



## **Assessment of Drug-Related Problems, Medication Adherence and Polypharmacy Among Elderly Outpatients in Sana'a City, Yemen**

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A Research Project Submitted to Faculty of Clinical Pharmacy in the  
Fulfillment of the Requirements for the Bachelor's Degree

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## **Dedication**

After a journey of hard work and perseverance, we stand today grateful to **Allah** for reaching this moment.

We dedicate this humble work, the result of our effort and collaboration, hoping it contributes to knowledge and serves the community.

To our **parents**... your endless support and prayers made this possible.

To our **doctors**... thank you for your guidance and for lighting our path with knowledge.

And to **everyone** who supported us along the way—this achievement is for you.

With sincere gratitude, we hope this is just the beginning of a successful journey.

## **Acknowledgement**

We would like to express our sincere gratitude to our supervisor, **Dr. Ali Alyahawi**, Assistant Professor of Clinical Pharmacy and Therapeutics and Dean of the Faculty of Clinical Pharmacy at 21 September University for Medical and Applied Sciences, for his invaluable guidance, supervision, and continuous support, which made the completion of this research possible.

We are also deeply grateful to **Dr. Doaa Manshaleen** for her continuous support, encouragement, patience, and valuable contributions throughout the course of this research.

We would also like to extend our sincere appreciation and thanks to **Dr. Mohammed Kubas** for his helpful advice and support, which greatly contributed to the success of this research

## Table of Contents

| Subject                                        | page |
|------------------------------------------------|------|
| <b>Dedication</b>                              | i    |
| <b>Acknowledgement</b>                         | ii   |
| <b>List of Contents</b>                        | iii  |
| <b>List of Tables</b>                          | v    |
| <b>List of figures</b>                         | v    |
| <b>List of Abbreviations</b>                   | vi   |
| <b>Abstract</b>                                | viii |
|                                                |      |
| <b>Chapter 1 Introduction</b>                  |      |
| 1.1 Background                                 | 1    |
| 1.2 Statement of the problem                   | 2    |
| 1.3 Study Question                             | 3    |
| 1.4 Study Objective                            | 3    |
| 1.4.1 General Objective                        | 3    |
| 1.4.2 Specific Objectives                      | 3    |
| 1.5 Study Significance                         | 4    |
| <b>Chapter 2 Literature Review</b>             |      |
| 2.1 Drug Related Problem                       | 5    |
| 2.1.1 Definition                               | 5    |
| 2.1.2 Common Drug-Related Problems             | 5    |
| 2.2 Polypharmacy                               | 7    |
| 2.2.1 Introduction                             | 7    |
| 2.2.2 Clinical Significance                    | 7    |
| 2.2.3 Issues of Concern in Polypharmacy        | 8    |
| 2.2.4 How to Avoid Polypharmacy                | 9    |
| 2.3 Medical Adherence                          | 10   |
| 2.3.1 Factors Influencing Adherence            | 10   |
| 2.3.2 General Medication Adherence Scale (GMAS | 10   |
| 2.4 Beers Criteria & older age                 | 11   |
| 2.4.1 The five sections of the Beers Criteria  | 11   |

|                                                                                                       |           |
|-------------------------------------------------------------------------------------------------------|-----------|
| 2.5 Previous Studies                                                                                  | 11        |
| <b>Chapter 3 Methodology</b>                                                                          |           |
| 3.1 Study Design & area                                                                               | 16        |
| 3.2 Study Population, period and sample size                                                          | 16        |
| 3.3 Inclusion Criteria                                                                                | 16        |
| 3.4 Exclusion Criteria                                                                                | 16        |
| 3.5 Validation of Age Definition                                                                      | 16        |
| 3.6 Data Collection                                                                                   | 17        |
| 3.7 Data Analysis                                                                                     | 18        |
| 3.8 Ethical Considerations                                                                            | 18        |
| <b>Chapter 4 Results &amp; Discussion</b>                                                             |           |
| 4.1 Results                                                                                           | 19        |
| 4.1.1 Demographic information                                                                         | 19        |
| 4.1.2 Patients' Clinical Characteristics                                                              | 20        |
| 4.1.3 Medication information                                                                          | 22        |
| 4.1.4 Types of Drug-Related Problems (DRPs                                                            | 23        |
| 4.1.5 Medical adherence                                                                               | 30        |
| 4.1.6 Association between medication adherence levels and various clinical and institutional factors  | 34        |
| 4.1.7 Association between overall medication adherence and various clinical and institutional factors | 36        |
| 4.2 Discussion                                                                                        | 38        |
| <b>Chapter 5 Conclusion &amp; Recommendations</b>                                                     |           |
| 5.1 Conclusion                                                                                        | 40        |
| 5.2 Recommendations                                                                                   | 40        |
| <b>Reference</b>                                                                                      | <b>42</b> |
| <b>Appendix</b>                                                                                       | <b>45</b> |
| <b>الملخص العربي</b>                                                                                  | <b>50</b> |

## List of Tables

|                                                                                                                                                            |           |
|------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| Table 1. Demographic information.....                                                                                                                      | <b>19</b> |
| Table 2. Patients' Clinical Characteristics.....                                                                                                           | <b>21</b> |
| Table 3. distribution of patients according to their estimated glomerular filtration rate (eGFR) stages .....                                              | <b>22</b> |
| Table 4. Medication information .....                                                                                                                      | <b>23</b> |
| Table 5. presents the prevalence of drug–drug interactions (DDIs) and their association.....                                                               | <b>24</b> |
| Table 6. drugs that should generally be avoided in elderly patients.....                                                                                   | <b>25</b> |
| Table 7. drugs that should be used with caution among elderly patients .....                                                                               | <b>26</b> |
| Table 8.dose adjustment in patients with renal impairment .....                                                                                            | <b>27</b> |
| Table 9. association between polypharmacy, excessive polypharmacy, and the presence of potentially inappropriate medications (PIMs).....                   | <b>28</b> |
| Table 10. prevalence of drug-related problems (DRPs) among elderly patients and their association.....                                                     | <b>29</b> |
| Table 11. association between the occurrence of drug-related problems (DRPs) and several medication-related factors .....                                  | <b>30</b> |
| Table 12. presents the descriptive statistics and reliability of the General Medication Adherence Scale (GMAS) across its domains.....                     | <b>32</b> |
| Table 13. summarizes the overall medication adherence levels as measured by GMAS.....                                                                      | <b>34</b> |
| Table 14. presents the relationships between medication adherence levels and various clinical and institutional factors.....                               | <b>35</b> |
| Table 15. presents the relationships between overall medication adherence (adherent vs. non-adherent) and several clinical and institutional factors ..... | <b>37</b> |

## List of Figurers

|                                                         |           |
|---------------------------------------------------------|-----------|
| Figure 1: key action areas to reduce DRP [8].....       | <b>5</b>  |
| Figure 2.presents the overall medication adherence..... | <b>31</b> |

## List of Abbreviations

| <b>Abbreviation</b> | <b>Definition</b>                                           |
|---------------------|-------------------------------------------------------------|
| <b>AGS</b>          | American Geriatrics Society                                 |
| <b>AHA/ACC</b>      | American Heart Association / American College of Cardiology |
| <b>BMI</b>          | Body Mass Index                                             |
| <b>BPH</b>          | Benign Prostatic Hyperplasia                                |
| <b>CKD</b>          | Chronic Kidney Disease                                      |
| <b>CNS</b>          | Central Nervous System                                      |
| <b>COPD</b>         | Chronic Obstructive Pulmonary Disease                       |
| <b>CVD</b>          | Cardiovascular Disease                                      |
| <b>DDI</b>          | Drug–Drug Interaction                                       |
| <b>df</b>           | Degrees of Freedom                                          |
| <b>DM</b>           | Diabetes Mellitus                                           |
| <b>DRP</b>          | Drug-Related Problem                                        |
| <b>eGFR</b>         | Estimated Glomerular Filtration Rate                        |
| <b>GIT</b>          | Gastrointestinal Tract                                      |
| <b>GMAS</b>         | General Medication Adherence Scale                          |
| <b>HIPAA</b>        | Health Insurance Portability and Accountability Act         |
| <b>HTN</b>          | Hypertension                                                |
| <b>IQR</b>          | Interquartile Range                                         |
| <b>MAT</b>          | Medication Adherence Therapy                                |
| <b>OTC</b>          | Over-The-Counter                                            |
| <b>PIM</b>          | Potentially Inappropriate Medication                        |
| <b>PMA</b>          | Poor Medical Adherence                                      |
| <b>POM</b>          | Prescription-Only Medicine                                  |
| <b>PPI</b>          | Proton Pump Inhibitor                                       |

|               |                                                          |
|---------------|----------------------------------------------------------|
| <b>PPO</b>    | Preferred Provider Organization                          |
| <b>SGLT2i</b> | Sodium-Glucose Cotransporter-2 Inhibitors                |
| <b>SPSS</b>   | Statistical Package for the Social Sciences              |
| <b>U.S.</b>   | United States                                            |
| <b>21UMAS</b> | 21 September University for Medical and Applied Sciences |
| <b>WHO</b>    | World Health Organization                                |

## Abstract

**Background:** Geriatric polypharmacy significantly increases the risk of drug-related problems (DRPs), potentially inappropriate medications, and poor adherence, especially in resource-limited settings such as Yemen. Despite the worldwide use of validated tools such as the AGS Beers Criteria and GMAS, local data are still limited. This study evaluates the prevalence of PIMs and medication adherence among elderly outpatients in Sana'a to provide data for optimizing geriatric pharmacotherapy and enhancing patient safety.

**Aim:** To evaluate medication adherence among elderly outpatients use the General Medication Adherence Scale (GMAS) and to assessment the prevalence of drug-related problems (DRPs) among elderly patients use the AGS Beers Criteria in the context of polypharmacy.

**Methods:** This cross-sectional study (Dec 2025–Feb 2026) involved 214 elderly outpatients ( $\geq 55$  years) in Sana'a. Data were collected by interviews using a structured form. DRPs and PIMs were identified using AGS 2023 Beers Criteria and Lexicomp, while adherence was measured by the GMAS scale. Statistical analysis was performed using SPSS, applying Chi-square tests ( $P < 0.05$ ) to assess associations between polypharmacy, DRPs, and adherence. Ethical approval was secured from 21 UMAS and participating hospitals.

**Results:** Excessive Polypharmacy ( $\geq 10$  drugs) was prevalent in 13.6% of patients, with a mean of  $7.30 \pm 2.00$  medications. DRPs were highly prevalent, occurring in 94.4% of the cohort. Specifically, 83.2% of patients were prescribed at least one PIM, with PPI (67.8%) and aspirin (21.0%) are the most common. Furthermore, 53.7% received drugs requiring caution, and 74.8% experienced at least one DDI. Suboptimal medication adherence was observed in 52.8% of patients. Excessive polypharmacy was significantly associated with major DDIs ( $P < 0.001$ ) and higher rates of non-adherence ( $P < 0.001$ ). Financial constraints and complex medication regimens were identified as primary barriers to adherence.

**Conclusion:** This study reveals a high burden of polypharmacy and PIMs among elderly Yemeni outpatients, coupled with suboptimal adherence rates. These findings underscore the urgent need for clinical pharmacist-led medication reviews and the implementation of de-prescribing protocols to optimize geriatric pharmacotherapy and improve clinical outcomes in Yemen.

**Keywords:** Polypharmacy, Beers Criteria, Medication Adherence, GMAS, Drug-Related Problems, Yemen, Geriatrics.

# **Chapter 1:**

## **Introduction**

# 1 Introduction

## 1.1 Background

Geriatrics, the branch of medicine concerned with the health care of older adults, emphasizes comprehensive, person-centered, and individualized treatment approaches rather than disease-oriented management alone. With advancing age, individuals commonly experience gradual declines in intrinsic capacity, including physical, cognitive, psychological, and sensory functions, which increase vulnerability to chronic diseases, functional impairment, and loss of independence [1].

The use of potentially inappropriate medications (PIMs) among older adults constitutes a major concern in geriatric medicine, as this population is at increased risk of adverse drug events due to age-related physiological changes affecting drug metabolism and response, the high prevalence of polypharmacy, and the presence of multiple chronic comorbidities. The American Geriatrics Society (AGS) 2023 Updated Beers Criteria provides evidence-based recommendations to support clinicians in identifying medications that should be avoided, used with caution, or carefully monitored in older adults. These criteria are intended to improve medication safety and prescribing quality, while recognizing that clinical judgment and individualized patient assessment remain essential. According to the AGS Beers Criteria, PIMs are medications for which the potential risks—such as drug–drug interactions, cognitive impairment, increased risk of falls, and functional decline—may outweigh the anticipated clinical benefits in older populations, particularly when safer therapeutic alternatives are available [2].

Drug-related problems (DRPs) can arise from multiple factors, among which polypharmacy is one of the most extensively studied contributors. Polypharmacy is commonly defined as the concurrent use of five or more medications, and it has been consistently associated with an increased risk of DRPs, including adverse drug events, drug–drug interactions, and therapeutic inefficacy, particularly in older adults with multiple comorbidities [3].

Older adults frequently present with multiple comorbidities, reduced physiological reserve, and consequently tend to use a larger number of medications. Although polypharmacy is not inherently inappropriate and may sometimes be clinically necessary, it is associated with an increased risk of adverse drug reactions (ADRs), drug–drug interactions (DDIs), and medication non-adherence, all of which can contribute to higher rates of hospitalizations, emergency department visits, and disease-related complications. Evidence from population-

based analyses indicates that the negative outcomes linked to polypharmacy often reflect cumulative and multifactorial risks rather than single-drug effects, highlighting the complexity of medication management in older adults [4].

Poor medication adherence (PMA) is a significant contributor to adverse health outcomes among older adults, including increased morbidity, hospitalization, and mortality. Polypharmacy not only elevates the risk of PMA by complicating medication regimens, but it is also independently associated with a range of negative clinical outcomes, such as adverse drug reactions, drug–drug interactions, and functional decline. These interrelated factors underscore the complexity of medication management in the elderly and highlight the need for careful, individualized pharmacotherapy [5].

In the present study, we assessed medication adherence, drug-related problems (DRPs), and polypharmacy among elderly outpatients in Sana’a City, Yemen. Medication adherence was evaluated using the General Medication Adherence Scale (GMAS), while DRPs were assessed based on the AGS 2023 Beers Criteria in patients receiving polypharmacy. A comprehensive evaluation of these interconnected factors, along with examination of the relationship between the number of prescribed medications and both adherence and DRP occurrence, can provide valuable insights for developing targeted interventions. Such evidence may guide healthcare providers in optimizing medication regimens, enhancing adherence, and minimizing drug-related complications, ultimately improving the quality of care for elderly outpatients.

