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## Review Article

# Medication Adherence in Geriatric Patients: A Comprehensive Review of Determinants, Barriers, and Evidence-Based Interventional Strategies

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## ABSTRACT

This cross-sectional descriptive study evaluated older adults' ability to manage medication preparation and the role of clinical pharmacist interventions in a geriatric acute care ward. Data were collected from 42 hospitalized patients through pharmaceutical interviews combining a questionnaire and direct observation of medication preparation. Nearly half of the patients (47.6%) experienced at least one difficulty, and 45.2% required pharmaceutical interventions. Common issues included problems with inhalers, tablet splitting, and opening medication packaging, often due to reduced strength, poor grip, or inappropriate habits. Interventions included patient education, substitution of dosage forms, assistive tools, and home support, with high acceptance rates by clinicians (100%) and patients (80%). Most identified difficulties had the potential to alter medication administration, increasing the risk of errors. The study highlights that direct observation is essential, as self-reporting underestimates difficulties. Tailored pharmacist-led interventions can improve medication management and may enhance safety and quality of life in older adults. The global population is aging rapidly, leading to a rise in multimorbidity and polypharmacy. Medication adherence in older adults is a critical determinant of successful therapeutic outcomes, yet it remains suboptimal across healthcare settings. Objective: This paper aims to comprehensively review the multifactorial determinants of medication non-adherence in geriatric patients and evaluate the effectiveness of current evidence based strategies to improve it. Methods: A narrative review synthesizing findings from recent systematic reviews, meta-analyses, randomized controlled trials, and observational studies (2015–2026) identified from databases including PubMed, Scopus, EMBASE, and the Cochrane Library. Key Findings: Adherence rates in geriatric populations are highly variable, ranging from approximately 25% in institutionalized patients to over 90% in controlled care settings with intensive support. Non-adherence is influenced by a complex interplay of patient-related factors (cognitive impairment, physical limitations, health beliefs), therapy-related factors (polypharmacy, regimen complexity, adverse effects),

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socioeconomic factors (medication cost, social support, health literacy), and healthcare system factors (provider-patient communication, care coordination). Multi-component interventions, including regimen simplification, caregiver engagement, pharmacist-led medication reviews, and digital health tools, demonstrate the most promise, although their effectiveness is often limited to the short-to-medium term, and evidence quality varies considerably. Conclusion: Improving medication adherence in older adults requires a holistic, patient-centered approach that moves beyond single-disease models. Future strategies should focus on personalizing interventions based on individual risk profiles, integrating technology thoughtfully, and implementing system-level changes such as medication optimization using tools like STOPP/START criteria to reduce pill burden and enhance safety. The pharmacist plays an essential role as a member of the healthcare team in conducting comprehensive medication reviews, providing patient education, and implementing adherence strategies.

## INTRODUCTION

Medication adherence is a critical component in the effective management of chronic diseases, particularly among older adults who often require multiple medications for comorbid conditions. With the global aging population increasing, the prevalence of cognitive impairment—including mild cognitive impairment and various forms of dementia—has also risen significantly. Cognitive impairment poses substantial challenges to medication adherence, as it affects essential cognitive functions such as memory, attention, reasoning, and the ability to follow complex instructions. These impairments can hinder an individual's capacity to manage medication regimens independently, increasing the risk of missed doses, incorrect administration, and adverse health outcomes. Older adults frequently manage multiple prescriptions alongside over-the-counter medications and dietary supplements, making adherence even more complex. Effective medication management requires a range of skills, including understanding dosing instructions, organizing medications, integrating them into daily routines, and ensuring timely refills.

Cognitive deficits can disrupt these processes, thereby compromising treatment outcomes and overall quality of life. Poor adherence has been associated with increased hospitalizations, disease progression, and higher healthcare costs. Although several factors such as medication burden, cost, and healthcare access influence adherence in older adults, cognitive impairment introduces unique barriers that are not fully addressed by conventional interventions. Despite existing research on adherence in the general elderly population, there remains a significant gap in understanding the specific challenges faced by cognitively impaired individuals. Therefore, it is essential to identify these barriers and evaluate targeted interventions to improve medication adherence in this vulnerable population, ultimately enhancing clinical outcomes and patient safety. Medication adherence is widely recognized as a major public health concern, particularly in the management of chronic diseases. According to the World Health Organization, adherence refers to the extent to which a patient's behavior—such as taking medication, following a diet, and implementing lifestyle changes—corresponds with the agreed recommendations of a healthcare provider. This definition highlights the importance of active patient participation and effective communication between patients and healthcare professionals.

Over the years, extensive research has been conducted to understand medication adherence, identify factors contributing to nonadherence, and develop strategies to improve it. Despite these efforts, nonadherence remains a persistent issue, with rates ranging from 30% to 50% in developed countries and even higher in developing regions. This problem is especially significant among older adults, who often suffer from multiple chronic conditions and are prescribed complex medication regimens (polypharmacy). As a result, they face



increased challenges in maintaining consistent adherence.

