ASSESSMENT OF PATTERN AND FACTORS ASSOCIATED WITH INAPPROPRIATE POLYPHARMACY PRACTICE AT MUHIMBILI NATIONAL HOSPITAL

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Master of Public Health Dissertation

Muhimbili University of Health and Allied Sciences

October 2024

Muhimbili University of Health and Allied Sciences

School of Public Health and Social Sciences

ASSESSMENT OF PATTERNS AND FACTORS ASSOCIATED WITH INAPPROPRIATE POLYPHARMACY PRACTICE AT MUHIMBILI NATIONAL HOSPITAL

By

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A Dissertation Submitted in Partial Fulfilment of the Requirements for the Degree of Master of Public Health of Muhimbili University of Health and Allied Sciences

October 2024

CERTIFICATION

The undersigned certify that they have read and hereby recommend for acceptance of a dissertation titled Assessment of Patterns and Factors Associated with Polypharmacy Practice at Muhimbili National Hospital in partial fulfilment of the requirement for the degree of Master of Public Health of Muhimbili University of Health and Allied Sciences.

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DECLARATION AND COPYRIGHT

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

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ACKNOWLEDGEMENT

First and foremost, I want to praise and thank almighty God for granting me the strength, wisdom, and perseverance needed to complete this dissertation.

I am profoundly grateful to my supervisor, Dr. Nathanael Sirili, whose expertise, guidance, and encouragement were instrumental throughout this research. His constructive feedback and continuous support made this journey enlightening and rewarding. His dedication to excellence and deep understanding of the subject matter have been a constant source of inspiration. I deeply appreciate his support, which has been vital in enhancing my research abilities and broadening my understanding of the subject matter.

I extend my thanks to Prof. Doreen Mloka, my co-supervisor from Muhimbili University of Health and Allied Sciences (MUHAS). Her expert guidance and willingness to share her extensive knowledge were instrumental in shaping the direction and outcomes of this work.

I am indebted to Dr. Deus Buma, my co-supervisor from Muhimbili National Hospital for his guidance and assistance throughout the research process. His practical insights and unwavering support were vital in completing this research successfully.

To my fellow researchers and colleagues, your insightful discussions have motivated and inspired me. I am particularly thankful to Calvin and Theresia for your assistance with data analysis, reviewing, and refining my dissertation. Our group's collaborative spirit and intellectual engagement have greatly enriched this research process.

On a personal note, I owe my family a huge debt of gratitude for their unwavering support and encouragement. To my father, Dr. Paulo Mhame, your belief in me has been my anchor throughout this journey. Your guidance and wisdom have been invaluable. To my siblings, Martha, Isaack, and Esther, your patience, love, and understanding have been my greatest strengths. Your constant encouragement and emotional support have sustained me through the challenges of this academic endeavour.

DEDICATION

This dissertation is dedicated to all the patients who have experienced the complexities and challenges of polypharmacy, particularly those affected by inappropriate polypharmacy. Your journeys through the healthcare system and your resilience in the face of multiple medication regimes have been a profound source of inspiration for this research.

To the healthcare professionals who strive daily to balance the fine line between necessary and excessive medication, your dedication to patient well-being amidst the intricacies of polypharmacy is deeply appreciated. Your commitment to ensuring that treatments are effective and safe is a testament to your unwavering compassion and professional integrity.

Lastly, this dedication extends to future researchers and healthcare practitioners who will continue to explore and address the issues of polypharmacy and inappropriate polypharmacy. May this work contribute to a greater understanding and improvement of medication practices, ensuring better health outcomes for patients worldwide

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ABBREVIATIONS

ADEs	Adverse Drug Events
ADRs	Adverse Drug Reactions
EHRs	Electronic Health Records
MNH	Muhimbili National Hospital
MOI	Medical Officer In charge
MUHAS	Muhimbili University of Health and Allied Sciences
MUHAS-IRB	Muhimbili University of Health and Allied Sciences Institutional Review Board
NEMELIT	National Essential Medicines List
STG	Standard Treatment Guidelines
WHO	World Health Organization

DEFINITION OF TERMS

Adverse Drug Events (ADEs): refer to harm resulting from the use of medication. These can include side effects, drug interactions, or other unintended consequences of drug therapy.(1).

Appropriate polypharmacy: is present when all medicines are prescribed to achieve a specific therapeutic objective where medications have been optimized to minimize the risk of adverse drug reactions(2).

Dependent Variable**:** In research, the dependent variable is the outcome or response that is being studied or measured(4). In this study, "Inappropriate polypharmacy" is a dependent variable as it is the main outcome of interest.

Inappropriate polypharmacy: is present when one or more medicines are prescribed that are no longer needed, either because there is no evidence-based indication, one or more medicines fail to achieve the intended therapeutic objectives, or a combination of several medicines causes ADRs(2).

Inappropriate polypharmacy indicators are criteria or guidelines used by healthcare professionals to identify situations where polypharmacy may be inappropriate or potentially harmful to patients. These indicators include: no evidence-based indication (or indication has expired), medications failure to achieve the therapeutic objective, and the risk of drug-drug interaction and drug-disease interaction(2).

Pattern refers to the recurring trends observed in the occurrence and characteristics of inappropriate polypharmacy. This includes the magnitude or prevalence of inappropriate polypharmacy, the most linked medical conditions, and the adherence to prescribing guidelines.

Polypharmacy**:** refers to the concurrent use of multiple medications by an individual. In this study, it is mainly focused on cases where five or more medications are used routinely.(2).

ABSTRACT

Background: Polypharmacy involves the use of multiple medications by a single individual, often due to multiple medical conditions or symptoms. Inappropriate polypharmacy occurs when a patient is prescribed multiple medications that are either unnecessary or potentially unsafe. Inappropriate polypharmacy can lead to adverse drug reactions, decreased adherence, morbidity, mortality, and increased healthcare costs. Despite global concerns about its adverse effects, the indications, magnitude, involved medical conditions, and patient factors associated with inappropriate polypharmacy Tanzania.

Objective: To assess patterns and factors associated with polypharmacy at Muhimbili National Hospital.

Materials & Methods: A cross-sectional study design was employed. Prescriptions of 682 patients who received treatment at Muhimbili National Hospital from January 2023 to June 2023 were reviewed using a random probability sampling technique. Descriptive statistics were used to assess the magnitude of inappropriate polypharmacy, identify involved medical conditions, and identify patterns. Logistic regression was used to determine the associations between patient factors, provider factors and inappropriate polypharmacy.

Results: More than half of the patients were female (58.4%), and 65.3% were adults aged 18-64. Most patients (67.2%) used insurance. Inappropriate polypharmacy occurred in 46.5% of cases. Higher risks were noted in females (aOR: 1.14,), adults aged 16-64 (aOR: 1.3), and insured patients (aOR: 1.16), while those with multi-morbidity had a lower risk (aOR: 0.59). Opioids & Narcotics were the most common drugs with addiction risks.

Conclusions and recommendations: Inappropriate polypharmacy is a significant issue, especially among females, adults, and insured patients, often linked to conditions like obstetrics and gynecology, oncologic, and cardiovascular diseases. To improve patient safety and medication use, the study recommends strict adherence to prescribing guidelines, regular medication reviews by multidisciplinary teams, and promotion of collaborative care models. These steps aim to reduce unnecessary or harmful medication use and enhance patient outcomes.

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background

Polypharmacy is the concurrent use of medications, mainly in older adults, due to multiple morbidities, which usually require treatment with multiple medications. Polypharmacy is often necessary and beneficial for managing complex health conditions. However, it also increases the risk of adverse drug reactions, drug interactions, medication errors, and non-adherence when polypharmacy is inappropriate. Polypharmacy can be appropriate or inappropriate, with appropriate polypharmacy aiming to achieve specific therapeutic objectives and minimize adverse drug reactions, while inappropriate polypharmacy occurs when prescribed unnecessary medicines or combinations cause adverse reactions(2).

Globally, inappropriate polypharmacy has been enhanced by the increasing burden of chronic diseases such as hypertension, diabetes, and cardiovascular conditions(8,9). Commonly prescribed drugs associated with inappropriate polypharmacy include those for managing chronic conditions, such as antihypertensives, antidiabetic agents, and statins. In addition, to these other factors contributing to inappropriate polypharmacy on a global scale include the influence of pharmaceutical marketing, fragmented healthcare systems, disease-focused approach to healthcare, and patient's expectations for quick treatment, prescribe knowledge, and insufficient communication among healthcare providers(10,11).

