outcomes in referral hospital settings. This study assessed healthcare-related determinants affecting TBI outcomes at MeTRH. A cross-sectional design was used, involving a sample of 152 participants derived using Nassiuma's formula and rule-of-thumb sampling. The sample included 84 medical records, 48 healthcare workers (specialists and non-specialists), and 20 patients attending the neurology clinic. Including patients allowed for capturing perspectives on post-discharge care and rehabilitation needs. Data were collected using questionnaires, structured interviews, and medical file checklists. Quantitative data were analysed in SPSS v27 using descriptive statistics, chi-square tests, and logistic regression. The reliability of the instrument was confirmed with a Cronbach's alpha coefficient of 0.825. Key findings revealed that delayed access to neurosurgical care, inadequate rehabilitation services, and lack of standardized TBI management protocols significantly influenced outcomes such as mortality, functional recovery, and quality of life. The Glasgow Outcome Scale showed poorer recovery where patients lacked timely surgery, ICU admission, or specialist follow-up. Variations in healthcare providers' knowledge and practices further highlighted gaps in standardized care. The study concludes that availability of specialised care, emergency responsiveness, and structured rehabilitation are pivotal in shaping TBI recovery. Strengthening institutional capacity through training, protocol enforcement, and investment in neurocritical care infrastructure is essential. Policy integration of national TBI management guidelines and establishment of neuro-rehabilitation units are recommended to improve outcomes in resource-limited settings.

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https://doi.org/10.58506/ajstss.v4i2.308

AFRICAN JOURNAL OF SCIENCE, TECHNOLOGY AND SOCIAL SCIENCES. ISSN:2958:0560