Medication nonadherence is a multifactorial issue influenced by five key dimensions identified by the WHO: social and economic factors, healthcare system-related factors, condition-related factors, therapy-related factors, and patient-related factors. These include aspects such as cost of treatment, complexity and duration of therapy, adverse drug reactions, patient beliefs, cognitive function, and the quality of patient-provider relationships. Consequently, managing chronic diseases requires continuous behavioral adaptation and psychological adjustment from patients. Nonadherence leads to poor health outcomes, reduced quality of life, and increased healthcare costs due to hospitalizations and complications. Importantly, improving medication adherence has been shown to significantly enhance health outcomes, sometimes even more than the development of new treatments.

#### • **The Global Aging Paradigm**

The world's population is undergoing an unprecedented demographic transformation. The World Health Organization (WHO) estimates that by 2050, there will be over 2 billion people aged 60 years and above—double the number recorded in 2000. This demographic shift is particularly pronounced in developed nations but is increasingly affecting middle-income countries as well. In Japan, for instance, the number of older adults requiring long-term care due to functional impairment is steadily increasing, reflecting broader global trends.

This aging population carries with it a high prevalence of chronic diseases. According to the National Council on Aging, approximately 92% of older adults have at least one chronic disease, and 77% have at least two chronic conditions.

Common conditions include hypertension, diabetes mellitus, cardiovascular disease, osteoarthritis, and neurodegenerative disorders such as Alzheimer's disease and Parkinson's disease. The management of these conditions typically requires long-term pharmacotherapy, resulting in what has become known as polypharmacy—generally defined as the concomitant use of five or more medications.

#### • **Defining Medication Adherence**

Before examining the challenges of medication-taking behavior in older adults, it is essential to establish clear definitions. A systematic review by Yimenu and colleagues examined the terminology used to describe medicines use behavior and found considerable inconsistency. Terms such as "adherence," "compliance," "persistence," and "concordance" have often been used interchangeably despite having distinct meanings.

For the purposes of this paper, medication adherence is defined as "the extent to which a person's medication-taking behavior corresponds with agreed-upon recommendations from a healthcare provider". This definition emphasizes three important elements: first, that adherence is about behavior rather than intention; second, that it involves agreement between patient and provider (moving away from the paternalistic notion of "compliance"); and third, that it is a matter of degree rather than an all-or-nothing phenomenon.

Adherence can be further conceptualized as comprising three components:

- **Initiation:** The patient begins taking the prescribed medication



- **Implementation:** The extent to which a patient's actual dosing corresponds to the prescribed dosing regimen over time
- **Discontinuation:** The point at which the patient stops taking the prescribed medication

Persistence refers to the length of time between initiation and discontinuation. These distinctions are important because different interventions may be needed to address problems at different stages of the adherence process.

- **The Public Health Challenge of Non-Adherence**

Poor medication adherence represents one of the most significant challenges in modern healthcare. The WHO recognizes non-adherence as a global priority, with improved adherence potentially having a greater impact on public health than advances in specific medical treatments. The consequences of non-adherence in older adults are particularly severe and include:

- **Poor disease control:** Inadequate medication intake leads to suboptimal management of chronic conditions such as hypertension, diabetes, and heart failure
- **Increased risk of adverse events:** Both under-treatment and erratic medication-taking can precipitate acute events such as stroke, myocardial infarction, or hypoglycemic episodes
- **Higher hospitalization rates:** A systematic review and meta-analysis by Walsh and colleagues demonstrated strong associations between medication non-adherence and adverse health outcomes in aging populations
- **Increased healthcare costs:** Non-adherence contributes to preventable hospital

admissions, emergency department visits, and disease progression requiring more intensive interventions

- **Increased mortality:** Antihypertensive medication adherence has demonstrated protective effects against mortality even in older adults with poor clinical status

- **Scope and Objectives of This Review**

Given the complexity of medication adherence in geriatric populations and the rapidly evolving evidence base, this paper aims to:

1. Synthesize current literature to identify the key determinants and barriers to medication adherence in older adults
2. Critically evaluate the spectrum of interventions—from technological to educational to systemic—designed to overcome these barriers
3. Provide a comprehensive overview for pharmacy students and practitioners to inform clinical practice and future research

By integrating findings from multiple disease contexts and using a multidomain conceptual framework, this review seeks to guide integrated, patient-focused strategies to improve adherence in older adults.

- **The Multifaceted Determinants of (Non-) Adherence**

Medication adherence in older adults is not determined by any single factor but rather by a complex interplay of variables operating at multiple levels. The WHO's multidimensional model provides a useful framework for understanding these factors, categorizing them into five interacting domains: patient-related



factors, therapy-related factors, socioeconomic factors, healthcare system factors, and condition-related factors . More recently, the Social Ecological Model (SEM) has been applied to medication adherence, recognizing that behavior is shaped by individual, interpersonal, organizational, community, and policy levels .