In Africa, factors that contribute to the prevalence of inappropriate polypharmacy, including limited access to comprehensive healthcare services, inadequate patient education, and lack of regulatory oversight in some regions(12). Additionally, the double burden of communicable and non-communicable diseases leads to simultaneous use of multiple medications, increasing the risk of drug interactions and side effects.

Currently, in Tanzania, comprehensive data on the prevalence of inappropriate polypharmacy is limited with a few studies and anecdotal evidence suggests that

inappropriate polypharmacy may be prevalent in prescription issued to older adults and children(13). Inappropriate polypharmacy and impact related to ADRs has not been extensively studied in Tanzania. This study therefore aims to determine magnitude of inappropriate polypharmacy at Muhimbili National hospital. The findings of this study will highlight the extent of the problem and medical conditions commonly involved, that in turn may improve prescribing practices in Tanzania.

1.2 Problem Statement

Appropriate prescribing practice, characterized by sound clinical judgment, careful follow-up and periodic dose adjustments, is emphasized in healthcare facilities(2). This aligns with the principles outlined in the Standard Treatment Guidelines and National Essential Medicines List (STG/NEMELIT) developed by the government of Tanzania(14).

However, even with the implementation of the guidelines, it has been observed that some polypharmacy prescriptions remain inappropriate(15).

Studies done in Tanzania on polypharmacy have shown that it is associated with adverse outcomes, including increased drug resistance, prolonged hospital stays, morbidity, mortality, and additional healthcare costs with prevalence of 18.2% (13).

The current information on the patterns and factors associated with polypharmacy is limited. Therefore, this study aimed to assess magnitude of inappropriate polypharmacy, commonly involved medical conditions, prescribing adherence to guidelines and factors associated with this practice at Muhimbili National Hospital.

1.3 Conceptual Framework

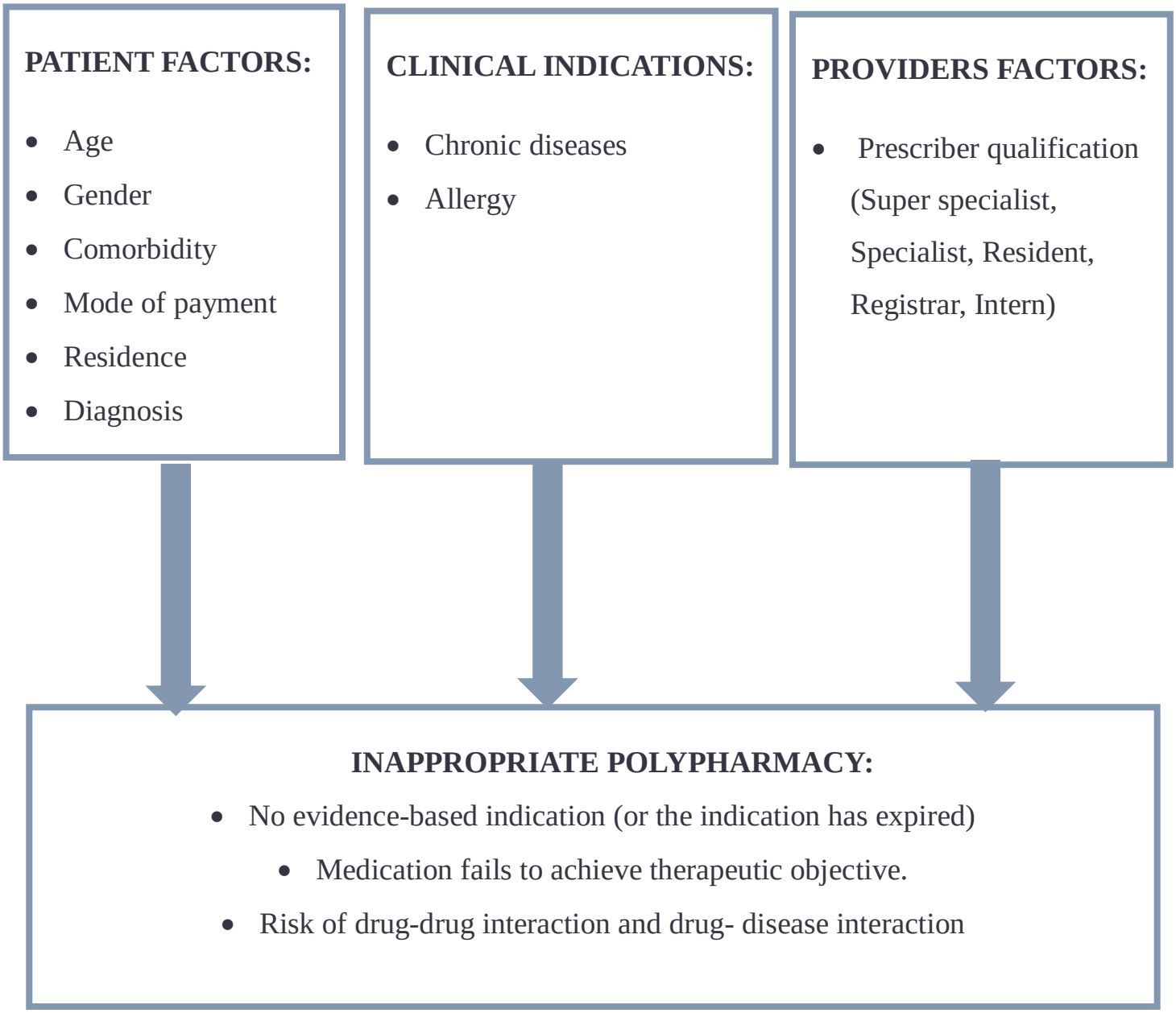


Figure 1: Conceptual framework of polypharmacy [Adapted from Mina Khezrian et al(16)

Independent Variables:

Patient factors:

1. **Age**: Elderly patients tend to have more chronic health conditions, which may necessitate multiple medications to manage these conditions, leading to a higher rate of inappropriate polypharmacy.

2. **Gender**: Gender can influence the prevalence of certain health conditions and treatment approaches, potentially affecting the likelihood of inappropriate polypharmacy. For instance, women may be more likely to be prescribed certain medications, such as hormone replacement therapy or medications for osteoporosis.

3. **Multiple Comorbidities**: Patients with multiple comorbidities often require multiple medications to manage each condition, hence, inappropriate polypharmacy.

4. **Mode of Payment**: The mode of payment can impact access to healthcare services and medications. Patients with insurance are less likely to be implicated with inappropriate polypharmacy since insurance companies emphasize evidence-based prescribing, whereas patients who use cash mode of payment may have easier access to medications, potentially leading to higher rates of inappropriate polypharmacy.

5. **Residence**: Geographic location and type of residence (urban vs. rural) can influence access to healthcare services and specialty care. Patients in rural areas may have limited access to healthcare providers, leading to suboptimal management of health conditions and potentially inappropriate polypharmacy. On the other hand, easy access to healthcare services and the availability of medicines in urban areas can also lead to inappropriate polypharmacy. Such as, the use of over-the-counter medications.

6. **Diagnosis/Clinical indication**: Certain medical conditions may require multiple medications for effective management. For example, patients with diabetes, hypertension, or heart failure may need multiple medications to control their conditions, hence, inappropriate polypharmacy. Also, Allergies to certain medications may limit treatment options and increase the complexity of medication regimens, potentially contributing to inappropriate polypharmacy.

7. **Admission**: The reason for hospital admission can influence the medications prescribed during hospitalization and upon discharge. Patients admitted for acute conditions may receive temporary medications that are discontinued upon discharge. In contrast, those admitted for chronic conditions may experience changes in their medication regimen, potentially leading to inappropriate polypharmacy.

Provider's factors:

Prescriber qualifications ranging from super specialists to interns, impact inappropriate polypharmacy. Superspecialists and specialists with extensive training and expertise, tend to prescribe medications based on evidence and clinical judgment, lowering the risk of inappropriate polypharmacy. In contrast, less experienced providers like residents and interns may rely more on protocols and supervision, potentially increasing inappropriate polypharmacy due to limited experience.

Dependent Variable (Inappropriate polypharmacy):

Inappropriate polypharmacy can lead to adverse drug reactions, drug interactions, non-adherence, and increased healthcare costs if medications are unnecessary, redundant, or prescribed without careful consideration of potential risks and benefits. This phenomenon may manifest through:

1. **No evidence-based indication (or the indication has expired)**: Medications prescribed without a valid indication or when the indication for medication use is

no longer present contribute to inappropriate polypharmacy. This practice increases the likelihood of unnecessary medication use and potential harm to the patient.