## **1.2 Statement of the problem**

The global increase in the elderly population has contributed to a higher prevalence of chronic diseases and greater reliance on multiple medications, making polypharmacy increasingly common among older adults, particularly in outpatient settings. Although often clinically necessary, polypharmacy substantially increases the risk of drug-related problems (DRPs), including potentially inappropriate medications, drug–drug interactions, and poor medication adherence. Medication adherence is a key determinant of therapeutic success in elderly patients; however, age-related cognitive and functional decline, complex treatment regimens, and polypharmacy frequently result in suboptimal adherence, leading to treatment failure, increased healthcare utilization, and reduced quality of life. Therefore, the use of validated tools such as the General Medication Adherence Scale (GMAS) is essential for identifying patients at risk. Potentially inappropriate medications constitute a major

component of DRPs in elderly patients with polypharmacy. While tools such as the American Geriatrics Society Beers Criteria are widely used to guide safer prescribing, data on the prevalence of such medications among elderly outpatients in Yemen remain limited. In Sana'a City, where healthcare resources are constrained and routine medication review is uncommon, this lack of local evidence hinders efforts to optimize pharmacotherapy. Consequently, assessing drug-related problems, medication adherence, and polypharmacy among elderly outpatients in Sana'a City is necessary to determine the magnitude of these issues and to support the development of targeted strategies to improve medication safety and adherence in geriatric outpatient care

### **1.3 Study Question**

- What is the level of medication adherence among elderly outpatients in Sana'a City as measured by GMAS?
- What is the prevalence of medication non-adherence among elderly outpatients?
- What is the prevalence of drug-related problems (DRPs), based on the AGS Beers Criteria, among elderly outpatients with polypharmacy?
- What are the most common types of DRPs (drug-drug interactions, potentially inappropriate medications) among elderly outpatients?
- Is polypharmacy associated with medication non-adherence among elderly outpatients?
- Is polypharmacy associated with the occurrence of DRPs among elderly outpatients?

### **1.4 Study Objective**

#### **1.4.1 General Objective**

- This study aims to evaluate medication adherence among elderly outpatients based on (GMAS) and assess the prevalence of drug related problem (DRP) in elderly patients based on the AGS Beers Criteria with Polypharmacy

#### **1.4.2 Specific Objectives**

- To assess adherence using the GMAS scale and report non-adherence rate.
- To identify the most common DRP types (interactions, PIMs, dosing problems).
- To explore the association between polypharmacy and non-adherence.
- To explore the association between polypharmacy and DRPs.

## **1.5 Study Significance**

This study is significant as it addresses key challenges related to polypharmacy, medication adherence, and drug-related problems among elderly outpatients, a population highly vulnerable to drug-related problems. By assess medication adherence using the General Medication Adherence Scale (GMAS) and identifying potentially inappropriate medications based on the American Geriatrics Society Beers Criteria, the study provides important insights into medication safety and effectiveness in geriatric outpatient care. The finding are expected to contribute valuable local evidence on the patterns of polypharmacy, poor adherence, and inappropriate medication use among elderly outpatients in Sana'a City, Yemen, helping to fill an existing knowledge gap in a resource-limited setting. Additionally, the results may support healthcare professionals, particularly physicians and clinical pharmacists, in optimize pharmacotherapy and developing targeted interventions to reduce drug-related problems and improve patient outcomes. In a wider context , this study may inform future research and policy initiatives aimed at enhancing geriatric medication management and promoting safer prescribing practices in outpatient car

# **Chapter 2:**

## **Literature Review**

## 2 Literature Review

### 2.1 Drug Related Problem

#### 2.1.1 Definition

Drug-related problems (DRPs) are defined as events or circumstances related to drug therapy that actually or potentially interfere with optimal health outcomes. These problems may arise at any stage of the medication-use process, including prescribing, dispensing, or drug use by the patient, and are outcome-oriented rather than process-oriented [6].

#### 2.1.2 Common Drug-Related Problems

##### Too Many Medicines

Medications and their patterns of use have become increasingly complex over the years, with overall consumption rising, particularly among older adults. Research indicates that the greater the number of medications a person takes, the higher the risk of experiencing medication-related problems. One key strategy to prevent polypharmacy is effective communication with healthcare providers. Patients or caregivers should ask for each

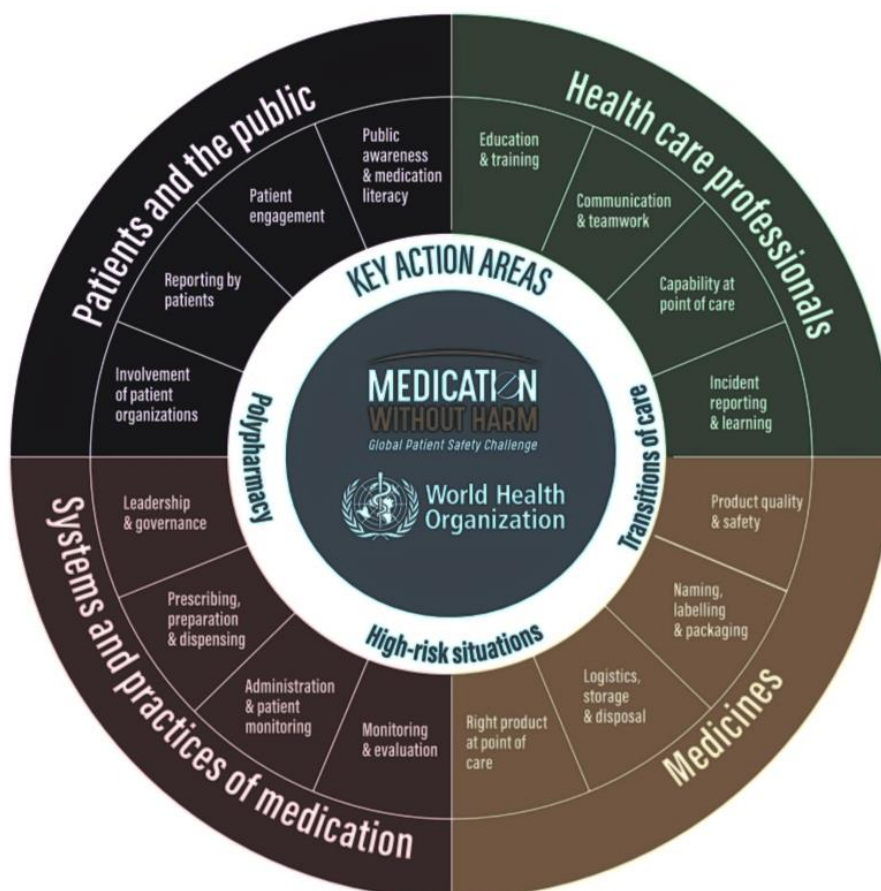


Figure 1: key action areas to reduce DRP [8].

medication: whether it is necessary, appropriate for the condition, safe with coexisting medical problems, prescribed at the correct dose, free from harmful interactions, and suitable for the patient's circumstances [7].

### **Unnecessary Medications**

Older adults frequently receive medications from multiple prescribing physicians. Studies have shown that most elderly patients consult at least two specialty care doctors, and nearly one-third visit five or more physicians annually. Poor communication among providers can lead to unnecessary medications, such as continuation of hospital-initiated treatments that are no longer required, or the use of combination therapy when a single drug would be sufficient. To mitigate this risk, clear understanding of prescribed medications and their intended use is essential. Drug reconciliation—a formal review of all prescribed medications at each care transition—can help prevent errors and omissions [7].

### **Incorrect Dose**

One of the most common medication-related problems in older adults is incorrect dosing. Age-related physiological changes, particularly in renal and hepatic function, can reduce the body's ability to process medications, making standard doses potentially harmful. Conversely, under-dosing may occur, resulting in suboptimal therapeutic effects and potential treatment failure. Ensuring proper dosing requires careful consideration of the patient's health status and close monitoring by healthcare providers [7].

### **Adverse Drug Reactions**

Older adults are especially susceptible to adverse drug reactions due to polypharmacy and the increased likelihood of drug–drug or drug–food interactions. Adverse reactions may also result from patient-specific factors, allergies, incorrect administration, or rapid dose adjustments. For example, the combined use of anticoagulants with aspirin or certain analgesics can increase bleeding risk. Maintaining an updated list of all medications, including supplements, and monitoring for symptoms are essential strategies to prevent adverse outcomes. [7].

### **Lack of Adherence**

Non-adherence is common among older adults, with studies showing that up to 50% do not take medications as prescribed. Reasons include confusion about instructions, inconvenience, concerns about side effects, and financial or physical limitations. Effective

adherence requires medications to be taken at correct doses, times, and durations. Pharmacists and nurses can improve adherence through education, reviewing instructions, and supporting organizational strategies such as pillboxes or medication reminders [7].

## **2.2 Polypharmacy**

### **2.2.1 Introduction**

The term polypharmacy was introduced more than one and a half centuries ago to describe problems related to the concurrent use of multiple medications and the excessive consumption of drugs. Over time, the concept has expanded to encompass a range of interpretations, including the use of unnecessary medications and the use of medications without a clear clinical indication. According to current evidence, the concurrent use of five or more medications is widely accepted as a standard definition of polypharmacy. This threshold has been consistently associated with an increased risk of adverse outcomes in older adults, including falls, frailty, functional disability, and mortality [9].

The World Health Organization emphasizes that although polypharmacy is often defined numerically, greater importance should be placed on evidence-based practice and the reduction of inappropriate polypharmacy. Given that the United States has one of the highest rates of medication use per capita worldwide, managing polypharmacy remains a significant challenge for healthcare providers. Therefore, this article reviews key strategies aimed at reducing polypharmacy and improving medication use management [10].

### **2.2.2 Clinical Significance**

The management of older adults is often complex due to the need for multiple medications to address coexisting medical conditions, making optimization of medication regimens a key component of comprehensive geriatric care. Polypharmacy is associated with preventable adverse drug events, which should be considered when assessing new symptoms in older patients in order to avoid prescribing cascades and reduce hospitalization risk. Awareness of polypharmacy-related risks, including falls, hip fractures, and cognitive impairment, may help prevent adverse outcomes and lower healthcare costs. Although the use of multiple medications may be unavoidable in certain clinical situations, healthcare professionals should strive to balance over- and under-prescribing by evaluating medication appropriateness in accordance with life expectancy and individual care goals [11]. Polypharmacy is frequently observed among patients receiving long-term opioid therapy, and the concomitant use of interacting medications may increase the risk of opioid overdose.

A study evaluated the association between opioid overdose and the use of nonopioid medications by estimating adjusted odds ratios for medications dispensed within 90 days preceding an overdose event, while controlling for prescription opioid dose and concomitant benzodiazepine use. In particular, the combined use of opioids and benzodiazepines has been associated with an increased risk of confusion, falls, and hip fractures [12]. The 2023 AHA/ACC Guideline for Chronic Coronary Disease highlights the importance of optimal prescribing, minimizing medication burden and polypharmacy, promoting deprescribing, and reducing the risk of adverse drug reactions [13].

### **2.2.3 Issues of Concern in Polypharmacy**

#### **Polypharmacy among Older Adults**

Although individuals aged 65 and older represent approximately 14% of the U.S. population, they account for over one-third of outpatient prescription medication spending. According to recent projections, this population is expected to more than double from 46 million today to over 98 million by 2060. Polypharmacy is a particular concern in older adults due to the associated risks and complexities of multiple medication use [14].

#### **Multi-Morbidity**

Aging increases the risk of multimorbidity, defined as the coexistence of two or more chronic conditions, due to physiological and pathological changes, which in turn raises the likelihood of being prescribed multiple medications [15].

#### **Drug-Drug Interactions**

The use of multiple medications increases the risk of drug-drug interactions (DDIs) and potentially inappropriate prescriptions. DDIs occur when the combined effect of drugs differs from the expected effect of each drug administered alone. Cardiovascular medications are the most frequent contributors to DDIs, with common adverse outcomes including neuropsychological events such as delirium, acute renal failure, and hypotension [16].

#### **Medication Non-Adherence**

Polypharmacy may impair medication adherence in older adults, particularly when combined with age-related cognitive or visual decline, potentially leading to adverse outcomes such as treatment failure or hospitalization [15].

## **Use of Over-the-Counter and Complementary Medications**

Over the past decade, the use of over-the-counter (OTC) medications has risen, particularly among older adults. Fewer than half of patients report their use of herbal supplements, complementary products, or other non-prescription agents to healthcare providers. Commonly used OTCs include analgesics, laxatives, vitamins, and minerals. Since the FDA does not regulate dietary supplements, information on their ingredients and potential effects is often unreliable, and their use carries safety concerns, including the risk of herb-drug interactions [17].

### **2.2.4 How to Avoid Polypharmacy**

- Regular medication review is crucial for older adults and patients with chronic diseases to ensure the continued necessity, effectiveness, and safety of prescribed therapies. Maintaining an up-to-date medication list and comprehensive medical history supports safe and informed clinical decision-making.
- Patient education is key to optimizing medication use. Clinicians should clearly explain dosing schedules, potential side effects, and the importance of adherence. Patients should be encouraged to bring all medications, including prescription drugs, OTC products, supplements, and herbal remedies, for thorough assessment.
- Treatment modifications should be discussed with patients and caregivers, with written documentation provided whenever possible. Prescribers should aim for the minimum number of medications, the simplest dosing regimen, and clear clinical indications for each drug. Unnecessary medications should be discontinued, and potential drug–drug or drug–disease interactions carefully evaluated.
- A multidisciplinary approach involving healthcare providers, caregivers, family members, and community pharmacists enhances medication safety and outcomes. Potentially inappropriate medications should be avoided following guidelines such as the Beers Criteria. New therapies should start at the lowest effective dose and be gradually titrated, while prescribing additional medications solely to manage side effects of other drugs should be avoided [11].
- Conduct careful medication reconciliation during care transitions and ensure post-discharge follow-up to prevent errors and rehospitalizations [18].
- Assess medication appropriateness considering patients’ goals of care and life expectancy.

- Polypharmacy definitions often exclude dose-reduced but not discontinued medications [19].
- Use STOPP/START tools for systematic medication review in multi-morbid older adults [20].
- AI shows promise in reducing polypharmacy when applied by multidisciplinary teams, but HIPAA, data privacy, and ethical issues must be addressed [21,22].

## **2.3 Medical Adherence**

Adherence is the degree to which a patient's health-related behaviors align with a mutually agreed treatment plan between the patient and the health care provider [23].

### **2.3.1 Factors Influencing Adherence**

Five interrelated dimensions collectively determine adherence, with patient-related factors representing only one of these determinants. The widespread assumption that adherence is solely the patient's responsibility is misleading, as it fails to recognize the substantial influence of other factors on individuals' behavior and their capacity to follow treatment regimens.