- **Patient-Related Factors**

### **Cognitive Function and Impairment**

Cognitive decline is one of the most significant barriers to medication adherence in older adults. The aging process is associated with loss of certain cognitive abilities, including processing speed, memory, language, visuospatial skills, and executive functions . These cognitive changes directly impact an individual's capacity to manage complex medication regimens.

In the large-scale Japanese LIFE Study involving 69,200 older adults requiring long-term care, severe cognitive impairment was significantly associated with poor antihypertensive medication adherence (odds ratio [OR]: 0.652, 95% confidence interval [CI]: 0.621–0.684) . This means that individuals with severe cognitive impairment were approximately 35% less likely to be adherent compared to those without such impairment.

Dementia represents an extreme form of cognitive decline that profoundly affects medication management. A systematic review by Arafa and colleagues found that adherence rates among patients with dementia ranged from 25.3% in institutionalized settings to higher rates when caregiver support was available . The progressive nature of dementia means that adherence challenges worsen over time, requiring adaptive strategies and increasing caregiver involvement.

### **Physical Function and Sensory Impairments**

Physical limitations associated with aging can create practical barriers to medication adherence that are often overlooked. According to the WHO, approximately 46% of people over age 60 suffer from some form of disability, with visual impairment, hearing impairment, cognitive limitations, and osteoarthritis being the most common causes .

Visual impairment affects the ability to read prescription labels, distinguish between different medications, and accurately measure liquid formulations. The LIFE Study found that moderate visual impairment was associated with reduced adherence (OR: 0.738, 95% CI: 0.675–0.808) . Age-related eye diseases such as cataracts, age-related macular degeneration, glaucoma, and diabetic retinopathy can progressively deteriorate visual function .

Manual dexterity and physical limitations present additional barriers. Arthritis, which affects a substantial proportion of older adults, can make it difficult to open child-resistant containers, manipulate small tablets, or administer eye drops. Research on rheumatoid arthritis patients revealed that hand function deterioration hindered their ability to open tablet containers and unit dose packs . The LIFE Study demonstrated that bilateral upper limb paralysis was strongly associated with non-adherence (OR: 0.605, 95% CI: 0.565–0.648), as was bilateral lower limb paralysis (OR: 0.837, 95% CI: 0.803–0.873).

Swallowing difficulties (dysphagia) affect many older adults and can make taking oral medications challenging or unpleasant. Severe swallowing impairment was one of the strongest predictors of non-adherence in the LIFE Study (OR: 0.199, 95% CI: 0.169–0.234).



## Psychological Factors and Health Beliefs

Depression is common in older adults and has been consistently linked to medication nonadherence. A study by Al-Noumani and colleagues examining patients with chronic diseases found that depressive symptoms were associated with lower adherence. Depression can reduce motivation, impair cognitive function, and create a sense of hopelessness that undermines engagement with treatment.

Patient beliefs about medications, as conceptualized in the Health Belief Model, strongly influence adherence behavior. Key belief dimensions include:

- Perceived susceptibility: Does the patient believe they are vulnerable to the health condition?
- Perceived severity: Does the patient view the condition as serious?
- Perceived benefits: Does the patient believe the medication will be effective?
- Perceived barriers: What costs, side effects, or inconveniences does the patient anticipate?

A study by Ibrahim and colleagues examining medication experiences and beliefs across two different societies found that negative medication beliefs were associated with low adherence. Common concerns among older adults include fear of side effects, worry about becoming dependent on medications, and skepticism about the necessity of longterm treatment.

Self-efficacy—the confidence in one's ability to successfully manage medications—is another important psychological factor. Higher self-efficacy has been associated with better adherence,

while lack of confidence can lead to unintentional non-adherence.

## Medication Literacy and Knowledge

Medication literacy refers to the ability to obtain, process, and understand basic medication information needed to make appropriate health decisions. Ocakoglu and colleagues found an association between health literacy and medication adherence in elderly populations with chronic disease.

Limited medication literacy can manifest in various ways: inability to read prescription labels, difficulty understanding dosing schedules, confusion about the purpose of different medications, and lack of awareness about potential side effects. A study by Magda and colleagues demonstrated that health literacy interventions could improve medication adherence among older adults with chronic diseases.

### • Therapy-Related Factors

## Polypharmacy and Regimen Complexity

Polypharmacy, commonly defined as the use of five or more medications, is extremely prevalent in older adult populations. In the rural Chinese study by Wang and colleagues, 55.04% of participants with chronic diseases had multiple conditions, inevitably leading to polypharmacy.

The relationship between polypharmacy and adherence is complex. While one might assume that taking more medications would lead to lower adherence, the evidence is mixed. Some studies show that polypharmacy itself is a barrier to adherence, as patients struggle to manage multiple medications with different dosing schedules. However, polypharmacy may also be a marker of greater disease burden and healthcare engagement,



which could be associated with better adherence in some contexts.

Regimen complexity encompasses more than just the number of medications. Factors contributing to complexity include:

- High dosing frequency (multiple times per day)
- Multiple dosage forms (tablets, liquids, inhalers, injections)
- Variable dosing instructions (take with food, empty stomach, specific times)
- Need for dose titration or tapering
- Complex administration procedures (e.g., inhaler technique, insulin injections)

A systematic review by Scotti and colleagues found that technical components of interventions, including regimen simplification, were present in 47.6% of studies and contributed to improved adherence.