2. **Medication fails to the achieve therapeutic objective**: When medications prescribed do not effectively manage the targeted health condition or fail to achieve the intended therapeutic outcome, it indicates a potential case of inappropriate polypharmacy. In such instances, patients may be subjected to unnecessary medication burden without realizing any clinical benefit.

3. **Risk of drug-drug interaction and drug-disease interaction**: Concurrent use of multiple medications increases the risk of drug-drug interactions, where the effects of one medication may be altered by another, potentially leading to adverse effects or therapeutic failure. Similarly, drug-disease interactions may occur when medications exacerbate underlying health conditions or interact unfavourably with the patient's medical history, further complicating their treatment regimen and contributing to inappropriate polypharmacy.

Generally, patient and provider factors interrelate to influence the occurrence of inappropriate polypharmacy. Healthcare providers must carefully assess each patient's individual needs, consider potential risks and benefits of medication therapy, and engage in shared decision-making to optimize medication regimens and minimize the risk of inappropriate polypharmacy-related complications. Addressing indicators such as evidence-based indication, therapeutic efficacy, and potential drug interactions is crucial in identifying and mitigating inappropriate polypharmacy, ultimately promoting safer and more effective medication use.

1.4 Rationale

Optimizing medication regimens at Muhimbili National Hospital is a pivotal step toward reducing the risks of inappropriate polypharmacy, ultimately enhancing patient health outcomes. By systematically identifying and addressing unnecessary or inappropriate medications, healthcare providers can prevent adverse drug reactions, reduce harmful drug

interactions, and achieve therapeutic goals with greater precision. This approach not only improves patient outcomes but also reduces hospital readmissions and healthcare costs associated with medication-related complications. Nationally, these efforts support Tanzania's health objectives to decrease disability, morbidity, and mortality. Sharing these findings across healthcare institutions can establish a standardized approach to medication management, promoting rational drug use, improving patient safety, and elevating the quality of care throughout the country.

1.4 Main research questions

What are the patterns and factors associated with inappropriate polypharmacy at MNH?

1.5 Specific questions

1. What is the magnitude of inappropriate polypharmacy at MNH?
2. What are the medical conditions commonly involved in inappropriate polypharmacy at MNH?
3. How does the prescribing practice at MNH adhere to guidelines**?**
4. What are the factors associated with inappropriate polypharmacy at MNH?

1.6 Broad objective

To assess patterns and factors associated with inappropriate polypharmacy at MNH.

1.6.1 Specific objectives

1. To determine the magnitude of inappropriate polypharmacy at MNH
2. To explore medical conditions commonly involved in inappropriate polypharmacy at MNH.
3. To assess prescribing adherence to guidelines at MNH.
4. To assess factors associated with inappropriate polypharmacy at MNH.

CHAPTER TWO

2.0 Literature review

2.1 Magnitude of inappropriate polypharmacy.

Inappropriate polypharmacy is characterized by the concurrent use of multiple medications without a clear medication indication or considering adverse effects. Many global studies have highlighted that the prevalence rates of inappropriate polypharmacy vary between countries and populations. In developed nations, the prevalence ranges from 28% to 48% due to the increased chronic diseases and the complexities of managing multiple conditions(17,18). In lower middle-income countries, the prevalence of inappropriate polypharmacy is 47.2%(19).

As global populations ages, the prevalence of inappropriate polypharmacy maybe consistently increasing due to aged suffered from multiple comorbidities. There is thus the need to address inappropriate polypharmacy as it significantly impacts patient safety, healthcare resource allocation, and overall healthcare outcomes. A study conducted in China highlighted the global significance of inappropriate polypharmacy, particularly in geriatric demonstrated that inappropriate polypharmacy is not confined to a single geographic location but is a global concern for healthcare systems(18).

In the Sub-Saharan African region, the significance of inappropriate polypharmacy is increasingly acknowledged as a distinct healthcare challenge(19). Evidence suggests that inappropriate polypharmacy led to the occurrence of potential drug–drug interactions. For instance, this was observed among geriatric patients attending the ambulatory care clinics in the University of Gondar (UOG) Teaching Hospital, Gondar, Ethiopia(19). While the magnitude of inappropriate polypharmacy may vary across African countries, the recognition of its significance is a significant step towards improving medication safety and the quality of care provided to African populations(20).

In Tanzania, a country distinguished by its distinctive healthcare system that combines traditional medicinal practices and modern healthcare services, the precise extent of inappropriate polypharmacy remains largely unknown(13). Lack of comprehensive data hinders the implementation of effective strategies to reduce inappropriate polypharmacy in Tanzania(21). This knowledge gap emphasizes the urgent need to initiate research projects aimed at quantifying the extent of inappropriate polypharmacy in Tanzania's healthcare system. Addressing this gap through extensive research is essential for the development of evidence-based policies and interventions that can effectively mitigate the risks associated with inappropriate polypharmacy and improve the overall quality of healthcare provided to Tanzanian populations.

2.2 Association of medical conditions with inappropriate polypharmacy.

Globally, extensive research has shed light on how the management of specific medical conditions contributes significantly to the continuation of inappropriate polypharmacy issue, emphasizing the need for comprehensive medication management strategies(22). For instance, hypertension often requires antihypertensive medications like beta-blockers, ACE inhibitors, or diuretics. However, individuals with hypertension commonly have accompanying conditions like diabetes or heart disease, leading to additional medications being prescribed(23). This simultaneous management of multiple risk factors contributes to the complexity of medication regimens and the occurrence of inappropriate polypharmacy.

Similarly, individuals with diabetes frequently require antidiabetic medications such as insulin, metformin, or other oral hypoglycemic agents. However, diabetes often coexists with conditions like hypertension or dyslipidemia, leading to the addition of medications targeting these comorbidities(24). This intertwined treatment regimen for diabetes and its associated conditions can quickly escalate, resulting in inappropriate polypharmacy concerns.

Likewise, patients suffering from chronic pain conditions, including osteoarthritis or fibromyalgia, often require the use of combination of medications. The same is also true

for patients with mental health disorders, gastroesophageal reflux disease (GERD), Parkinson's disease, and Human immunodeficiency Virus (HIV)(21,25).

In Africa, data specifically identifying the types of medications involved in inappropriate polypharmacy are limited. However, studies suggest that common medications implicated in polypharmacy may include antihypertensive, antidiabetics, and analgesics(26).

Despite the uniqueness of the Tanzanian healthcare context, there is a lack of specific information regarding the categories of medications and medical conditions commonly implicated in inappropriate polypharmacy(27). Understanding the most common medical conditions linked to inappropriate polypharmacy is critical in optimizing treatment plans and improving patient outcomes. Therefore, focused studies on inappropriate polypharmacy are required for care quality improvement in the Tanzanian healthcare context.

2.3 Prescribing adherence to guidelines

One of the main criteria contributing to inappropriate polypharmacy is the prescription of medications without evidence-based indications or when the indication has expired. It is observed in both developed and developing countries, where healthcare providers may overprescribe medications due to various reasons such as patient demand, lack of time for thorough assessment, or financial incentives(28).

Furthermore, medications failing to achieve therapeutic objectives contribute to inappropriate polypharmacy. This issue is exacerbated by the increasing burden of chronic diseases globally, leading to the use of multiple medications to manage complex health conditions. Additionally, adverse drug reactions (ADRs) resulting from inappropriate polypharmacy pose a significant challenge to healthcare systems worldwide(28,29). These ADRs not only compromise patient safety but also contribute to increased healthcare utilization and costs.

In African countries, inappropriate polypharmacy is a growing concern due to the rising prevalence of chronic diseases and the increasing availability of medications(26). Limited

access to evidence-based guidelines and regulatory frameworks further exacerbates the problem. The prescription of unnecessary medications, including those with no evidence-based indication or expired indications, is common in many African healthcare settings(20).

Patients in African nations frequently face challenges in accessing comprehensive healthcare services, leading to suboptimal treatment outcomes(26). Furthermore, in Africa, where pharmacovigilance mechanisms may be poor, ADRs resulting from inappropriate polypharmacy place a significant burden on already overburdened healthcare systems.

ADRs resulting from inappropriate polypharmacy pose considerable challenges in Tanzania, where healthcare resources are frequently scarce. Patients may experience adverse effects due to interactions between multiple medications or inappropriate dosage regimens(13). Additionally, patient non-adherence to prescribed medications contributes to the problem of inappropriate polypharmacy in Tanzania.