- Social and economic factors
- Health care team and system-related factors
- Condition-related factors
- Therapy-related factors
- Patient-related factors [23].

### **2.3.2 General Medication Adherence Scale (GMAS)**

General Medication Adherence is a critical determinant of therapeutic outcomes among elderly patients with polypharmacy, a population particularly vulnerable to medication-related problems and treatment failure. Accurate assessment of adherence is therefore essential in both clinical practice and research involving older adults receiving multiple medications. The (GMAS) is a validated, self-reported instrument developed to assess adherence in patients with chronic conditions. Unlike several traditional adherence measures, GMAS captures multiple dimensions of nonadherence, including patient behavior, comorbidity- and pill burden-related factors, and cost-related nonadherence, making it especially suitable for evaluating adherence in elderly patients exposed to polypharmacy across diverse clinical and socioeconomic settings [24].

## **2.4 Beers Criteria & older age**

Geriatric patients, defined as those aged > 65 years, are among the highest consumers of medications [25]. All countries face substantial challenges in adapting their health and social care systems to the ongoing demographic transition. Population ageing is occurring at an unprecedented pace, with projections indicating that by 2050 approximately 80% of older adults will reside in low- and middle-income countries. In 2020, individuals aged 60 years and older outnumbered children under five years of age globally, and between 2015 and 2050, the proportion of the world's population over 60 years is expected to nearly double from 12% to 22%. Within this rapidly ageing population, the use of potentially inappropriate medications (PIMs) represents a major concern in geriatric medicine. Older adults are particularly vulnerable to adverse drug events due to age-related physiological changes affecting drug metabolism and response, the high prevalence of polypharmacy, and the presence of multiple chronic comorbidities. The American Geriatrics Society (AGS) 2023 Updated Beers Criteria provides evidence-based guidance to assist clinicians in identifying medications that should be avoided, used with caution, or closely monitored in older adults, with the aim of improving medication safety and prescribing quality while emphasizing the importance of individualized clinical judgment. According to these criteria, PIMs are drugs for which the potential risks—such as drug–drug interactions, cognitive impairment, increased risk of falls, and functional decline—may outweigh their expected clinical benefits, particularly when safer alternatives are available [26,2]

### **2.4.1 The five sections of the Beers Criteria**

1. Medications that are potentially inappropriate in older adults
2. Medications that are potentially inappropriate in older adults with certain diseases or syndromes
3. Medications to be used with caution in older adults
4. Potentially clinically important Drug–Drug interactions that should be avoided in older adults
5. Medications that should be avoided or have their dosage reduced based on kidney function [2]

## **2.5 Previous Studies**

Abdu et al., 2025 (BMC Geriatrics): Eritrea This cross-sectional study assessed inappropriate medication prescribing, polypharmacy, potential drug–drug interactions

(pDDIs), and medication regimen complexity (MRC) among older adults attending three referral hospitals in Asmara, Eritrea. A total of 430 patients aged  $\geq 65$  years were included. Polypharmacy prevalence was low (5.3%), but clinically significant pDDIs were common (51.5%), with enalapril and acetylsalicylic acid most frequently involved. Potentially inappropriate medications (PIMs) were detected in 27.4% of patients, predominantly long-acting sulfonylureas and aldosterone antagonists, while potential prescribing omissions (PPOs) occurred in 13.3%, mainly missed proton pump inhibitors and cardio-selective beta-blockers. Higher number of medications and presence of chronic illness were strong predictors of pDDIs and PIMs, whereas medication regimen complexity predicted PPOs. The study highlights substantial medication-related risks among older adults, emphasizing the need for vigilant prescribing practices and monitoring to improve safety and optimize therapy in this population [27].

Endalifer et al., 2025 (Front Public Health): This cross-sectional study evaluated polypharmacy, potential drug–drug interactions (pDDIs), and potentially inappropriate medications (PIMs) among 236 older adults ( $\geq 65$  years) attending Dessie Comprehensive Specialized Hospital, Ethiopia. Polypharmacy ( $\geq 5$  medications) was observed in 33.9% of patients, pDDIs in 47.0%, and PIMs were identified in 45.7% by Beers Criteria and 39.8% by STOPP/START criteria. The most common PIMs included long-acting sulfonylureas (Glibenclamide) and omissions of cardio-selective beta-blockers. Female sex, age  $\geq 75$ , and polypharmacy were significantly associated with Beers PIMs, while age 70–74 and polypharmacy were associated with STOPP/START PIMs. The study highlights the high prevalence of PIMs and pDDIs in older Ethiopian patients, emphasizing the need for careful medication review and pharmacist involvement to improve medication safety [28].

Rieckert et al., 2018 (BMC Family Practice, Europe) This cross-sectional analysis investigated factors associated with excessive polypharmacy ( $\geq 10$  daily medications) in older adults with chronic diseases. The study used baseline data from the PRIMA-eDS trial, including 3,904 patients aged  $\geq 75$  years taking  $\geq 8$  regular medications across five European centers. Data collected included demographics, medical diagnoses, BMI, frailty status, smoking, and physical and mental health (SF-12). A multivariable generalized linear mixed model was used to identify factors associated with excessive polypharmacy. Results showed that frailty, multimorbidity ( $> 8$  diagnoses), obesity (BMI  $\geq 30$ ), and lower physical and mental health scores were significantly associated with excessive polypharmacy. Conversely, age  $\geq 85$  years was associated with a lower risk. No significant associations were

observed for sex, educational level, or smoking. The study also highlighted differences between study centers, with patients in the UK having higher rates of excessive polypharmacy than in Germany. The authors concluded that frail, obese, and multimorbid older patients with reduced physical and mental health are at higher risk of excessive polypharmacy, emphasizing the importance of regular medication review to ensure appropriateness, safety, and avoidance of adverse drug interactions [29].

Rodrigues et al., 2023 (Online Brazilian Journal of Nursing): This cross-sectional study assessed polypharmacy prevalence and medication adherence among 231 older adults ( $\geq 60$  years) attending primary health care services in Cuité, Brazil. Polypharmacy, defined as the use of five or more medications, was identified in 16.0% of participants. Medication adherence among elderly patients with polypharmacy was high, with 86.5% classified as adherent using the Medication Adherence Measurement (MAT) instrument. A significant association was observed between the number of medications and sex, as well as the presence of a caregiver. Additionally, age showed a positive correlation with the number of medications used. The findings highlight the importance of primary care monitoring, caregiver involvement, and professional training to support appropriate polypharmacy management and maintain medication adherence among older adults [30].

Anthoorathodi et al., 2021 (Int J Community Medicine and Public Health): This cross-sectional study evaluated the prevalence of polypharmacy and potentially inappropriate medications (PIMs) among 50 hospitalized older adults ( $\geq 60$  years) in a tertiary care center in central Kerala, India. Polypharmacy, defined as the use of five or more medications, was identified in 42% of patients, with a mean medication count of  $5.1 \pm 4.1$ . Potentially inappropriate medications were detected in 20% of participants using Beers Criteria. Diabetes mellitus and hypertension were significantly associated with polypharmacy, while no significant association was observed with gender. The study highlights polypharmacy and PIM use as emerging public health concerns among elderly patients and emphasizes the importance of deprescribing strategies and prescriber education on Beers Criteria to promote rational and safe medication use [31].

Chen et al., 2021 (Frontiers in Pharmacology): This cross-sectional study examined the prevalence and predictors of polypharmacy among 720 hospitalized patients aged  $\geq 50$  years with chronic diseases in Hubei Province, China. Polypharmacy, defined as the concurrent use of five or more medications, was observed in 50.14% of participants. Using inverse

probability treatment weighting and logistic regression analyses, the study identified several significant predictors of polypharmacy, including a higher number of chronic diseases, use of traditional Chinese medicine, depressive symptoms, greater patient involvement in treatment decision-making, urban residence, and higher income levels. Female patients also demonstrated a higher prevalence of polypharmacy compared with males. The authors concluded that polypharmacy is highly prevalent among elderly patients with chronic conditions in China and emphasized the need for personalized prescribing, improved patient–physician shared decision-making, and careful application of clinical guidelines to reduce inappropriate medication use and improve patient safety [32].

Liu et al., 2023 (BMC Geriatrics): This multicenter cross-sectional study investigated risk factors for medication nonadherence and its association with potentially inappropriate medication (PIM) use among community-dwelling older adults with multimorbidity and polypharmacy in China. The study included 773 outpatients aged  $\geq 65$  years recruited from 16 tertiary hospitals across 12 provinces. Medication adherence was assessed using the Visual Analog Scale (VAS), while PIMs were identified using the 2019 American Geriatrics Society Beers Criteria. The prevalence of medication nonadherence was 31.8%, and PIM use was observed in 62.0% of participants. Multivariate analysis showed that medication nonadherence was significantly associated with female sex, cognitive impairment, higher number of comorbidities, higher medication costs, inability to self-administer medications, and PIM use. The authors concluded that medication nonadherence and PIM use are common among older patients with multimorbidity and polypharmacy, highlighting the need for targeted interventions focusing on medication review, cost reduction, cognitive support, and adherence-enhancing strategies to optimize pharmacotherapy in this high-risk population [33].

Gupta et al., 2025 (European Journal of Cardiovascular Medicine): This hospital-based cross-sectional study assessed prescription patterns, polypharmacy, potentially inappropriate medications (PIMs), and potential drug–drug interactions among elderly outpatients attending a tertiary care teaching hospital. A total of 320 patients aged  $\geq 60$  years were included. Prescription practices were evaluated using WHO core prescribing indicators, while PIMs were identified according to the 2023 AGS Beers Criteria. The mean number of drugs per prescription was  $5.7 \pm 2.2$ . Polypharmacy (5–9 drugs) was observed in 56.6% of patients, and excessive polypharmacy ( $\geq 10$  drugs) in 13.1%. Cardiovascular and antidiabetic medications were the most frequently prescribed drug classes. At least one PIM was

identified in 34.4% of prescriptions, most commonly long-acting benzodiazepines, first-generation antihistamines, NSAIDs in high-risk patients, and long-term proton pump inhibitors without clear indication. Potential drug–drug interactions were present in 42.8% of prescriptions, including 9.4% classified as potentially major. Polypharmacy was significantly associated with advanced age ( $\geq 70$  years), presence of  $\geq 3$  comorbidities, frequent outpatient visits, and PIM use. The authors concluded that polypharmacy and inappropriate prescribing are highly prevalent among elderly outpatients, underscoring the need for regular prescription audits, geriatric pharmacology training, and implementation of structured medication review and deprescribing strategies in tertiary care settings [34]

# **Chapter 3:**

## **Methodology**

### 3 Methodology

#### 3.1 Study Design & area

A cross-sectional study was conducted on adult outpatients in several hospitals and clinics in Sana'a city, mainly Al-Thawra Hospital, AL- Gmuheri Hospital, Science and Technology Hospital and Modern German Hospital.

This study will be carried out in Sana'a city, the capital of Yemen.

#### 3.2 Study Population, period and sample size

The population or community of this study involved all Elderly outpatients visiting the different hospitals in Sana'a city at the time of study **The duration** of the study from Dec 2025 to Feb 2026

#### 3.3 Sampling

All elderly patients who met the inclusion criteria were approached and invited to participate in the study. This size of sample will be calculated according to the Cochran formula (sample size formula for an Infinite Population):

$$n = \frac{z^2 \times \hat{p}(1-\hat{p})}{\epsilon^2}$$

Where, n= sample size, Z= at confidence level (95%) (Z= 1.96), P= estimated proportion (0.5); E= estimation error.(0.05) About 214 patients

#### 3.4 Inclusion Criteria

- Patients of age 55 years and above of both sexes will be include in the study.
- Patients do not stay overnight at the health care facility( outpatients )
- Patients visiting the targeted hospitals and clinics within the study period
- Patients can access the required information
- Patients have five drugs and above

#### 3.5 Exclusion Criteria

- Patients aged 54 years and younger.
- Patients stay overnight at the health care facility( inpatients )

#### 3.6 Validation of Age Definition

According to the World Health Organization (2023), individuals aged  $\geq 65$  years represent approximately 3.4% of the total population in Yemen, indicating a relatively small

proportion of older adults compared with high-income countries [35,37]. In contrast, older adults constitute nearly 18% of the population in the United States, as reported by America's Health Rankings. Furthermore, life expectancy at birth in Yemen was estimated at 65.8 years in 2021, whereas life expectancy in the United States reached 76.4 years during the same year [36,37]. These demographic differences highlight substantial variations in population aging patterns between low- and middle-income and high-income settings.

Based on these contextual and demographic considerations, this study defined older adults as individuals aged 55 years and above. Although international research frequently adopts age thresholds of  $\geq 60$  or  $\geq 65$  years, such definitions may not adequately reflect the biological and clinical realities of aging in resource-limited countries. In Yemen, lower life expectancy, earlier onset of chronic diseases, a high burden of cardiovascular risk factors, and long-standing socioeconomic and healthcare challenges may contribute to accelerated physiological aging compared with populations in high-income countries.

### **3.7 Data Collection**

Data were collected through face-to-face interviews using a structured, multi-component data collection form developed for the purpose of this study. The instrument comprised four main sections. The first section captured participants' socio-demographic and clinical characteristics, including age, gender, educational level, lifestyle habits (smoking and qat chewing), Body Mass Index (BMI), renal function indicators (serum creatinine and estimated Glomerular Filtration Rate [eGFR]), comorbidities, and duration of chronic illnesses. The second section documented all current medications, including Prescription-Only Medicines (POM) and Over-the-Counter (OTC) products. For each medication, the drug name, dose, frequency, route of administration, duration of use, and indication were recorded. Polypharmacy was defined as the concurrent use of five or more medications ( $\geq 5$ ), while excessive polypharmacy was defined as the use of more than ten medications ( $> 10$ ). The third section focused on the identification of Drug-Related Problems (DRPs). Potentially inappropriate medications (PIMs), medications requiring caution, and those needing renal dose adjustment were identified using the 2023 Beers Criteria developed by the American Geriatrics Society. Potential drug-drug interactions were assessed using the Lexicomp® database, and interactions were categorized according to their severity (moderate or major). The fourth section assessed medication adherence using the validated 11-item General Medication Adherence Scale (GMAS). The scale evaluates three domains of non-adherence: patient behavior, comorbidity and prescription-related factors, and

financial constraints. Total scores range from 0 to 33 and were categorized into five adherence levels: High, Good, Partial, Low, and Poor.

### **3.8 Data Analysis**

Data were analyzed using the Statistical Package for the Social Sciences (SPSS) version .... Descriptive statistics were performed to summarize the study variables. Categorical variables, including sociodemographic characteristics, comorbidities, medication indications, and General Medication Adherence Scale (GMAS) categories, were presented as frequencies and percentages. Continuous variables were summarized using means and standard deviations or medians and interquartile ranges, as appropriate.