### **Potentially Inappropriate Medications and Adverse Effects**

Potentially inappropriate medications (PIMs) are those for which the risks outweigh the benefits in older adults, particularly when safer alternatives exist. PIMs can cause adverse effects that lead patients to discontinue treatment. Common examples include:

- Long-acting benzodiazepines (fall risk, cognitive impairment)
- Anticholinergic medications (constipation, dry mouth, confusion)

- Non-steroidal anti-inflammatory drugs (gastrointestinal bleeding, renal impairment)

The experience of adverse effects is a powerful driver of non-adherence. Patients who attribute unpleasant symptoms to their medications may decide that the treatment is worse than the disease. This is particularly problematic when side effects occur early in treatment before therapeutic benefits are apparent.

The STOPP/START criteria (Screening Tool of Older Persons' Prescriptions/Screening Tool to Alert to Right Treatment) provide evidence-based guidance for identifying PIMs (STOPP) and potential prescribing omissions (START). Use of these criteria in medication reviews can help optimize prescribing and potentially improve adherence by reducing the burden of inappropriate medications.

- **Socioeconomic Factors**

### **Medication Cost and Financial Barriers**

Cost-related non-adherence occurs when patients skip doses, take smaller doses, or fail to fill prescriptions due to financial constraints. This is a significant issue even in countries with universal healthcare coverage, as out-of-pocket costs for medications can still be substantial.

The LIFE Study found that predictors of non-adherence included having no low-income subsidy. Similarly, a study by Arafa and colleagues identified medication cost as a contributor to non-adherence that could be mitigated by subsidies and financial assistance programs.

In the rural Chinese context, Wang and colleagues found that employment status and travel time to healthcare facilities were significantly correlated



with adherence, reflecting the economic and logistical barriers faced by rural populations.

### **Social Support and Caregiver Involvement**

Social support is one of the most important facilitators of medication adherence in older adults. The presence of family members, friends, or paid caregivers who can assist with medication management can make the difference between successful adherence and treatment failure.

The systematic review by Arafa and colleagues demonstrated that caregiver involvement improved adherence rates, particularly in patients with dementia and schizophrenia, where rates ranged from 77.4% to 97.6%. Conversely, social isolation—common among older adults requiring long-term care—is associated with diminished ability to manage one's health and poorer medication adherence.

Caregiver support can take various forms:

- Physical assistance (opening containers, administering doses)
- Reminders and supervision
- Medication organization (filling pillboxes)
- Communication with healthcare providers
- Monitoring for adverse effects and treatment response

The need for medication intake assistance was strongly associated with non-adherence in the LIFE Study. Compared to those who could manage independently, individuals requiring partial assistance (OR: 0.502, 95% CI: 0.478–0.526) and those requiring full assistance (OR: 0.296, 95% CI: 0.279–0.315) were significantly less likely to be adherent. This finding underscores

that while caregivers are essential, the need for assistance itself indicates vulnerability that must be addressed.

### **• Living Situation and Environmental Factors**

Where and how an older adult lives can significantly impact medication adherence. In the Japanese LIFE Study, at the time of long-term care certification application, 78.3% of adherent participants lived at home compared to 64.1% of nonadherent participants. This suggests that community-dwelling older adults may face different challenges than those in institutional settings.

Environmental factors within the home also matter. Adequate lighting, organized storage, and a quiet space for medication preparation can facilitate adherence. Conversely, cluttered counters, poor lighting, and distractions can contribute to errors.

### **Provider-Patient Communication and Relationship**

The quality of communication between healthcare providers and older patients profoundly influences adherence. When providers take time to explain medication purposes, listen to concerns, and involve patients in decisions, adherence improves. Conversely, rushed consultations, use of medical jargon, and dismissive attitudes can undermine trust and engagement.

The concept of concordance—a consultative process in which patient and provider agree on therapeutic decisions—represents an ideal that is rarely achieved in practice. Yimenu and colleagues found only one study specifically examining medicines concordance in older adults, highlighting a gap in both practice and research.



## Care Coordination and Continuity

Older adults with multiple chronic conditions often see multiple specialists, each prescribing medications for their specific area. Without effective coordination, this can result in duplicated therapies, drug interactions, and unnecessarily complex regimens. Poor continuity of care—seeing different providers who lack access to complete medication histories—increases the risk of prescribing errors and conflicting advice.

## Access to Pharmacy Services

Community pharmacists are the most accessible healthcare professionals for many older adults. However, access to pharmacy services varies considerably. In rural areas, travel time to pharmacies can be substantial, creating a barrier to obtaining medications and receiving counseling. Wang and colleagues found that travel time to primary healthcare centers and distance to county hospitals were significantly correlated with medication adherence in rural China.