In Tanzania, inappropriate polypharmacy is a multifaceted issue with significant implications for public health. The prescription of unnecessary medications is prevalent, driven by factors such as limited access to evidence-based guidelines and the influence of pharmaceutical marketing practices(30). The frequent occurrence of drugs not accomplishing their therapeutic objectives further emphasizes the necessity for better medication management and prescribing practices(30). Moreover, it has been observed that prescribers in public health facilities do not adhere to the national STG/NEMLIT(31).

ADRs resulting from inappropriate polypharmacy pose considerable challenges in Tanzania, where healthcare resources are frequently scarce. Patients may experience adverse effects due to interactions between multiple medications or inappropriate dosage regimens(13). Additionally, patient non-adherence to prescribed medications contributes to the problem of inappropriate polypharmacy in Tanzania.

2.4 Factors associated with inappropriate polypharmacy.

Patient factors.

Aging populations and advances in medical technology have caused a rise in chronic illnesses and inappropriate polypharmacy in developed nations like the United Kingdom (UK)(32). In these conditions, patient factors like advanced age, multiple comorbidities, and female gender are frequently found to be predictive of inappropriate polypharmacy. Higher rates of inappropriate polypharmacy result from the fact that elderly individuals frequently have many chronic diseases requiring multiple drugs(33). Additionally, due to physiological variables and variations in healthcare-seeking behaviour, the feminine gender has been linked to increased medication consumption. There are several key physiological differences between females and males that influence how medications are absorbed, distributed, metabolized, and eliminated, potentially contributing to inappropriate polypharmacy in females. Females typically have higher body fat and lower muscle mass than males, affecting the distribution of fat-soluble drugs, which are more likely to accumulate in women's fat tissue, leading to prolonged drug action and a higher risk of side effects. On the other hand, males generally have a higher percentage of lean body mass, influencing drug metabolism and clearance differently. Changes in a woman's hormones, especially during menstruation, pregnancy, and menopause, can also affect how drugs are broken down by changing the activity of liver enzymes. Hormonal contraception and hormone replacement therapy may further influence drug effectiveness and toxicity. Additionally, women tend to have slower gastric emptying and reduced liver enzyme activity, such as cytochrome P450 enzymes, which can delay drug clearance, raising the risk of adverse effects, particularly with chronic medication use. Differences in kidney function and blood flow between genders also require dose adjustments for women. Also, women may have different drug sensitivities due to variations in receptor types and densities, making them more sensitive to certain medications like opioids and sedatives, increasing the risk of overdose or dependency if not properly managed.

In paediatric patients, inappropriate polypharmacy can occur due to the complexities of treating both chronic and acute conditions and challenges in adjusting doses based on age, weight, and developmental stages. Children are often vulnerable to adverse drug reactions due to immature organ systems and differing metabolic rates**.** Furthermore, the method of payment for healthcare services affects prescription medication patterns. Healthcare professionals may be financially motivated to prescribe additional prescriptions in nations with fee-for-service reimbursement models, which could lead to inappropriate polypharmacy(34). On the other hand, initiatives to cut medicine use may be made in settings with capitated payment schemes to control expenditures.

The burden of inappropriate polypharmacy is made worse in Africa by difficulties such as a lack of resources for healthcare, a deficient infrastructure for healthcare, and a greater frequency of infectious diseases combined with a rise in non-communicable diseases (NCDs)(26). The patient factors linked to inappropriate polypharmacy in Africa are like those observed worldwide, with age and several comorbidities playing a major role. But other elements, such a poorer socioeconomic status, less access to healthcare, and a dependence on conventional treatment, can make inappropriate polypharmacy problems worse.

Similar patterns of inappropriate polypharmacy are seen in Tanzania, where issues with the healthcare system, an aging population, and the rise in chronic illness prevalence are the main drivers. Since the public sector provides most healthcare services, inadequate staffing and resource constraints may result in less-than-ideal prescribing practices.

Patients in Tanzania frequently require polypharmacy due to their various chronic and acute diseases, especially HIV/AIDS, malaria, tuberculosis, and NCDs like diabetes and hypertension. Geographical location affects access to healthcare services; urban populations have easier access to healthcare facilities, which may result in the inappropriate use of medications(13). Easy access to healthcare can lead to inappropriate medication use due to over-prescription, conflicting prescriptions from multiple providers, increased patient expectations for immediate relief, and self-medication with over-the-

counter drugs, raising the risk of drug interactions and unnecessary medications being added when thorough reviews are limited. Furthermore, individuals who pay for healthcare services out of pocket may attract irrational prescription and dispensing patterns which may lead to inappropriate polypharmacy.

Provider factors.

Prescribers' qualifications play a crucial role in shaping medication prescribing practices and, subsequently, influencing the prevalence of inappropriate polypharmacy. On a global scale, provider factors such as advanced prescriber qualifications (e.g., super specialists, specialists) are associated with varying prescribing patterns. Research indicates that healthcare professionals with higher qualifications may exhibit more cautious prescribing behaviours, leading to reduced rates of inappropriate polypharmacy(35). Conversely, inexperienced prescribers, such as interns and residents, may be more prone to prescribing multiple medications without adequate clinical justification, contributing to the problem of inappropriate polypharmacy.

In Africa, where healthcare resources are often limited, provider factors such as staffing shortages and inadequate infrastructure pose significant challenges to medication prescribing practices. Despite similarities in patient factors contributing to inappropriate polypharmacy, such as advanced age and multiple comorbidities, provider-related issues exacerbate the problem(26). Additionally, reliance on conventional treatment methods and disparities in access to healthcare further complicate prescribing practices, potentially leading to inappropriate polypharmacy.

Likewise, in Tanzania, where the burden of chronic illnesses is rising, provider factors significantly impact medication prescribing practices and contribute to inappropriate polypharmacy. Challenges within the healthcare system, including inadequate staffing and resource constraints, may result in suboptimal prescribing behaviours(21). Inadequate staffing leads to inappropriate polypharmacy because overburdened healthcare providers have less time for thorough patient reviews, often resulting in rushed prescriptions and less careful medication management. Moreover, disparities in access to healthcare services,

particularly between urban and rural areas, influence prescribing patterns and contribute to the inappropriate use of medications.

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Study Design

This was a quantitative study that employed a cross-sectional design to determine the magnitude of inappropriate polypharmacy, medical conditions commonly involved, prescribing adherence to guidelines, and factors associated with inappropriate polypharmacy.

3.2 Study population, Sample size and Selection

The study focused on the study population, which included medical records of both inpatients and outpatients who have received five or more medicines during the period from January 2023 to June 2023 from Muhimbili National Hospital, which is in Upanga West ward of Ilala District in Dar es Salaam region of Tanzania. The selection of healthcare facility was made purposefully, because it is a high-level tertiary facility that serves large number of patients.

3.2.1 Selection of Study Units (Patients):

Patient's medical records: data were retrieved from MNH databases to identify patients with a history of taking five or more medications. The MNH databases provided a comprehensive source of patient records encompassing medication prescriptions, diagnoses, and demographic information. The required sample size was selected through probability sampling. A structured data extraction process was employed to gather information on medication usage patterns, comorbidities, duration of treatment, and demographic characteristics of individuals with polypharmacy.

3.2.2 Sample size:

For patient medical records, the sample size was selected by means of using the Fisher equation:

$$n = \frac{Z^2 \times p(1-p)}{e^2}$$

Where:

n = required sample size

Z = (Z-score is the confidence interval for a 95% confidence level, Z ≈ 1.96)

p = proportion is 47.2% (0.472) prevalence of inappropriate polypharmacy from Bhagavatula AS et al(19)

e = margin of error 3.95% (0.0395)

The sample size was calculated as follows:

$$n = \frac{1.96^2 \times 0.472(1-0.472)}{0.0395^2}$$ n = 614

The sample size required was 614 patients but accounting for samples with incomplete documents (non-response rate): 10% (0.1)

To adjust for non-response:

Adjusted sample size = Original sample size / (1- non-response rate)

Adjusted sample size = 614 / (1 – 0.10)

Adjusted sample size = 614 / 0.90

Adjusted sample size ≈ 682

Therefore, 682 patients were required for medical records and prescription review.

3.2.3 Inclusion criteria

1. Patient medical records:

- Medical records of patients who received treatment at MNH.
- Medical records with at least 5 medications.