The chi-square test was used to assess the association between polypharmacy (defined as the concurrent use of  $\geq 5$  medications) and medication adherence levels. In addition, the association between polypharmacy and the presence of potentially inappropriate medications (PIMs), identified according to the 2023 Beers Criteria, was evaluated. Furthermore, the relationship between polypharmacy and the occurrence of potential drug–drug interactions (DDIs) was also examined using the chi-square test. A p-value of  $<0.05$  was considered statistically significant

### **3.9 Ethical Considerations**

The study protocol was approved by both the 21 September University for Medical & Applied Sciences (21 UMAS) and the hospital's research ethics committee.

# **Chapter 4:**

## **Results & Discussion**

## 4 Results & Discussion

### 4.1 Results

#### 4.1.1 Demographic information

**Table 1:** shows demographic information of total 214 elderly patients were included in the study. The majority of participants were recruited from governmental hospitals (63.1%), while 36.9% were recruited from private hospitals. Regarding age distribution, most patients were aged 65–74 years (33.6%), followed by 60–64 years (29.9%), 55–59 years (21.0%), and 75–84 years (13.1%), while only 2.3% were aged 85 years or older. In terms of gender, males constituted the majority (73.8%), whereas females accounted for 26.2% of the study population. With respect to educational level, nearly half of the participants were illiterate (46.7%), followed by secondary education (19.6%), primary education (18.7%), and university education (15.0%). Regarding body mass index (BMI), almost half of the patients had normal weight (49.1%), while 34.6% were overweight, 10.7% were underweight, and 5.6% were obese. Concerning lifestyle habits, the majority of participants were non-smokers (71.5%), while 28.5% reported smoking. However, Qat chewing was common, with 67.3% of the patients reporting Qat chewing. In contrast, the use of other tobacco products was relatively low, with 3.3% reporting different tobacco use and 2.3% reporting other forms of Harmful Habits.

**Table 1. Demographic information**

|                                     | Variant                | Frequency | Percent (%) |
|-------------------------------------|------------------------|-----------|-------------|
| <b><i>Name of Hospitals</i></b>     | Al-Gmuhori             | 93        | 43.5        |
|                                     | Al-Thawra              | 42        | 19.6        |
|                                     | Science and Technology | 60        | 28.0        |
|                                     | Modern German          | 19        | 8.9         |
|                                     | Total                  | 214       | 100.0       |
| <b><i>Patients' Age (years)</i></b> | 55-59                  | 45        | 21.0        |
|                                     | 60-64                  | 64        | 29.9        |
|                                     | 65-74                  | 72        | 33.6        |
|                                     | 75-84                  | 28        | 13.1        |
|                                     | > 85                   | 5         | 2.3         |
|                                     | Total                  | 214       | 100.0       |

|                                         |             |     |       |
|-----------------------------------------|-------------|-----|-------|
| <b><i>Patients' Gender</i></b>          | Male        | 158 | 73.8  |
|                                         | Female      | 56  | 26.2  |
|                                         | Total       | 214 | 100.0 |
| <b><i>Patients' Education Level</i></b> | Illiterate  | 100 | 46.7  |
|                                         | Primary     | 40  | 18.7  |
|                                         | Secondary   | 42  | 19.6  |
|                                         | University  | 32  | 15.0  |
|                                         | Total       | 214 | 100.0 |
| <b><i>Patients' Body Mass Index</i></b> | Underweight | 23  | 10.7  |
|                                         | Normal      | 105 | 49.1  |
|                                         | Overweight  | 74  | 34.6  |
|                                         | Obese       | 12  | 5.6   |
|                                         | Total       | 214 | 100.0 |
| <b>Smoking</b>                          | No          | 153 | 71.5  |
|                                         | Yes         | 61  | 28.5  |
|                                         | Total       | 214 | 100.0 |
| <b>Qat Chewing</b>                      | No          | 70  | 32.7  |
|                                         | Yes         | 144 | 67.3  |
|                                         | Total       | 214 | 100.0 |
| <b>Different Tobacco</b>                | No          | 207 | 96.7  |
|                                         | Yes         | 7   | 3.3   |
|                                         | Total       | 214 | 100.0 |
| <b>Other Harmful Habits</b>             | No          | 209 | 97.7  |
|                                         | Yes         | 5   | 2.3   |
|                                         | Total       | 214 | 100.0 |

#### 4.1.2 Patients' Clinical Characteristics

**Table 2:** shows patients' clinical characteristics the clinical characteristics of the study participants are presented in Table Hypertension was the most common comorbidity, reported in 74.8% of the patients, followed by cardiovascular diseases (57.9%), diabetes mellitus (52.3%), and stroke (15.4%). Other reported conditions included benign prostatic

hyperplasia (21.0%), chronic kidney disease (12.6%), liver disease (3.7%), and asthma/COPD (3.3%). Regarding the burden of chronic diseases, the mean number of chronic conditions was  $2.73 \pm 0.98$ , with a median of 3 and an interquartile range (IQR) of 2–3. The number of chronic diseases ranged from 0 to 6. Concerning the duration of illness, 29.9% of patients had a disease duration of 1–5 years, 20.6% had 6–10 years, while 49.5% had a duration of more than 10 years. With respect to hospitalization during the last year, 36.4% of the patients reported being hospitalized, whereas 63.6% had no hospitalization during the same period

**Table 2. Patients' Clinical Characteristics**

|                                         |               | Frequency | Percent (%) |                |        |                           |
|-----------------------------------------|---------------|-----------|-------------|----------------|--------|---------------------------|
| <i>Patients’<br/>Comorbidities *</i>    | CVD           | 124       | 57.9        |                |        |                           |
|                                         | Stroke        | 33        | 15.4        |                |        |                           |
|                                         | HTN           | 160       | 74.8        |                |        |                           |
|                                         | DM            | 112       | 52.3        |                |        |                           |
|                                         | Liver Disease | 8         | 3.7         |                |        |                           |
|                                         | Asthma/COPD   | 7         | 3.3         |                |        |                           |
|                                         | BPH           | 27        | 12.6        |                |        |                           |
|                                         | CKD           | 45        | 21.0        |                |        |                           |
|                                         | Other         | 62        | 29          |                |        |                           |
| <b>Number of Chronic Diseases</b>       | Mean          | Minimum   | Maximum     | Std. Deviation | Median | Interquartile Range (IQR) |
|                                         | 2.73          | 0         | 6           | 0.979          | 3      | 2 – 3                     |
| <i>Duration of Illness (years)</i>      | 1 – 5         | 64        | 29.9        |                |        |                           |
|                                         | 6 – 10        | 44        | 20.6        |                |        |                           |
|                                         | > 10          | 106       | 49.5        |                |        |                           |
|                                         | Total         | 214       | 100.0       |                |        |                           |
| <i>Hospitalization During Last Year</i> | No            | 78        | 36.4        |                |        |                           |
|                                         | Yes           | 136       | 63.6        |                |        |                           |
|                                         | Total         | 214       | 100.0       |                |        |                           |

**Table3.** presents the distribution of patients according to their estimated glomerular filtration rate (eGFR) stages. Among the 214 patients included in the study, the largest proportion was classified as Stage 2 (eGFR 60–89 mL/min/1.73 m<sup>2</sup>), comprising 83 patients (38.8%).

Normal kidney function (Stage 1, eGFR >90 mL/min/1.73 m<sup>2</sup>) was observed in 51 patients (23.8%). Moderate renal impairment (Stage 3, eGFR 30–59 mL/min/1.73 m<sup>2</sup>) was present in 37 patients (17.3%), while 16 patients (7.5%) were classified as Stage 4 (eGFR 15–29 mL/min/1.73 m<sup>2</sup>). Additionally, 27 patients (12.6%) had Stage 5 renal failure (eGFR <15 mL/min/1.73 m<sup>2</sup>).

**Table 3. Distribution of patients according to their estimated glomerular filtration rate (eGFR) stages**

| (eGFR) stages         | Frequency | Percent (%) |
|-----------------------|-----------|-------------|
| <b>STAGE1 &gt; 90</b> | 51        | 23.8        |
| <b>STAGE2 89 – 60</b> | 83        | 38.8        |
| <b>STAGE3 59 – 30</b> | 37        | 17.3        |
| <b>STAGE4 29 – 15</b> | 16        | 7.5         |
| <b>STAGE5 &lt; 15</b> | 27        | 12.6        |
| <b>Total</b>          | 214       | 100.0       |

#### 4.1.3 Medication information

**Table 4:** shows Most patients were using prescription-only medicines (POM), accounting for 99.1%, whereas 17.8% reported the use of over-the-counter (OTC) medications. Regarding the number of medications used, the mean number of medications was  $7.30 \pm 2.00$ , with a median of 7 and an interquartile range (IQR) of 6–8. The number of medications ranged from 5 to 16. Polypharmacy ( $\geq 5$  medications) was observed in 86.4% of the patients, while 13.6% were taking fewer than five medications. In addition, excessive polypharmacy ( $\geq 10$  medications) was identified in 13.6% of the study participants. With regard to the types of medications used, cardiovascular medications were the most commonly prescribed (93.5%), followed by antihypertensive medications (80.8%), gastrointestinal medications (68.7%), and antidiabetic medications (54.2%). Additionally, vitamins, supplements, or herbal products were used by 36.4% of patients, analgesics by 23.4%, and central nervous system medications by 4.7%. Antimicrobial medications were reported in 7.5% of the patients, while other medications were used by 31.3% of the participants.

**Table 4. Medication information**

|                                    |                                       | Frequency |         | Percent (%)    |        |                           |
|------------------------------------|---------------------------------------|-----------|---------|----------------|--------|---------------------------|
| Over The Counter (OTC) Medications | No                                    | 176       |         | 82.2           |        |                           |
|                                    | Yes                                   | 38        |         | 17.8           |        |                           |
|                                    | Total                                 | 214       |         | 100.0          |        |                           |
| Prescription Only Medicines (POM)  | No                                    | 2         |         | 0.9            |        |                           |
|                                    | Yes                                   | 212       |         | 99.1           |        |                           |
|                                    | Total                                 | 214       |         | 100.0          |        |                           |
| Number of medications              | Mean                                  | Minimum   | Maximum | Std. Deviation | Median | Interquartile Range (IQR) |
|                                    | 7.30                                  | 5         | 16      | 2.003          | 7      | 6 – 8                     |
| Polypharmacy ≥ 5                   | No                                    | 29        |         | 13.6           |        |                           |
|                                    | Yes                                   | 185       |         | 86.4           |        |                           |
|                                    | Total                                 | 214       |         | 100.0          |        |                           |
| Excessive Polypharmacy ≥10         | No                                    | 185       |         | 86.4           |        |                           |
|                                    | Yes                                   | 29        |         | 13.6           |        |                           |
|                                    | Total                                 | 214       |         | 100.0          |        |                           |
| Type of Medications Used *         | DM Medication                         | 116       |         | 54.2           |        |                           |
|                                    | HTN Medication                        | 173       |         | 80.8           |        |                           |
|                                    | CVD Medication                        | 200       |         | 93.5           |        |                           |
|                                    | Antimicrobial Medication              | 16        |         | 7.5            |        |                           |
|                                    | Vitamins, Supplements, and/or Herbals | 78        |         | 36.4           |        |                           |
|                                    | Analgesic Medication                  | 50        |         | 23.4           |        |                           |
|                                    | GIT Medication                        | 147       |         | 68.7           |        |                           |
|                                    | CNS Medication                        | 10        |         | 4.7            |        |                           |
|                                    | Other Medications                     | 67        |         | 31.3           |        |                           |

#### 4.1.4 Types of Drug-Related Problems (DRPs):

##### A. Drug–Drug Interactions (DDIs)

**Table 5:** show presents the prevalence of drug–drug interactions (DDIs) and their association with polypharmacy and excessive polypharmacy among elderly patients. Out of

214 participants, 90 patients (42.1%) had no DDIs recorded, while 105 patients (49.1%) experienced at least one moderate DDI, and 55 patients (25.7%) had major DDIs. The total number of DDIs recorded per patient showed a mean of  $1.05 \pm 1.10$ , ranging from 0 to 4 interactions. The median number of DDIs was 1, with an interquartile range (IQR) of 0–2. Regarding moderate DDIs, 79 patients (75.2%) with polypharmacy and 26 patients (24.8%) with excessive polypharmacy were exposed to moderate interactions, whereas 106 patients (97.2%) with polypharmacy and 3 patients (2.8%) with excessive polypharmacy were not exposed. This association was statistically significant ( $\chi^2 = 22.115$ ,  $df = 1$ ,  $p < 0.001$ ). For major DDIs, 39 patients (70.9%) with polypharmacy and 16 patients (29.1%) with excessive polypharmacy were exposed, while 146 patients (91.8%) with polypharmacy and 13 patients (8.2%) with excessive polypharmacy were not exposed. This association was also statistically significant ( $\chi^2 = 15.258$ ,  $df = 1$ ,  $p < 0.001$ ), indicating a higher occurrence of major drug–drug interactions among patients with excessive polypharmacy.