## Measurement of Medication Adherence

Accurate measurement of medication adherence is essential for research, clinical practice, and quality improvement. However, no single measurement method is perfect, and each has strengths and limitations. Understanding these is crucial for interpreting research findings and assessing adherence in clinical settings.

### Direct Methods

**Directly Observed Therapy (DOT):** Healthcare providers or trained observers watch patients take their medications. While this provides certainty about ingestion, it is impractical for routine use and may not reflect real-world behavior when patients are not being observed.

**Measurement of drug or metabolite levels:** Blood, urine, or other biological samples can be analyzed for the presence of medications or their breakdown products. This provides objective evidence of recent ingestion but has several limitations: it only confirms short-term adherence, results can be affected by individual metabolic differences, and it is invasive and costly.

### Indirect Methods

Indirect methods are more commonly used in both research and clinical practice.

**Self-report measures:** Patients are asked about their medication-taking behavior through interviews, questionnaires, or diaries. Examples include the Morisky Medication Adherence Scale (MMAS) and the Self-Care Inventory-Revised. Self-report is simple and inexpensive but subject to recall bias, social desirability bias, and overestimation of adherence.

**Pill counts:** The number of remaining doses is counted and compared to the expected number based on the dispensing date. This method is objective but can be manipulated by patients who discard pills before appointments ("pill dumping").

**Pharmacy refill records:** Administrative claims data or pharmacy records are used to calculate refill adherence measures. Common metrics include:

- **Medication Possession Ratio (MPR):** The sum of days' supply obtained over a time period, divided by the number of days in the period
- **Proportion of Days Covered (PDC):** The number of days with medication on hand, divided by the number of days in the period.



PDC is generally preferred over MPR because it accounts for overlapping prescriptions and provides a more conservative estimate. In research, a PDC > 0.8 (meaning medication was available for at least 80% of days) is commonly used to define adherence .

Pharmacy refill data are objective, non-intrusive, and can assess long-term patterns. However, they only indicate that medication was dispensed, not that it was taken, and they cannot capture daily dosing patterns.

Electronic monitoring: Devices such as Medication Event Monitoring Systems (MEMS) caps record the date and time each time a bottle is opened. Smart pillboxes and blistered packs with electronic tracking serve similar functions. Electronic monitoring is considered a gold standard in research because it provides detailed temporal data. However, devices are expensive, and opening the container does not guarantee ingestion .

The randomized controlled trial by Sagara and colleagues used a digital smart spacer device to monitor inhaler use in asthma patients, demonstrating the application of electronic monitoring to respiratory medications .

### **Choosing Appropriate Measures**

The choice of adherence measure depends on the purpose of assessment. For clinical practice, a combination of approaches is often useful: brief self-report questions during consultations, supplemented by pharmacy refill data when available. When nonadherence is suspected, exploring specific barriers through open-ended questions is more valuable than obtaining a precise adherence rate.

For research, the optimal approach often involves multiple methods to triangulate adherence estimates. The high heterogeneity in adherence measures across studies—including different cut-off values and calculation methods—has been identified as a major challenge for comparing findings and synthesizing evidence .

- **Evidence-Based Strategies to Improve Adherence**

A wide range of interventions has been developed to improve medication adherence in older adults. This section reviews the evidence for different approaches, drawing on recent systematic reviews and randomized controlled trials.

- **Educational and Behavioral Interventions**

### **Patient Education and Counseling**

Education is the most common component of adherence interventions. The systematic review by Scotti and colleagues found that an educational component was present in 56.3% of included studies . Education can be delivered by various healthcare professionals, including pharmacists, nurses, and physicians, and can take individual or group formats.

- Address the patient's specific knowledge gaps
- Use clear, jargon-free language
- Employ teach-back methods to confirm understanding
- Be tailored to the patient's health literacy level
- Address beliefs and concerns about medications

The randomized controlled trial by NCT05291000 combined patient education with a medication



reminder wristwatch for elderly hypertensive patients. The 12-week program significantly improved adherence, blood pressure control, and self-efficacy compared to training alone or standard care .

### **Peer-Led Education**

Peer-led education leverages the experience and credibility of individuals who share similar health conditions. The IRCT20180519039710N1 trial compared peer-led versus nurse-led education for medication adherence in elderly patients with hypertension. Peer-led sessions were more effective and cost-efficient, with benefits sustained for up to six weeks post-intervention . This approach may be particularly valuable because peers can relate to patients' lived experiences and provide practical tips based on their own successes and challenges.

### **Attitudinal Interventions and Motivational Interviewing**

Attitudinal interventions aim to change patients' beliefs, motivation, and engagement with treatment. Scotti and colleagues found that attitudinal components were present in 32.0% of interventions.

Motivational interviewing (MI) is a client-centered counseling style that addresses ambivalence about behavior change. Rather than telling patients what to do, MI helps them explore and resolve their own reasons for change. A study by Mohan and colleagues examined a pharmacist-led telephonic MI intervention to improve adherence to cardioprotective medications (ACEIs/ARBs) among nonadherent older adults with comorbid hypertension and diabetes.