3.2.4 Exclusion criteria

1. Patient medical records:
    - Medical records with incomplete information.

3.3 Variables

Table 1: Variables

CATEGORY	VARIABLE	OPERATIONAL DEFINITION	SCALE OF MEASUREMENT
DEPENDENT VARIABLE	INAPPROPRIATE POLYPHARMACY	Yes or No	Binary
INDEPENDENT VARIABLE	Age	Age of patients in years	Quantitative
Patient Factors	Gender	Male or Female	Binary
	Occupation	Type of work or employment status of the patient	Nominal
	Comorbidity	Presence of two or more diagnosed medical conditions or chronic illnesses	Nominal
	Mode of payment	Categorized into Private insurance, Government insurance, Out-of-pocket, or other relevant categories	Nominal
	Residence	Urban or Rural	Binary
	Diagnosis	Recorded based on the specific medical conditions identified in patient's medical records	Nominal
	Admission	Inpatient or Outpatient	Binary

3.4 Data collection methods

The data collection process involved a team of five trained data collectors (pharmacists, doctors, or nurses) who underwent a comprehensive two-day training session. During this training, they became proficient in using the data extraction tool to capture information regarding indicators of inappropriate polypharmacy, its magnitude, commonly involved medical conditions, and relevant patient factors associated with inappropriate polypharmacy. The data collection tool (Appendix 1) consisted of three sections: Patient Characteristics, Clinical Characteristics, and Medication Assessment.

The Patient Characteristics section gathered essential patient data, including demographic details, payment methods, admission status, and prescriber qualification. Clinical Characteristics included diagnoses, laboratory tests, referral history, comorbidities, and prescribed medicines. Additionally, the tool assessed medication inappropriateness in terms of no evidence-based indication, expired indication, failure to achieve therapeutic objectives (such as duration, dosing frequency, and dosage), and the risk of drug-drug and drug-disease interactions, ensuring comprehensive data collection for analysis.

Data entry was facilitated through the utilization of the KoboToolbox platform, ensuring efficient and accurate data capture. Detailed guidelines and protocols were provided to the data collectors, allowing any individual who did not participate in the proposal's development to effectively and consistently collect data by the study's objectives.

3.4.1 Resources required.

1. **Human Resources:**

- Trained data collectors: Collected data from patients’ medical files.
- Data analysts: Processed and analyzed data, including statistical analysis.
- Research team: Oversaw the data collection process, provided training, and ensured quality control.

2. **Data extraction form.**

- A data extraction form was used to acquire specific variables of interest from patients.

3.5 Investigation tools and validity and reliability issues

This study used a data extraction tool to collect and measure the relevant data. To assess the magnitude of inappropriate polypharmacy, medical conditions commonly involved, prescribing adherence to guidelines, as well as patient factors associated with inappropriate polypharmacy, the data extraction tool systematically gathered information from patient medical records at MNH. The validity of the tools was established using established guidelines and consulting with experts in the field, while reliability was assessed through pilot testing and inter-rater reliability checks. These checks were conducted in a non-participating healthcare facility to refine the tool's effectiveness and alignment with the research objectives. These steps collectively aimed to ensure that the study measured the desired variables accurately and consistently.

3.6 Data analysis

Objective 1: Determine the magnitude of inappropriate polypharmacy.

To assess the magnitude of inappropriate polypharmacy, descriptive statistical analysis was conducted for variables related to the number of medications prescribed and the frequency of inappropriate polypharmacy.

Objective 2: Determine medical conditions commonly involved in inappropriate polypharmacy.

Data coding and classification techniques were employed to determine the medical conditions commonly involved in inappropriate polypharmacy. Medications were categorized based on the medical condition and their therapeutic classes or drug categories.

The frequency and percentage distribution of medications within each category were calculated.

Objective 3: Examine prescribing adherence to guidelines.

Indicators of inappropriate polypharmacy included no evidence-based indication (or indication had expired), medications failing to achieve therapeutic objectives, and the risk of drug-drug and drug-disease interactions. The data analysis plan for examining these indicators involved collecting patient medical records and coding variables related to evidence-based medication indications, medication doses, and therapeutic objective achievement according to the Standard Treatment Guideline (STG)

The review process involved the four (4) steps approach adapted from WHO(2)

1. Aims: Identify the objectives of the therapy. Diagnoses were reviewed and therapeutic objectives were identified concerning: Management of existing health problems and Prevention of future health problems.

2. Need: Identify essential drugs. The need for drugs was reviewed by checking whether the patient took unnecessary drug therapy. Drugs with temporary indications, higher than usual maintenance doses, and limited benefit in general for the indication they are used for were identified.

3. Effectiveness: Determined if therapeutic objectives were being achieved. Assessed if drug therapy achieved therapeutic objectives such as symptoms control, achievement of clinical targets, or prevention of disease progression.

4. Safety: Identified if the patient had adverse drug reactions (ADRs) or was at risk of ADRs by: Checking for drug-disease and drug-drug interactions and assessing the risk of addiction.

Descriptive analysis was conducted to calculate frequencies and percentages of these variables, assessing the extent of inappropriate polypharmacy according to defined indicators/criteria. Patterns and trends in medication prescribing were identified, and

findings were interpreted to inform recommendations for improving medication management practices and patient safety.

Objective 4: Assess factors associated with inappropriate polypharmacy.

Investigating factors associated with inappropriate polypharmacy involved collecting demographic and clinical data from patient records and coding variables accordingly. Logistic regression analysis was employed to assess associations between factors (such as age, gender, comorbidities, and prescribers' qualifications) and inappropriate polypharmacy. Crude odds ratios were calculated to determine unadjusted associations, while adjusted odds ratios accounted for potential confounders. Findings were interpreted to identify significant associations.

3.7 Ethical issues

Ethical clearance was sought and obtained from the University Ethical Committee of Muhimbili University of Health and Allied Sciences (MUHAS-IRB), Tanzania. Formal approval letters were secured from the Director at Muhimbili National Hospital, ensuring adherence to institutional administrative protocols.

To ensure data confidentiality during the extraction of patient prescription data, records were anonymized and de-identified, with identifying information such as names or patient file numbers replaced by unique codes (e.g., 001). Additionally, strict access controls were enforced, ensuring that only trained data collectors could access to the data. These data collectors were thoroughly informed about the importance of data privacy maintaining the highest standards of confidentiality.

3.8 Study limitation and mitigation

Reliance on the electronic data introduced information bias since some data were entered inaccurately, which could represent a limitation to the precision of the findings.

Mitigation: Medical files enhanced data accuracy review.

CHAPTER FOUR

4.0 RESULTS

4.1 Socio-demographic characteristics of the study population.

The study involved 682 patients who received treatment at Muhimbili National Hospital from January 2023 to June 2023 with equal representation of inpatients and outpatients (table 2). More than half (58.4%) of the patients were female. Most of the patients were adults (18 to 64 years), comprising 65.3% of the sample. The mean age of the patients was 40.3 years, with a standard deviation of 23.1 years.

Most patients resided in Dar es Salaam, accounting for 65.3% of the population. Regarding the mode of payment for healthcare services, insurance was the most common method used by 67.2% of the patients.

Table 2: Socio-Demographic characteristics

Variable	Frequency (n)	Percent (%)
Sex		
Female	398	58.4
Male	284	41.6
Age group		
Children (0-15)	125	18.3
Adults (16-64)	445	65.3
Elderly (+65)	112	16.4
Mean (SD)	40.3	23.1
Residence		
Dar es Salaam	445	65.3
Outside DSM	237	34.7
Mode of payment		
Cash	224	32.8
Insurance	458	67.2
Patient category		
Inpatient	341	50.0
Outpatient	341	50.0

4.2 Magnitude of inappropriate polypharmacy

The study examined the distribution of appropriate and inappropriate polypharmacy among 682 patients. It shows that 53.5% (365) of the patients received a combination of medications considered medically suitable and necessary, indicating appropriate polypharmacy. On the other hand, 46.5% (317) of the patients received inappropriate polypharmacy prescriptions.

4.3 Appropriateness and Inappropriateness of polypharmacy

Out of 628 prescriptions reviewed, 53.5% (365) were deemed appropriate, while 46.5% (317) were classified as inappropriate. Of the 317 prescriptions categorized inappropriate41.0% had no clear clinical indication, and 31.8% involved significant drug interactions., 25.6% were associated with the risk of addiction as shown in table 3 below. For appropriate polypharmacy, the median number of interactions was 1 (IQR 1-3). Inappropriate polypharmacy had a higher median of 3 interactions (IQR 2-5), with cases extending up to 20 interactions, indicating increased complexity and risk. Category D interactions had a median of 4 (IQR 2-6), and category X interactions had a median of 2 (IQR 2-7), highlighting the severity of these interactions in inappropriate cases as shown in figure 2 below.