**Table 5. Prevalence of drug–drug interactions (DDIs) and their association**

|                                              |              | Frequency |     |  | Percent (%) |  |  |
|----------------------------------------------|--------------|-----------|-----|--|-------------|--|--|
| <i>DDI Categories</i><br><i>Prevalence *</i> | No DDI       |           | 90  |  | 42.1        |  |  |
|                                              | Moderate DDI |           | 105 |  | 49.1        |  |  |
|                                              | Major DDI    |           | 55  |  | 25.7        |  |  |
|                                              | Total        |           | 214 |  | 100.0       |  |  |

|                                      |      |         |         |                |        |                           |  |
|--------------------------------------|------|---------|---------|----------------|--------|---------------------------|--|
| <b>Total number of DDIs recorded</b> | Mean | Minimum | Maximum | Std. Deviation | Median | Interquartile Range (IQR) |  |
|                                      | 1.05 | 0       | 4       | 1.100          | 1      | 0 – 2                     |  |

|                                                                     |                           |     |              |                        |            |                     |                |
|---------------------------------------------------------------------|---------------------------|-----|--------------|------------------------|------------|---------------------|----------------|
| <i>Association DDI with polypharmacy and excessive polypharmacy</i> |                           |     | Polypharmacy | Excessive Polypharmacy | Total      | $\chi^2$ (df)       | P – value *    |
|                                                                     | Presence of Moderate DDIs | No  | 106 (97.2%)  | 3 (2.8%)               | 109 (100%) | <b>22.115</b> * (1) | < <b>0.001</b> |
|                                                                     |                           | Yes | 79 (75.2%)   | 26 (24.8%)             | 105 (100%) |                     |                |
|                                                                     | Presence of Major DDIs    | No  | 146 (91.8%)  | 13 (8.2%)              | 159 (100%) | <b>15.258</b> * (1) | < <b>0.001</b> |
|                                                                     |                           | Yes | 39 (70.9%)   | 16 (29.1%)             | 55 (100%)  |                     |                |

## B. Potentially Inappropriate Medications (PIMs)

**Table 6:** shows presents the prevalence of drugs that should generally be avoided in elderly patients. Out of 214 participants, 178 patients (83.2%) were prescribed at least one potentially inappropriate medication (PIM) that should be avoided, while 36 patients (16.8%) were not exposed to any such medications. The mean number of drugs that should be avoided per patient was  $1.25 \pm 0.83$ , ranging from 0 to 3. The median number was 1, with an interquartile range (IQR) of 1–2. The most commonly prescribed potentially inappropriate medications included proton pump inhibitors (PPIs) in 145 patients (67.8%), followed by Aspirin in 45 patients (21.0%) and Glibenclamide in 32 patients (15.0%). Other less frequently prescribed medications were Meloxicam (4.7%), Diclofenac (3.3%), and Glipizide (2.8%). Several medications were rarely reported, including Risperidone (1.4%), Rivaroxaban (1.4%), Metoclopramide (0.9%), Naproxen (0.9%), Warfarin (0.9%), Paroxetine (0.9%), Trihexyphenidyl (0.9%), and Digoxin (0.9%). Very low frequencies were observed for Spironolactone, Ibuprofen, Dimenhydrinate, Meclizine, Nortriptyline, and Pregabalin, each accounting for 0.5% of the prescriptions.

**Table 6. Drugs that should generally be avoided in elderly patients**

|                                                          |                | Frequency | Percent (%)               |
|----------------------------------------------------------|----------------|-----------|---------------------------|
| <b>Drugs That Generally Should Be Avoided in Elderly</b> | No             | 36        | 16.8                      |
|                                                          | Yes            | 178       | 83.2                      |
|                                                          | Total          | 214       | 100.0                     |
| <b>Number of drugs should be avoided in Elderly</b>      | Mean           | Minimum   | Maximum                   |
|                                                          | Std. Deviation | Median    | Interquartile Range (IQR) |
|                                                          | 1.25           | 0         | 3                         |
|                                                          |                | 0.829     | 1                         |
|                                                          |                |           | 1 – 2                     |
| <b>Total</b>                                             | PPI            | 145       | 67.8%                     |
| <b>Names of Drugs Should Be</b>                          | Glipizide      | 6         | 2.8%                      |
|                                                          | Glibenclamide  | 32        | 15.0%                     |
|                                                          | Spironolactone | 1         | 0.5%                      |
|                                                          | Metoclopramide | 2         | 0.9%                      |
|                                                          | Ibuprofen      | 1         | 0.5%                      |

|                                                 |                 | Frequency | Percent (%) |
|-------------------------------------------------|-----------------|-----------|-------------|
| <b>Avoided /<br/>Most<br/>common<br/>PIMs *</b> | Diclofenac      | 7         | 3.3%        |
|                                                 | Meloxicam       | 10        | 4.7%        |
|                                                 | Naproxen        | 2         | 0.9%        |
|                                                 | Warfarin        | 2         | 0.9%        |
|                                                 | Aspirin         | 45        | 21.0%       |
|                                                 | Risperidone     | 3         | 1.4%        |
|                                                 | Paroxetine      | 2         | 0.9%        |
|                                                 | Trihexyphenidyl | 2         | 0.9%        |
|                                                 | Dimenhyriate    | 1         | 0.5%        |
|                                                 | Meclozine       | 1         | 0.5%        |
|                                                 | Nortriptyline   | 1         | 0.5%        |
|                                                 | Rivaroxaban     | 3         | 1.4%        |
|                                                 | Digoxin         | 2         | 0.9%        |
|                                                 | Pregabalin      | 1         | 0.5%        |

**Table 7:** shows presents the distribution of drugs that should be used with caution among elderly patients. Out of 214 participants, 115 patients (53.7%) received at least one drug requiring caution, while 99 patients (46.3%) were not exposed to any such medications. The mean number of drugs used with caution per patient was  $0.71 \pm 0.77$ , ranging from 0 to 3. The median number was 1, with an interquartile range (IQR) of 0–1. The most frequently prescribed drugs requiring caution were loop diuretics in 62 patients (29.0%), followed by SGLT2 inhibitors in 34 patients (15.9%), Spironolactone in 26 patients (12.1%), and Hydrochlorothiazide in 23 patients (10.7%). Less frequently prescribed drugs included Escitalopram (0.9%) and Rivaroxaban (0.9%), while Mirtazapine, Carbamazepine, Tramadol, and Pizotifen were rarely reported, each accounting for 0.5% of the prescriptions.

**Table 7. Drugs that should be used with caution among elderly patients**

|                                                         |       | Frequency | Percent (%) |
|---------------------------------------------------------|-------|-----------|-------------|
| <b>Drugs To Be Used<br/>with Caution in<br/>Elderly</b> | No    | 99        | 46.3        |
|                                                         | Yes   | 115       | 53.7        |
|                                                         | Total | 214       | 100.0       |

|                                              |      |             |             |                       |            |                              |
|----------------------------------------------|------|-------------|-------------|-----------------------|------------|------------------------------|
|                                              | Mean | Mini<br>mum | Maxi<br>mum | Std.<br>Devia<br>tion | Medi<br>an | Interquartile<br>Range (IQR) |
| <b>Number of drugs used<br/>with caution</b> | 0.71 | 0           | 3           | 0.774                 | 1          | 0 – 1                        |

|                                           |                     |    |       |
|-------------------------------------------|---------------------|----|-------|
| <b>Total Names of<br/>Drugs Used with</b> | Loop                | 62 | 29.0% |
|                                           | Hydrochlorothiazide | 23 | 10.7% |

|                                                      |                | Frequency | Percent (%) |
|------------------------------------------------------|----------------|-----------|-------------|
| <b>Caution / Most common used with caution drugs</b> | Spironolactone | 26        | 12.1%       |
|                                                      | SGLT2I         | 34        | 15.9%       |
|                                                      | Mirtazapine    | 1         | 0.5%        |
|                                                      | Carbamazepine  | 1         | 0.5%        |
|                                                      | Escitalopram   | 2         | 0.9%        |
|                                                      | Tramadol       | 1         | 0.5%        |
|                                                      | Pizotifen      | 1         | 0.5%        |
|                                                      | Rivaroxaban    | 2         | 0.9%        |

**Table 8:** shows presents the prevalence of drugs requiring dose adjustment in patients with renal impairment among the study participants. Out of 214 patients, only 7 patients (3.3%) were prescribed at least one drug requiring dose adjustment, while the majority, 207 patients (96.7%), were not exposed to any such medications. The mean number of drugs requiring dose adjustment per patient was  $0.04 \pm 0.19$ , ranging from 0 to 1. The median number was 0, with an interquartile range (IQR) of 0–0. Regarding the specific medications, Gabapentin was the most frequently reported drug requiring dose adjustment, prescribed to 4 patients (1.9%). Other less commonly reported drugs included Ciprofloxacin, Baclofen, and Levetiracetam, each prescribed to 1 patient (0.5%).

**Table 8. Dose adjustment in patients with renal impairment**

|                                                            |       | Frequency | Percent (%) |
|------------------------------------------------------------|-------|-----------|-------------|
| <b>Drugs Requiring Dose Adjustment in Renal Impairment</b> | No    | 207       | 96.7        |
|                                                            | Yes   | 7         | 3.3         |
|                                                            | Total | 214       | 100.0       |

|                                                                      |      |         |         |                |        |                           |
|----------------------------------------------------------------------|------|---------|---------|----------------|--------|---------------------------|
| <b>Number of Drugs Requiring dose Adjustment in Renal Impairment</b> | Mean | Minimum | Maximum | Std. Deviation | Median | Interquartile Range (IQR) |
|                                                                      | 0.04 | 0       | 1       | 0.190          | 0      | 0 – 0                     |

|                                                                   |               |     |       |
|-------------------------------------------------------------------|---------------|-----|-------|
| <b>Name of Drug Requiring Dose Adjustment in Renal Impairment</b> | Non           | 207 | 96.7  |
|                                                                   | Gabapentin    | 4   | 1.9   |
|                                                                   | Ciprofloxacin | 1   | 0.5   |
|                                                                   | Baclofen      | 1   | 0.5   |
|                                                                   | Levetiracetam | 1   | 0.5   |
|                                                                   | Total         | 214 | 100.0 |

**Table 9:** shows the association between polypharmacy, excessive polypharmacy, and the presence of potentially inappropriate medications (PIMs), drugs to be used with caution, and drugs requiring dose adjustment in renal impairment among elderly patients. For PIMs, 151 patients (84.8%) with polypharmacy and 27 patients (15.2%) with excessive polypharmacy were exposed to at least one PIM, whereas 34 patients (94.4%) with polypharmacy and 2 patients (5.6%) with excessive polypharmacy were not exposed. This association was not statistically significant ( $\chi^2 = 2.362$ ,  $df = 1$ ,  $p = 0.124$ ). Regarding drugs to be used with caution, 94 patients (81.7%) with polypharmacy and 21 patients (18.3%) with excessive polypharmacy received at least one such drug, while 91 patients (91.9%) with polypharmacy and 8 patients (8.1%) with excessive polypharmacy were not exposed. This association was statistically significant ( $\chi^2 = 4.706$ ,  $df = 1$ ,  $p = 0.030$ ). For drugs requiring dose adjustment in renal impairment, 5 patients (71.4%) with polypharmacy and 2 patients (28.6%) with excessive polypharmacy were exposed, whereas 180 patients (87.0%) with polypharmacy and 27 patients (13.0%) with excessive polypharmacy were not exposed. This association was not statistically significant ( $\chi^2 = 1.394$ ,  $df = 1$ ,  $p = 0.238$ ).

**Table 9. Association between polypharmacy, excessive polypharmacy, and the presence of potentially inappropriate medications (PIMs)**

| <b>Association PIM</b>                                                                               |                        | <b>Presence of PIMs</b> |                | <b><math>\chi^2</math><br/>(df)</b> | <b>P –<br/>value<br/>*</b> |
|------------------------------------------------------------------------------------------------------|------------------------|-------------------------|----------------|-------------------------------------|----------------------------|
|                                                                                                      |                        | No                      | Yes            |                                     |                            |
| <b>Association Between Polypharmacy and drugs should be avoided in Elderly</b>                       | Polypharmacy           | 34<br>(94.4%)           | 151<br>(84.8%) | 2.362<br>* (1)                      | 0.124                      |
|                                                                                                      | Excessive Polypharmacy | 2<br>(5.6%)             | 27<br>(15.2%)  |                                     |                            |
|                                                                                                      | Total                  | 36<br>(100%)            | 178<br>(100%)  |                                     |                            |
|                                                                                                      |                        |                         |                |                                     |                            |
| <b>Association Between Polypharmacy and The Presence of Drugs to Be Used with Caution in Elderly</b> | Polypharmacy           | 91<br>(91.9%)           | 94<br>(81.7%)  | 4.706<br>* (1)                      | 0.030                      |
|                                                                                                      | Excessive Polypharmacy | 8<br>(8.1%)             | 21<br>(18.3%)  |                                     |                            |
|                                                                                                      | Total                  | 99<br>(100%)            | 115<br>(100%)  |                                     |                            |
|                                                                                                      |                        |                         |                |                                     |                            |
| <b>Association Between Polypharmacy and The Presence of Drugs Requiring Dose Adjustment in RI</b>    | Polypharmacy           | 180<br>(87.0%)          | 5<br>(71.4%)   | 1.394<br>* (1)                      | 0.238                      |
|                                                                                                      | Excessive Polypharmacy | 27<br>(13.0%)           | 2<br>(28.6%)   |                                     |                            |
|                                                                                                      | Total                  | 207<br>(100%)           | 7<br>(100%)    |                                     |                            |
|                                                                                                      |                        |                         |                |                                     |                            |

### C. Overall DRP Presence

**Table 10:** shows presents the prevalence of drug-related problems (DRPs) among elderly patients and their association with polypharmacy and excessive polypharmacy. Out of 214 participants, 202 patients (94.4%) experienced at least one DRP, while 12 patients (5.6%) had no identified DRPs. The mean number of DRP categories per patient was  $1.99 \pm 0.91$ , ranging from 0 to 4. The median number was 2, with an interquartile range (IQR) of 1–3. Regarding the association with medication use patterns, 173 patients (85.6%) with polypharmacy and 29 patients (14.4%) with excessive polypharmacy had at least one DRP, whereas 12 patients (100.0%) with polypharmacy and none with excessive polypharmacy had no DRPs. However, this association was not statistically significant ( $\chi^2 = 1.993$ ,  $df = 1$ ,  $p = 0.158$ ).

**Table 10. Prevalence of drug-related problems (DRPs) among elderly patients and their association**

|                                       |       | Frequency | Percent (%) |
|---------------------------------------|-------|-----------|-------------|
| <b>Presence of Any DRP in Elderly</b> | No    | 12        | 5.6         |
|                                       | Yes   | 202       | 94.4        |
|                                       | Total | 214       | 100.0       |

| <b>Number of DRP categories present</b> | Mean | Minimum | Maximum | Std. Deviation | Median | Interquartile Range (IQR) |
|-----------------------------------------|------|---------|---------|----------------|--------|---------------------------|
|                                         | 1.99 | 0       | 4       | 0.909          | 2      | 1 – 3                     |

| <b>Association Between Polypharmacy, Excessive Polypharmacy, and The Presence of DRPs</b> |                        | <b>Presence of DRPs</b> |             | $\chi^2$ (df)         | <b>P – value *</b> |
|-------------------------------------------------------------------------------------------|------------------------|-------------------------|-------------|-----------------------|--------------------|
|                                                                                           |                        | No                      | Yes         |                       |                    |
|                                                                                           | Polypharmacy           | 12 (100.0%)             | 173 (85.6%) | <b>1.993 *</b><br>(1) | <b>0.158</b>       |
|                                                                                           | Excessive Polypharmacy | 0 (0.0%)                | 29 (14.4%)  |                       |                    |
| Total                                                                                     |                        | 12 (100%)               | 202 (100%)  |                       |                    |

**Table 11:** shows the association between the occurrence of drug-related problems (DRPs) and several medication-related factors, including potentially inappropriate medications (PIMs), drugs to be used with caution in the elderly, drugs requiring dose adjustment in renal impairment, and drug–drug interactions (DDIs). For PIMs, all patients without DRPs (12 patients, 100%) had no PIMs, whereas among patients with DRPs, 178 patients (100%) were

exposed to at least one PIM and 24 patients (11.9%) had no PIMs. This association was statistically significant ( $\chi^2 = 62.858$ ,  $df = 1$ ,  $p < 0.001$ ). Regarding drugs to be used with caution in the elderly, all patients without DRPs (12 patients, 100%) were not exposed to such medications, while among those with DRPs, 115 patients (56.9%) received at least one drug requiring caution and 87 patients (43.1%) were not exposed. This association was also statistically significant ( $\chi^2 = 14.767$ ,  $df = 1$ ,  $p < 0.001$ ). For drugs requiring dose adjustment in renal impairment, 195 patients (96.5%) with DRPs and all patients without DRPs (12 patients, 100%) were not exposed to such drugs, while only 7 patients (3.5%) with DRPs required dose adjustment. This association was not statistically significant ( $\chi^2 = 0.430$ ,  $df = 1$ ,  $p = 0.512$ ). Regarding drug–drug interactions (DDIs), 127 patients (62.9%) with DRPs had at least one DDI, while 75 patients (37.1%) had no DDIs. All patients without DRPs (12 patients, 100%) had no DDIs. This association was statistically significant ( $\chi^2 = 18.558$ ,  $df = 1$ ,  $p < 0.001$ ).