Using administrative claims data, the researchers identified patients with problematic adherence

trajectories ("rapid decline," "gaps in adherence," and "gradual decline"). The brief MI intervention significantly improved medication adherence at one-year postintervention. Notably, patients in the "rapid decline" trajectory were less responsive, suggesting that greater engagement may be needed for this subgroup.

The study also identified predictors of lower adherence trajectories, including male sex, lack of low-income subsidy, depression, and prior hospitalizations, highlighting the importance of targeting interventions to high-risk individuals.

### **• Technological and Digital Interventions**

#### **Medication Reminder Systems**

Simple reminder systems, including text messages, automated phone calls, and alarm devices, can help patients remember to take their medications. The wristwatch reminder device used in the NCT05291000 trial exemplifies this approach .

Evidence for reminder systems is mixed. While they can improve adherence in the short term, effectiveness may wane over time as patients become accustomed to the reminders or find them annoying. Integration with other supports, such as education and caregiver involvement, appears to enhance effectiveness.

#### **Smart Pillboxes and Electronic Monitors**

Smart pillboxes provide both reminders and tracking of medication removal. Some devices can notify caregivers or healthcare providers when doses are missed. The IRCT20191231045966N1 trial examined a mobile drug management application for elderly patients with polypharmacy. The intervention reduced medication errors, hospital readmissions, and



adverse events such as falls and blood pressure fluctuations.

### Mobile Health (mHealth) Applications

Smartphone applications for medication management have proliferated, though evidence for their effectiveness in older adults is still developing. The KCT0006790 trial tested a mobile health intervention for self-management in people with Parkinson's disease, including apps, smartwatches, text messages, and phone counseling. The intervention improved self-efficacy and non-motor symptoms but did not significantly affect motor symptoms, self-management behaviors, or quality of life .

The NCT02157519 trial evaluated a smartphone app to improve adherence to oral cancer therapy. While the app did not significantly improve adherence in the general cancer population, it was beneficial for patients with baseline adherence issues or anxiety . This finding highlights the importance of targeting digital interventions to those most likely to benefit.

### Virtual Assistants and Voice-Activated Devices

Voice-activated virtual assistants offer a promising interface for older adults, particularly those with visual impairment or limited dexterity. The IVAM-ED randomized controlled trial by Matzenbacher and colleagues evaluated a smart speaker (Amazon Echo Dot) programmed to deliver behavioral intervention to older adults with type 2 diabetes.

Over 12 weeks, the intervention group showed:

- Reduced mental distress (SRQ-20 score: 6.39 vs. 7.66; adjusted mean difference - 1.28, P=0.04)

- Improved quality of life (adjusted MD 9.46, P=0.001)
- Greater treatment adherence (P<0.001)
- Lower HbA1c levels (7.56% vs. 8.04%; P=0.01)

The device provided medication and glucose test reminders, health tips, and educational podcasts. As editorialist Mathioudakis noted, "A voice-activated, hands-free, home embedded interface may be particularly well suited for older adults with visual impairment, limited dexterity, or other functional limitations that can make web-based or smartphone apps less effective" .

Practical considerations for virtual assistant interventions include the need for WiFi access, device cost (ranging from approximately \$30 to over \$200), and current low ownership rates among older adults (only 15-25% of those over age 55 own a smart speaker) .

### Web-Based Programs

Computer-tailored web programs can provide personalized education and support. The NL6664 trial evaluated a web-based program for patients with type 2 diabetes and found improvements in overall treatment adherence and reduced unhealthy snacking, though no significant effect on physical activity or adherence to specific diabetes medications .

### Pharmacist-Led Interventions

Pharmacists are uniquely positioned to improve medication adherence through their expertise in pharmacotherapy and their accessibility to patients. A substantial body of evidence supports pharmacist-led interventions.



## • Medication Therapy Management and Comprehensive Medication Reviews

Medication Therapy Management (MTM) involves comprehensive reviews of patients' medications to identify and resolve drug therapy problems. These reviews can:

- Identify and address adverse effects that may be causing non-adherence
- Simplify complex regimens
- Eliminate unnecessary medications
- Resolve drug interactions
- Provide patient education and counseling

The systematic review by Arafa and colleagues found that pharmacist-led programs achieved adherence rates as high as 97.6% in some populations .

## • Deprescribing Interventions

Deprescribing—the systematic process of identifying and discontinuing medications where harms outweigh benefits—has emerged as a key strategy for reducing polypharmacy and improving adherence. A systematic review and meta-analysis by Tesfaye and colleagues examined pharmacist-led deprescribing interventions in older adults .

Seven studies encompassing 3,607 older adults met inclusion criteria. Overall, the pooled mean difference in total medications favored intervention but did not reach statistical significance (-0.55 medications, 95% CI: -2.17 to 1.07). However, in subgroup analyses, intensive interventions—characterized by comprehensive in-person reviews, explicit deprescribing criteria, patient education, and direct physician outreach—

yielded a significant reduction in medication count (MD -1.74, 95% CI: -2.86 to -0.62) and increased successful deprescribing (RR 3.55, 95% CI:2.45-5.15).