Table 3: Appropriateness and Inappropriateness of polypharmacy

Polypharmacy	**Frequency(n=682)**	**Percentage (%)**
Appropriate	365	53.5
Inappropriate	317	46.5
Inappropriate parameters	**Frequency(n=468)**	**Percentage (%)**
Clinical indication		
No	192	41.0
Drug interaction		
D	149	31.8
X	7	1.5
Risk of addiction	120	25.6

Key: D, X- Drug interaction categories

D- indicates a significant risk of adverse effects that requires close monitoring and potential modification of therapy.

X- indicates a high risk of serious adverse effects, and the combination should be avoided as the risks outweigh any potential benefits.

Out of the total cases, 53.5% were deemed appropriate, while 46.5% were classified as inappropriate, highlighting a substantial issue with misuse of multiple medications. Notably, 41.0% had no clear clinical indication, and 31.8% involved significant drug interactions. Additionally, 25.6% presented a risk of addiction.

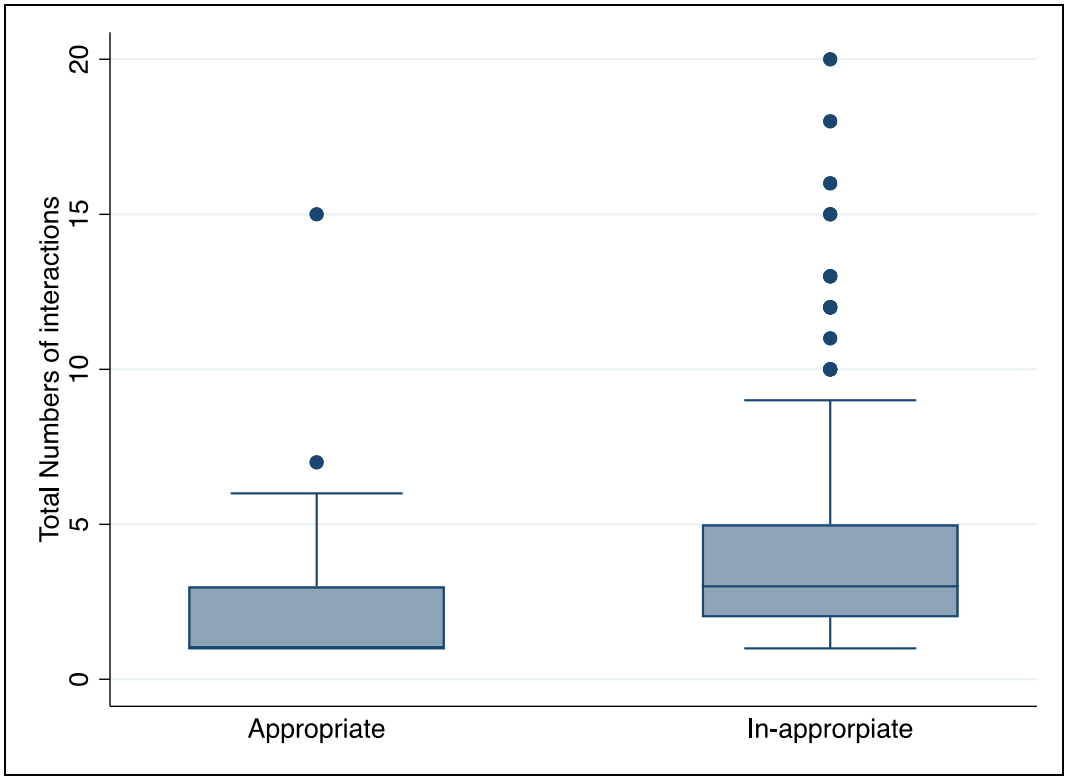


Figure 2: Number of interactions by Appropriate and Inappropriate polypharmacy

4.4 Number of inappropriate polypharmacy prescriptions per medical conditions

Obstetrics and gynecological conditions had the highest number of inappropriate polypharmacy prescriptions (32%), followed by patients with oncological conditions (20%) and cardiovascular disease patients (18%) respectively as shown in figure 3

Figure 3: Number of inappropriate polypharmacy prescriptions per medical conditions (n=317)

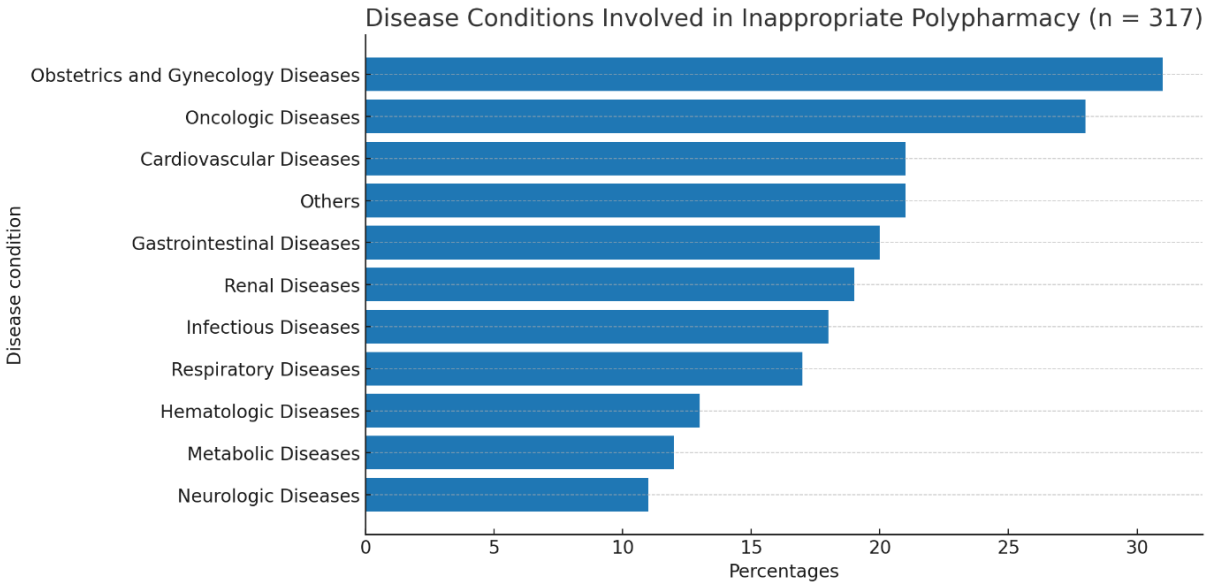


Figure 3: Disease condition involved in inappriate polypharmacy

4.5 Medicines with potential risk of addiction

Most drugs with a potential risk of addiction were Opioids and Narcotics, accounting for 79.0%, followed by antiepileptics at 21.0% and Anaesthetics at 14.5% as shown in figure 4.