**Table 11. Association between the occurrence of drug-related problems (DRPs) and several medication-related factors**

| DRPs                                                      |     | Occurrence of DRPs |                | Total          | $\chi^2$ (df)           | P – value *       |
|-----------------------------------------------------------|-----|--------------------|----------------|----------------|-------------------------|-------------------|
|                                                           |     | No                 | Yes            |                |                         |                   |
| <b>Drugs should be avoided in Elderly</b>                 | No  | 12<br>(100%)       | 24<br>(11.9%)  | 36<br>(16.8%)  | <b>62.858<br/>* (1)</b> | <<br><b>0.001</b> |
|                                                           | Yes | 0<br>(0.0%)        | 178<br>(100%)  | 178<br>(83.2%) |                         |                   |
| <b>Drugs to be used with caution in elderly</b>           | No  | 12<br>(100%)       | 87<br>(43.1%)  | 99<br>(46.3%)  | <b>14.767<br/>* (1)</b> | <<br><b>0.001</b> |
|                                                           | Yes | 0<br>(0.0%)        | 115<br>(56.9%) | 115<br>(53.7%) |                         |                   |
| <b>Drug Requiring dose Adjustment in Renal Impairment</b> | No  | 12<br>(100%)       | 195<br>(96.5%) | 207<br>(96.7%) | 0.430 *<br>(1)          | 0.512             |
|                                                           | Yes | 0<br>(0.0%)        | 7 (3.5%)       | 7 (3.3%)       |                         |                   |
| <b>DDIs</b>                                               | No  | 12<br>(100%)       | 75<br>(37.1%)  | 87<br>(40.7%)  | <b>18.558<br/>* (1)</b> | <<br><b>0.001</b> |
|                                                           | Yes | 0<br>(0.0%)        | 127<br>(62.9%) | 127<br>(59.3%) |                         |                   |

#### 4.1.5 Medical adherence

**Figure2:** shows presents the overall medication adherence among the study participants. Out of 214 elderly patients, 101 patients (47.2%) were classified as adherent (high or good adherence), while 113 patients (52.8%) were non-adherent (partial, low, or poor adherence).

These results indicate that more than half of the participants demonstrated suboptimal adherence to their prescribed medications, which may have implications for therapeutic outcomes and the occurrence of drug-related problems in this population.

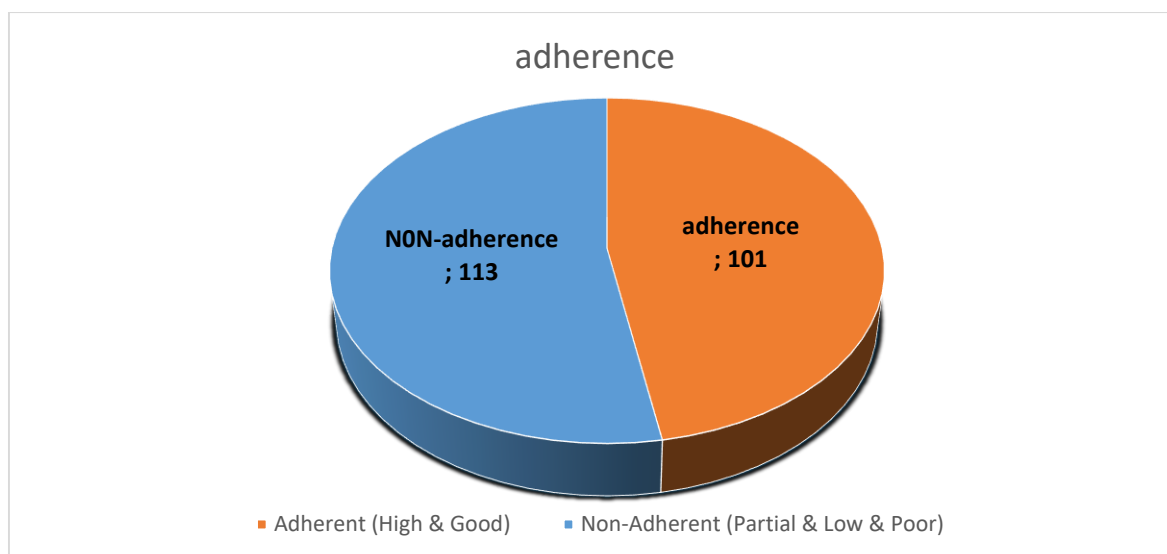


**Figure 2. Overall medication adherence**

**Table 12:** shows presents the descriptive statistics and reliability of the General Medication Adherence Scale (GMAS) across its domains. The overall scale, comprising 11 items, demonstrated good internal consistency with a Cronbach's alpha of 0.793. The behavior domain (5 items) had a Cronbach's alpha of 0.677, the comorbidities or additional medications domain (4 items) had 0.679, and the financial constraints domain (2 items) showed 0.678, indicating acceptable reliability for all subscales. The item-wise responses indicate that adherence issues were most commonly reported for forgetting to take medications due to routine interruptions, side effects, or improvement in health. For example, 51.4% of participants reported sometimes forgetting medications due to routine activities, and 68.7% reported stopping medications when feeling better. Difficulties related to comorbidities were also observed, with 46.3% sometimes stopping medications due to having to take additional drugs. Financial constraints impacted adherence as well; 44.4% reported sometimes avoiding medication purchase due to cost, and 70.1% sometimes discontinued medications they considered not worth the cost. Mean scores for each GMAS domain were as follows: behavior domain 11.99 (range 2–15, IQR 11–14), comorbidity domain 8.92 (range 2–12, IQR 7–11), and financial domain 4.63 (range 0–6, IQR 4–6), indicating variability in adherence behaviors, comorbidity-related challenges, and financial barriers.

**Table 12. Descriptive statistics and reliability of the General Medication Adherence Scale (GMAS) across its domains**

| GMAS                                                                                                                                                                                                                                                                                                     | Always |         | Mostly  |                | Sometimes |                           | Never |      |             |      |         |         |                |        |                           |  |  |      |       |   |    |       |    |         |  |  |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|---------|---------|----------------|-----------|---------------------------|-------|------|-------------|------|---------|---------|----------------|--------|---------------------------|--|--|------|-------|---|----|-------|----|---------|--|--|
|                                                                                                                                                                                                                                                                                                          | N      | %       | N       | %              | N         | %                         | N     | %    |             |      |         |         |                |        |                           |  |  |      |       |   |    |       |    |         |  |  |
| 1) Do you find it difficult to remember to take your medications regularly?                                                                                                                                                                                                                              | 6      | 2.8     | 18      | 8.4            | 80        | 37.4                      | 110   | 51.4 |             |      |         |         |                |        |                           |  |  |      |       |   |    |       |    |         |  |  |
| 2) Do you ever forget to take your medication due to being busy with household or work responsibilities, travel, socializing, parties, weddings, or religious events?                                                                                                                                    | 6      | 2.8     | 28      | 13.1           | 101       | 47.2                      | 79    | 36.9 |             |      |         |         |                |        |                           |  |  |      |       |   |    |       |    |         |  |  |
| 3) Do you stop taking your medications due to side effects (e.g., stomach upset or digestive issues)?                                                                                                                                                                                                    | 7      | 3.3     | 33      | 15.4           | 60        | 28.0                      | 114   | 53.3 |             |      |         |         |                |        |                           |  |  |      |       |   |    |       |    |         |  |  |
| 4) Do you often stop taking your medication without informing your doctor?                                                                                                                                                                                                                               | 3      | 1.4     | 18      | 8.4            | 52        | 24.3                      | 141   | 65.9 |             |      |         |         |                |        |                           |  |  |      |       |   |    |       |    |         |  |  |
| 5) Do you stop taking your medications when you start feeling better?                                                                                                                                                                                                                                    | 1      | 0.5     | 22      | 10.3           | 44        | 20.6                      | 147   | 68.7 |             |      |         |         |                |        |                           |  |  |      |       |   |    |       |    |         |  |  |
| <table border="1"> <tr> <th>Behavior</th><th>Mean</th><th>Minimum</th><th>Maximum</th><th>Std. Deviation</th><th>Median</th><th colspan="3">Interquartile Range (IQR)</th></tr> <tr> <td>GMAS</td><td>11.99</td><td>2</td><td>15</td><td>2.499</td><td>12</td><td colspan="3">11 – 14</td></tr> </table> |        |         |         |                |           |                           |       |      | Behavior    | Mean | Minimum | Maximum | Std. Deviation | Median | Interquartile Range (IQR) |  |  | GMAS | 11.99 | 2 | 15 | 2.499 | 12 | 11 – 14 |  |  |
| Behavior                                                                                                                                                                                                                                                                                                 | Mean   | Minimum | Maximum | Std. Deviation | Median    | Interquartile Range (IQR) |       |      |             |      |         |         |                |        |                           |  |  |      |       |   |    |       |    |         |  |  |
| GMAS                                                                                                                                                                                                                                                                                                     | 11.99  | 2       | 15      | 2.499          | 12        | 11 – 14                   |       |      |             |      |         |         |                |        |                           |  |  |      |       |   |    |       |    |         |  |  |
| 6) Do you stop taking your medication for this illness because you have to take medications for other illnesses?                                                                                                                                                                                         | 4      | 1.9     | 30      | 14.0           | 81        | 37.9                      | 99    | 46.3 |             |      |         |         |                |        |                           |  |  |      |       |   |    |       |    |         |  |  |
| 7) Do you find it difficult to remember your medications due to prescription complexity (e.g., before or after meals, half or full tablet, etc.)?                                                                                                                                                        | 17     | 7.9     | 50      | 23.4           | 93        | 43.5                      | 54    | 25.2 |             |      |         |         |                |        |                           |  |  |      |       |   |    |       |    |         |  |  |
| 8) The past month, have you forgotten to take your medication due to worsening of your illness or being prescribed additional medications?                                                                                                                                                               | 3      | 1.4     | 29      | 13.6           | 83        | 38.8                      | 99    | 46.3 |             |      |         |         |                |        |                           |  |  |      |       |   |    |       |    |         |  |  |
| 9) Do you often alter the dosage or schedule of your prescribed medications on your own?                                                                                                                                                                                                                 | 3      | 1.4     | 21      | 9.8            | 62        | 29.0                      | 128   | 59.8 |             |      |         |         |                |        |                           |  |  |      |       |   |    |       |    |         |  |  |
| <table border="1"> <tr> <th>Comorbidity</th><th>Mean</th><th>Minimum</th><th>Maximum</th><th>Std. Deviation</th><th>Median</th><th colspan="3">Interquartile Range (IQR)</th></tr> <tr> <td>GMAS</td><td></td><td></td><td></td><td></td><td></td><td colspan="3"></td></tr> </table>                    |        |         |         |                |           |                           |       |      | Comorbidity | Mean | Minimum | Maximum | Std. Deviation | Median | Interquartile Range (IQR) |  |  | GMAS |       |   |    |       |    |         |  |  |
| Comorbidity                                                                                                                                                                                                                                                                                              | Mean   | Minimum | Maximum | Std. Deviation | Median    | Interquartile Range (IQR) |       |      |             |      |         |         |                |        |                           |  |  |      |       |   |    |       |    |         |  |  |
| GMAS                                                                                                                                                                                                                                                                                                     |        |         |         |                |           |                           |       |      |             |      |         |         |                |        |                           |  |  |      |       |   |    |       |    |         |  |  |

|                                                                                  |      |         |         |                |        |                           |     |      |
|----------------------------------------------------------------------------------|------|---------|---------|----------------|--------|---------------------------|-----|------|
|                                                                                  | 8.92 | 2       | 12      | 2.250          | 9      | 7 – 11                    |     |      |
| 10) Do you avoid buying medications because they are too expensive?              | 25   | 11.7    | 33      | 15.4           | 61     | 28.5                      | 95  | 44.4 |
| 11) Do you stop taking medications because you feel they are not worth the cost? | 8    | 3.7     | 12      | 5.6            | 44     | 20.6                      | 150 | 70.1 |
| Financial GMAS                                                                   | Mean | Minimum | Maximum | Std. Deviation | Median | Interquartile Range (IQR) |     |      |
|                                                                                  | 4.63 | 0       | 6       | 1.581          | 5      | 4 – 6                     |     |      |

**Table 13:** shows summarizes the overall medication adherence levels as measured by GMAS. Non-adherence was categorized based on three domains: patient behavior, comorbidities/additional medications, and financial constraints.

- Behavior-related non-adherence (GMAS 1): 105 participants (49.1%) exhibited high adherence, 77 (36.0%) good adherence, 28 (13.1%) partial adherence, 3 (1.4%) low adherence, and 1 (0.5%) poor adherence.
- Comorbidity-related non-adherence (GMAS 2): 93 participants (43.5%) had high adherence, 68 (31.8%) good adherence, 42 (19.6%) partial adherence, 10 (4.7%) low adherence, and 1 (0.5%) poor adherence.
- Financial constraint-related non-adherence (GMAS 3): 90 participants (42.1%) had high adherence, 40 (18.7%) good adherence, 62 (29.0%) partial adherence, 14 (6.5%) low adherence, and 8 (3.7%) poor adherence.

considering the overall adherence levels across all domains, 45 participants (21.0%) were classified as highly adherent, 56 (26.2%) as good adherent, 94 (43.9%) as partially adherent, 17 (7.9%) as low adherent, and 2 (0.9%) as poorly adherent. These findings highlight that almost half of the elderly participants experienced some degree of non-adherence, with financial and behavioral factors contributing substantially to suboptimal adherence.