The use of tools such as the STOPP/START criteria and the Drug Burden Index can guide deprescribing decisions and help prioritize medications for discontinuation.

## • Compliance Packaging

Pre packaged medications in blister packs or unit-dose packaging organized by day and time can simplify medication administration for both patients and caregivers. This intervention addresses practical barriers related to organizing multiple medications and remembering whether doses have been taken.

## • Regimen Simplification

Simplifying medication regimens is a straightforward strategy that can significantly improve adherence. Approaches include:

- Once-daily formulations: Whenever possible, prescribing medications with long half-lives or extended-release formulations that allow once-daily dosing reduces the number of daily doses patients must remember.
- Fixed-dose combination pills ("polypills"): Combining multiple medications into a single tablet reduces pill burden and simplifies administration. This approach has been particularly well-studied in cardiovascular disease prevention.
- Dosing schedule alignment: Coordinating doses so that multiple medications can be taken at the same times simplifies the routine and reduces confusion.



The meta-analysis by Arafa and colleagues identified single-pill regimens as an effective strategy, increasing adherence by 25-59% and reducing cardiovascular events.

- **Multi-Component Interventions**

The consensus from recent literature is that single-component interventions are less effective than multi-faceted approaches. Combining, for example, patient education, regimen simplification, caregiver support, and technological tools addresses multiple barriers simultaneously and shows the greatest potential, especially for patients with complex needs .

The AMMA study demonstrated that a program combining patient training and a medication reminder watch significantly improved adherence in hypertensive patients . Similarly, effective interventions identified in the Arafa review combined caregiver support, digital platforms, and regimen simplification .

- **System-Level Reforms and Policy Interventions**

Individual-level interventions, no matter how effective, cannot overcome systemic barriers such as medication costs, fragmented care, and limited access to pharmacy services. System-level reforms are essential to create an environment that supports adherence.

Financial assistance programs: Subsidies, insurance coverage, and patient assistance programs can reduce cost-related non-adherence. The Arafa review identified financial support as a factor that could mitigate socioeconomic barriers .

Integrated care models: Collaborative practice arrangements that facilitate communication between pharmacists, physicians, and other

providers can improve care coordination and reduce prescribing conflicts.

Culturally tailored approaches: Interventions that respect and incorporate patients' cultural beliefs and values are more likely to be accepted and effective .

## **CHALLENGES AND FUTURE DIRECTIONS**

Despite decades of research on medication adherence, significant challenges remain in translating evidence into practice and achieving sustained improvements.

- **Heterogeneity of Evidence**

A consistent finding across systematic reviews is the substantial heterogeneity in study designs, populations, interventions, adherence measures, and follow-up durations . This heterogeneity makes it difficult to compare interventions directly, draw firm conclusions, or conduct meaningful meta-analyses.

The Arafa review reported an  $I^2$  statistic of 99% in their meta-analysis, indicating extreme heterogeneity . The GRADE certainty of evidence was rated "Very Low," reflecting concerns about risk of bias, inconsistency, and imprecision. Of the 10 pooled trials assessed using the Cochrane RoB 2 tool, only 2 were at low risk of bias, 4 had some concerns, and 4 were at high risk .

This situation calls for:

- Greater standardization of adherence measures and definitions
- More rigorous study designs with adequate sample sizes and longer follow-up · Improved reporting to facilitate comparison and synthesis



- **Short-Term Effectiveness**

Many interventions show positive effects on adherence only in the short term ( $\leq 6$  months), with benefits diminishing over time. This pattern suggests that initial improvements may reflect novelty effects or intensive support that is not sustained. Long-term adherence requires ongoing support and adaptation as patients' circumstances and needs change.

Future research should include longer follow-up periods to assess durability of effects and identify factors that predict sustained improvement.

- **The Need for Personalization**

One-size-fits-all approaches to improving adherence are unlikely to be optimal given the diversity of older adults and the multiple factors that influence adherence. The finding that a smartphone app was effective only for cancer patients with baseline adherence issues or anxiety illustrates the importance of targeting interventions to those most likely to benefit.

Machine learning models show promise for predicting non-adherence and identifying subgroups that may respond to different interventions. Arafa and colleagues reported that such models achieved high accuracy in predicting non-adherence (AUC up to 0.935).

Future research should focus on developing and validating prediction tools that can guide personalized intervention selection.

- **Integration of Artificial Intelligence and Predictive Analytics**

Artificial intelligence (AI) and machine learning offer new opportunities for understanding and improving adherence. Beyond predicting which patients are at risk, AI could:

- Analyze patterns in electronic health records and claims data to identify modifiable risk factors
- Personalize intervention content and delivery based on individual characteristics
- Optimize the timing and frequency of reminders
- Detect early signs of adherence decline and trigger proactive outreach

However, the implementation of AI in clinical practice raises important questions about data privacy, algorithmic bias, and the need for human oversight.