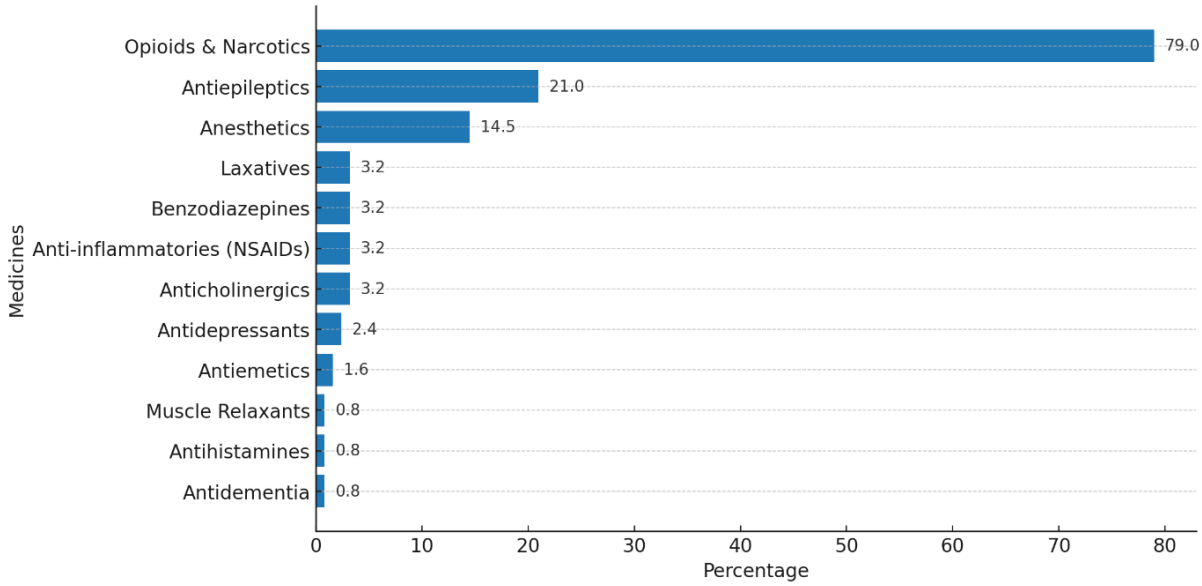


Figure 4: Medicines with potential risk of addiction

4.6 Factors associated with inappropriate polypharmacy

Females were more likely to experience inappropriate polypharmacy than males (aOR: 1.16, $p < 0.001$). Adults (16-64) were at higher risk compared to children (0-15) (aOR: 1.3, $p < 0.001$), while the elderly showed no significant risk (aOR: 1.08, $p = 0.865$). Patients using insurance had a higher likelihood compared to those paying with cash (aOR: 1.16, $p = 0.001$). Inpatients had a lower risk of inappropriate polypharmacy compared to outpatients (aOR: 0.75, $p < 0.001$). The number of drugs prescribed was a significant factor, with medium (aOR: 2.63, $p = 0.012$) and high (aOR: 11.55, $p = 0.005$) categories indicating a higher risk compared to a low number of drugs.

Table 4: Association between factors and inappropriate polypharmacy

Variable	cOR(95% CI)	*p*-value	aOR(95% CI)	*p*-value
		Sex		
Female	1.19(0.86-1.63)	0.298	1.16(1.08-1.23)	**<0.001**
Male	1		1	
		Age group		
Children (0-15)	1		1	
Adults (16-64)	1.34(0.88-2.03)	0.174	1.3(1.15-1.48)	**<0.001**
Elderly (>65)	1.05(0.6-1.83)	0.855	1.08(0.46-2.55)	0.865
		Residence		
Dar es Salaam	0.98(0.77-1.25)	0.862	0.98(0.7-1.39)	0.925
Outside DSM	1		1	
		Mode of payment		
Cash	1		1	
Insurance	1.06(0.83-1.34)	0.640	1.16(1.06-1.27)	**0.001**
		Doctor category		
Non specialist	1		1	
Specialist	1.07(0.92-1.24)	0.382	1.07(0.71-1.63)	0.739
		Patient category		
Inpatient	1.01(0.96-1.07)	0.669	0.75(0.72-0.78)	**<0.001**
Outpatient	1		1	
		Disease status		
Single	1		1	
Co-morbidity	1.04(0.5-2.15)	0.926	1.09(0.59-2.04)	0.779
Multi-morbidity	0.62(0.58-0.66)	<0.001	0.62(0.33-1.18)	0.145
		Number of drugs prescribed		
Low (3-8)	1		1	
Medium (9-14)	2.39(2.25-2.55)	<0.001	2.63(1.24-5.58)	0.012
High (15-20)	10.54(2.46-45.23)	0.002	11.55(2.09-63.77)	0.005

CHAPTER FIVE

5.0 DISCUSSION

5.1 Magnitude of Inappropriate Polypharmacy

The study found that approximately half of the patients experienced inappropriate polypharmacy, indicating a significant issue with unnecessary or potentially inappropriate medication combinations. This aligns with findings from Faquetti et al. 2024 and MacRae et al. 2021, who also reported high rates (64.7%) of potentially inappropriate prescriptions (PIPs) and adverse drug events (ADEs) among patients with complex health needs(36,37). Similarly, Maher et al. 2014, found that inappropriate polypharmacy contributes significantly to adverse drug reactions and higher healthcare costs(38). These findings underscore the need for strict medication review processes to mitigate the risks associated with inappropriate polypharmacy and improve patient outcomes.

5.2 Medical Conditions Commonly Involved in Inappropriate Polypharmacy

Obstetrics and gynecology diseases were most involved in inappropriate polypharmacy, due to the need for medications for pregnancy-related issues, hormonal therapies, and management of comorbidities like hypertension or diabetes in consistent with Thunbo et al. 2024.(39). Both preventive (e.g., prenatal vitamins, iron supplements) and symptomatic treatments (e.g., antiemetics for nausea, analgesics for pain) contributed to the high number of medications prescribed. Oncologic, cardiovascular, gastrointestinal, renal, and infectious diseases were also involved in inappropriate polypharmacy, reflecting the complexity of treatment regimens required for these conditions, comparable to those reported by Prabahar et al. 2024. and Nguyen et al. 2023.(40,41). This emphasizes the importance of targeted interventions in these medical fields to optimize patient safety and treatment efficacy.

5.3 **Prescribing Adherence to Guidelines**

Inappropriate polypharmacy included numerous cases without a clear clinical indication, significant drug interactions, and risks of addiction. It occurred due to lack of regular medication review and inadequate documentation of the reasons for prescribing specific medications. This aligns with the study by Diez et al. 2022, which identified inappropriate polypharmacy as a prevalent issue leading to adverse drug reactions and higher healthcare costs(22). Furthermore, the study observed higher median of drug interactions in inappropriate polypharmacy cases, likely due to the presence of patients with chronic diseases who were prescribed multiple medications, similar to the findings by Kamajian et al. 2023.(42). These insights underscore the importance of guideline adherence to minimize risks and enhance patient care quality.

5.4 Factors Associated with Inappropriate Polypharmacy

Females had a higher risk of inappropriate polypharmacy than males (aOR: 1.16, $p < 0.001$), likely because they often utilize healthcare services more frequently for preventive care and specific health needs such as reproductive health. This finding aligns with Ye et al. 2022 and Rochon et al. 2021 who observed higher healthcare utilization and high pharmacokinetic and pharmacodynamic changes among women(43,44). Adults (16-64) were more at risk compared to children (0-15) (aOR: 1.3, $p < 0.001$), as they experience more health issues that require medical attention such as chronic diseases which increase with age, consistent with Guillot et al. 2020.(45).

Insured patients had higher odds of inappropriate polypharmacy (aOR: 1.16, $p = 0.001$), primarily due to easier access to covered treatments and less concern about out-of-pocket costs, echoing Park et al. 2021. and Prabahar et al. 2024.(40,46). In contrast to Diez et al. 2022. inpatients had a lower risk compared to outpatients (aOR: 0.75, $p < 0.001$), likely due to intensive monitoring and better medication management(22). The number of drugs prescribed was a significant risk factor, with medium (aOR: 2.63, $p = 0.012$) and high (aOR: 11.55, $p = 0.005$) categories indicating increased risk compared to a low number of drugs as found by Saldanha et el. 2020.(47). These insights highlight the need for targeted

interventions and careful medication management to reduce inappropriate polypharmacy and its associated risks.

5.5 Limitation of the study

The study faced several limitations related to the use of electronic medical records (EMRs). Extracting and preparing data for research was complex and time-consuming, hence, it required advanced data management and analytical skills. The use of varying formats, terminologies, and coding systems across different records, such as pharmacy and diagnosis records, further exacerbated the challenge. This lack of standardization made it difficult to integrate and analyze data across these diverse sources effectively.
The study relied on retrospective data from electronic health records, which may have introduced biases due to incomplete or inaccurately entered information.

The accuracy of the data depended on healthcare providers' documentation practices, which might have led to inaccurate classification of outcome, and over-estimated prevalence of inappropriate polypharmacy.

5.6 Strength of the study

The strength of this study lies in its large sample size of 682 patients, which enhances the generalizability of the findings, and its comprehensive data collection from electronic health records, allowing for an in-depth analysis of inappropriate polypharmacy across various demographic and clinical characteristics.

CHAPTER SIX

6.0 CONCLUSION AND RECOMMENDATION

6.1 Conclusion

Inappropriate polypharmacy was found to be a significant issue among the patients, with a considerable proportion of them receiving medications that may be unnecessary or potentially inappropriate. Addressing this issue is crucial to ensure safe and effective medication use, thereby improving patient care outcomes.

Female gender, adult age, and the use of insurance as a mode of payment were key factors contributing to inappropriate polypharmacy, with the number of prescribed drugs significantly increasing the risk. In contrast, inpatients had a lower risk of inappropriate polypharmacy compared to outpatients, likely due to the intensive monitoring and better medication management in hospital settings. This suggests the need for targeted interventions to address these factors.