**Table 13. Summarizes the overall medication adherence levels as measured by GMAS**

|                                                                              | High Adherence |      | Good Adherence |      | Partial Adherence |      | Low Adherence |     | Poor Adherence |     |
|------------------------------------------------------------------------------|----------------|------|----------------|------|-------------------|------|---------------|-----|----------------|-----|
|                                                                              | N              | %    | N              | %    | N                 | %    | N             | %   | N              | %   |
| <b>Non-Adherence Due to Patient Behavior (GMAS 1)</b>                        | 105            | 49.1 | 77             | 36.0 | 28                | 13.1 | 3             | 1.4 | 1              | 0.5 |
| <b>Non-Adherence Due to Comorbidities or Additional Medications (GMAS 2)</b> | 93             | 43.5 | 68             | 31.8 | 42                | 19.6 | 10            | 4.7 | 1              | 0.5 |
| <b>Non-Adherence Due to Financial Constraints (GMAS 3)</b>                   | 90             | 42.1 | 40             | 18.7 | 62                | 29.0 | 14            | 6.5 | 8              | 3.7 |
| <b>Overall Medication Adherence Level</b>                                    | 45             | 21.0 | 56             | 26.2 | 94                | 43.9 | 17            | 7.9 | 2              | 0.9 |

#### **4.1.6 Association between medication adherence levels and various clinical and institutional factors**

**Table14:** shows presents the relationships between medication adherence levels and various clinical and institutional factors, including hospitals, the presence of drug–drug interactions (DDIs), the presence and number of drug-related problems (DRPs), and polypharmacy status. Relationship with Hospitals: Medication adherence levels varied significantly across the four hospitals included in the study ( $\chi^2 = 25.473$ ,  $df = 12$ ,  $p = 0.013$ ). The highest proportions of patients with high adherence were observed in Al-Gmuhuri Hospital (51.1%), while the lowest high adherence was seen in Al-Thawra Hospital (11.1%). Relationship with DDIs: Patients without any DDIs had higher rates of high adherence (51.1%) compared to those with at least one DDI (48.9%). Lower adherence levels (partial, low, poor) were more common among patients with at least one DDI. This association was statistically significant ( $\chi^2 = 10.366$ ,  $df = 4$ ,  $p = 0.035$ ). Relationship with DRPs: The presence of DRPs did not show a statistically significant association with medication adherence levels ( $\chi^2 = 1.488$ ,  $df = 4$ ,  $p = 0.829$ ). The majority of patients across all adherence levels had at least one DRP. Relationship with the Number of DRPs: There was a significant association between adherence levels and the number of DRPs ( $\chi^2 = 50.287$ ,  $df = 16$ ,  $p < 0.001$ ). Higher numbers of DRPs were generally associated with lower adherence, with patients reporting low and

poor adherence showing higher proportions of three or more DRPs. Association with Polypharmacy and Excessive Polypharmacy: Polypharmacy status was strongly associated with adherence levels ( $\chi^2 = 45.430$ ,  $df = 4$ ,  $p < 0.001$ ). Patients with polypharmacy were more likely to have high or good adherence, whereas those with excessive polypharmacy showed higher rates of partial, low, or poor adherence. For instance, all patients with poor adherence (100%) were receiving excessive polypharmacy, highlighting the impact of complex medication regimens on adherence.

**Table 14. Relationships between medication adherence levels and various clinical and institutional factors**

|                         | Hospitals        | High Adherence | Good Adherence | Partial Adherence | Low Adherence | Poor Adherence | $\chi^2$ (df)           | P – value *       |
|-------------------------|------------------|----------------|----------------|-------------------|---------------|----------------|-------------------------|-------------------|
| <i>Hospitals</i>        | Al-Gmuhori       | 23 (51.1%)     | 25 (44.6%)     | 40 (42.6%)        | 4 (23.5%)     | 1 (50%)        | <b>25.473 *</b><br>(12) | <b>0.013</b>      |
|                         | Al-Thawra        | 5 (11.1%)      | 8 (14.3%)      | 19 (20.2%)        | 9 (52.9%)     | 1 (50%)        |                         |                   |
|                         | Technology       | 9 (20.0%)      | 21 (37.5%)     | 27 (28.7%)        | 3 (17.6%)     | 0 (0.0%)       |                         |                   |
|                         | German           | 8 (17.8%)      | 2 (3.6%)       | 8 (8.5%)          | 1 (5.9%)      | 0 (0.0%)       |                         |                   |
|                         | Total            | 45 (100%)      | 56 (100%)      | 94 (100%)         | 17 (100%)     | 2 (100%)       |                         |                   |
| <i>Presence of DDI</i>  | No DDI           | 23 (51.1%)     | 28 (50.0%)     | 33 (35.1%)        | 3 (17.6%)     | 0 (0.0%)       | <b>10.366 *</b><br>(4)  | <b>0.035</b>      |
|                         | At least one DDI | 22 (48.9%)     | 28 (50.0%)     | 61 (64.9%)        | 14 (82.4%)    | 2 (100%)       |                         |                   |
|                         | Total            | 45 (100%)      | 56 (100%)      | 94 (100%)         | 17 (100%)     | 2 (100%)       |                         |                   |
| <i>Presence of DRPs</i> | No               | 3 (6.7%)       | 4 (7.1%)       | 5 (5.3%)          | 0 (0.0%)      | 0 (0.0%)       | <b>1.488 *</b><br>(4)   | <b>0.829</b>      |
|                         | Yes              | 42 (93.3%)     | 52 (92.9%)     | 89 (94.7%)        | 17 (100%)     | 2 (100%)       |                         |                   |
|                         | Total            | 45 (100%)      | 56 (100%)      | 94 (100%)         | 17 (100%)     | 2 (100%)       |                         |                   |
| <i>Number of DRPs</i>   | No DRP           | 3 (6.7%)       | 4 (7.1%)       | 5 (5.3%)          | 0 (0.0%)      | 0 (0.0%)       | <b>50.287 *</b><br>(16) | <b>&lt; 0.001</b> |
|                         | One DRP          | 15 (33.3%)     | 14 (25.0%)     | 19 (20.2%)        | 2 (11.8%)     | 0 (0.0%)       |                         |                   |
|                         | Two DRPs         | 17 (37.8%)     | 23 (41.1%)     | 39 (41.5%)        | 4 (23.5%)     | 0 (0.0%)       |                         |                   |

|                                       |                        |               |               |               |               |               |                  |            |
|---------------------------------------|------------------------|---------------|---------------|---------------|---------------|---------------|------------------|------------|
| Polypharmacy, Excessive Polypharmacy, | Three DRPs             | 10<br>(22.2%) | 14<br>(25.0%) | 30<br>(31.9%) | 11<br>(64.7%) | 1 (50.0%)     |                  |            |
|                                       | Four DRPs              | 0 (0.0%)      | 1 (1.8%)      | 1 (1.1%)      | 0 (0.0%)      | 1 (50.0%)     |                  |            |
|                                       | Total                  | 45<br>(100%)  | 56<br>(100%)  | 94<br>(100%)  | 17<br>(100%)  | 2 (100%)      |                  |            |
|                                       | Polypharmacy           | 44<br>(97.8%) | 54<br>(96.4%) | 79<br>(84.0%) | 8<br>(47.1%)  | 0 (0.0%)      |                  |            |
|                                       | Excessive Polypharmacy | 1 (2.2%)      | 2 (3.6%)      | 15<br>(16.0%) | 9<br>(52.9%)  | 2<br>(100.0%) | 45.43<br>0 * (4) | <<br>0.001 |
|                                       | Total                  | 45<br>(100%)  | 56<br>(100%)  | 94<br>(100%)  | 17<br>(100%)  | 2 (100%)      |                  |            |

#### 4.1.7 Association between overall medication adherence and various clinical and institutional factors

**Table 15.** shows presents the relationships between overall medication adherence (adherent vs. non-adherent) and several clinical and institutional factors, including hospitals, the presence of drug–drug interactions (DDIs), the presence and number of drug-related problems (DRPs), and polypharmacy status. Relationship with Hospitals: Adherence rates varied across the four hospitals, with the highest proportion of adherent patients observed at Al-Gmuhori Hospital (46.5%) and the lowest at Al-Thawra Hospital (12.9%). However, this association was not statistically significant ( $\chi^2 = 5.925$ ,  $df = 3$ ,  $p = 0.115$ ).

Relationship with DDIs: Patients without any DDIs had higher adherence (50.5%) compared to patients with at least one DDI (49.5%). Non-adherence was notably higher among those with at least one DDI (68.1% vs. 31.9%). This association was statistically significant ( $\chi^2 = 7.678$ ,  $df = 1$ ,  $p = 0.006$ ), indicating that the presence of DDIs negatively impacts adherence. Relationship with DRPs: The overall presence of DRPs was similar between adherent and non-adherent patients, with no statistically significant difference ( $\chi^2 = 0.040$ ,  $df = 1$ ,  $p = 0.841$ ). Relationship with the Number of DRPs: There was a significant association between adherence and the number of DRPs ( $\chi^2 = 10.257$ ,  $df = 4$ ,  $p = 0.036$ ). Patients with three or more DRPs were more likely to be non-adherent, whereas those with fewer or no DRPs tended to have higher adherence. Association with Polypharmacy and Excessive Polypharmacy: Polypharmacy status showed a strong and significant relationship with

adherence ( $\chi^2 = 18.280$ ,  $df = 1$ ,  $p < 0.001$ ). Among adherent patients, the majority (97.0%) had polypharmacy, whereas non-adherent patients had higher proportions of excessive polypharmacy (23.0%). This highlights the negative impact of complex medication regimens on adherence.

**Table 15. Relationships between overall medication adherence (adherent vs. non-adherent) and several clinical and institutional factors**

|                                | Hospitals              | Adherence  |               | $\chi^2$ (df) | P – value * |
|--------------------------------|------------------------|------------|---------------|---------------|-------------|
|                                |                        | Adherent   | Non-Adherence |               |             |
| <i>Hospitals</i>               | Al-Gmuhori             | 47 (46.5%) | 46 (40.7%)    | 5.925 * (3)   | 0.115       |
|                                | Al-Thawra              | 13 (12.9%) | 29 (25.7%)    |               |             |
|                                | Technology             | 30 (29.7%) | 30 (26.5%)    |               |             |
|                                | German                 | 11 (10.9%) | 8 (7.1%)      |               |             |
|                                | Total                  | 101 (100%) | 113 (100%)    |               |             |
| <i>Presence of DDI</i>         | No DDI                 | 51 (50.5%) | 36 (31.9%)    | 7.678 * (1)   | 0.006       |
|                                | At least one DDI       | 50 (49.5%) | 77 (68.1%)    |               |             |
|                                | Total                  | 101 (100%) | 113 (100%)    |               |             |
| <i>Presence of DRPs</i>        | No                     | 6 (5.9%)   | 6 (5.3%)      | 0.040 * (1)   | 0.841       |
|                                | Yes                    | 95 (94.1%) | 107 (94.7%)   |               |             |
|                                | Total                  | 101 (100%) | 113 (100%)    |               |             |
| <i>Number of DRPs</i>          | No DRP                 | 6 (5.9%)   | 6 (5.3%)      | 10.257 * (4)  | 0.036       |
|                                | One DRP                | 31 (30.7%) | 19 (16.8%)    |               |             |
|                                | Two DRPs               | 40 (39.6%) | 43 (38.1%)    |               |             |
|                                | Three DRPs             | 24 (23.8%) | 42 (37.2%)    |               |             |
|                                | Four DRPs              | 0 (0.0%)   | 3 (2.7%)      |               |             |
|                                | Total                  | 101 (100%) | 113 (100%)    |               |             |
| <i>Polypharmacy, Excessive</i> | Polypharmacy           | 98 (97.0%) | 87 (77.0%)    | 18.280 * (1)  | < 0.001     |
|                                | Excessive Polypharmacy | 3 (3.0%)   | 26 (23.0%)    |               |             |
|                                | Total                  | 101 (100%) | 113 (100%)    |               |             |

## 4.2 Discussion

The findings of this study provide a critical assessment of medication safety and adherence among elderly outpatients in Sana'a, Yemen. The results reveal an alarming prevalence of drug-related problems (DRPs) (94.4%) and polypharmacy (86.4%), highlighting a significant challenge in the clinical management of geriatric patients in this region. The prevalence of polypharmacy (86.4%) in our cohort reflects a high medication burden, though it is slightly lower than the 97.3% reported by Carmona-Torres et al. in an observational study in Spain. However, a noteworthy discrepancy arises in the category of excessive polypharmacy ( $\geq 10$  medications); while Carmona-Torres et al. reported a prevalence of only 2.7%, our study identified a substantially higher rate of 13.6%. This sharp contrast suggests that while global trends show high medication use among the elderly, the intensity of polypharmacy in the local context is more severe. This may be driven by the lack of integrated clinical pharmacy services or formal "de-prescribing" protocols that are more established in European healthcare systems. Regarding medication safety, our results are concordant with, yet more pronounced than, previous local research. Alyahawi reported that 61.2% of medications in his study were classified as "avoid" according to prescribing criteria. In comparison, the present study found that 83.2% of patients were prescribed at least one PIM. This increase suggests an escalating trend in the use of inappropriate therapies, particularly Proton Pump Inhibitors (PPIs) and Glibenclamide. Furthermore, Alyahawi noted that 11% of medications required dose adjustments for renal impairment, while our study found a lower rate of 3.3%. Despite this lower percentage in renal adjustments, the overall risk remains high due to the statistically significant association ( $p < 0.001$ ) between excessive polypharmacy and major drug-drug interactions (DDIs). These findings suggest that the complexity of the regimen is a more significant driver of potential harm than improper dosing alone in this specific population. The evaluation of medication adherence using the General Medication Adherence Scale (GMAS) allows for a direct comparison with regional data. Naqvi et al. reported an overall adherence rate of 50.9% among patients with chronic diseases in Saudi Arabia, with 49.1% classified as non-adherent. Our findings are remarkably similar, with 47.2% adherent and 52.8% non-adherent. However, the item-wise analysis in our study reveals specific sociocultural and economic drivers. Unlike the broader regional trends noted by Naqvi et al., our cohort faced significant financial barriers, with 44.4% avoiding medication purchases due to cost.

Additionally, the prevalence of Qat chewing (67.3%) and the tendency to stop medication upon symptomatic improvement (68.7%) represent specific behavioral hurdles. The strong correlation between excessive polypharmacy and poor adherence ( $p < 0.001$ ) confirms that as the number of prescribed drugs increases, the patient's capacity to remain adherent diminishes, likely due to both cost and "pill fatigue."