- **Assessment Tools and Comprehensive Measurement**

Current tools for assessing medication management capacity focus primarily on cognitive and physical skills, with significant emphasis on adherence. However, medication self-management is broader than adherence, encompassing managing supply, monitoring health status, communicating with healthcare providers, and adapting to changing circumstances.

A scoping review by Baby and colleagues identified 44 validated tools to measure various challenges that older adults encounter with medication management. These tools assess combinations of physical, cognitive, sensory, motivational, and environmental barriers.

Promising tools include:

- Self-Medication Assessment Tool (SMAT)
- ManageMed Screening (MMS)



- Self-Medication Risk Assessment Tool (RAT)
  - HOME-Rx revised
  - Medication Management Ability Assessment (MMAA)
- Key implementation considerations include:
- Reach: Does the intervention reach the intended population, including those most in need?
  - Adoption: Do healthcare providers and organizations adopt the intervention?
  - Fidelity: Is the intervention delivered as intended?
  - Sustainability: Can the intervention be maintained over time with available resources?

However, no single tool measures all five barrier domains. Further research is needed to develop a comprehensive tool that simultaneously assesses the full range of factors affecting medication self-management. Such a tool could guide targeted interventions and monitor change over time.

#### • **The Hospital-to-Home Transition**

The transition from hospital to home is a particularly vulnerable period for older adults. New medications are often initiated, regimens may be changed, and patients are expected to resume self-management after a period of acute illness. Adverse drug events are common during this period, with 37% of adults 65 years and older in the UK experiencing medication-related harm in the early weeks post-discharge.

Despite this vulnerability, there is limited evidence on optimal strategies for supporting medication self-management during care transitions. Future research should focus on developing and testing interventions that bridge the hospital-to-home gap, involving patients, caregivers, and healthcare providers across settings.

#### • **System-Level Implementation**

Perhaps the greatest challenge is moving from efficacy in research studies to effectiveness in real-world practice. Even proven interventions may fail when implemented without attention to local context, resources, and workflows. Implementation science provides frameworks for understanding and addressing these challenges.

## CONCLUSION

Medication adherence in older adults is a complex, multifactorial challenge with profound implications for individual and population health. This review has synthesized current evidence on the determinants of non-adherence and the effectiveness of strategies to address it, with several key conclusions.

First, non-adherence is pervasive. Adherence rates among older adults vary widely, from approximately 25% in institutionalized patients to over 90% in settings with intensive support. Even in community-dwelling populations, a substantial minority—often 25-40%—are non-adherent to prescribed medications.

Second, non-adherence is multifactorial. No single factor explains why older adults do or do not take medications as prescribed. Rather, adherence is shaped by an interacting web of patient-related factors (cognitive function, physical abilities, beliefs), therapy-related factors (polypharmacy, regimen complexity, adverse effects), socioeconomic factors (cost, social support, health literacy), and healthcare system factors (communication, care coordination, access).



Effective interventions must address this complexity.

Third, multi-component interventions are most promising. Single-component interventions—education alone, reminders alone, or regimen simplification alone—are unlikely to be sufficient for most patients. The strongest evidence supports multi-faceted approaches that combine, for example, patient education, caregiver engagement, regimen simplification, and technological supports.

Fourth, personalization is essential. Given the diversity of older adults and the multiple pathways to non-adherence, interventions should be tailored to individual risk profiles, barriers, and preferences. Predictive analytics may help identify those most likely to benefit from specific interventions .

Fifth, the pharmacist's role is central. Pharmacists possess unique expertise in pharmacotherapy and are often the most accessible healthcare professionals. Evidence supports pharmacist-led interventions including comprehensive medication reviews, deprescribing, patient education, and motivational interviewing . Collaborative practice models that integrate pharmacists into care teams can amplify their impact.

Sixth, system-level changes are needed. Individual-level interventions cannot overcome systemic barriers such as medication costs, fragmented care, and limited access. Policy interventions, including financial assistance programs, integrated care models, and support for caregiver involvement, are essential complements to clinical strategies.

Finally, evidence gaps remain. The high heterogeneity and generally low quality of available evidence limit confidence in findings and

point to the need for more rigorous research. Standardization of definitions and measures, longer follow-up periods, and attention to implementation are priorities for future studies.

For the B Pharmacy student and future practitioner, this review offers both a foundation for understanding medication adherence and a call to action. In daily practice, opportunities abound to assess adherence, identify barriers, and implement evidence-based strategies. Simple actions—asking non-judgmental questions about medication-taking, listening to patients' concerns, checking for practical barriers, involving caregivers when appropriate— can make meaningful differences. More intensive interventions, including comprehensive medication reviews and deprescribing, require additional training and collaboration but offer substantial benefits for selected patients.

Ultimately, improving medication adherence in older adults is not about finding a single magic bullet but about consistently applying a patient-centered, multi-dimensional approach. The goal is not perfect adherence—an unrealistic standard—but rather optimal use of medications to achieve the outcomes that matter most to each individual patient. In this endeavor, the pharmacist's expertise, accessibility, and commitment to patient care are invaluable assets..

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