Obstetrics and gynecology, oncologic, and cardiovascular diseases were the most prevalent conditions associated with inappropriate polypharmacy. These areas should be prioritized for intervention to reduce the misuse of medications. The study also revealed significant concerns regarding drug interactions and the risk of addiction, particularly with medications such as opioids and narcotics, underscoring the need for careful assessment and monitoring of patients.

6.2 Recommendation

Based on the findings, to enhance patient safety, promote rational medication use, and reduce the risks associated with inappropriate polypharmacy, these are the recommendations:

Prescribing adherence to guidelines: Clinicians must follow established guidelines for polypharmacy, ensuring the correct selection, dosage, duration, and clinical indications for medications. This adherence reduces risks associated with inappropriate polypharmacy and promotes safe medication use.

Implement comprehensive medication review systems: Regular medication reviews by multidisciplinary teams should be established to identify and address inappropriate polypharmacy. These reviews assess the necessity, effectiveness, and safety of all prescribed medications, preventing unnecessary use and minimizing drug-related complications.

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APPENDICES

APPENDIX 1: Data extraction form for data obtained in patients files.

	Client ID (e.g. 001, 002, …)	**001**	002	003	004 etc.
PATIENT CHARACTERISTICS					
1	**Age**				
2	**Sex**				
3	**Residence**				
4	**Occupation**				
5	**Mode of payment**				
6	**Admission (Inpatient/Outpatient)**				
7	**Prescriber Qualification/ Expertise (Specialist, MO, Intern)**				
CLINICAL CHARACTERISTICS					

1	**Diagnoses (on visit day)**				
2	**Laboratory tests requested**				
3	**Referral history**				
4	**Comorbidities (mention)**				
5	**Prescribed medicines (mention)**				
6	**Classes of prescribed medicines (antihypertensive, Antidiabetics, etc.)**				
7	**Prior history of using other medicines (Y/N)**				
	If yes mention				
MEDICATION ASSESSMENT					
1	**Are the drugs for clinical indication appropriate? (Y/N)**				
	If not mention the inappropriateness				
2	**Is the combination of the medicines appropriate? (Y/N)**				
	If not mention the inappropriateness				

3	**Is there risk of an addiction from medicine? (Y/N)**				
	If yes mention				
4	**Is any of the drug being used in inappropriate duration? (Y/N)**				
	If yes mention				
5	**Is any of the drugs being used in inappropriate dosages? (Y/N)**				
	If yes mention				
6	**Is any of the drugs being used in inappropriate dosing frequency? (Y/N)**				
	If yes mention				

Appendix II: Ethical clearance letter

UNITED REPUBLIC OF TANZANIA

MINISTRY OF EDUCATION, SCIENCE AND TECHNOLOGY

MUHIMBILI UNIVERSITY OF HEALTH AND ALLIED SCIENCES

OFFICE OF THE DIRECTOR – RESEARCH, PUBLICATIONS AND INNOVATION

Ref. No.DA.282/298/01.C/ 2209 Date: 23/05/2024

MUHAS-REC-05-2024-2209
MARGARETH PAULO MHAME,
School of Public Health and Social Sciences,
MUHAS

RE: APPROVAL FOR ETHICAL CLEARANCE FOR A STUDY TITLED:

ASSESSMENT OF PATTERN AND FACTORS ASSOCIATED WITH INAPPROPRIATE POLYPHARMACY AT MUHIMBILI NATIONAL HOSPITAL.

Reference is made to the above heading,

I am pleased to inform you that the Chairman has on behalf of the University Senate, approved ethical clearance of the above-mentioned study, on recommendations of the Senate Research and Publications Committee meeting accordance with MUHAS research policy and Tanzania regulations governing human and animal subjects research.

APPROVAL DATE: 23/05/2024
EXPIRATION DATE OF APPROVAL: 23/05/2025

STUDY DESCRIPTION:
Purpose:

The purpose of this study is to show the assessment of pattern and factors associated with inappropriate polypharmacy at Muhimbili national hospital.

The approved protocol and procedures for this study is attached and stamped with this letter, and can be found in the link provided:
https://irb.muhas.ac.tz/storage/Certificates/Certificate%20-%2014532.pdf and in the MUHAS archives.

The PI is required to:

1. Submit bi-annual progress reports and final report upon completion of the study.
2. Report to the IRB any unanticipated problem involving risks to subjects or others including adverse events where applicable.
3. Apply for renewal of approval of ethical clearance one (1) month prior its expiration if the study is not completed at the end of this ethical approval. You may not continue with any research activity beyond the expiration date without the approval of the IRB. Failure to receive approval for continuation before the expiration date will result in automatic termination of the approval for this study on the expiration date.
4. Obtain IRB amendment (s) approval for any changes to any aspect of this study before they can be implemented.
5. Data security is ultimately the responsibility of the investigator.
6. Apply for and obtain data transfer agreement (DTA) from NIMR if data will be transferred to a foreign country.
7. Apply for and obtain material transfer agreement (MTA) from NIMR, if research materials (samples) will be shipped to a foreign country.
8. Any researcher, who contravenes or fail to comply with these conditions, shall be guilty of an offence and shall be liable on conviction to a fine as per NIMR Act No. 23 of 1979, PART III section 10 (2)
9. The PI is required to ensure that the findings of the study are disseminated to relevant stake holders.
10. PI is required to be versed with necessary laws and regulatory policies that govern research in Tanzania. Some guidance is available on our website https://drp.muhas.ac.tz/

Dr. Nahya S. Masoud

For Chairperson, MUHAS Research and Ethics Committee



Appendix III: Introduction letter

UNITED REPUBLIC OF TANZANIA
MINISTRY OF EDUCATION, SCIENCE AND TECHNOLOGY
MUHIMBILI UNIVERSITY OF HEALTH AND ALLIED SCIENCES
OFFICE OF THE DIRECTOR – POSTGRADUATE STUDIES

In reply quote;
Ref. No. HD/MUH/T.750/2022

23rd May, 2024

The Executive Director,
Muhimbili National Hospital,
P.O. Box 65000,
DAR ES SALAAM

Re: INTRODUCTION LETTER

The bearer of this letter is Margareth Paulo Mhame (HD/MUH/T.750/2022), a student at Muhimbili University of Health and Allied Sciences (MUHAS) pursuing MPH-Executive Track.

As part of her studies,she will be doing an elective research titled: **"Assessment of Pattern and Factors Associated with Inappropriate Polypharmacy at Muhimbili National Hospital.** She is being supervised by from Dr. Nathanael Sirili from MUHAS and Dr. Deus Buma from MNH.

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

Kindly provide her the necessary assistance to facilitate the conduct of her research.

We thank you for your cooperation.

Ms. Victoria Mwanilwa
For: DIRECTOR, POSTGRADUATE STUDIES

c.c. Margareth Paulo Mhame

9 United Nations Road; Upanga West; P.O. Box 65001, Dar Es Salaam; Tel. G/Line: +255-22-2150302/8; Ext. 1015; Direct Line:+255-22-2151378;Telefax:+255-22-2150465;E-mail:dpgs@muhas.ac.tz;Web:

Appendix IV: Permission letter

THE UNITED REPUBLIC OF TANZANIA

MINISTRY OF HEALTH

MUHIMBILI NATIONAL HOSPITAL

In reply please quote:

Ref. No.: MNH/CRTCU/Perm/2024/232 Date: 31st May, 2024

Head of Department,

- Pharmacy
- Medical Records

Muhimbili National Hospital

RE: PERMISSION TO COLLECT DATA AT MNH

Name of Student	**Margareth Paulo Mhame**
Title	**"Assessment of Pattern and Factors Associated with in appropriate Polypharmacy Practice at MNH"**
Institution	Muhimbili University of Health and Allied Sciences
Supervisor	Dr. Nathanael Sirili (MUHAS) Dr. Doreen Mloka
Co – supervisors	Dr. Deus Buma (MNH)
Period	31st May 2024 to 30th June, 2024

Approval has been granted to the above principal investigators to collect data at MNH. Dissemination of study findings at MNH shall be overseen by **Dr. Deus Buma** (MNH) supervisor.

Kindly ensure the named principal investigator abide to the ethical principles and other conditions of the research approval.

Sincerely,

Mbwaiha Ng'amilo

For: Head of Clinical Research, Training and Consultancy Unit

c.c DMS, DICT

c.c Margareth Paulo Mhame

c.c **Margareth Paulo Mhame**

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