#### Clinical Implications and Limitations

While this study is limited by its cross-sectional design and reliance on self-reported adherence—which can be subject to recall bias—the data provides clear directions for clinical practice. The high prevalence of PIMs and DDIs compared to the findings of Alyahawi and Carmona-Torres et al. underscores the need for:

**Systematic De-prescribing:** Targeted efforts to reduce the use of long-term PPIs and high-risk sulfonylureas (e.g., Glibenclamide) in the elderly.

**Pharmacoeconomic Interventions:** Addressing the financial constraints that lead to non-adherence, as identified through the GMAS domains.

**Enhanced Counseling:** Bridging the gap between clinical intent and patient behavior, especially regarding the management of asymptomatic chronic conditions.

# **Chapter 5:**

## **Conclusion & Recommendations**

## 5 Conclusion & Recommendations

### 5.1 Conclusion

In conclusion, this study provides a comprehensive evaluation of medication adherence and DRPs among elderly outpatients in Sana'a, Yemen, revealing a critical public health challenge. The results underscore a substantial burden of polypharmacy, affecting 86.4% of participants, with 13.6% experiencing excessive polypharmacy (mean = 7.30 drugs). Drug-related problems (DRPs) were nearly universal, prevalent in 94.4% of the cohort. A significant concern is the high exposure to Potentially Inappropriate Medications (83.2%) according to the 2023 Beers Criteria, driven largely by the over-prescription of Proton Pump Inhibitors (67.8%) and Aspirin (21.0%). Furthermore, the study confirms that the escalation to excessive polypharmacy is a primary driver of clinically relevant drug-drug interactions and medication non-adherence ( $P < 0.001$ ). Medication adherence was suboptimal in 52.8% of patients, as measured by the GMAS scale, with therapeutic complexity and financial constraints identified as the most significant barriers. These findings highlight an urgent need for the integration of clinical pharmacists into multidisciplinary healthcare teams to implement systematic medication reviews and de-prescribing protocols. Such interventions are vital to bridging the gap between global geriatric care standards and Yemen's strained healthcare landscape, ultimately ensuring safer pharmacotherapy for the elderly population.

### 5.2 Recommendations

1. Conduct regular medication reviews to reduce polypharmacy and identify drug-related problems.
2. Involve clinical pharmacists in patient care to optimize medication therapy.
3. Follow geriatric prescribing guidelines (e.g., Beers Criteria) when prescribing for elderly patients.
4. Review medications after any change in health status or hospitalization.
5. Encourage use of health technology (reminder apps, electronic records) for better tracking.
6. Improving medication adherence should be considered a key priority. Healthcare professionals should educate patients about the importance of adhering to prescribed treatments, simplify medication regimens when possible.
7. Medication cost should be considered during prescribing decisions, particularly for patients with chronic diseases. Selecting effective and affordable therapeutic

alternatives when appropriate may help reduce the financial burden on patients and improve medication adherence.

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# **APPENDIX**

## Assessment of Drug-Related Problems , Medication Adherence and Polypharmacy Among Elderly Outpatients in Sana'a City, Yemen

Patient Demographics

PT ID .....

- Age (years) ( )
- Gender ☐ Male ☐ Female
- Education Level ☐ Illiterate ☐ Primary ☐ Secondary ☐ University
- Harmful habits ☐ Smoking ☐ Qat chewing ☐ Different tobacco ☐ Other
- Body mass index( BMI ) Underweight ( ) Normal ( )  
Overweight ( ) Obese ( )

### Laboratory information:

- Serum Creatinine .....GFR .....

### Clinical Characteristics

Co-Morbidity : ---

Number of Chronic Diseases ( )

Duration of Illness (years) ( )

Hospitalization during last year ☐ Yes ☐ No

### **Medication Profile**

Number of medications

OTC (    )

POM (    )

TOTAL (    )

Polypharmacy  $\geq 5$  (    )

excessive Polypharmacy  $\geq 10$  (    )

### **Medication Data Collection Table**

| <b>DrugName<br/>(Brand/Generic)</b> | <b>Dose</b> | <b>Frequency</b> | <b>Route</b> | <b>Duration</b> | <b>Indication</b> |  |
|-------------------------------------|-------------|------------------|--------------|-----------------|-------------------|--|
|                                     |             |                  |              |                 |                   |  |
|                                     |             |                  |              |                 |                   |  |
|                                     |             |                  |              |                 |                   |  |
|                                     |             |                  |              |                 |                   |  |
|                                     |             |                  |              |                 |                   |  |
|                                     |             |                  |              |                 |                   |  |
|                                     |             |                  |              |                 |                   |  |
|                                     |             |                  |              |                 |                   |  |
|                                     |             |                  |              |                 |                   |  |
|                                     |             |                  |              |                 |                   |  |
|                                     |             |                  |              |                 |                   |  |
|                                     |             |                  |              |                 |                   |  |
|                                     |             |                  |              |                 |                   |  |
|                                     |             |                  |              |                 |                   |  |
|                                     |             |                  |              |                 |                   |  |
|                                     |             |                  |              |                 |                   |  |

| <b><u>TYPE OF (DRP)</u></b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Yes    | No       |          |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|----------|----------|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|
| <p>Drugs that generally should be avoided in older</p> <p>If yes, specify</p> <p>- Number of drug ( )</p> <p>- Drug names :</p> <p>_____</p> <p>_____</p>                                                                                                                                                                                                                                                                                                                                                                                                                           |        |          |          |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| <p>Drugs to be used with caution in older</p> <p>If yes, specify</p> <p>- Number of drug ( )</p> <p>- Drug names :</p> <p>_____</p> <p>_____</p>                                                                                                                                                                                                                                                                                                                                                                                                                                    |        |          |          |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| <p>Drug Requiring dose Adjustment in Renal Impairment</p> <p>If yes, specify</p> <p>- Number of drug ( )</p> <p>- Drug names :</p> <p>_____</p> <p>_____</p>                                                                                                                                                                                                                                                                                                                                                                                                                        |        |          |          |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| <p>Potential Drug–Drug Interactions (Lexicomp)</p> <table border="1" data-bbox="129 1543 1133 1762"> <thead> <tr> <th>Drug 1</th> <th>Drug 2</th> <th>severity</th> </tr> </thead> <tbody> <tr><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td></tr> </tbody> </table> <p>Severity</p> <p><input type="checkbox"/> Minor <input type="checkbox"/> Moderate <input type="checkbox"/> Major</p> | Drug 1 | Drug 2   | severity |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Drug 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Drug 2 | severity |          |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |        |          |          |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| <b>Patient Non-Adherence Due to Patient Behavior (1 GMAS)</b>                                                                                                                |                                                        |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------|
| <b>1.</b> Do you find it difficult to remember to take your medications regularly?                                                                                           | Always = 0<br>Mostly = 1<br>Sometimes = 2<br>Never = 3 |
| <b>2.</b> Do you ever forget to take your medication due to being busy with household or work responsibilities, travel, socializing, parties, weddings, or religious events? | Always = 0<br>Mostly = 1<br>Sometimes = 2<br>Never = 3 |
| <b>3.</b> Do you stop taking your medications due to side effects (e.g., stomach upset or digestive issues)?                                                                 | Always = 0<br>Mostly = 1<br>Sometimes = 2<br>Never = 3 |
| <b>4.</b> Do you often stop taking your medication without informing your doctor?                                                                                            | Always = 0<br>Mostly = 1<br>Sometimes = 2<br>Never = 3 |
| <b>5.</b> Do you stop taking your medications when you start feeling better?                                                                                                 | Always = 0<br>Mostly = 1<br>Sometimes = 2<br>Never = 3 |
| TOTAL ( )                                                                                                                                                                    |                                                        |
| <b>Non-Adherence Due to Comorbidities or Additional Medications (2 GMAS)</b>                                                                                                 |                                                        |
| <b>6.</b> Do you stop taking your medication for this illness because you have to take medications for other illnesses?                                                      | Always = 0<br>Mostly = 1<br>Sometimes = 2<br>Never = 3 |
| <b>7.</b> Do you find it difficult to remember your medications due to prescription complexity (e.g., before or after meals, half or full tablet, etc.)?                     | Always = 0<br>Mostly = 1<br>Sometimes = 2<br>Never = 3 |
| <b>8.</b> the past month, have you forgotten to take your medication due to worsening of your illness or being prescribed additional medications?                            | Always = 0<br>Mostly = 1<br>Sometimes = 2<br>Never = 3 |
| <b>9.</b> Do you often alter the dosage or schedule of your prescribed medications on your own?                                                                              | Always = 0<br>Mostly = 1<br>Sometimes = 2<br>Never = 3 |
| TOTAL ( )                                                                                                                                                                    |                                                        |
| <b>Non-Adherence Due to Financial Constraints (3 GMAS)</b>                                                                                                                   |                                                        |
| <b>10.</b> Do you avoid buying medications because they are too expensive?                                                                                                   | Always = 0<br>Mostly = 1<br>Sometimes = 2<br>Never = 3 |
| <b>11.</b> Do you stop taking medications because you feel they are not worth the cost?                                                                                      | Always = 0<br>Mostly = 1<br>Sometimes = 2<br>Never = 3 |
| TOTAL ( )                                                                                                                                                                    |                                                        |
| <b>Overall Medication Adherence:</b>                                                                                                                                         |                                                        |
| High Adherence = 30 - 33<br>Good adherence = 27 - 29<br>Partial Adherence = 17 - 26<br>Low Adherence = 11 - 16<br>Poor Adherence = 0 - 10                                    |                                                        |

## الملخص العربي

**خلفية عامة:** يؤدي تعدد الأدوية (Polypharmacy) لدى كبار السن إلى زيادة كبيرة في خطر حدوث المشكلات المرتبطة بالأدوية (DRPs)، واستخدام الأدوية غير المناسبة (PIMs)، وضعف الالتزام الدوائي، خاصة في البيئات محدودة الموارد مثل اليمن. وعلى الرغم من الاستخدام العالمي للأدوات المعتمدة مثل معايير بيرز الصادرة عن الجمعية الأمريكية لطب الشيخوخة (AGS Beers Criteria) ومقياس الالتزام الدوائي العام (GMAS)، لا تزال البيانات المحلية محدودة. تهدف هذه الدراسة إلى تقييم معدل انتشار الأدوية غير المناسبة ومستوى الالتزام الدوائي لدى المرضى المسنين من مراجعي العيادات الخارجية في مدينة صنعاء، وذلك لتوفير بيانات تساهم في تحسين العلاج الدوائي لكبار السن وتعزيز سلامة المرضى.

**الهدف:** تقييم الالتزام الدوائي لدى المرضى المسنين من مراجعي العيادات الخارجية باستخدام مقياس الالتزام الدوائي العام (GMAS)، إضافة إلى تقييم معدل انتشار المشكلات المرتبطة بالأدوية لدى المرضى المسنين باستخدام معايير بيرز (AGS Beers Criteria) في سياق تعدد الأدوية (Polypharmacy).

**الاسلوب:** أجريت هذه الدراسة المقطعية خلال الفترة من ديسمبر ٢٠٢٥ إلى فبراير ٢٠٢٦، وشملت ٢١٤ مريضاً مسناً من مراجعي العيادات الخارجية (بعمر  $\leq 55$  سنة) في مدينة صنعاء. جمعت البيانات من خلال مقابلات مباشرة باستخدام استمارة منظمة. تم تحديد المشكلات المرتبطة بالأدوية والأدوية غير المناسبة باستخدام معايير بيرز لعام ٢٠٢٣ وقاعدة بيانات Lexicomp، بينما تم قياس الالتزام الدوائي باستخدام مقياس GMAS. أُجري التحليل الإحصائي باستخدام برنامج SPSS مع تطبيق اختبار مربع كاي (Chi-square) عند مستوى دلالة إحصائية ( $P < 0.05$ ) لدراسة العلاقة بين تعدد الأدوية (Polypharmacy)، والمشكلات المرتبطة بالأدوية، والالتزام الدوائي. وتم الحصول على الموافقة الأخلاقية من جامعة ٢١ سبتمبر للعلوم الطبية التطبيقية والمستشفيات المشاركة.

**النتائج:** بلغ معدل انتشار تعدد الأدوية المفرط (Excessive Polypharmacy) ( $\leq 10$  أدوية) نسبة ١٣,٦% من المرضى، بمتوسط عدد أدوية بلغ  $7.30 \pm 2.00$  دواء لكل مريض. وكانت المشكلات المرتبطة بالأدوية (DRPs) شائعة بدرجة كبيرة، حيث ظهرت لدى ٩٤,٤% من المشاركين. كما تبين أن ٨٣,٢% من المرضى وُصف لهم دواء واحد على الأقل غير مناسب، وكان مثبط مضخة البروتون (PPI) الأكثر شيوعاً بنسبة ٦٧,٨%، يليه الأسبرين بنسبة ٢١,٠%. بالإضافة إلى ذلك، تلقى ٥٣,٧% من المرضى أدوية تتطلب الحذر عند استخدامها، بينما تعرض ٧٤,٨% منهم لتداخل دوائي واحد على الأقل (DDI). ولوحظ التزام دوائي دون المستوى الأمثل لدى ٥٢,٨% من المرضى. كما أظهرت النتائج وجود علاقة ذات دلالة إحصائية بين تعدد الأدوية المفرط وحوادث التفاعلات الدوائية الخطيرة ( $P < 0.001$ )، وكذلك ارتفاع معدلات عدم الالتزام الدوائي ( $P < 0.001$ ). وتم تحديد القيود المالية وتعقيد الأنظمة العلاجية كأهم العوائق المؤثرة في الالتزام الدوائي.

**الختام:** تكشف هذه الدراسة عن عبء مرتفع لتعدد الأدوية واستخدام الأدوية غير المناسبة بين المرضى المسنين اليمنيين من مراجعي العيادات الخارجية، مصحوباً بمعدلات التزام دوائي دون المستوى الأمثل. وتؤكد هذه النتائج الحاجة الملحة إلى إجراء مراجعات دوائية يقودها الصيدلي السريري، وتطبيق استراتيجيات إيقاف وصف الأدوية غير الضرورية (De-prescribing) بهدف تحسين العلاج الدوائي لكبار السن وتحسين النتائج السريرية في اليمن.

**الكلمات المفتاحية:** تعدد الأدوية، معايير بيرز، الالتزام الدوائي، مقياس GMAS، المشكلات المرتبطة بالأدوية، اليمن، طب الشيخوخة.



## تقييم المشكلات المرتبطة بالأدوية، والالتزام الدوائي، وتعدد الأدوية لدى المرضى المسنين في العيادات الخارجية في مدينة صنعاء، اليمن.

مشروع بحثي مُقدّم إلى كلية الصيدلة السريرية استيفاءً لمتطلبات الحصول  
على درجة البكالوريوس

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